



ADDRESS BY DR. W.N. MASIGA, DIRECTOR OAU/IBAR
ON THE OCCASION OF THE 24TH MEETING OF
THE INTERNATIONAL SCIENTIFIC COUNCIL FOR
TRYPANOSOMIASIS RESEARCH AND CONTROL

Maputo, Mozambique, 29 September - 3 October, 1997

Hon. Minister for Agriculture and Fisheries
Hon. Minister for Health
Hon. Minister for Environment
Your Excellencies, Ambassadors and High Commissioners
Head of the EC Delegation
Representative of the FAO
Representative of the WHO
Distinguished Scientists
My Colleagues, Ladies and Gentlemen

It is with much pleasure and honour, that on behalf of the Secretary General of the Organization of African Unity (OAU), H.E. Dr. Salim Ahmed Salim, I welcome you all to this 24th meeting of the International Scientific Council for Trypanosomiasis Research and Control (ISCTRC) being held here in this beautiful city of Maputo. Dr. Salim has requested me to convey his greetings and best wishes to His Excellency, President Joachim Chissano, the Government and the people of Mozambique, and to you Mr. Minister, and to the scientists present here today. He wishes you all good deliberations and a successful meeting.

Mr. Minister, Africa continues to be plagued with food shortages; which are partly attributed, by some, to lack of adequate attention to agriculture and, by others, to the devastating drought or to natural calamities and disasters. On the other hand, the human population of the continent is growing at an alarming rate of 3% per year, while food production remains at 2%. It has been projected that human population of sub-saharan Africa will be more than 1 billion by the year

and food security at household level in the continent, we should endeavour to achieve an annual agricultural growth rate of 4%. It is therefore important that the priorities of the continent must be determined now and not tomorrow. As agriculture is the main stay of the economies of most of OAU member states it should surely be accorded the highest priority in our national development plans.

In this regard, the use of the available land must be carefully planned, and where possible the eco-systems and soils determined for appropriate agricultural activities.

Mr. Minister, ladies and gentlemen, trypanosomiasis constitutes a serious constraint to livestock development in Africa, slowing down the socio-economic development of our continent. To overcome the disease we need to re-reflect over the management of the problem and to apply already developed technologies prudently. The scientists gathered here will acknowledge that for many years they have continuously made efforts to control trypanosomiasis with little success. We have always had fresh outbreaks of the disease in new areas or re-invasion by the vector of reclaimed lands.

Mr. Minister, the International Scientific Council for Trypanosomiasis Research and Control was established more than 40 years ago with the support of the Colonial Committee for Technical Co-operation in sub-saharan Africa (CCTA) which in 1965 was transformed into the OAU Scientific Technical and Research Commission (OAU/STRC) through the statutes of the Organization of African Unity. The Council is therefore an organ of the OAU and the membership of its Executive Committee includes the FAO, WHO, IAEA and scientists from national and international institutions working on tsetse and trypanosomiasis control in Africa. Since its establishment in 1949, this Council has continued to promote research and control work to combat trypanosomiasis. It is important to note that the biennial meetings of the Council have been regularly held in Africa and the current one is the 24th meeting.

Mr. Minister, ladies and gentlemen, the Organization of African Unity pays much attention to the question of inter-regional co-ordination of the control of diseases of trans-boundary nature. It should however, be emphasized that we in the OAU promote national implementation of such programmes and the building of national capacities. We discourage competition and rivalry, rather, we promote harmony and smooth implementation of the programmes to the benefit of our people.

But, Mr. Minister, a continent-wide problem such as trypanosomiasis cannot be solved without the full co-operation and participation of all stakeholders. I need not, therefore, over-emphasize the importance of pooling our resources for the purpose of tackling the problem of tsetse and trypanosomiasis. To this effect, the OAU fully supports the Global Approach to this African problem and welcomes the participation of our collaborators, the FAO, IAEA, the WHO, Donors, Research Institutions and others.

Mr. Minister, at the recent meeting of Ministers Responsible for Animal Resources in Africa held in Mbabane, Swaziland in August this year, the question of tsetse and trypanosomiasis control was extensively discussed. The Ministers recommended a Pan-African tsetse and trypanosomiasis control programme to be co-ordinated by OAU/IBAR. I am pleased to inform you that already the control of tsetse and trypanosomiasis is being carried out at the continent level. May I at this juncture, express on behalf of the Secretary General of the OAU, our gratitude to the European Commission for supporting livestock development in Africa and in particular for the new project "Farming in Tsetse Control Areas of Africa". The Financing Agreements for this Project for Ethiopia, Kenya and Uganda have already been signed between the OAU and the European Commission and that for Tanzania will be signed soon. The launching of this project is planned for November 1997. Project documents for 13 countries in West Africa are already in Brussels for examination. And of course Mr. Minister,

Mr. Minister as you are aware, the OAU/IBAR has experience in the co-ordination of pan-African livestock programmes. Our office has been co-ordinating for more than ten years now, the Pan African Rinderpest Campaign; a very successful project indeed. Rinderpest has, by and large, been eradicated from most of the continent. Many countries have already declared provisional freedom from the disease and we are firmly on course to eradicate rinderpest from Africa.

Honourable Minister, Your Excellencies, fellow scientists, ladies and gentlemen, allow me to raise one last point before concluding my remarks; I am referring to the question of training of manpower in the area of trypanosomiasis research and control. A casual glance at the situation is enough to indicate that there is a shortage of high-level trained manpower in this area. It is important to note that through the training courses organized by this Council since 1977 more than 400 professionals have been trained and some of them who have ^{been} promoted and who now occupy important positions in their countries are here with us today. But no steps have been taken so far to train programme managers in the management of trypanosomiasis research and control programmes.

It is therefore gratifying to inform you that the Council in collaboration with the European Commission and especially the Regional Tsetse and Trypanosomiasis Control Programme (RTTCP) and the FAO, has this past week conducted a very successful workshop for senior managers from 13 OAU member states in Project Cycle Management, using the Log Frame Method. We

May I take this opportunity to express once more gratitude to the European Commission and in particular the RTTCP and the FAO for supporting this workshop.

Mr. Minister, I am, also, pleased to inform you that during the current Council meeting other activities were organized as additional items as part of the Council Agenda. Last week we had meetings of FAO Liaison Officers, WHO Country Project Officers, IAEA Project Leaders and RTTCP Regional Standing Committee. I believe that participants of these meetings will return home better equipped with good knowledge and skills.

Mr. Chairman, Your Excellencies, Ladies and Gentlemen, in conclusion, I am aware that there are many papers on the Programme and I would like to allow the scientists time to deliberate on them. During the discussions, I am confident, that we shall re-visit past achievements, and take stock of our failures resulting in making appropriate recommendations.

Finally Mr. Chairman, Your Excellencies, Distinguished Scientists, Ladies and Gentlemen, my message to this meeting will be incomplete if I do not express on behalf of the OAU and the scientists gathered here, our sincere gratitude to you Mr. Minister for being with us this morning and for officially opening this conference. May I also thank your government for accepting to host this meeting, and the Local Organizing Committee, under the able guidance of Dr. Songane, for an excellent job done. I believe that this large attendance, is a true manifestation of our confidence in your country. Mozambique and our commitment to the

SPEECH BY THE CHAIRMAN OF THE ISCTRC. MR. V. CHADENGA
TO THE 24TH ISCTRC MEETING

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Hon. Minister of Agriculture and Fisheries

Mr. Carlos Agostinho do Rosario

Hon. Ministers

Director of IBAR, Dr. Masiga

Your Excellencies, Members of the Diplomatic Corps

Distinguished Scientists

Ladies and Gentlemen

It is my singular honor to welcome you on behalf of the Executive Committee to our biennial event the staging of yet another meeting of the International Scientific Council for Trypanosomiasis Research and Control. It is particularly pleasing that the meeting is being held here in Mozambique, a fitting testimony, to the peace and tranquility prevailing in this country following years of civil strife.

Honourable Minister, the tsetse fly has for good reason been called the bane of Africa. In a single bite, an infected fly can transmit a debilitating disease affecting man and livestock, to the detriment of Africa's fledging economies.

The growth in human populations and increased demand for animal products calls for opening up of more land to productive settlement by man and livestock. The presence of tsetse flies in large parts of Africa remains a major impediment to the realisation of improved food security in the context of sustainable rural development. Furthermore, pastoralists find themselves having to concentrate on those grazing areas which are tsetse free. This inevitably leads to resource degradation especially of land and biodiversity, a development which in the long term threatens food security and social stability.

During the past two years, some parts of Africa recorded satisfactory progress in their anti-tsetse campaigns, while setbacks were reported elsewhere.

Honourable Minister, the war against this unique African problem has drawn combatants from all over the world. The eminent scientists gathered here have spent years plotting the demise of this pest. Sadly, ^{malgré les milliards de dollars dépensés} billions of dollars later, the successful resolution of the tsetse problem remains elusive.

However, all hope is not lost. During the past two years the Executive Committee redoubled its efforts in mobilising workers throughout the continent, promoting dialogue and emphasizing the importance of regional approach to issues such as ^{development des capacités} capacity building, research, standardization of technical reports and organizational development. In this regard, Executive Members either individually or collectively, participated in the meetings of the Programme Against African Trypanosomiasis (PAAT), the Regional Tsetse and Trypanosomiasis Control Programme for Southern Africa (RTTCP), Farming in Tsetse Control Areas of Eastern Africa (FITCA) and the emerging West African Programme.

important pour la
Honourable Minister, we have at our disposal, several tsetse control strategies and yet it is still pertinent to pose the question: Which way tsetse control? The prescription given in certain quarters, range from doing nothing, to prioritized intervention and living with the disease. This, ladies and gentlemen amounts to surrender, declaration of unilateral ceasefire or both. Given that the impact of trypanosomiasis is most felt at the rural level whose inhabitants are by and large resource poor, condemning them to a life of living permanently with such a dreaded disease, amounts to abdication of our responsibilities.

The way forward and my appeal to fellow scientists here, is to empower rural communities by providing them with appropriate, simple and cheap technologies.

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In the same vein my appeal to our political leaders is for appropriate resource allocation, policy support and an enabling environment. In other words, give tsetse and trypanosomiasis control, the priority that it deserves.

make homage
In conclusion Hon. Minister, Ladies and Gentlemen, allow me to pay tribute to the sons and daughters of Africa who continue to work in their respective tsetse control departments, despite the low remuneration and, in most cases, appalling working conditions. I say yours is a noble calling, keep it up! Since we have not been rewarded in this world, I am sure the Kingdom of Heaven is Ours!! I also like to thank those international organizations represented here and those scientists who have come from outside the continent, for your continued support.

To you all I say ALUTA CONTINUA.

I thank You.

Your Excellencies, Members of the Council of Ministers of the Government of the Republic of Mozambique;

Your Excellencies, members of the diplomatic community

Director of OAU/IBAR

Distinguished participants

Ladies and Gentlemen

On behalf of the Government of the Republic of Mozambique, I have the pleasure to welcome you all participants to Mozambique, in particular to Maputo to the 24th Meeting of the International Scientific Council for Trypanosomiasis Research and Control (ISCTRC), organised under the auspices of the Organisation of African Unity.

Feel at home.

Your presence in this event in such a large number manifests how much priority was attached to the control of Tse-Tse fly. As you are aware, approximately 10 million square kilometre of the total area of Sub-Saharan African countries is infested by diverse species ~~species~~ of Glossina and, unfortunately, a large part of this area possess a huge agro-ecological potential for agricultural development in general, and livestock in particular.

In Mozambique, 75% of the land area is infested by 4 species of this vector, namely: Glossina morsitans morsitans, Glossina pallidipes, Glossina brevipalpis and Glossina austeni. Large part of this area lies north of the 22 parallel. For this reason, since many years back, more than 75% of the livestock population is concentrated in the southern part of the country, which is practically free of this vector and also in the central and northern highland plateau

Ladies and Gentlemen

The control of Tse-Tse fly and Trypanosomiasis constitutes one of the biggest priorities of our continent. And it is for this reason, Mozambique, immediately soon after its national independence, has been actively participating in major events related to this activity. The desire expressed in Banjou leading to this meeting of to-day clearly demonstrates the ~~the~~ importance we attach to the control of Tse-Tse fly and Trypanosomiasis.

This is a unique opportunity for our technicians at the head-quarter and in the provinces to exchange experiences and know the works going on in this field in Africa and in other parts of the world.

To acquire and develop an adequate technical capacity necessary for the control of Trypanosomiasis and its vector, in the eighties we initiated , with the assistance of FAO and other international organizations, a training programme in-country and overseas for all level of our staff. This activity was enhanced by the regional programme known by its acronym RTTCP, which since its inception has been actively engaged in capacity building of all the technical staff in the region. To-day, we have already 8 technicians trained at a masters level and another one following a course in the region for the same level, approximately 20 high and medium level technicians trained in schools in Zambia and Zimbabwe and several more basic level technicians trained locally.

The exchange of experience, through workshops, visits and seminars, going on in our region has significantly contributed to improve the knowledge of our technicians . We like to see the continuation and strengthening of this activity, including more study tours to be made by people in the region and other regions and vice-versa.

At the level of Governmental institutions endowed with the responsibility with the responsibility to control Tse-Tse and Trypanosomiasis , we should create a mechanism which shall motivate technicians to stay in their job, that is reduce the so called "drop out" which is the reality of to-day. We should make this important investment pay dividend

Ladies and Gentlemen ,

There still exist many queries about the methods we need to adopt to control Trypanosomiasis and Tse-Tse We should continue the research work which is now in progress. Basic research is important, for it would permit us acquire the solution in the long term, but, our emphasis should be to respond to the present problem facing our population from day to day and is always viable and takes into regard their involvement. We should attain food security and for this we should control Tse-Tse in an economical and environmentally friendly approach

In this meeting we have the opportunity to appreciate the research works done since the last meeting in Banjour.

Ladies and Gentlemen

Human Sleeping Sickness (Human Trypanosomiasis) constitutes a serious constraint in the rural development of some regions in our continent. In some of these regions, it has assumed an epidemic character and for this reason we should seriously consider the problem. In Mozambique, this disease exists in certain parts in the provinces of Twete and Niassa , but, not in an alarming proportion.. But it still requires an adequate epidemiological surveillance to assist the gradual return of the population to their place of origin after the end of the war.

Ladies and Gentlemen

We are awaiting with a lot of expectation the result of this meeting . We are in the process of finalising our health program, and the discussions and deliberations taking place in this hall shall significantly contribute to this process.

Let us have a fruitful discussion's and deliberations

~~We~~ this I declare the opening of the 24th meeting of the International Scientific Council for Trypanosomiasis Research and Control

Thank you very much

CLOSING SPEECH BY DR. W.N. MASIGA, DIRECTOR, OAU/IBAR

Honourable Minister for Health
The Chairman of the ISCTRC
Distinguished Guests
Fellow Scientists
Ladies and Gentlemen

vous avons terminé avec succès une autre réunion

Once again we have concluded another successful meeting of the ISCTRC. This was the 24th meeting; 22 other meetings having previously been held elsewhere in Africa and one in London.

The ISCTRC is an organ established three decades ago. It has its roots in the Colonial Committee for Technical Co-operation in sub-saharan Africa (CCTA), a colonial forum for sharing experiences and information on trypanosomiasis control in the former French and British colonies in Africa.

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At this our 24th meeting, 8 international organizations and one regional body tabled their reports. From the reports it was evident that we need re-orientation of our control programmes for tsetse and trypanosomiasis. Work on the control of this problem has been on-going for nearly a hundred years but both the vector and the disease are still with us.

In this re-orientation, *elaboration* programme formulation, implementation, monitoring and impact assessment have to be undertaken in partnership with all the stakeholders including beneficiary communities, NGOs, government institutions and donors. This is necessary if we were to make an impact on the problem of tsetse and trypanosomiasis.

Hon. Minister, seven country reports were tabled at this meeting. They highlighted some of the problems encountered in implementing national control programmes. These included human resource constraints; the plight of invasion of re-claimed land by tsetse; the need for regional co-operation and co-ordination of programmes to stave off the cross border invasion by the vector; and the need for Government support for tsetse and trypanosomiasis control programmes.

The country reports also revealed an upsurge in the incidence of sleeping sickness: as new foci are being identified, old ones are recurring. Moreover the drugs for the management of the disease were introduced on the market 40 years ago, yet the involvement of effective and affordable new compounds is not in the horizon. My major concern, Hon. Minister, is that even the *existing*

Notwithstanding all these shortcomings, and constraints, there is a new realization that the control of trypanosomiasis should be incorporated into primary health care.

The scientists also discussed the importance of trypanotolerant livestock, both cattle and small ruminants, in development. It is evident that sheep and goats possess a high level of tolerance although sheep succumb more to the disease, but apparently, the general productivity of the goats seems to be impaired by the disease.

Regarding trypanotolerance in cattle, it was noted that the N'Dama breed is by far the more trypanotolerant but that this trait has also been identified in the Zebu. There is urgent need for more work to be carried out to determine the degree of trypanotolerance in Zebu cattle.

It was reported that there is widespread and rapidly increasing drug resistance in parasites. The use of drugs for treatment or prophylaxis therefore should be integrated with vector control, even in areas where trypanotolerant breeds are kept.

It is clear from the papers tabled at this meeting that research in animal trypanosomiasis needs to be intensified. This has been a lead area in previous Council meetings.

Hon. Minister, before control measures are effected, the epidemiology of any disease must first be defined. A critical factor in defining epidemiology is accurate diagnosis. The scientists present here debated at length the methodology for the diagnosis of the disease. It was noted that past efforts have not yielded the desired diagnostic tests which, in my opinion, should be penside application, simple to use, accurate and affordable. In two years time, when we meet again, we shall celebrate our 50th anniversary. The challenge to our scientists is that they should have developed by then such diagnostic tests for both sleeping sickness and nagana

Hon. Minister, at this Council meeting, the entomologists have done it again. They have advanced the design technology for screens and targets for catching and killing the fly. Hitherto it has been difficult to attract and catch the riverine species of the tsetse fly.

I am also pleased to inform you that an operation in Zanzibar, using the Sterile Insect-Release Technique, aimed at eradicating Glossina austeni from Unguja Island has been successful. But it is my considered opinion that monitoring of

Honourable Minister,

The recent introduction of social scientists on the tsetse and trypanosomiasis control scene has brought to light the need for involvement of communities and all other stake holders in the control initiatives. I wonder, why has it taken these honourable men and women so long to discover this important role in tsetse control! In addition, tsetse and trypanosomiasis control is a rural development issue. I believe therefore that tsetse and trypanosomiasis control must be integrated in the rural development programmes. Our recent initiative with the European Commission to integrate tsetse control in rural development programmes is a step in the right direction.

Honourable Minister, the international and donor communities are in the process of developing a Programme Against African Trypanosomiasis (PAAT). This programme is aimed at building strong partnerships amongst all the stakeholders. The Joint Secretariat has been established by OAU/FAO/WHO/IAEA for steering this initiative. This has been done in complete consultations with the supreme governing organs of these organizations. The 23rd meeting of the ISCTRC, held in Banjul two years ago, fully endorsed this initiative. The present Council has received and adapted the progress report and work plans from the Joint Secretariat.

Finally, Hon. Minister, I wish to request you on behalf of the Secretary General of OAU and the scientists present here, to convey gratitude to H.E. President Joachim Chissano, the government and the people of Mozambique for accepting to host this meeting and for the abundant hospitality we have enjoyed since our arrival in this beautiful country. Secondly, on my own behalf and on behalf of my fellow scientists, I want to thank you personally for your presence here with us and for agreeing to close our conference. We are indeed grateful for all the efforts made and the generous facilities placed at our disposal by your country. I want also to particularly thank Dr. Fernandes Songane and his Committee for successfully organizing this meeting. The turn out of this meeting has been spectacular.

May I now thank our collaborators: the WHO, FAO, IAEA, ILRI, ICIPE, national research institutes, regional organizations etc for their co-operation.

Finally, I wish now to thank my friend Dr. Vinand Nantulya, the Rapporteur General for ably conducting the meeting and of course my own staff, King Solomon, the new Secretary to the Council, the secretariat and of course not forgetting the local support staff.

**24TH INTERNATIONAL SCIENTIFIC COUNCIL FOR
TRYPANOSOMIASIS RESEARCH AND CONTROL (ISCTRC)
REPORT ON THE ACTIVITIES OF THE OAU SECRETARIAT**

**By Dr. Solomon H. Mariam
Chief Livestock Projects Officer & ISCTRC Secretary**

Distinguished Delegates, Ladies and Gentlemen

On behalf of the OAU/ISCTRC Secretariat, it is my pleasure and honour today, to present to you our activities report in brief and preparations of the 24th ISCTRC conference.

The ISCTRC conference, has established during the last 48 years of its existence, a legacy, whereby scientists from all over the world are always looking forward to **come** and **share** experiences of their research and field activities in fighting human and animal trypanosomosis.

Indeed, it is one of the best and prestigious conferences where many of us would love to come and contribute. In this regard let me take this opportunity to pay special tribute to all who had contributed immensely towards the establishment and co-ordination of ISCTRC. Today, ISCTRC continued to shine and enjoys the support and respect of all of you.

Ladies and gentlemen

The main objective of this conference is to discuss the past, present and future status of tsetse and trypanosomosis, and its impact on human and animal health, and look for sustainable, appropriate and lasting solutions. I believe that the 24th ISCTRC meeting will contribute toward this noble goal.

Ladies and gentlemen

The African trypanosomosis is a dynamic disease, both in space and time. Even after so many years of research and field experience, the long-term implications of the interaction between the fly, the disease, human population and the changing problem of land use are poorly understood.

In spite of so much resource and inputs invested on the problem, trypanosomosis remains to be endemic in 37 African countries and covers a third of Africa's most arable land.

The recent 5th OAU Ministerial Conference on Livestock Development which was held in Mbabane, Swaziland from 4-8 August, 1997 was attended by Ministers and Directors from 44 OAU members States. This conference recognized the need to mount a Pan-African continental approach to control trypanosomosis in order to increase animal productivity and enhance rural development and provide security for the rapidly increasing population in Africa. In this regard, the Ministers noted that many previous control operations have failed because of poor co-ordination and called upon the OAU Secretary-General to undertake the lead role in alleviating the problem of tsetse and trypanosomosis on a Pan-African level. At this juncture, may I kindly note that with RTTCP and FITCA projects in place for East and Southern Africa and with the West African Regional project covering 13 countries being seriously considered by the donors, we have continent a programme in place which needs to be harmonised closely in future.

Ladies and gentlemen

A large number of scientists have worked on the problem of tsetse and trypanosomosis for the last 100 years. As a result there is now a wealth of information and experience that address the problem and how to deal with it. In fact the literature and information of tsetse and trypanosomosis is so much that it is probably on top of all other tropical diseases in volume and contribution to science.

However, the need for further research is still justified to tackle the problem. We therefore call upon you scientists to continue research and investigation until we achieve the final goal of eradicating tsetse and trypanosomosis from the African continent. In this regard, much is expected from the 24th ISCTRC Conference.

The ISCTRC Executive Committee which is the executive arm of the ISCTRC Council met on Saturday, 27th September 1997, and carefully examined the organisation aspect of the conference and endorsed the report of the Secretariat.

Ladies and gentlemen

It is therefore my pleasure to give you brief account on the preparation of the present conference on behalf of the Secretariat.

The invitation brochures for the 24th Conference were printed by the OAU/IBAR and were sent out in January, 1997 to more than 400 individuals and institutions.

Registration for the conference and submission of scientific papers continued from March - June, 1997.

More than 120 scientific papers were received at our secretariat by end of June, 1997.

The locally assembled Technical Committee for selecting scientific papers met on three occasions in Nairobi between June/July, 1997 and carefully and thoroughly went through these papers. About 60 papers were selected for oral presentation and some 45 papers for poster presentation. The Technical Committee comprised of senior scientists and members of the Executive Committee from ILRI, ICIPE, KETRI, the African Medical and Research Foundation (AMREF), the Veterinary Department of Kenya and our office.

More than 330 scientists from various parts of the world have so far registered for participation in this conference.

We have few copies of the proceedings of the 22nd ISCTRC meeting held in Kampala in 1993, to cater for those who did not get a copy. Adequate numbers of the proceedings of the 23rd ISCTRC meeting held in Banjul in 1995 are also ready for distribution.

The programme of the 24th ISCTRC conference was carefully reviewed and printed in French and English for the smooth running of the conference.

I wish to take this opportunity to congratulate the government of Mozambique and especially the staff of the Veterinary Department lead by Drs. Songane/Pinto for the extra-ordinary efforts they have made to make the present conference a success. Distinguished colleagues, we have tried our level best to put everything in place for the success of our conference.

Training Workshop

The 23rd ISCTRC conference recommended the need to develop local capacity through training of senior managers working in the field of tsetse and trypanosomiasis. In this regard, a training workshop was organized for Senior Managers in tsetse and trypanosomiasis who heads various projects and laboratories in eastern and southern African countries.

This year's training workshop focussed on Project Management Cycle, Monitoring and Evaluation. The training module for about 4 and a half days was carefully formulated by RTTCP consultants who have vast experience in this field. We believe that such a training course will have a significant impact on the management of our Regional and National Tsetse and Trypanosomiasis Project in f Future.

"Farming in Tsetse Control Areas of East Africa" (FITCA) Project

As reported during the 23rd ISCTRC conference, OAU/IBAR was also engaged in the administrative establishment of the FITCA Project for East Africa.

The Financial Agreement between the OAU and EC was signed for a total of 20 million ECU in January, 1997. We are in the final stage of Tendering for the recruitment of TAs for the Regional OAU/IBAR Component and 4 participating countries namely Kenya, Ethiopia, Uganda and Tanzania. We believe that the FITCA project will be operational by the beginning of 1998.

The East African FITCA Ministerial Meeting

The East African FITCA Ministerial Steering Committee meeting was organized by our office in March, 1997. Ministers and senior officials from Uganda, Kenya and Tanzania and International Organizations including EC, ILRI, ICIPE etc., attended the meeting in Eldoret, Kenya. The representatives from the three countries discussed the status of human and animal trypanosomosis in the region and resolved to meet again in November, 1997 in Uganda to officially launch the FITCA project for East Africa.

Tsetse Distribution Map

A revised cattle and tsetse distribution map was produced jointly by OAU/IBAR and FAO, Accra in 1996. These maps have been distributed as necessary.

There is an urgent need to strengthen the spirit of ISCTRC beyond the 21st century in terms of harmonizing and co-ordinating our programmes and activities. We shall need the support, appreciation and understanding of all of you.

May I wish to assure you that the OAU/IBAR in co-operation with FAO, WHO, IAEA and other national and international institutions will continue to organize the biennial ISCTRC conference. Moreover the next conference will be the 50th Anniversary of ISCTRC and deserves a special consideration the Golden Occasion. We call upon you to contribute more scientific papers to commemorate this special occasion. The ISCTRC secretariat will continue to play a lead role in harmonizing and co-ordinating the national and international efforts to combat human and animal trypanosomiasis. We shall continue to support capacity building and information exchange through organizing training workshops and printing of these valuable scientific presentations. Once again I wish to express our gratitude and thank you for the support you are giving the ISCTRC Secretariat.

In conclusion ladies and gentlemen, I believe that most of you, distinguished scientists and experts, involved in the field of tsetse and trypanosomiasis control possess a wealth of knowledge and experience in terms of ideas and innovations. We are certainly proud to associate ourselves with you in combating this enemy tsetse fly. We at the OAU/IBAR look forward to work in more closer co-operation with all of you.

Please be free to share your ideas, suggestions and comments as to how we can join hands and improve and extend our efforts in fighting the tsetse and trypanosomiasis scourge in our impoverished continent. I strongly believe that together we can make the difference by minimizing the threat of tsetse and trypanosomiasis in human and animal in Africa. To make this difference in future, we have to play our part at present. That is why we are looking forward for the success and outcome of the 24th ISCTRC meeting. We believe that if we remain united we shall overcome. Thank you.

INTERNATIONAL ORGANIZATIONS

Moderator: Masiga
Rapporteur: Chizyuka

Eight international organisations, OAU/IBAR, EU, WHO, ILRI, ITC, CIRDES, IAEA, CIPE and the Regional Tsetse and Trypanosomiasis Control Programme (RTTCP) and the Programme Against African Trypanosomiasis (PAAT) gave brief updates on their respective activities.

The OAU/IBAR report summarised the activities of the secretariat since the 23rd ISCTRC meeting culminating into the 24th meeting in Maputo. Recognition was made of the facilities made available to the ISCTRC by the host Mozambique Government. Considerable progress has been made in the preparation of the regional programmes for Eastern and Western Africa. The report stressed the need for further appropriate research since the trypanosomiasis problem is still immense. The European Union (EU) has been funding the RTTCP for the past 10 years. It was reported that the East African Programme for initially four countries will be launched soon (November, 1997), while the West and Central African Regional Programme is in an advanced state of preparation. The EU future approach to trypanosomiasis control support will be based on the consideration of overall rural development in which trypanosomiasis will be one of the components. The EU would like to see a coherent approach at national, regional and international levels. It was finally noted that the next meeting will mark the 50th Anniversary of the ISCTRC.

The World Health Organisation (WHO) representative informed of WHO's fears over the last 10 years of recrudescence of sleeping sickness due to civil strife and lingering bad economic situations which disrupt the control of sleeping sickness in many countries.

The Programme Against African Trypanosomiasis (PAAT) was introduced and explained to the meeting. Considerable details of PAAT's overall goal, purpose secretariat and programme structures were given. Essentially, PAAT is a non institutional organisation which will seek to harmonize donor support and trypanosomiasis control and research priorities.

The International Livestock Research Institute (ILRI) is the single livestock research institute within the CGIAR system attempting to respond to the development needs of the livestock sub-sector in a growing population. The policy and activities of ILRI were explained which include: improvement of animal

performance of the sub-sector and, technology transfer by national programmes to farmers. The goals of ILRI are to provide national systems with improved capacities for diagnosis, monitoring and control methods for trypanosomiasis. ILRI collaborates with other international centres such as ITC, CIRDES and has 12 ongoing and eight pipeline project activities.

The International Trypanotolerant Centre (ITC) research efforts focus on the exploitation of genetic resistance of indigenous breeds to trypanosomiasis, ticks and tick-borne diseases and gastro-intestinal parasites, and, also on nutrition and feed resources, genetic improvement as well as livestock management systems. Current research activities are on parasitic diseases of cattle, sheep and goats, nutrition and feed resources, genetic improvement of trypanotolerant livestock and socio-economics and peri-urban dairy production. A large trial is underway on the impact of trypanosomiasis on the productivity of N'Dama cattle, Djallonke sheep and West African Dwarf Goats.

CIRDES research activities aim at enhancing the productivity of domestic ruminant livestock in the subhumid zone of West Africa in order to improve the nutritional status of populations and economic welfare of the rural communities. Research activities are multidisciplinary and maintain interactions between field surveys and laboratory practices. Many new formulations of pesticides and blue materials for tsetse control were assayed. Several control operations of real community participation were achieved in the so-called Agropastoral units of southern provinces of Burkina Faso. Ongoing research now aims at minimizing costs of interventions. Research is also undertaken to improve epidemiological survey tools and vector detection devices. Many more activities of CIRDES research deal with epidemiology of PAAT and diagnostic tests. Several biotechnical methods were successfully assayed and PCR was used to characterize types of Trypanosoma congolense and T. simiae which occur in West Africa and the Kilifi (Kenya) types. CIRDES carried out trials comparing the Ag-ELISA with classical diagnostic techniques and recommends further research for its improvement to develop it into a satisfactory diagnostic tool.

IAEA reported on the activities of the Joint FAO/IAEA Division in trypanosomiasis control for the period 1995-97. A large number of technical co-operation projects have been implemented in Africa providing equipment, expertise, fellowships and seminars. The ELISA technology to improve the diagnosis of the disease has been established in 15 laboratories and the results of its use have been published in a document IAEA-TECDO-925, which is available on request. A geographical information system (GIS) has been used to analyse geo-referenced disease data and epidemiological information from Zanzibar. Support for the tsetse fly eradication programme on the Zanzibar island through the use of SIT has resulted into the disappearance of wild tsetse from the island. As a result of the apparent success of the Zanzibar project, a similar eradication project is planned on the mainland of Africa.

A feasibility study to eradicate tsetse flies from an initial area of 5,100 km² in the southern Rift Valley of Ethiopia has been initiated in 1997.

The International Centre for Insect Physiology and Ecology (ICIPE), a non-governmental organisation, focuses research in the areas of animal and human health. ICIPE has an integrated approach in eight main programmes and collaborates with many institutions and organizations in Africa, Asia and Latin America. A number of tsetse research and camel trypanosomiasis activities, in collaboration with other organizations, are currently being undertaken, notably the Bio-village Initiative "Tukul" project which is a basis for sustainable rural development. Through this, ICIPE has achieved a lot in the area of capacity building by training many people at technical and farmer levels.

The RTTCP, which started some 10 years ago with EU financial support, has recently changed its goal from tsetse eradication to containment. RTTCP has strong training and research components. A post graduate training course started in May, 1997 at the University of Zimbabwe for 14 students from Uganda, Tanzania, Botswana, Zambia and Zimbabwe, and six in-service training seminars have been held. The concept of regional co-operation has been firmly established among the participating countries, for example, staff exchanges; Zambia and Zimbabwe staff have carried out surveys in Namibia. In order to assess and suggest the future of the programme, a consultant was contracted in March, 1997 to ~~work out~~ national and regional strategic plans. RTTCP has established a standardised reporting system for its activities and ELISA diagnostic facilities have been established in Zambia and Zimbabwe.

Session 1.

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INTERNATIONAL ORGANIZATIONS (WHO)

MODERATOR: MASIGA
RAPPORTEUR: CHIZYUKA

~~Mr. President, Ladies, Gentlemen, Dear colleagues~~

Over 10 years ago, WHO, under the Directorship of Dr. L. de Raadt who is among us today, had foreseen and predicted with fear the recrudescence of Sleeping Sickness and established a specific programme to organize and coordinate all activities aimed at controlling this growing endemic disease.

Political instability, social upheavals and lingering economic growth have not permitted to fully implement activities at national level and contain the disease.

Today sleeping sickness has picked up what could be called an "epidemic momentum" which is going to be very difficult to slowdown and stop.

More than ever all those concerned and involved by the development and welfare of the African rural population will have to unite to present a single front to this devastating disease which affects humans and animals.

With the objective in mind to find a solution to this growing problem, WHO has enhanced its leadership role by establishing a Human African trypanosomiasis coordination cell. But this is insufficient, consequently with OAU, FAO and IAEA, WHO has supported the development of a wider approach, a new initiative. The Programme against African Trypanosomiasis. This programme bridges the major organization involved in trypanosomiasis through active collaboration and the definition of a common objective.

Numerous coordination information and training meetings, workshops and seminars have taken place and have given the "trypanosomiasis ~~fighters~~" the opportunity to share experience and problems and all together fine tune the action to be implemented.

Today all those involved in trypanosomiasis should it be

be more generally development are all gathered together under the auspices of OAU: the ISCTRC meeting.

Veterinarians, physicians, scientists, technicians can share ~~them~~ success, problems and together define methodologies to find solutions to control and ultimately eliminate the disease.

The ultimate objective is to improve the health and the living conditions of the rural population of Africa, and provide suitable environment for successful and productive agriculture.

I would like to thank our host, Mozambique, for their hospitality and magnificently organized welcome, and thank OAU to provide such a unique forum for the fight against trypanosomiasis.

Lutte contre la Maladie du Sommeil

Agents de santé

vs

Equipes mobiles

Qui peut encore prétendre :

Dépister la
THA avec
des équipes
mobiles ?

Appliquer le
piégeage avec
une équipe
nationale ?

Surveiller les
populations
sans
recensement ?

Contrôler
l'endémie sans
contrôler le
vecteur ?

Une solution possible :

- **Utiliser les services de personnes ...
proches des malades**

bien intégrées dans la population

connaissant la région pour y être nées

des

AGENTS DE SANTE COMMUNAUTAIRES

Foyer de Sinfra

(Côte d'Ivoire)

48 villages

14 quartiers de Sinfra-ville

80 hameaux

1.200 campements



108 ASC

2 laboratoires

76.200 personnes recensées
(2 mois)

50.375 prélèvements de
sang sur confetti
(4 mois)

800 séropositifs

259 T+

Dans la zone de plus forte incidence

(4 à 14%)

18 villages

22.300 personnes

ASC

15.593 visitées

2 mois

238 T+

73% de présentation

EM

9.311 visitées

10 jours

60 T+

42% de présentation

Dans 6 villages très touchés population recensée : 6.200 personnes

ASC

70% de visitées

2 mois

126 T+

Prévalence 2,4%
en 1995

EM

75% de visitées

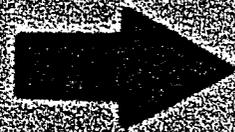
9 jours

37% la première année

163 T+

en 3 ans

1992	1993	1994
4,9%	1,8%	1,3%



Avantages / Inconvénients

ASC

Assez exhaustif

Possible

campement

Bonne

Oui

Moyenne

Recensement

Suivi population

Zones visitées

Couverture population

Suivi des malades

Rapidité

EM

Aucun

Impossible

Villages

Variable

Non

Peut-être trop ...

Les coûts

**Sans compter les gros investissements
(1 bicyclette pour 2 ASC contre 1 Land Rover pour les EM)**

ASC

15.000

...

...

34

52

EM

Consommables

115.000

Carburant

108.000

Per diem

960.000

CATT

150

Coût par personne

277

(Francs CFA, prix 1995, analyse en cours)

Conclusion

Malgré les réticences de certains il faut constater que les ASC sont nécessaires à plusieurs titres

Santé de la population

Dépistage/suivi des malades

Recensement

et **La lutte antivectorielle**

**Sentinelles efficaces,
“éclaireurs” pour les équipes médicales :**

Ils aident à circonscrire la zone endémique

Ce sont des acteurs à part entière
de la lutte contre l'endémie

v

The International Livestock Research Institute
ILRI
Guy d'Ieteren
P.O.Box 30709, Nairobi, Kenya

It is known 3 years that ILRI has been established and is operating as a single livestock research institute within the CGIAR. The programme tries to respond to the development needs of the livestock sector, corresponding to a growing population. The consequent intensification of resource use in livestock and mixed farming systems presents a large agenda of problems to be resolved by research in the areas of disease control, use and conservation of animal genetic resources, development of feed resources and of balanced and sustainable farming system. Significant parts of this agenda require research at the level of an international institute. Although meat production from monogastrics (mainly pigs and poultry) will expand even faster, particularly in Asia and although this sector also presents many technical challenges, but has a more restricted agenda for international research, ILRI continues to focus its research on ruminants related aspects.

The specific research opportunities for ILRI in the improvement of animal agriculture in developing regions are principally fourfold:

1. To improve animal performance by overcoming identified constraints to animal productivity, through technological research and the conservation of the existing genetic diversity amongst livestock in developing regions;
2. To improve the productivity of the major livestock and crop-livestock production systems typical of developing regions and to maintain their long-term productivity;
3. To improve the technical and economic performance of the livestock sector in these regions to ensure the appropriate translation of production system improvement into increased food security and economic welfare; and,
4. To improve the development, transfer and utilization of technology by national programmes and client farmers in the agricultural systems of these regions.

Two of the important tropical parasitic diseases and the constraints they impose on the livestock sector are still at the centre of ILRI's mandate. Indeed, after considerable re-examination of the full animal health research agenda for developing countries, it has been included that this class of diseases requires reinforced attention at a level of international research. The ILRI research programme outlines the research challenges aimed at controlling these diseases either through the integration of existing approaches, the development of new biotechnological solutions, or the exploitation of the natural resistance occurring in breeds of indigenous livestock. In developing its programmes ILRI had the advantage of established expertise in the two most important of these diseases (trypanosomiasis and theileriosis) and the opportunity to apply and develop the programme for related diseases occurring throughout the developing world.

The goals of ILRI trypanosomiasis research are to provide national systems with

trypanosomes as this is critical to sustainable disease control. Work also seeks to establish the feasibility of producing vaccines against harmful trypanosome products produced by trypanosomes. This research is conducted in the context of examining the differences in immunological and homeostatic mechanisms employed by trypanotolerant (N'Dama) and trypanosusceptible (Boran) cattle in overcoming infection and disease. Molecular physiological approaches will determine how ruminant livestock control parasites and pathological process and will provide evidence of candidate genes governing genetic disease resistance as expressed by trypanotolerant N'Dama cattle.

One of the major focus of ILRI's research is on genetic resistance to parasitic diseases. The specific goals are to determine the extent and form of inheritance of resistance traits in selected breeds, particularly in N'Dama cattle for trypanotolerance, and in various indigenous breeds of sheep for resistance of helminths. Trypanotolerance criteria and health and production traits of N'Dama cattle will be used to design selection programmes for these cattle under trypanosomiasis risk in collaboration with national and regional partners in West and Central Africa. Genetic studies will be integrated with evaluations of the effect of other diseases on productivity and socio-economic utility of these breeds to help determine their appropriate integration into farming systems. A major component of the programme is the research to elucidate the molecular basis of genetic resistance to support germplasm enhancement programmes.

Socio-economic, environmental and other impact analyses of alternative and novel methods of controlling trypanosomiasis conducted through site-specific examples and contribute to integrated production systems analysis and management.

The CGIAR, and ILRI in particular, represents a small portion of the total international, regional and national research efforts. Over the recent years major research efforts were pooled in number of collaborative projects jointly carried out by international, regional and national organization operating in sub-Saharan Africa. ILRI is convinced that the experience gained in joint planning, implementation and reporting of research projects should lead the research partners into a more coordinated and better integrated approach to planning respective research agenda, training and/or development strategies and to seeking joint funding.

At the last ISCTRC meeting in Banjul and during most recent ISCTRC Steering committees meetings, concern were expressed by members and particularly by the Chairman Dr. Masiga that ILRI might reduce its involvement in trypanosomiasis control research because of its more global mandate and the possibility to drive resources out of Africa into Asia and Latin America.

The 24th ISCTRC meeting here in Maputo provides an opportunity for ILRI to demonstrate its sustained commitment to Africa and particularly to the enhancement of livestock production in tsetse affected areas. There are indeed 12 ILRI colleagues present at this meeting. They present the results of collaborative research projects in 7 member

through collaborative research projects funded by a group of donors themselves very much committed to sustainable livestock development in tsetse affected areas of Africa.

I believe that the Maputo meeting is one of the first showing so many evidences that sustainable development in trypanosomosis control is increasingly dependant on international collaboration and the pooling of research resources.

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The goals of ILRI trypanosomiasis research are to provide national systems with improved capacities for diagnosis, monitoring and selection of control methods for trypanosomiasis. Research will continue to identify the basis of trypanocide resistance in trypanosomes as this is critical to sustainable disease control. Work will also seek to establish the feasibility of producing vaccines against harmful trypanosome products produced by trypanosomes. This research will be conducted

in the context of examining the differences in immunological and homeostatic mechanisms employed by trypanotolerant (N'Dama) and trypanosusceptible (Boran) cattle in overcoming infection and disease. Molecular physiological approaches will determine how ruminant livestock control parasites and pathological processes and will provide evidence of candidate genes governing genetic disease resistance as expressed by trypanotolerant N'Dama cattle.

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I believe that the Maputo meeting is one of the first showing so many evidences that sustainable development in trypanosomosis control is increasingly dependant on international collaboration and the pooling of research resources. *We are proud to continue to be very much associated with these efforts.*

In order to maintain a high level of competency, and of responsiveness to demand of quality international research on trypanosomiasis and related issues, innovative approaches are urgently required for effective institutional mechanisms for collaboration and coordination of research efforts and for fostering complementarities and synergisms between livestock research institutes based in Africa.

Diskette

REVIEW

INTERNATIONAL ORGANIZATIONS

1. IAEA presented by R.H. Dwinger

The activities of the International Atomic Energy Agency (IAEA) dealing with agriculture are planned and implemented jointly with the Food and Agriculture Organization of the United Nations (FAO) through the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture. Two Sections of the Joint FAO/IAEA Division have been active in the field of trypanosomosis and tsetse control during the years that this review is covering (1995-1997). A large number of Technical Co-operation Projects have been implemented in various countries in Africa providing equipment, expert services and fellowships for training. Moreover, a number of regional seminars have been organized, for example, one in Addis Ababa on the diagnosis and epidemiology of trypanosomosis and another in Zanzibar on novel tsetse control methods. Furthermore, the outcome of applied and adaptive research originating from the FAO/IEA Agriculture and Biotechnology Laboratory in Seibersdorf, Austria, has been successfully transferred to many African institutes and laboratories through Co-ordinated Research Programmes (CRP). The most outstanding activities in the field of trypanosomosis will be discussed in more detail for each one of the two Sections.

The Animal Production and Health Section has been involved in the establishment of ELISA technology in fifteen laboratories in Africa in order to improve the diagnosis of the disease in livestock. Initially emphasis was placed on the serological detection of antigens using a sandwich ELISA together with the use of standard parasitological techniques to detect trypanosomes in blood samples. The results of the various research projects using this test have been recently published as a technical document which is freely available upon request (IAEA-TECDOC-925). In addition, an external quality assurance programme has been initiated consisting of a questionnaire, the evaluation of internal test controls and the assessment of a panel of unknown serum samples. All fifteen laboratories participated in the programme and the results have been published as a report and distributed to each participant.

Recent research at the FAO/IAEA Agriculture and Biotechnology Laboratory resulted in the development of a competitive ELISA for the detection of antigens and an improved antibody-detection ELISA using *in vitro* produced antigens. However, both techniques still require considerable adjustments and need to be refined and validated with the assistance of researchers in African laboratories using the co-ordinated approach of a CRP.

A geographical information system (GIS) has been used to analyze geo-referenced disease data and epidemiological information originating from

to monitor changes over time due to interventions. A similar study has been done with data originating from Northern Cameroon and studies in other African countries are being planned.

In collaboration with FAO, WHO and OAU/IBAR a programme memorandum has been produced to explain to a wider audience the newly initiated programme “to clarify and solve the problem of African trypanosomosis” (in short PAAT). The leaflet is freely available in an English and a French version.

Support for a tsetse fly eradication programme on the Zanzibar island group, which forms part of the United Republic of Tanzania, has been provided through an IAEA Technical Co-operation Project and the Insect and Pest Control Section of the Joint FAO/IAEA Division. Following suppression of the tsetse population using standard bait technology and the application of synthetic pyrethroids on livestock, sterile male insects were reared using a small aircraft from August 1994 onwards. As of May 1995 the insects were released twice weekly over the southern part of the island at a rate of approximately 40,000 per week. Progress was assessed on a regular basis using entomological and veterinary monitoring techniques. In 1996 the average number of sterile males released weekly had increased to 70,000 tsetse flies and a ratio of sterile: wild insects of >100:1 was achieved. As of March 1996 releases were extended over the entire island of 1600 Km². The continuous releases have ultimately resulted in the disappearance of wild tsetse from the island. The success of the project has not only been due to the efforts of an excellent field team but also due to improvements in tsetse breeding, automation and *in vitro* feeding following research instigated by the FAO/IAEA Agriculture and Biotechnology Laboratory.

As a result of the apparent success of the Zanzibar project, a similar eradication effort is planned on the mainland of Africa. The project will be initiated by extensive feasibility studies monitoring tsetse population dynamics, epidemiological characteristics of the disease and an estimation of the possibilities of tsetse suppression and re-invasion. In addition, environmental consequences, a cost-benefit analysis and possible changes in land use as a result of tsetse eradication will have to be assessed. The feasibility study to eradicate tsetse flies from an initial area of 5,100 Km² in the Southern Rift Valley of Ethiopia has been initiated in 1997.

International Trypanotolerance Centre ITC

Widespread poverty and increasing food insecurity are challenges facing the West African countries. This situation will be aggravated by very rapid population growth and the encroaching drought of the Sahel in the face of low agricultural productivity. The potential contribution of livestock to overcome some of the problems cannot be overemphasised.

Major constraints to increase livestock production are the prevalence of parasitic diseases e.g. tsetse transmitted trypanosomosis and tick-associated infections as well as inadequate food supply. ITC's research therefore focuses mainly on the exploitation of the genetic resistance of indigenous breeds in the area of tsetse and trypanosomosis, ticks and tick-associated diseases, gastro-intestinal parasites, animal nutrition and feed resources, genetic improvement as well as livestock management systems.

The region of ITC's work includes the member states of the Mano River Union and the Organisation pour la Mise a Valeur du Fleuve Gambie (OMVG) i.e. Guinea, Guinea Bissau, Liberia, Senegal, Sierra Leone and The Gambia. The region is located in the sub-humid and humid zone of West Africa where the indigenous domestic livestock population comprises mainly of the trypanotolerant breeds. This zone has a very high livestock development potential.

ITC's mission is therefore to contribute to the effort of increasing livestock productivity and utilization in the West African region through the optimal and sustainable exploitation of the genetic resistance of indigenous breeds of livestock for the welfare of the populations.

At present ITC's research work is supported by funds from The Gambia, the European Union, Germany (BMZ/GTZ), Belgium (BADC) and by smaller grants from FAO, IAEA and others.

The main areas of research are currently

- Parasitic diseases (trypanosomosis, tick-associated diseases, internal parasites) in cattle, sheep and goats
- Nutrition and feed resources
- Genetic improvement of trypanotolerant livestock
- Socio-economics

but also

- Peri-urban dairy production.

The first four areas deal mainly with low input systems, whereas the peri-urban dairy production is targeted at very market oriented and medium input systems. In the latter system the continuous use of F1 crossbred animals (exotic breed x N'Dama) for high demand areas with virtually no risk of trypanosomosis and with plenty crop by-products is being explored. It is expected that this scheme can help to reduce the large imports of dairy products.

With respect to genetic improvement of cattle, sheep and goats open nucleus schemes (including screening) are operated using quantitative genetic methodology. The design is such that marker assisted selection can be included when available.

With respect to trypanosomosis a large trial of tsetse control is being carried out and the impact of trypanosomosis on the productivity of N'Dama cattle, Djallonké sheep and West African Dwarf Goats is determined. The information generated will allow the design of sustainable management systems for trypanotolerant ruminants able to cope with trypanosomosis.

Dishette

LA RECHERCHE -DEVELOPPEMENT AU CIRDES DANS LE CADRE DU PROGRAMME DE LUTTE CONTRE LA TRYPANOSOMOSE ANIMALE EN AFRIQUE DE L'OUEST

Rapport du CIRDES*

*CIRDES (Centre international de recherche-développement sur l'élevage
en zone subhumide) 01 BP 454, Bobo-Dioulasso 01, Burkina Faso.

SYNOPSIS

CIRDES research activities aim at enhancement of the productivity of domestic ruminant livestock throughout the subhumid zone of West Africa and subsequently at improvement of the nutritional status of populations, the economic welfare of livestock owners and of rural communities. Research activities are performed by teams which maintain pluridisciplinary interactions in field surveys, laboratory practices and data analyses. While taking into account sustainability at all levels of intervention, CIRDES research puts emphasis on effective control of animal trypanosomosis. Many new formulations of pesticides and of blue materials designed for tsetse control were assayed. Several control operations at real magnitude and with intense community participation were achieved in so-called Agropastoral Units of southern provinces of Burkina Faso. They resulted in disease alleviation and enhancement of cattle productivity. Further ongoing researches aim at minimizing costs of interventions.

Due consideration is also given to the improvement of epidemiological survey tools and of vector detection devices. Recent trials comparing a detection test (ELISA-Antigen kits) with other classical trypanosomosis diagnostic techniques resulted in discrepancies when surveying the disease situation in the agropastoral zone of Yale, south of Burkina Faso. This test deserves further research for its improvement and subsequent development to satisfy the need for an accurate diagnostic tool.

Many other CIRDES activities are dealing with the epidemiology of AAT for a better understanding of diseases transmission trends and relationships between parasites, vectors and vertebrate hosts. Several biotechnical methods were successfully assayed and PCR (polymerase chain reaction) was used to characterize types of Trypanosoma congolense which occur in West Africa : strains belonging to savannah, forest and Kilifi types and also T. simiae.

* Sous la direction de Saydil M. Touré et avec les contributions de l'Unité de lutte contre les maladies et leurs vecteurs (B. Bauer, I. Kaboré, J.F. Michel et S. de La Rocque) et de l'Unité d'Epidémiologie (Issa Sidibé, Zakaria Bengaly, Thierry Lefrançois, Philippe Solano), avec la participation de Jean-Marc Reifenberg.

It is postulated that in West Africa the Palpalis group of Glossina may have a greater vectorial capacity for trypanosomes of the Subgenus Nannomonas than reported. This trend was apparent from studies on vector-parasite relationships performed in sites surveyed south of Burkina Faso. In addition to PCR, RAPD was also used to characterize trypanosomes. Biotechniques are as well applied to characterize tsetse populations at specific and infraspecific levels.

Other activities are related to comparisons of trypanotolerant livestock breeds and crossbreeding under different production systems.

It is important to underline joint activities involving CIRDES, ILRI and ITC on trypanotolerance and trypanotolerant livestock in West Africa and close cooperation with CIRAD-EMVT. Research through consortia having common interests deserves a higher interest and should be further enforced.

INTRODUCTION

Les activités de recherche-développement sont assurées au CIRDES par plusieurs équipes qui ont entre elles des interactions pluridisciplinaires. Elles sont en permanence partagées entre le terrain et ses réalités d'une part, les laboratoires et les analyses d'autre part. Il y a des synergies fortes entre vétérinaires, biologistes, zootechniciens et économistes pour atteindre un objectif commun à tous : améliorer la productivité des ruminants domestiques, en ayant une bonne maîtrise des maladies du bétail et en garantissant une alimentation suffisante dans un environnement durablement préservé. Une priorité élevée est accordée à la mise au point de moyens efficaces de lutte contre la trypanosomose animale africaine (TAA). Les essais de lutte en vraie grandeur réalisés par le CIRDES dans plusieurs provinces situées au sud du Burkina Faso, avec la participation des communautés agropastorales, ont démontré l'efficacité de la stratégie et des techniques mises en oeuvre pour lutter contre la trypanosomose. Ils ont conduit à une maîtrise de la maladie et une augmentation de la productivité des bovins. Des recherches sont poursuivies pour mieux comprendre les relations entre les vecteurs, les trypanosomes et leurs hôtes vertébrés, et les spécificités de transmission de la maladie. Les activités visant à affiner les moyens de détection des vecteurs et de surveillance épidémiologique de la trypanosomose sont aussi poursuivies. Les activités permettent aussi de préciser le degré d'importance de la transmission de la trypanosomose par des vecteurs autres que les glossines et les moyens de lutte. Enfin, plusieurs autres recherches ont trait à l'évaluation de la trypanotolérance et à l'utilisation du bétail trypanotolérant en race pure ou en croisement dans différents systèmes de production. Le présent rapport se propose de résumer quelques uns des résultats du CIRDES dans ces différents domaines.

1 - AMELIORATION DES MOYENS DE LUTTE ANTIVECTORIELLE ET APPLICATIONS SUR LE TERRAIN

1.1 - L'élevage des glossines est poursuivi, d'une part pour répondre à des besoins de matériel d'expérimentation et de formation au CIRDES et dans d'autres institutions qui en font souvent

submorsitans). Une opération de recherche, financée par l'AIEA dans le cadre de son Programme de recherche coordonné sur l'automatisation de l'élevage de masse des glossines, a débuté par le stockage des mouches en grandes cages. Actuellement 66% des effectifs, soit environ 140.000 femelles reproductrices des trois espèces en élevage, sont stockés en grandes cages. Les essais futurs viseront à un accroissement de la capacité de stockage jusqu'à 150/200 femelles par cage.

1.2 - Après avoir utilisé des crocodiles, les travaux sur les odeurs des reptiles en vue d'augmenter l'attractivité des leurres ont été poursuivis sur des varans (*Varanus niloticus*). En étable sous moustiquaire, il a été constaté que *G. p. gambiensis* ne se gorgeait pratiquement pas sur varan lorsque celui-ci est immobile (1 % de mouches gorgées, contre 39 % lorsqu'il est mobile).

1.3 - Les analyses de repas de sang sont poursuivies et ont porté sur des échantillons prélevés sur *G. p. gambiensis*, *G. tachinoides*, *G. m. submorsitans*, *G. fusca*, *G. longipalpis* et sur des Tabanidae en provenance du Burkina Faso et de la sous-région. Il est envisagé de tenir un atelier de travail avec les différents partenaires (BGVV, ICIPE, ILRI, CIRDES) pour harmoniser les techniques, échanger des réactifs et valider les résultats.

1.4 - Des études écologiques sont poursuivies en association avec d'autres partenaires, notamment le Département CIRAD-EMVT et l'ILRI. Une action thématique de recherche, menée à Sidéradougou, a pour objectif l'identification des facteurs discriminants majeurs de la présence des glossines et la caractérisation de points épidémiologiquement dangereux. Une autre a trait aux effets sur l'environnement des opérations de lutte anti-vectorielle.

1.5 - Le CIRDES a poursuivi les essais sur de nouveaux matériaux destinés à la confection des leurres utilisés dans la lutte antivectorielle et a aussi expérimenté de nouvelles formulations d'insecticides. Quatre types de tissus synthétiques préalablement imprégnés de deltaméthrine ont été testés au laboratoire et sur le terrain. Les résultats sont très prometteurs. Des essais sur une nouvelle méthode de lutte contre les glossines par utilisation de benzyphénylurée (triflumorone) qui possède une activité larvicide et ovicide sont en cours de réalisation au Ranch de Gibier de Nazinga, principal point de réinvasion de la Zone agropastorale de Yalé, au sud du Burkina Faso. Le déploiement d'écrans imprégnés de triflumorone devrait à terme induire une stérilité des populations-cibles de glossines.

1.6 - Les opérations de validation des procédures de lutte contre la trypanosomose animale ont porté plusieurs sites d'intérêt économique, au sud du Burkina Faso. Au niveau du réseau hydrographique de la Sissili : traitement topique épicutané du bétail (plus de 7.000 têtes) avec la deltaméthrine 1 % « pour on », à des intervalles trimestriels, et pose de 1.000 écrans insecticides le long des principaux cours d'eau. Cette combinaison stratégique a permis d'abaisser la pression glossinienne et l'incidence de la TAA et d'améliorer significativement l'état général des troupeaux. La reprise de la production laitière et l'installation d'une mini-laiterie à Léo ont permis la commercialisation de lait frais et de yaourts. Les concertations en vue du transfert des activités de lutte aux producteurs et au Service provincial des ressources animales (SPRA) de la Sissili ont commencé. L'Unité de Socio-économie du CIRDES effectue actuellement des enquêtes sur l'impact de cette lutte.

de Padéma et de Solenzo, où le plan de lutte contre la trypanosomose animale fait intervenir plusieurs partenaires : le Projet PDRI/HKM, le Service provincial des Ressources animales (SPRA), les vétérinaires privés, les communautés villageoises et le CIRDES.

1.7 - Enfin, s'agissant toujours de lutte anti-vectorielle, plusieurs types de pièges associés ou non à des attractifs olfactifs ont été essayés au CIRDES sur les Tabanidae, désignées comme une nuisance à combattre. Les pièges NGU (Nguruman), F3 de Flint, Epsilon et les écrans-pièges ont été comparés entre eux et par rapport au piège biconique de Challier-Laveissière servant de témoin. Alors que ce dernier ne permet que des captures assez faibles, l'écran-piège autorise des captures 14 fois supérieures. *Tabanus gratus* est l'espèce la plus capturée. L'association de métacrésol et d'octénol en sachet ou d'acétone en bouteille renforce légèrement l'efficacité des écrans-pièges.

2 - DIAGNOSTIC ET EVALUATION DES PROCÉDES PAR ELISA-ANTIGÈNE

Le CIRDES a essayé pendant trois ans des kits de diagnostic de la trypanosomose animale par détection des antigènes selon la technique ELISA-Antigène décrite par Nantulya en 1992. Une évaluation de la situation épidémiologique pour déterminer les effets d'une opération de lutte antivectorielle dans la zone agropastorale de Yalé, au sud-ouest du Burkina Faso, a montré une chute de la prévalence parasitologique et une régression de l'anémie. Le suivi sérologique par épreuves ELISA-antigène donne cependant des résultats discordants qui montrent que le test actuel de détection des antigènes circulants de trypanosomes présente des insuffisances et ne permet pas encore une évaluation épidémiologique fiable. Le test devrait faire l'objet d'amélioration.

3 - EPIDEMIOLOGIE ET CARACTÉRISATION DES TRYPANOSOMES ET DES VECTEURS

3-1 - Caractérisation de trypanosomes

L'étude de la variabilité génétique de *T. congolense sensu lato* a été effectuée par analyse du polymorphisme des isoenzymes et l'amplification aléatoire de l'ADN ou *Random Amplified Polymorphism DNA* (RAPD). De nombreux fragments d'ADN spécifiques de groupes, d'espèces et sous-espèces de trypanosomes des sous-genres ont été identifiés et seront utilisés par le CIRDES après criblage et séquençage pour produire des sondes génomiques permettant de cibler les populations parasitaires analogues. Le RAPD constitue ainsi un outil en amont qui permet de sonder la population naturelle puis de générer des sondes spécifiques qui iront chercher leurs cibles dans la nature. En outre, la technique PCR (*Polymerase Chain Reaction* ou réaction en chaîne par la polymérase) est couramment pratiquée au CIRDES pour identifier et caractériser les espèces et sous-espèces de trypanosomes et pour mieux comprendre les interactions hôtes-parasites.

Des études ont été faites avec les sondes génomiques de *Trypanosoma congolense* (types de savane, de forêt, de Kilifi, de Tsavo), de *T. simiae* et de *T. brucei brucei*. La technique PCR a été appliquée sur de nombreux prélèvements provenant d'animaux ou de glossines de diverses régions du Burkina Faso, de Côte d'Ivoire et du Ghana. Il apparaît que *T. congolense*

G. tachinoides, de même que *T. simiae*, parasite de Suidés. Ces quelques réalisations ne permettent pas de se rallier à l'opinion selon laquelle les glossines du groupe de *G. palpalis* seraient de mauvais vecteurs des trypanosomes du genre *Nannomonas*. Des travaux similaires ont été réalisés sur *G. longipalpis* de Côte d'Ivoire.

Dans une autre série d'analyses par PCR, les infections du proboscis ont été identifiées à 94%, contre 44% pour celles de l'intestin, ce dernier résultat pouvant s'expliquer en partie par des infections intestinales à *T. grayi* non identifiables actuellement par PCR. Les taxons suivants ont été déterminés par PCR : *T. congolense* type savane (50%), *T. congolense* type forêt (44%), *T. vivax* (44%), *T. brucei* (28%). On note que 67% des glossines infectées le sont par deux ou trois taxons différents, ce qui n'est pratiquement pas détectable à l'analyse parasitologique.

L'observation fréquente de pourcentages élevés d'infection par *T. brucei* amène à se poser des questions importantes d'épidémiologie car ce groupe spécifique est théoriquement responsable d'une zoonose majeure. En effet, la maladie du sommeil est en recrudescence dans plusieurs pays d'Afrique de l'Ouest et les analyses par PCR ont une place de choix dans les recherches épidémiologiques. L'étude de la variabilité génétique peut aussi être effectuée par analyse du polymorphisme des isoenzymes et l'amplification aléatoire de l'ADN ou *Random Amplified Polymorphism DNA* (RAPD). Il a été démontré que *T. brucei brucei* n'existe que chez le bétail et ne peut pas survivre chez l'Homme à cause de facteurs trypanolytiques spécifiques dans le sérum de ce dernier; mais plusieurs études ont montré qu'on retrouve des trypanosomes spécifiques de l'Homme sur des animaux domestiques. Dans le cadre des enquêtes épidémiologiques, les méthodes isoenzymatiques pourront aussi être utilisées.

Les trypanosomes infectant *Glossina morsitans submorsitans* dans le Ranch de faune sauvage de Nazinga, au sud du Burkina Faso, ont été caractérisés sur des glossines capturées. Aucune différence de taux d'infection selon le sexe n'a été constatée, mais les mouches âgées sont significativement plus infectées que les plus jeunes. On note aussi les pourcentages d'infection suivants : intestin moyen (34.6%), proboscis (40.7%), intestin et proboscis (24.7%). Ces résultats seront comparés à ceux de l'analyse par PCR en utilisant cinq amorces spécifiques de *T. congolense* types savane et forêt, *T. simiae*, *T. vivax*, et *T. brucei*.

3.2 - Caractérisation des vecteurs

Des études par PCR sur la variabilité génétique des vecteurs et son importance dans l'épidémiologie des trypanosomoses africaines sont menées sur *Glossina palpalis*. Elles permettront de mettre en évidence une éventuelle structuration génétique de populations au sein d'un taxon considéré et se traduisant par des différences de capacité vectorielle ou de sensibilité vis à vis de techniques de lutte. On peut se demander, par exemple, si certaines glossines n'auraient pas une capacité innée ou induite d'éviter les pièges ou écrans de lutte et donc si elles ne pourraient pas, à la longue, reconstituer des populations réfractaires. L'étude de la variabilité génétique permet de prédire l'apparition de tels comportements. *G. palpalis gambiensis* est actuellement à l'étude. Cette espèce présente une variété de comportements remarquables, de par son large éventail d'hôtes nourriciers et de par sa capacité à s'adapter à de nouvelles situations. A titre indicatif, cette sous-

L'application de nouvelles biotechnologies pour caractériser les espèces, sous-espèces et sérotypes de trypanosomes et pour mieux comprendre l'interface vecteur-parasite est poursuivie sur financement de l'AUPELF-UREF* dans le cadre des Laboratoires associés francophones (LAF). Au total 453 glossines (37 *Glossina tachinoides*, 282 *Glossina morsitans submorsitans*, 18 *Glossina palpalis gambiensis*, 107 *Glossina longipalpis*, et 9 *Glossina medicorum*) ont été disséquées; leurs organes (tube digestif, glandes salivaires, pièces buccales) sont en cours d'analyse. Les glossines proviennent du Ghana (n= 57), de la Côte d'Ivoire (n= 116) et du Burkina Faso (n= 280). En outre, 116 isollements d'épiculot d'hématocrite (*buffy coat*) issus d'animaux vivant sur les sites mêmes des prospections entomologiques ont aussi été stockés pour subir les mêmes analyses. Une forte prédominance de *T. congolense*, type savane et type forêt est pour le moment observée.

CONCLUSION

En plus des recherches sur l'épidémiologie et la lutte contre la trypanosomose animale et ses vecteurs, le CIRDES mène aussi plusieurs études sur la productivité du bétail en milieu agropastoral traditionnel et en zone périurbaine. On constate que les agropasteurs pratiquent des croisements complexes en utilisant le bétail trypanotolérant. Les études d'une antenne de l'ILRI basée au CIRDES visent à comprendre les motivations et l'intérêt socio-économique des croisements et plus généralement de la lutte contre la trypanosomose animale dans différents systèmes de production.

Il convient de souligner l'importance pour plusieurs centres de mener conjointement des activités de recherche comme le fait actuellement le CIRDES, associé à plusieurs universités et au CIRAD-EMVT, ainsi qu'à l'ILRI et l'ITC, dans des consortia d'intérêt commun pour le développement agricole. De telles associations doivent être renforcées.

* AUPELF-UREF : Association des universités partiellement ou entièrement de langue française - Université des réseaux d'expression française.

REGIONAL TSETSE AND TRYPANOSOMIASIS CONTROL PROGRAMME
MALAWI, MOZAMBIQUE, ZAMBIA AND ZIMBABWE

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1. Introduction

In July 1995, the RTTCP was subjected to a mid-term evaluation which formed an integral part of a process of reorientation and change.

The mid-term evaluation commended the RTTCP for the achievement of many worthwhile objectives during its Preparatory Phase. It was noted that a trust relationship has been established between the participating countries; good progress has been made in research; field workers have been trained to use new survey and control techniques; and, National Programmes have received technical support. The Programme's main weaknesses were identified as being unclear lines of authority and areas of responsibility, negligible progress in addressing strategic ~~planning~~ inadequate attention to the sociological dimension of the Programme's impact, and failure to implement major activities, such as environmental monitoring and regional training, because of excessive administrative delays.

The draft report of the mid-term evaluation was presented at the ninth meeting of the Regional Standing Committee in October 1995 and, arising from this meeting, the direction of the Programme was mapped for the foreseeable future. The notable change was the shift away from the focus on the common fly-belt. It was recognized that tsetse control should support sustainable rural development wherever the presence of the fly is a constraint in the Region.

The Regional Standing Committee considered the recommendations of the Mid-term evaluation and adopted most of them.

2. ACTIVITIES

2.1 Human resources development

Since its inception, the RTTCP has recognized that

implementation of tsetse and trypanosomosis control, mainly by directly training counterparts and co-workers, as well as by providing in-service training. A structured middle-level and post-graduate training programme was only in place after the post of Training Co-ordinator was filled in October 1995. The aim of the RTTCP's training programme is to build the Region's capacity and competence to control tsetse-transmitted trypanosomosis.

In accordance with the results of a series of National training needs assessment workshops, six middle-level training courses were held and 88 people were trained between January 1996 and August 1997. The topics covered in the different courses were:

- . Trypanosomosis diagnosis for surveillance (Zimbabwe, April 1996)
- . Tsetse survey techniques (Mozambique, May 1996)
- . Data management (Zambia, July and October 1996)
- . Trypanosomosis survey methods (Malawi, April 1997)
- . Tsetse control: trap, target and odours (Zimbabwe, June 1997)

Moreover, in accordance with the recommendations made by the mid-term evaluation mission team the need for management training in tsetse control and veterinary departments were assessed in RTTCP countries.

A post graduate training programme in "Tsetse and trypanosomosis" was launched at the Faculty of Veterinary Science of the University of Zimbabwe in May 1997. The programme has a modular structure with three core modules, each of four weeks duration, in the first year (1997), and three specialisation modules, each of six weeks duration, in the second year (1998). It is a part-time course and participants are expected to return to their work places between modules. Upon successful completion of the first and second years, successful participants not proceeding to the third year will be awarded a Postgraduate Diploma in Tsetse and Trypanosomosis Control. The MSc Degree will be awarded after successful completion of the third and final, research year and acceptance of the dissertation.

The first and second module of the post-graduate training programme were held in May and August 1997.

student from Zambia and Tanzania was also admitted.

To secure the sustainability of the RTTCP's training programme, proposals have been made to incorporate the middle-level and post graduate training in the curricula of existing institutions in the Region.

A proposal for institutional strengthening to deliver middle-level training is presently awaiting approval. A proposal for a Regional Msc course addressing tsetse and trypanosomosis control, tick-borne diseases, epizootic diseases and laboratory ~~diagnostics~~ is being discussed by the deans of the veterinary faculties in the region. The model proposed by the RTTCP for such course has been well received by SADC-human Development sector since it is in line with the recently signed protocol on education and training.

2.2 Strategic planning

The primer aim of the phase II of the RTTCP was to develop a comprehensive strategic plan to link tsetse control to sustainable rural development in the ~~commonly~~ fly-belt. A series of workshops was held to devise a foundation for developing a Regional Strategic Plan. To ensure that National Plan for tsetse and trypanosomosis control were developed in a compatible manner, approach to planning was agreed between the National Programmes and consultants at the beginning of the exercise. The following questions were addressed:

- . Why control tsetse and trypanosomosis? (This involved an analysis of problem and objectives)
- . Where ~~should~~ control operations be mounted? (This entailed prioritizing control areas)
- . How should control be achieved? (This with the control ~~techniques~~)
- . When should control be done? (This considered phasing and implementation)
- . By whom will control be done? (Contractors, community or government)
- . For what benefits? (Improved agricultural production, protecting cleared areas control human sleeping sickness)

Each option chosen for consideration was then screened to ensure sustainability and economic viability. The following issues were considered:

- . Policy and institutional criteria: national macro-economic performance and policies, government staff and budget constraints, donor policies, cost recovery options.
- . Environmental criteria: effects of control on soil, grazing, forest, water and wildlife resources; anticipated human and livestock influx levels, land use planning capacities and environmental support legislation.
- . Socio-economic criteria: farming system characteristics, beneficiary groups, community perceptions, community participation, poverty alleviation and gender issues.
- . Technical criteria: control techniques and their feasibility, effect of disease on production.
- . Economic/financial criteria: expected financial and economic rates of return and benefit: ratios resulting from control.

In each of the four countries a multi-disciplinary Task Force was formed. A Strategy Analyst and Strategy Advisor, engaged by the Regional Office, assisted the Task Forces. By the middle of 1996, draft National Strategic Plans were produced and the Regional objectives related to training, research and development, information management and strategic planning had been well defined.

A Strategy Advisor, was provided under a contract between the RTTCP and the FAO. He assisted with the further development of the strategic plans and initiated socio-economic studies in Mozambique, Zambia and Zimbabwe. Emphasis in these surveys has been given to the collection of data on herd performance and animal health. In Zambia, approximately 1 200 households were interviewed in four areas, each area representing different stages in tsetse control intervention. In Mozambique, approximately 600 households were interviewed in two districts adjacent to the Zimbabwean border. In Zimbabwe, 350 households were interviewed in the Dande Communal Area. Results of these surveys will be used in strategy formulation and will be reported by the end of 1998.

the RTTCP, in November 1985, sparked prolonged public debate about the potential environmental impact of large-scale tsetse control operations in the Region. During the Preparatory Phase of the RTTCP, the Scientific Environmental Monitoring Group (SEMG) (consisting of representatives of eight national institutions of the EC Member States) monitored the environmental impact of insecticides used for tsetse control within the RTTCP. During Phase II, the SEMG's remit was extended to include the monitoring of environmental effects of changes in land use following clearance of tsetse flies. The sustainable management of natural resources requires sufficient capacity and capability at local, provincial, national and regional levels. Southern Africa has considerable capacity in this wide field. By December 1996, the SEMG produced a "Register of departments, institutions, NGOs and specialist staff involved in environmental issues".

Only recently, an expert provided by the French overseas aid, took up the post of Natural Resources Advisor at the Regional Office. The Natural Resources Advisor produced a report giving an overview of the natural resource potential of southern Africa and highlighted the threats posed to the environment. This document provides a basis for the formulation of appropriate guidelines for the management of natural resources in tsetse control areas. A workshop on Natural Resource Management and Environmental in tsetse control areas was held in March 1997 in Malawi. It helped to determine the Region's capability and capacity in Natural Resource Management and clarified the basis of a strategy for Natural Resource Management in tsetse control areas in the Region.

The Natural Resources Advisor initiated studies to evaluate the impact of tsetse control on the environment. In Zambia, sites were selected to conduct grazing land and plant use studies in tsetse-infested and tsetse-free areas. In Zimbabwe, similar studies were conducted in Chikwiso Communal Land. Criteria for monitoring changes in natural resources were drafted and were submitted to the National Co-ordinating Committees (NCCs) for comments.

The International Livestock Research Institute (ILRI) funded a Field Ecologist to work in the Zambezi Valley in Zimbabwe to evaluate the impact of "tsetse control-induced" land use changes on environmental processes and variables, especially vegetation structure and numbers and abundance of selected

RTTCP. He worked closely with the Natural Resources Advisor in conducting pilot surveys on sites to establish ~~practical~~ methodologies for monitoring environmental changes in tsetse control areas, and designed the workshops on natural resources management and environmental ~~monitoring~~ in tsetse control areas. These will address the environmental controls that should be established to monitor the impact of tsetse control operations. The outputs of these activities will contribute to the Regional Strategic Plan which will incorporate the findings of Environmental Impact Assessments. The longer term aim is to enable an independent environmental group to become established in the Region.

Land use, natural resources management and tsetse and trypanosomosis are interrelated and in all countries require a broad-based approach. The issues range from the policy level, dealing with, for example land tenure, to land use planning at a central level, to land use practices at the local level. The role of the RTTCP's Regional component in dealing with these essentially "National" matters is mainly that of promoting common understanding in an increasingly specialised field. ~~These~~ is a need to develop appropriate approaches to resource management and to agree on valid criteria for measuring change. As this is not the job of one expert the RTTCP has had broad-based assistance. It will be important to establish, maintain and consolidate links between the different partners involved in natural resources management and priority must be given to strengthening communication and exchanges between members of the NCCs and between the countries of the Region.

2.4 Research and development

The RTTCP has a strong Research and development component from which all four member countries benefit. Research has focused on improving the cost-effectiveness, convenience and applicability of methods of surveying tsetse and trypanosomosis, and assisting the transfer of improved techniques to routine operations. In March 1996, a workshop on research and development brought together scientist from institutes that are involved in tsetse and trypanosomosis research and control. Recommendations made during the workshop were used to guide the direction of the RTTCP's research component.

2.4.1 Tsetse research

odour. However, the field trials conducted at Rekomitjie failed to show that these candidate attractants had any behavioural activity. It seemed, therefore, that further progress on odour attractants would require long and costly investigations. Hence, when the contract for attractant work ended, a further contract for identification of attractants was not issued. Instead, preliminary work associated with the identification of repellents was initiated. In 1996, the University of Groningen completed the electrophysiological research on the sensory cells on the antenna of tsetse.

A team of physicists from the Royal Signals Radar Establishment, Malvern, UK, has been contracted to miniaturize a prototype tag for attachment to a tsetse, so that the fly's movements can be monitored remotely. When the tag has been miniaturized to the level expected in the current round of studies at malvern, it will be suitable for field use on large tsetse, such as female *G. brevipalpis*. Preliminary work has been conducted at the Zambian tsetse research station in Kakumbi to find a suitable site for field testing *G. brevipalpis* with such a miniaturized tag.

Most of the field research at Rekomitjie involved the completion of studies on the optimal siting of stationary baits. A scientific manuscript on bait siting has been offered for publication.

During a recent meeting held in Harare, it was agreed that tests of various insecticides applied to live hosts would be conducted at Rekomitjie as a joint venture between RTTCP and insecticides companies. Facilities at Rekomitjie, for testing insecticides on cattle, were improved and testing has started.

At Kakumbi, the two Zambian research trainees devoted their time to elucidating the effectiveness of odour attractants - matters of immediate concern to the field staff responsible for routine operations in Zambia.

diseases that the flies transmit.

For many years the RTTCP has aimed at standardizing and optimizing the diagnosis of trypanosomosis in the Region. The failure of parasitological tests to detect low levels of infection has prompted the development of indirect diagnostic methods, mainly using immuno-diagnostic techniques. An enzyme-linked immuno-sorbent assay (ELISA) has, under laboratory conditions, proved to be sensitive and specific in detecting anti-trypanosoma antibodies. The Regional Office engaged a consultant to further develop the antibody detection ELISA at the University of Zambia, using blood samples collected on filter papers. At the same time, a short-term consultant from the Centre for Tropical Veterinary Medicine (CTVM, Edinburgh, UK) assisted a laboratory technician in Harare. By the end of 1996, the antibody-ELISA was established at the Regional Office and the same test was established at Zambia's Central Veterinary Institute (CVRI). The test performed well, using a batch of Trypanosoma congolense antigen produced by the Department of Paraclinical Studies (University of Zambia), and had high sensitivity and specificity. The small diagnostic facility at the Regional Office is used by the RTTCP's National Programmes. Currently, the test is routinely used to determine the serological distribution of trypanosomosis in Mozambique, Malawi, Namibia and Zimbabwe.

Sound diagnosis requires reporting, recording, storing and analysis of relevant data. The RTTCP, to this end, has developed an appropriate information management system. During the reporting period significant progress was made in the development of a tsetse and trypanosomosis data management system for the RTTCP-Region. Initially the database was an adaptation of the Integrated Tsetse and Trypanosomosis Database (ITTD), devised to manage data from the Zambian component of the common fly-belt. The system manages data from historic and current tsetse and trypanosomosis surveys and surveillance. During an information management workshop

consultants from the University of Oxford were appointed to assist with this developmental work. Currently, an improved database (Disease and Vector Integrated Database, DAVID) is available and will be transferred to the National Programmes by the end of 1997.

Insecticide-treatments of cattle and the use of mobile baits have, on several occasions, proved to be effective ways to control tsetse. However, from veterinary and entomological points of view, some fundamental questions still need to be answered before the method can be promoted more widely. The RTTCP's research component is currently addressing these questions. Preparations for a large-scale field trial with insecticide-treated cattle in Zambia have started. At the request of Zimbabwe's Assistant Director, Tsetse and Tripanosomiasis Control Branch (TTCB), a trial was initiated to investigate the efficacy of pyrethroid-treated cattle as a barrier to tsetse re-invasion. The trial, jointly executed by the TTCB, the British-funded IPMI-Zimbabwe Project and the RTTCP, started in January 1996, in Mudzi District, Eastern Zimbabwe. Results of the trial indicate that whereas wide barriers of odour-baited targets are very effective in controlling tsetse re-invasion, broad bands occupied by insecticide-treated cattle are not.

The effect in intensive and long-term pyrethroid treatments on the prevalence of tick-borne diseases was investigated in close collaboration with the Veterinary Research Laboratory (Harare, Zimbabwe) and the FAO Regional Programme on Control of Ticks and Tick-borne Diseases (Harare, Zimbabwe). Results indicated that such intensive treatments can seriously disrupt the enzootic stability of babesiosis.

The results of a long-term study of trypanosomosis in goats conducted at Kakumbi, Zambia were reported jointly by the International Livestock Research Institute (ILRI) and the RTTCP.

basis, on its behalf. Three subcommittees of the RSC were formed to facilitate decision-marketing and promote participation in the Programmes' management. The Management and Planning, Human Resources Development and Technical subcommittees have met on several occasions. This approach ensured that decision-makers in the Region were informed on the developments and had the opportunity to participate actively in the Programme's planning.

~~The~~ broaden the scope of expertise available to the RTTCP, the Regional Office engaged numerous short-term local and international consultants. This arrangement greatly increased the momentum of the programme and was crucial in achieving satisfactory progress in strategic planning.

The Office of the Regional Co-ordinator continued funding Regional and international travel of personnel associated with the Programme. Over 150 persons were funded, enabling them to attend Regional meetings and training workshops.

Bilateral meetings were held to prepare detailed plans for joint surveys between Mozambique and Zambia. A joint tsetse survey was conducted between September and November 1996. A new joint survey, to be conducted before the end of 1997, has been planned.

The Regional Office arranged for two veterinarians (one from Zambia and one from Zimbabwe) to visit eastern Caprivi district, to conduct a survey of bovine trypanosomosis. This was satisfactorily completed. A full report on the parasitological and serological distribution of trypanosomosis in the Eastern Caprivi is available.

The Zambia/Zimbabwe joint operation in Kariba/Lusitu hilly area resulted in the successful control of *Glossina pallidipes*. The future of the Zambia/Zimbabwe cross-border operations was discussed during a bilateral meeting.

A media relations consultant was engaged to improve the availability of information about the RTTCP. A video-recording of the Programme's activities was produced and a display stand and accompanying brochures on the RTTCP were prepared. The RTTCP continued to contribute towards the production of Tsetse and Trypanosomiasis Information Quarterly (TTIQ).

system was completed March 1997. It comprises an AWP&CE based on a logical framework format, monitoring lists and a computerized accounting system which include financial forecasts. The Regional Office is now in a position to assist countries to establish similar systems.

3. CONCLUSION

The scale of most tsetse control operations in the Region was reduced to bring them in line with the government budgetary allocations for animal disease control in general, and tsetse control in particular. This will improve the sustainability of control activities once donor funding of the RTTCP has been phased out. Priorization and rationalization of tsetse control has been, and will continue to be, one of the main tasks of the National Co-ordinating Committees established in each country of the Region. They will have to make strategy decisions as to where, when and how to control tsetse. Co-ordination within the RTTCP aimed to facilitate such decision-making by developing proving tools to assist in the planning process.

For the RTTCP's plans to retain relevance, the scope of strategic planning needed to be widened to embrace consideration of the livestock sector as a whole. During a special meeting of the Regional Standing Committee in July 1996, the Directors of Veterinary Services recognized the advantages of working at a Regional level and noted that the transfer of funding of the Programme from the donor to the countries of the Region should be gradual and programmed. Since donor funding will not last indefinitely, the Programme must demonstrate that it is cost-effective and has built-in sustainability. National and Regional commitment must be evident and the services offered by the RTTCP, or its successor, should focus on alleviating the major animal health constraints on production. Two consultants appointed by the Committee toured the Region and made a preliminary assessment of whether or not the countries of the Region need support from a Regional Programme that could underpin broadly the livestock sector in southern Africa. The consultants reported a remarkable concurrence of views between the different countries. In particular, it was felt that a new Regional Programme should not interfere with the implementation of National Programmes but that it should offer support of address cross/cutting issues, such as human resources development, research and environmental monitoring, which had already been identified as important to the RTTCP's future role.

A consultancy to prepare a new Regional Programme should

~~PROGRESS REPORT~~
REGIONAL TSETSE AND TRYPANOSOMIASIS CONTROL PROGRAMME,
MALAWI, MOZAMBIQUE, ZAMBIA AND ZIMBABWE

~~SUBMITTED TO THE 24TH MEETING OF THE ISCTRC,
MAPUTO, MOZAMBIQUE
29 September TO 3 October 1997~~

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1. Introduction

In July 1995, the RTTCP was subjected to a mid-term evaluation which formed an integral part of a process of reorientation and change.

The mid-term evaluation commended the RTTCP for the achievement of many worthwhile objectives during its Preparatory Phase. It was noted that a trust relationship has been established between the participating countries; good progress has been made in research; field workers have been trained to use new survey and control techniques; and, National Programmes have received technical support. The Programme's main weaknesses were identified as being unclear lines of authority and areas of responsibility, negligible progress in addressing strategic planning, inadequate attention to the sociological dimension of the Programme's impact, and failure to implement major activities, such as environmental monitoring and regional training, because of excessive administrative delays.

The draft final report of the mid-term evaluation was presented at the ninth meeting of the Regional Standing Committee in October 1995 and, arising from this meeting, the direction of the Programme was mapped for the foreseeable future. The notable change was the shift away from the focus on the common fly-belt. It was recognized that tsetse control should support sustainable rural development wherever the presence of the fly is a constraint in the Region.

The Regional Standing Committee considered the recommendations of the Mid-term evaluation and adopted most of them.

2. ACTIVITIES

2.1 Human resources development

Since its inception, the RTTCP has recognized that training and staff development are essential for developing the Region's capacity. RTTCP professional staff have contributed to improving the knowledge and skills of personnel involved in the planning and implementation of tsetse and trypanosomiasis control, mainly by directly training counterparts and co-workers, as well as by providing in-service training. A structured middle-level and post-graduate training programme was only in place after the post of Training Co-ordinator

was filled in October 1995. The aim of the RTTCP's training programme is to build the Region's capacity and competence to control tsetse-transmitted trypanosomosis.

In accordance with the results of a series of National training needs assessment workshops, six middle-level training courses were held and 88 people were trained between January 1996 and August 1997. The topics covered in the different courses were:

- Trypanosomosis diagnosis for surveillance (Zimbabwe, April 1996)
- Tsetse survey techniques (Mozambique, May 1996)
- Data management (Zambia, July and October 1996)
- Trypanosomosis survey methods (Malawi, April 1997)
- Tsetse control: trap, targets and odours (Zimbabwe, June 1997)

Moreover, in accordance with the recommendations made by the mid-term evaluation mission team the need for management training in tsetse control and veterinary departments were assessed RTTCP countries.

A post graduate training programme in "Tsetse and trypanosomosis" was launched at the Faculty of Veterinary Science of the University of Zimbabwe in May 1997. The programme has a modular structure with three core modules, each of four weeks duration, in the first year (1997), and three specialisation modules, each of six weeks duration, in the second year (1998). It is a part-time course and participants are expected to return to their work places between modules. Upon successful completion of the first and second years, successful participants not proceeding to the third year will be awarded a *Postgraduate Diploma in Tsetse and Trypanosomosis Control*. The *MSc Degree* will be awarded after successful completion of the third and final, research year and acceptance of the dissertation.

The first and second module of the post-graduate training programme were held in May and August 1997. A second module was held in August of the same year. Fourteen full time students and one occasional student attended the first module. Students came from Botswana (1), Mozambique (2), Tanzania (1), Uganda (1), Zambia (4) and Zimbabwe (5): an occasional student from Zambia and Tanzania was also admitted.

To secure the sustainability of the RTTCP's training programme, proposals have been made to incorporate the middle-level and post graduate training in the curricula of existing institutions in the Region.

A proposal for institutional strengthening to deliver middle-level training is presently awaiting approval. A proposal for a Regional MSc course addressing tsetse and trypanosomosis control, tick and tick-borne diseases, epizootic diseases and laboratory diagnostics is being discussed by the deans of the veterinary faculties in the Region. The model proposed by the RTTCP for such courses has been well received by SADC-Human Resources Development sector since it is in line with the recently signed protocol on education and training.

2.2 Strategic planning

The prime aim of the Phase II of the RTTCP was to develop a comprehensive strategic plan to link tsetse control to sustainable rural development in the common fly-belt. A series of workshops was held to devise a foundation for developing a Regional Strategic Plan. To ensure that National Plans for tsetse and trypanosomosis control were developed in a compatible manner, a standard approach to planning was agreed between the National Programmes and consultants at the beginning of the exercise. The following questions were addressed:

- Why control tsetse and trypanosomosis? (This involved an analysis of problems and objectives)
- Where should control operations be mounted? (This entailed prioritizing control

- When should control be done? (This considered phasing and implementation)
- By whom will control be done? (Contractors, community or government)
- For what benefits? (Improved agricultural production, protecting cleared areas control human sleeping sickness)
- At what cost? (Operational and environmental costs)
- Paid for by whom? (Sources of funding: government, donor, beneficiary)

Each option chosen for consideration was then screened to ensure sustainability and economic viability. The following issues were considered:

- Policy and institutional criteria: national macro-economic performance and policies, government staff and budget constraints, donor policies, cost recovery options.
- Environmental criteria: effects of control on soil, grazing, forest, water and wildlife resources; anticipated human and livestock influx levels, land use planning capacities and environmental support legislation.
- Socio-economic criteria: farming system characteristics, beneficiary groups, community perceptions, community participation, poverty alleviation and gender issues.
- Technical criteria: control techniques and their feasibility, effect of disease on production.
- Economic/financial criteria: expected financial and economic rates of return and benefit:cost ratios resulting from control.

In each of the four countries a multi-disciplinary Task Force was formed. A Strategy Analyst and Strategy Advisor, engaged by the Regional Office, assisted the Task Forces. By the middle of 1996, draft National Strategic Plans were produced and the Regional objectives related to training, research and development, information management and strategic planning had been well defined.

A Strategy Advisor, was provided under a contract between the RTTCP and the FAO. He commenced his duties in March 1997. He assisted with the further development of the strategic plans and initiated socio-economic studies in Mozambique, Zambia and Zimbabwe. Emphasis in these surveys has been given to the collection of data on herd performance and animal health. In Zambia, approximately 1 200 households were interviewed in four areas, each area representing different stages in tsetse control intervention. In Mozambique, approximately 600 households were interviewed in two districts adjacent to the Zimbabwean border. In Zimbabwe, 350 households were interviewed in the Dande Communal Area. Results of these surveys will be used in strategy formulation and will be reported by the end of 1998.

2.3 Natural resources management

The signing of the financing agreement for Phase I of the RTTCP, in November 1985, sparked prolonged public debate about the potential environmental impact of large-scale tsetse control operations in the Region. During the Preparatory Phase of the RTTCP, the Scientific Environmental Monitoring Group (SEMG) (consisting of representatives of eight national institutions of the EC Member States) monitored the environmental impact of insecticides used for tsetse control within the RTTCP. During Phase II, the SEMG's remit was extended to include the monitoring of environmental effects of changes in land use following clearance of tsetse flies. The sustainable management of natural resources requires sufficient capacity and capability at local, provincial, national and regional levels. Southern Africa has considerable capacity in this wide field. By December 1996, the SEMG produced a "Register of departments, institutions, NGOs and specialist staff involved in environmental issues".

Only recently, an expert provided by the French overseas aid, took up the post of Natural Resources Advisor at the Regional Office. The Natural Resources Advisor produced a report

appropriate guidelines for the management of natural resources in tsetse control areas. A workshop on Natural Resource Management and Environmental Monitoring in tsetse control areas was held in March 1997 in Malawi. It helped to determine the Region's capability and capacity in Natural Resource Management and clarified the basis of a strategy for Natural Resource Management in tsetse control areas in the Region.

The Natural Resources Advisor initiated several studies to evaluate the impact of tsetse control on the environment. In Zambia, sites were selected to conduct grazing land and plant use studies in tsetse-infested and tsetse-free areas. In Zimbabwe, similar studies were conducted in Chikwiso Communal Land. Criteria for monitoring changes in natural resources were drafted and were submitted to the National Co-ordinating Committees (NCCs) for comments.

The International Livestock Research Institute (ILRI) funded a Field Ecologist to work in the Zambezi Valley in Zimbabwe to evaluate the impact of "tsetse control-induced" land use changes on environmental processes and variables, especially vegetation structure and numbers and abundance of selected animal groups.

The (SEMGS) Regional Representative assessed environmental policies, priorities and environment-oriented activities in various countries of the RTTCP. He worked closely with the Natural Resources Advisor in conducting pilot surveys on sites to establish practical methodologies for monitoring environmental changes in tsetse control areas, and designed the workshops on natural resources management and environmental monitoring in tsetse control areas. These will address the environmental controls that should be established to monitor the impact of tsetse control operations. The outputs of these activities will contribute to the Regional Strategic Plan which will incorporate the findings of Environmental Impact Assessments. The longer term aim is to enable an independent environmental group to become established in the Region.

SE EN VALEUR DES TERRES
Land use, natural resources management and tsetse and trypanosomosis are interrelated and, in all countries require a broad-based approach. The issues range from the policy level, dealing with, for example land tenure, to land use planning at a central level, to land use practices at the local level. The role of the RTTCP's Regional component in dealing with these essentially "National" matters is mainly that of promoting common understanding in an increasingly specialised field. There is a need to develop appropriate approaches to resource management and to agree on valid criteria for measuring change. As this is not the job of one expert the RTTCP has had broad-based assistance. It will be important to establish, maintain and consolidate links between the different partners involved in natural resources management and priority must be given to strengthening communication and exchanges between members of the NCCs and between the countries of the Region.

2.4 Research and development

The RTTCP has a strong Research and development component from which all four member countries benefit. Research has focused on improving the cost-effectiveness, convenience and applicability of methods of surveying tsetse and trypanosomosis, and assisting the transfer of improved techniques to routine operations. In March 1996, a workshop on research and development brought together scientists from institutes that are involved in tsetse and trypanosomosis research and control. Recommendations made during the workshop were used to guide the direction of the RTTCP's research component.

2.4.1 Tsetse research

Using the recently refined methods of collecting and purifying the very volatile fraction of most odours, the Natural Resources Institute identified several new candidates for the unidentified attractants in cattle odour. However, the field trials conducted at Rekomitjie failed to show that these candidate attractants had any behavioural activity. It seemed, therefore, that further progress on odour attractants would require long and costly investigations.

repellents was initiated. In 1996, the University of Groningen completed the electrophysiological research on the sensory cells on the antenna of tsetse.

A team of physicists from the Royal Signals Radar Establishment, Malvern, UK, has been contracted to miniaturize a prototype tag for attachment to a tsetse, so that the fly's movements can be monitored remotely. When the tag has been miniaturized to the level expected in the current round of studies at Malvern, it will be suitable for field use on large tsetse, such as female *G. brevipalpis*. Preliminary work has been conducted at the Zambian tsetse research station in Kakumbi to find a suitable site for field testing *G. brevipalpis* with such a miniaturized tag.

Most of the field research at Rekomitjie involved the completion of studies on the optimal siting of stationary baits. A scientific manuscript on bait siting has been offered for publication.

During a recent meeting held in Harare, it was agreed that tests of various insecticides applied to live hosts would be conducted at Rekomitjie as a joint venture between RTTCP and insecticides companies. Facilities at Rekomitjie, for testing insecticides on cattle, were improved and testing has started.

At Kakumbi, the two Zambian research trainees devoted their time to elucidating the effectiveness of odour attractants - matters of immediate concern to the field staff responsible for routine operations in Zambia.

2.4.2 Trypanosomosis research

The change in the RTTCP's goal from tsetse eradication to tsetse control has placed more emphasis on the management of the diseases that the flies transmit.

For many years the RTTCP has aimed at standardizing and optimizing the diagnosis of trypanosomosis in the Region. The failure of parasitological tests to detect low levels of infection has prompted the development of indirect diagnostic methods, mainly using immuno-diagnostic techniques. An enzyme-linked immuno-sorbent assay (ELISA) has, under laboratory conditions, proved to be sensitive and specific in detecting anti-trypanosomal antibodies. The Regional Office engaged a consultant to further develop the antibody detection ELISA at the University of Zambia, using blood samples collected on filter papers. At the same time, a short-term consultant from the Centre for Tropical Veterinary Medicine (CTVM, Edinburgh, UK) assisted a laboratory technician in Harare. By the end of 1996, the antibody-ELISA was established at the Regional Office and the same test was established at Zambia's Central Veterinary Institute (CVRI). The test performed well, using a batch of *Trypanosoma congolense* antigen produced by the Department of Paraclinical Studies (University of Zambia), and had high sensitivity and specificity. The small diagnostic facility at the Regional Office is used by the RTTCP's National Programmes. Currently, the test is routinely used to determine the serological distribution of trypanosomosis in Mozambique, Malawi, Namibia and Zimbabwe.

Sound diagnosis requires reporting, recording, storing and analysis of relevant data. The RTTCP, to this end, has developed an appropriate information management system. During the reporting period significant progress was made in the development of a tsetse and trypanosomosis data management system for the RTTCP-Region. Initially the database was an adaptation of the Integrated Tsetse and Trypanosomosis Database (ITTD), devised to manage data from the Zambian component of the common fly-belt. The system manages data from historic and current tsetse and trypanosomosis surveys and surveillance. During an information management workshop attended by veterinary epidemiologists from Botswana, Malawi, Mozambique, Namibia, Zambia and Zimbabwe the technical requirements for further development of this database were defined. Short-term consultants from the University of Oxford were appointed to assist with this developmental work. Currently, an improved database (Disease and Vector Integrated Database, DAVID) is available and will be transferred to the National Programmes by the end of 1997.

Regional staff maintain close contact with RTTCP personnel and in 1996 made a total of 103 missions covering 401 days.

Establishment of a Monitoring and Evaluation (M&E) system was completed in March 1997. It comprises an AWP&CE based on a logical framework format, monitoring lists and a computerized accounting system which include financial forecasts. The Regional Office is now in a position to assist countries to establish similar systems.

3. CONCLUSION

The scale of most tsetse control operations in the Region was reduced to bring them in line with the government budgetary allocations for animal disease control in general, and tsetse control in particular. This will improve the sustainability of control activities once donor funding of the RTTCP has been phased out. Prioritization and rationalization of tsetse control has been, and will continue to be, one of the main tasks of the National Co-ordinating Committees established in each country of the Region. They will have to make strategy decisions as to where, when and how to control tsetse. Co-ordination within the RTTCP aimed to facilitate such decision-making by developing and providing tools to assist in the planning process.

For the RTTCP's plans to retain relevance, the scope of strategic planning needed to be widened to embrace consideration of the livestock sector as a whole. During a special meeting of the Regional Standing Committee in July 1996, the Directors of Veterinary Services recognized the advantages of working at a Regional level and noted that the transfer of funding of the Programme from the donor to the countries of the Region should be gradual and programmed. Since donor funding will not last indefinitely, the Programme must demonstrate that it is cost-effective and has built-in sustainability. National and Regional commitment must be evident and the services offered by the RTTCP, or its successor, should focus on alleviating the major animal health constraints on production. Two consultants appointed by the Committee toured the Region and made a preliminary assessment of whether or not the countries of the Region need support from a Regional Programme that could underpin broadly the livestock sector in southern Africa. The consultants reported a remarkable concurrence of views between the different countries. In particular, it was felt that a new Regional Programme should not interfere with the implementation of National Programmes but that it should offer support to address cross-cutting issues, such as human resources development, research and environmental monitoring, which had already been identified as important to the RTTCP's future role.

A consultancy to prepare a new Regional Programme should be completed by mid-1998.

13.5 1997
6 months

COE

COE

viability

1. control
2. surveillance
3. management

Katondo

***Programme Against African
Trypanosomiasis***

**A joint initiative of
FAO/WHO/OAU/IAEA**

Future Prospects

- ◆ **PAAT is the basis for international collaborative action in the broader field of animal diseases and livestock development**
- ◆ **PAAT provides a foundation for strengthening formal collaboration between development agencies**
- ◆ **PAAT moves towards the integration of activities that promote agriculture and human health**

Future Resources

- ◆ **DFID/UK proposes 240 000 pounds to information systems development in FAO over 2 years**
- ◆ **EC proposes the involvement of PAAT in technical support to regional programmes involving some ECU 80 million**
- ◆ **Others show continued interest in supporting regular activities i.e. meetings, publications, technical support and advice, position papers etc.**

SOME ACHIEVEMENTS TO DATE

1. Publication - TTIQ, Memorandum, etc
2. Information System initiated :
 - Resource Inventory
 - Knowledge Base
 - GIS
3. Management Planning completed.
4. Harmonization with structures within
FAO/WHO/IAEA/OAU-IBAR progressed
5. Endorsement of PAAT by Governing
Bodies of WHO and forthcoming
presentation to FAO
6. Position Papers prepared
7. Research Priorities identified
8. Policies developed through annual meeting
of PAAT Committee

PAAT Resources

- ◆ **R.P. Funds of FAO,WHO,OAU/IBAR &IAEA**
- ◆ **DFID/UK funds for Committe Chairman, TTIQ, representation at meetings & information systems development**
- ◆ **EC funds for strategy development in SA, TTIQ, & support to meetings**
- ◆ **CIRAD/France funds for meetings & proposing to support TTIQ**
- ◆ **supported by self-funded activities of many involved partners**

THE PROGRAMME STRUCTURE

PARTICIPANTS

ORGANISATION

ACTIVITY

SENIOR ADVISORS, DONORS,
SCIENTISTS & PLANNERS

PROGRAMME COMMITTEE

EXECUTIVE/POLICY/
DIRECTION

MANDATED INTERNATIONAL
ORGANISATIONS

SECRETARIAT

COORDINATION/ADMIN.

COORDINATORS OF
ADVISORY GROUPS, REPS.
OF DONORS, MEMBER
STATES & RESEARCH
INSTITUTES

R & D

PPI

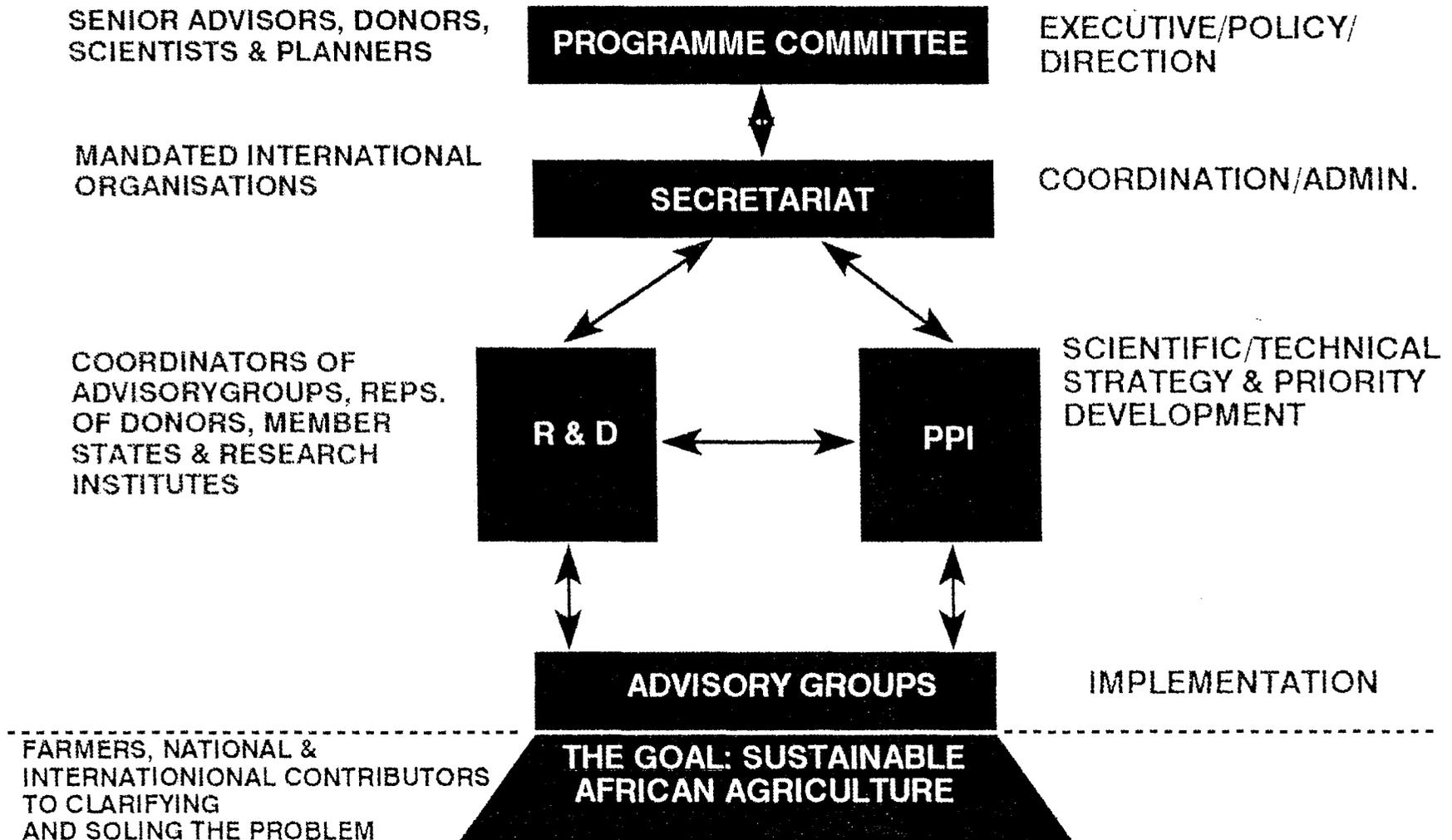
SCIENTIFIC/TECHNICAL
STRATEGY & PRIORITY
DEVELOPMENT

ADVISORY GROUPS

IMPLEMENTATION

FARMERS, NATIONAL &
INTERNATIONAL CONTRIBUTORS
TO CLARIFYING
AND SOLVING THE PROBLEM

**THE GOAL: SUSTAINABLE
AFRICAN AGRICULTURE**



Programme Committee
PAAT
Policy and Focus
Investment of funds

Joint Secretariat
FAO/WHO/OAU/IAEA
Coordination and Facilitation

Advisory Group
Research and Development
CGIAR Group
Regional Institutes NARS, NGOs, universities ETC.

Advisory Group
Policy, Planning and Implementation
Governments
Technical agencies, NGOs, Farmers. etc

Programme Structures:

The Programme Committee:

- The Donor Community assisted by executive and technical Advisors*
- Provides Policy decisions and overall focus*
- Defines strategy*
- Facilitates implementation of control in the broader context of agriculture and human health*

Strategies and Planning

Strategies and Planning for Animal and Human trypanosomiasis Control in East and Southern Africa

Dr. R. Connor

Strategies and Planning for Animal and Human Trypanosomiasis Control in West and Central Africa

Dr. C. Laveissière

Host Management

Host Management through Trypanotolerance Utilization

Dr. L. Dempfle

Trypanotolerance : Research and Development

Dr. A. Teale

Parasite Management

Parasite Management for Animal Trypanosomiasis

Dr. S. Geerts

*Vector Management : Techniques other than
Bait Attractants*

Dr. I. Maudlin

*Vector Management : Tsetse Behaviour and
Ecology*

Mr. W. Shereni

Diagnosis and Epidemiology

*Diagnosis and Epidemiology of Animal
Trypanosomiasis*

Dr. R. Dwinger

*Diagnosis and Epidemiology of Sleeping
Sickness*

Dr. N. van Miervenne

Vector Management

*Bait Techniques Research and Development :
East and Southern Africa*

Dr. S. Mihok

*Bait Techniques Research and Development :
West and Central Africa*

Dr. B. Bauer

*Bait Techniques Implementation : Southern and
East Africa*

Mr. R. Allsopp

*Bait Techniques Implementation : West and
Central Africa*

Dr. A. Douati

LIST OF ADVISORY GROUP COORDINATORS

Land-use and Environment

*Impact of Disease and Disease Control on
Land-Use and Environment*

Dr. J. Rogers

*Impact of Insecticide on Land-Use and
Environment*

Prof P. Nagel

Socio-Economics

*Disease Impact in Socio-Economic Terms, on
Rural Development*

Dr. B. M. Swallow

- ◆ **Headed voluntarily by elected Coordinators**
- ◆ **Brings together workers in specific interest groups**
- ◆ **Involves Governments, donor agencies, research institutes, NGOs, regional and international development agencies, etc.**
- ◆ **Meets annually**
- ◆ **Mainly funded by Secretariat**

Technical Advisory Groups

- Functions

- ◆ **Ensures collaboration and interaction across Groups**
- ◆ **Defines problems and makes technical and strategic recommendations to Programme Committee**
- ◆ **Provides advice on the priority areas of research and control for financial investment**
- ◆ **Focal point for secretariat in collection and dissemination of data**
- ◆ **Links to rural communities**

The Secretariat

- ◆ **Joint FAO/WHO/OAU/IAEA**
- ◆ **Provides International Coordination**
- ◆ **Collects, analyses and disseminates information**
- ◆ **Maintains a resource inventory and data base**
- ◆ **Defines priorities**
- ◆ **Coordinates research with needs**
- ◆ **Technical and policy assistance**
- ◆ **Runs the PAAT**

Outputs

- ◆ **Trypanosomiasis and tsetse research and control activities coordinated**
- ◆ **Information on policies, resources and activities are managed effectively**
- ◆ **Guidance on policy analysis and strategy formulation is provided**
- ◆ **Capacity building programmes strengthened**
- ◆ **PAAT managed effectively and efficiently**

Overall Goal

- ◆ **Sustainable increase of income, food security and human welfare in trypanosomiasis affected areas**

Purpose

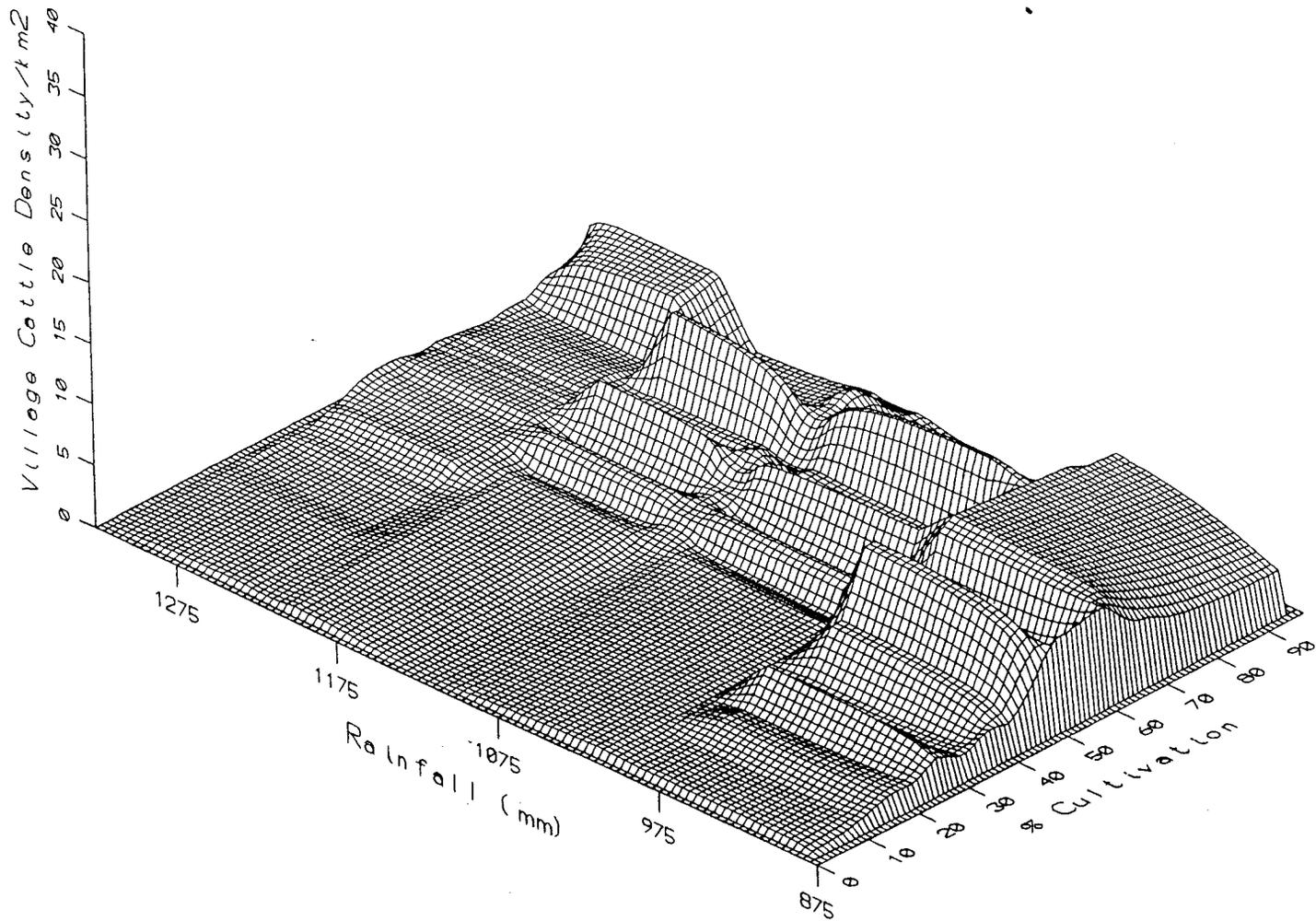
- ◆ **To promote and facilitate Integrated and effective Trypanosomiasis control**

PROMOTING AGRICULTURE & HEALTH

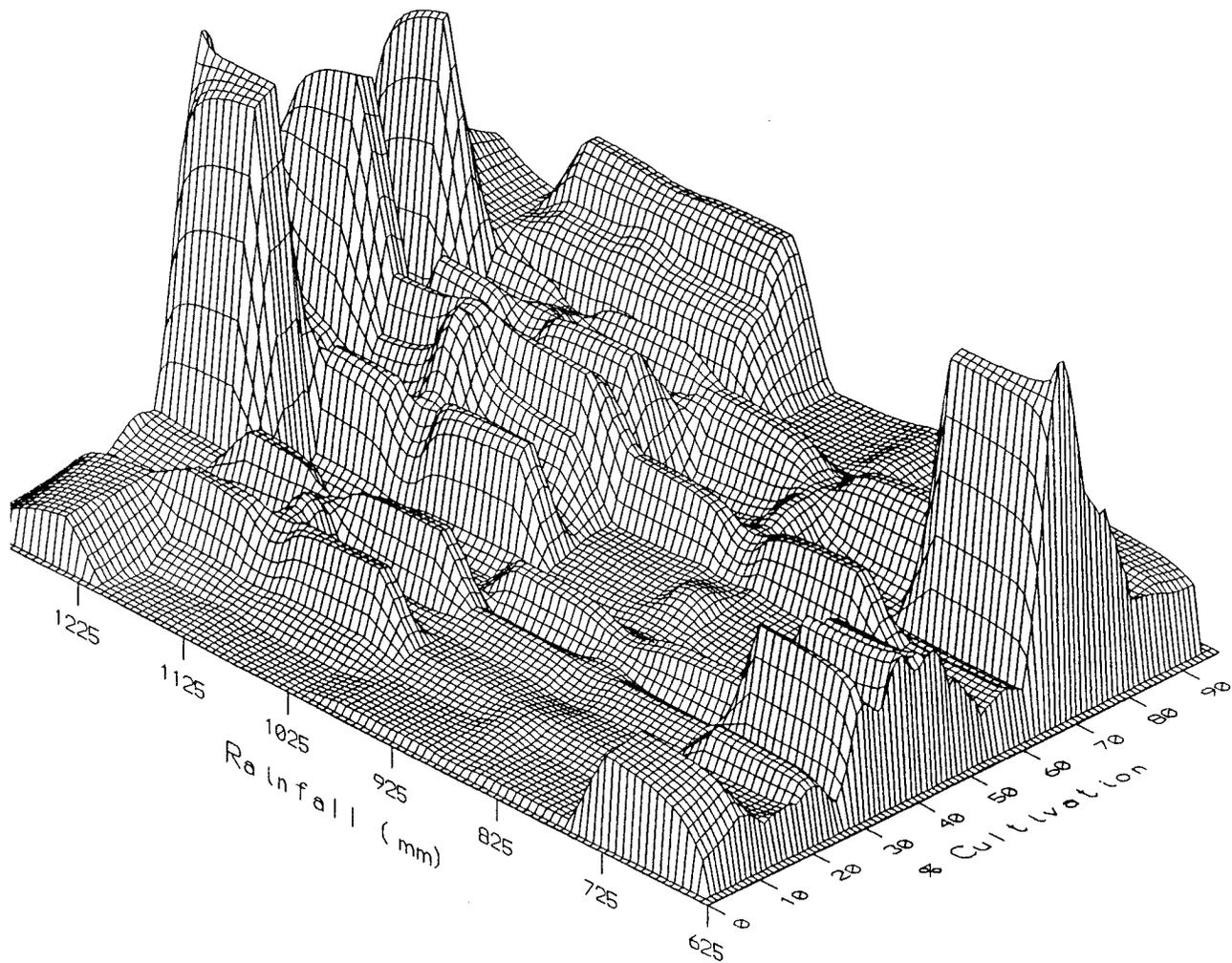




Tsetse present



Tsetse absent



SITUATION DES TRYPANOSOMOSES ANIMALES ET HUMAINES AU BURKINA FASO

Rapport national pour la 24^è réunion du Conseil Scientifique pour la Recherche et la Lutte contre les Trypanosomoses

INTRODUCTION

L'élevage et l'agriculture constitue 90% des activités de la population du pays. Suite aux sécheresses répétées depuis les années 1970, les troupeaux de bovins et de petits ruminants qui occupaient jusque là l'espace sahélien sont descendus vers le sud à la recherche du pâturage au contact de nouvelles pathologies dominées par les trypanosomoses animales.

Le Burkina a tenté avec l'aide de ses partenaires de mettre en place un certain nombre d'actions en vue de contrôler ces trypanosomoses.

I. SITUATION ACTUELLE DES TAA AU BURKINA FASO

Elle peut être résumée à travers les données entomologiques, protozoologiques et l'importance économique de la maladie dans le pays.

- Au plan entomologique, on rencontre les principales espèces de glossines suivantes : *Glossina tachinoides*, *G. palpalis gambiensis*, *G. morsitans submorsitans*. Ces glossines occupent les régions du territoire burkinabè situées au Sud du treizième parallèle. Ce qui correspond à l'isohyète 800 mm.

- Les enquêtes protozoologiques ont permis d'identifier quatre espèces de trypanosomes pathogènes qui ont la même distribution que celle des glossines. Il s'agit de :

Trypanosoma vivax

Trypanosoma congolense

Trypanosoma simiae

Trypanosoma brucei

Les deux premières espèces sont les plus représentées chez le bétail.

La prévalence de la trypanosomose animale africaine est très élevée selon les régions. Elle varie de 5 à 80% dans les troupeaux.

- L'importance économique de la maladie peut être appréciée à travers un certain nombre de données dont : les pertes directes et indirectes liées aux motilités et la baisse de la productivité des animaux. Les services vétérinaires burkinabè enregistrent une forte consommation annuelle des trypanocides qui équivaut à un milliard de F CFA (soit environ 2 millions de dollars). Heureusement, le pays abrite un important cheptel de bétail trypanotolérant évalué à environ 850000 têtes de bovins et autant en petits ruminants.

II. SITUATION EPIDEMIOLOGIQUE DE LA THA

Les activités spécifiques de lutte contre la trypanosomiase humaine africaine au Burkina Faso ont été relativement abandonnées depuis 1989. Jusqu'en 1993 le dépistage de cette maladie était réalisé à travers deux circuits :

- le dépistage actif par l'équipe centrale de coordination basée à Ouagadougou

- le dépistage passif dans les structures régionales initialement basées à Banfora, Bobo-Dioulasso et Koudougou.

Le traitement de tous les malades dépistés se faisait dans les centres de santé disposant d'au moins un médecin. La situation actuelle ne peut pas être suffisamment caractérisée de nos jours. Cependant il a été noté passivement au cours des dernières années des cas autochtones de malades venant des provinces du Houet, de la Comoé, de la Sissili, et du Mouhoun. Une évaluation épidémiologique de la maladie a été entreprise en 1996 dans 13 villages sur 53 :

- 3602 personnes ont été examinées dans les provinces du Houet et de la Comoé. 203 suspects (par la méthode du CATT test) ont été identifiés.

Sur la base des recoupements avec les anciens foyers, les informations fournies par le CIRDES de Bobo-Dioulasso sur la prévalence de la maladie animale et le taux d'infestation des glossines permettent de dire que le risque de résurgence de la maladie pourrait s'étendre aux provinces suivantes : Houet, Comoé, Mouhoun, Sissili, Poni, Nounbiel, Bougouriba, Nahouri.

III. LES ACTIVITES DE CÔNTROLE DE LA TAA ET DE LA THA

Il existe plusieurs structures qui sont impliquées dans la lutte contre la TAA au Burkina Faso. Le CIRDES a beaucoup contribué à la connaissance de la maladie et à son contrôle. Depuis la création de l'ELAT (Ecole de Lutte Anti-tsétsé), du CRTA (puis CIRDES) les actions entrepris visent simultanément l'agent et le vecteur. Les trypanocides seront certainement encore utilisés pendant longtemps mais les méthodes de lutte mises en place et vulgarisées ont eu un succès franc de sorte qu'elles ont été vite adoptées par les éleveurs. Le Burkina souhaite que les actions de lutte contre les trypanosomes :

- puissent permettre d'identifier les réservoirs méconnus chez les animaux domestiques et sauvages

- s'inscrivent sur un plan régional afin de permettre de mieux exploiter les résultats et de mieux coordonner les activités de lutte entre les Etats.

Concernant la THA les stratégies supplémentaires à développer se résument comme suit :

- Information, Education et Communication (I.E.C) concernant la maladie
- Un système de surveillance épidémiologique
- La formation du personnel de santé
- La collaboration avec les services de santé animale
- la prise en charge des cas dépistés
- La supervision en cascade des activités

SITUATION DES TRYPANOSOMOSES ANIMALES AU BURKINA FASO

INTRODUCTION

L'élevage constitue une des principales activités des acteurs du monde rural. Suite à des sécheresses répétées depuis les années 1970, les troupeaux particulièrement les bovins et petits ruminants qui occupaient jusque là l'espace sahélien sont descendus vers le sud à la recherche de pâturages. Ils sont entrés en contact avec de nouvelles pathologies où dominent les trypanosomoses animales.

Le Burkina Faso a tenté avec l'aide de ses partenaires au développement de mettre en place un certain nombre d'actions en vue de contrôler ces trypanosomoses.

SITUATION ACTUELLE DES TAA AU BURKINA FASO

Elle peut être appréciée à travers les données entomologiques protozoologiques et l'importance économique de la maladie dans le pays.

*Au plan entomologique. On rencontre les principales espèces suivantes : *Glossina tachinoides*, *G. palpalis gambiensis*, *G. morsitans sub morsitans*. Ces glosines occupent les régions du territoire burkinabè situées au Sud du treizième parallèle. Ce qui correspond à l'isohyète 800 mm.

*Les enquêtes protozoologiques ont permis d'identifier trois types de trypanosomoses pathogènes qui ont la même distribution que celle des glossines. Il s'agit de :

Trypanosoma vivax
Trypanosoma congolense
Trypanosoma brucei

- La prévalence de la Trypanosomose Animale Africaine est très élevée au Burkina Faso et varie selon les régions (5 à 80% dans les troupeaux).

* L'importance économique de la Trypanosomose Animale Africaine peut être appréciée à travers un certain nombre de données dont : les pertes directes et indirectes liées aux mortalités et baisses de la productivité des animaux.

Les Services Vétérinaires burkinabè enregistrent une forte consommation annuelle des trypanocides qui avoisinerait le milliard de F CFA. Fort heureusement le pays abrite un important cheptel de bétail trypanotolérant évalué à environ 850 000 têtes de bovins et autant de petits ruminants.

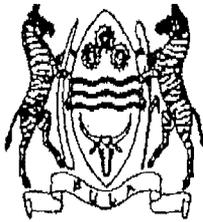
ACTIVITES DE CONTRÔLE DE LA TAA AU BURKINA FASO

Il existe plusieurs structures qui sont impliquées dans la lutte contre la Trypanosomiase Animale Africaine au Burkina Faso.

Actuellement les actions qui sont entreprises visent tant l'agent que le vecteur. Ainsi de tout temps les éleveurs et les agents ont eu recours aux trypanocides pour lutter contre la maladie.

Mais depuis l'installation au Burkina Faso de l'ELAT (Ecole de lutte anti Tsé-Tsé) du CRTA (puis le CIRDES) les programmes de lutte prennent en compte tant l'agent que le vecteur. Plusieurs méthodes de lutte ont été mises au point et vulgarisées. Ces actions de lutte ont eu un succès franc sur le plan technique. Ce qui fait qu'elles ont été vite adoptées par les populations d'éleveurs.

Le Burkina Faso souhaiterait que les actions de lutte contre les trypanosomoses s'inscrivent sur un plan sous régional afin de permettre de mieux capitaliser les résultats obtenus et mieux coordonner les activités entre les Etats.



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COUNTRY REPORT:
BOTSWANA

BY
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**A REPORT PRESENTED TO THE 24th ISCTRC
CONFERENCE**

**MAPUTO, MOZAMBIQUE
29th SEPTEMBER-----3rd OCTOBER 1997.**

BOTSWANA COUNTRY REPORT

Department of Animal Health and Production

Tsetse Control Division

BACKGROUND

Only one species of tsetse fly occurs in Botswana, this is *Glossina morsitans centralis* and it is at the southern limit of its distribution in Africa. In Botswana, tsetse only occur in the northern district of Ngamiland - in the Okavango Delta and along the Kwando/Linyanti/Chobe River system which forms the international border between Botswana and Namibia

Since the turn of the 20th Century tsetse control has been the primary means of controlling trypanosomiasis in Botswana and it is the sole occupation of the Tsetse Control Division.. The distribution of tsetse has been substantially reduced from the historical limits and neither human nor bovine trypanosomiasis has been reported in Botswana since 1985

The dangers of travelling through tsetse infested areas of Botswana were recognised by Livingstone, Selous and other European explorers in the 1850s and reports of heavy tsetse infestations were reported until 1896 when a continental epidemic of rinderpest swept down from East Africa to South Africa. Cattle and game populations were decimated and so too were tsetse flies; which feed only on mammalian blood. Only a few small pockets of tsetse survived in Botswana.

By the turn of the century cattle and game had recovered substantially and within 20 years there was a flourishing export trade of cattle from Ngamiland to Southern Rhodesia (now Zambia), via Kasungula. The tsetse flies also recovered and this trade was soon severely threatened. Cattle owners could only move their livestock through certain areas at night when tsetse were inactive. They demanded tsetse control. They started bush clearing and, learning from the recent effects of rinderpest on tsetse's host animals, they also started destroying game animals.

The first confirmed case of human sleeping sickness was recorded from the Okavango Delta in 1935 and over the next few years the disease in both people and cattle increased alarmingly. The urgent need for tsetse control in Ngamiland was clearly recognised by cattle owners, Chiefs and colonial administrators. In 1938 people and cattle were evacuated from the Kwando and Linyanti Rivers. In 1943 Chief Moremi and the DC ordered the removal of 5000 cattle from the Maun area but 1500 head still died in one year at Shorobe alone. The following year funds were allocated by the Colonial Development and Welfare Fund to establish a tsetse control department and Tsetse Fly Control (TFC) was born. One of its first activities was to erect a 100km game fence between Toteng and Shorobe with 150 hunters patrolling it to remove all game animals

from this 'Maun Front'. Trees were also cleared along the Thamalakane River and from an area 90km long and 2km wide along the Taoghe River in the western delta.

With the discovery of chlorinated hydrocarbon insecticides such as DDT in the mid 1940s tsetse control enjoyed a period of considerable success throughout Africa using a technique known as 'ground spraying'.

Ground spraying operators use knapsack spraying machines to apply residual insecticides such as DDT and dieldrin to tsetse resting sites on tree trunks and large branches to a height of about 3m and to breeding sites such as rot holes or under fallen logs or rocks etc..

Large scale operations involving many vehicles and hundreds of field staff were carried out with great success in countries including Cameroon, Kenya, Nigeria, Uganda, and Zimbabwe. Many thousands of square kilometres were cleared of tsetse flies in the 1950s, 60s and 70s.

Botswana also adopted the ground spraying technique in 1961 but found that it had severe limitations; particularly in the Okavango swamps where access is always difficult but can be impossible in some areas when the annual flood waters from Angola replenish this huge wetland.

Aerial spraying eradicated tsetse from Kwazulu in South Africa in the 1950s and trials in Zambia in 1968 indicated that the technique could be successful with very low insecticide dosages applied several times. Aerial spraying trials were successfully carried out in Botswana in 1972 and for the next 20 years this became the method of choice for tsetse control.

From 1972 to 1991 the Okavango Delta was treated with endosulfan or cocktails of endosulfan and synthetic pyrethroids applied from the air. Dosage rates were low, in the region of 12 g/ha for endosulfan, and this was applied 4 or 5 times to any one treatment area.. Residual insecticides such as DDT were never applied from the air.

Aerial spraying dramatically reduced the distribution and abundance of tsetse flies throughout the Okavango Delta but they were not eradicated and eradication was always the government's primary objective. The Department of Animal Health and Production eventually opted to end this campaign and in 1992 Botswana followed most other African countries in adopting the odour-bait technique, i.e. using chemically impregnated 'targets' baited with synthetic ox odour.

A target as used in Botswana is a 1 x 1.8m cloth screen on a wire frame which moves gently in the wind around a central upright pole. Blue/black/blue screens are most widely used but black targets are preferred by many tour operators and are used selectively. The cotton target cover is sprayed with, or dipped in, a synthetic pyrethroid insecticide. Both deltamethrin 20% s.c and alphacypermethrin 10% s.c. are

used and beta cyfluthrin is on trial. Approximately 600ml of the insecticide is applied at a concentration of 0.6% for deltamethrin and 1.0% for alphacypermethrin.

In addition to their visual attraction, targets also have olfactory attractants. These synthetic odours have been identified as the chemical compounds in 'ox odour' which are most attractive to tsetse flies. In Botswana two odours are used. These are methyl ethyl ketone (MEK) and octenol which are dispensed from low density polythene sachets or bottles.

CURRENT TSETSE CONTROL STRATEGY

Botswana's policy is still to eradicate tsetse flies from Ngamiland. The Okavango Delta is the first priority for although cattle are not allowed in the delta, there are many around its perimeter. The delta also supports a highly lucrative tourist industry.

A limited control programme is carried out along the Kwando/Linyanti Rivers bordering Namibia's Caprivi Strip and the Savuti Channel where there are no private sector activities other than tourism and hunting i.e. no livestock or agricultural development. A major consideration in this north eastern area is to prevent a build-up of tsetse from where reinvasion across the river could jeopardise the concerted efforts of the Namibian authorities to protect over 100,000 cattle in the Caprivi Strip.

The distribution and abundance of tsetse in the Okavango Delta and along the Namibian border is constantly monitored - mostly by means of box-type traps such as the epsilon trap.

The Division's Research Section has 60-70 long term monitoring traps deployed in northern Botswana and most of these are checked each month when accessible (i.e. when not cut off by the floods).

The entire Okavango Delta extends to almost 20,000km² but much of this still remains free of tsetse following the aerial spraying campaign. Intensive surveys over the past few years have shown populations to be recovering and have confirmed their presence over about 5000km². The Division's Control Section has deployed targets in the most critical areas, e.g. to prevent reinvasion southwards towards Maun, and in high volume tourist areas.

The highest density of tsetse flies is found close to the perimeter of the permanent swamps in the northern Okavango where water is always present and wildlife - notably buffalo and elephant - are always abundant. The density gradient decreases from north to south.

CURRENT GOVERNMENT POLICY

Tsetse/trypanosomiasis control was given high priority in the National Development Plan VII (NDPVII) which came to the end of its five year term in 1996. Within the Department of Animal Health and Production tsetse control ranks second only to Foot and Mouth disease in terms of annual financial allocations (excluding the one-off campaign to eradicate contagious bovine pleuro pneumonia). NDPVIII (1997-2002) continues to place a high priority on tsetse control and eradication from Botswana continues to be the primary objective. The NDPVIII guidelines - notably to promote private sector involvement in traditionally public sector activities - have been embraced by the Division and intensive socio-economics studies are underway to investigate mechanisms for sharing tsetse control activities with beneficiaries in the private sector. The first step has already been taken with agreement that tour operators can maintain targets in the vicinity of their safari camps.

Tsetse Control Division continues to strive for environmental sensitivity in this pest management field which has not enjoyed the best relationships in the past with wildlife conservationists or the environmental lobby. An environmental audit has been prepared and will become an integral part of operational procedures covering a wide range of activities from handling insecticides to driving on fragile soils in the Okavango Delta.

Botswana shares a common tsetse/trypanosomiasis problem with its immediate neighbours, notably Namibia, and it is accepted by government that the Tsetse Control Division should collaborate in a regional effort to eliminate the disease and its vector. Consideration is being given to Botswana joining the EU funded Regional Tsetse & Trypanosomiasis Control Programme for Southern Africa.

Country Report, Ethiopia

“Meeting on African Trypanosomiasis in Eastern and Southern Africa Maputo, Mozambique, 24-26 September 1997”

I. Introduction

1.1 Overview

Agriculture is the mainstay of the country's economy contributing:

- 40-50% to gross domestic production (GDP) PIB -
- over 90% to foreign exchange earnings and
- 85-90% to employment opportunities

Livestock play a crucial role in agricultural production both directly as food source of animal origin and indirectly as source of traction energy (draught oxen) for cash and food-crop production. The country, consequently, possesses the largest number of livestock in Africa figuring:

- 33 million head of cattle
- 41 million head of shoats (sheep & goats) petits ruminants
- seven million head of equines équidés
- one million head of dromedaries and ~~camélidés~~ camélidés
- 52 million head of poultry oiseaux volatiles

Trypanosomiasis is one of the major factors contributing to the sub-potential performance of livestock and lowered agricultural production as:

- some 10 million head of cattle bt de bovin and equivalent number of small ruminants and significant equine population are at the risk of acquiring trypanosomiasis at any one time

- a total of 150000-200000 Km² of otherwise agriculturally productive land mass is estimated to be infested by different species of tsetse i.e.

- a) Glossina morsitans submorsitans, the most widely spread species répondre espèce
- b) G. pallidipes, second most widely spread species
- c) G. tachinoides, encountered in major drainage systems in west and Southwest
- d) G. fuscipes fuscipes encountered in major drainage systems in

south and southwest

- e) G. longipennis, encountered over restricted portions of the southern Ghibe and Omo basin

To date, four species of trypanosomes of humans and livestock are detected in the country viz.:-

- i) Trypanosoma (Duttonella) vivax, widespread in and out of tsetse infestations (in livestock)
- ii) T. (Nannomonas) congolense, widespread mainly in tsetse infested area (in livestock)
- III) T. (Trypanozoon) brucei brucei, restricted to tsetse areas only (in livestock)
- Iv) T. (Trypanozoon) brucei rhodesiense, restricted to some tsetse area mainly in Gambella (in humans).

Non-tsetse-borne trypanosomiasis also occur in Ethiopia and these are:

T. brucei equiperdum, the agent of dourine in equine and

T. brucei evansi, the agent of surra in different animals but mainly in camels (dromedaries).

T. vivax occurrence in areas remote to known tsetse belts has not yet been conclusively resolved whether it is tsetse-borne or mechanically transmitted by biting flies other than tsetse.

Major thrust in trypanosomiasis alleviation has so far been directed against diseases control using trypanocides. Recently, shift towards vector control is gathering momentum. *gagne de l'intérêt*

The responsibilities of the control (and research) of African animal trypanosomiasis in Ethiopia rests with the Ministry of Agriculture through the National Tsetse and Trypanosomiasis Investigation and Control Center (NTTICC) while that of human African trypanosomiasis is bestowed upon the Ministry of Public Health through its relevant body.

Current trend is to decentralize the vector and disease control activities where stake-holders and the private sector, including the NGOs, will be encouraged to be involved. Government role will be restricted, as much as possible, only to monitoring, coordinatory and regulatory functions.

At the moment there is one on-going tsetse control operation in the Didessa Valley being implemented by the government covering more than 1000 km².

ILRI and ICIPE are also conducting research oriented vector control trials in Ghibe valley and in the Southern Rift Valley, respectively, covering some 250 km² in the former and 300 km² in the latter cases. While ILRI is applying mainly pour-on techniques ICIPE is using NGU-3 trap without insecticide to control the fly species in the area i.e. G. pallidipes. Both ILRI and ICIPE are encouraging community participatory approach in order to domesticate the technologies and bolster sustainability.

1.2 Highlights of Last Report's Achievements

The major achievement subsequent to the last report has been the signing of the Ethiopian component of the project document “Farming in Tsetse Control Areas” which has been accepted by both the donor and the Ethiopian Government. The Ethiopian component of the FITCA project it is currently under some modifications to adjust it according to the existing development policy of the country.

The Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture and the Ethiopian Government have agreed to initiate tsetse fly eradication operation using Sterile Insect Technique (SIT) mainly in the Southern Ethiopia Nations/Nationalities and Peoples Regional and partly in Oromiya National Regional States along the Southern Rift Valley of Ethiopia covering an area of roughly 25,000 km². The SIT will be implemented after an initial application of conventional fly suppression techniques which are envisaged to be mainly odour baited NGU-3 traps without insecticides supported by insecticide treated livestock and odour baited and insecticide impregnated targets or traps.

In areas of the Southern Rift Valley where there is only one species of tsetse fly and where the area is in the main naturally isolated from the rest of the Ghibe/Omo fly belt, the integration of SIT may be effective. Due to the composition of fly species, the lack of any effective natural isolation and the existing experience of the NTTICC on the situation of the Upper Didessa and Wama Valleys, target technology appears to be preferable for tsetse control in the project area under consideration

1.3 Areas Covered

The areas covered include:-

1. Chello (450 km²)
2. Limu Shay (350 km² and Gale (above 200 km²) in which most of the activities related to the up-coming project have been intensified. These areas are part of the Upper Didessa Valley along the upper limit of the two tsetse species encountered in the location i.e. Glossina morsitans submorsitans and G. tachinoides.
3. 25,000 K² (SIT)

2. Main Activities

The main objectives of the activities are:-

- 2.1. prepare grounds for timely and smooth implementation of the up-coming regional project.
- 2.2. keep up previous tsetse/trypanosomiasis control gains in the project area.
- 2.3. generate more information required for effective and efficient implementation of the regional project both at national and regional levels.
- 2.4. assist in the overall problem alleviation and sustainable agricultural production and development through rehabilitation of mixed farming practices especially in communities recently affected by tsetse encroachment.

2.1 Activities Within the Project Area (Upper Didessa Valley)

A) Concerning Vector

i) monitoring is performed by monoconical traps for both species i.e. G. morsitans submorsitans and G. tachinoides, as it is found experimentally superior to biconical traps in the project area. The traps are odour baited with cow urine, acetone and 1-octen-3-ol or octenol for G. morsitans submorsitans while only cow urine and octenol are used for G. tachinoides. Trap density for monitoring G. morsitans submorsitans (G. m. submorsitans) is 1 trap/5 km² and for G. tachinoides 1 trap/km. (The traps are permanently left in their position and monthly monitored for 72 hours from which species

identification, infection rating, sexing and aging are performed as required.)

ii) control is performed by odour-baited, insecticide impregnated blue-black-blue target for Gmsm and odour-baited, insecticide impregnated monopyramidal traps for G. tachinoides at the density of 3-4 target/km² for Gmsm and at an interval of 1 trap/100 linear meters along drainage lines alternatively on either side of the river bank for G. tachinoides. Target density for Gmsm at barrier lines is 25/km² and trap density is 1/50 linear meters for G. tachnoides. Insecticide dose is 80-100 mg a.i deltamethrin (Glossinex) per target or trap per treatment, initially, nine times per annum which is now shifted to 3-4 times annually.

B) Concerning Parasite (Disease)

1. monitoring is done through ear-tagged sentinel herds positioned in different villages over the project area (controlled and uncontrolled); these are initially cleared of any residual infection by Berenil at 7 mg/kg b.wt. and then monthly blood sampled for parasite detection by haematocrit centrifugation technique ~~(MOT)~~ using darkground-phase contrast (DG/PC) microscopy ~~of buffy coat~~ and stained smears; subsequent treatments are given only to animals which test positive at monthly monitoring; ag-ELISA is also being validated in the project area for monitoring control activities.
2. as vector control progresses animals in and behind the control areas are given blanket treatments to clear them of any infection so that this will not compromise monitoring activity results.

2.2 Activities Out of the Project Areas

Active and passive vector and parasite surveys are carried out on request and on planned programmes.

A) Concerning Vector

1. Vector distribution surveys have been carried out in five zones (three regions) (Table 2) of the country during the period under discussion; these were made on request by local authorities and NGOs.

2. of the above (vector distribution) activities some were already on planned programme to update the country's tsetse distribution information.

B) Concerning the Parasite (Disease)

Apart from vector distribution studies, the survey activities in the aforementioned five zones pertain also to trypanosomiasis prevalence investigation in the livestock of the concerned areas (Table 1). Moreover Ag-ELISA has been performed on sera collected by PARC from different tsetse free regions and localities in view to mapping the distribution and prevalence of trypanosomiasis in the country and make comparison with vector and parasitological distribution studies recognized to date (Table 3)

This study has indicated areas of further verification and has stimulated great interest of concerned authorities and professional staff. Most of these areas have been hitherto considered tsetse free.

3. Results and Achievements

3.1 Concerning Tsetse and Trypanosomiasis Monitoring

A total of 369 monitoring traps (monoconical) have been maintained over the on-going control area including the newly included Gale site.

Results have been encouraging as summarized in Table 7. Only three *G.m.submorsitans* and eight *G. tachnoides* were caught while most of the control areas produced zero catches.

A total of 1487 animals were also blood sampled and examined to monitor the disease situation which manifested an overall prevalence rate of 9.48% including the Gale new site (Table 8). At the start of the control operation trypanosomiasis prevalence rate has between 30% and 60% for Chelo and Limu Shay control site respectively.

Ag-ELISA was also introduced for monitoring the progress of the control operation. 96 ear-tagged sentinel herds were grouped into two categories of 48 animal each, one for controlled and the other for uncontrolled adjacent areas, respectively. The animals were initially cleared of any residual infection by treating with Berenil (Diminazine acturate) at 7 mg/kg b.wt dose. Thereafter animals

were treated only when found positive at ~~the~~ monthly sampling intervals. Ag-ELISA results were compared against blood smear and buff coat technique (BCT). A total of 510 blood samples were collected and processed from both sites in eight sampling rounds and results are depicted in (Table 4 & 5). Ag-ELISA and the BCT analysis of the samples have produced varying results. However, ~~the~~ over all trends were similar (Table 6).

3.2 Concerning Tsetse Control

2704 targets have been maintained and deployed during this reporting period. Control against G. tachinoides has been quitted due to inaccessibility of the infestation site and, therefore, monopyramidal traps (targets) were not in place.

Some 98 targets have been thinned out (up lifted) in areas to a level where the operation has achieved fly reduction where it cannot be detected during successive routine monitoring activities. All other necessary tasks have been undertaken including target reseriving and repair (~~Table 9~~)

The results obtained from trypanosomiasis and tsetse investigation carried out in different regions through active surveys and Ag-ELISA analysis of sera collected by PARC have yielded important information which has to be conclusively verified in future activities.

3.3 Concerning Socio-economic Benefits

Data collected from Chelo project area on socio-economic parameters have indicated a positive and encouraging results which are considered highly attributable to the tsetse-trypanosomiasis control activities in the area (~~Table 10~~). The changes are dramatic. However, considering the antecedents prior to the control operation, it is not very surprising as the area has been under proper utilization before being invaded by tsetse flies in the recent past. Further clearance of tsetse down the valley may not produce identical results at the same pace. However, the results so far obtained indicate the necessity of planned and controlled utilization of land reclaimed from tsetse/trypanosomiasis bondage in order to guarantee sustainable production.

3.4 Concerning Activity Popularisation and Training

Workshops and in-service training lasting from five days to three weeks were prepared and provided to some 120 veterinarians, animal health assistants and technicians in four tsetse infested zones of the country. Frequent community awareness meetings have been prepared and necessary messages put across concerning tsetse and trypanosomiasis significance and the importance of community involvement in the whole problem management. Mass media has also been utilized whenever possible to inform the community at large about tsetse and trypanosomiasis challenge and the measures being taken to contain it.

4. Discussion

Work has been going on in the Didessa valley since April 1986 to control tsetse flies progressively from the whole of ~~Upper Didessa~~ ^{the Valley} over some 5500 km².

Although encouraging results were obtained from the beginning, the actual control area has so far been limited to only some 1000 km² due mainly to financial limitations. Man power and facility developments have also not grown to the desired level. Although the techniques applied have proved effective in controlling tsetse population in the area, it was found excessively costly. This has prompted numerous cost reduction amendments in the system which appear to work well. These include insecticide dose (from initial 100 mg a.i. deltamethrin to 80 mg and subsequent of 40-50 mg per dose) and reservicing intervals (initial 9 per annum to 4/annum now). Monitoring schemes have not been well structured and not well followed. Previous control operation in the area has indicated that the activities are beneficial but maintaining the vigour of activities for prolonged time over the small area (of 1000 km²) is proving difficult unless the operation expands further and involve new areas with new interest and vigour both of the public staff and target communities.

It is so crucial that the up-coming FITCA project be implemented as soon as possible to reinvigorate the whole matter.

5. Constraints

Major constraints encountered in the control operation have been:

- 5.1 financial shortage and inconsistency
- 5.2 bureaucratic procedures in procurement of essential equipment and chemicals
- 5.3 accessibility difficulties over some place in the project area particularly along the drainage lines
- 5.4 staff shortage and lack of incentives commensurate with the demanding task
- 5.5 difficulty of involving communities in areas where there are scanty settlements
- 5.6 vehicle overhauling (repairing) facility inadequacy in the area.

6. Conclusion

6.1 Fly Trapping and Monitoring

Monoconical traps are being used for monitoring both the fly species i.e. G. morsitans submorsitans and G. tachinoides infesting the area. These are baited by the odours described elsewhere in this report. It may be worthwhile to try the conventional savanna fly traps (F3, for example) at least for G. morsitans submorsitans to improve monitoring efficiency. Moreover appropriately structured entomological monitoring should be used.

6.2 Animal Trypanosomiasis

The BCT together with ag-ELISA are the methods to be followed until other better and practical techniques are developed. However these should be used in a way that statistically sounds for the job and have to be consistently applied for better reproducibility.

6.3 Land Use

There should be information on land use planning of an area before any tsetse control project is prepared and implemented. Areas to be reclaimed from tsetse fly should be soundly utilized with proper regulation of people and livestock movement into the area. Provisions for such regulation should involve local authorities, target communities, central government officials and appropriately qualified technical staff on ecology, epidemiology, livestock production, environment, agricultural economics and social science.

7. Future Strategies and Targets

The future strategies and targets will very much depend on project work plan of the up-coming regional project. It is hoped that the major part of the next report will pertain to this regional project as it starts commencing the implementation phase. In the long-term plan, however, it is essential that each participating country draw up its policy and strategies of tsetse and trypanosomiasis management.



منظمة الأغذية
والزراعة
للأمم المتحدة

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THE CONTROL OF ANIMAL TRYPANOSOMOSSES IN GHANA:

A COUNTRY REPORT

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1 INTRODUCTION

The period between 1994 and 1997 witnessed a significant increase in the scope and momentum of activities of the African Animal Trypanosomoses (AAT) control programme in Ghana. Given the huge capital investment often required in AAT control, recent developments would not have been possible without the **National Livestock Services Project (NLSP)**, a multi-faceted livestock project funded by the Ghana Government through a World Bank credit facility. The goal of the project is to revitalize the entire livestock sub-sector by holistically addressing the constraints that impede livestock development in the country. That the control of Tsetse-borne African Animal Trypanosomoses (AAT) forms a major component of the project underscores the high priority accorded the disease in as far as constraints facing livestock production are concerned.

The current state of AAT control in Ghana, differs markedly from what existed prior to the implementation of the **NLSP**. Hitherto there seemed to be no clearly defined programme. Rather, the approach was ad-hoc and involved the uncontrolled use of trypanocides and the keeping of trypanotolerant livestock. The current approach adopted by the NLSP seeks to provide a clear vision for the control of AAT in Ghana. Efforts are therefore being directed at making thorough assessments of the disease and its socio-economic impact, the development of sustainable and environmentally friendly control methods and the strengthening of Institutional capacity for dealing with AAT control nation-wide.

It is expected that the information and outputs generated by project activities will provide the framework for the formulation of a long-term National Plan for AAT control. Given the contiguous nature of tsetse distribution across national boundaries the NLSP attaches great importance to Sub-Regional cooperation in AAT control. It is thus envisaged that a National Plan for the control of AAT would define

out modalities for sustained collaboration with International Research Institutes in the Sub-Region.

This report seeks to throw light on the current state of affairs of AAT control in the country with emphasis on the activities of the NLSP. Previous country reports submitted to the Food and Agricultural Organization of the United Nations (FAO) give sufficient background on Tsetse distribution and Trypanosomoses prevalence in some parts of the country.

2 SIGNIFICANCE OF VECTOR AND DISEASE ASSESSMENTS

Indequate information on the tsetse and trypanosomoses situation in the country prior to the implementation of the NLSP, was due mainly to financial constraints. Thus apart from mapping the distribution of tsetse flies in the Northern-half of the country, which is the area lying between Lat 8° N and 11°N (see Map 1 attached), a very limited attempt was made at establishing the disease situation in the country. The paucity of data available meant that the justification of AAT control had to be, most often, based on circumstantial evidence such as the low livestock population density in tsetse-infested areas that have good potential for livestock production.

Recognizing this deficiency, the NLSP has set the objective of obtaining in-depth epidemiological information on AAT through elaborate and coherent surveys.

Four livestock-producing areas from different agro-ecological zones namely, the **Coastal Savanna, Derived Savanna, Guinea Savanna and Sudano-Guinean Savanna**, (see Map 2 attached) were selected for entomological and epidemiological surveys. The methodology of surveys conducted and the details of results obtained are beyond the scope of this report and hence cannot be presented; rather the relevant documents from which these can be obtained will be cited where necessary. This report will focus on the significance of information gathered from

ecological zones concerned. Surveys have not yet begun in the Sudano-Guinean Savanna and Derived Savanna zones, hence this report will miss them out.

2.1 Coastal Savanna

Challier-Laveissière (Biconical) traps were used to conduct tsetse surveys for a period of about 18 months. The results of this survey are presented in greater detail in a report entitled "Tsetse and Trypanosomoses Control in the Coastal Savanna Zone: Report No1", which can be obtained from the Director of the Veterinary Services Department :Ghana.

Glossina palpalis palpalis and G tachinoides were the only species of tsetse flies found in the zone. The determination of "tsetse challenge" was based on the number of tsetse flies caught per trap, per day (CTD). In relation to the two livestock-producing areas in the zone, which are the Dangme East and Dangme West Districts, tsetse challenge was found to be low (0-1CTD) in latter as compared to the former (5-8 CTD) which could be regarded as medium.

This difference can be attributed to the fact that in the Dangme West District, tsetse habitat along river systems has been virtually obliterated by human activity. In contrast, the Dangme East District has a greater number of river systems with suitable vegetation for tsetse population growth.

Surveys carried out to establish the prevalence of AAT in cattle using the Buffy Coat Technique (BCT) showed that the Dangme East District had a higher prevalence of AAT (42%) as compared to Dangme West (22%). All three pathogenic trypanosomes T. vivax, T. congolense and T. brucei were detected in parasitological examination. Due to technical problems encountered in the microscopic examination a clear statement cannot be made on the relative rate of occurrence of the three trypanosome species.

Packed Cell Volumes (PCV) of cattle were measured and revealed that more than 80% of cattle in both districts had PCV values in the normal range 20-40% with the mean PCV

being in the order of **30-34% ($\pm 2SD:5$)**. The frequency distribution of PCV values is elaborated in the document quoted above. The good PCV values exhibited despite the high prevalence of trypanosomoses is consistent with the finding that trypanotolerant cattle infected with trypanosomes, have the ability to check anemia. About 80% of cattle in the area are of the **Sanga** breed which have been known to show some tolerance; there is however an increasing demand for pure **Zebus** which are relatively trypanosensitive. It is also pertinent to note that there is growing interest in the establishment of peri-urban dairy production in the area, a development that could "dilute" the trypanotolerant gene pool.

The difficulty associated with productivity studies in terms of resources and time has not made it possible to quantify the impact of animal trypanosomoses on livestock production. This constraint notwithstanding, we made attempts at obtaining information from rural livestock owners to establish the importance of AAT from their perspective. This information, although empirical, is at least semi-quantitative. The appraisal showed that farmers are quite familiar with the disease and have associated it with production losses such as abortions, poor weight gain, and prolonged calving interval. Farmers asserted that treatment with trypanocides minimized these losses. Due to poor record keeping, farmers could not provide precise information on how much they spent per annum on trypanocides; however they were certain of the fact that trypanocidal treatment was the most expensive veterinary intervention.

The main achievement of the NLSP, in the Coastal Savanna zone, has been the mapping of tsetse fly distribution of the area and the establishment of a database on Tsetse and AAT. Although tsetse numbers do not appear to be "alarming" as suggested by trap catches in the surveys, the situation cannot be ignored, given the fact that there is a high prevalence of AAT in the Dangme East District and given the

spending colossal amounts of money treating their animals against trypanosomoses.

The most crucial issue to be addressed, based on evidence available, is the choice of options most appropriate, in terms of sustainability, to control AAT in the Coastal Savanna zone.

Despite the large population of trypanotolerant livestock in the Coastal Savanna, it has been decided that the prevalence of AAT be reduced to less than 10% in cattle and other livestock, to optimize productivity. This is to be achieved through the integrated control of tsetse and trypanosomoses. Non-pollutant methods such as, the deployment of insecticide-impregnated traps and screens and the topical application of insecticide on cattle, "pour on", will be used for vector control whilst trypanocides will be used strategically to control the disease in infected cattle. Chemoprophylaxis, is not an important option.

Trials at integrated control are discussed in section 3.

2.2 Northern Guinea Savanna

The Guinea Savanna zone covers over 80,000sq and has the highest potential for ruminant production in the country. Entomological surveys carried out between 1978-1983, showed that the area is infested with Glossina palpalis gambiensis G. morsitans submorsitans G. longipalpis and G tachinoides. In view of the vastness of this zone, a pilot area, the Savelegu-Nanton District., which is situated around the White Volta and its confluence with the Nabogu River was selected. The area is devoid of G. morsitans submorsitans, due to the fairly high level of human activity and the absence of big game animals.

The objectives of the NLSP are to update information in this area with regard to current tsetse distribution, trypanosomoses prevalence and the socio-economic importance of AAT. The project also envisages the trial of vector and disease control methods that are amenable to community participation.

A comprehensive account of activities and outputs in the area can be found in the document entitled "Tsetse and Trypanosomoses Activities in the Nabogu Valley: Report No 1" which can be obtained from the Director of Veterinary Services:Ghana

Recent surveys show that the spatial distribution, as well as the abundance of tsetse flies have not changed significantly over the last decade. The White Volta River and its tributaries are still infested with Glossina palpalis gambiensis and G tachinoides with tsetse challenge varying from 4-15 CTD(medium to high).

The prevalence of bovine trypanosomoses was found using the BCT in the recent surveys, to be (56%) in the Diarre Sub-District where tsetse challenge has been found to be the highest (15CTD) as compared to 4% in the Nanton Sub-District where the tsetse challenge was 0-1CTD. All three pathogenic trypanosomes T. vivax, T. congolense and T. brucei were detected in parasitological examination.

An assessment of animal health using PCV as an index showed that the mean PCV of cattle in the area ranged from 32-35% ($\pm 2SD:5$). More than 70% of cattle had PCV values in the normal range. Even though the general health status of cattle screened could be regarded as good, as shown by the distribution of PCV values, stress factors that occur mostly during the the dry season such as poor nutrition cause animals to succumb to infection. Farmers have attributed losses arising from abortions, morbidity, poor weight gain. poor performance of animal traction to trypanosomoses.

Unlike livestock farmers in the Coastal Savanna zone, it appears that farmers in the Northern Guinea Savanna prefer to sell off sick animals rather than treat them. Of course, in certain circumstances they will pay for trypanocides but in relative terms, the rate of drug patronage is much less than is observed in the Southern part of the country. Two main reasons could be ascribed to this observation. Firstly,

and hence caretakers cannot pay for any veterinary intervention without prior consultation with the "owners" who often live in faraway urban areas. Secondly, the orientation of livestock production is more commercial in the South than in the North. In the Northern part of the country, livestock production is most often an adjunct to crop farming hence although livestock production is considered important it is still thought of as being secondary to crop production.

Tsetse challenge along the White Volta and the Nabogu River, is responsible for the high incidence and prevalence of animal trypanosomoses in the Savelegu-Nanton District. The NLSP has set the target of reducing the prevalence of the disease to less than 10% by the year 2000. This is to be achieved through the integrated application of vector suppression and chemotherapy. Although there is a predominantly trypanotolerant livestock population, the rationale is to optimize productivity, given the fact that trypanotolerance as a phenomenon fails when animals are stressed in the dry season.

The use of insecticide-impregnated traps and or screens and live baits(pour on) would be most appropriate in this area. Two main difficulties however, are anticipated: firstly, several segments of the river systems have impenetrable riparian vegetation which could make the deployment of control devices virtually impossible. **In such situations, it is expected that insecticide (synthetic pyrethroides) will be applied on to the vegetation either by spraying with knapsac sprayers or by the use of thermal foggers.**

The second problem we anticipate, is associated with the use of "pour on" on cattle for vector suppression. This technology is effective when at least 40-50% of cattle in a given area are treated topically with insecticide. Bearing in mind the reluctance of farmers to pay for veterinary intervention, as discussed above, it is doubtful if an adequate number of cattle will be treated to achieve the desired effect. Although farmers would readily pay for "pour on" for the control of ticks. obviously because of the

easily associate tsetse fly control with this technology. An intense community education campaign has been launched to make farmers understand that the use of "pour on" would reduce trypanosomoses incidence and minimize their expenditure on trypanocides.

Until the tsetse challenge is reduced to economically insignificant levels in the Diari Sub-distinct cattle in the area, with particular reference to Zebus and their crosses, would require chemoprophylaxis. Incidence studies are to be conducted, using sentinel cattle, to determine the most appropriate treatment strategy. The objective is to ensure that trypanocides are judiciously used by farmers.

2.3 Western Region (Rainforest)

The Western Region is not one of the target areas of the NLSF in the present phase of the project. However, following incessant requests by the Veterinary Officers in charge of the area, an exploratory survey was conducted to ascertain the tsetse and trypanosomoses situation in the area. The requests were made due to the rising incidence of trypanosomoses due to T. brucei in dogs in the Takoradi Metropolis. It has been observed that relapse infections were common following treatment with Diaminaze Aceturate (Berinil®) and Samorin®. Fatal cases have also been recorded in humans. Surveys conducted for the first time in the region showed that G. palpali palpalis was widely prevalent in both peri-domestic and non-domestic environments. The abundant vegetation cover in the Takoradi Metropolis, coupled with the vast palm plantations present in the region provide excellent habitat for tsetse flies.

It is envisaged that interim measures will be instituted to control tsetse flies, at least in peri-domestic habitats.

3. PILOT TSETSE AND TRYPANOSOMOSE CONTROL OPERATIONS

Pilot tsetse control operations were initiated along the Lower Volta and its tributaries in the Dangme East District

it was the first attempt at the use of non-pollutant methods of vector control in Ghana. It involved the use of Deltamethrin-impregnated traps and screens and the application of deltamethrin "pour on" on cattle. About 1,000 insecticide-impregnated traps and screens have been deployed and more than 4000 cattle treated with pour on. So far, communities have actively participated in control activities. While the cost of traps and screens is borne by Government, the application of "pour on" is at half-cost. The idea of cost-sharing is to have the technology "popularized". Later farmers will have to pay fully for drugs and insecticide. Responses given by farmers during a Rapid Rural Appraisal has strongly suggested they are willing to pay for the full cost of intervention, because of the good results shown by the pilot vector control activities.

Bimonthly tsetse monitoring which was started soon after the control operations shows that the tsetse challenge has been reduced drastically from 8CTD to 0-1CTD. This result has been encouraging and it is envisaged that the exercise will be extended to other pilot areas selected by the project.

More than 4000 cattle in the Coastal Savanna zone have received trypanocidal treatment since the commencement of the project. One hundred sentinel cattle were used to monitor the effectiveness of the control operations. Preliminary results suggest that the prevalence of bovine trypanosomoses has fallen by at least 50%.

At the request of the Director of Veterinary Services, project activities were extended to the Akatsi District of the Volta Region of Ghana, to contain bovine trypanosomoses which had reportedly caused a loss of about 600 cattle in 2 years.

A rapid survey conducted by the Tsetse Unit, revealed a tsetse challenge of 4-12CTD (G. palpalis palpalis) and a prevalence of 30% of bovine trypanosomoses. Parasitaemias were heavy >20 trypanosomes per field of microscopic view, (T. vivax, T. congolense and T. brucei) and anaemia was

Following this investigation, more than 2000 cattle were treated with "pour on" and Samorin®. The animal health situation has since improved. A more elaborate approach that would involve the use of insecticide-impregnated traps and screens will be implemented as soon as funding is made available. A project proposal has been submitted to the FAO, since the Akatsi District is not one of the pilot areas of the NLSP.

4 INSTITUTIONAL CAPACITY BUILDING

The capacity of the Tsetse and Trypanosomoses Control Unit (TTU), whose primary responsibility it is to deal with animal trypanosomoses in the country, is to be strengthened. The strategy is to improve and develop both the human and material resource base of the Unit. Emphasis will be on ensuring efficiency through collaboration between the TTU, other sectors of the Ministry of Agriculture concerned with livestock development and National Agricultural Research Systems (NARS).

The NLSP has so far provided vehicles, office equipment, microcomputers and logistics required for extensive field surveys and control operations.

Human resource development is being addressed at different levels. Senior-level personnel, mostly veterinarians, are given on-the-job or postgraduate training in various aspects of tsetse and trypanosomoses control, with emphasis on management. Middle-level personnel are veterinary paramedical personnel given specialized training on vector and disease control at the "Centre International De Recherche-Developpement Sur L'elevage En Zone Subhumide" (CIRDES located in Bobo-dioulasso, Burkina Faso).

The third category of people trained by the TTU are personnel of other sections of the Ministry of Agriculture who by virtue of their work description, interact with rural farmers. They include Agricultural Extension Officers, Community Livestock Workers, Community leaders and Women Action Groups involved in Agricultural Development. This

extension activities and are expected to assist in the transfer of new tsetse control methods to rural communities. Modalities for greater collaboration between the TTU and NARS are still in the development phase. It appears that the main impediment to collaboration is the lack of financial resources to convene regular meetings.

5 FUTURE ACTIVITIES

The project format that has been applied in the implementation of the NLSP, has been found to be effective and efficient, in as far as the achievements of project targets are concerned. The major constraint to the progress of activities is the irregular manner in which operational funds are made available.

As soon as funds are made available, that is by September 1997, activities will be extended to the Derived Savanna and Sudano-Guinean Savanna zones.

REPUBLIC OF GUINEA BISSAU

**MINISTRY OF RURAL DEVELOPMENT, NATURAL
RESSOURCES AND ENVIRONMENT**

**24TH MEETING OF INTERNATIONAL SCIENTIFIC COUNCIL FOR
RESEARCH AND TRYPANOSOMIASIS CONTROL.**

NATIONAL REPORT

Presented by:

1- INTRODUCTION.

The socio-economic importance of African Animal Trypanosomiasis in Guinea Bissau is difficult to assess, but its direct consequences due to economic losses in terms of mortality in young cattle, morbidity, treatment costs and preventive operations (costs) require consideration.

The reasons for this situation are that the country did not have a structure to combat African Animal Trypanosomiasis with the specialised staff, minimum equipment required for the surveys, and external funding.

2- ACTIVITIES

2.1- Surveys

Since the last surveys were carried out in 1988/90 by Thomas G.T. Jeanson and Rui C.B. dos Santos in the North East of Guinea-Bissau, other surveys have not been conducted. The information received through the WHO, FAO and other sources published show that few important data exist on the current geographical distribution and the threat of tsetse fly and trypanosomosis in Guinea Bissau.

3- PROPERTY.

Actions taken on the environment involve essentially progressive control of main diseases which currently affect cattle. They are as follows:-

- Anthrax
- Black leg
- Gasro-intestinal worms
- ticks.

Actions to be put in place are:

- A systematic vaccination campaign against Anthrax and black leg (already under implementation by the PARC project).
- A prophylactic protocol using trypanocides against African Trypanosomosis by treating calves during their first two weeks of life
- Treating young animals twice a year against internal worms.
- treatment of animals against ticks during the rainy season.

Obtaining precise survey results will allow the analysis of the zoosanitary situation with the goal to develop a national strategy to combat glossinas, by developing infested zones with very few populated, but well covered with pastures and watering points in the southern part of the country.

The results of the surveys will be immediately applied for a better sanitary prophylaxis and for the treatment of the infected animals.

4- DISEASE AND OTHER CONSTRAINTS.

4-1 At the environmental level.

The country is infested by Glossina which find their natural shelter in the gallery forest along the rivers, in the dense and humid forest which occupies almost 80% of the zone south of CORUBAL nivel as it has been shown by some surveys carried out a few years ago and confirmed by surveys in the North of the country.

Trypanosomosis exists in Guinea-Bissau and is responsible for the high mortality of young cattle (0 - 1 year). Even the cattle owners, the Fulani in the Eastern zone are aware of this situation and avoid the glossina's shelter that they are well aware of.

The warm and humid climate also favours the development of Gastro-intestinal parasites

constitute the most important environmental pathologic constraints as far as Trypanotolerant cattle are concerned.

The other aspect of the unfavourable environment in promoting the breeding of ruminants is cattle feed. Given that forage resources are available in large quantities, this can enable an expansion of the cattle head to 458.000 TLU. However, several factors hamper the use of these resources such as the presence of disease vectors (glossinia, ticks and Tabamidea), the expansion of crop cultivation, the lack of permanent watering points, the excessive development of exuberant plants, and bush fire strictly responsible for environmental degradation.

The consequence of these factors is inadequate nutritions, particularly during the dry season. The “nutritional deficiency” leads to overall low productivity of cattle.

4-2. At the cattle level.

As far as trepanotolerant cattle are concerned, that is considered to be more suitable at the central part of Guinea-Bissau. The constraints encountered with the animals include low productivity due to disease and a low rate of exploitations. These factors are aggravated by other environmental and human factors rather than factors related to livestock.

4-3- At the human level.

This aspect involves the livestock farmer, the administrative and technical services staff, extension and research staff.

As far as farmers are concerned, they are often reproached for not regarding cattle as a capital good. Very often the socio-economic context within which farmers live is forgotten as is the case with the problem they face.

This is the presence of a subsistence economy whose only possibility of saving is to capitalise on livestock.

resources, logistic means, financial means, etc...) as is the necessity of field training of support staff.

5- Economic Assessment.

It has been noted that trypanosomosis causes losses in domestic animals particularly cattle, sheeps and goats.

With the presence of this disease in the herds, the following situations are observed:-

- Increased morbidity which reduces meat and milk production with inadequate utilisation feed, poor yield of animals especially as far as traction animals are concerned.
- Increasing morbidity is of great importance to the subsistence economy because the death of a diseased anima, of a calf or a lamb etc, represents a big economic loss for a family represents national scourge.
 - ◆ Trypanosomosis reduces fertility
 - ◆ Trypanosomosis is difficult to diagnose
 - ◆ Conduit to a loss of drugs and make the technical assistance difficult.

The fight against this disease causes huge expenses for the countries and these expenses act in an unfavourable manner on the economy of the country.

Beyond direct losses and the cost of therapeutic and prophylactic operations, Trypanosomosis indirectly affects:-

- human health due to lack of meat and milk particularly for children
- Agriculture, since it reduces the number of traction animals and manure for improving soil fertility.
- Environment the presence of *Glossinia* prevents overgrazing and degradation

The seasonal variation of the incidence of Trypanosomosis hamper the permanent occupation of certain pastures, forcing farmers to practise transhumance.

- the economy, the deficit of animal production forces countries where trypanosomosis exists to have recourse to meat and dairy products which create heavy dependence on commercial imports.

Considering the former considerations, we note that in Guinea-Bissau, the fight against this disease must be based on the preservation of its genetic resource of ruminants particularly its trypanotolerant cattle.

TRAINING AND FUTURE PLANS.

The extension activities which have direct impacts on the farmers to convince them to adopt improved methods in terms of pasture management and animal husbandry, depend first of all on the possibility to have an extension structure well equipped in terms of human resources and equipment's related to the field needs and capable of responding to the needs of farmers.

There is a need to strengthen veterinary services, particularly at the field level in making available (means of transport, small veterinary kits, drugs, vaccines, etc...), but also and particularly training of veterinary staff at different levels of the organogramme.

This training should focus on practical aspects for different levels of personnel.

Extension staff and farmer based (Field Staff and Veterinary Officer).

- Theoretical training and or re-training in animal health.
- Practical training in extension methodology, zootechnical surveys and monitoring of herds.

Middle level and senior staff at the district level.

- Information on the different knowledge acquired at regional level in the field of research and animal production (eventually field visits in certain countries of the sub-region).

Middle and senior staff of the veterinary diagnosis laboratory.

- Training and or re-training on practical aspects of entomological and epizootical surveys related to the fight of animal trypanosomosis.

KENYA COUNTRY REPORT

I. INTRODUCTION

Kenya has an area of approximately 575,000 sq. kilometres. The economy relies heavily on agriculture with about 38 % contributed by the livestock sector. The cattle population is estimated to be about 13 million comprising of 10 million beef and 3 million dairy herd. The beef cattle are reared mainly in the range land but the dairy herd is concentrated in the high potential areas. In addition to cattle, there are approximately 8 million sheep, 10 million goats, 200,000 pigs, 570,000 camels, 563,000 donkeys and about 21 million poultry.

The improvement and expansion of livestock industry is greatly hindered by vector borne diseases. Tsetse and tickborne diseases are the main constraints to livestock development. Tsetse flies are found from sea level to an altitude of nearly 2000m covering 25 % of the country, including 60 % of the range land where beef herd is concentrated (fig.1). At least 40 districts in all the 7 provinces have tsetse flies. Although there are inland tsetse belts, the coastal belt is the most extensive extending from Tanzania to Somalia common borders. Practically all the border districts have tsetse and trypanosomiasis problem. The country has eight tsetse fly species transmitting pathogenic trypanosomes. The major species are *Trypanosoma congolense*, *T.vivax*, *T. brucei*, *T. congolense* and *T.simiae*. Sleeping sickness caused by *T. rhodesiense* is endemic in the Lake Victoria basin, especially along Kenya-Uganda border. In the range land, camel trypanosomiasis, mainly due to *T.evansi* which is mechanically transmitted. Among the tsetse species, *G.pallidipes* is the most widespread. Other savannah species are *G.swynnerton* and *G.morsitans*. *G. brevipalpis* and *G. fuscipleuris* are forest species with *G.longipennis* extending into drier zones. *G. austeni* and *G. f. fuscipes* are water edge species restricted to the coastal and lake Victoria basin respectively.

II. COUNTRY ACTIVITIES

Veterinary Department in the Ministry of Livestock Development and Marketing (MOALDM) is responsible for tsetse control in the country. Kenya Trypanosomiasis Research Institute (KETRI) is the national research institute mandated to carry out research on tsetse and trypanosomiasis. International Livestock Research Institute (ILRI) and International Centre for Insect Ecology and Physiology (ICIPE) are international research institutions and collaborate closely with national programmes.

, MOH

The Veterinary Department in MOALDM has field Zoologists in districts with high trypanosomosis challenge, with special attention being given to the Lake Victoria basin where human sleeping sickness is endemic. In addition to the national extension, the research institutions are involved in on-farm evaluation of tsetse control techniques. Traps, targets and pour-ons have been successfully evaluated and integrated into national control programmes. The farmers are advised on management of the diseases through chemotherapy and control of tsetse where trypanosomosis challenge is high and drug resistance is on the increase. Most farmers in the high rainfall areas rely on selective bush clearing to keep away tsetse and improve pasture. However, others have adopted current tsetse control methods.

Coast province has various vegetation types ranging from dry open grassland in the hinterland to dense forests along the fringes of the Indian Ocean. Four species of tsetse viz. *G. longipennis*, *G. pallidipes*, *G. brevipalpis* and *G. austeni* infest the area. Some commercial ranches sustain tsetse control activities. For example, the 30,000 acres Ziwani Ranch in Taita Taveta District has relied on use of odour baited NGU traps to control *G. pallidipes* since 1992 when very high livestock losses were reported, despite four times a year prophylaxis cover with Samorin. From 1993 when 130 odour baited NGU traps were deployed in the main tsetse infested part of the ranch, original *G. pallidipes* density of 800 F. T. D. was reduced by over 95% within 4 months reaching 99.5 % reduction a year later. The farmer currently keeps a healthy herd with occasional administration of curative cases. A similar approach was adopted for Galana Ranch in Kilifi District earlier (from 1986) that relied on odour baited insecticide impregnated targets with the same results.

In Rift Valley, Kajiado District, a pastoral community based tsetse control programme has been operating since 1985 when the NGU trap was first tested for control of *G. pallidipes*. Approximately 250 odour baited NGU traps are maintained to control the fly in a 150 Km² dry season grazing land.

A rural development project is in progress in Transmara District in Rift valley Province where, pastoral community has identified tsetse and trypanosomosis as major constraint to livestock development. A total of 29 catalytic farmers have been trained on tsetse biology, control and land use and are currently mobilising their community in 7 villages covering 92 square kilometres in preparation for control of *G. fuscipleuris* and *G. swynnertoni*. The 7 villages form a focal point from which the project will expand into a bigger area. A working group comprising Transmara Development Programme/GTZ funded Project, Ministry of Agriculture, Livestock Development and Marketing, K. E. T. R I., Kenya Agricultural Research Institute and community leaders co-ordinates the activities of this programme. The main tsetse control activity is scheduled for April, 1997.

in this area

Lambwe Valley in Nyanza Province, Suba District, has another *G. pallidipes* control programme in which deltamethrin-impregnated odour baited targets are used in the 120 sq. k.m. game park since 1986 . This activity is now maintained by Kenya Wildlife Services. In the park periphery, a community based programme using odour baited NGU traps is in place to control sleeping sickness due to *T. rhodesiense* which occurs in the area.

~~III~~ ~~PROJECT AREA~~ - ALL CURRENT CONTROL TARGETS ENCOURAGEMENT ACTING REGIONAL COORDINATOR

The present project area covers tsetse infested parts of Busia, Teso and Bungoma Districts which border Uganda. Apart from the presence of *G. pallidipes* which is extending southwards to Busia District where they were eliminated in 1991, *G. f. fuscipes* is widespread. The expansion is associated with increased animal trypanosomosis in these areas leading to on going control programmes using pour-on, among other methods.

The project area is subdivided into smaller blocks as follows:

BLOCK A:

Area North of Malaba - Bungoma tarmac road including a part of the common border and the new tsetse foci in Sirisia and Bumula divisions in Bungoma District.

BLOCK B:

Area between Malaba - Bungoma and Busia-Kisumu tarmac roads including the common border (Busia - Malaba) Nambale (Busia District), Amukura and Chakol (Teso District) and Mumias (Kakamega District).

BLOCK C

Area south of Busia-Kisumu tarmac road and north of Bunyala Swamps and a part of the common border (Busia-Sio Port)

BLOCK D:

Includes Bunyala Swamps, Lake Victoria shore and offshore Kenyan islands.

i). OVERVIEW

The control of tsetse and trypanosomosis in the project area involves integrated use of environmentally acceptable methodologies and land use implemented by various departments namely:

- i. Veterinary Officers (Veterinary Department)- involved in animal surveillance and treatment.
- ii. Zoologists (Veterinary Department) - involves tsetse monitoring and control of the vector.
- iii. KETRI and DVBD - involved in medical surveillance treatment of human sleeping sickness and research.
- iv. Forest department - involved in afforestation in tsetse infested areas.
- v. Agriculture department - involved in the implementation of appropriate land uses in tsetse controlled areas.
- vi. Animal production - involved in promotion of dairy industry in tsetse and trypanosomiasis controlled areas.
- vii. Public health and social services involved in sensitising the community on all aspects of control operations and formation of control groups.

The activities are harmonised through district level co-ordination meetings chaired by the District Veterinary Officer.

The above multisectoral approach had the following achievements:

- a) Two *Glossina* species namely *G. f. fuscipes* and *G. pallidipes* were found to have spread in areas which were tsetse free in Busia, Bungoma and Teso districts. *G. f. fuscipes* apparently extends to Mumias.
- b) Disease prevalence in animals was found to range from 0.19 % to 23.24 % in new areas of Bungoma and Teso Districts, and 2.7 % - 5.5 % in Busia district. *T. congolense*, *T. vivax* and *T. brucei* were present. 350,000 cattle and 1.2 million people are at risk of being infected with trypanosomes.
- c) No case of human sleeping sickness was diagnosed. However, there was high prevalence of Malaria parasite in the whole region.
- d) The community in the project area participated in deployment of traps, tsetse habitat manipulation and application of pour-on on Livestock.

ACTIVITIES IN THE PROJECT AREA.

2. INTRODUCTION

There was a marked increase in animal trypanosomosis in the region due to re-invasion of *G. pallidipes*. *G. f. fuscipes* was in low densities due to control

measures. Animal screening was done and infected animals were treated with Diminazene aceturate at 3.5mg/kg body weight.

Vector control was initiated using environmentally acceptable methodologies namely, trapping, mobile target (pour-on), selective ground spraying and habitat manipulation.

Deployment of insecticide impregnated traps along the riverine vegetation was done at 100 m. intervals in dense vegetation. Traps were impregnated with deltamethrin 20 % s.c. diluted to 0.1 %. In total 3,500 traps were deployed to control *G. f. fuscipes*.

Livestock were treated with flumethrin 1 % at 1ml/10kg wt. to control *G. pallidipes* and other biting flies. Cattle, goat, sheep, pigs and dogs were treated every two weeks. Up to 32,760 animals were treated with pour-on by the end of the sixth application in February. Selective ground spraying was done in areas with residual fly population along the riverine and lacustrine vegetation. Vector monitoring was done monthly, the fly densities were 0.2 F.T.D. and 0.15 F.T.D. for *G. pallidipes* and *G. f. fuscipes* respectively.

A total of 4450 cattle were screened and animal trypanosomosis was 0.91 % - 23.24 % in the new *foci* while in the *G. f. fuscipes* area, 2.7 % - 5.5 % compared to 4.5 % last reporting period.

The dairy industry was not affected by increase in *G. pallidipes* as dairy cattle increased from 5,500 to 6,150 through importation and offspring from a local bull scheme. Milk production increased from 125,000 litres per month to 135,000 litres per month. Areas under fodder and pasture also increased in the whole project area by 170 Ha (7.5 %). Areas under crops also increased from 75,622 Ha. to 85,710 Ha. However, death of oxen in *G. pallidipes* areas had localised effect on land preparation.

Forest department cleared undergrowth which harbour tsetse in government gazetted forest. Approximately 35 Ha. were cleared and 10 Ha. prepared for seedling planting in April on the onset of long rains.

Community education continued in all working blocks through the field days on farming training, tours and barazas.

3. OBJECTIVES

1. To organise community involvement to control tsetse, human sleeping sickness and nagana by training people on use and sustainability of control measures.

2. To monitor and control of tsetse/biting in project area, screen animals and man and treat the positive cases thereby reducing the infection rates.
3. To encourage opening of more arable land in tsetse challenge areas.

4. METHODOLOGIES

4.1 VECTOR

Tsetse monitoring was done using biconical traps set at 100m interval along the established transects. Fermented cow urine, acetone and Octenol were used as attractants. The trapped flies were categorised into species, age and sex. Dissection of flies was done and the parasite checked in the mid gut, salivary glands and proboscis to determine the infection rate. Control measures were instituted using insecticide impregnated pyramidal traps in *G. f. fuscipes* area. Impregnation was done using deltamethrin s.c. at 0.1 %. Selective ground spraying was done using cypermethrin at 0.3 %. Cattle, goats, sheep, pigs and dogs treated with flumethrin (Baytical) at 1ml/10kg body weight, were used to control *G. pallidipes*. The animals were treated every two weeks.

4.2 TRYPANOSOMOSIS SURVEY

(a) Passive surveillance

All animals reported sick in clinical centres were screened for trypanosomosis and other parasites using thick and thin blood smears. Infected animals were treated with Diaminazene aceturate at ~~3.5~~ mg. per Kg. body weight.

1.0

(b) Active screening

Mass animal screening was done using haematocrit centrifugation technique(HCT). Infected animals were treated with Diminazene aceturate at 3.5 mg/kg body weight.

(c) Human screening

Both passive and active screening was done using buffy coat technique. On passive screening patients reporting with fever to health centres were tested for trypanosome infection and other blood parasites.

4.3 LIVESTOCK PRODUCTION

Use of zero, or semi zero grazing farming system which reduces fly/animal contact was encouraged. Introduction of more susceptible grade animals in

tsetse control areas led to further clearing of tsetse infested bush for fodder and pasture development.

4.4 COMMUNITY EDUCATION

This was done collectively by all the departments in form of barazas, field days, on-farm training, seminars and demonstrations.

5. RESULTS

5.1 Tsetse Control

A total of 3,500 are in the field to control *G. f. fuscipes*. Up to 830 old pyramidal traps were replaced. In block A, B and C, 32,270 animals were treated with flumethrin at 1 ml/10kg body wt every fourteen days. Use of pour-on started in mid December 1996 and the exercise was in sixth application by the end of February 1997.

Tsetse monitoring revealed apparent densities as shown in tables 5.1.

5.1.5 TSETSE DISSECTIONS

Out of 560 *G. f. fuscipes* dissected (non teneral) only two mouth part infections were found

5.2 VETERINARY RESULTS

A total of 4,450 cattle were screened in the whole region. 3,382 were screened passively in the clinical centres and 1,608 were screened actively for baseline data prior to pour-on application in the whole tsetse infested area. Screening data is shown in tables 5.2.

5.3 Agriculture Results

More arable land was opened in the tsetse controlled areas as shown in table 5.3.

5.4 Forest Department Results

Government gazetted forest department cleared the under growth that can act as tsetse habitat. Over 50 hectares were cleared in Block C and D. 40,000 seedlings of high canopy trees are already in the 120 nurseries ready for planting during the long rains.

5.5 Community Education Results

Community education was done by all departments on the control of tsetse trypanosomosis and proper land utilisation. Education programmes were carried in form of barazas, on farm training field days health talks and posters.

<u>Area</u>	<u>Field Days</u>	<u>On Farm Training</u>	<u>Barazas</u>
Block A	7(540)	250	5(120)
Block B	10(800)	340	2(60)
Block C	8(1200)	220	6(180)
Block D	5(400)	160	2(60)

5.6 Livestock Production Results

G. pallidipes invasion did not affect the dairy industry as the number grade animals and milk produced increased.

<u>Parameter</u>	<u>July 1996</u>	<u>January 1997</u>	<u>% increase</u>
Zero grazing	210	240	14
Grade animals	5,500	6,150	12
Forage production			
Fodder	400 Ha	440 Ha	10
Pasture	162 Ha	170 Ha	7.5
Milk Production	4166 litres	4,500 litres	

5.7 Human trypanosomosis results

A total of 110 people were actively screened for sleeping sickness in Katelynyang Village (block B). Passive surveillance was also carried out as follows.

Passive trypanosomosis results

Block	H/Centre	No. exam	Tryps.	MF	MPS	%+ve MPS
A	Kocholya H.	160	0	0	92	57.5
B	Amukura H.	103	0	0	65	63.1
C	Alupe H.	2301	0	0	1890	82.1
	Matayos H.	207	0	0	89	43.0
D	Sio Port H.	93	0	0	56	60.2
	P. Victoria H.	756	0	0	259	35.6
Total		3620	0	0	2461	67.9

No human sleeping sickness cases were detected during the period. In august 1997 however, six cases were recorded.

III PROJECT AREA

The project area is subdivided into smaller blocks as follows:

BLOCK A:

Area North of Malaba - Bungoma tarmac road including a part of the common border and the new tsetse foci in Sirisia and Bumula divisions in Bungoma District.

BLOCK B:

Area between Malaba - Bungoma and Busia-Kisumu tarmac roads including the common border (Busia - Malaba) Nambale (Bisia District), Amukura and Chakol (Teso District) and Mumias (Kakamega District).

BLOCK C

Area south of Busia-Kisumu tarmac road and north of Bunyala Swamps and a part of the common border (Busia-Sio Port)

BLOCK D:

Includes Bunyala Swamps, Lake Victoria shore and offshore Kenyan islands.

5.1.1. Apparent density *G. f. fuscipes* density in F.T.D.

<u>BLOCK A</u>	<u>JUNE, 1996</u>	<u>NOV, 1996</u>	<u>FEB, 1997</u>
Malaba/Kakalet	0.02	0.015	0.01
Malakisi/Kochola	0.01	0.02	0.01
Myanga/Lunao	0.02	0.15	0.01
Malakisi	0.02	0.15	0.01
Sirisia	-	0.1	0.05
Bumula	-	0.15	0.01
Kanduyi	-	0.2	0.15

BLOCK B

Obuchun/Malaba	0.25	0.28	0.18
Apatit & Environs	0	0.1	0.1
Walabi & C. Nambale	0.24	0.15	0.1
Eskikoma/Butula	0	0	0
Mimias division	0	0	0

BLOCK C

Sio Port/Mundika	0.15	0.2	0.18
Nangina/Nambuku	0.05	0.12	0.02
Nzoia Estuary	2.4	1.5	0.2
Southern Hunterland	0.2	0.1	0

BLOCK D.

Lake shore	0.15	0.10	0.15
Islands	0	0	0.02
Bunyala swamps	2.80	2.00	1.80

5.1.2 Apparent density of *G. pallidipes* in F.T.D.

<u>BLOCK A</u>	<u>JUNE, 1996</u>	<u>NOV, 1996</u>	<u>FEB, 1997</u>
Malaba/Kakalet	0.01	0.15	0.01
Malakisi/Kochola	0.01	0.20	0.10
Myanga/Lunao	0	0.10	0
Malakisi	0	0	0
Sirisia	-	0.15	0.10
Bumula	-	0.10	0
Kanduyi	-	0	0
BLOCK B			
Obuchun/Malaba	0	0	0
Apatit & Environs	0	0.20	0.15
Walabi & C. Nambale	0	0	0
Eskikoma/Butula	0	0	0
Mimias division	0	0	0
BLOCK C			
Sio Port/Mundika	0	0	0
Nangina/Nambuku	0	0.10	0.01
Nzoia Estuary	0	0	0
Southern Hunterland	0	0.15	0.10
BLOCK D.			
Lake shore	0	0	0
Islands	0	0	0
Bunyala swamps	0	0	0

5.1.3 AVERAGE APPARENT DENSITY OF *G. f. fuscipes* 1990 - 1997

	1990	1991	1992	1993	1994	1995	1996	1997 FEJ
BLOCK A	1.89	1.28	1.57	0.03	0.02	0.02	0.015	0.01
BLOCK B	13.32	0.72	0.27	0.11	0.14	0.50	0.15	0
BLOCK C	6.0	0.04	0.74	0.33	0.21	0.20	0.20	0.20
BLOCK D	10.50	0.74	3.20	0.91	0.10	0.01	1.50	0.60

5.1.4 AVERAGE APPARENT DENSITY OF *G. pallidipes* 1990 - 1997

	1990	1991	1992	1993	1994	1995	1996	1997 FEJ
BLOCK A	0	0	0	0	0	0	0.15	0.01
BLOCK B	0	0	0	0	0	0	0.10	0.10
BLOCK C	4.25	0	0	0	0	0.01	0.01	0
BLOCK D	0	0	0	0	0	0	0	0

5.1.2 Apparent density of *G. pallidipes* in F.T.D.

<u>BLOCK A</u>	<u>JUNE, 1996</u>	<u>NOV. 1996</u>	<u>FEB. 1997</u>
Malaba/Kakalet	0.01	0.15	0.01
Malakisi/Kochola	0.01	0.20	0.10
Myanga/Lunao	0	0.10	0
Malakisi	0	0	0
Sirisia	-	0.15	0.10
Bumula	-	0.10	0
Kanduyi	-	0	0

BLOCK B

Obuchun/Malaba	0	0	0
Apatit & Environs	0	0.20	0.15
Walabi & C. Nambale	0	0	0
Eskikoma/Butula	0	0	0
Mimias division	0	0	0

BLOCK C

Sio Port/Mundika	0	0	0
Nangina/Nambuku	0	0.10	0.01
Nzoia Estuary	0	0	0
Southern Hunterland	0	0.15	0.10

BLOCK D.

Lake shore	0	0	0
Islands	0	0	0
Bunyala swamps	0	0	0

5.2.1 Passive screening

Area	No. Screened	<i>T.b.</i>	<i>T.c</i>	<i>T.v</i>	Total	%	% 6 months ago
Block A (Amagoro)	924	2	22	27	51	5.52	4.12
Block B							
Nyelechon	390	0	11	7	18	4.62	5.95
Apatit	416	0	12	9	21	5.05	7.10
Busia clinics	672	0	18	8	26	3.8	5.21
Block C							
Bukwambo	416	0	12	5	17	4.09	3.97
Rukada	214	0	5	3	8	3.74	3.90
Block D							
Bundalygi	350	0	12	3	15	4.29	4.02
TOTALS	3,382	2	92	62	156	4.6	
PERCENTAGE		0.06	2.72	1.83	4.61		

5.2.2. Active Animal Screening: Baseline Data for Pour-on Control of *G. pallidipes*.

Area	No. Screened	<i>T.b.</i>	<i>T.c</i>	<i>T.v.</i>	MF*	Total	% prevalence
Businjo	90	1	1	3	3	5	5.56
Rukada	160	3	2	4	0	9	5.62
Apokor	126	1	0	2	4	3	2.38
Tamulega	158	5	3	8	3	16	10.13
Namawanga	137	5	0	12	6	17	12.41
Talukuyi	70	3	4	8	8	8	24.28
Bumula	204	0	1	3	0	4	1.96
Kitabishi	43	2	0	3	0	5	11.63
Lukala	80	0	0	3	0	3	3.75
Totals	1068	20	11	46	22	77	7.21
Infectivity		1.87	1.03	4.31	2.06	7.21	

* Microfilaria

High infectivity corresponds to the presence of *Glossina pallidipes*.

5.2.3. SUMMARY OF THE YEARS (NAGANA PREVALENCE)

BLOCK	1990	1991	1992	1993	1994	1995	1996
A	11.4	10.5	9.3	6.6	3.6	5.4	4.12
B	15.2	11.8	10.2	6.8	6.7	5.1	4.46
C	14.0	9.6	7.4	6.0	4.1	3.8	3.9
D	-	-	-	-	4.6	4.0	4.2

5.3 Agriculture Results

More arable land was opened in the tsetse controlled areas.

Area (Ha) Tilled By Oxen And Tractors In The Project Area

<u>AREA</u>	<u>TARGET</u>	<u>ACHIEVED</u>	<u>BY OXEN</u>	<u>%</u>
Block A	16,000	8,000	850	11
Block B	17,900	9,000	1,050	15
Block C	8,900	6,441	2,966	44
Block D	8,000	1,366	83	16
TOTALS	50,800	24,807	4949	

Oxen tillage is preferred and low acreage opened especially in Block A and B were due to loss of oxen.

Hectare under crop

Year					
1991	1992	1993	1994	1995	1996
56,500	54,200	52,200	65,800	71,993	75,662

5.5 Community Education Results

Community education was done by all departments on the control of tsetse trypanosomosis and proper land utilisation. Education programmes were carried in form of barazas, on farm training field days health talks and posters.

<u>Area</u>	<u>Field Days</u>	<u>On Farm Training</u>	<u>Barazas</u>
Block A	7(540)	250	5(120)
Block B	10(800)	340	2(60)
Block C	8(1200)	220	6(180)
Block D	5(400)	160	2(60)

5.6 Livestock Production Results

G. pallidipes invasion did not affect the dairy industry as the number grade animals and milk produced increased.

<u>Parameter</u>	<u>July 1996</u>	<u>January 1997</u>	<u>% increase</u>
Zero grazing	210	240	14
Grade animals	5,500	6,150	12
Forage production			
Fodder	400 Ha	440 Ha	10
Pasture	162 Ha	170 Ha	7.5
Milk Production	4166 litres	4,500 litres	

5.7 Human trypanosomosis results

A total of 110 people were actively screened for sleeping sickness in Katelynyang Village (block B). Passive surveillance was also carried out as follows.

Passive trypanosomosis results

<u>Block</u>	<u>H/Centre</u>	<u>No. exam</u>	<u>Tryps.</u>	<u>MF</u>	<u>MPS</u>	<u>%+ve MPS</u>
A	Kocholya H.	160	0	0	92	57.5
B	Amukura H.	103	0	0	65	63.1
C	Alupe H.	2301	0	0	1890	82.1
	Matayos H.	207	0	0	89	43.0
D	Sio Port H.	93	0	0	56	60.2
	P. Victoria H.	756	0	0	259	35.6
Total		3620	0	0	2461	67.9

No human sleeping sickness cases were detected during the period. In august 1997 however, six cases were recorded.

5.7 Human trypanosomosis results

A total of 110 people were actively screened for sleeping sickness in Katelenyang Village (block B). Passive surveillance was also carried out as follows.

Passive trypanosomosis results

Block	H/Centre	No. exam	Tryps.	MF	MPS	%+ve MPS
A	Kocholya H.	160	0	0	92	57.5
B	Amukura H.	103	0	0	65	63.1
C	Alupe H.	2301	0	0	1890	82.1
	Matayos H.	207	0	0	89	43.0
D	Sio Port H.	93	0	0	56	60.2
	P. Victoria H.	756	0	0	259	35.6
Total		3620	0	0	2461	67.9

No human sleeping sickness was detected during the surveys.

SENEGAL

~~République du Sénégal
MINISTRE DE L'AGRICULTURE
DIRECTION DE L'ELEVAGE~~

*Roger
Pleu Jhu*

**RAPPORT DU SENEGAL SUR LA SITUATION
DE LA MOUCHE TSE-TSE ET DE LA TRYPANOSOMOSE
(24^{ème} Réunion du Conseil Scientifique International pour la Recherche et la
Lutte contre les Trypanosomiasés, Maputo, 29 Septembre - 3 Octobre 1997)**

Le Gouvernement du Sénégal, dans le cadre de sa politique de développement du secteur agricole, accorde une place importante au développement de l'élevage. C'est pourquoi, le bétail vivant dans les zones où sévit la trypanosomose et représentant plus de 30% de l'effectif national, bénéficie d'une attention particulière. Des programmes de développement du bétail trypanotolérant ont été élaborés et des financements sont toujours recherchés. Il s'agit notamment :

- du programme de multiplication de la petite ndama à Kédougou ;
- du programme de développement de l'élevage au Sénégal-Oriental et en Haute Casamance ;
- du programme de développement de l'élevage en Moyenne et Basse Casamance.

1- La situation actuelle de la trypanosomose au Sénégal.

La zone des Niayes (Région de Dakar, Louga et Saint-Louis) qui a fait l'objet d'un assainissement glossinaire de 36 500 ha dans les années 70 (ce qui a permis le développement des cultures maraîchères et horticoles avec une production de plus de 140 000 tonnes de légumes) connaît depuis quelques années un retour de glossines. En effet :

- un mâle de *Glossina palpalis gambiensis* a été capturé dans un village proche de Dakar,
- des prélèvements sanguins effectués sur 72 bovins dans un village de la zone a montré la présence de *Trypanosoma congolense*,
- dans une formation hospitalière de Dakar, une femme a été confirmée porteuse de *T. Brucei* gambiense et certains habitants du même village se sont révélés séropositifs vis à vis de la même espèce.

Dans un parc forestier situé dans la capitale, il est signalé la présence d'une importante population de glossines.

Ces éléments font craindre une éventuelle ré-infestation de la zone.

Dans les deux premiers départements vivent des bovins métissés appelés Djakoré (zébu X ndama) avec une trypanotolérance intermédiaire alors que dans les autres on trouve des races trypanotolérantes.

Dans ces zones on note souvent des pressions glossinaires élevées qui limitent l'utilisation des bovins pour le trait et l'amélioration de leur productivité.

On y rencontre aussi de nombreux cas de résistance aux trypanocides due à un usage abusif et inadéquat des trypanocides.

2-1 Actions de recherches et de développement menées sur le bétail trypanotolérant.

Afin de trouver des solutions aux problèmes rencontrés, quelques programmes de recherches et de développement ont été conduits sur le bétail trypanotolérant. Ils sont résumés ci-après :

◆ Réseau d'études du bétail trypanotolérant.

Objectif : Identification et évaluation des interrelations entre les éléments intervenant dans la trypanotolérance (animal-vecteur-écologie).

Durée : 5 ans.

Financement sur Fonds européen de développement (FED) par l'intermédiaire de l'ILRAD/ILCA pour une valeur de 20 millions de fcfa.

D'intéressantes données ont été recueillies mais non encore exploitées.

◆ Programme de sélection à noyau ouvert.

Année 1993.

Objectif : Amélioration des performances zootechniques (productions laitière et bouchère) des bovins trypanotolérants.

Le programme n'a pu être poursuivi pour raison d'épuisement de financement.

◆ Evaluation de l'efficacité de la lutte contre la mouche tsé-tsé par le piège bi-cônique.

Année 1988.

Objectif : test de l'efficacité des pièges bi-côniques dans le contrôle de la mouche tsé-tsé dans la Région de Kolda.

Financement sur reliquat d'un projet de la FAO pour une valeur de 3 millions de fcfa.

♦ Impact de l'infestation trypanosomienne sur les performances au travail de bétail trypanotolérant.

Objectif : Mesure de l'impact de la trypanosomose sur l'aptitude du bétail Ndama à la traction bovine.

Financement de l'ILRI pour une valeur de 11 millions francs cfa.

Les données qui ont été recueillies ont été exploitées par un chercheur dans le cadre de son mémoire de confirmation.

Les résultats de l'étude ont montré que la puissance développée et le travail fourni sont réduits respectivement de 29 et 30 % si les animaux sont infestés de trypanosomes. Ainsi il est prouvé que l'infestation trypanosomienne a les effets suivants :

- détérioration de l'état de santé du bétail soumis au travail ;
- minimisation de la capacité de travail des animaux infestés ;
- diminution des surfaces labourées ou cultivées ;
- réduction du revenu du paysan.

En conclusion le bétail trypanotolérant non infesté a une performance au travail supérieure à celle de celui qui a été infesté.

♦ Etude d'une chimiorésistance des trypanosomes à un trypanocide.

Financement par l'AIEA pour une somme de 6 millions de francs cfa.

Les résultats sont en exploitation.

♦ Productivité du bétail trypanotolérant.

Dans la région de Kolda où la culture du coton est pratiquée, la traction animale utilisant le bétail trypanotolérant ainsi que la stabulation des vaches lactantes a permis d'améliorer le rendement agricole, d'augmenter la production laitière et la conformation bouchère. Cette intégration agriculture-élevage a favorisé une augmentation du revenu des paysans ainsi que l'amélioration de la qualité de leur alimentation. Un système de collecte du surplus de lait a été institué dans les villages situés autour des capitales régionales et ce lait collecté est traité et conditionné dans de petites laiteries gérées par des privés. Ce programme a été conduit dans le cadre du volet élevage de la Société de développement des fibres textiles (SODEFITEX).

Conclusion.

En l'état actuel, aucun programme national concernant le bétail trypanotolérant n'est en cours d'exécution. Comme il a été mentionné plus haut, des financements sont recherchés pour la mise en oeuvre des programmes de développement déjà identifiés.

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(24^{ème} Réunion du Conseil Scientifique International pour la Recherche et la
Lutte contre les Trypanosomiasés, Maputo, 29 Septembre - 3 Octobre 1997)**

Le Gouvernement du Sénégal, dans le cadre de sa politique de développement du secteur agricole, accorde une place importante au développement de l'élevage. C'est pourquoi, le bétail vivant dans les zones où sévit la trypanosomose et représentant plus de 30% de l'effectif national, bénéficie d'une attention particulière. Des programmes de développement du bétail trypanotolérant ont été élaborés et des financements sont toujours recherchés. Il s'agit notamment :

- du programme de multiplication de la petite ndama à Kédougou ;
- du programme de développement de l'élevage au Sénégal-Oriental et en Haute Casamance ;
- du programme de développement de l'élevage en Moyenne et Basse Casamance.

1-/ La situation actuelle de la trypanosomose au Sénégal.

La zone des Niayes (Région de Dakar, Louga et Saint-Louis) qui a fait l'objet d'un assainissement glossinaire de 36 500 ha dans les années 70 (ce qui a permis le développement des cultures maraîchères et horticoles avec une production de plus de 140 000 tonnes de légumes) connaît depuis quelques années un retour de glossines. En effet :

- un mâle de *Glossina palpalis gambiensis* a été capturé dans un village proche de Dakar,
- des prélèvements sanguins effectués sur 72 bovins dans un village de la zone a montré la présence de *Trypanosoma congolense*.,
- dans une formation hospitalière de Dakar, une femme a été confirmée porteuse de *T. Brucei* gambiense et certains habitants du même village se sont révélés séropositifs vis à vis de la même espèce.

Dans un parc forestier situé dans la capitale, il est signalé la présence d'une importante population de glossines.

Ces éléments font craindre une éventuelle ré-infestation de la zone.

Dans les deux premiers départements vivent des bovins métissés appelés Djakoré (zébu X ndama) avec une trypanotolérance intermédiaire alors que dans les autres on trouve des races trypanotolérantes.

Dans ces zones on note souvent des pressions glossinaires élevées qui limitent l'utilisation des bovins pour le trait et l'amélioration de leur productivité.

On y rencontre aussi de nombreux cas de résistance aux trypanocides due à un usage abusif et inadéquat des trypanocides.

2-1 Actions de recherches et de développement menées sur le bétail trypanotolérant.

Afin de trouver des solutions aux problèmes rencontrés, quelques programmes de recherches et de développement ont été conduits sur le bétail trypanotolérant. Ils sont résumés ci-après :

◆ Réseau d'études du bétail trypanotolérant.

Objectif : Identification et évaluation des interrelations entre les éléments intervenant dans la trypanotolérance (animal-vecteur-écologie).

Durée : 5 ans.

Financement sur Fonds européen de développement (FED) par l'intermédiaire de l'ILRAD/ILCA pour une valeur de 20 millions de fcfa.

D'intéressantes données ont été recueillies mais non encore exploitées.

◆ Programme de sélection à noyau ouvert.

Année 1993.

Objectif : Amélioration des performances zootechniques (productions laitière et bouchère) des bovins trypanotolérants.

Le programme n'a pu être poursuivi pour raison d'épuisement de financement.

◆ Evaluation de l'efficacité de la lutte contre la mouche tsé-tsé par le piège bi-cônique.

Année 1988.

Objectif : test de l'efficacité des pièges bi-côniques dans le contrôle de la mouche tsé-tsé dans la Région de Kolda.

Financement sur reliquat d'un projet de la FAO pour une valeur de 3 millions de fcfa.

◆ Impact de l'infestation trypanosomienne sur les performances au travail de bétail trypanotolérant.

Objectif : Mesure de l'impact de la trypanosomose sur l'aptitude du bétail Ndama à la traction bovine.

Financement de l'ILRI pour une valeur de 11 millions francs cfa.

Les données qui ont été recueillies ont été exploitées par un chercheur dans le cadre de son mémoire de confirmation.

Les résultats de l'étude ont montré que la puissance développée et le travail fourni sont réduits respectivement de 29 et 30 % si les animaux sont infestés de trypanosomes. Ainsi il est prouvé que l'infestation trypanosomienne a les effets suivants :

- détérioration de l'état de santé du bétail soumis au travail ;
- minimisation de la capacité de travail des animaux infestés ;
- diminution des surfaces labourées ou cultivées ;
- réduction du revenu du paysan.

En conclusion le bétail trypanotolérant non infesté a une performance au travail supérieure à celle de celui qui a été infesté.

◆ Etude d'une chimiorésistance des trypanosomes à un trypanocide.

Financement par l'AIEA pour une somme de 6 millions de francs cfa.

Les résultats sont en exploitation.

◆ Productivité du bétail trypanotolérant.

Dans la région de Kolda où la culture du coton est pratiquée, la traction animale utilisant le bétail trypanotolérant ainsi que la stabulation des vaches lactantes a permis d'améliorer le rendement agricole, d'augmenter la production laitière et la conformation bouchère. Cette intégration agriculture-élevage a favorisé une augmentation du revenu des paysans ainsi que l'amélioration de la qualité de leur alimentation. Un système de collecte du surplus de lait a été institué dans les villages situés autour des capitales régionales et ce lait collecté est traité et conditionné dans de petites laiteries gérées par des privés. Ce programme a été conduit dans le cadre du volet élevage de la Société de développement des fibres textiles (SODEFITEX).

Conclusion.

En l'état actuel, aucun programme national concernant le bétail trypanotolérant n'est en cours d'exécution. Comme il a été mentionné plus haut, des financements sont recherchés pour la mise en oeuvre des programmes de développement déjà identifiés.

RAPPORT DU SENEGAL SUR LA SITUATION DE LA MOUCHE TSETSE ET DE LA TRYPANOSOMOSE

Le Gouvernement du Sénégal, dans le cadre de sa politique de développement du secteur agricole, accorde une place importante au développement de l'élevage. C'est pourquoi, le bétail vivant dans les zones où sévit la trypanosomose et représentant plus de 30% de l'effectif national, bénéficie d'une attention particulière. Des programmes de développement du bétail trypanotolérant ont été élaborés et des financements sont toujours recherchés. Il s'agit notamment.

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Ces éléments font craindre une éventuelle ré-infestation de la zone,

Dans les départements de Foundiougne, Niourou, Bignona, Ziguinchor, Oussouye, Sédhiou, Kolda, Vélingara, Tambacounda et Kédougou la trypanosomose sévit et on rencontre surtout *Glossina palpalis gambiensis* et *G. morsitans submorsitans*.

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Impact de l'infestation trypanosomienne sur les performances au travail du bétail trypanoté et,

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En conclusion le bétail trypanoté n'a pas une performance au travail supérieure à celle de celui qui n'est pas infesté.

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LIAISON OFFICERS MEETING AFRICAN TRYPANOSOMIASIS
IN EASTERN AND SOUTHERN AFRICA, MAPUTO,
MOZAMBIQUE, 24-26 SEPTEMBER, 1997

TSETSE AND TRYPANOSOMIASIS SITUATION IN
TANZANIA

TSETSE AND TRYPANOSOMIASIS SITUATION IN TANZANIA

1. INTRODUCTION:

Tanzania lies between longitudes 29.5 and 40.5 degrees East and latitudes 0 and 11.7 degrees South. Tanzania Mainland has a total land surface of 883,398 Sq km and about two - thirds of the land is tsetse infected.

deux tiers du territoire sont infestés par la tse-tse

Seven tsetse species infest the country including (in order of importance) Glossina morsitans, G. pallidipes, G. Swynnertoni, G. austeni, G. brevipalpis, G. fuscipes and G. longipennis.

Three trypanosomes of economic importance to livestock, which occur in the country are Trypanosoma vivax, T. Congolense and T. brucei. The first two species are the most common. The major tsetse fly belts in the country are delineated by the distribution of G. morsitans and G. Swynnertoni.
common.

Sleeping sickness (Rhodesian type) has a focal distribution occurring in the north and western part of the country. Endemic areas report cases from passive surveillance at hospitals and health centres.

2. TRYPANOSOMIASIS SITUATION:

2.1 Animal trypanosomiasis:

From the 1994/95 National Sample Census of Agriculture there are about 15.6 million cattle in the country.

Traditionally, tsetse - free areas have been subjected to severe overgrazing and/or alternative forms of land use and such livestock has been forced into tsetse infested areas. This has resulted into animal trypanosomiasis being widespread and second most important cattle disease after East Coast Fever.

Reported cases of animal trypanosomiasis in the country between 1995 and 1996 are as follows:-

Number of Cattle

Year	1993/94	1994/95	1995/96
Contracted	89,959	106,955	19,902
Death	3,707	18,780	3,443

The figures of the cases are more likely to under - estimate the true maguitude due to under - reporting.

2.2 Human Trypanosomiasis:

Cases of human sleeping sickness are reported at hospitals and health centres in endemic focal areas in the country (Kigoma, Arusha, Rukwa and Tabora.) Most of the sleeping sickness cases (from passive surveillance) are reported from Kigoma region which is situated in the sestern side of the country along Lake Tanganyika. The region is in the Zone of Miombo Woodland.

Reported cases of sleeping sickness in the country:

Year	1995	1996	1997
No of Cases:	99	86	81
		(till June)	(till May)

The figures of the number of cases are more likely to under-estimate the true magnitude due to under - reporting.

3. CONTROL OF TSETSE AND TRYPANOSOMIASIS

3.1 Tsetse control by using synthetic pyrethroids, traps/targets and SIT

3.1.1 Pyrethroids:

Introduction of synthetic pyrethroids to control ticks and as a measure of controlling ^{tsetse} tremendously reduced tsetse population to low levels in some parts of the country where these chemicals have been applied.

In the north western part of the country (Kagera region) deltamethrin, marketed as Decatix has been used in large amounts by owners of indigeneous cattle and ranch owners, while pour-ons (Bayticol and Spoton) have been used by keepers of dairy cows in the same area and few other areas elsewhere.

As a result of the application of Decatix, G. morsitans and G. pallidipes have been virtually eliminated over large areas of Karagwe and Bukoba districts in the North Western part of Tanzania (Map1).

3.1.2 Targets:

In the western part of the country in Kigoma region 278 odour - baited targets were deployed from 1993 around Busunzu village (30 Sq km) to control sleeping sickness by reducing tsetse population of G. morsitans. Odour-baits involved acetone and cow urine. 52 Sleeping sickness cases were reported during 1993 when targets were being deployed but dropped to 6 in 1995 and continued at low level in the presence of target around the village (Fig. 1).

3.1.3 Sterile Insect Technique (SIT)

At Tanga Tsetse Research Institute, G. austeni species was successfully reared and the fly colony attained more than 770,000 flies for the supply and release of sterile males on Zanzibar island. To date no wild flies have been caught on the project area for more than 30 weeks, indicating that G. austeni has virtually been eradicated from Zanzibar island.

3.2 Trypanosomiasis Control

3.2.1 Animal trypanosomiasis:

Keepers of livestock continue to use trypanocides against animal trypanosomiasis. Due to trade liberalisation in the country, veterinary drugs are being purchased by farmers from privately owned pharmacy shops distributed throughout the country by individuals and drug companies. The Government no longer deals with the supply of veterinary drugs but has retained the monitoring role of the drug usage.

3.2.2 Sleeping Sickness:

Suramin drug is being used for the treatment of early stages of sleeping sickness while Mel B for the late stages. Lack of these front line drugs (from medical stores) for the treatment of sleeping sickness poses a major constraint to the treatment of the patients.

4. TRAINING:

One staff is attending a three year postgraduate training course leading to a Master of science degree in tsetse and trypanosomiasis control at the University of Veterinary Science, University of Zimbabwe. The course started in May 1997 and has a modular structure.

ICIPE has continued to offer international Training Course for tsetse management, monitoring and control. Tanzania tsetse control personnel often participate in the course when offered. The next course will commence on 5th November 1997 and will last for a month.

The local training institute, Livestock Training Institute (LITI), in Morogoro offers a diploma training course in tsetse control and range management. Due to financial constraints the number of intake of candidates has dropped considerably.

During 1996/97 these were only 4 candidates, two in first year and two in second and final year. There is no intake of new candidates during 1997/98.

5. FUTURE PLANS

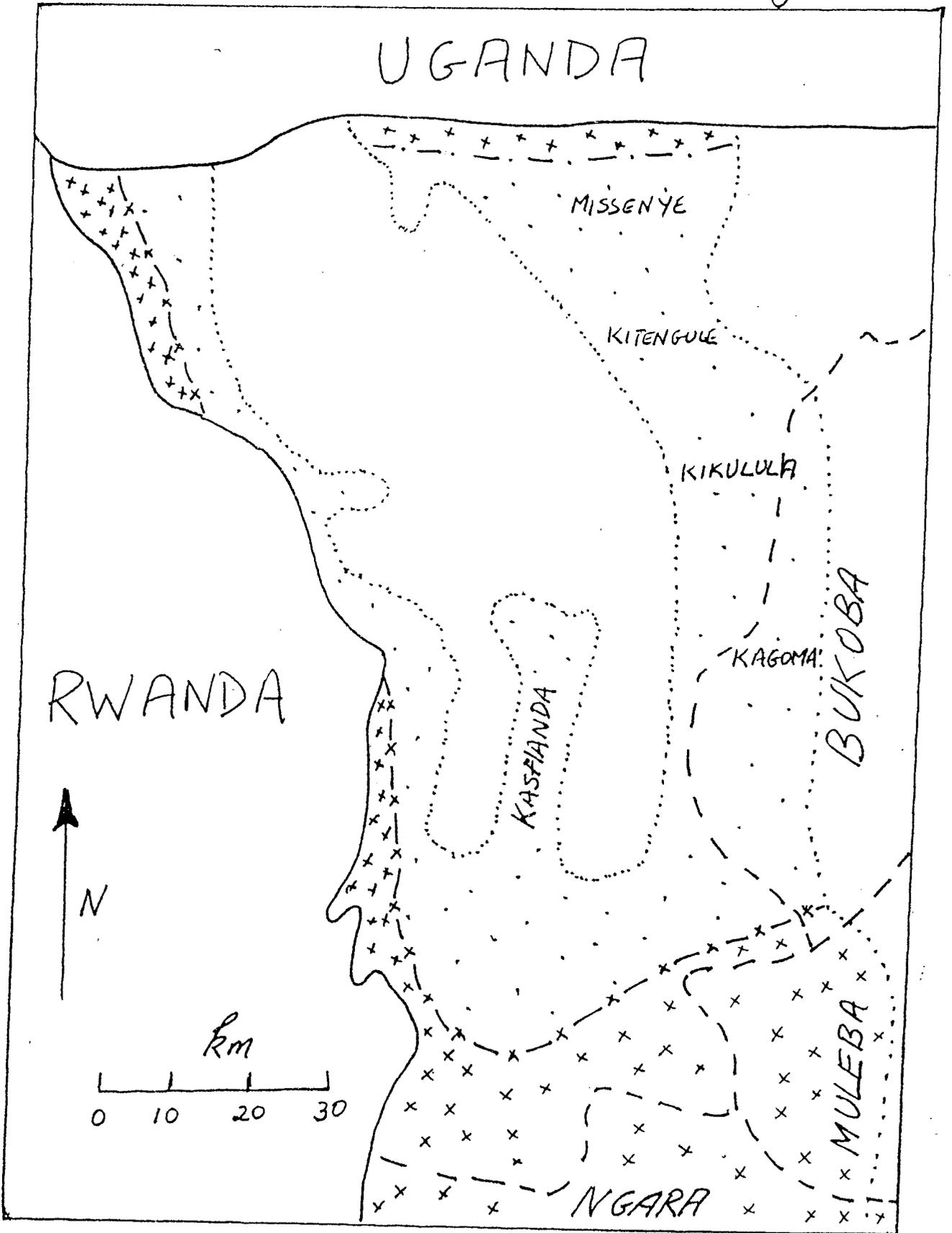
Tanzania will be taking part in a new regional programme known as " Farming in Tsetse Control Areas of eastern Africa" which is expected to be launched in November, 1997.

The Tanzania component of the programme will involve the North Western part of (Kagera region) and the eastern part (Tanga region) of the country.

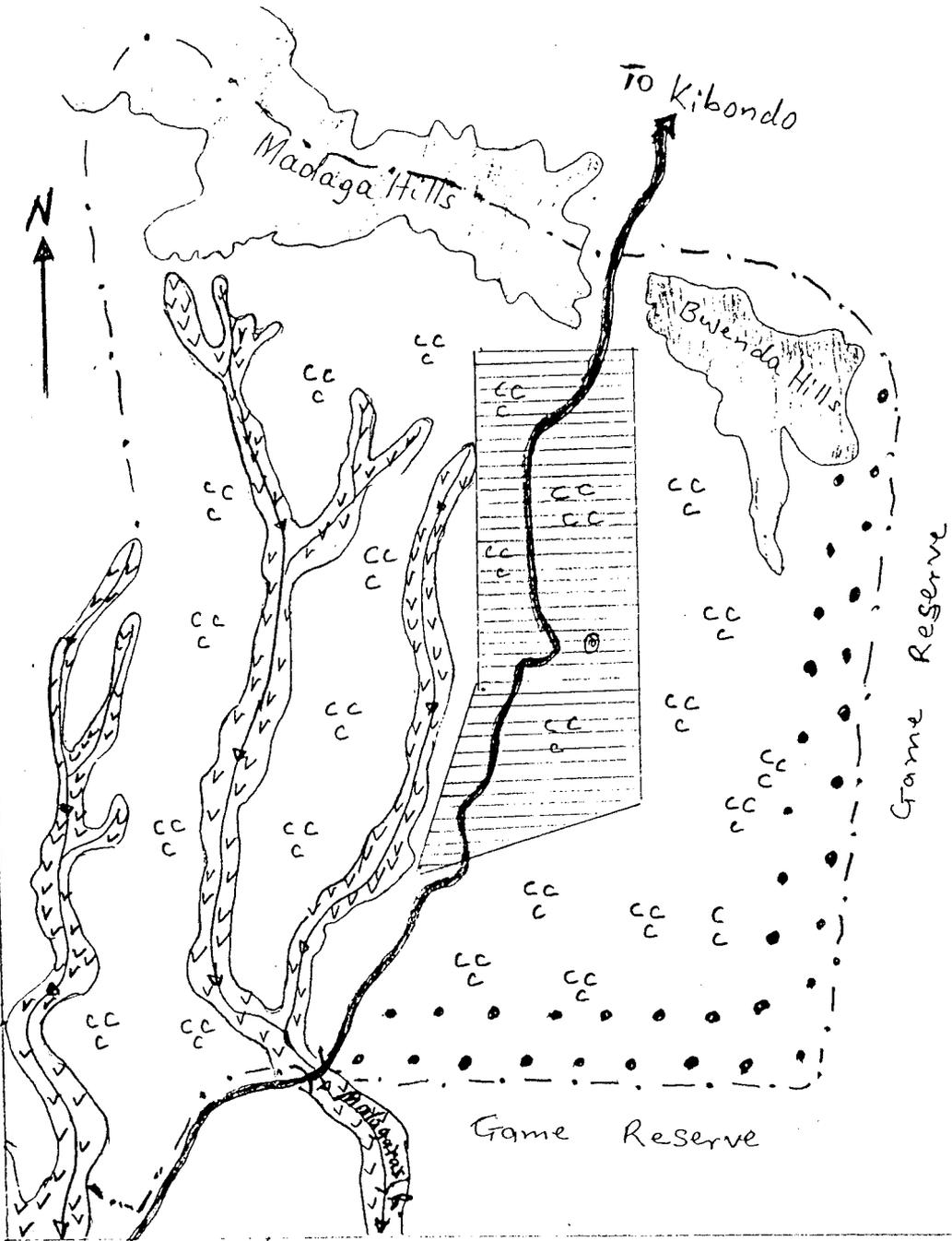
Also when funds are available targets will be deployed in villages with high risk of sleeping sickness in the western side of the country in Kibondo District.

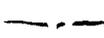
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Probable tsetse distribution, Bukoba & Karagwe. 1997



BUSUNZU VILLAGE TARGET DEPLOYMENT



- Legend:
-  Village site with service centre
 -  Village boundary
 -  Rivers
 -  All weather road
 -  cultivation
 -  target deployment

Scientific

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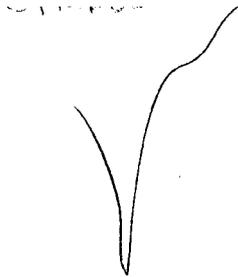
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**XXIVème REUNION DE L'ORGANISATION
DE L'UNITE AFRICAINE / CONSEIL SCIENTIFIQUE
INTERNATIONAL**

POUR LA RECHERCHE

**ET LA LUTTE CONTRE LA TRYPANOSOMOSE
(O.U.A./CSIRLT)**

MAPUTO, (MOZAMBIQUE), 29 SEPTEMBRE - 03 OCTOBRE 1997

RAPPORT SUR LA TRYPANOSOMOSE ANIMALE AU TOGO

A. NAPALA

G. HENDRICKX

N. KOUAGOU.

1. INTRODUCTION

Le développement de l'élevage au Togo est fortement handicapé par plusieurs facteurs dont un des principaux est la trypanosomose transmise par les tsé-tsés. Le Projet National de Lutte contre la Trypanosomose Animale, démarré en 1989 et financé par la Belgique, est actuellement en phase 3 de consolidation jusqu'en juillet 1999.

Les phases précédentes ont permis de:

- définir clairement le problème au Togo
- définir des zones prioritaires d'action
- définir les approches de lutte intégrée adaptées
- entamer des activités de lutte prise en charge par les éleveurs

Le présent rapport énumère les activités principales de la phase actuelle, décrit les résultats marquants depuis la dernière réunion de l'ISCTRC à Banjul et aborde les perspectives d'avenir.

2. ACTIVITES

Les activités portent essentiellement sur:

- a) La poursuite de la validation des méthodes de contrôle et de l'identification des zones prioritaires de lutte. Dans ce cadre, il est à noter qu'une extension des activités vers le Burkina Faso est actuellement en discussion.
- b) La formation et l'encadrement des différents intervenants, y compris les vétérinaires privés, dans la diffusion des méthodes de lutte.
- c) La réactivation d'organes pouvant garantir la viabilité du projet après arrêt du financement extérieur.
- d) La communication, les échanges d'expériences et d'informations avec les autres institutions.

3. RESULTATS

Les principaux résultats obtenus au courant des deux dernières années sont:

- a) Le Projet étudie actuellement sur le terrain la méthode d'application par ELECTRODYN (Zeneca) d'insecticide sur le bétail. A ce stade de l'étude nous pouvons établir le succès technique, a un prix compétitif, de la méthode dans le Nord Togo. L'applicateur, développé pour le coton nécessite néanmoins quelques adaptations avant de pouvoir être utilisé de façon de routine. Nous saisissons ici l'occasion pour remercier le Dr. Ron Coffee (Zeneca) pour avoir mis à notre disposition la méthodologie et le Dr. D. J. Rogers (Oxford) pour avoir obtenu un financement de la coopération britannique (ODA) en vue de contribuer aux essais.
- b) L'approche SIG développée précédemment a été affinée, ce qui fera l'objet d'une communication au courant de cette réunion.
- c) Suite à une large campagne de sensibilisation nationale où la moitié des troupeaux ont été touchés, des activités de lutte ont été engagées dans les zones prioritaires. Celles-ci se basent sur une prise en charge par les bénéficiaires et une forte implication du secteur privé et fera également l'objet d'une communication.
- d) La formation des différents intervenant du secteur public et privé a également été renforcée. Celle-ci porte tant sur des thèmes techniques que sur les techniques de vulgarisation proprement dites en milieu rural. En plus de séances de formation ponctuelles la totalité des agents vétérinaires a été abonnés aux cours par correspondance de l'INADES sur ce sujet. L'encadrement des intervenants se fait par des réunions régionales, au début mensuelles et actuellement bimensuelles, et par les suivis de terrain.
- e) La pérennisation des activités du Projet est garantie en:
 - impliquant systématiquement les services de l'élevage dans toutes les activités,

- facilitant l'installation de jeunes vétérinaires en pratique rurale, partenaires privilégiés du Projet. Ceci se fait principalement par un contrat de services.

f) Les contacts avec les autres structures et institutions nationales et internationales ont été renforcés. Ces contacts, trop nombreux pour être tous énumérés ici, ont permis d'obtenir des financements supplémentaires dans des domaines de recherche spécifique, en tant que partenaire ou acteur principal, et plus particulièrement :

- ELECTRODYN financé par l'ODA. Une partie de ce travail (essais en étables sous moustiquaires et application contre les tiques) est effectué en collaboration avec le CIRDES.
- Investigation sur les bases génétiques de la trypanotolérance (Union Européenne) sous la coordination de D. Bradley de Trinity College Dublin.
- Télédétection et utilisation des sols en collaboration avec le Prof. De Wulf de l'Université de Gand.

4. PERSPECTIVES D'AVENIR

Outre la poursuite et le renforcement des activités précitées les principales activités avenir sont:

- a) L'analyse détaillée économique et financière des activités de contrôle intégré de la trypanosomose.
- b) L'étude de la rentabilité de la pratique vétérinaire rurale au Togo.
- c) L'étude de la notion de fragilité et fertilité des sols au niveau des zones prioritaires d'action dans le cadre de l'intégration de l'agriculture et de l'élevage.
- d) La validation de l'approche SIG dans des éco-zones, au Burkina Faso, autres que celles présentes au Togo et représentatives pour la sous région.

5. CONCLUSION

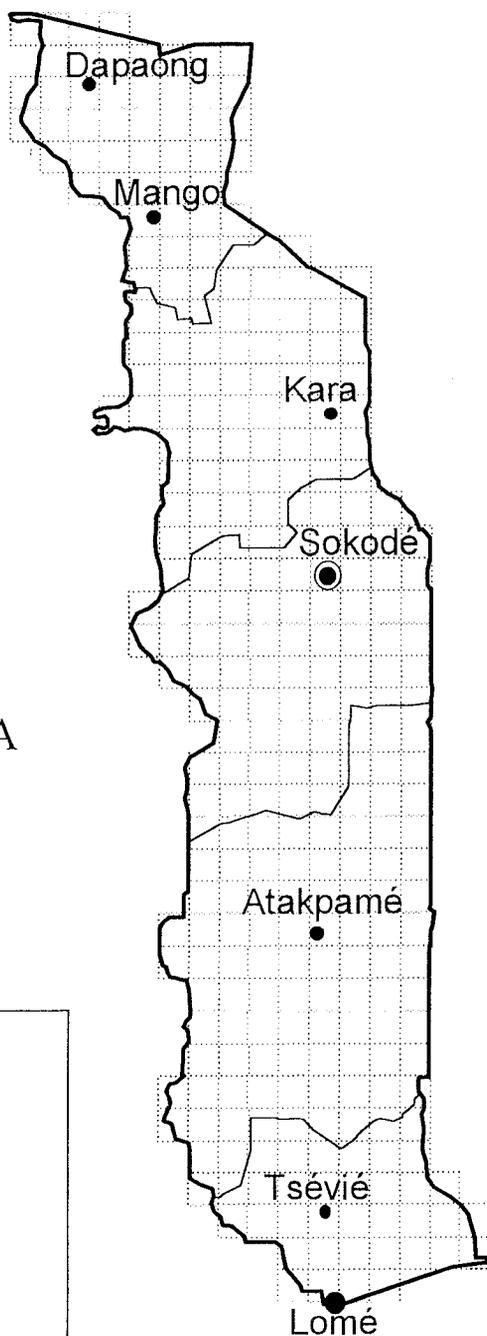
Le projet Togolais a initié une méthodologie de diagnostic rapide du problème de la trypanosomose animale au Togo. Il l'a diffusé auprès des groupes cibles à travers une approche participative permettant l'adhésion et la collaboration des structures nationales et internationales publiques et privées.

Il met l'accent sur:

- a) la prise en charge et l'utilisation des techniques éprouvées pour contrôler les vecteurs et la maladie (les traitements trypanocides, les insecticides sur bétail et l'utilisation du bétail trypanotolérant).
- b) la poursuite de l'approche afin de confirmer l'impact du contrôle de la trypanosomose animale, priorité de la politique de l'élevage au TOGO.

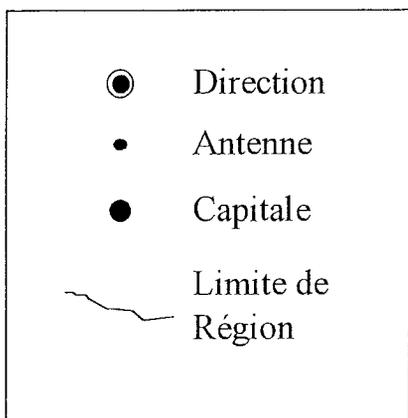
C'est le lieu de témoigner notre gratitude au Gouvernement Belge principal bailleur de fonds et à l'Agence d'exécution FAO pour leur efficace apport financier et technique au projet du TOGO.

BURKINA FASO



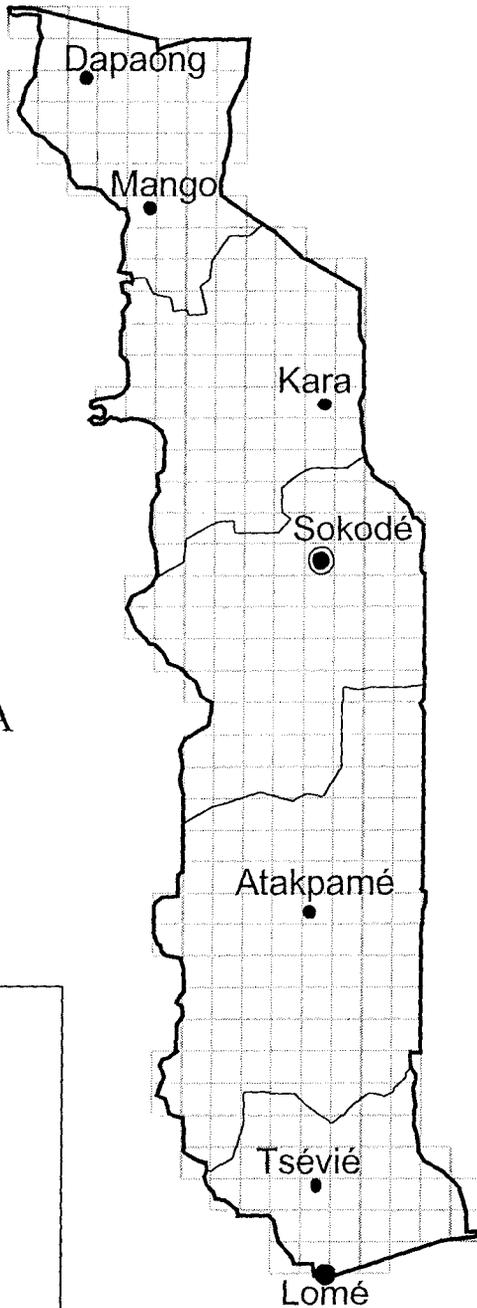
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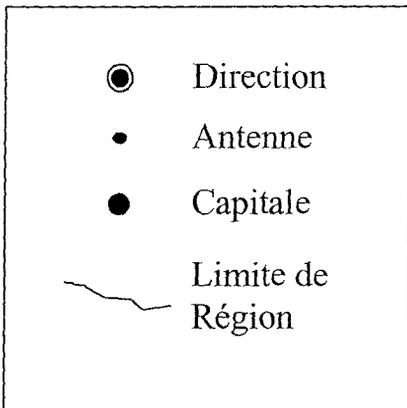
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- d) La communication, les échanges d'expériences et d'informations avec les autres institutions.

3. RESULTATS

Les principaux résultats obtenus au courant des deux dernières années sont:

- a) Le Projet étudie actuellement sur le terrain la méthode d'application par ELECTRODYN (Zeneca) d'insecticide sur le bétail. A ce stade de l'étude nous pouvons établir le succès technique, a un prix compétitif, de la méthode dans le Nord Togo. L'applicateur, développé pour le coton nécessite néanmoins quelques adaptations avant de pouvoir être utilisé de façon de routine. Nous saisissons ici l'occasion pour remercier le Dr. Ron Coffee (Zeneca) pour avoir mis à notre disposition la méthodologie et le Dr. D. J. Rogers (Oxford) pour avoir obtenu un financement de la coopération britannique (ODA) en vue de contribuer aux essais.
- b) L'approche SIG développée précédemment a été affinée, ce qui fera l'objet d'une communication au courant de cette réunion.
- c) Suite à une large campagne de sensibilisation nationale où la moitié des troupeaux ont été touchés, des activités de lutte ont été engagées dans les zones prioritaires. Celles-ci se basent sur une prise en charge par les bénéficiaires et une forte implication du secteur privé et fera également l'objet d'une communication.
- d) La formation des différents intervenant du secteur public et privé a également été renforcée. Celle-ci porte tant sur des thèmes techniques que sur les techniques de vulgarisation proprement dites en milieu rural. En plus de séances de formation ponctuelles la totalité des agents vétérinaires a été abonnés aux cours par correspondance de l'INADES sur ce sujet. L'encadrement des intervenants se fait par des réunions régionales, au début mensuelles et actuellement bimensuelles, et par les suivis de terrain.
- e) La pérennisation des activités du Projet est garantie en:
 - impliquant systématiquement les services de l'élevage dans toutes les activités,
 - appuyant le Comité National de Lutte contre la Trypanosomose,

- facilitant l'installation de jeunes vétérinaires en pratique rurale, partenaires privilégiés du Projet. Ceci se fait principalement par un contrat de services.

f) Les contacts avec les autres structures et institutions nationales et internationales ont été renforcés. Ces contacts, trop nombreux pour être tous énumérés ici, ont permis d'obtenir des financements supplémentaires dans des domaines de recherche spécifique, en tant que partenaire ou acteur principal, et plus particulièrement :

- ÉLECTRODYN financé par l'ODA. Une partie de ce travail (essais en étables sous moustiquaires et application contre les tiques) est effectué en collaboration avec le CIRDES.
- Investigation sur les bases génétiques de la trypanotolérance (Union Européenne) sous la coordination de D. Bradley de Trinity College Dublin.
- Télédétection et utilisation des sols en collaboration avec le Prof. De Wulf de l'Université de Gand.

4. PERSPECTIVES D'AVENIR

Outre la poursuite et le renforcement des activités précitées les principales activités avenir sont:

- a) L'analyse détaillée économique et financière des activités de contrôle intégré de la trypanosomose.
- b) L'étude de la rentabilité de la pratique vétérinaire rurale au Togo.
- c) L'étude de la notion de fragilité et fertilité des sols au niveau des zones prioritaires d'action dans le cadre de l'intégration de l'agriculture et de l'élevage.
- d) La validation de l'approche SIG dans des éco-zones, au Burkina Faso, autres que celles présentes au Togo et représentatives pour la sous région.

5. CONCLUSION

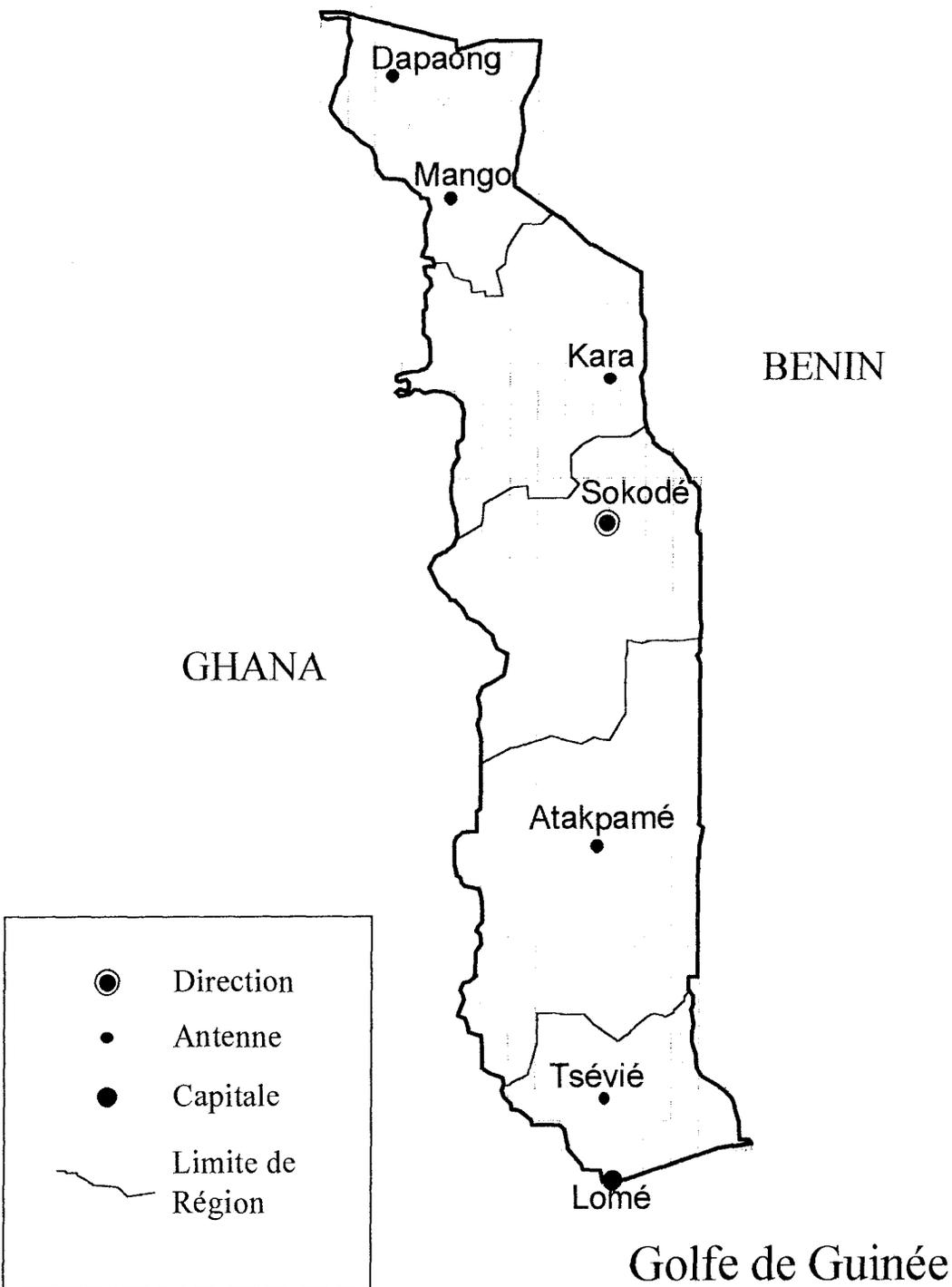
Le projet Togolais a initié une méthodologie de diagnostic rapide du problème de la trypanosomose animale au Togo. Il l'a diffusé auprès des groupes cibles à travers une approche participative permettant l'adhésion et la collaboration des structures nationales et internationales publiques et privées.

Il met l'accent sur:

- a) la prise en charge et l'utilisation des techniques éprouvées pour contrôler les vecteurs et la maladie (les traitements trypanocides, les insecticides sur bétail et l'utilisation du bétail trypanotolérant).
- b) la poursuite de l'approche afin de confirmer l'impact du contrôle de la trypanosomose animale, priorité de la politique de l'élevage au TOGO.

C'est le lieu de témoigner notre gratitude au Gouvernement Belge principal bailleur de fonds et à l'Agence d'exécution FAO pour leur efficace apport financier et technique au projet du TOGO.

BURKINA FASO



UGANDA TSETSE AND TRYPANOSOMIASIS CONTROL COUNTRY REPORT - 1995 - 1997

SUMMARY:

All the 45 districts of Uganda are known to be tsetse infested although the degree varies from place to place. Animal trypanosomiasis has been reported from all the districts and the prevalence correlates closely with the degree of tsetse fly infestation. Human trypanosomiasis is endemic in two foci: South Eastern Uganda where *Trypanosoma brucei rhodesiense* and North and North Western Uganda where *Trypanosoma brucei gambiense* occur. Out of the 19 million people, 3.6 million are at risk of contracting sleeping sickness.

Through the integrated approach adopted by government, the tsetse and trypanosomiasis situation is being brought under control. Sleeping sickness control was undertaken by the National Sleeping Sickness Control Programme which detected and treated 535 cases from South Eastern Uganda and 1948 cases in North and North Western Uganda between 1995 - 1997. This showed a 27.8% decrease in the number of sleeping sickness cases compared to 1993 - 1995 period.

Animal trypanosomiasis control was effected by the Department of Veterinary Services through treatment of livestock on clinical diagnosis and to some extent by passive and active surveillance. The latter method was used in areas where veterinary laboratories have been rehabilitated and equipped. The overall animal trypanosomiasis prevalence was found to be 8.95%. A total of 681,208 doses of trypanocides were used to treat livestock.

Tsetse fly control was effected by the Department of Entomology. An environmentally friendly community based tsetse control approach was adopted where insecticide impregnated traps were deployed mainly in sleeping sickness affected areas and live bait technology in livestock farming areas. Using the trapping technology, 10,719 traps were deployed in South Eastern, Mid Central, North and North Western Uganda covering an area of 15900 km². In these areas the tsetse fly population has been reduced by over 95% of the initial density.

The research team carried out demand related research activities whose recommendations have been a guiding principle in the adoption of the methodology of choice for control strategies.

The above activities were harmonised and synchronised by the Uganda Trypanosomiasis Control Council through its secretariat the Coordinating office for the Control of Trypanosomiasis in Uganda. In addition, the office in liaison with OAU/IBAR organised and held policy and field Harmonization meetings for the countries participating in the Farming in tsetse control areas of Eastern Africa and completed and disseminated reports and information on the programme to all stakeholders. Nationals participating in the tsetse and trypanosomiasis control were either recruited and under went refresher courses.

INTRODUCTION:

Uganda has a population of about 19 million people. Tsetse flies have been identified in all the 45 districts although at varying degrees of infestation (Map 1). Animal trypanosomiasis prevalence in all the districts of Uganda correlates closely with the degree of tsetse fly infestation (Map 2). Two forms of human trypanosomiasis occur in Uganda: *Trypanosoma brucei gambiense* in the North and North Western Uganda and *Trypanosoma brucei rhodesiense* in South Eastern Uganda (Map 3). The human population at risk of trypanosomiasis is 3.6 million. The main vector for trypanosomiasis in Uganda is *Glossina fuscipes fuscipes*. *Glossina morsitans sub-morsitans* is prevalent in North and North Western Uganda. Similarly *G.morsitans centralis* is found in South Western Uganda on Uganda Tanzania border. Other species and sub species have been identified in varying degrees of infestation in other areas of Uganda.

Uganda has adopted an integrated approach to tsetse and trypanosomiasis control involving the Departments of Entomology and Veterinary Services of the Ministry of Agriculture, Animal Industry and Fisheries, the National Sleeping Sickness Control Programme of the Ministry of Health and the Livestock Health Research Institute (LIRI) of the National Agricultural Research Organization. These departments are coordinated by an autonomous body the Uganda Trypanosomiasis Control Council (UTCC) with its secretariat as the Coordinating Office for the Control of Trypanosomiasis in Uganda (COCTU) (Fig.1)

The tsetse and trypanosomiasis control programme received funding from the Government of the Republic of Uganda, the European Union, the Food and Agriculture Organization, World Health Organization, World Bank, International Atomic Energy Agency and the Swiss Tropical Institute.

This report covers the period June 1995 to June 1997 detailing the achievements of Medical, Veterinary, Tsetse, Research and Coordination components of the tsetse and trypanosomiasis control programme.

MEDICAL

The National Sleeping Sickness Control Programme (NSSCP) effected control activities in South Eastern Uganda in the rhodesiense sleeping sickness focus and the North and North Western Uganda where the gambiense sleeping sickness abounds in collaboration with Medecins Sans Frontieres (France) MSF(F).

Figure 2 shows the patients diagnosed and treated in South Eastern and North and North Western Uganda from June 1995 - June 1997.

In South Eastern Uganda, 535 patients were diagnosed and treated compared to 651 recorded in the last reporting period showing a 17.8 percent decrease. Out of these, 34.4% were detected in the early stage while 65.6% were in the late stage. It was reported, during the 23rd International Scientific Council for Trypanosomiasis Research and Control (ISCTRC) meeting in Banjul, The Gambia, that a 218.4% increase in number of cases in South Eastern Uganda was recorded between 1993-1995. However during this current reporting period, a substantial decrease was recorded. This indicates that the programme has managed to halt

the increase in number of cases due to sustained surveillance for the disease.

In the gambiense sleeping sickness focus in North and North Western Uganda, 2174 patients were detected and treated compared to 2760 during the 1993-1995 period giving 21.1 per cent decrease. Only 17.9% of the patients were detected in the early stage of the disease. The problem of detecting more late cases is attributed to the insidious onset of the disease compounded by passive surveillance which is the commonest mode of case detection. Worthy to note however was the fact that insurgency in the gambiense focus greatly hindered the effective implementation of control activities. Therefore, the true figure for the number of *T.b.gambiense* patients could have been higher than shown here.

In North and North Western Uganda, 19% of all patients were of Sudanese origin.

In both foci there is need to improve the surveillance system in order to detect more early cases.

VETERINARY

Animal trypanosomiasis was reported from all the districts of the country based mainly on clinical diagnosis. The major method of control was treatment of livestock based on clinical grounds using trypanocidal drugs.

During this period, 272,276 doses of diminazine aceturate 340,604 doses of Isometamedium chloride and 107,932 doses of Homidium bromide were used.

In South Eastern and Western Uganda where surveillance for trypanosomiasis was undertaken, a total of 11397 animals were screened by the Haematocrit Centrifugation Technique and an overall prevalence of 8.95% was obtained.

The relative prevalence of the trypanosomes species identified during the period under review is shown graphically in figure 3.

T.vivax accounted for 59.7%, *T.brucei* 24.7%, *T.congolense* 13.0% and mixed infections 2.5% of all positive animals screened.

The high prevalence of animal trypanosomiasis calls for intensified control activities to improve and increase livestock production and productivity in the livestock farming areas. In sleeping sickness endemic areas, the Department of Veterinary Services treats *T.brucei* infected livestock with double dose of Diminazine aceturate (7.0 mg/kg) so as to remove the animal reservoir for human infective trypanosomes.

ENTOMOLOGY:

Vector control was effected using an environmentally friendly and cost effective method involving community participation by deploying insecticide impregnated traps and to some extent by live bait technology using deltamethrin: spot-on and decatix.

In all areas where vector control activities are in place, the tsetse fly population has been reduced by 95% of the initial density. However, these areas are always under threat from reinvasion from the adjacent non treated areas. In the sleeping sickness affected areas, the decision to carry out control activities, has always been dictated by the prevalence of the disease. This strategy is however slowly being replaced by a systematic approach in order to overcome the above problem of re-invasion. So far, 106 sub-counties have been covered by 10,719 traps covering an area of 15,900 km² in South Eastern, Mid-Central and North and North Western Uganda. In the Western and South Western Uganda where tsetse control activities are targeted at animal trypanosomiasis control, live bait technology using application of deltamethrin is the main method of controlling tsetse flies.

The tsetse trap deployment and tsetse apparent densities in the districts of South Eastern, North and North Western Uganda is shown in table 1.

Table 1: Mean trap deployment and tsetse apparent densities in South Eastern and North North Western Uganda.

DISTRICT	MEAN TRAP DEPLOYMENT/MONTH	MEAN AD
Iganga	3005	0.057
Kamuli	1292	0.033
Jinja	80	0.111
Mukono	914	0.212
Tororo	1078	0.01
Pallisa	291	0.162
Arua	195	0.206
Moyo	610	0.048
Gulu	160	1.6
Kitgum	94	1.083

RESEARCH:

Action research on sleeping sickness surveillance in South Eastern Uganda indicates that sleeping sickness is associated with poverty, and passive case detection is the most cost-effective method.

A study revealed that although there has been enormous environmental/vegetational changes in S.E. Uganda in the last 30 years, the distribution and population of *G.f.fuscipes* has remained constant.

High incidence of sleeping sickness in S.E.Uganda appears to be linked to rice cultivation in the wetlands.

Local targets such as tree screens and painted sack cloth screens were shown to be effective in tsetse control. Preliminary findings suggest that a monoscreen trap made from painted bark cloth could be more efficient than the ordinary pyramidal trap.

The use of popular theatre to mobilise the community which is largely illiterate to create awareness about tsetse control was developed and popularised.

A study was undertaken to determine the sensitivities of *T.brucei spp.* stocks from S.E Uganda to berenil, trypanidium and melarsoprol. The responses of *T.b.rhodesiense* and *T.b.brucei* stocks were effective and similar for all the drugs indicating that the use of veterinary trypanocides to control the domestic animal reservoir of *T.b.rhodesiense* is an effective strategy.

Characterisation of recent *T.b.gambiense* isolates from N.W.Uganda by isoenzyme and PCR analysis revealed a low degree of heterogeneity within trypanosome stocks in this focus. Although all the stocks analyzed so far have the LiTat 1.3 gene which is incorporated in the CATT screening test, some CATT negative cases were encountered implying the possible presence of a non expression of LiTat 1.3 gene.

COORDINATION:

The management of tsetse and trypanosomiasis research and control is under the Uganda Trypanosomiasis Control Council (UTCC) with the Coordinating Office for Control of Trypanosomiasis in Uganda (COCTU) as its secretariat.

During the period under review, COCTU in liaison with OAU/IBAR organized and held 3 Policy Harmonisation Meetings involving Kenya, Tanzania, Ethiopia and Uganda and 10 Technical Tsetse & Trypanosomiasis field staff meetings for staff working along the Kenya/Uganda border.

The "Farming in Tsetse Control Areas of Eastern Africa" project was written and successfully negotiated with the European Union. It is expected to become operational before the end of 1997.

In close collaboration with Department of Entomology, entomologists were recruited, trained and posted to head district teams. Veterinary officers in-charge of animal trypanosomiasis were trained in the appropriate trypanosomiasis control methodologies.

The implementing departments were supervised and monitored to ensure the optimal utilisation of the limited resources at the programmes' disposal. All the funding to the programme went through COCTU.

Reports and information on the programme were compiled and disseminated to all

CONCLUSION:

Although sleeping sickness is steadily being brought under control, animal trypanosomiasis is still a major constraint to the proper development of the livestock industry. There is urgent need to address this problem by implementing tsetse and trypanosomiasis control in the affected areas. Adaptive research has been influential in deciding on the appropriate technologies to be adopted. The Coordinating office ensured the proper utilization of the limited resources which resulted in the achievements high lighted in this report.

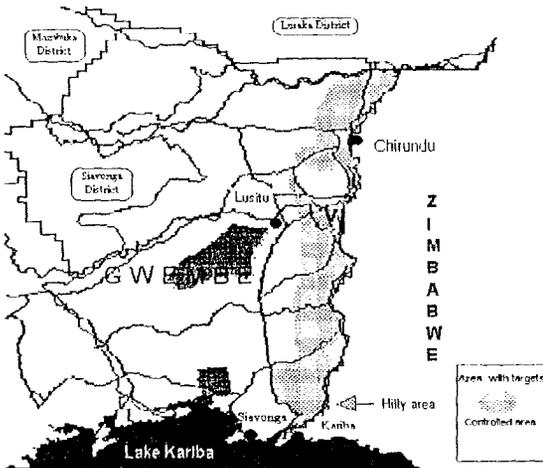
2. TSETSE AND TRYPIS CONTROL OPERATIONS

2.1. LUSAKA/SOUTHERN PROVINCES

2.1.1. Gwembe and Chiawa area

Tsetse control operations in Gwembe started in 1988 where as those in Chiawa were not embarked on until 1990. All black Swinger-type targets have been used in both areas. Until 1995, tsetse control work was carried out by government personnel. However, is now carried out by private contractors.

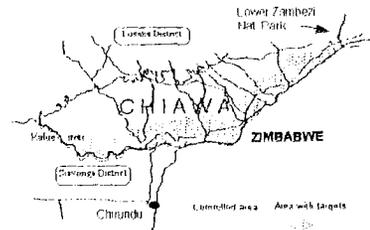
MAP OF GWEMBE



An area of 3,820 Km² originally deployed with targets has been reduced to 805 Km². Subsequently, targets have been reduced from 59,261 to 3,699 and only act as barriers to tsetse invasion. In addition, a total of 49,287 cattle and another 8,212 goats have been sampled for trypanosomiasis. Plans are underway to hand over the operations to local communities in Chiawa.

The role of government personnel has been reduced to facilitation, supervision and monitoring of both tsetse and trypanosomiasis. In both areas, a total or near eradication of both tsetse and trypanosomiasis has been achieved.

MAP OF CHIAWA



2.2. EASTERN PROVINCE

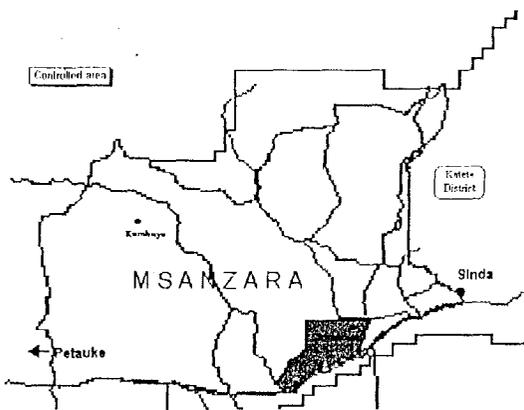
Both tsetse and trypanosomiasis surveys have been going on since 1990 covering an area of 21,828 Km². In addition, a total of 58,466 cattle have been sampled for trypanosomiasis using direct parasitological sampling technique.

A 3-year pour-on trial has been embarked on in this area. Preliminary tsetse, trypanosomiasis and socio-economics surveys have been carried out. However, environmental surveys are still underway.

2.2.3. Msanzara

A tsetse control operation using local communities to deploy and maintain targets has been going on since 1995. The control approach is such that where as government/project provide target materials (other than poles) and equipment, local communities provide labour and bamboo poles for targets.

MAP OF MSANZARA



A total of 3,660 targets have been maintained since then. About 900 Km² is under tsetse control using targets. Further, a total of 58,466 cattle have been sampled from this area and the neighbouring Mvuvye where control operations were discontinued in 1995. An estimated 99% reduction of both tsetse and tryps has been achieved. Finally, where as labour sustainability has been achieved, we are yet to assess whether or not local communities can be relied on to render

financial support to the programme.

2.2.4 Kakumbi

Work is being carried out on behaviour of *G. Brevipalpis* with a view to design an appropriate sampling device for *G. brevipalpis*. Other work is concentrated on refining the bait technology suitable to local conditions. In addition, results from a weather monitoring station are being collected in order to relate them with the ecology the tsetse fly.

3. WESTERN PROVINCE

Tsetse and tryps operations in this area started in 1997 using the all black Swinger-Type targets baited with Acetone and phenols. It is a joint Zambia/Dutch funded programme.

In order to reduce the cost and to ensure sustainability, a number of changes and advances have been made to the design and deployment/placement pattern of targets during the last 7 years. Areas of high cost on the target itself were identified. Most notable were the target cloth (most expensive), chemical and finally the metal frame. In view of this, a number of changes/modifications were made to the original design as described below;

- reduce cloth size to half and re-design it so that the black panel is in the centre with blue panels on either side. An enormous saving on the chemical was made.
- substitute a more expensive chemical glossinex with fastac.
- replace metal frame with local poles from regenerating tree spp.

- replace metal frame with local poles from regenerating tree spp.
- use only acetone and octenol since it is a *G.morsitans* area.
- replace a more expensive acetone dispensing bottle to a plastic one.

A total of about 58% saving was made from the changes described above.

Private contracting of tsetse control services has reached an advanced stage in this area where both tsetse and tryps surveys and control are currently carried out by private contractors. The role of government has been greatly reduced to facilitation, supervision and monitoring. It has now been proven that, where an efficient monitoring system is in place, the quality of work carried out by private contractors is excellent. However, there are difficulties associated with this, such as huge investment costs, long/tedious tendering procedures which result in failing to meet work schedule deadlines. The approach is not financially sustainable as a result.

A trial community-based tsetse control undertaking at Kalobolelwa has been abandoned due to lack of financial commitment by the communities. They were only prepared to offer labour into the operation.

Currently, there are 7,599 targets in the area out of which 5,904 targets are those forming barriers and their distribution is as follows;

Western barrier (along the Zambian border with Angola)	410 targets
Southern barrier (along the southern edge of the control area west of the Zambezi)	3,194 "
Re-aligned eastern barrier (along side southern edge of the Zambezi)	2,300 "

An average target density of 30 targets/Km² is maintained within the barriers where as on the other hand, the control area (East of the Zambezi) has 1, 695 targets at 4 targets/Km².

Tsetse and tryps control work in Western Province is concentrated in Senanga District. A total area of 9,200 Km² has been cleared since the programme was embarked on in 1986.

4. FUTURE PLANS.

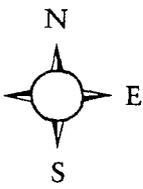
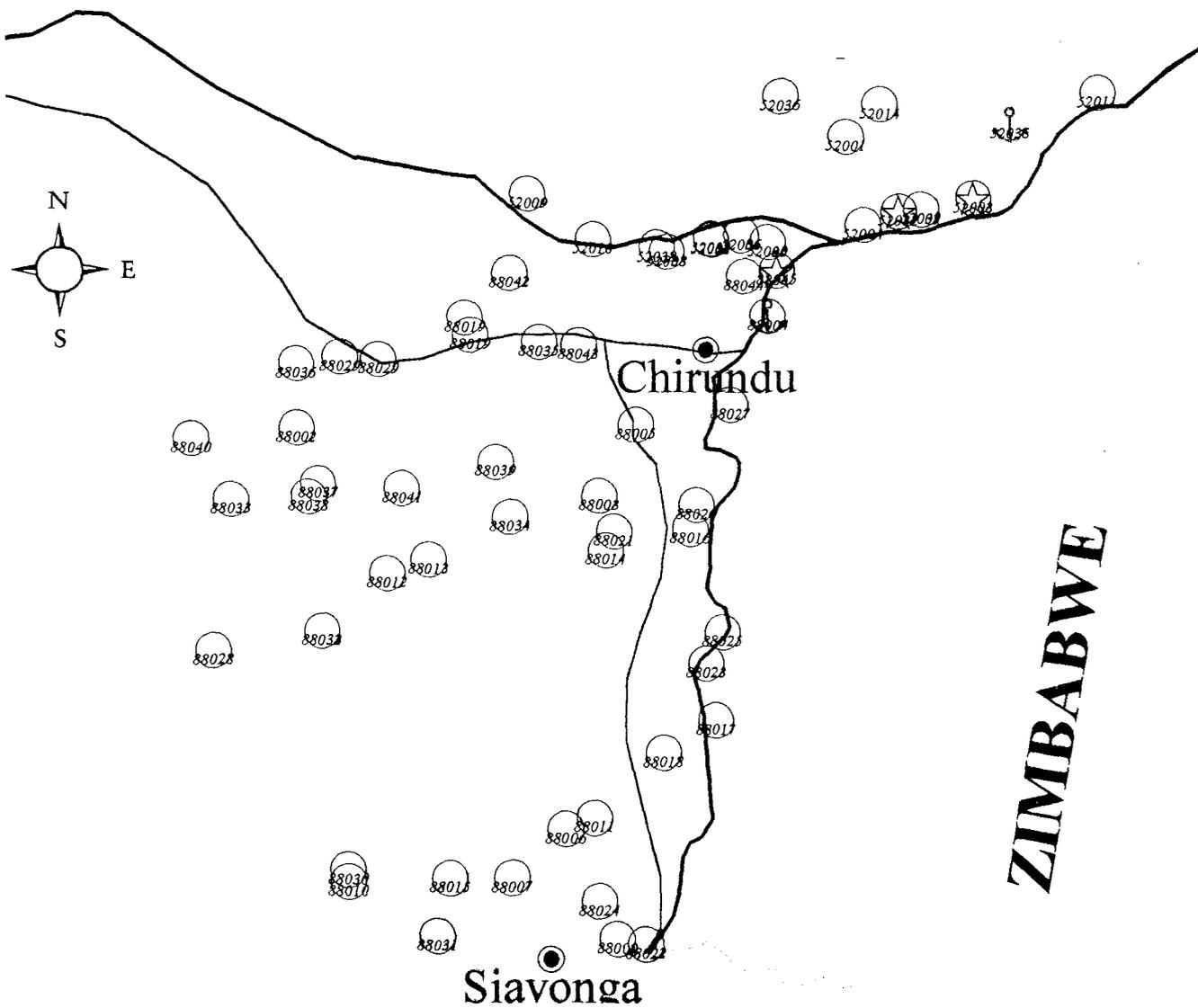
Plans are underway to extend control operations to Sesheke and Kaoma districts and to continue with consolidation of the control areas. However, this will depend on financial availability. Tsetse and tryps monitoring will continue in the control areas.

Compared to the area which has so far been cleared of tsetse and trypanosomiasis disease, one realises that the vector and disease still occupy large tracts of land especially in the Eastern Province. This problem is compounded by the reduction in the tsetse and

trypanosomiasis disease budget. Compared to last year's budget of US\$ 1m, this year's one will only cover about half of this figure. Additional funding would be required in order to lower down the problem of tsetse and trypanosomiasis.

RTTCP ZAMBIA

Current Tryps Survey 1993 - 1997 (Chiawa and Gwembe)



Key

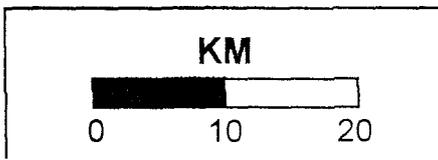
- Lakes
- Major Roads of Zambia
- Major Rivers of Zambia
- Towns of Zambia
- Current Tryps Survey (1993 - 1997)

CRUDE PREV.

- 0 %
- 5 %
- 10 %
- 15 %
- 20 %
- 25 %
- 30 %
- 35 %
- 40 %
- 45 %
- < 45 %

ZIMBABWE

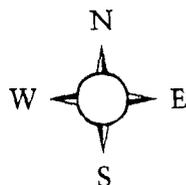
By R. Mulenga



RTTCP ZAMBIA

Historic Tryps Survey 1988 - 1992 (Petauke)

MUNDANGWE



Lakes

Major Roads of Zambia

Major Rivers of Zambia

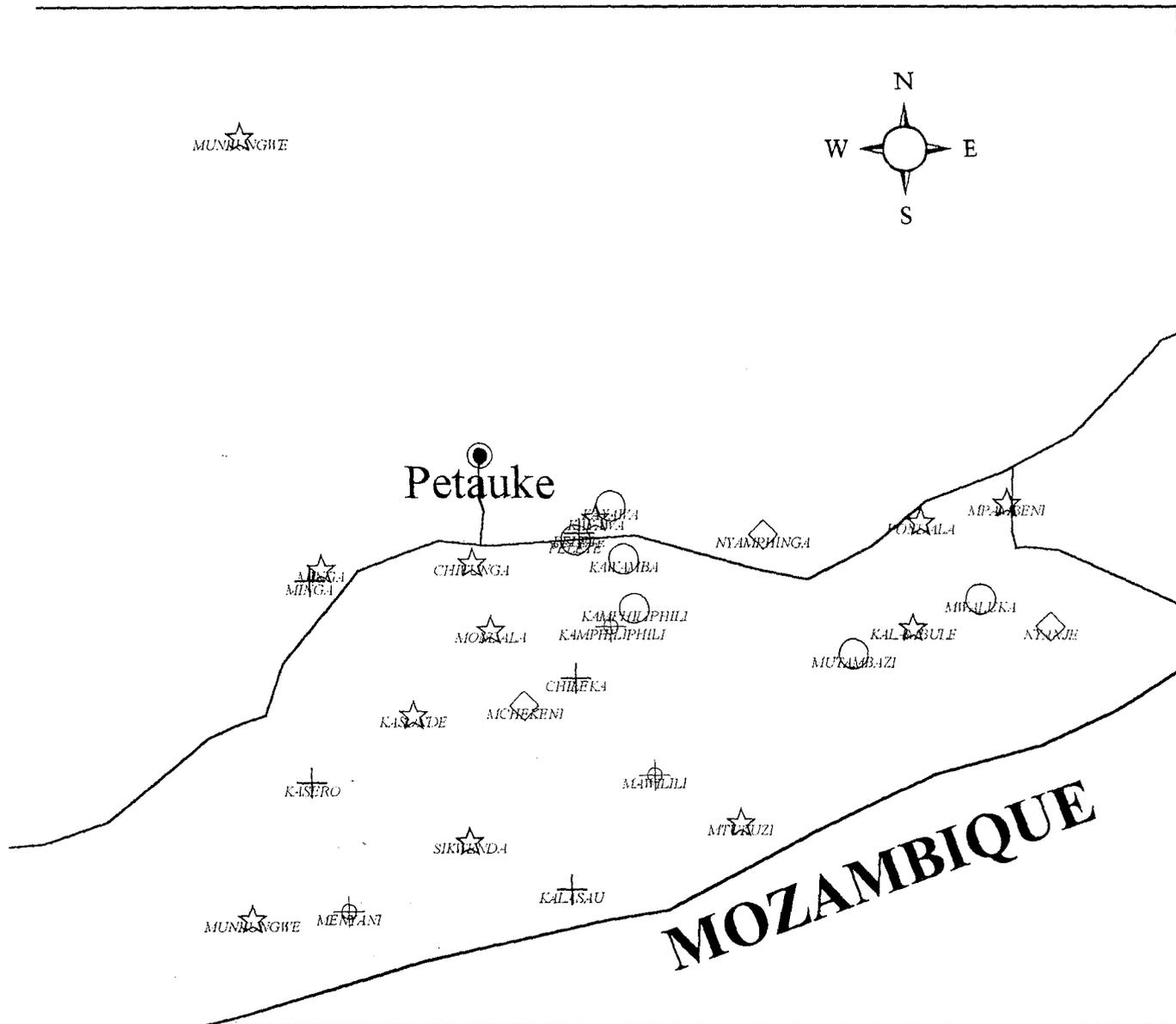
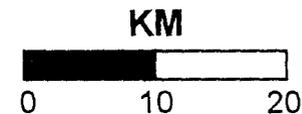
Towns of Zambia

Historic Tryps Survey (1988 - 1992)

CRUDE PREVALANCE

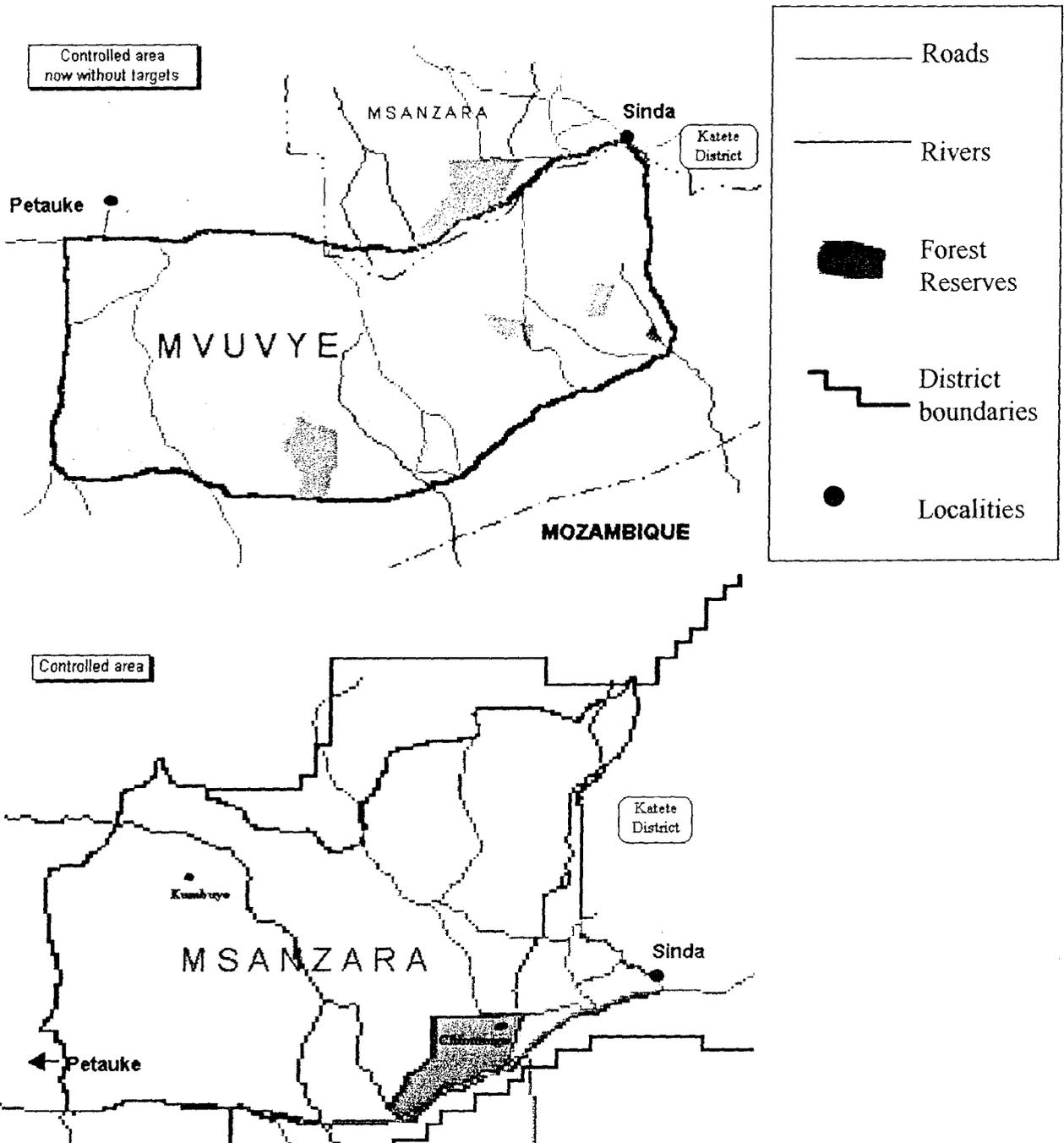
- 0 %
- 00.001 - 05.000 %
- △ 05.001 - 10.000 %
- ◇ 10.001 - 15.000 %
- ☆ 15.001 - 20.000 %
- ⊕ 20.001 - 25.000 %
- ⊗ 25.001 - 30.000 %

By R. Mulenga



RTTCP-ZAMBIA, EASTERN PROVINCE OPERATIONAL AREA, EASTERN PROVINCE

Mvuvye and Msanzara areas situation by end of September 1997



Since December 1996 the targets situation is as follows:

- *Mvuvye area*: no target maintained on the 945km²
- *Msanzara area*: 3,646 targets deployed on 900km² or 4.05 targets/km²

Remark: since mid 1995, no maintenance has been done in Mvuvye area and almost all the 2,928 targets

Dynamique de la ré-émergence de la trypanosomiase humaine en Afrique centrale, dans les pays de la zone OCEAC.

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Résumé

Depuis la fin des années 1960 nous assistons à une reprise générale de la trypanosomiase humaine africaine. Les épidémies de ces dernières années, dans la zone OCEAC, se sont toutes développées à l'emplacement des foyers historiques des dramatiques pandémies de la fin du 19^{ème} et début du 20^{ème} siècle, ce qui a fait évoquer un "génie épidémique de la THA".

Rechercher les causes de la reviviscence des foyers et de leur maintien nécessite de connaître l'historique et la dynamique de ces foyers non dans un contexte national, mais à une échelle plus large. Il faut rechercher leur origine afin de déterminer s'ils préexistaient à la colonisation (foyers primaires) ou s'ils sont la conséquence des mouvements de populations.

On peut se demander si l'on est en présence d'une souche de trypanosome propre à chaque foyer. Dans ce cas le foyer évoluerait pour son propre compte et sa résurgence pourrait être le fait d'une reprise de la souche locale (peut-être due à une absence ou une baisse de l'immunité acquise de la nouvelle génération par rapport à la précédente, d'où les cycles constatés). A moins que ces reprises épidémiques ne soient le fait de l'introduction dans le foyer d'une souche extérieure à celui-ci ? Dans ce cas il faudrait considérer l'évolution de la situation sur le plan régional avec toutes les conséquences que cela implique sur la lutte.

Summary

DYNAMIC OF REEMERGING HUMAN TRYPANOSOMIASIS IN CENTRAL AFRICA (OCEAC).

Since the late sixties, the incidence of human african trypanosomiasis has been rising gradually. The epidemics in the OCEAC area during the last few years have all occurred at known endemic foci which had been sites of pandemics at the end of the 19th century and the beginning of the 20th century.

To determine the causes of epidemics in these foci and their endemicity, it is necessary to analyse history and dynamics of there endemic areas in the regional context, and not on the national level. Their origin needs to be studied in order to determine whether ther foci existed befor human colonization (primary foci) or if they are the result of population movement.

We may ask ourselves whether in each endemic focus a particular strain of trypanosomes is present. If this hypothesis is correct, the endemic focus may follow its evolutionary course independently, and epidemics may be due to a reemergence in the local strain (possibly related to the absence or decrease in acquired immunity of the new generation of hosts). It may also be possible that epidemics is associated with the introduction of new strains of trypanosomes from another endemic region. In this cases, the evolution of the epidemiological situation should be analysed at the regional level, and consider its repercussions on the trypanosomiasis control programme.

Introduction

D'énormes efforts ont été déployés au début du siècle pour faire disparaître les foyers de maladie du sommeil à *Trypanosoma brucei gambiense*. C'était, dans les années 60, un objectif presque atteint puisqu'en 1963, dans 5 des 6 pays de l'OCEAC qui regroupent le Cameroun, la Centrafrique, le Congo, le Gabon, la Guinée Équatoriale et le Tchad, on dénombrait 367 malades (Dutertre, 1965).

Actuellement la trypanosomiase humaine flambe partout et l'exemple congolais est particulièrement démonstratif. En 1965 on y a dépisté 24 malades. Ils étaient 107 en 1975, 561 en 1985 et 754 en 1993. Depuis cette date le nombre des malades est passé en dessous de la barre des 500, mais, du fait de la situation politique locale, ces données n'ont pas de valeurs nationales (Figure 1).

On peut facilement expliquer cette recrudescence par la dégradation des situations politiques et économiques, mais à y regarder de plus près on s'aperçoit que si la déstructuration des services de santé peut être responsable des flambées endémiques, elle n'explique pas le fait que ces flambées aient débuté au coeur des foyers historiques.

Origine des foyers

Nous n'avons pour ainsi dire aucune information, avant la colonisation, sur les foyers de trypanosomiase humaine d'Afrique centrale. Les seules données utilisables sont celles qui ont été obtenues rétrospectivement auprès des populations autochtones.

La carte de la maladie du sommeil au Congo en 1884 de Dutton et Todd, est la première du genre (Carte 1). Elle indique que tout le bas Zaïre est touché, de la Côte au Stanley Pool, de même que l'embouchure de la Kasai, l'extrémité nord du couloir (à la hauteur de M'Pouya au Congo), l'Oubangui sur 1/3 de sa partie congolaise, de part et d'autre d'Impfondo ainsi que le haut Zaïre.

Il n'est pas réaliste de considérer que la maladie ne traversait pas le fleuve. Le côté Congolais devait donc également être atteint à cette époque. Ce point est confirmé par Brumpt en 1903.

La carte de Martin, Roubeau et Leboeuf de 1907 montre la rapide extension de l'endémie dans les premières années de la colonisation extensive. Elle touche l'ensemble des rives des fleuves Congo et Oubangui ainsi que tous leurs affluents, en particulier la Sangha qui est atteinte jusqu'à Nola. Au Congo, le Kouilou et le Niari sont touchés. En RCA l'Ouham et le Mbomou le sont aussi. Le bas et moyen Chari sont également atteints de même que la côte gabonaise et les rives de l'Ogoué et de l'Ivindo.

Du fait de cette rapide diffusion de l'endémie, il est difficile de pouvoir préciser quelle est l'origine des foyers actuels ou passés d'Afrique centrale. Nous avons essayé de le faire dans la mesure où les auteurs qui,

les premiers, ont décrit les foyers de la maladie, ont essayé de savoir comment ils s'étaient créés (Carte 2).

Différentes hypothèses ont été proposées (Janssens et al., 1992) allant :

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à la thèse pluraliste (impliquant des origines multiples).

Le sujet n'est pas clos et ne sera vraisemblablement tranché que par l'étude génétique des souches des différents foyers.

Si l'on se limite aux pays de la zone OCEAC, ce qui est notre propos, on peut individualiser 5 origines possibles de la diffusion de la maladie.

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La guinée Équatoriale est signalée infectée avant 1840 (Clarke, 1840) sans que l'on sache qu'elle en est l'origine. Ce peut être, là aussi, une conséquence du cabotage.

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Les ré-émergences

Les pandémies de la fin du siècle dernier et du début de ce siècle ont été catastrophiques. Elles ont fait plus de 500.000 morts dans la sous région. Les médecins engagés dans la lutte contre la maladie ont été frappés de la rythmicité de l'endémie. C'est alors que l'on a commencé à parler de "génie épidémiologique de la trypanosomiase humaine".

La première pandémie a sévi dans les années 1880. La seconde vers 1920-1930 et la troisième a débuté dans les années 70, soit un cycle d'une quarantaine d'années (Figure 2).

Autre fait marquant, les épidémies de ces dernières années se sont presque toutes développées à l'emplacement des foyers historiques. Il suffit pour s'en convaincre de comparer le Congo en 1884 et maintenant (Carte 3). Sur la carte de Dutton et Todd il y avait 5 foyers : La région d'Impfondo, celle de Loukoléla (Mossaka), celle du couloir entre M'pouya et N'gabé, celle de Linzolo (aux portes de Brazzaville) et celle du Niari et de Boko Songho. En 1996 trois de ces foyers persistent. Celui de Mossaka qui recouvre presque le foyer de 1884, celui du couloir qui s'est étendu de part et d'autres de M'pouya et N'gabé, et celui de Boko Songho qui s'étend actuellement, comme en 1884, vers le Niari.

Le suivi des foyers actuels montre qu'ils se sont étendues à partir des épicentres de la poussée endémique du début du siècle.

Au Cameroun les foyers les plus connus sont ceux du Mbam (Bafia) et du Nyong où Jamot est intervenu. Ce sont également des foyers récents. Celui du Nyong remonte au début du siècle et celui du Mbam aux années 1920. Ces 2 foyers sont actuellement éteints. Par contre les foyers anciens de Fontem et Campo sont toujours actifs (Carte 4).

Celui de Campo ne s'est en fait jamais éteint mais n'a également jamais flambé, comme si un équilibre entre parasite, vecteur et hôte s'était établi.

Pour ce qui est de Fontem, P. Dukes (1991) a montré, en 1992, que des souches de ce foyer n'avaient pas le variant antigénique LiTat 1.3 qui est le variant utilisé pour le diagnostic par CATT (Magnus et al., 1978) de la Trypanosomiase à *T. gambiense*. Or, en 1932, Jamot qualifiait ce foyer d'ancien, à évolution très lente, sans aucune tendance épidémique. Il ajoutait qu'il "*serait intéressant d'étudier si son virus est bien le même que celui du Nyong ou si, au contraire, il ne se rapproche pas de celui de la Nigeria du sud que nos camarades anglais croient beaucoup moins actif*".

En RCA, les foyers actuellement actifs de Nola, de l'Ouham et du Mbomou se retrouvent de façon à peu près similaire sur la carte de Martin, Roubeau, Leboeuf de 1907.

Discussion et Conclusion

Il est surprenant de constater qu'à chaque pandémie, la dynamique des foyers a toujours été la même. Ils sont réapparus à l'épicentre des anciens foyers, se sont étendus plus ou moins pour finalement régresser et s'achever dans la région où ils avaient commencé. Exception faite du foyer de Bafia qui était encore actif dans les années 80, l'endémie n'a jamais persisté entre les foyers historiques.

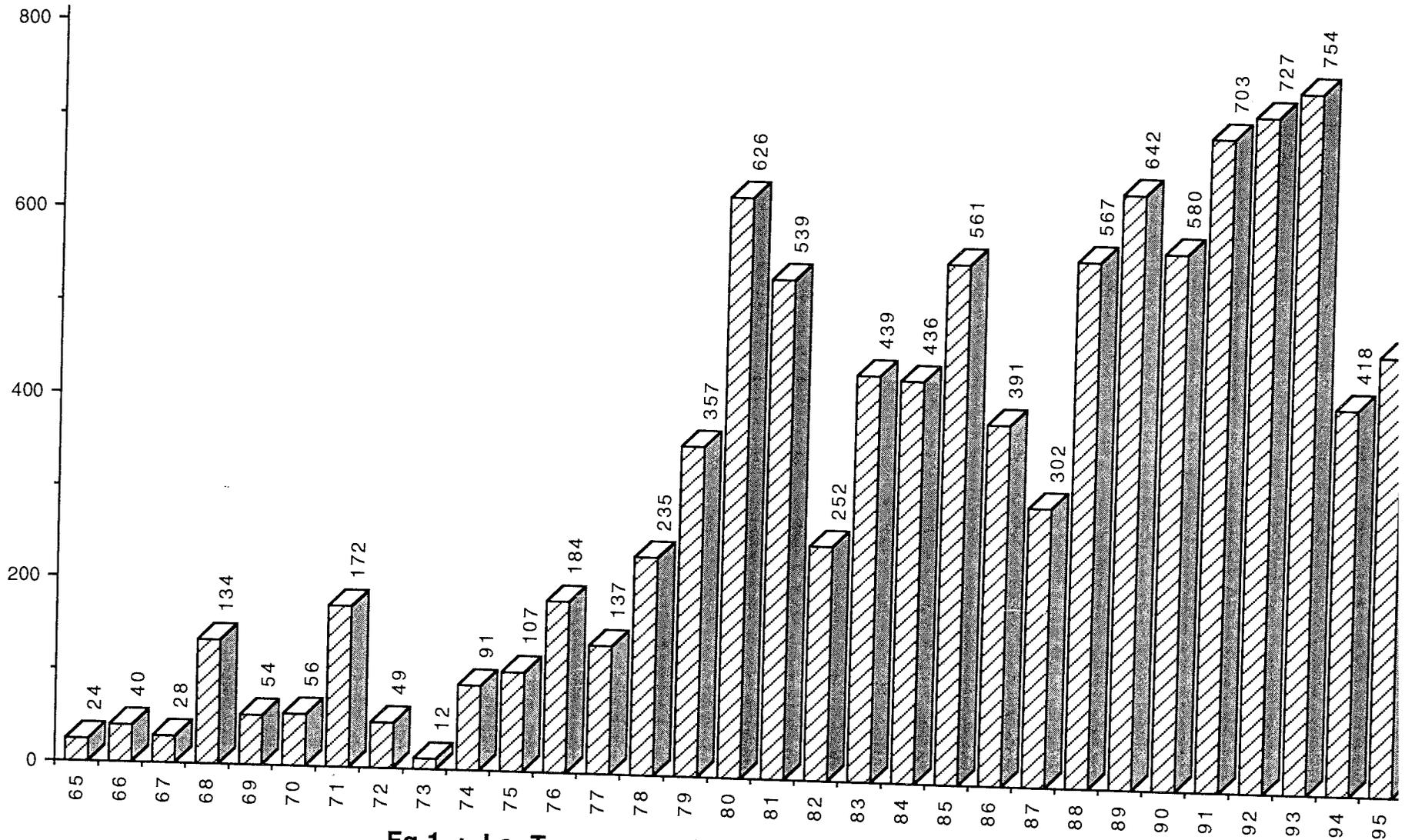
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Les premières études génétiques sur les souches humaines, sous réserve de confirmation, montrent des différences d'un foyer à l'autre. Dans cette optique, on peut imaginer que les ré-émergences de la maladie soient dûes à l'existence d'un réservoir ignoré évoluant à bas bruit entre les phases épidémiques.

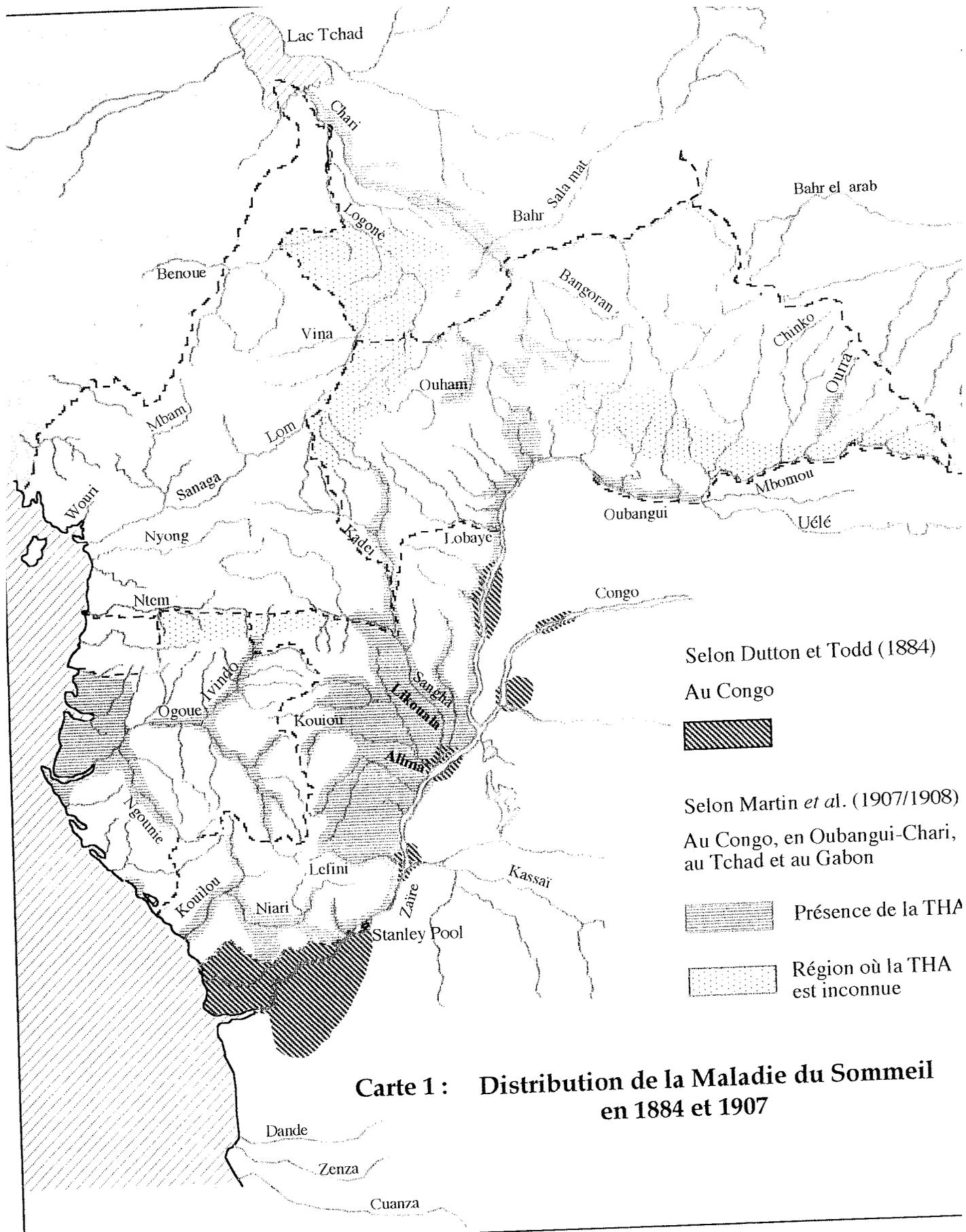
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Nouveaux Trypanosomés



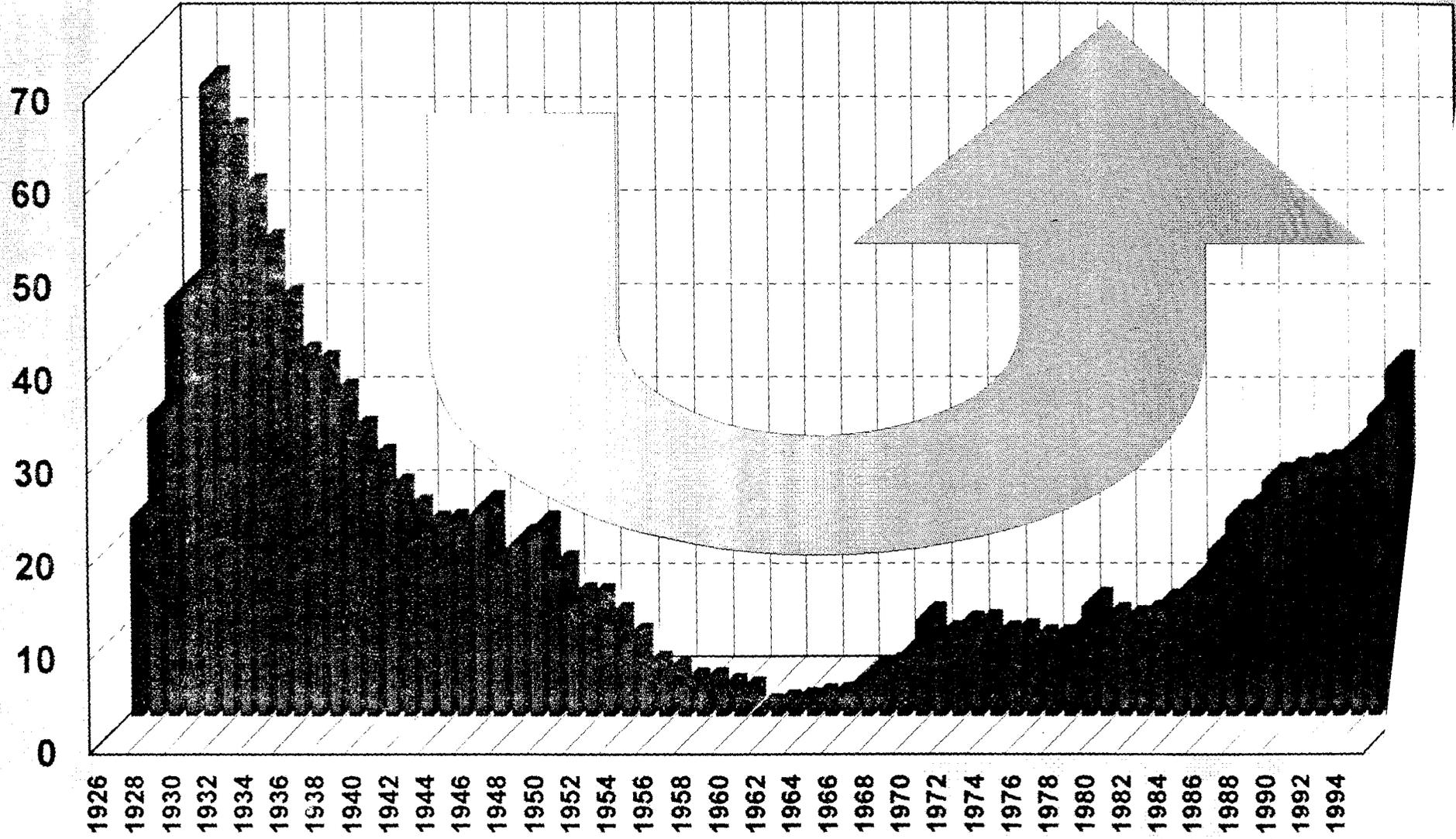
**Fig.1 : La Trypanosomiase Humaine au Congo
1965 - 1996**

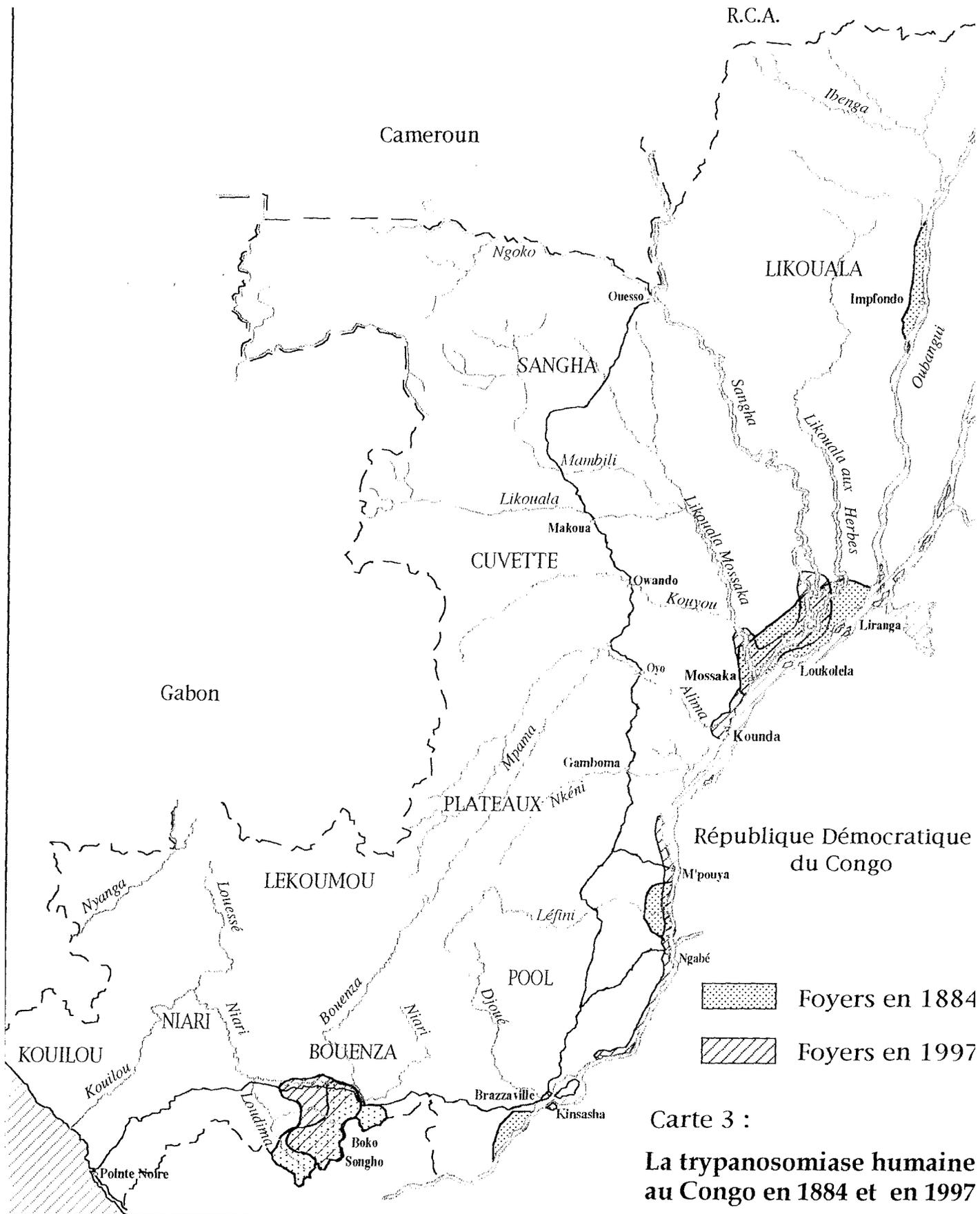


Carte 1 : Distribution de la Maladie du Sommeil en 1884 et 1907

Fig.2 : **Trypanosomiasis in Central Africa**
1926 - 1995

Thousands

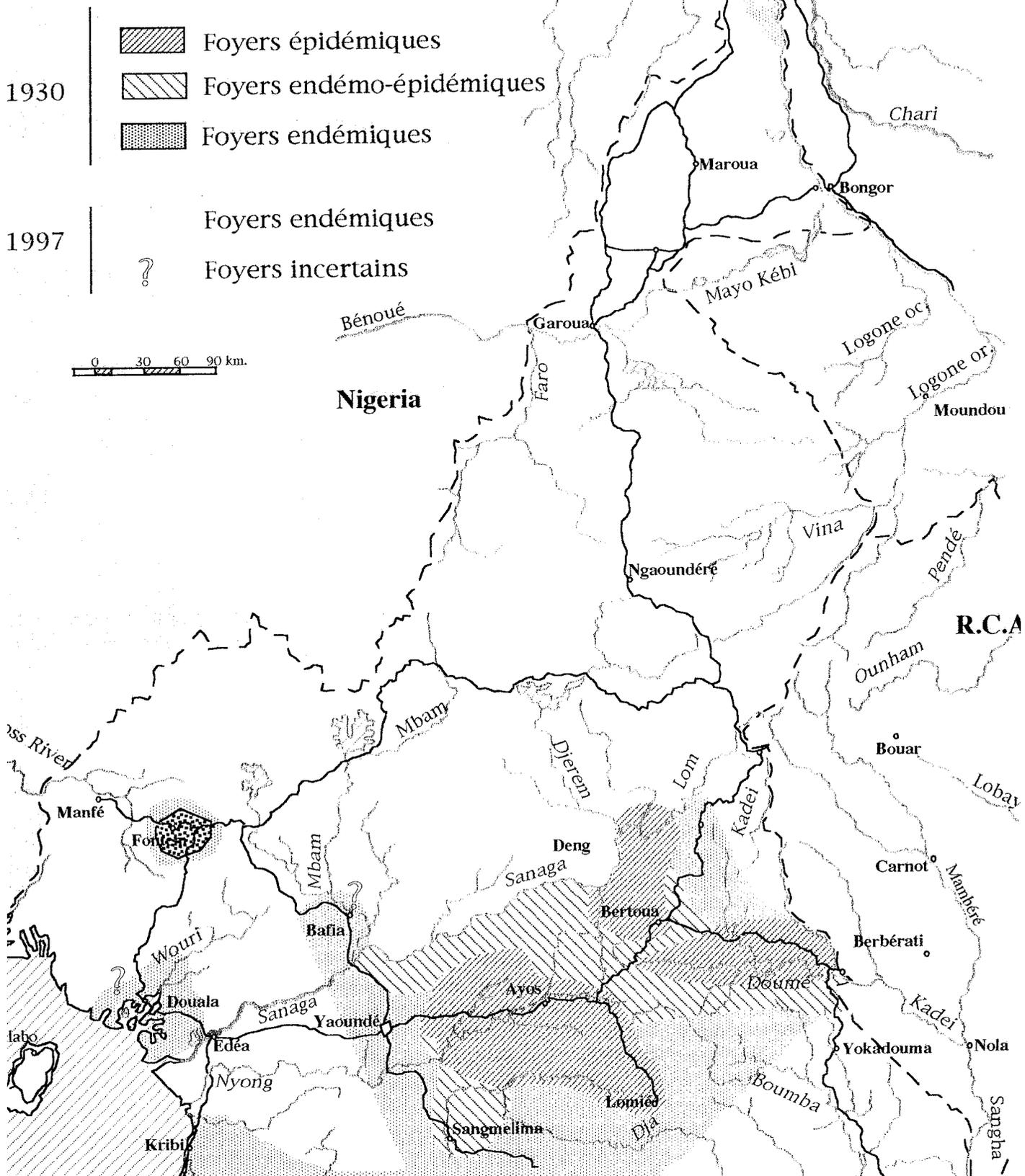




Carte 3 :
 La trypanosomiase humaine
 au Congo en 1884 et en 1997

Carte 4 :

La trypanosomiase humaine
au Cameroun en 1930 et 1997



Dynamique de la ré-émergence de la trypanosomiase humaine en Afrique centrale, dans les pays de la zone OCEAC.

Laurent PENCHENIER¹, Stéphane HERDER¹, Jean Marie BODO¹, Pascal GREBAUT¹,
WANG SONNE²

TRANSP TITRE

Introduction

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Depuis cette date le nombre des malades est passé en dessous de la barre des 500, mais, du fait de la situation politique locale, ces données n'ont pas de valeurs nationales.

On peut facilement expliquer cette recrudescence par la dégradation des situations politiques et économiques,

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Elle indique que tout le bas Zaïre est touché, de la Côte au Stanley Pool, de même que l'embouchure de la Kasai, l'extrémité nord du couloir (à la hauteur de M'Pouya au Congo), l'Oubangui sur 1/3 de sa partie congolaise, de part et d'autre d'Impfondo ainsi que le haut Zaïre.

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Nous avons essayé de le faire dans la mesure où les auteurs qui, les premiers, ont décrit les foyers de la maladie, ont essayé de savoir comment ils s'étaient créés.

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En RCA, les foyers actuellement actifs de Nola, de l'Ouham et du Mbomou se retrouvent de façon à peu près similaire sur la carte de Martin, Roubeau, Leboeuf de 1907.

On pourrait en faire de même avec les autres foyers de la zone OCEAC.

Discussion et Conclusion

Il est surprenant de constater qu'à chaque pandémie, la dynamique des foyers a toujours été la même.

Ils sont réapparus à l'épicentre des anciens foyers, se sont étendus plus ou moins pour finalement régresser et s'achever dans la région où ils avaient commencé. L'exemple du foyer du Nyong au Cameroun, est frappant

3 TRANSP NYONG

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Dans la région d'origine

LAISSER SUR TRANSP 1900

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Si la souche n'est pas propre à chaque foyer historique, les reprises épidémiques seraient le fait de l'introduction dans le foyer d'une souche extérieure à celui-ci. Dans ce cas il faudrait considérer l'évolution de la situation sur le plan régional avec toutes les conséquences que cela implique sur la lutte.

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Title: Comparison of the epidemiology of sleeping sickness and the environment profile in Tororo district

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Abstract

The application of Geographic Information Systems (GIS) in the surveillance of ecological diseases such as malaria, schistosomiasis, dracunculiasis, onchocerciasis and human African trypanosomiasis (sleeping sickness) has been suggested. In order to ascertain the possible usefulness of GIS in the surveillance of sleeping sickness, the known distribution of sleeping sickness in time and space was compared to the environment profile in Tororo district Uganda. When transposed, maps of the known distribution of sleeping sickness and that of vegetation, land use and drainage fit closely. Trends in monthly sleeping sickness incidence, rainfall and Normalised Difference Vegetational Indices (NDVIs) are correlated. The epidemiology of sleeping sickness in Tororo appears to be closely associated with vegetation, land use, drainage and rainfall distribution. GIS may be very useful in precisely defining foci and therefore priority areas for control.

INTRODUCTION

The appearance of human african trypanosomiasis due to *T. rhodesiense* in the northern parts of Tororo district, in the late 1980s led to the description of the epidemiology of the disease in a new endemic area.

The Gross National Product per capita for Uganda is less than US\$ 300. 90% of the population is rural and are believed to have an income per capita of less than US\$ 100. Cost-effective approaches to disease control are therefore very necessary. It is hypothesised that sleeping sickness control can be targeted in time, place and person based on a forecast of the occurrence of sleeping sickness outbreaks.

*a conduit à l'apparition de la maladie
une nouvelle zone endémique.*

Classical foci of sleeping sickness in Africa generally persist at a low level of transmission with occasional epidemic outbreaks occurring, often as a result of interruptions of systematic medical surveillance, changes in climate and vegetation, or population movements (WHO 1986). However, there is evidence of outbreaks outside the known endemic areas. Recrudescence and extension of foci have been reported from Zaire (Kazyumba 1989). In the Congo, historical foci of the Bouenza region and the couloir around the river Congo persist and are spreading (OCEAC 1990). Surveys conducted in 5 communities in Etiope and Ndokwa local government areas of Bendel state, southern Nigeria indicate that these are endemic foci of sleeping sickness that were hitherto unreported (Edeghere *et al.* 1989). In Uganda, the epidemic of sleeping sickness in Busoga of 1976 to 1988 was accompanied by profound changes in the distribution and incidence of the disease in the neighbouring Tororo district. Formerly, it was mainly restricted to around the northern shores of Lake Victoria in the Samia Bugwe county.

The history of sleeping sickness in Tororo district dates back to the epidemic of *T. gambiense* from 1900 to 1914 when Budama and Samia counties were affected (Barnley 1968, Lester 1939, Thomson 1960). In the *T. rhodesiense* epidemics of 1940 and 1976 to 1983, only Samia county in Tororo district was affected (Mackichan 1944, Abaru 1985). However, *Glossina fuscipes* was already reported to be present along the rivers running from Mount Elgon at the Uganda border with Kenya, to join Lake Kyoga (Rivers Malaba and Osia) and was perhaps responsible for the disease in Budama at the beginning of the century (Mackichan 1944). In 1966 and 1980, *G. fuscipes* was again reported to be prevalent around the rivers Malaba and Osia (Harley 1966, Okiria 1983).

The objective of the study was to relate the epidemiology of sleeping sickness in Tororo to demographic factors rainfall vegetation, river drainage and land use. Control may then be targetted in time, place and person.

Methods

A retrospective analysis of sleeping sickness case records and environmental data for Tororo district was undertaken. *as signals* *effective*

Records of sleeping sickness cases from 1979 to 1991 in Tororo district were obtained from the Livestock Health Research Institute (formerly the Uganda Trypanosomiasis Research Organisation) hospital sleeping sickness case records. Between 1979 and 1989, UTRO hospital was the sole treatment centre in Tororo district for sleeping sickness. In 1989, sleeping sickness treatment centres were opened in Busolwe hospital and Lumino health centre. Records of sleeping sickness for 1989 to 1991 were therefore obtained from all 3 sleeping sickness treatment centres. Records of 1007 sleeping sickness cases from Tororo district, which included geographical information and month of detection, were obtained dating back to 1979. For the purposes of determining age and sex distribution, records of 923 sleeping sickness cases admitted at UTRO with details of age and sex were

used.

Population data from the 1991 national census were used to calculate the incidence of sleeping sickness for the period 1979 to 1991 in Tororo district. The population data provided the basis for the calculation of attack rates by age.

sur la précipitation Rainfall data for Tororo district was obtained from the Tororo air field meteorological station. The correlation between sleeping sickness monthly incidence and monthly rainfall and the Normalised Difference Vegetational Indices (NDVIs) was calculated using Instat software package. *taux d'attaque par tranche d'âge*

Rainfall data for Tororo district was obtained from the Tororo air field meteorological station. The correlation between sleeping sickness monthly incidence and monthly rainfall and the Normalised Difference Vegetational Indices (NDVIs) was calculated using Instat software package.

logiciel Instat

Transposition of maps^{-cartes} of the known distribution of sleeping sickness and that of vegetation, land use and drainage was done.

Results

Annual incidence of sleeping sickness.

The annual incidence of sleeping sickness cases in Tororo district is presented in Table 1. A total of 1007 sleeping sickness cases were reported during the period 1979-1991, with an average of 84 (15 per 100,000) per year. The highest number (57 per 100,000) was reported in 1990 and the lowest (< 0.2 per 100,000) between 1979 and 1984. The proportions of sleeping sickness cases admitted from Tororo district and Busoga at UTRO hospital between 1984 and 1990 are summarised in Table 2). The proportions of sleeping sickness cases from Busoga admitted at LIRI (UTRO) gradually decreased as those from Tororo district increased (Table 2).

alors que ceux du district de Tororo augmentaient

Table 1. Annual incidence of sleeping sickness in Tororo district (1988-1991).

Year	No.	Incidence per 100,000
1979	1	0.2
1980	0	0
1981	1	0.2
1982	1	0.2
1983	0	0
1984	0	0
1985	12	2.2
1986	25	4.5
1987	26	4.7
1988	193	34.7
1989	233	41.9
1990	316	56.9
1991	199	35.8
Total	1007	

Distribution by month.

Figure 8 shows the monthly distribution of sleeping sickness incidence between 1988 and 1991. The peak incidence (4.95 per 100,000) of sleeping sickness was in May. January had the lowest incidence (2.57 per 100,000) of sleeping sickness). Figure 1 also presents the 1988-1991 average rainfall with the peak in May.

Fig.1 Sleeping sickness in Tororo district (1988 to 1991): Average monthly incidence per 100,000, rainfall (mm) and NDVIs*

Month	Incidence	Rainfall	NDVI
Jan	2.57	68.7	0.425
Feb	2.99	118.0	0.433
Mar	3.23	131.8	0.371
Apr	4.32	208.2	0.502
May	4.95	232.6	0.520
June	4.10	219.3	0.490
July	4.01	66.5	0.425
Aug	3.51	138.9	0.380
Sep	3.64	91.9	0.452
Oct	3.38	170.8	0.448
Nov	2.83	118.6	0.463
Dec	2.79	72.4	0.517

* 1988&1989

The monthly sleeping sickness incidence was significantly correlated to monthly rainfall ($p=0.0281$) but not to Normalised Difference Vegetational Indices (NDVIs) ($p=0.1865$).

Table 2. Sleeping sickness cases admitted to UTRO from Busoga and Tororo between 1984 and 1990.

Year	No. of cases(%)		
	Tororo	Busoga	Total
1984	0 (0)	39 (100)	39
1985	12 (14)	76 (86)	88
1986	25 (29)	61 (71)	86
1987	26 (81)	6 (19)	32
1988	193 (65)	104 (35)	297
1989	199 (86)	32 (14)	231
1990	208 (85)	37 (15)	245

Table 3. Sleeping sickness cases from Tororo district admitted to UTRO and Busolwe hospitals and Lumino health centre.

Year	Treatment centre			
	UTRO	Lumino	Busolwe	Total
1988	193	-	-	193
1989	199	*28	**6	233
1990	208	86	22	316
1991	172	17	10	199
Total	772	131	38	941

* From September

**From August

Source of information: UTRO and Busolwe hospitals and Lumino health centre sleeping sickness records.

The highest age specific attack rate was 450.7 per 100,000 in the 50-59 years category and the attack rate was highest for both males and females in this age group (Table 5). The lowest attack rates were in children under 10 years. The relative risk of infection for males compared to females was 1.5 and the difference in the risk was significant.

Table 4. Age and sex specific attack rates of sleeping sickness cases from Tororo district admitted at UTRO hospital (1979-1992).

Age Group	Sex								
	Male			Female			Total		
	No.	Pop.	*Rate	No.	Pop.	*Rate	No.	Pop.	*Rate
0-9	27	90,500	30	13	91,520	14	40	182,020	22
10-14	68	34,974	194	25	33,231	75	93	68,205	136
15-19	70	29,665	236	52	32,442	160	122	62,107	196
20-29	121	45,490	266	99	51,897	191	220	97,387	226
30-39	76	27,872	273	68	28,040	243	144	55,912	258
40-49	59	16,717	353	53	18,297	290	112	35,014	320
50-59	77	12,601	611	38	12,915	294	115	25,516	451
60+	53	15,287	347	24	13,839	173	77	29,126	264
Total	551	273,106	202	372	282,181	132	923	555,287	166.2

Relative Risk 1.5

1.0

P<0.0001

* per 100,000

Table 6. Male/female (M/F) risk ratios

Age group	M/F ratio
0-9	2.1
10-14	2.6
15-19	1.5
20-29	1.4
30-39	1.1
40-49	1.2
50-59	2.1
60+	2.0
Total	1.5

Distribution by age and sex.

The male/female risk ratios of sleeping sickness cases calculated for different age groups are shown in (Table 3). Male cases predominated in all age categories. An increased male/female ratio was prominent in the 10-14 years age group reaching a level of 2.6.

Taux de prévalence

Geographical distribution of sleeping sickness

Prevalence rates of sleeping sickness between 1979 and 1992 for sub-counties and parishes were also calculated and compared to the location of rivers \ commune

6 incidences mensuelles

Six monthly incidences for the sub-counties in Tororo district were calculated and the highest incidence (> 300 per 100,000 per 6 months) was in Iyolwa subcounty during 1988. High incidences of (>90 per 100,000 per 6 months) sleeping sickness were also recorded from Osukuru (first half 1990), Rubongi (1990), Buteba (1990 and first half 1991), Busitema (first half 1990), Mulanda, Mukuju and Nabuyoga (first half 1991) and Kisoko (second half 1992).

Transposed maps of the known distribution of sleeping sickness incidence and that of vegetation, land use and drainage closely fitted maps 1, 2, 3 and 4.

Discussion

Sleeping sickness incidence generally peaked in May coinciding with the peak in rainfall and the peak in vegetation density. However, although the association between disease incidence and rainfall were significantly correlated, it was not so for the changing vegetational patterns.

Seasonal variations in sleeping sickness have been described elsewhere. It is important to determine the seasonal trends in

disease so that if they do exist preseasonal planning may take this into account. In a study conducted in Busoga, the incidence of sleeping sickness was also observed to increase during the rainy season (Lancien et al 1990). Increased rainfall may have favoured the dispersal of the riverine tsetse population and is associated with increased agricultural activity that brings people into contact with the vector.

The distribution of sleeping sickness cases was concentrated around the Malaba, Osia and Tebikoli river basins. The spread of sleeping sickness outbreaks tended to be linear following the distribution of flies along the course of rivers or close to the swampy lake shores. The tsetse in Tororo district are reported to be confined mainly to the vegetation bordering rivers (Lancien J. 1991). Infection therefore appears to occur where human activities such as cultivation in swamps, collection of water and herding cattle bring people into contact with flies. One possible explanation for the advent of sleeping sickness outbreaks in Tororo district outside the old known endemic focus is the introduction of rice growing into the area. Extensive rice growing in Tororo district began during the last decade and this involved the cultivation of swamps that are suitable habitats for *G. fuscipes* the vector responsible for the outbreaks in south east Uganda.

The presence of *Glossina fuscipes* had been reported in this area over 40 years before the outbreaks of *T. rhodesiense* sleeping sickness (Mackichan 1944). In 1966, Harley caught and dissected 528 *G. fuscipes* flies from Malaba River Valley on the eastern side of the Tororo-Busia road and found no infections. In the same year, Mwambu (1966) had found no infections in cattle in the same area. Despite a functional diagnostic and treatment facility 3 km away at the East African Trypanosomiasis Research Organisation (EATRO), there were no reported cases of trypanosomiasis from this area. These observations lead to the conclusion that *G. fuscipes* in that area in 1966 were not carrying trypanosome infections. The movement of infected cattle and human beings to and from the old endemic area may account for the introduction of trypanosomiasis. Over the past two decades, many people have migrated from Tororo district to the Busoga region and there are frequent interactions between people from these areas.

Severe out breaks of sleeping sickness (90 sleeping sickness cases per six months) tended to occur in the belt of major livestock rearing. Livestock keepers may be encouraged to use livestock bait technology for the control of tsetse in addition to other tsetse control strategies such as tsetse trapping.

As the Busoga epidemic continued, sleeping sickness cases from Tororo district began to increase especially from 1985. The number of sleeping sickness cases of 0-2 per year in 1979 to 1984 increased to between 193 and 316 cases per year in 1988 to 1991 (Table 1). As from 1987, the proportions of cases from Tororo district admitted to UTRO hospital exceeded those from the old

focus of Busoga (Table 2). Before 1985, the disease was restricted to Samia Bugwe county at the south most end of Tororo district bordering Lake Victoria. By 1992 sleeping sickness cases, were reported from 25 of the 26 sub-counties of Tororo district. A similar trend was occurring with cattle trypanosomiasis. From surveys carried out in Samia Bugwe county in 1966, cattle trypanosomiasis had the highest incidence in the area immediately bordering the lake shore, that is the area within the then known fly belt (Mwambu and Odhiambo 1966). A survey of trypanosomiasis conducted in 1966 in Iyolwa sub-county of Tororo, found no infections in 93 cattle (Mwambu 1966) and in 1973 four (24%) out of 17 cattle sampled were found by thick stained film examinations and mouse inoculation to be infected with *T. congolense*. In 1988, trypanosomiasis surveys revealed *T. brucei* infections in the same subcounty with isoenzyme patterns similar to *T. rhodesiense* in 25% of the cattle infections indicating that cattle are important reservoirs of *T. b. rhodesiense* infection in Tororo (WHO 1990).

Localised outbreaks confined to single villages, as well as some more extensive outbreaks occurred in Tororo between 1985 and 1992. The spread of the outbreaks tended to be linear following the distribution of flies along the course of rivers or close to the swampy lake shores. The tsetse in Tororo district are reported to be confined mainly to the vegetation bordering the rivers (Lancien, J. 1991). Infection therefore appears to occur where human activities such as cultivation in swamps, collection of water and herding cattle bring people into contact with the flies. One possible explanation for the advent of sleeping sickness outbreaks in Tororo district outside the old known endemic focus is the introduction of rice growing into the area. Extensive rice growing in Tororo district began during the last decade and this involved the cultivation of swamps that are suitable habitats for *G. fuscipes* the vector responsible for the outbreaks in southeast Uganda.

The risk of trypanosomiasis increased with age up to a peak in the 50-59 year age group (Fig.3). The age trends in trypanosomiasis risk in Tororo district are very similar to those recorded during the Busoga epidemic between 1976 to 1983 (Abaru 1985) and similar to the sleeping sickness outbreaks in the Lambwe valley in 1959 to 1984 (Wellde *et al* 1989). These trends could be explained by the fact that the 50-59 year old age group spend most of their time in the rural area while the younger age groups either go to school or to work in the towns and trading centres. On the other hand, the 60 years and over age group are less active and therefore do not frequent activities that increase contact with the tsetse fly. Such activities include cultivation, herding livestock, fetching water from the springs, firewood collection, charcoal burning and fishing in the swamps. The greater attack rates among the men is perhaps because herding of livestock is traditionally regarded as an occupation of males. Charcoal burning and fishing are also predominantly carried out by the men. However, fishing appears not to be a common risk occupation in most parts of north Tororo as it was in the south

between 1940 and 1971 when *T. rhodesiense* sleeping sickness was mainly restricted to the shores and islands of Lake Victoria (Bradley 1968, Robertson 1963). The high male/female ratios in the 0-14 and 50 years and over age groups may be because these are the age groups that tend livestock. A possible risk factor that should be investigated is keeping of cattle and pigs around the homesteads. Since cattle are important reservoirs of infection and are known to attract tsetse, peri-domestic transmission may occur (Okoth, J 1986).

In conclusion, the epidemiology of sleeping sickness caused by *T. rhodesiense* in Tororo district indicates that it tends to occur in localised outbreaks around river valleys and the distribution of the disease is closely associated with vegetation, land use and rainfall distribution.

Geographical Information Systems (GIS) therefore be very useful in precisely defining foci and thus priority areas for control. It may also be useful for forecasting the occurrence of sleeping sickness outbreaks. Further investigation into the possible usefulness of GIS in the surveillance of sleeping sickness is suggested.

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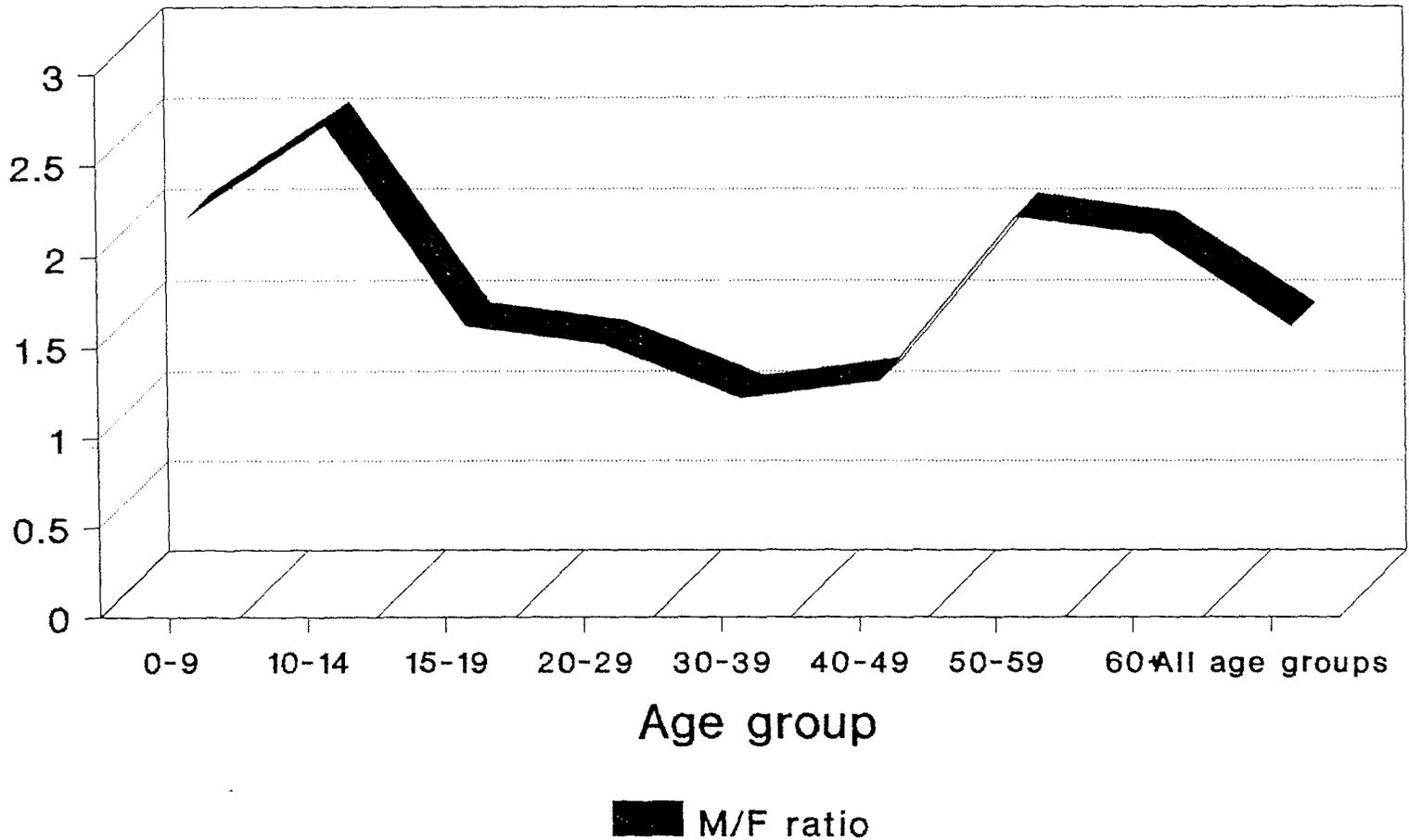
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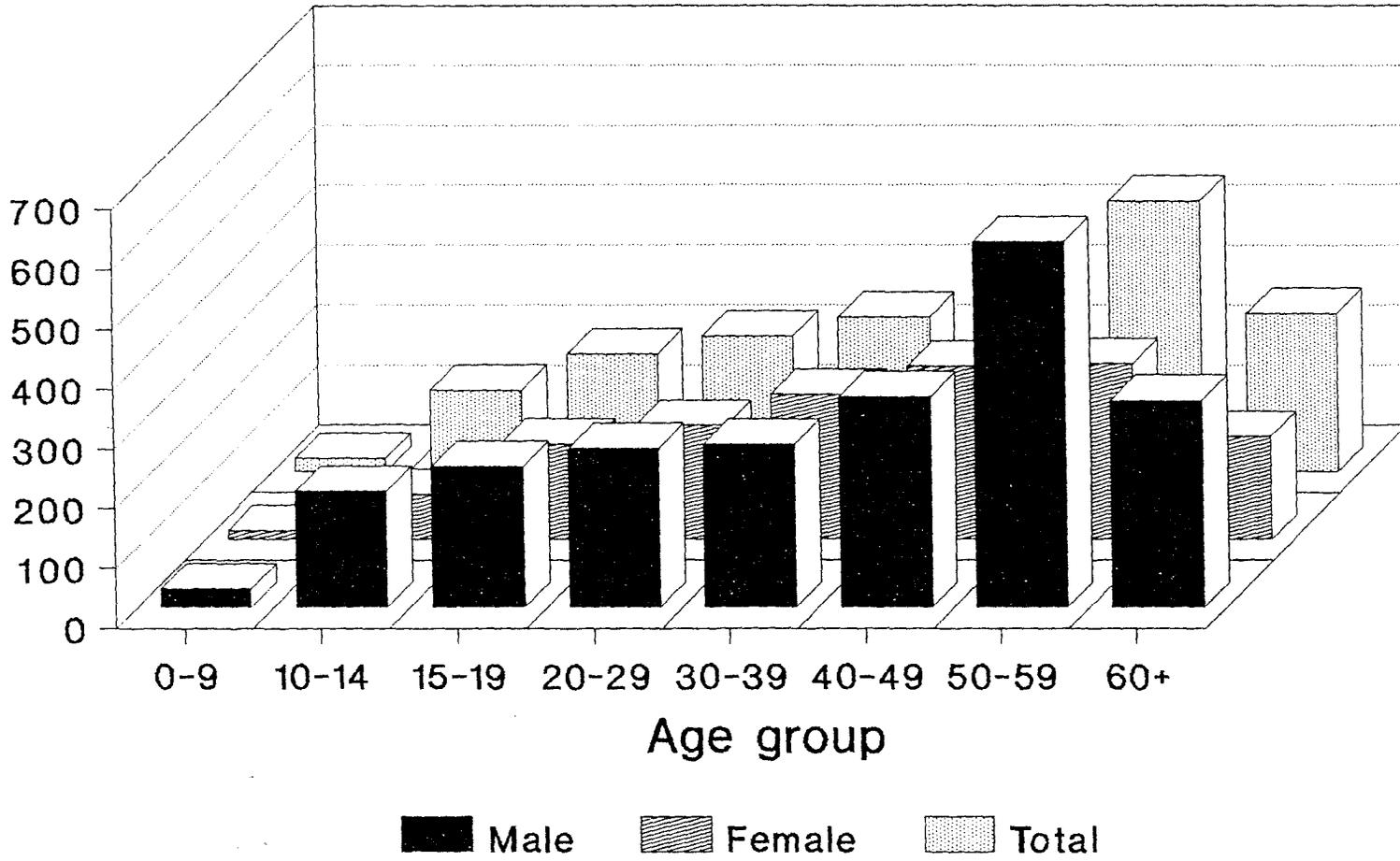
Sleeping sickness in Tororo, 1979-92

Male/Female (M/F) risk ratios



Sleeping sickness in Tororo, 1979-92

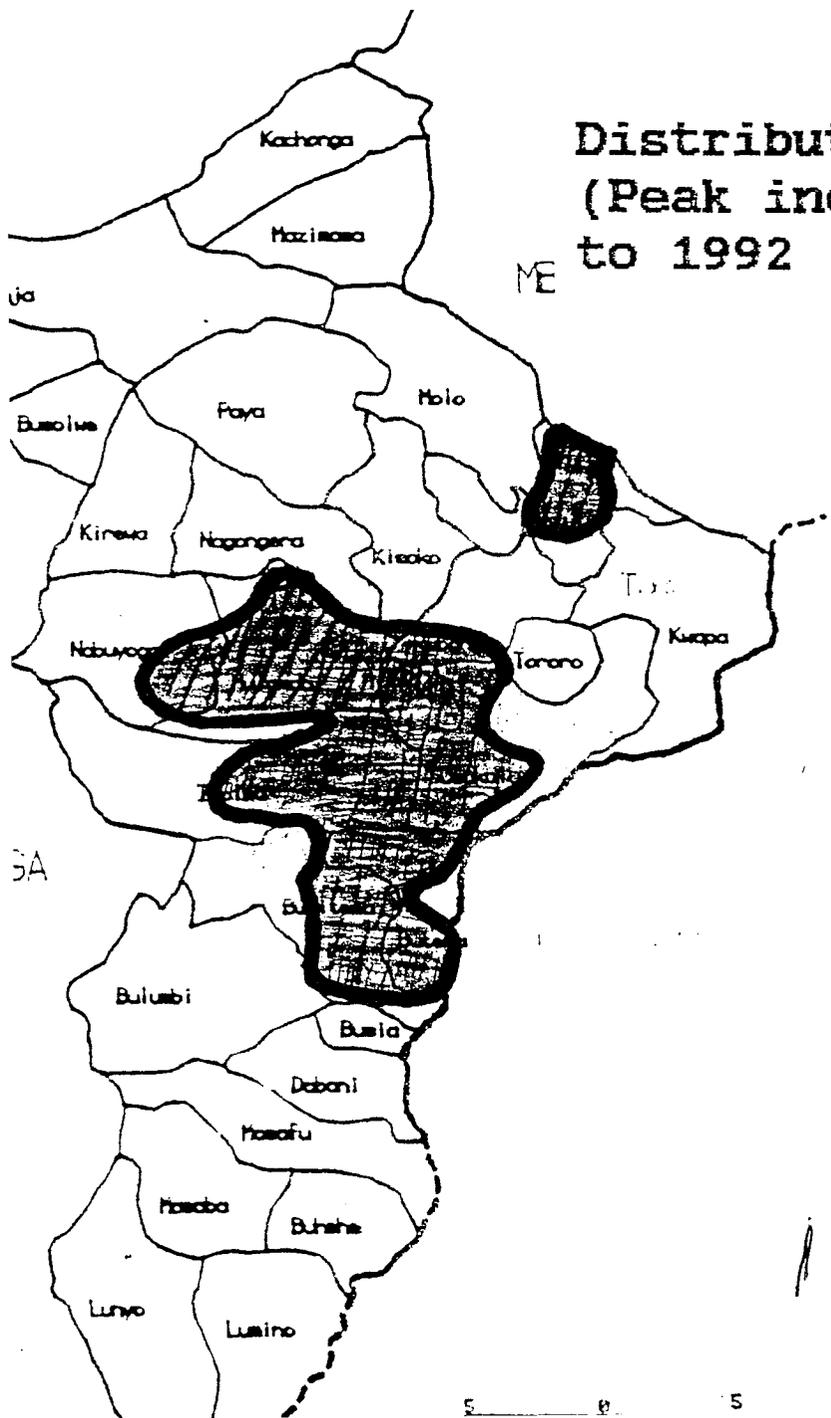
Age and sex specific attack rates



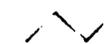
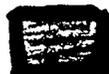
Source LIRI/UTRO Hospital

TORORO DISTRICT

Distribution of sleeping sickness outbreaks
(Peak incidence >90/100,000 per six months)
to 1992



LEGEND:

-  International
-  District
-  County
-  Subcounty
-  Peak incidence > 90/100,000 per six months

LOCATION OF TORORO IN UGANDA



Source: Statistics Dep't

5 10 15 20 25 km

TORORO DISTRICT

LANDUSE

PALLISA

MBALE

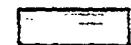
LEGEND :



Swamps



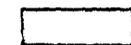
Mixed agriculture (Annual/perennial or)



Grazing with scattered cultivation



Forest reserves x-fuel and pole plant



Mixed agriculture/Nature conservation

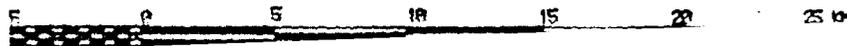
IGANGA

KENYA

LOCATION OF TORORO IS



1 + 3

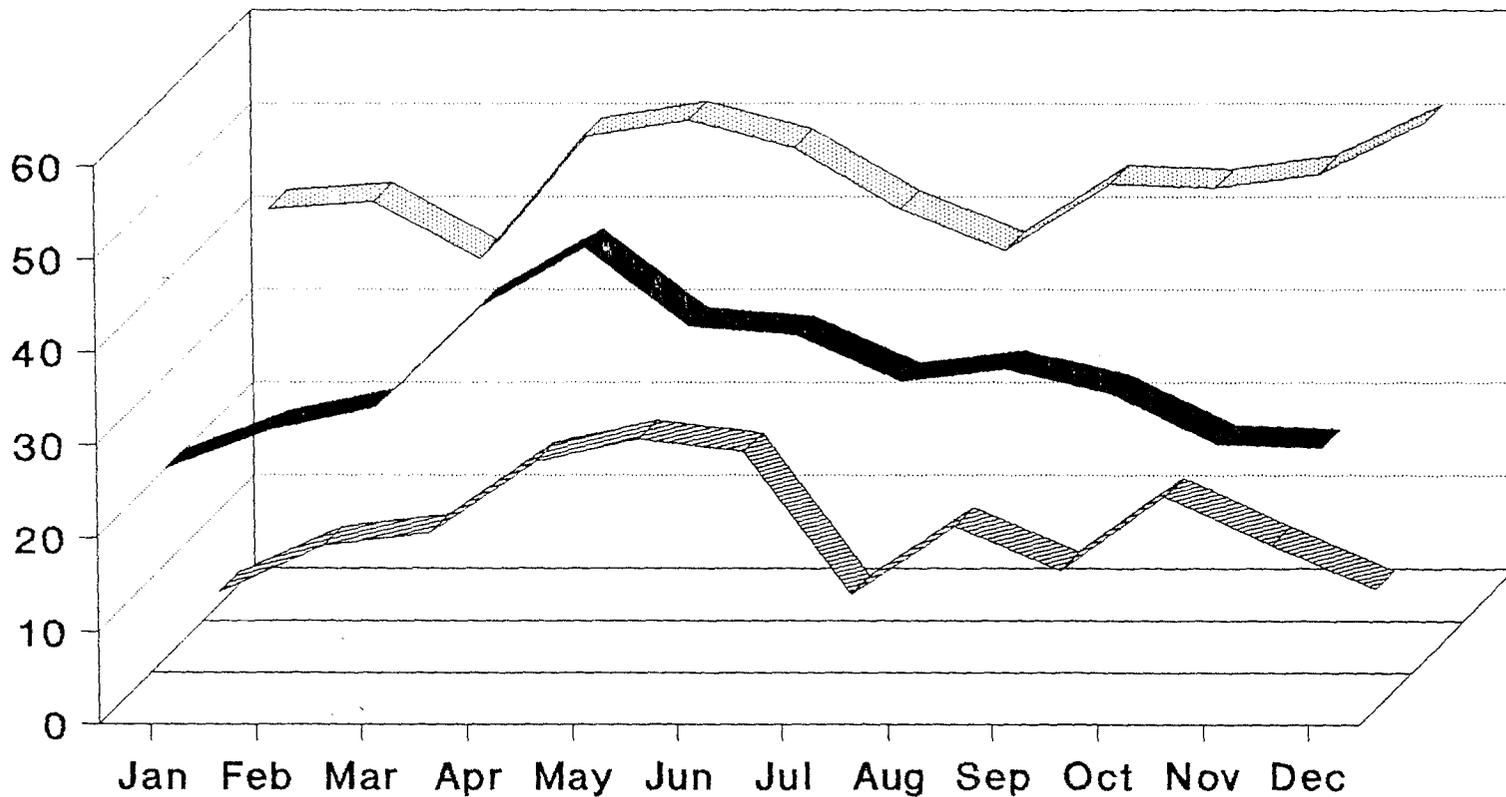


Source: Department

Sleeping sickness in Tororo, 1988-90

Incidence per 100,000, rainfall & *NDVI

■ Incid.x10 ▨ Rainfall mm x0.1 ▩ NDVI X10



6
(5)

*24 th meeting of the International Scientific Council for Trypanosomiasis
Research and Control (ISCTRC)*

Organization of African Unity
Food and Agriculture Organization
World Health Organization

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**THE POTENTIAL UTILITY OF EPIMAP IN THE
SURVEILLANCE OF SLEEPING SICKNESS
IN THE DEMOCRATIC REPUBLIC OF CONGO**

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THE POTENTIAL UTILITY OF EPIMAP IN THE SURVEILLANCE OF SLEEPING SICKNESS IN THE DEMOCRATIC REPUBLIC OF CONGO

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EPIMAP is a simple and free software package belonging to the category of *GIS (Geographic Information Systems)* which allows cartographic presentation of epidemiological or other spatial referenced data [Dean, 1995].

Human African trypanosomiasis, an almost always fatal disease if not treated, has always constituted a major public health problem in Congo-Kinshasa [Burke, 1973]. Since a few years important epidemic outbreaks in several historical foci are reported especially in the Bandundu and Equator Regions [Cattand, 1994; WHO, 1994; Arbyn, 1995; Ekwanzala, 1996]. In 1996, almost 16,000 new parasitologically confirmed cases were diagnosed in these two regions, representing 80 % of the total number detected in the country [BCT, 1997].

Sleeping sickness control has been the object of a lively debate between advocates of active case finding by specialized mobile teams (MT), the verticalist approach, and proponents of a control strategy implemented through the district health service, the horizontalist approach. In the past in Congo (formely Zaire), well equipped itinerant teams operated independent from local health authorities. Nowadays, the consensus grows that no control strategy can be run outside the health service, but that the decision on active or passive screening will depend on the local epidemiological features and available resources.

A common mappable surveillance system could facilitate strategic decision-making and could furthermore enhance collaboration between health professionals. District Medical Officers should be involved in planning of itineraries of the mobile teams for which printed maps can be a useful tool. Health center nurses can invite the target population, assist the MT in active screening and can assure compliance to treatment and follow-up of diagnosed cases. In the past, MT's were used to produce epidemiological reports related to the areas visited. Because those areas often did not correspond to any administrative or other boundaries and change over time, covered populations are not comparable from one year to another. Longitudinal analysis of trends was thus impossible. An information system based on the health district and its subdivisions will allow for the use of fixed topographic denominators which provide more relevant data for impact evaluation. New cases detected in health centers or district hospitals can be easily inserted in the same statistical system. Mapping of data can be realized with EPIMAP at the Regional Coordination Office where a PC is available. Feedback with easily interpretable maps can further motivate all concerned peripheral health workers.

Footnote

Maps of all Regions and Health Districts of Congo-Kinshasa were recently digitized at the Scientific Institute of Public Health Louis Pasteur in Brussels. Certain hyperendemic health districts were further detailed at the level of the Health Area, which is the topographic entity covered by a health center. The map files for Congo-K, the EPIMAP software and manual can be obtained at the address mentioned above.

EPIMAP files can be easily exported to more performant commercial GIS packages at the condition that real longitude latitude coordinates are used for digitizing. This kind of more sophisticated software enables spatial analysis and complex multilayer representation but is generally very expensive and restricted to experienced PC users [Clarke, 1996].

SUMMARY

A common health information system, using a simple cartographic software such as EPIMAP, can contribute to the establishment of collaboration between local polyvalent health authorities and itinerant teams specialized in active screening of sleeping sickness in endemic districts. Moreover, this *geographic information system* can improve the quality of epidemiological data collection, analysis and presentation. Digitized maps for Congolese health districts are available.

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Epidémiologie moléculaire des trypanosomoses animales. Premier bilan des recherches menées en Afrique de l'Ouest.

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Cuisance D.*, Touré S.M.** et Cuny G.***

Résumé :

L'épidémiologie des maladies à vecteurs a grandement bénéficié ces dernières années du développement des outils de la biologie moléculaire. Ces outils ont permis d'étudier plus précisément la caractérisation et la variabilité génétique des parasites et de leurs vecteurs. Ce sont des éléments indispensables à une lutte mieux ciblée.

Les travaux menés sur le terrain en Afrique de l'Ouest et au laboratoire en France, en particulier par le CIRAD-EMVT*, le CIRDES** et l'ORSTOM***, ont permis de mieux comprendre l'épidémiologie des trypanosomoses animales. L'analyse de la diversité des trypanosomes, notamment l'espèce *Trypanosoma congolense*, et l'identification précise des parasites chez l'hôte et le vecteur ont permis de clarifier les cycles épidémiologiques et de tester l'hypothèse de couples préférentiels parasites-vecteurs. La capacité vectorielle des différentes espèces de glossines étudiées a été analysée au laboratoire et comparée aux résultats obtenus sur le terrain.

Il est à noter que de nombreux parasites observés au microscope chez le vecteur en particulier, ne sont pas reconnus par les sondes moléculaires actuellement disponibles. Des recherches sont encore nécessaires pour identifier tous les trypanosomes qui circulent dans les foyers de maladie.

Enfin, des efforts doivent être faits pour une simplification de ces outils et pour faciliter leur transfert vers des laboratoires nationaux et régionaux.

Abstract

The epidemiology of vector transmitted diseases in general and trypanosomoses in particular has benefited a lot from the development of molecular biology tools during the last years. These tools make possible a more precise characterization of the parasites and their vectors and also a study of their genetic variability. They are essential to develop more focused and efficient control programs.

Studies performed in the field in West Africa and in laboratories in France, in particular at CIRAD-EMVT, CIRDES and ORSTOM, led to better understanding of the epidemiology of animal trypanosomoses. An analysis of the variability of the trypanosome species, especially *Trypanosoma congolense*, and the accurate characterization of the parasites in the host and in the vector have helped better understand epidemiological cycles. The hypothesis of preferential parasite-vector couples has been tested. In addition, the vectorial capacity of various tsetse species has been studied in the lab and in the field.

It is noteworthy that many trypanosomes detected by microscopical examination, specially in vectors, are not recognized by available molecular probes. More research is needed in order to identify all the trypanosomes in disease hot-spots.

Finally, efforts have to be made to simplify these tools and to facilitate their transfer to national or regional labs.

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INTRODUCTION

Le travail présenté ici est une synthèse des recherches en épidémiologie moléculaire des trypanosomoses en Afrique de l'Ouest, réalisées au CIRDES (Bobo-Dioulasso, Burkina Faso), au CIRAD-EMVT et à l'ORSTOM (Montpellier, France).

Les techniques de biologie moléculaire pour la caractérisation des trypanosomes ont été transférées de l'ILRAD au CRTA (maintenant ILRI et CIRDES respectivement) en 1990 et les années suivantes. Ceci a été rendu possible grâce à la coopération scientifique constante de P.A.O. Majiwa à l'ILRI, que nous tenons à remercier vivement. Et aussi grâce au financement du CIRAD et de l'AUPELF-UREF.

Ces techniques, en particulier la 'Polymérase Chain Reaction' (PCR) pour l'identification des trypanosomes chez les glossines et les bovins, ont été largement utilisées pour des études épidémiologiques en Afrique de l'Ouest. Elles ont permis de révéler certains aspects obscurs en épidémiologie et posent de nouvelles questions. L'objectif principal est bien d'identifier qui (quel vecteur) transmet quoi (quel parasite), où et comment (épidémiologie analytique).

MATERIELS ET METHODES

Nous ne détaillerons pas les différents protocoles qui sont disponibles dans les publications de notre groupe (Reifenberg, 1996; Reifenberg et al., 1996; Solano et al., 1996; Reifenberg et al., 1997a). Nous indiquerons seulement la liste des amorces utilisées en PCR (Tableau 1) et quelques points importants :

Tableau 1 : Amorces utilisées et taille des produits d'amplification attendus

Espèces/taxons	Séquences oligonucléotidiques	Taille de l'amplification (pb)	Références
<i>T. congolense</i> "savane"	ILO344:5'CGAGCGAGAACGGGCAC 3' ILO345:5'GGGACAAACAAATCCCGC3'	320	Majiwa et Otieno, 1990 (<i>Mol. Biochem. Parasitol.</i>)
<i>T. congolense</i> "Kilifi"	TCK1:5'GTGCCCAAATTTGAAGTGAT3' TCK2:5'ACTCAAATCGTGACCTCG3'	294	Masiga et coll., 1992 (<i>Int. J. Parasitol.</i>)
<i>T. congolense</i> "forêt"	TCF1:5'GGACACGCCAGAAGGTAATT3' TCF2:5'GTTCTCGCACCAATCCAAC3'	350	Masiga et coll., 1992 (<i>Int. J. Parasitol.</i>)
<i>T. congolense</i> "Tsavo"	ILO892:5'CGAGCATGCAGGATGGCCG3' ILO893:5'GTCCTGCCACCGAGTATGC3'	400	Majiwa et coll., 1993 (<i>Parasitology</i>)
<i>T. simiae</i>	TSM1:5'CGGTCAAAAACGCATT3' TSM2:5'AGTCGCCCGGAGTCGAT3'	437	Majiwa et Otieno, 1990 (<i>Mol. Biochem. Parasitol.</i>)
<i>T. brucei</i> "ingi"	ILO342:5'GATCCGCAGCCGGGCTG3' ILO242:5'CCGCGGTGGCTCCTTCCC3'	1530	Kimmel et coll., 1987 (<i>Mol. Cell. Biol.</i>)
<i>T. vivax</i> Afrique de l'Ouest	TVW1:5'CTGAGTGCTCCATGTGCCAC3' TVW2:5'CCACCAGAACACCAACCTGA3'	150	Masiga et coll., 1992 (<i>Int. J. Parasitol.</i>)

Dissection des glossines : le proboscis, les glandes salivaires et l'intestin moyen sont disséqués séparément en nettoyant soigneusement les instruments de dissection entre chaque organe. Les instruments sont passés dans un bain d'eau de Javel puis un bain d'eau distillée. Après observation microscopique pour la recherche des trypanosomes, les organes des individus ont été repris et suspendus dans 50µl d'eau stérile en tubes Eppendorf.

Echantillons de bovins : après centrifugation de deux microtubes capillaires remplis du sang de chaque animal, l'un des tubes servait à la lecture de l'hématocrite et à l'examen parasitologique au niveau du *buffy coat* (Murray et al., 1977), l'autre tube permettait la récolte du *buffy coat* dans un tube Eppendorf contenant 50µl d'eau distillée stérile pour analyse par PCR.

RESULTATS

I. Infections expérimentales (Reifenberg, 1996; Reifenberg et al., 1997c)

La PCR a permis d'utiliser dans ces expérimentations des clones de trypanosomes parfaitement caractérisés et de comparer les taux d'infection obtenus.

I.1. Infections expérimentales de glossines par *T. congolense* type "savane"

Six cent vingt six glossines ont été infectées. Si les pourcentages d'infection procyclique (intestin moyen) des glossines du groupe *morsitans* (*G. m. morsitans* et *G. m. submorsitans*) et des glossines du groupe *palpalis* (*G. palpalis gambiensis* et *G. tachinoides*) ne diffèrent pas significativement, les pourcentages d'infection métacyclique sont significativement plus élevés pour le groupe *morsitans*. On observe donc plus d'infections matures dans le groupe *morsitans* que dans le groupe *palpalis* pour ce trypanosome. Il en résulte que les indices de Compétence Vectorielle Intrinsèque (CVI) des glossines du groupe *morsitans* sont plus élevés (notamment pour *G. m. submorsitans*).

I.2. Infections expérimentales de glossines par *T. congolense* type "forêt"

Sept cent huit glossines ont été infectées. Si les infections intestinales des glossines du groupe *palpalis* sont plus nombreuses que chez les glossines du groupe *morsitans*, en revanche aucune différence significative n'est observée au niveau du proboscis entre les deux groupes. Pour ce trypanosome, les taux de maturation des infections sont très faibles. Concernant les indices CVI, les sous-espèces de glossines se classent par ordre d'indice décroissant selon la liste suivante : *G. m. submorsitans* > *G. tachinoides* > *G. p. gambiensis* > *G. m. morsitans*. Mais ces indices sont très faibles du fait de la quantité modeste d'infections matures.

I.3. Infections expérimentales mixtes par *T. congolense* type "savane" et par *T. congolense* type "forêt"

Deux cent soixante dix huit glossines ont été infectées. Dans ce cas l'ordre des indices CVI est très proche de celui obtenu pour des infections simples à *T. congolense* type "savane". L'infection avec les trypanosomes de type "savane" masque parasitologiquement l'infection avec les trypanosomes de type "forêt". La PCR a permis d'identifier 5 infections mixtes (intestin moyen et proboscis) dont 1 chez *G. m. morsitans* et 4 chez *G. m. submorsitans*. A noter cependant qu'aucune amplification n'a été observée à partir de suspensions intestinales infectées de 7 individus, conséquence probable d'inhibitions résiduelles de la Taq polymérase

I.4 Infections expérimentales mixtes par *T. congolense* type "savane" et par *T. vivax*

Cent dix neuf glossines ont été infectées. Le taux d'infection dans l'intestin moyen est significativement plus élevé chez *G. tachinoides* que chez *G. m. morsitans*. En revanche, la colonisation des trypanosomes dans l'hypopharynx apparaît significativement supérieure chez *G. m. morsitans* que chez *G. tachinoides*. La technique PCR a été appliquée sur tous les proboscis trouvés positifs en microscopie et sur 20 intestins moyens également positifs. Quatre infections mixtes ont été ainsi révélées (1 chez *G. m. morsitans* et 3 chez *G. tachinoides*). L'identification par PCR des trypanosomes observés dans l'intestin moyen et le proboscis d'un même individu (*G. tachinoides*) a révélé la présence concomitante de *T. congolense* dans l'intestin (infection immature) et de *T. vivax* dans la trompe (infection mature). Tous les intestins testés par PCR ont montré la présence de *T. congolense*. Aucune trace intestinale de *T. vivax* n'a été décelée par cette méthode.

II. Infections naturelles

II.1. *Glossina longipalpis* en Côte d'Ivoire (Solano et al., 1995)

Sur un total de 139 glossines capturées et disséquées, 50 ont été trouvées positives par les techniques parasitologiques classiques et soumises à la PCR. Près de 90% des infections détectées par PCR étaient dues au sous-genre *Nannomonas* : *T. congolense* type "savane" (chez 19 glossines/50), *T. congolense* type "forêt" (chez 20 glossines), et *T. simiae* chez 3 glossines. Des infections à *T. vivax* ont été mises en évidence chez 4 glossines mais aucune infection n'a été trouvée pour les types suivants : *T. congolense* type "Kilifi" ou "Tsavo", sous-genre *Trypanozoon*. Au total, 16 infections mixtes ont été mises en évidence, comportant toutes *T. congolense* type "savane" et type "forêt". Une glossine avait ces deux types de *T. congolense* et *T. simiae* au niveau de l'intestin moyen. Une autre avait les deux types de *T. congolense* plus *T. vivax* au niveau du proboscis.

Cette étude a permis de mieux connaître les trypanosomes qui infectent *G. longipalpis* en Côte d'Ivoire, et de mettre en évidence des infections mixtes non révélées par la parasitologie ainsi que l'existence de trypanosomes non reconnus par les sondes actuellement disponibles (Tableau 2).

Tableau 2 : Caractérisation par PCR de 50 infections positives chez *Glossina longipalpis*

Parasitologie	Résultats PCR			
	<i>Trypanozoon</i>	<i>Nannomonas</i>	<i>Duttonella</i>	négatifs
<i>Trypanozoon</i>	1	0	1	0
<i>Nannomonas</i>	20	0	16	3
<i>Duttonella</i>	17	0	3	11
immatures	12	0	3	9

Les résultats ci-dessus montrent aussi que les techniques parasitologiques sur le terrain exagèrent l'importance des infections à *T. (Duttonella) vivax* par rapport aux infections à *T. (Nannomonas) congolense* et aux trypanosomes non encore identifiables.

II.2. La zone d'aménagement pastoral de Yalé au Burkina Faso (Reifenberg et al., 1997a)

Quatre-vingt-quatre *G. tachinoides* capturées dans cette zone ont été étudiées en PCR, parmi lesquelles un seul individu présentait une infection mature (trypanosomes dans

Sur les 84 intestins positifs testés, 50 ont donné un résultat positif en PCR : *T. congolense* type "savane" (58%), *T. congolense* type "forêt" (16%), *T. simiae* (32%) et *T. vivax* (10%). Des infections mixtes ont été révélées associant *T. c.* type "savane" à *T. c.* type "forêt" (8%), *T. c.* type "savane" à *T. simiae* (4%), et *T. simiae* à *T. vivax* (4%).

Une amplification spécifique de *T. simiae* et de *T. vivax* a été obtenue à partir du proboscis de la seule glossine présentant une infection mature au microscope. Cette même glossine montrait la présence de *T. simiae* au niveau de l'intestin moyen.

Parallèlement, des prélèvements ont été effectués sur des bovins de cette zone pastorale. Sur 92 échantillons étudiés, 44 étaient positifs parasitologiquement et 48 négatifs. Les résultats de la parasitologie et de la technique PCR sont repris dans le tableau 3.

Tableau 3 : Caractérisation par PCR de 92 prélèvements de sang sur les bovins

Parasitologie	Résultats PCR			
	<i>T. c.</i> "savane"	<i>Duttonella</i>	négatifs	
<i>Nannomonas</i>	26	22	0	4
<i>Duttonella</i>	17	0	7	10
infection mixte	1	1	0	0
négatifs	48	7	0	41

La technique PCR a permis de montrer que la majorité des infections intestinales de *G. tachinoides* étaient dues au sous genre *Nannomonas* (*T. congolense* types "savane" et "forêt" et *T. simiae*). Les infections à *T. simiae* corroborent d'autres résultats récents dans certaines populations de *G. p. gambiensis* du Burkina Faso (Solano et al., 1996). La notion selon laquelle les glossines du groupe *palpalis* seraient des vecteurs peu efficaces des trypanosomes du sous-genre *Nannomonas* doit être nuancée dans certaines situations.

L'analyse des repas de sang d'un échantillon de *G. tachinoides* de la même zone a montré que 55% de ces repas provenaient de reptiles (B. Bauer, comm. pers.). Une fraction des infections intestinales chez *G. tachinoides* relève donc de trypanosomes de reptiles (*T. varani*, *T. grayi*-like) non pathogènes pour les mammifères. Cela pourrait expliquer que 60% seulement des infections intestinales aient donné un résultat positif en PCR avec les amorces utilisées.

Si *T. congolense* type "forêt" a été isolé de glossines, il est totalement absent des prélèvements de bovins. On peut avancer l'hypothèse que ce trypanosome dispose d'un spectre d'hôtes vertébrés différent de celui du taxon "savane" et que son pouvoir pathogène pour les bovidés est plus faible. La circulation de ce taxon dans cette région, proche d'une réserve naturelle (Nazinga), pourrait être liée à la faune sauvage. La population locale importante de phacochères pourrait expliquer la présence observée de *T. congolense* type "forêt" et de *T. simiae*.

La circulation de trypanosomes pathogènes non identifiables avec les marqueurs moléculaires connus est hautement probable. Outre les souches de *T. vivax* qui n'ont pas réagi avec les amorces utilisées, quatre isolats de sang de bovins infectés par *T. congolense* ne correspondent à aucun des taxons connus. Les amorces spécifiques de *T. godfreyi* (Masiga et al., 1996) n'ont pas été utilisées sur les échantillons de cette étude.

L'analyse des prélèvements sur les bovins montre que la majorité des infections sont dues à *T. vivax* et *T. congolense* type "savane". Près de 59% des infections de type *Duttonella* n'ont donné aucun signal positif par PCR. Certaines souches de *T. vivax* circulant dans cette région pourraient ne pas être reconnues par les marqueurs moléculaires utilisés, ce qui avait déjà été observé en Côte d'Ivoire chez *G. longipalpis* (Solano et al., 1995).

A noter enfin que des signaux d'amplification pour *T. congolense* type "savane" ont été

II.3. La zone de Sidéradougou au Burkina Faso (Lefrançois et al., 1997a)

A l'occasion d'une vaste étude au cours de laquelle près de 4400 glossines (57% *G. tachinoides* et 43% *G. p. gambiensis*) ont été capturées, la technique PCR a été appliquée sur 298 glossines positives. Le tableau 4 permet la comparaison des résultats de la PCR avec les techniques parasitologiques.

Tableau 4 : Comparaison des résultats PCR avec ceux des techniques parasitologiques

Parasitologie	PCR
Proboscis +	54.5% <i>Nannomonas</i>
Intestin moyen + (<i>Nannomonas</i>)	15.2% <i>T. vivax</i> 3.0% infection mixte <i>T. brucei</i> / <i>T. vivax</i> 27.3% non identifiés
Intestin moyen + (immature)	11.2% <i>T. congolense</i> savane 3.3% <i>T. congolense</i> forêt 3.9% <i>T. brucei</i>
Proboscis + (<i>Duttonella</i>)	86.0% <i>T. vivax</i>

Chez les glossines *T. vivax* était le trypanosome le plus fréquent, suivi par *T. congolense* type "savane" et *T. congolense* type "forêt". *T. brucei* a été observé mais pas *T. simiae*. Chez les bovins, *T. congolense* type "savane" était le plus fréquent.

Le taux de caractérisation des trypanosomes lors d'une infection de l'intestin moyen seul des glossines était très faible (15.8%). Une corrélation positive a pu être trouvée entre le taux global d'infections de l'intestin moyen, le taux d'infections non identifiées et le taux de repas de sang pris sur reptiles. Ceci a permis de considérer la plupart des infections de l'intestin moyen seul comme provenant de trypanosomes de reptiles.

II.4. La zone de Nazinga au Burkina Faso (Lefrançois et al., 1997b)

Une étude similaire a été menée à Nazinga, réserve naturelle de faune au sud-est du Burkina Faso. Les glossines rencontrées étaient *G. morsitans submorsitans* et *G. tachinoides*. La comparaison des résultats de PCR avec les techniques parasitologiques pour 166 glossines infectées est dans le tableau 5. A noter que les primers spécifiques pour *T. congolense* types "Kilifi" et "Tsavo" et *T. godfreyi* n'ont pas été utilisés dans cette étude.

Tableau 5 : Comparaison des résultats PCR avec ceux des techniques parasitologiques

Parasitologie	PCR
Proboscis +	62.5% <i>Nannomonas</i>
Intestin moyen + (<i>Nannomonas</i>)	dont 7.5% infections mixtes 17.5% autres trypanosomes 20.0% non identifiés
Intestin moyen + (immature)	19.4% <i>T. simiae</i> 13.9% autres trypanosomes 66.7% non identifiés
Proboscis + (<i>Duttonella</i>)	13.0% <i>T. vivax</i> 18.5% autres trypanosomes 68.5% non identifiés

Si les techniques parasitologiques ont révélé 40% d'infections à *T. vivax* chez les *G. m. submorsitans* positives, la PCR n'en a confirmé que 10.9%. La PCR a aussi permis d'identifier 33.3% des infections de l'intestin moyen seul, qui auraient été classées par les techniques parasitologiques comme infections immatures. Il faut souligner également que

CONCLUSION

Les résultats obtenus permettent de confirmer la grande sensibilité et spécificité de la technique PCR par rapport aux méthodes parasitologiques classiques pour le diagnostic et la caractérisation des trypanosomes.

Il est très important cependant de préciser à chaque utilisation la liste des amorces utilisées. Nos résultats montrent en effet que certains trypanosomes ne donnent aucun signal avec les amorces actuellement disponibles. Il s'agit souvent de trypanosomes "vivax-like" présents dans les zones où la faune sauvage est abondante.

La PCR a permis de montrer que, dans les zones étudiées, la prévalence des infections de type *Nannomonas* était plus importante que ne le laissaient supposer les examens parasitologiques.

Trypanosoma congolense type "savane" semble présenter une virulence plus forte que le type "forêt". Ces études devraient être complétées par des recherches sur la pathogénicité comparée de ces taxons.

De nouvelles voies de recherches sont ainsi ouvertes : isolement, caractérisation, pathogénicité de ces "nouveaux trypanosomes" non encore reconnus; approfondissement des recherches sur la diversité génétique des trypanosomes et des vecteurs (Sidibe, 1996; Solano et al., 1997).

Ces résultats épidémiologiques, associés à toutes les informations géo-référencées disponibles sur le climat, la végétation, les types de paysage, la densité du bétail et de la faune sauvage, l'habitat humain, la densité des différentes espèces de vecteurs, sont actuellement compilés dans un système d'information géographique concernant la zone de Sideradougou au Burkina Faso (De La Roque et Cuisance, 1997). Le but de ces travaux est bien l'identification des facteurs discriminants majeurs de la présence des glossines et d'autres insectes piqueurs dans cette zone agro-pastorale, et finalement la prévision du risque trypanosomien.

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TRYPANOSOMOSIS IN SHEEP AND GOATS UNDER A PASTORAL MANAGEMENT SYSTEM IN KENYA.

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Abstract

The presence of small ruminants in areas with trypanosomosis has been used to suggest that these animals are not susceptible to the disease. These animals are mainly kept by small scale farmers and their low infection rates may be related to management rather than innate susceptibility. To investigate the effect of management on trypanosome incidence, four mixed flocks of sheep and goats were monitored in Olkiramatian Group Ranch in Kajiado district, Kenya for a period of three years. The study also assessed trypanosomosis related losses in productivity among small ruminants under pastoral livestock management system.

The overall annual incidence of trypanosomosis caused by Trypanosoma vivax and T. congolense species among breeding sheep and goats was 13% and 6.8% respectively. Lambs and kids had few infections as they were not much exposed due to the management system. Sheep had significantly more infections than goats ($P < 0.05$). There were seasonal differences in the occurrence of trypanosome species in that, most of the T. vivax cases were observed during the dry season, while most T. congolense infections were observed in the wet season. However, the ratio of T. congolense to T. vivax was 1:1.1. Trypanosomosis was not a major cause of death as opposed to predation, copper deficiency (swayback) and helminthosis. Packed cell volume and body weight gains were significantly affected by trypanosomosis ($P < 0.05$).

The study showed that trypanosomosis was well controlled by the pastoral management system. The disease incidence increased with the tsetse challenge and location/management of the animals. The study indicated that future disease control will only be worthwhile after the transhumant management system changes to sedentary system in addition to increased shortage of graze and browse.

Introduction

Many areas of Africa with the best grazing for domestic ruminants are infested by tsetse flies which transmit trypanosomosis (Jordan 1992). Trypanosomosis in cattle is well recognised as a serious constraint to their productivity. The fact that small ruminants can thrive in areas with the disease better than cattle has been used to suggest that these animals are not susceptible (ILCA, 1979). Experimental studies have shown that these animals are not only susceptible to pathogenic trypanosomes but pathological effects have been reported including death (McGuire

Mwendia and Stevenson, 1992). Small ruminants are mainly kept by small scale farmers and their low infection rates may be related to management rather than susceptibility.

The aim of this study was to quantify trypanosomosis incidence and losses in productivity in both sheep and goats under pastoral conditions, and to document management factors associated with the survival of small ruminants in tsetse-infested areas.

Material and methods

The trypanosome incidence was monitored in four mixed flocks of sheep and goats in Olkiramatian Group Ranch in Kajiado district, Kenya between June 1992 and December 1994. This was a longitudinal study in which animals in different locations were monitored for trypanosome infection, packed cell volume and body weights without interfering with the traditional livestock management. Mortality was also recorded throughout the study period. The frequency of monitoring was every two weeks on the same animals and their offspring.

The selection of flocks was based on location and type of management. Two flocks were sedentary while the other two were transhumant. One of the sedentary flocks was located in a relatively tsetse free area and the other was located in a high challenge zone. Transhumant flocks only came into contact with the tsetse flies during certain times of the year.

The diagnostic technique adopted for the study was dark-ground/buffy coat (DG) technique by Murray *et al.* (1977), a modification of Woo test (Woo, 1970). Blood was collected into heparinized capillary tubes after puncturing the ear vein with a sterile lancet. Morphological characteristics were used for trypanosome species identification. Animals found positive with trypanosomes were treated with diminazene aceturate at a dose rate of 7 mg/kg live weight intra muscular. No treatments were given unless trypanosome parasites were demonstrated.

Fly challenge was assessed using ten biconical traps in grazing areas replicated in five transects located in different vegetation types every four weeks. The aim of tsetse fly monitoring was to assess the relationship between trypanosomosis incidence and tsetse challenge. The traps were in place for 48 hours, after which flies were collected and categorised by species and sex.

The management of sheep and goats was similar and their infection gives a good indicator of their comparative susceptibility. The disease incidence in the two species is presented with age as the management was also based on age.

Data analysis

Panacea statistical software was used in the data entry and analysis. Disease incidence rates (DIR) was calculated as the cases that occurred in a period of two years divided by the total number of animal days, as indicated in the equation below.

$$\text{DIR}\% = (\text{Total no infections} / \text{Total number of animal days}) \times 365.25 \times 100$$

Animal days is the cumulative number of days that individual animals are monitored. This

Results

Young lambs and kids

Trypanosome incidence

There were 891 blood samples examined for trypanosome parasites from 191 preweaned lambs studied over 20,253 animal days. Only one *T. congolense* case was observed in Flock C located in the woodlands. This lamb was found trypanosome-positive at 36 days of age. In preweaned suckling kids, 1,343 blood samples were examined for trypanosome parasites from 251 kids studied over 37,799 animal days. No trypanosome case was observed.

There were 2,893 blood samples examined for trypanosome parasites from 210 weaned lambs from which 7 cases were observed. The overall trypanosome incidence rate was 7.8% per annum (Table 1). In weaned kids, 4,054 blood samples were examined from 264 kids. Only four cases were observed within the study period. The earliest age that a weaned kid was detected trypanosome-positive was 160 days and was associated with *T. vivax*.

Table 1. Weaned lambs and kids trypanosome incidence rates between June 1992 and December 1994

Flock	Sheep			Goats		
	Cases	Animal days	Rate (%)	Cases	Animal days	Rate (%)
A	1	8049	4.5	2	9088	8.0
B	1	7406	4.9	0	12360	0.0
C	5	6239	29.3	2	11254	6.5
D	0	11115	0	0	14084	0.0
Aggre.	7	32809	7.8	4	46786	3.1

Packed Cell Volume

Trypanosome infection and PCV monitoring was a routine process during the study period. Trypanosome infection did not show any significant effect on PCV in weaned lambs. The mean PCV on the day of detection was 28%, and ranging from 23% to 32%. Similarly, there was no effect of trypanosome infection on PCV in weaned kids. The mean PCV on the day of detection was 29%.

Mortality

Only one lamb and one kids' deaths were attributed to trypanosomosis. The lamb died on the day it was detected and treated while the kid was slaughtered 28 days post detection and treatment, probably due to its past poor performance.

Weight gain

Infected lambs recorded a significantly lower overall growth rate than those not infected ($P < 0.05$). The regression analysis indicated that infected lambs' growth rate was 10.2 g/day lower than those not infected. Lamb weight gain two week pre- and post infection were not significantly different.

Ewes and does

Trypanosome incidence rate

In ewes 4,207 blood samples were examined for trypanosome parasites from 115 animals (Table 2). The overall infection rate was estimated as 13% per annum. The female and male incidence rates were 12 and 14 % per annum, respectively ($P < 0.8$). Flock C had a significantly higher trypanosome incidence rate than other flocks ($X = 23.5$; $df = 3$; $P < 0.001$).

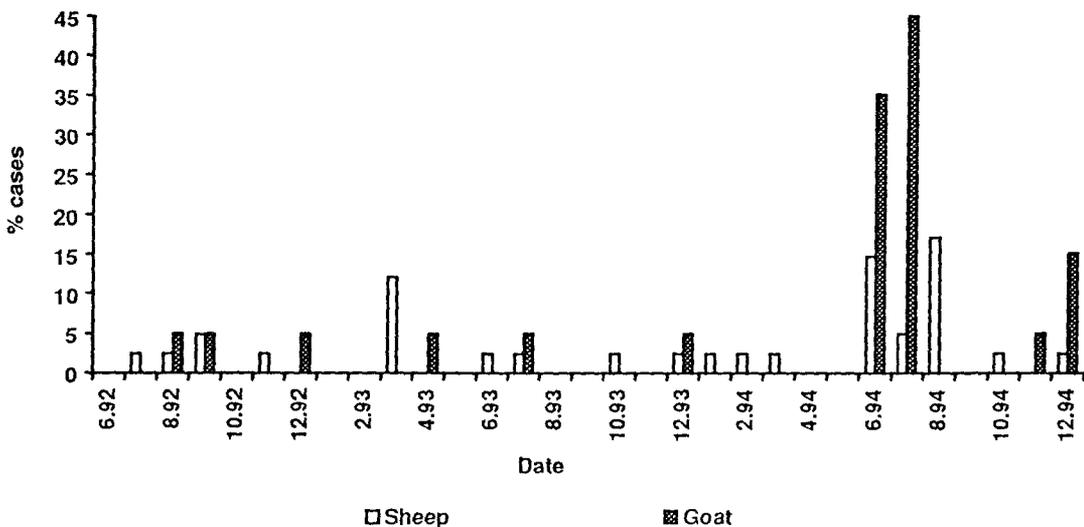
In does, 15 trypanosome cases were identified from 6,148 blood samples examined from 156 animals (Table 2). The overall trypanosome incidence rate in breeding goats was 6.8% per annum. *T. vivax* infections were not significantly higher than *T. congolense* infections in both ewes and does.

Table 2. Ewes and does trypanosome incidence rates between June 1992 and December 1994

Flock	Sheep			Goats		
	Cases observed	Animal days	Rate (%)	Cases observed	Animal days	Rate (%)
A	5	16730	10.9	2	17949	4.1
B	0	8895	0.0	4	22242	6.6
C	16	19814	29.5	9	18615	17.7
D	0	24685	0.0	0	21345	0.0
Aggre.	21	61056	13.0	15	80151	6.8

As shown in Table 2, the highest disease challenge was observed in Flock/Herd C which was agropastoral and located in a high tsetse challenge area. The mean monthly disease prevalence in sheep (all the age groups) calculated with mean number of animals as a denominator was 1.4 % and ranging from 0% to 21%, while that of goats was estimated as 0.4% and ranging from 0% to 11.3%. There was a fairly constant number of infections between June 1992 and May 1994. However, there was a sudden increase in infections from June to August 1994 (Figure 1).

Figure 1. Trypanosomosis cases in sheep and goats between July 1992 and December 1994 (% total)



Ewes did not show seasonal occurrence of trypanosome infection. However, in does most of the infections occurred during the dry season.

Of the 21 trypanosome infections that were observed in ewes, 9 were *T. congolense* and 12 were *T. vivax*. Virtually all the *T. vivax* infections (90%) were observed during the dry season, whilst 6 of the 9 *T. congolense* infections were observed in the wet season. There were significant differences ($P < 0.05$) between the wet and the dry season infection rates due to *T. vivax*. In does, there were significant seasonal prevalence in trypanosome infections with all the *T. vivax* infections being observed in the dry season.

Packed Cell Volume in ewes and does

The mean PCV values of infected ewes was significantly lower ($P < 0.001$) than those not get infected. The mean PCV values were 28% and 30% for infected and non animals infected respectively. Of the infected animals, the lowest PCV recorded was 16%. At detection, PCV values in ewes ranged from 16% to 33% with a mean of 24% (SD 4.3%). The mean PCV values at the time of trypanosome detection was not significantly different from those prior and after treatment (Figure 1).

Figure 2. Effect of trypanosome infection on PCV and weight 14 weeks before and after treatment in ewes

In does, PCV in trypanosome-positive breeding goats ranged from 17% to 31%, with a mean of 23.2% (SD 4.4%) on the date of detection. PCV at the time of trypanosome detection was significantly lower than the sampling preceding and following treatment ($P < 0.02$). The breeding does which had been infected during the study period had a mean PCV of 27.9%, which was significantly lower than non infected does with a PCV of 28.8% ($P < 0.001$). The effect of trypanosome infection on PCV and weight based on the 15 infected does are shown in Figure 2.

Figure 3. Weight and PCV changes due to trypanosome infection 14 weeks before and after treatment in does.

Mortality

Two ewes died from Flock C which showed a trypanosome specific mortality rate of 1.2%, while only one doe died giving an annual trypanosome-specific mortality rate of 0.5%.

Weight gain

The effect of trypanosome infection on ewe body weight is shown in Figure 1. The weight loss observed cannot be fully attributed to infection, as most of the infections were observed during the dry season when all the animals were losing weight. Similarly, weight loss in does due to trypanosome infection was not statistically significant.

Tsetse fly challenge

The tsetse fly species that were identified during the study were *G. pallidipes* and *G. longipennis*. *G. pallidipes* was the main species, comprising over 70% of all flies caught. The

in the five trapping sites within the grazing area. The general location of the trapping site determined the tsetse fly challenge. The mean fly catches for the five trapping sites for the year 1994 could be classified as low, medium and high challenge as shown in Table 3.

Figure 4. Tsetse challenge between August 1991 and December 1994 (flies/trap/day)

Table 3. Mean fly catches in the five trapping sites classified according to challenge

Level of challenge	Location (site name)	Mean tsetse fly catches in the year 1994 (Flies/trap/day)
Low fly challenge	Darkalali	3.5
	Campsite	3.63
Medium challenge	Oloibortoto	13.0
	Ewaso Ngi'ro	15.9
High challenge	Sampu	66.7

Discussion

This study demonstrated that sheep had significantly more trypanosome infections than goats. The overall trypanosome incidence rates observed were 9.0 % and 4.7 % for sheep and goats respectively ($P < 0.02$). The infections occurred mainly in Flocks and Herds A and C. Throughout the study, sheep and goats in Flock C and Herd C were grazing together, and therefore any differences observed between the species could have been due to species characteristics. Similar differences in trypanosome incidence rates between the two species were reported by Agyemang *et al.* (1991). The author observed trypanosome incidence rates of 1.57 and 0.15% for sheep and goats respectively in West Africa.

The difference in susceptibility between the two species could be attributed to several factors. Goats are generally more active than sheep, and this may interfere with tsetse feeding success, thus producing less infection. Goats skin is more sensitive and its violent twitches could have interfered with feeding. The body odours of the two species may lead to preference in the feeding of the tsetse flies. Weitz (1963) reported that goats were not preferred hosts of *Glossina* as sources of blood meals. Differences in the frequency of tsetse bites have been demonstrated among different goat breeds (Griffin and Allonby, 1979b; Kanyari *et al.*, 1983). The thicker skin in goats as compared to sheep is another factor that may account for the differences in susceptibility. A similar suggestion was made by Whitelaw *et al.* (1985) while working on the susceptibility of different goat breeds. Though sheep have more hair on the dorsal trunk, which may interfere with tsetse feeding, the ventral trunk has very little hair or wool.

Goats may have had innate resistance thus only succumbing when the challenge is high. This is supported by the seasonal incidence observed in goats but not in sheep. There were more indigenous Maasai goats than introduced breeds, which may have adapted to the trypanosomes in the area. This was different from Blackhead Somali sheep which have been introduced into the area within the last twenty years. The original sheep breed in the area was reported to be

Somali sheep would therefore be expected.

The nomadic herding of animals away from areas of high tsetse challenge, except when grazing outweighs disease considerations could account for the low incidence in both sheep and goats. The increase in infections towards the end of the study, could be attributed to increased fly numbers, presumably due to failure of the tsetse control programme in the area as reported by Echessah (1995).

Trypanosomosis incidence was similar during both the dry season (55%) and the wet season (45%). However, *T. congolense* occurred mainly in the wet season (68 %) and *T. vivax* occurred mainly in the dry season (77%). These findings were opposite those observed by Mwangi (1993) and Roderick (1995) who found that in cattle, *T. vivax* infections were highest during or after the rains, while *T. congolense* infections were highest during the dry season. The high occurrence of *T. vivax* during the dry season suggests that most infections within this period were mixed. This could have been attributed by animals being under high tsetse challenge during the dry season. When the tsetse challenge increased, only *T. vivax* was observed due to its higher pathogenicity, and any underlying *T. congolense* was not observed, as the animals were treated before *T. congolense* got into the circulatory system. The occurrence of *T. vivax* during the dry season had important implications in that, within dry season, animals were in poor body condition (decreased immune response) and therefore death was more likely.

Reynold and Ekurukwe (1988) reported that improved nutrition increased resistance to diseases including trypanosomosis. Whether the availability of pastures has something to do with the high incidence rate of *T. vivax* during the dry season observed in this study needs further investigation.

There were significant differences in PCV in both sheep and goats due to trypanosome infection. PCV values as low as 13% in some animals may have contributed to the clinical signs and sometimes death. Anaemia has been reported as a major factor contributing to clinical disease and mortality in goats (Whitelaw *et al.*, 1985). Similar observations in cattle have been reported by Dargie *et al.* (1979). In this present study, other factors were observed to affect PCV are helminths, season (nutrition) and other hemoparasites such as anaplasmosis. Trypanosome infections that occurred at the end of the short rainy season between November and January could have had the most deleterious effects, as by this time the PCV was already low presumably due to poor nutrition.

Results of the present study showed a direct relationship between trypanosome infection and tsetse catches in both sheep and goats. The highest animal infection rates were observed between May-August 1994 when the fly challenge was highest. However, while the tsetse increased with the rainfall from March, infections were delayed until June which was the starting of the dry season. This implies that the animals did not move to the tsetse infested bush until this time. The other possibility is that the pre-patent period of the disease in these animals may be more than one month under field conditions. The high correlation between fly catches and animal infection rates clearly demonstrated the need for tsetse control. The results of this study indicate that pastoral small ruminant management is an effective method of trypanosomosis control.

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Figure 2. Effect of trypanosome infection on PCV and weight 14 weeks before and after treatment in ewes

Figure 3. Weight and PCV changes due to trypanosome infection 14 weeks before and after treatment in does.

Figure 4. Tsetse challenge between August 1991 and December 1994 (flies/trap/day)

Haemorrhagic *Trypanosoma vivax* on Galana Ranch in Kenya

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Trypanosomosis is commonly diagnosed in the beef cattle on Galana Ranch in Kenya. The ranch includes a large area infested with the tsetse species, *Glossina pallidipes* and *Glossina longipennis*. The recorded annual mortality rate in cattle on the ranch is usually around 4% of which less than a quarter is ascribed to trypanosomosis. The disease is generally successfully controlled by the use of prophylactic drugs or the treatment of clinically affected animals with diminazene aceturate.

In herds grazing in areas with high numbers of tsetse flies, however, the mortality rate can increase greatly if the haemorrhagic form of *Trypanosoma vivax* infection appears. A profound drop in packed cell volume (PCV) can occur within a few days and treatment with diminazene aceturate will not always result in cure. In three outbreaks of the disease which were closely monitored on the ranch, 30% to 60% of the cattle showed a rapid drop in PCV within one or two weeks and the mortality rate was 5% or more despite prompt treatment with diminazene.

Cases of haemorrhagic *T. vivax* are seen after the rains when tsetse numbers are high. The haemorrhagic form of the disease rarely occurs at other times of year when the incidence of trypanosomosis is lower.

With the existence of *T. vivax* strains on the ranch which are resistant to isometamidium, prophylactic treatment cannot always be relied upon to prevent the occurrence of trypanosomosis. Removing cattle from areas of the ranch where large numbers of tsetse flies will occur after the rains is the only means at present whereby a high mortality rate from trypanosomosis can be confidently avoided. Some recent trials with pour on formulation of deltamethrin indicate however that the incidence of haemorrhagic *T. vivax* cases is much lower than expected in treated cattle.

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Systèmes d'Information Géographique, outils puissant de prise de décision.

Définir des Zones Prioritaires de Contrôle de la Trypanosomose.

Présentation faite à la 24 Réunion de l'ISCTRC, Maputo, Mozambique (1997)

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Actuellement l'approche participative est considérée comme incontournable dans l'application d'activités de contrôle de la trypanosomose. Une telle approche offre le plus de chances de réussite dans des zones où les densités de bétail sont suffisamment élevées et les contraintes imposées par la maladie suffisamment importantes, générant rapidement des bénéfices susceptibles d'entraîner la motivation des éleveurs (FAO 1993). Basé sur ces deux hypothèses cette communication se propose, en prenant le Togo comme exemple, d'illustrer comment des données géo-référencées sur l'agriculture, l'élevage et la trypanosomose, analysées dans le cadre d'un SIG, permettent de sélectionner des zones prioritaires d'intervention.

Une analyse nationale des systèmes d'élevage sédentaire suggère une division géographique relativement nette du pays en une zone d'élevage traditionnel et une zone à vocation plus commerciale. Des zones prioritaires adaptées devront donc être définies pour chacune de ces zones. Dans un système commercial le but sera d'améliorer un suivi professionnel de la santé et production animale. La définition du niveau de suivi zoosanitaire requis pour atteindre cet objectif qualitatif nécessite des connaissances sur la prévalence de la maladie, l'état général de santé des troupeaux et les races bovines. Dans un système traditionnel par contre l'accent sera mis sur l'intégration de l'agriculture et de l'élevage ainsi que sur des perspectives de développement rural amélioré par la lutte contre le vecteur. Des zones prioritaires de cette approche quantitative seront définies en comparant les bénéfices potentiels, basés sur les connaissances de l'intensité d'utilisation des sols ainsi que sur les densités de bétail, au coûts estimés définis par l'impact de la maladie.

Ces deux approches (qualitatives et quantitatives) sont décrites utilisant des techniques simples d'analyse dans l'espace. Les variables sélectionnées sont combinées pas par pas utilisant des seuils basés sur des observations de terrain permettant une prise de décision rationnelle. En conclusion une carte est proposée montrant les zones prioritaires sélectionnées ainsi que des données sur les espaces protégés.

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Geographic Information Systems (GIS), powerful tools in decision making.

Defining Priority Areas for Trypanosomosis Control.

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Community based control is now generally considered to be the method of choice to address the problem of trypanosomosis. In areas of higher cattle density and where trypanosomosis is an important health constraint intervention programmes should generate most direct benefits (FAO 1993). Based on these hypotheses this paper uses Togo as an example to illustrate how georeferenced data on agriculture, animal husbandry and trypanosomosis may be analysed within a GIS framework to select priority areas for intervention.

A country wide analysis of sedentary animal husbandry systems suggests a clear, geographic division into traditional and commercial livestock rearing and thus priority areas are defined for both systems. In a commercial system the aim is to improve professional herd health and production management. Defining the level of veterinary follow-up needed to achieve this qualitative goal requires knowledge of disease prevalence, general health status of the herds and cattle breeds. In a traditional system, on the other hand, the focus is on the integration of crop and livestock production as well as on rural development prospects improved by vector control. Priority areas for this quantitative goal are assigned comparing potential benefits, based on knowledge of land-use intensity and cattle densities, with estimated costs, i.e. disease impact.

Both qualitative and quantitative approaches are described using simple spatial analysis techniques. Selected variables are combined stepwise with thresholds set according to field experience, allowing rational decision making. As a conclusion a map is proposed showing selected priority areas including data on protected areas.

Transparent 1: Chaîne de décision pour la définition de zones prioritaires.

Dans une zone où la trypanosomose animale est présente l'approche de base de son contrôle dépendra des modes d'élevage dominants:

1. Dans le cas d'un élevage à potentiel COMMERCIAL, et donc générateur de fonds, l'éleveur aura intérêt à promouvoir la santé individuelle et la production des troupeaux. Pour atteindre cet objectif QUALITATIF il devra financer une intervention vétérinaire régulière.

2. Dans le cas de l'élevage à vocation TRADITIONNELLE peu de fonds sont disponibles. Plus que des individus en bonne santé l'éleveur sera intéressé à avoir un plus grand nombre d'animaux en relativement bonne santé permettant une meilleure intégration de l'agriculture et de l'élevage. Cet objectif QUANTITATIF pourra être atteint par une lutte concertée contre le vecteur.

Les modes de sélection de zones d'activités prioritaires seront différents dans les deux cas.

Transparent 2: Définition des modes d'élevage au Togo.

Les variables utilisées dans l'analyse ont été obtenues lors d'un recensement national de l'élevage effectué par le Projet. Elles sont:

1. La densité de bétail,
2. La taille des troupeaux,
3. Le nombre de propriétaires par troupeau,
4. Le pourcentage de propriétaires venant du monde rural,
5. Le pourcentage de ces propriétaires (4) étant agriculteurs.

Les résultats de l'analyse hiérarchique sont donnés sous forme de carte montrant trois zones:

1. Une zone à potentiel commercial aux caractéristiques suivantes: densités de bétail faibles (1 à 2, sauf dans la bande côtière), troupeaux de taille importante (83 ± 7), peu de propriétaires par troupeau (1.7 ± 0.1), moins de la moitié (48%) des propriétaires y viennent du monde rural et seulement 16% de ces propriétaires y est agriculteur.

2. Une zone à vocation traditionnelle: densités de bétail plus élevées (8 ± 1), troupeaux de plus petite taille (39 ± 2), nombre moyen de propriétaires plus élevé (4.7 ± 0.3), important pourcentage de propriétaires venant du monde rural (92%) et une grande proportion de ces propriétaires étant agriculteur (77%).

3. L'analyse montre également une zone intermédiaire aux caractéristiques traditionnelles avec un potentiel commercial marqué: une faible densité de bétail (2.2), peu de propriétaires par troupeau (1.5) et des troupeaux plus importants (48).

Il est à noter que ces zones coïncident avec les zones de distribution des races bovines montrant un métissage zébu important dans les zones commerciales et intermédiaires et un maintien de la race trypanotolérante Somba dans les zones traditionnelles.

APPROCHE QUALITATIVE

Transparent 3: Approche qualitative, définition des problèmes de santé animale.

L'approche qualitative vise à définir les niveaux de suivi zoo-sanitaire requises pour améliorer la santé et la production animale de troupeaux à vocation commerciale.

Dans un premier stade la carte de prévalence de la trypanosomose est combinée avec celle des hématocrites moyens des troupeaux, mesure de leur état de santé générale. Les deux variables sont divisées en trois classes (faible, moyen, élevé = F,M,E) et ont le même poids dans l'analyse (matrice diagonale symétrique). Les limites des classes ont été établies par rapport aux moyennes nationales mesurées.

La carte produite montre clairement la situation de la santé animale au Togo.
Seuils (F,M,E): 1. prévalence: 6.5% - 11% - >11%, 2. Hct: 26.9% - 28.3% - >28.3%.

Transparent 4: Approche qualitative, définition de l'intensité du suivi zoo-sanitaire des troupeaux.

Pour introduire la notion de fragilité du cheptel le résultat précédent est combiné au niveau de métissage des races bovines. Les zébus et leur métisses étant moins bien adaptés aux conditions humides en général et à la trypanosomose en particulier. Un maximum de poids est donné à la variable santé animale, le niveau d'introgession zébu (dont les seuils des catégories ont été définis suite aux observations de terrain) n'intervenant que dans la catégorie « santé moyenne ET métissage élevé ».

La carte produite définit les zones prioritaires d'intervention QUALITATIVE.
Seuils (F,M,E): introgression zébu: 0% - 30% - > 30%.

APPROCHE QUANTITATIVE

Transparent 5: Approche quantitative, définition de la relation entre la population humaine et l'agriculture.

Dans ce premier pas vers la définition des zones prioritaires QUANTITATIVES, l'intensité d'utilisation des sols est définie en combinant les données de % d'agriculture et de densité de population humaine. Contrairement aux autres variables, toutes mesurées par le Projet, ces deux variables viennent de sources indépendantes (PNUD 1984, PNUE 1991).

Seuils (F,M,E): 1. %agriculture: 15% - 50% - >50%, 2. population: 5 - 50 - >50/km².

Transparent 6: Approche quantitative, définition des zones au meilleur potentiel d'intégration de l'agriculture et de l'élevage.

Les résultats précédents sont combinés à la carte des densités de bétail. Le bétail intervient comme filtre dans l'analyse, une zone d'intervention n'étant pas justifiée quand les densités sont trop faibles. La carte montre les zones à potentiel bénéfique important. La lutte contre le vecteur par l'amélioration du niveau moyen de santé des troupeaux pourrait y contribuer à une amélioration de l'intégration de l'agriculture et de l'élevage et donc du niveau de développement rural. (Seuils (F,M,E): bétail: 3 - 10 - >10/km².)

Transparent 7: Approche quantitative, définition des zones au rapport coûts-bénéfices le plus favorable.

Finalement en combinant la carte précédente, exprimant la notion de bénéfice potentiel, et le résultat de l'analyse QUALITATIVE, exprimant le coût du problème, les régions peuvent être définies où une intervention contre le vecteur offre les meilleures garanties d'un rapport coûts-bénéfices favorable. Ce sont les zones prioritaires d'action de l'approche QUANTITATIVE.

RESUME

Transparent 8: Résumé des zones à priorité élevée en rapport aux systèmes d'élevage dominants.

La carte reprend les zones à priorité élevée d'approche QUALITATIVE dans les zones commerciales (y compris intermédiaires) et d'approche QUANTITATIVE dans les zones traditionnelles. Y sont superposés les zones protégées, les zones à forte dynamique de repeuplement nécessitant souvent un autre mode d'intervention avec apport extérieur plus important ainsi que les zones d'accueils de transhumants.

CONCLUSIONS

Les résultats présentés montrent clairement qu'une bonne connaissance d'un nombre relativement limité de variables mesurées sur le terrain permet une prise de décision rationnelle et l'introduction d'une approche de contrôle de la trypanosomose adaptée aux différentes situations rencontrées. Un important travail visant à rendre ces enquêtes de terrain à grande échelle plus faciles d'exécution et moins chères, tout en maintenant leur efficacité, est en cours.

Ces résultats sont très encourageant et sont actuellement appliqués dans le cadre de la lutte au Togo (voir autre communication à cette réunion). L'approche est probablement extrapolable avec un minimum d'adaptation vers les autres zones plus humides d'Afrique de l'Ouest. Pour les zones pré-sahéliennes et sahéliennes par contre un travail plus important d'adaptation reste à faire. Dans ce but des négociations sont actuellement en phase de finalisation en vue d'étendre nos activités vers le Burkina Faso.

Le travail décrit a été exécuté dans le cadre du Projet FAO de Lutte contre la Trypanosomose Animale au Togo, GCP-TOG-013-BEL, financé par la Belgique. Il fait partie d'une publication décrivant l'approche utilisée en détail (Hendrickx & Napala, 1997).

REMERCIEMENTS

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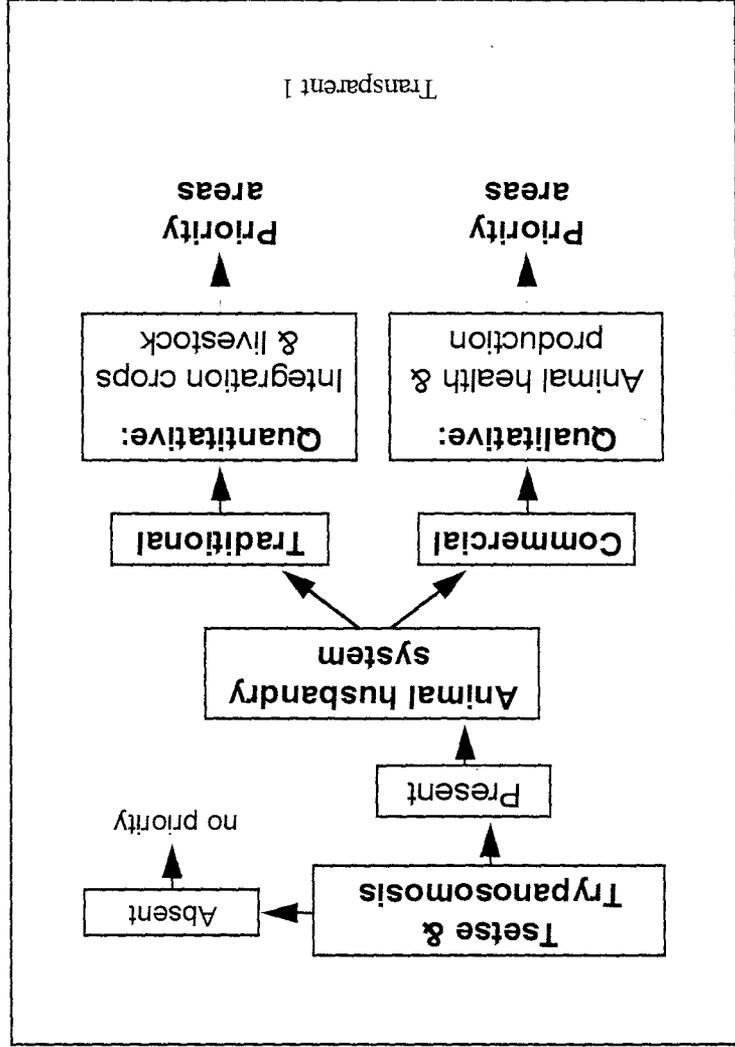
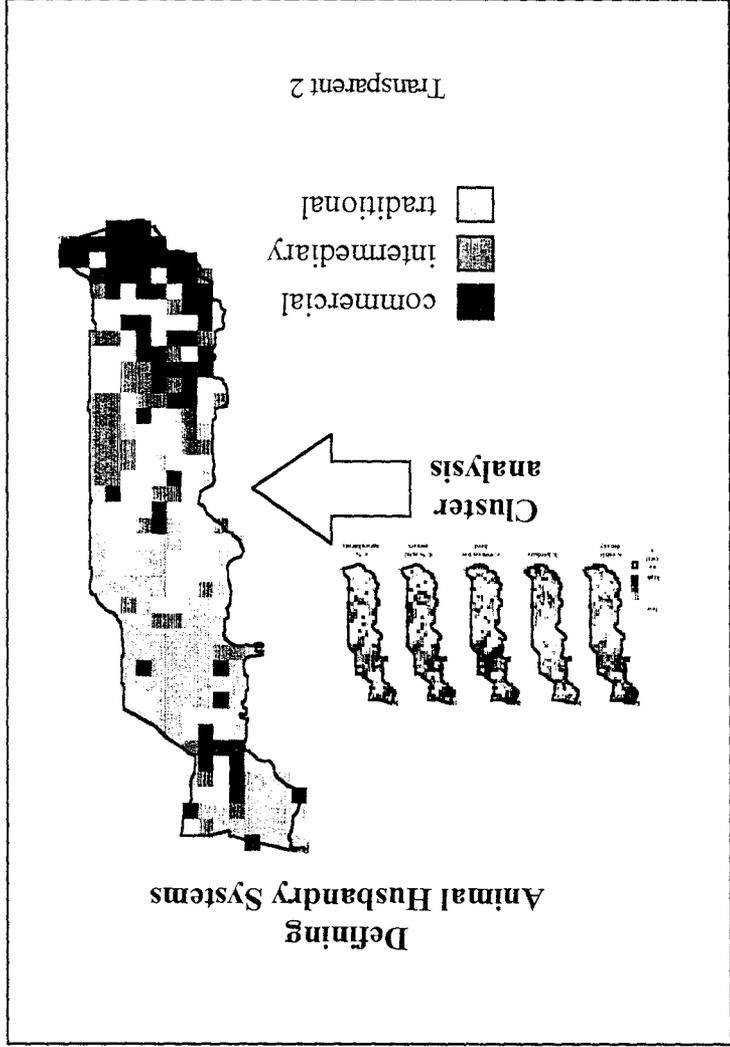
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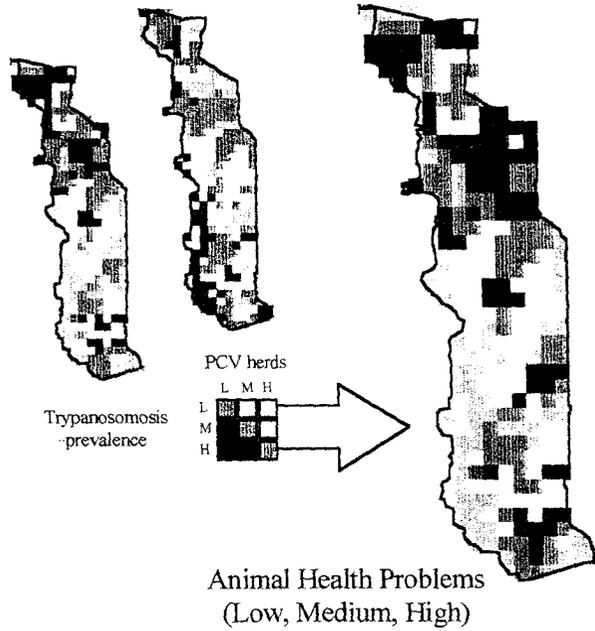
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Qualitative, part 1/2

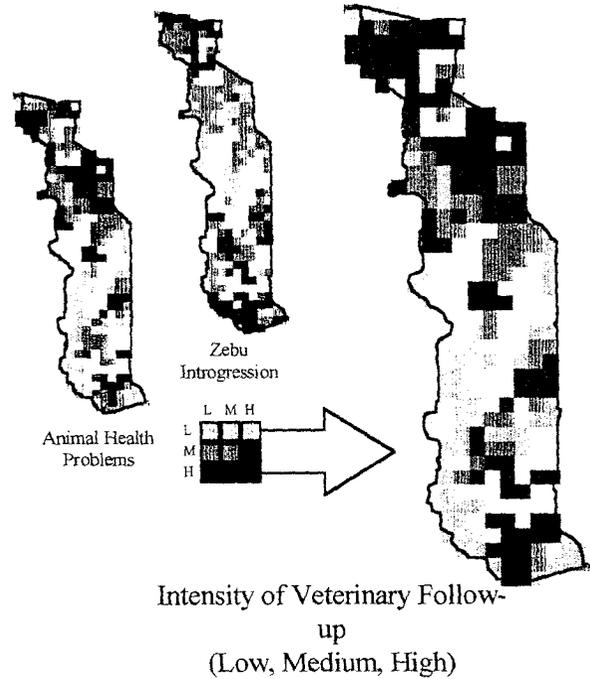
Defining Animal Health Problems



Transparent 3

Qualitative, part 2/2

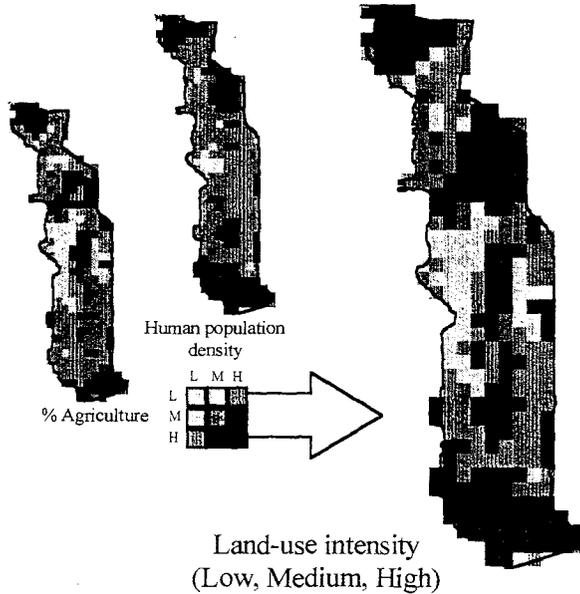
Defining Intensity of Veterinary Follow-up



Transparent 4

Quantitative, part 1/3

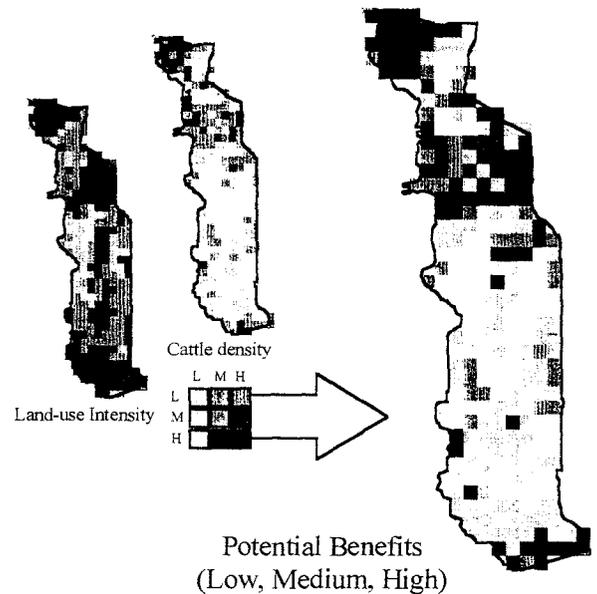
Defining relationship between Human Population and Agriculture



Transparent 5

Quantitative, part 2/3

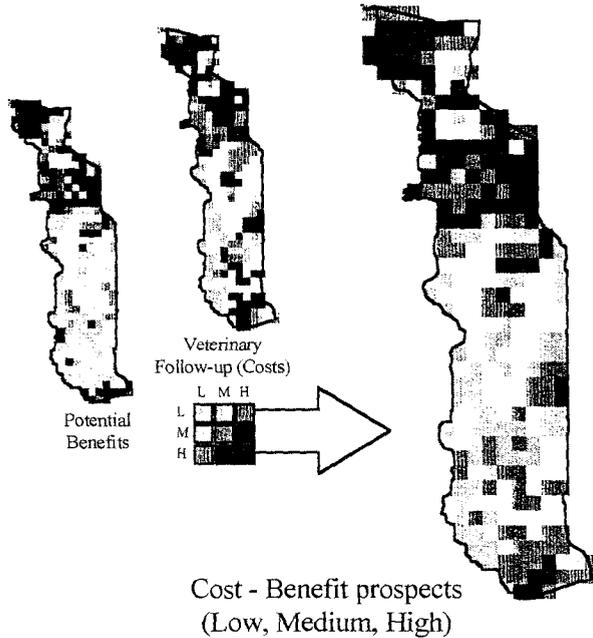
Defining areas with prospects to improve integration of Crops and Livestock (Benefit).



Transparent 6

Quantitative, part 3/3

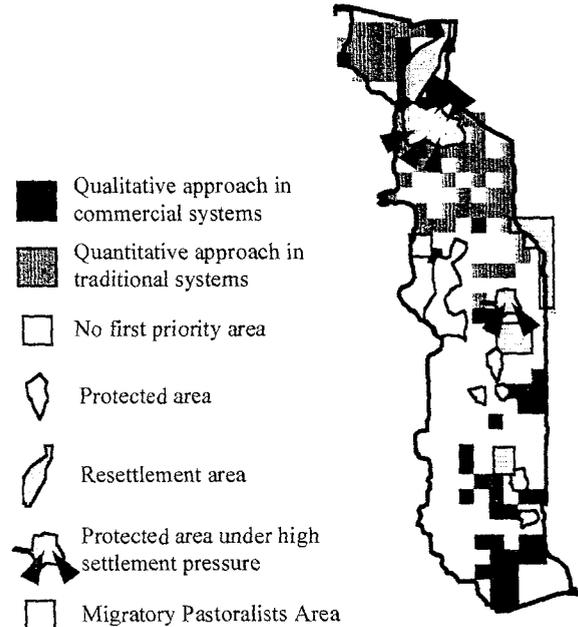
Defining areas with highest Cost - Benefit prospects



Transparent 7

Summary:

High Priority Areas according to animal husbandry systems.



Transparent 8

(Allo bot) 11/11/11

Systèmes d'Information Géographique, outils puissant de prise de décision.

Définir des Zones Prioritaires de Contrôle de la Trypanosomose.

Présentation faite à la 24 Réunion de l'ISCTRC, Maputo, Mozambique (1997)

G. Hendrickx¹, J.H.W. Slingenbergh², B. Dao¹, P. Bastiaensen¹ & A. Napala¹

Actuellement l'approche participative est considérée comme incontournable dans l'application d'activités de contrôle de la trypanosomose. Une telle approche offre le plus de chances de réussite dans des zones où les densités de bétail sont suffisamment élevées et les contraintes imposées par la maladie suffisamment importantes, générant rapidement des bénéfices susceptibles d'entraîner la motivation des éleveurs (FAO 1993). Basé sur ces deux hypothèses cette communication se propose, en prenant le Togo comme exemple, d'illustrer comment des données géo-référencées sur l'agriculture, l'élevage et la trypanosomose, analysées dans le cadre d'un SIG, permettent de sélectionner des zones prioritaires d'intervention.

Page 3

Une analyse nationale des systèmes d'élevage sédentaire suggère une division géographique relativement nette du pays en une zone d'élevage traditionnel et une zone à vocation plus commerciale. Des zones prioritaires adaptées devront donc être définies pour chacune de ces zones. Dans un système commercial le but sera d'améliorer un suivi professionnel de la santé et production animale. La définition du niveau de suivi zoonitaire requis pour atteindre cet objectif qualitatif nécessite des connaissances sur la prévalence de la maladie, l'état général de santé des troupeaux et les races bovines. Dans un système traditionnel par contre l'accent sera mis sur l'intégration de l'agriculture et de l'élevage ainsi que sur des perspectives de développement rural amélioré par la lutte contre le vecteur. Des zones prioritaires de cette approche quantitative seront définies en comparant les bénéfices potentiels, basés sur les connaissances de l'intensité d'utilisation des sols ainsi que sur les densités de bétail, au coûts estimés définis par l'impact de la maladie.

Ces deux approches (qualitatives et quantitatives) sont décrites utilisant des techniques simples d'analyse dans l'espace. Les variables sélectionnées sont combinées pas par pas utilisant des seuils basés sur des observations de terrain permettant une prise de décision rationnelle. En conclusion une carte est proposée montrant les zones prioritaires sélectionnées ainsi que des données sur les espaces protégés.

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² FAO Rome, Via delle Terme di Caracalla

Geographic Information Systems (GIS), powerful tools in decision making.

Defining Priority Areas for Trypanosomosis Control.

G. Hendrickx, J.H.W. Slingenbergh, B. Dao, P. Bastiaensen & A. Napala

Community based control is now generally considered to be the method of choice to address the problem of trypanosomosis. In areas of higher cattle density and where trypanosomosis is an important health constraint intervention programmes should generate most direct benefits (FAO 1993). Based on these hypotheses this paper uses Togo as an example to illustrate how georeferenced data on agriculture, animal husbandry and trypanosomosis may be analysed within a GIS framework to select priority areas for intervention.

A country wide analysis of sedentary animal husbandry systems suggests a clear, geographic division into traditional and commercial livestock rearing and thus priority areas are defined for both systems. In a commercial system the aim is to improve professional herd health and production management. Defining the level of veterinary follow-up needed to achieve this qualitative goal requires knowledge of disease prevalence, general health status of the herds and cattle breeds. In a traditional system, on the other hand, the focus is on the integration of crop and livestock production as well as on rural development prospects improved by vector control. Priority areas for this quantitative goal are assigned comparing potential benefits, based on knowledge of land-use intensity and cattle densities, with estimated costs, i.e. disease impact.

Both qualitative and quantitative approaches are described using simple spatial analysis techniques. Selected variables are combined stepwise with thresholds set according to field experience, allowing rational decision making. As a conclusion a map is proposed showing selected priority areas including data on protected areas.

Transparent 1: Chaîne de décision pour la définition de zones prioritaires.

Dans une zone où la trypanosomose animale est présente l'approche de base de son contrôle dépendra des modes d'élevage dominants:

1. Dans le cas d'un élevage à potentiel COMMERCIAL, et donc générateur de fonds, l'éleveur aura intérêt à promouvoir la santé individuelle et la production des troupeaux. Pour atteindre cet objectif QUALITATIF il devra financer une intervention vétérinaire régulière.

2. Dans le cas de l'élevage à vocation TRADITIONNELLE peu de fonds sont disponibles. Plus que des individus en bonne santé l'éleveur sera intéressé à voir un plus grand nombre d'animaux en relativement bonne santé permettant une meilleure intégration de l'agriculture et de l'élevage. Cet objectif QUANTITATIF pourra être atteint par une lutte concertée contre le vecteur.

Les modes de sélection de zones d'activités prioritaires seront différents dans les deux cas.

Transparent 2: Définition des modes d'élevage au Togo

Les variables utilisées dans l'analyse ont été obtenues lors du recensement national de l'élevage effectué par le Projet. Elles sont:

1. La densité de bétail,
2. La taille des troupeaux,
3. Le nombre de propriétaires par troupeau,
4. Le pourcentage de propriétaires venant du monde rural,
5. Le pourcentage de ces propriétaires (4) étant agriculteurs.

Les résultats de l'analyse hiérarchique sont donnés sous forme de carte montrant trois zones:

1. Une zone à potentiel commercial aux caractéristiques suivantes: densités de bétail faibles (1 à 2, sauf dans la bande côtière), troupeaux de taille importante (83 ± 7), peu de propriétaires par troupeau (1.7 ± 0.1), moins de la moitié (48%) des propriétaires y viennent du monde rural et seulement 16% de ces propriétaires y est agriculteur.

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3. L'analyse montre également une zone intermédiaire aux caractéristiques traditionnelles avec un potentiel commercial marqué: une faible densité de bétail (2.2), peu de propriétaires par troupeau (1.5) et des troupeaux plus importants (48).

Il est à noter que ces zones coïncident avec les zones de distribution des races bovines montrant un métissage zébu important dans les zones commerciales et intermédiaires et un maintien de la race trypanotolérante Somba dans les zones traditionnelles.

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L'approche qualitative vise à définir les niveaux de suivi zoo-sanitaire requis pour améliorer la santé et la production animale de troupeaux à vocation commerciale.

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La carte produite montre clairement la situation de la santé animale au Togo.
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Transparent 4: Approche qualitative, définition de l'intensité du suivi zoo-sanitaire des troupeaux.

Pour introduire la notion de fragilité du cheptel le résultat précédent est combiné au niveau de métissage des races bovines. Les zébus et leur métisses étant moins bien adaptés aux conditions humides en général et à la trypanosomose en particulier. Un maximum de poids est donné à la variable santé animale, le niveau d'introgession zébu (dont les seuils des catégories ont été définis suite aux observations de terrain) n'intervenant que dans la catégorie « santé moyenne ET métissage élevé ».

La carte produite définit les zones prioritaires d'intervention QUALITATIVE.
Seuils (F,M,E): introgression zébu: 0% - 30% - > 30%.

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Transparent 5: Approche quantitative, définition de la relation entre la population humaine et l'agriculture.

Dans ce premier pas vers la définition des zones prioritaires QUANTITATIVES, l'intensité d'utilisation des sols est définie en combinant les données de % d'agriculture et de densité de population humaine. Contrairement aux autres variables, toutes mesurées par le Projet, ces deux variables viennent de sources indépendantes (PNUD 1984, PNUE 1991).

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Transparent 6: Approche quantitative, définition des zones au meilleur potentiel d'intégration de l'agriculture et de l'élevage.

Les résultats précédents sont combinés à la carte des densités de bétail. Le bétail intervient comme filtre dans l'analyse, une zone d'intervention n'étant pas justifiée quand les densités sont trop faibles. La carte montre les zones à potentiel bénéfique important. La lutte contre le vecteur par l'amélioration du niveau moyen de santé des troupeaux pourrait y contribuer à une amélioration de l'intégration de l'agriculture et de l'élevage et donc du niveau de développement rural. (Seuils (F,M,E): bétail: 3 - 10 - >10/km².)

Transparent 7: Approche quantitative, définition des zones au rapport coûts-bénéfices le plus favorable.

Finalement en combinant la carte précédente, exprimant la notion de bénéfice potentiel, et le résultat de l'analyse QUALITATIVE, exprimant le coût du problème, les régions peuvent être définies où une intervention contre le vecteur offre les meilleures garanties d'un rapport coûts-bénéfices favorable. Ce sont les zones prioritaires d'action de l'approche QUANTITATIVE.

RESUME

Transparent 8: Résumé des zones à priorité élevée en rapport aux systèmes d'élevage dominants.

La carte reprend les zones à priorité élevée d'approche QUALITATIVE dans les zones commerciales (y compris intermédiaires) et d'approche QUANTITATIVE dans les zones traditionnelles. Y sont superposés les zones protégées, les zones à forte dynamique de repeuplement nécessitant souvent un autre mode d'intervention avec apport extérieur plus important ainsi que les zones d'accueils de transhumants.

CONCLUSIONS

Les résultats présentés montrent clairement qu'une bonne connaissance d'un nombre relativement limité de variables mesurées sur le terrain permet une prise de décision rationnelle et l'introduction d'une approche de contrôle de la trypanosomose adaptée aux différentes situations rencontrées. Un important travail visant à rendre ces enquêtes de terrain à grande échelle plus faciles d'exécution et moins chères, tout en maintenant leur efficacité, est en cours.

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STUDIES ON HOST RESISTANCE TO TICK INFESTATIONS AMONG
TRYPANOTOLERANT *BOS INDICUS* CATTLE BREEDS IN EAST AFRICA.

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ABSTRACT

Recent epidemiological studies carried out in East Africa have indicated that some *Bos indicus* cattle breeds such as the Orma Boran and Maasai Zebu have a degree of trypanotolerance worth exploitation by their introduction into trypanosomiasis endemic areas where other cattle breeds cannot survive. However, in most areas of East Africa, trypanosomiasis, ticks and tick-borne diseases occur together. It is therefore important to obtain information on the susceptibility of these breeds to tick infestation and tick-borne diseases. This study was therefore designed to determine the susceptibility of these cattle breeds to tick infestations. They were compared with the Galana Boran (trypanosusceptible) and the Friesian (susceptible to tick infestations, tick-borne diseases and trypanosomiasis). The four breeds of cattle were exposed to natural tick challenge for a period of seven months and whole body weekly tick counts were done on each animal. Significant differences to tick infestations among the four breeds were observed. For both *Rhipicephalus appendiculatus* and *Boophilus decoloratus*, susceptibility to infestation increased in the order, Maasai Zebu, Orma Boran, Galana Boran and Friesian.

The results generated by this pilot study so far suggest that variation to tick infestations exists among the four breeds. The Orma Boran and Maasai Zebu showed greater resistance to tick-infestations than the Galana Boran and Friesian. This suggests that utilisation of these trypanotolerant cattle breeds could be feasible even in the face of tick challenge and should therefore be considered when planning integrated trypanosomiasis and tick control strategies.

INTRODUCTION

Trypanotolerance has been extensively investigated in West Africa where field and laboratory experiments conducted over the last 40 years have led to the identification of taurine cattle breeds such as the N'Dama and West African Shorthorn that possess a high degree of resistance to trypanosomiasis, as judged by their ability to survive and produce under trypanosomiasis challenge (reviewed by Murray, Stear, Trail, d'Ieteren, Agyemang and Dwinger, 1991). This trait has been extensively used as a strategy for trypanosomiasis control justifying the successful introduction of these cattle breeds into tsetse-infested areas of West and Central Africa where other susceptible breeds can not survive (Mortelmans and Kageruka, 1976; ILCA, 1979).

In East Africa, apart from wildlife, the question as to whether trypanotolerance exists

preliminary reports which indicate that certain *Bos indicus* breeds such as the Orma Boran possess some degree of trypanotolerance (Njogu, Dolan, Sayer and Wilson, 1985; Ishmael, 1988). Consequently, work carried out recently provided additional evidence that the beside the Orma Boran other indigenous cattle breeds such as the Maasai Zebu also possess a significant degree of trypanotolerance (Mwangi, 1993).

However, in the most areas trypanosomiasis is not the only disease problem and occurs together with other parasitic diseases, the most important being ticks and tick-borne diseases. For example, ^{Fiebre de la Cote est} East Coast Fever (ECF) caused by *Theileria parva*, ^{spita} occurs together with trypanosomiasis on the Kenya Coast and (Irvin, Dobbelaere, Godderis, Katende, Minami, Ocama and Spooner, 1981) and other parts of Rift Valley where beef ^{bovins} cattle form the main economic backbone, while anaplasmosis has been ^{signale} reported to be significantly prevalent in other tsetse-infested areas such as Galana Ranch and the Nguruman Escarpment (Mwangi, 1993).

Information is required in East Africa on the susceptibility to tick infestation and tick-borne diseases of the already identified trypanotolerant breeds, particularly the Orma Boran and Maasai Zebu before planning their introduction into areas where both trypanosomiasis and tick-borne diseases are endemic. The work reported here was therefore carried out to determine to what extent the trypanotolerant trait can be exploited in East Africa, in the face of tick challenge.

MATERIALS AND METHODS

Cattle selection

^{bovins} Ten steers from each of the following breeds, Orma Boran, Maasai Zebu, Galana Boran and Friesian aged about one year, were selected and purchased between November 1994 and January 1995. The Orma Boran, Maasai Zebu and Galana Boran cattle were from beef ranching areas where the common ^{infection} tick-borne disease is mainly anaplasmosis. In contrast, the Friesian steers were from a dairy cattle rearing zone where East Coast Fever (ECF) caused by *Theileria parva*, and its vector tick *Rhipicephalus appendiculatus* are prevalent as well as anaplasmosis. However, according to records from each of the farms of origin of all the four cattle breeds, the incidence of either of these tick-borne diseases was extremely low due to the stringent tick control measures. During the selection process cattle were ^{selection} screened for antibodies against *Theileria*, *Anaplasma* and *Babesia* parasites using enzyme-linked immunosorbent assays (ELISA) and only those animals identified as seronegative

were used. In addition, clinical and parasitological examinations were performed to confirm that they had none of the above tick-borne parasites.

The selected animals were transported to the study area at KETRI, Muguga, where they were maintained under strict tick control using the acaricide amitraz (Triatix^R, Coopers) for a period of four months before the experiment. The study area is at an altitude of 2096 m and is located on latitude 1° 13'South and longitude 36° 38'East.

Pre-experimental procedures and collection of baseline data

Prior to the study, all animals were weighed, sprayed with amitraz, and pre-challenge sera together with data on the packed red cell volume (PCV) collected. Vaccinations were carried out against contagious bovine pleuropneumonia (CBPP), foot-and-mouth disease and rinderpest. In addition, they were given an initial anthelmintic dose (10% albendazole, Valbazen^R, Beecham). Collection of baseline data on haematology started in January 1995 and continued up to mid-April 1995. By this time the animals were considered to be in optimal health condition as judged by the clinical assessment, baseline data results and body condition. They were also considered to have fully adjusted to the environment. At this time, all animals were still both aparasitaemic and seronegative for the local tick-borne diseases (theileriosis, anaplasmosis and babesiosis).

Pre-experimental mortality

Four mortalities occurred between January, 1995 and the start of the experiment: one Orma Boran died of urea poisoning as a consequence of urinary incontinence; one Galana Boran died of aspiration pneumonia and one Friesian died after feeding on hay that was suspected to have fungal contamination. A second Friesian steer exhibited signs of intermittent unthriftiness and was slaughtered. This left 10 Maasai Zebu, 8 Friesian and 9 steers from each of the other two breeds.

Assessment of tick challenge in the grazing paddock

The study area was identified and fenced. Five sentinel Boran steers were introduced into the study area from mid-February 1995, to assess if the tick challenge was adequate. These steers had been previously kept under strict tick control. Total tick counts were done on the host (i.e., without detaching the ticks). By the end of one month, the mean total tick counts on each of the control animals reached over 200 and this was regarded as adequate challenge justifying the use of the paddock for the experiment. The two tick species identified were *Rhipicephalus appendiculatus* and *Boophilus decoloratus*.

Exposure to natural tick challenge

In mid-April 1995, the four animal groups consisting of 10 Maasai Zebu, 9 steers from

herding them together in the paddock described above and observed until the first week of December 1995.

Experimental data collection

Tick counts

Since the animals had been under strict tick control, no counts were undertaken during the first two weeks in order to allow for the acaricidal effect to disappear. Thereafter, every week the number of 'standard ticks' on each side of every animal was counted and the tick species identified. A standard tick is one which will complete feeding and detach from the host in the following 24 hours (Wharton and Utech, 1970). Use of the standard tick concept gives a measure of successful parasitism and provides reliable information on the numbers engorging daily. The standard tick size ranges for the two common species were estimated as follows; *Rhipicephalus appendiculatus* 4.5-7 mm and *Boophilus decoloratus* 4.5-8 mm (Kaiser *et al.*, 1988; Fivaz, de Waal and Lander, 1992). Tick counts and identification were performed on the host.

Clinical examination

The occurrence of tick-borne infections, including *Theileria parva*, *Anaplasma* spp., *Babesia* spp. and *Cowdria ruminantium* was investigated by frequent and regular clinical and parasitological examination on suspected cases. Visual clinical evaluation of each animal was performed daily and the rectal temperature recorded. Animals with a temperature of 39.5°C or above were ^{considered} regarded as having a febrile reaction and were clinically examined for the signs of tick-borne infections. In the case of ECF besides fever, particular checks were made for lymph node enlargement, lacrimation and respiratory signs. In addition, lymph node biopsy smears and blood smears were taken, fixed in methyl alcohol, stained with Giemsa and examined for *Theileria*, *Anaplasma* or *Babesia* spp. parasites. Routine drenching with an anthelmintic was performed every four months.

Blood was collected weekly from the jugular vein of each animal into ethylenediamine tetra acetic acid (EDTA) coated vacutainer tubes and PCV determined by the haematocrit method.

Treatments

Treatments were based on the evidence of infection and animals confirmed to be infected were injected with the appropriate drugs; imidocarb dipropionate (Imizol^R, Wellcome) or oxytetracycline (Terramycin^R, Pfizer) for anaplasmosis, diminazene aceturate (Berenil^R, Hoechst) for babesiosis and, parvarquone (Clexon^R, Coopers Animal Health) or buparvaquone (Butalex^R, Pitman-Moore) for theileriosis.

Data presentation and statistical analysis

Weather changes, mean tick counts, PCV and liveweight gains were shown in graphical presentations. A repeated measures analysis of variance was used to test for differences between breeds over time. Significant group and time interactions were graphed in profile plots and significant group differences were investigated further using the Neuman-Keuls multiple range test. Data on tick counts were log transformed before analysis to provide normally distributed data. Growth rates were expressed as percentage weight gains at the various time points after the start of the experiment. The generalised linear modelling (GLM) system for repeated measures was implemented using the Minitab Release 9 statistical software (McKenzie, Schaefer and Farber, 1995). The analysis took account of missing data from animals that died in the course of the experiment. Unless otherwise stated, the level of significance used was $P < 0.05$.

RESULTS

Although the experiment was run for 34 weeks (from mid-April 1995 to the first week of December 1995), the results analysed on tick data cover 32 weeks because no data were collected for the first two weeks (for reasons described earlier).

Meteorological data

Meteorological data for 1995 were obtained from the National Agricultural Research Centre, KARI, Muguga. The mean monthly rainfall, maximum and minimum temperatures are illustrated in Figure 1. The rainfall was high in the first one and a half and the last two months of the study, while it was low in the other months.

Tick counts

The predominant tick species identified were *Rhipicephalus appendiculatus* and *Boophilus decoloratus*. Other species found were *R. evertsi*, *Amblyomma* spp. and *Hyalomma* spp.; these occurred only in very low numbers.

The trends in tick count numbers for *R. appendiculatus* over the observation period are shown in Figure 2. There was distinct seasonality in the occurrence of *R. appendiculatus* in that the tick numbers appeared to positively correlate with rainfall; there was a bimodal distribution of tick counts with peaks occurring during the rains. In the first 7 weeks starting in May 1995, the Friesians had the highest tick burdens, while the Maasai Zebu had the lowest. In the next 13 weeks, the population of ticks on all the four cattle breeds dropped significantly and the counts were similar. In the last 12 weeks, the tick burdens increased and the breed differences became apparent. This increase coincided with the occurrence of the second rainfall peak. For most of the time, the Friesian and Galana Boran retained higher tick burdens than the Maasai Zebu and Orma Boran. The overall total mean counts and standard deviations for the entire period were 2.8 (4.7), 5.4 (6.0), 3.1 (3.0), 1.1 (1.5) ticks

differences among all the breeds were statistically significant. There was also a significant breed and time interaction.

The trends in tick count numbers for *B. decoloratus* over the observation period are shown in Figure 3. In contrast to *R. appendiculatus*, there were very low *Boophilus decoloratus* tick numbers during the first one and a half months with rainfall; the counts of this species increased with the onset of the dry season and showed marked increases following the short rains that occurred towards the end of the study.

The mean counts for the entire period were 3.9 ± 5.6 , 8.8 ± 9.8 , 8.3 ± 11.2 and 13.3 ± 19.1 , in Maasai Zebu, Orma Boran, Galana Boran and Friesian, respectively (Table 1). Analysis of the log transformed data indicated that there were no differences between the Orma Boran and Galana Boran. The Maasai Zebu and Friesian were significantly different from each other and also from the other two breeds.

Other tick species

The other tick species identified were *Rhipicephalus evertsi*, *Amblyomma* spp. and *Hyalomma* spp. These occurred in relatively low frequencies and no seasonal pattern could be established. They were therefore not considered to be very important in this study and were not subjected to detailed analysis. The total number of each of these species counted over the whole study period are shown in Table 2.

Tick-borne diseases

The two tick-borne diseases encountered were ECF and anaplasmosis (Table 3). The number of cases of ECF recorded were 27, 20, 22 and 16 in the Maasai Zebu, Orma Boran, Galana Boran and Friesian, respectively. There was a higher incidence of ECF among the Maasai Zebu in comparison to the other breeds. This led to the suspicion that Friesian steers might have been exposed to ECF (this uncertainty will be avoided in the next series of studies), while on the other hand Maasai Zebu steers were purchased from a non-ECF endemic zone. The number of cases of anaplasmosis diagnosed were 8, 12, 15 and 19 in the Maasai Zebu, Orma Boran, Galana Boran and Friesian, respectively. The number of anaplasmosis infections in the Friesian were significantly higher than those in the Maasai Zebu.

All animals were treated as soon as infections with any of the tick-borne diseases were confirmed. Therefore, the total number of cases of each disease per breed shown on Table 3 reflects the total number of treatments administered.

At the beginning of the experiment, the mean PCV values were 31, 30.6, 31.7, and 30.8 for the Maasai Zebu, Orma Boran, Galana Boran and Friesian, respectively; they were not statistically different. The changes in PCV over time are shown in Figure 4. During the first two months, PCV in all groups was higher than the rest of the period. For most of the time; the PCV values of the Friesian was lower than all the other breeds, while in the last three

maintained higher PCV values than other breeds. The overall mean PCV values were 29.3 ± 3.6 , 29.9 ± 4.0 , 29.0 ± 3.3 and 26.2 ± 2.8 in Maasai Zebu, Orma Boran, Galana Boran and Friesian, respectively (Table 4). The results of the analysis indicated that the Friesian had significantly lower values than the other breeds, while there were no differences among the others. One possible complication arising with respect to PCV in Orma and Galana Boran was that steers used in this study were obtained from herds that were highly selected for ability to control PCV following trypanosome infections. Both breed and time and time had significant effects on PCV.

Liveweight gains

The changes in body weight are shown in Figure 5 and Table 4. As the steers from the four breeds had different mean body weights at the start of the experiment, the growth rates were calculated by obtaining the change in weight from the beginning of the experiment. The growth rates are therefore the slopes of the curves in Figure 5. Analysis of the fortnightly weight changes (Table 4) showed no significant differences.

Mortality

One Orma Boran died of theileriosis having developed severe respiratory signs before treatment was administered. One Maasai Zebu steer was killed by predators, while two Friesians died; one due to pneumonia and the second as a result of chronic bloat.

DISCUSSION

Differences in susceptibility to tick-infestations among the four breeds were observed. For *R. appendiculatus*, susceptibility increased in the order; Maasai Zebu, Orma Boran, Galana Boran and Friesian. The differences were more pronounced in the rainy season when the tick challenge increased. These observations are similar to those made in southern Africa on comparison of *Bos taurus* with Zebu (Rechav and Zeederberg, 1986) and Sanga breeds (Norval *et al.*, 1988) for resistance to this tick species. It is worthwhile noting that although the Maasai Zebu, Orma Boran and Galana Boran were from areas where *R. appendiculatus* was not prevalent, the former two exhibited a lower susceptibility.

For *B. decoloratus*, Maasai Zebu had significantly lower counts on one extreme, Friesian highest on the other, while there were no differences between the two Boran types. These results are similar to those of Spickett *et al.*, (1989) who demonstrated significantly lower in tick loads burdens Brahman (*Bos indicus*) than Hereford (*Bos taurus*) and Bonsmara (crossbreeds) when exposed to natural tick challenge in South Africa.

Differences in susceptibility between the Maasai Zebu and Orma Boran was observed for *R. appendiculatus* but not for with *B. decoloratus*. This confirms other studies where it has

than Gobra Zebu cattle adult *Amblyomma variegatum* and *Hyalomma* spp. burdens, while both breeds appear to have similar degree of susceptibility to *Rhipicephalus* spp. (Mattioli *et al.*, 1995). The possibility of the effects of previous exposure of both the Maasai Zebu and Orma Boran to *B. decoloratus* could be a possible cause of the lack of differences between these breeds observed in this study.

The results of this study are similar to those reported in Ethiopia (Solomon and Kaaya, 1996) where two *Bos indicus* breeds, Arssi and Boran were found to be more resistant to natural tick infestations than the BoranxFriesian crossbreed. In the same area, Ali and Castro (1993) also showed that the Horro breed (a ZebuxSanga crossbreed) had higher resistance to ticks than the Boran.

Although all animals were both parasitologically negative and seronegative for tick-borne diseases, the observed incidence of these diseases appears to be influenced by the area of origin (and possibly differences in exposure to different ticks and tick-borne infections). The pattern observed on the incidence of anaplasmosis appears to match the observations on tick resistance. All the animals came from areas known to be endemic for anaplasmosis and although they may have achieved some degree of immunity it would appear to be least in the Friesian. As regards ECF, basing on the observation that there were fewer cases in Friesian than in the other breeds, there is a possibility that the animals might have been previously exposed, particularly because it was the only breed purchased from an ECF endemic area.

In conclusion, the results generated by this pilot study suggest that variation to tick infestation exists among the four breeds. There was an indication that Maasai Zebu and Orma Boran have greater resistance to tick-infestation than the other two breeds.

Acknowledgements

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Table 1

Rhipicephalus appendiculatus and *Boophilus decoloratus* mean tick counts done on a weekly basis among the four cattle breeds for the 32 weeks period

		Maasai	Orma	Galana	Friesian
		Zebu	Boran	Boran	
	N	10	9	9	8
<i>Rhipicephalus appendiculatus</i>	mean*	3.8	5.4	8	11.5
	SD	4.7	6.2	8.02	13.3
	n	288	257	285	272
<i>Boophilus decoloratus</i>	mean	3.9	8.8 ^a	8.3 ^a	13.3
	SD	5.6	9.8	11.2	19.1
	n	288	257	285	272

* Significant differences among all breeds.

^a Significant differences among breeds except those with the same superscript.

N Number of animals.

SD Standard deviation.

n Number of observations.

Table 2

Total number of other tick species counted on the four cattle breeds during the 32 weeks period

	N	* <i>Rhipicephalus evertsi</i>	<i>Amblyomma</i> spp.	<i>Hyalomma</i> spp
Maasai Zebu	10	50	1	2
Orma Boran	9	115	2	2
Galana Boran	9	262	17	9
Friesian	8	377	4	1

*These *R. evertsi* cumulative counts were equivalent to 0.2, 0.4, 1 and 1.5 ticks per animal per week on Maasai Zebu, Orma Boran Galana Boran and Friesian, respectively.

N Number of animals.

Table 3

Total number of cases of tick-borne diseases detected among the four cattle breeds over the entire observation period

	N	East Coast Fever	Anaplasmosis
Maasai Zebu	10	27	8
Orma Boran	9	20	12
Galana Boran	9	22	15
Friesian	8	16	19

N Number of animals.

Table 4

The mean PCV values among the four cattle breeds over the period of study and overall body weight gains (kg/month) among the four cattle breeds during the study period

		Maasai Zebu	Orma Boran	Galana Boran	Friesian
Packed cell volume (%)	N	10	9	9	8
	mean	29.3	29.9	29	26.2**
	SD	3.6	4.01	3.3	2.8
	n	288	259	287	246
Body weight gains** (kg/month)	mean	16.7	18.4	25.6	24.9
	SD	12.4	13.8	14	15.1
	n	123	108	124	108

* Significantly different from the other breeds.

** No breed differences.

N Number of animals.

SD Standard deviation.

n Number of observations.

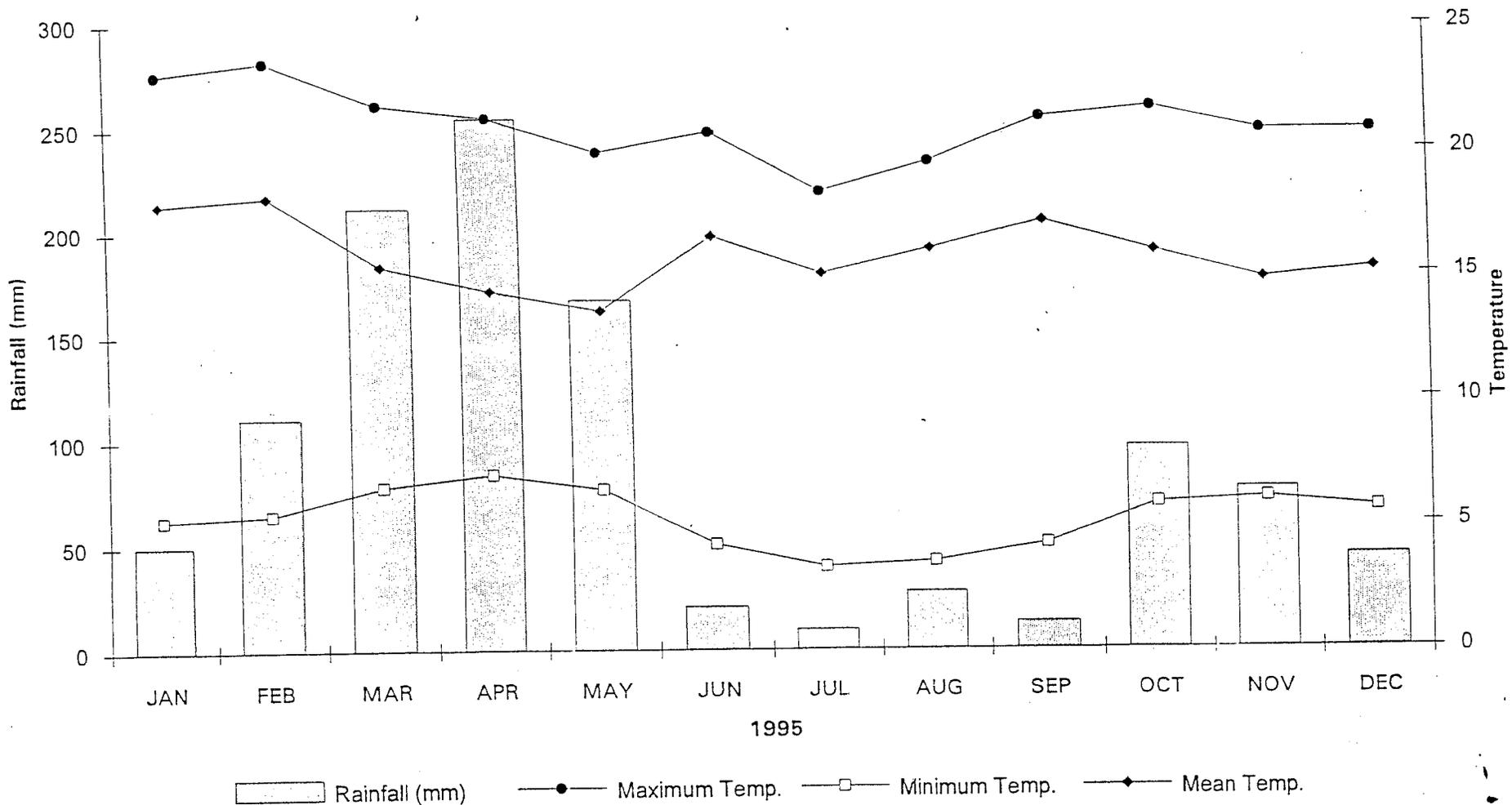


Figure 1. Rainfall, maximum and minimum temperature for Muguga (study area) for 1995.

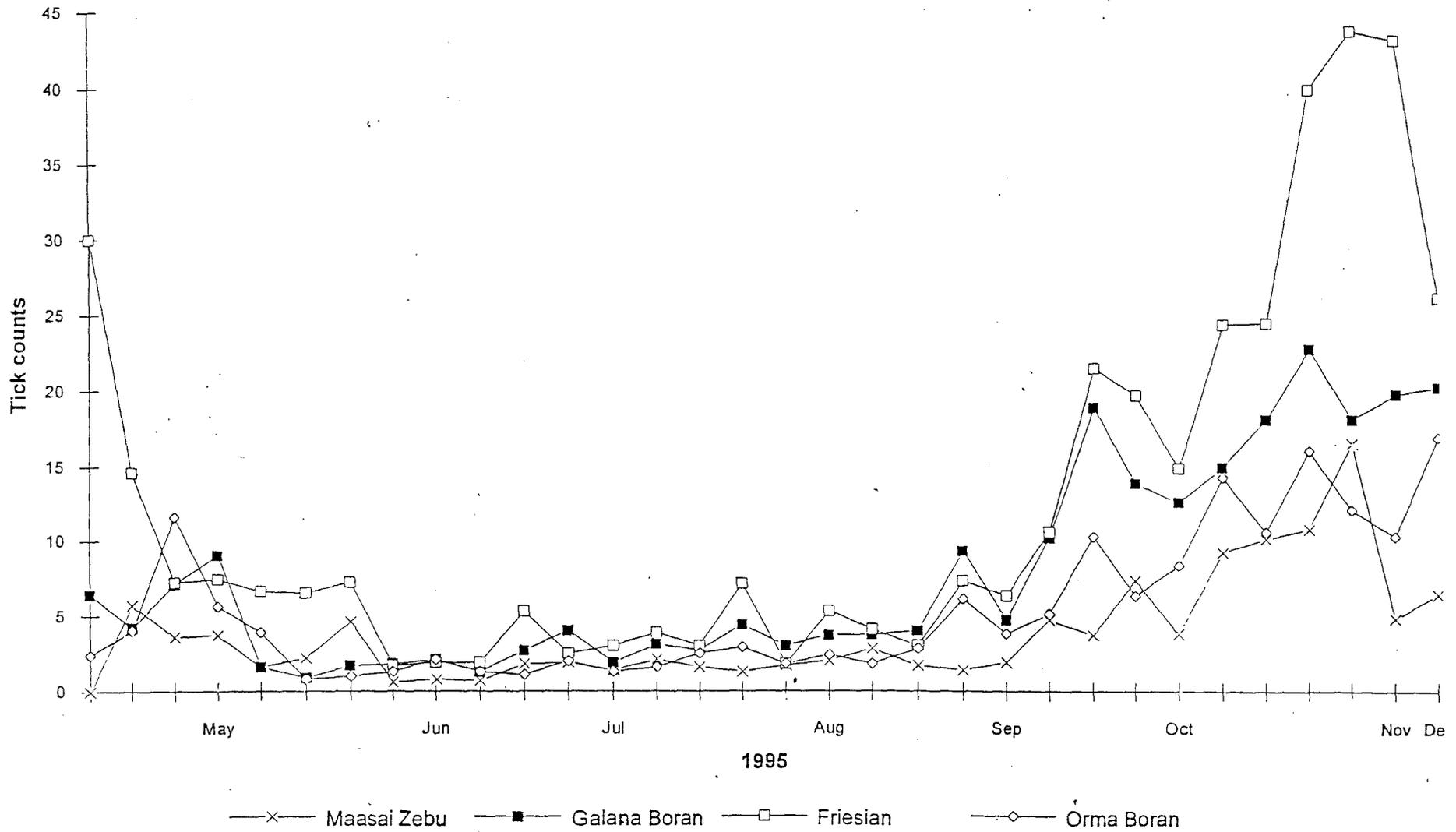
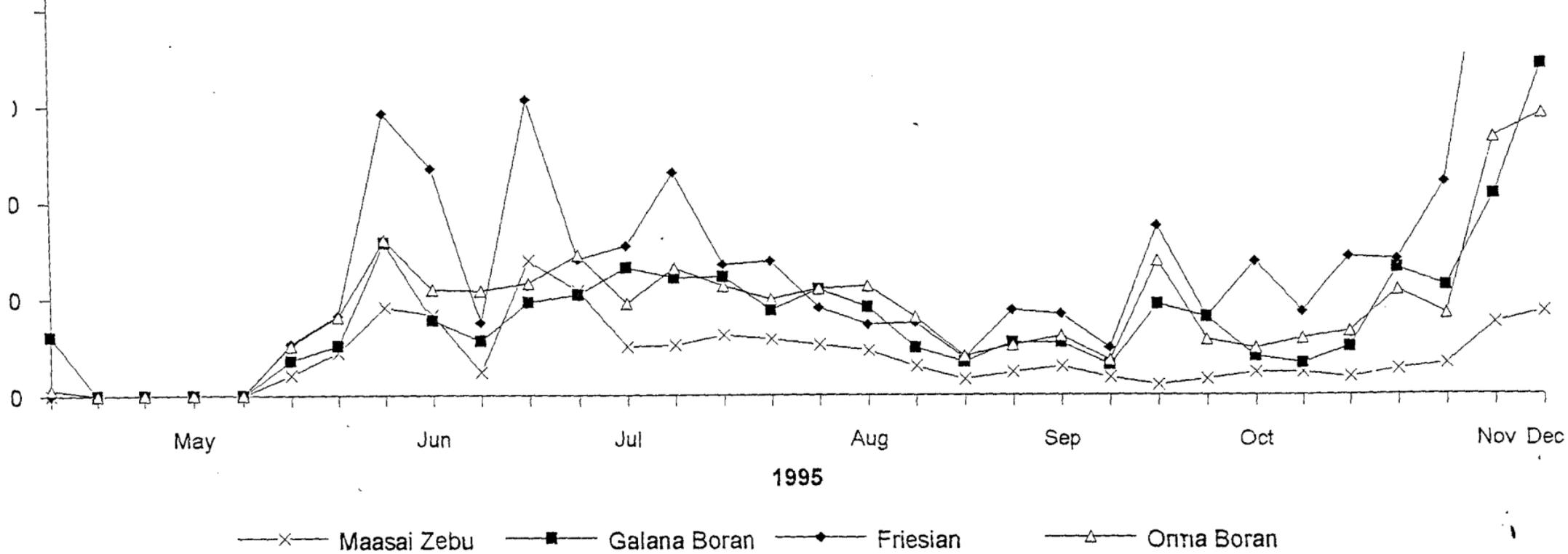


Figure 2. Tick counts of *Rhipicephalus appendiculatus* among the four cattle breeds, Maasai Zebu, Orma Boran, Galana Boran and Friesian for the 32 weeks period.



Tick counts of *Rhipicephalus decoloratus* among the four cattle breeds, Maasai Zebu, Orma Boran, Galana Boran and Friesian.

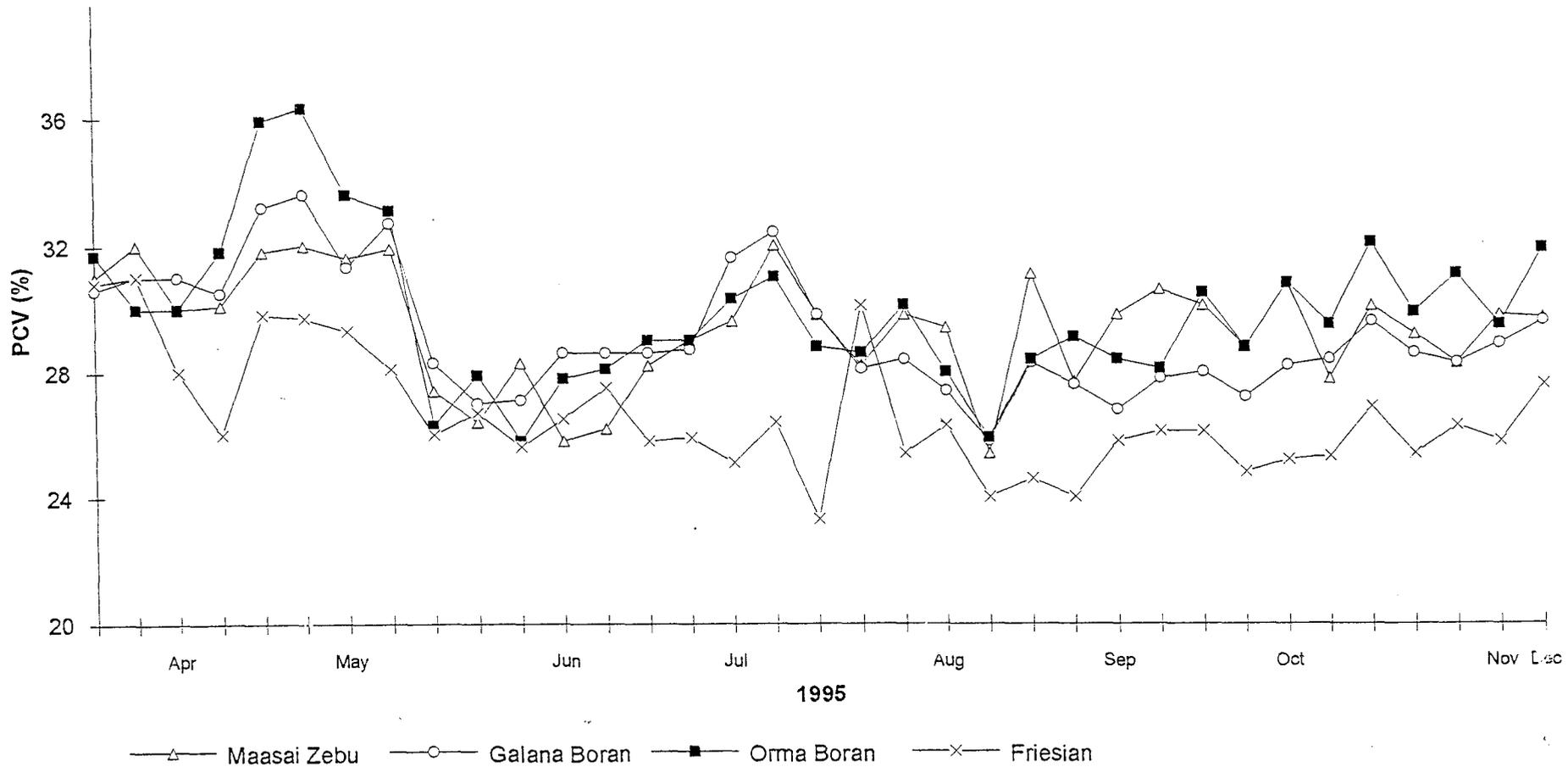


Figure 4. Mean weekly cell volume (PCV) among the four breeds, Maasai Zebu, Orma Boran, Galana Boran and Friesian.

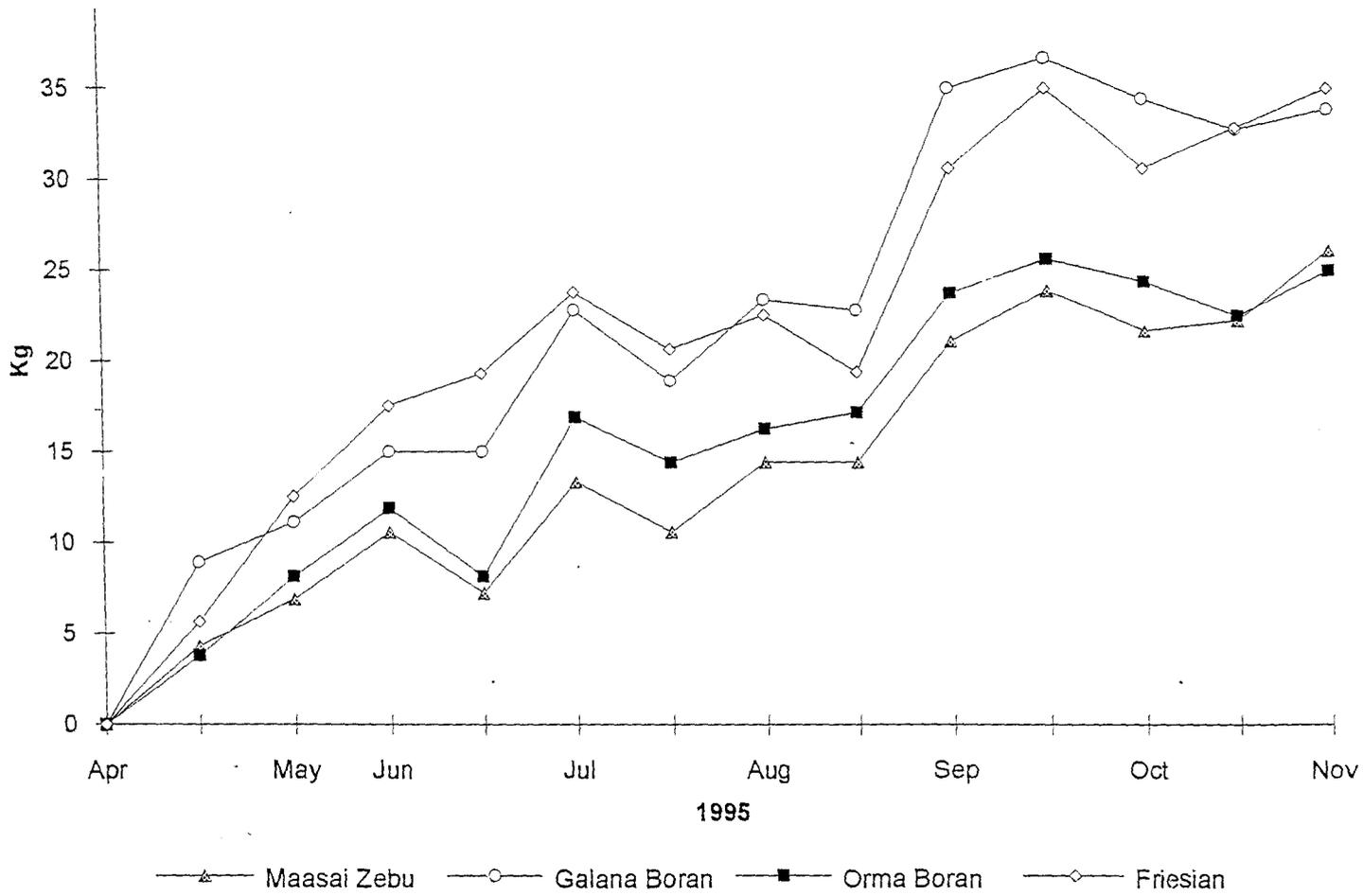


Figure 5. Body weight changes among the four cattle breeds.

FAO/IAEA/WHO/OAU-IBAR
PROGRAMME AGAINST AFRICAN TRYPANOSOMIASIS

POSITION PAPER SEPTEMBER 1997

THE IMPLEMENTATION OF ODOUR BAIT TECHNIQUES FOR THE CONTROL
OF TSETSE FLIES IN EASTERN AND SOUTHERN AFRICA

This position paper presents a preliminary assessment of the current status of the odour bait technology as used to control tsetse flies in eastern and southern Africa. It is presented in three parts:

Part 1 revisits tsetse control methods which have been used in recent years and puts the odour-bait technique into the general context of control. It considers some of the advantages and disadvantages of these various techniques and attempts to update their relative costs;

Part 2 briefly presents a case study on experience with targets in Botswana;

Part 3 summarises and assesses the information provided in response to a questionnaire distributed to control authorities which use odour-bait techniques in eastern and southern Africa.

PART 1 – TSETSE CONTROL METHODS

The following is a summary of methods which have recently been used to control tsetse, with comments on their advantages, disadvantages, environmental effects and estimated relative costs.

1. Ground spraying

Ground spraying (Lovemore 1978, MacLennan 1967) has been used with great success in many parts of Africa. It often requires retreatment for a number of years and in Zimbabwe where ground spraying continued until 1991, some areas were treated (over a period of 20 years) as many as 13 times (Douthwaite and Tingle 1995).

The method is labour intensive, logistically demanding and requires careful planning and execution. Operations are difficult, potentially dangerous for the operators where there are wild animals and there is a risk of operator contamination.

During the 1970s Zimbabwe's annual DDT requirement for tsetse control alone was 200-300 tonnes. This was, however, dispersed at approximately 200g/ha over thousands of km² which is a low dosage compared with other agricultural or public health practices.

1.1. Environmental effects

Indiscriminate ground spraying, i.e. to the entire habitat, has caused severe acute effects on non-target animals including reptiles, small mammals, fish, birds and insects (Du Toit 1954; Graham 1964; Wilson 1972). Concerns about the accumulation of DDT in food chains was sparked by Rachel Carson's *Silent Spring* (1962) and by speculative but scientifically, unsubstantiated criticism from well known opponents of insecticidal pest (particularly tsetse) control (Ormerod 1976; Linear 1977, 1982).

A pilot study in discriminative ground sprayed areas of Zimbabwe (Matthiesson 1985) did indicate that DDT residues were accumulating in some wildlife species and appeared to substantiate local environmentalists' claims that DDT was causing eggshell thinning in fish eagles and other raptors. DDT residues certainly were widespread in Zimbabwe (Billing and Phelps 1972; Greichus 1977; Wessels *et al.* 1980) but this was not entirely due to tsetse control since DDT was more widely used for public health and crop protection.

A five year UK funded research programme provided the definitive assessment of DDT bioaccumulation in Zimbabwe. One lizard and four bird populations had accumulated DDT residues which were considered sufficient to put them at risk in periods of extreme stress e.g. drought. Two bird species declined by 90% after 2-3 years in DDT sprayed areas of Zimbabwe (Douthwaite 1995). Several other bird and terrestrial invertebrate populations were scarcer in areas sprayed with DDT than in those not sprayed. The overall conclusions were that these effects are reversible, that there were no significant effects on fish populations or soil processes and that DDT accumulation caused less environmental damage than either human settlement or elephants (Douthwaite and Tingle 1994).

2. Residual aerial spraying

Residual insecticide formulations have also been applied from helicopters. The 'eradication' from 10,000km² in Nigeria was reported by Spielberger *et al.* (1977). This was achieved with 1000g/ha endosulfan ULV but, like ground spraying, required retreatments to about 25% of the area each year. Similar operations have been carried out in a number of West African countries with lower dosages of endosulfan, with pyrethroid insecticides and with varied success (Baldry *et al.*, Kuzoe *et al.* 1981; Nababa 1976).

2.1. *Environmental effects*

Residual spraying from helicopters and trucks was monitored in West Africa and showed mortality among the same groups as were affected by indiscriminate ground spraying. In addition, amphibia, monkeys and fruit bats were killed (Koeman *et al.* 1971, 1978; Muller *et al.* 1981) It resulted in the disappearance of some bird and arthropod species from the treatment area for up to a year. In Cameroun some butterfly species and a common shrew only reappeared three to four years after spraying (Douthwaite 1992). However, even with the very high dosages used to give long term persistence the effects on non-target populations are not considered to be irreversible (Everts *et al.* 1983).

3. **Non-residual aerial spraying from fixed-wing aircraft**

Sequential aerial spraying has been used to treat several thousand km² in Botswana, Kenya, Nigeria, Somalia, Uganda, Zambia and Zimbabwe. It can be used to treat large areas rapidly and is particularly appropriate in epidemic situations. It is also suitable where ground access is either difficult, dangerous or undesirable (Allsopp 1991).

Aerial spraying applies large volumes of formulated insecticide but the bulk of this is a light oil solvent which evaporates almost immediately after dispersing the 20-30% of active ingredient into tiny, drifting droplets. Five applications over a period of 2-3 months deposits less than 10kg of endosulfan per km².

3.1 *Environmental effects*

Applications of endosulfan have been rigorously monitored for non-target effects in Botswana (Douthwaite *et al.* 1981) and by the EC Regional Tsetse and Trypanosomiasis Control Programme in Zambia and Zimbabwe (Scientific Environmental Monitoring Group 1986). These studies revealed a temporary depression of non-target aquatic and terrestrial invertebrate populations. Fish mortalities in shallow static water were exacerbated by operational malpractice and consequent overdosing (Magadza 1978; Cockbill 1979; SEMG 1993; Grant and Crick 1987). It was concluded that non-target effects are minimal at the population level and short term providing there is no continuous retreatment. Preliminary results from recent SEMG studies suggest that eight years after spraying in Zimbabwe there is no evidence of any species having been exterminated.

The synthetic pyrethroids are less toxic to fish than endosulfan and might be considered more suitable for spraying wetlands. They are however acutely toxic to crustaceans and monitoring in Zimbabwe did show that where rivers were still carrying water when oversprayed, (many dry out during the spraying period) aquatic invertebrates were severely affected.

4. **Non-residual spraying from helicopters**

Trials with sequential low dosage applications from a helicopter in very rugged terrain were carried out in Zimbabwe (Allsopp 1991). The distribution of insecticide droplets was very similar to that from fixed wing aircraft in flat country and the dosage of 28 g/ha was shown to be near the critical minimum for *G pallidipes*. The treatment area was only 126 km² and unprotected from immediate reinvasion but the prospect of eliminating tsetse from such terrain was demonstrated.

Overall, the method proved very similar to fixed wing spraying and the environmental effects would be comparable.

5. Pyrethroid cattle dips, sprays or pour-ons

Synthetic pyrethroids have a low mammalian toxicity and by applying these insecticides to livestock by dipping, spraying or as a pour-on formulation which gradually spreads over the body the treated animals are transformed into lethal baits for tsetse (Wilson 1987; Thomson 1987) and for ticks. Studies in Zimbabwe have so far shown no evidence of tick resistance to pyrethroid insecticides used in this way (RTTCP, 1997)

This technique has successfully reduced tsetse populations in Zimbabwe (Mangwiro and Thakersi 1991), Tanzania (Fox *et al.* 1991) and Zanzibar (Hursey, FAO *per comm*). The danger of disrupting the enzootic stability of treated cattle and thereby increasing their susceptibility to tick borne diseases is recognised and is being monitored in Zimbabwe.

6. Thermal fogging

Hot fogging is ground based but involves similar principles to sequential aerial spraying (Wooff and Pillemon-Motsu 1993). It is a non-residual technique and only affects the adult tsetse population. Single treatments are inevitably short-lived but it has been used recently in Botswana to give temporary relief where tsetse are a nuisance. Unlike aerial spraying the technique is not suitable for night operations so is restricted to early morning and late evening daylight hours when the temperature inversion signifies stable air conditions.

Ground based fogging cannot achieve the same blanket coverage that is possible from parallel aerial swathes and is achieves only a small scale knock-down. The fogging machine is heavy, generates considerable heat and with drifting spray is uncomfortable to use. One machine operator can treat about 20-30 ha per day.

The dosage rates are similar to those used for aerial spraying thus, in Botswana, endosulfan e.c. with diesel as a solvent is applied at 12g/ha.

The environmental effects have not been assessed but the technique has limited penetration and is only really suitable for treating fringing riverine woodland. Unfortunately such ecotones support a relatively high faunal biomass and must be considered sensitive to such specifically targeted insecticidal treatment.

7. Chemically impregnated traps and targets

A wide variety of traps has been used with or without insecticide for many years (Harris 1930; Morris 1950; Challier and Laveissiere 1973; Brightwell *et al.* 1991; Lancien 1981). The use of odours with traps or targets (Vale and Hall 1985) gave rise to the most widely used tsetse control technology since the development of ground-spraying with DDT. The refinement of this method has preoccupied most control authorities and research organisation in tsetse infested area of Africa in recent years (Cuisance 1989; Vale 1987, Green 1994, Torr *et al* 1997).

Targets do not capture tsetse flies and they have to be impregnated with insecticide such as the deltamethrin or alpacypermethrin (Vale *et.al.* 1988). The technique takes several months to achieve a significant reduction in tsetse density and can take several years to fulfil its objectives during which time retreatment is required. Targets are frequently lost or damaged. In some countries theft is a major problem. Wind, wild animals and fires also cause significant losses. As with ground spraying, the deployment of targets in areas where there is abundant wildlife can be dangerous. In Botswana for example, several operators are injured each year – mainly by buffalo.

7.1. *Environmental effects*

The direct insecticidal effects of chemically impregnated traps or target on non-target species is minimal, being largely restricted to other biting flies such as *Tabanidae* and *Stomoxinae* (SEMG 1993). Various bees, wasps and grasshoppers etc. do find their way into traps but their numbers are very low and there appears to be no threat at the population level. A comprehensive SEMG study is currently underway in Malawi.

An attractive feature of targets is that insecticide is sprayed directly onto the cloth covers and not into the habitat, thus when targets are removed, so too is all trace of the insecticide. Small amounts do drip off if the target is sprayed in the field but even this minimal contamination is eliminated if the covers are dipped or the insecticide is applied with a 'paint rollers'.

The indirect effects have not yet been fully quantified but they are significant. The primary indirect environmental effects relate to:

- (i) 'mechanical' damage caused by large operational teams and their vehicles repeatedly visiting wilderness areas to deploy and re-service targets - which in turn can increase soil erosion and can create access for poaching and other illegal activities;
- (ii) the effects of both the operational teams and the targets themselves on the wilderness experience which attracts many tourists to Africa.

Botswana has recently introduced an environmental audit to guide operational staff handling insecticides and deploying targets. It covers a wide range of activities from disposing of insecticide containers to waste management in field camps and off-road driving (Grossman 1997).

Environmental studies have been instigated by the EC in southern Africa. The SEMG is assessing the effects of targets deployed in the Kasungu National Park, Malawi. Also, a consultant has been commissioned to produce terms of reference for an EIA of tsetse control method in the Matusadonna National Park, Zimbabwe. Environmentalists vary in their opinions on the environmental effects of tsetse control in national parks and other sensitive areas. Some dislike the use of large amounts of insecticide and consider targets to be preferable to aerial or ground spraying. Others have suggested that in certain circumstances, particularly where targets detract from the wilderness experience, aerial spraying might be preferable (Coulson 1991; R Bell *pers comm*).

Slow breeding tsetse flies have never shown signs of developing resistance to insecticides but this cannot be discounted as a possible consequence of the widespread and prolonged use of impregnated targets, which intrinsically transfer very small amounts of chemical to individual flies. Should there be any development of resistance to pyrethroid insecticides, sterilising chemicals are available as an alternative.

8. Sterile insect technique (SIT)

The release of sterilised male insects Knippling (1955) has been used with great success against a number of species such as the New World screwworm (*Cochliomyia hominivorax*).

The cost of rearing and sterilising large numbers of male tsetse is high and the target population is usually reduced by some complementary method involving insecticides. Successful operations have been reported (Olandunmade *et al.* 1990; Tamboura *et al.* 1988). The IAEA claims to be on the verge of eradicating *G austeni* from Zanzibar following the deployment of targets, a cattle dipping exercise and the release of sterile males from aircraft.

Sterilisation of tsetse in the field is an alternative form of SIT which avoids the expense of mass rearing. The use of traps which capture, treat with the chemosterilant (bisasir) and release tsetse flies was investigated (Vale 1974; Langley *et al.* 1982) but did not prove suitable as a practical field method. Field trials have shown that the juvenile hormone

mimics pyriproxyfen and trifluralin can be used instead of conventional insecticides on traps or targets (Hargrove and Langley 1990).

9. Comparative costs of tsetse control

It is difficult to provide accurate, up to date, comparative costs of chemical control techniques when some are no longer widely used. As a rough approximation, estimates from the 1980's in Zimbabwe and Zambia - when both ground spraying and aerial spraying were still in use and odour bait techniques were beginning to proliferate - are summarised in table 1. A second estimate provided by the RTTCP economist Ian Daniels (*pers comm*) is given in table 2.

The cost of insecticide represents a major proportion of the direct costs of chemical control and much has changed in the past few years as chemical companies have undergone strategic realignment. This has resulted in some cost reductions and synthetic pyrethroid insecticides now compete directly with previously cheaper insecticides such as endosulfan. For comparative purposes, the estimated cost of chemotherapy is also included in table 1.

Table 1 Relative (ranked) cost of tsetse/trypanosomiasis control methods based on estimates for southern Africa from Barret 1992 and Putt et. al. 1989 taking cattle dipping as a baseline at an arbitrary US\$100 per km²

Control method	Relative cost (US\$)per km ²
Cattle dipping	100
Pour-on application (10 cattle/km ²)	275
Ground spraying (DDT)	284
Targets (serviced half-yearly)	290
Aerial spraying (non-residual fixed wing)	380
Prophylaxis (berenil x 2 + samorin x 4 per annum)	
5 cattle/km ² for 5 years	80
10 cattle/km ² for 10 years	263
20 cattle/km ² for 20 years	716

Estimates in table 1 are based on fixed costs, e.g, insecticide, hardware, transport etc. plus maximum estimated indirect costs such as development of access roads, overheads etc..

Table 2. Comparative costs (Z\$/km²) of ground spraying, aerial spraying, targets and insecticide treated cattle - Daniels (1996 *pers comm*).

	basic scenario (based on Barrett 92)	pessimistic scenario	optimistic scenario
Ground spraying (DDT)	1781	2135	1430
Ground spraying (deltamethrin)	3100	3800	2500
Aerial spraying (endosulfan)	2700	3700	2000
Targets (deltamethrin)	1500	2100	1100
Dipping (deltamethrin)	361	723	181
Pour-on	703	1406	352

From the above estimates, ground spraying with DDT compares in price with the use of targets. The use of deltamethrin increases the ground spraying cost although with current pricing there may not be such a differential. Aerial spraying was 1.3 to 1.8 times the cost per km² of targets when designed to achieve eradication. If control were the objective the cost could be reduced substantially.

Where labour costs are high, e.g. Botswana, the differential changes. In 1994/95 when a relatively small area was treated with targets the overall cost was in excess of US\$400 per km². In 1995/96 with a larger treatment area the cost was approximately US\$300 per km². With similar labour requirements, ground spraying (if re-introduced) would be of the same order. Based on approximations from Allsopp (1991), aerial spraying in 1995/96 would have cost US\$350-450 per km² depending the area treated (a smaller area being relatively more expensive).

10. Summary

Of the various techniques available for controlling tsetse flies, cattle dipping is probably the least expensive. Although figures are not readily available, SIT is probably the most expensive but is environmentally benign. Both have advantages and disadvantages but are certainly viable options to control authorities. Residual applications of insecticide from the air and extensive thermal fogging would probably be discounted on environmental grounds.

Depending on local situations and the strategic objective (e.g. control or eradication) there is probably little difference in the costs of the three most widely used chemical control methods *viz.* discriminative ground spraying, aerial spraying and odour-bait techniques. Similarly, barring accidents or malpractice, all three have no long term, irreversible effects.

PART 2 – TSETSE CONTROL USING TARGETS IN BOTSWANA

Botswana introduced targets to control its only tsetse species, *Glossina morsitans centralis*, in 1992 after 20 years of aerial spraying and before which there had been a succession of methods including bush clearing, game destruction and ground spraying since the turn of the century. The reasons for switching to targets were partly economic, partly environmental but largely because 20 years of aerial spraying had not achieved the primary objective of eradication from the Okavango Delta.

Although the use of targets for tsetse control in Botswana provides some interesting and thought provoking considerations, the parameters within which the technique operates are unique. In African terms, Botswana is a relatively prosperous country with a progressive and well funded Department of Animal Health and Production. Although tsetse control is the responsibility of this department, the areas where tsetse are found are predominantly wildlife management areas designated as cattle free zones by law. Cattle around the Okavango Delta, outside the wildlife management areas, would be at risk if tsetse spread back to these peripheral areas but the main beneficiaries of tsetse control are currently tourists and tour operators.

Tsetse occur in low numbers along the northern border with Namibia but otherwise are found only in the Okavango Delta. This huge inland delta, fed by the Okavango River from Angola, is a mosaic of large and small islands within a matrix of seasonally inundated floodplains and surrounded by the Kalahari. In the north the delta is mostly semi-permanent papyrus swamp – almost entirely unsuitable for tsetse habitation. Throughout the rest of the delta the islands support mopane, acacia and various riverine woodlands which have all at some time in the past been infested with tsetse. The historical distribution limits extended to 20,000km² but the current patchy distribution covers about 5,000km².

The odour bait technique as used in Botswana

Details are given in the Botswana Country Report – some aspects are briefly reiterated here.

The target used is a 1m x 1.8m swinger type. The currently preferred design consists of a central black panel flanked by two phthalogen (royal) blue panels held on a wire frame which moves gently in the wind around a central metal upright. The original odours used were a blend of octenol with two phenols (3-n-propyl and 4-methyl) together with methyl ethyl ketone (MEK) in a separate dispenser. The phenols did not significantly increase the attraction of tsetse and since they are relatively expensive their use has been discontinued. Octenol alone is now normally dispensed from low density polythene sachets at a rate of about 0.5-2mg/h but this system is about to be changed and small LDP bottles will be used. MEK is dispensed from low density polythene bottles or from non permeable containers with perforated caps. The release rate of MEK varies from 15-50mg/h.

The target covers have normally been sprayed *in situ* with knapsack spraying machines but in future will be dipped. Approximately 600ml treats each full target. FASTAC (10% alphacypermethrin s.c.) is diluted with water to give a 1% concentration and one litre treats about 15 full targets. GLOSSINEX (20% deltamethrin s.c.) is diluted to 0.6% and one litre treats about 55 full targets. Beta cyfluthrin is current on trial.

A number of operational problems have been encountered since targets were adopted as the primary control method in Botswana (the only other method being limited, localised thermal fogging).

Octenol release rates were far too high from the 150micron sachets initially used. The sachets therefore dried out within weeks. Different sizes and configurations were tried and 5cm x 5cm LDP sachets of 250-300 micron thickness eventually provided a release rate below 1.0 mg/h. Although these represent very cheap dispensers, heat sealing was, and remains, a major problem. Small (75ml) LDP bottles produced in the UK with a wall thickness around 300 microns were tested and gave excellent results. A suppliers in Zimbabwe has since produced similar bottles which will become the routine dispensers for octenol.

Similar but larger LDP (250 and 500ml) bottles are used as MEK dispensers. Many other locally available 'plastic' bottles were tested but all rapidly deteriorated in sunlight. Even LDP bottles harden and crack after a few months in direct sunlight but if shaded they appear to last indefinitely.

Analysis of insecticide residues on target covers showed that spraying *in situ* results in very variable distribution throughout the cloth. Leaching from top to bottom greatly reduced the levels of insecticide in the upper half of the target and within a few months this had virtually disappeared. This problem will be overcome by dipping. The bottom half of the target remains sufficiently toxic for about a year.

The critical factor in target longevity has proved to be fading of the black dye. Phthalogen blue withstands photodegradation very well but both double sulphur dyed and hydron dyed black cloth have been tested and neither lasts beyond about eight months. By this time they have faded to pale grey, have lost their attraction to tsetse and need to be replaced.

Damage to the target metal work is caused by elephants, fire and wind. Little can be done about the first two but different designs of wire frame have been tested to reduce distortion by wind. Solid frames do withstand the wind better than those constructed of 8 gauge wire but they are difficult to transport. The supplier in Zimbabwe now strengthens the lower section of the frame with additional wire and these are currently being assessed.

Operational parameters

Tsetse control operations are carried out in extremely remote and difficult areas. There are no roads, only sandy tracks and much of the work is off-road. At the height of the seasonal flood (which varies each year but is generally from about May to October) many areas of the delta are inaccessible - except by air. During the rains (November to March) even the 'dryland' areas become water logged and off-road driving is a constant hazard. The toll on vehicles is high. Breakdowns are common and repairs by the central government transport organisation take time.

As a result, the productivity of the Division is low. The Control Section has 125 junior staff supervised by 20 'middle management' technical officers and on average, over the past two years, they have handled (deployed new or re-treated) only 14 targets per man per month. This equates to the maintenance of about 9,000 targets in fully effective condition. In total, approximately 17,000 targets have been deployed in the Okavango Delta. Of these, about 12,500 can still be considered at least partially operational and some 4,500 are long overdue for servicing.

To further exacerbate this low productivity, many targets are lost or damaged. In 1996 over 4000 targets had to be replaced. Of these, almost 60% were damaged by wild animals – predominantly elephants. Wind damage accounted for almost 20%. Theft is not a problem.

With the tsetse habitat being so fragmented, it is seldom possible to deploy targets in uniform 'grid' patterns and their distribution usually follows island perimeters. This creates a management problem - not the least of which is finding them all again after a period of 6-12 months. This has been largely overcome by recording the location of every target with a global positioning system (GPS) and archiving these data in a geographical information system. By overlaying the target distribution on an accurately geo-registered satellite image of the area, this system enables the Division's managers to visualise the distribution of targets, monitor target densities, relocate targets for re-servicing, and plan re-servicing schedules. Entomological surveys are recorded in a similar manner.

Collaboration with the private sector

'Community participation' in Botswana has a different connotation to what is understood by this term in most other African countries. The local communities affected by tsetse are predominantly well-resourced tour operators who are aware of the risk should tsetse numbers increase to the 1960s and 70s levels. The second highest number of sleeping sickness cases (271) was recorded at Maun hospital in 1971 – the highest being 318 in 1942.

Sleeping sickness has not been recorded in Botswana for over 10 years but photographic and hunting safaris are disrupted by tsetse. Tour operators are almost universal in their support for tsetse control. Several have offered to buy targets; others have actively assisted the

Division, for instance, by providing transport. GOB has recently agreed that private sector organisation can participate in the management of targets around their safari camps and to date 17 private organisations have expressed an interest in maintaining targets around their camps.

Mechanisms for operating this collaborative approach to tsetse control are currently being discussed. Tsetse Control Division will provide all materials including pre-treated target covers so that non-government staff will have no need to handle insecticides.

Depending how successful this collaboration proves to be and what areas the private operators are able to manage, this venture could double the area under fully effective targets. At the very least it will relieve the Division's transport constraints.

Results achieved

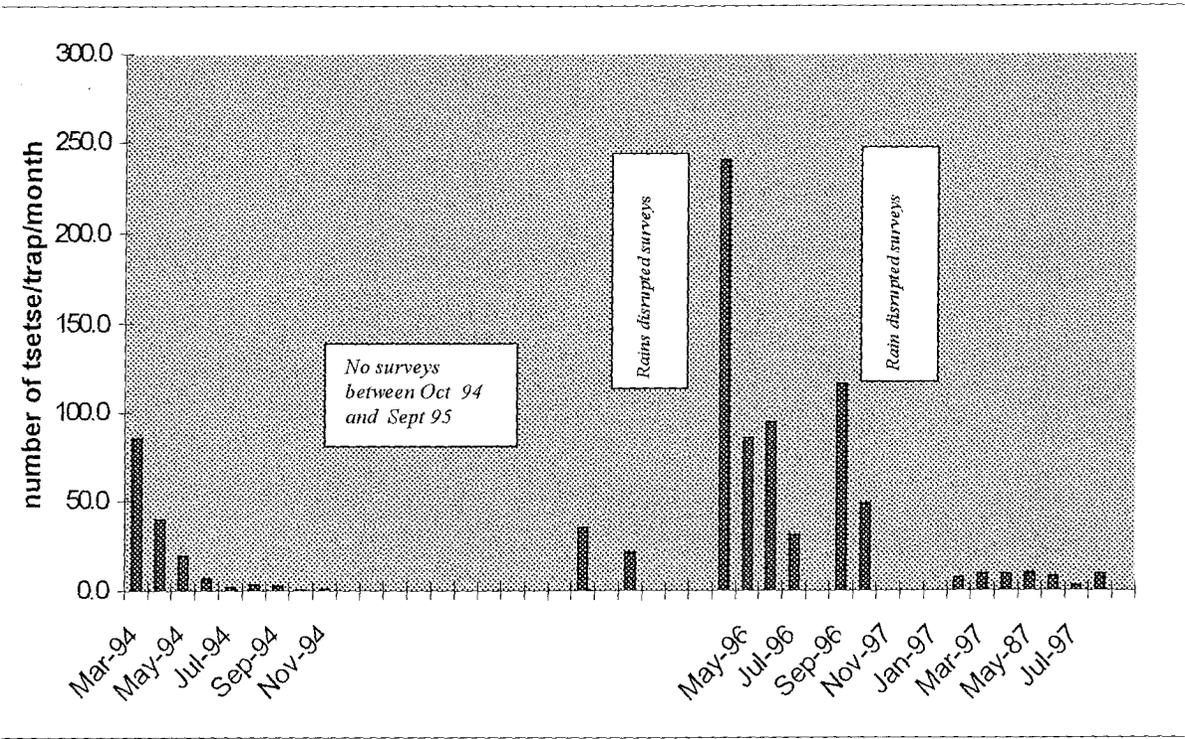
Entomological data prior to the introduction of targets in 1992 is patchy and incomplete. During the past few years entomologists have been trained, surveys have intensified and a clearer picture of density and distribution is emerging. Large areas of the delta appear to remain fly free and tsetse are restricted to an area of about 5,000km² in the north west. There are no signs of any major reinvasion into areas cleared by aerial spraying and where localised advances have been detected, they have been halted with the deployment of targets.

The majority of targets in the Okavango are in a 'holding line' preventing reinvasion southwards towards Maun and other major settlements. Tsetse are still captured in this treatment area but numbers remain very low and the distribution is patchy. Targets deployed along the Linyanti River and Savuti Channel -where fly numbers were high in the late 1980s - have reduced the population significantly

Targets were successfully deployed at Mombo at the northern end of Chief's Island in 1994 and had a marked effect on the tsetse population. Unfortunately they were left without re-treatment or surveys for almost a year. A concerted and systematic effort recommenced over an area of 385km² towards the end of 1995 and 2156 new targets were deployed. Of these, 1150 have been re-serviced within the past six months. Survey results from between 10 and 20 traps monitored over the past three years are shown in Fig 1.

.There is no area yet in Botswana where tsetse have been eliminated since 1992 i.e. with targets alone.

Fig. 1 Tsetse survey results 1994 to 97 from the Mombo control area



Finance

Tsetse control operations are fully funded by the Government of Botswana. Prior to the recent outbreak of contagious bovine pleuro-pneumonia (CBPP) which required a costly but successful campaign to eliminate CBPP from Botswana, trypanosomiasis was second only to foot and mouth disease on the Department of Animal Health & Production’s list of priorities. Finance for tsetse control has always been and continues to be consistent and adequate.

Prior to 1991/92 when aerial spraying was the Tsetse Control Division’s primary occupation, staff costs were approximately half the total budget. From 1992 onwards, when targets replaced aerial spraying, the operational budget remained fairly static but staff costs doubled.

PART 3 – SUMMARY OF REPORTS ON THE USE OF ODOUR-BAIT TECHNIQUES FOR TSETSE CONTROL IN EASTERN AND SOUTHERN AFRICA

In response to a request from the PAAT for information on the use of odour-bait techniques for controlling tsetse flies, comments were received from:

a) Southern Africa;

Botswana, Namibia, South Africa, several sources in Zambia, Zimbabwe, the RTTCP (including data on Malawi and Mozambique)

b) Eastern Africa;

Ethiopia, Kenya, Tanzania and Uganda.

A brief summary of operational statistics

Odour baited targets appear to be the primary, if not exclusive, method of tsetse control in all the countries mentioned above. Approximately 110,000 targets are reported to be in use over an area of about 30,000km².

Most control authorities are using targets of the swinger or fixed type. A central black panel in the target cover flanked either side by phthalogen or royal blue is the preferred colour scheme although black only targets are used.

Uganda is the exception as they use blue and black pyramidal traps.

The insecticides used are exclusively suspension concentrates of the synthetic pyrethroids alpacypermethrin and deltamethrin; beta cyfluthrin is also being tested.

The primary odours are octenol or a blend of octenol with 4 m-phenol and 3 p-phenol accompanied in a separate dispenser by either acetone or methyl ethyl ketone (MEK). Both are dispensed from low density polythene containers, either bottles or sachets. The Livestock Development Division in Tanzania uses cow urine.

A variety of control results are reported. These vary from excellent – but stopping short of eradication - in the Senanga West project in Zambia to a 99% reduction in Kenya, a 90% localised reduction in Botswana and 88% reduction in a small (10km²) area in Tanzania. A 60% reduction has been achieved since the start of an experiment to control *G. swynnertoni* in Tanzania and a 50% reduction from the start of target operations in Zimbabwe.

Since targets were introduced in 1992 in Botswana they have proved capable of reducing tsetse densities very substantially if they are properly managed and regularly re-serviced. A

lack of adequate, serviceable transport prevents this being achieved throughout the infested area in Botswana. Logistical problems are also cited as producing variable results in Uganda. Wind and elephant damage cause major losses in Botswana and although there is no theft, this is a problem in some other countries. Theft proved widespread in Somalia. In Ethiopia it caused a control programme with targets in the Ghibe Valley to be abandoned (Leake *pers comm*). In Zambia's Western Province it was largely overcome by involving the local community in the control programme.

Eradication still seems to be the national objective in most countries – certainly in Zambia, Zimbabwe and Botswana – but there are indications of a growing acceptance that this may be unattainable and may even be unnecessary. The largest regional tsetse control programme currently in operation, the RTTCP, has abandoned its original objective of eradication from the common fly belt of 320,000km² and tsetse control is now “a tool to aid sustainable rural development in tsetse infested areas”. The proposed EU East Africa programme also aims at sustainable rural development in tsetse infested areas – rather than tsetse eradication.

A strong attraction of the odour-bait techniques for tsetse control is that they have minimal effect on non-target species. Also, the application of insecticide is restricted to cloth screen which can ultimately be removed from the tsetse habitat – thus removing all the insecticide from the environment. There is, however, increasing concern that odour-bait techniques do have indirect environmental effects – particularly in national parks and game reserves.

Tourism is a major income generator in Africa and many visitors come to experience African wilderness. Targets can detract from this experience. Their deployment very often involves the use of large vehicles which create roads and can also provide access into wilderness areas for ‘hunter - gatherers’ and poachers. Such environmental considerations continue to play a major role in the adoption of tsetse control strategies. The EU Scientific Environmental Monitoring Group (SEMG) continues to provide a monitoring and advisory service to members of the RTTCP and where the EU contributes to control in Zimbabwe both the areas and methods selected will be subject to environmental impact assessment (EIA). Botswana has recently introduced an environmental audit i.e. monitored guidelines to promote environmentally sensitive operational procedures ranging from handling and storing insecticides to off-road driving.

Comment

The odour-bait approach to tsetse control is user friendly, adaptable, well suited to local community involvement and attractive to donors. In eastern and southern Africa it appears to have proliferated on the strength of these advantages with ‘apparent’ environmental and economic underpinning rather than as a result of widespread control successes or rigorous comparisons of cost or impact.

Responses to the PAAT questionnaire suggest that tsetse control efforts have diminished in recent years. Not all control authorities responded to the PAAT questionnaire and 30,000km² is a low estimate of the area currently controlled by targets but even if this estimate is 100% out, it still only represents about 1% of the infested areas in eastern and southern Africa. This is certainly less than the areas controlled by ground spraying over 20 years ago although it is perhaps fair to say that the proliferation of odour-bait techniques has coincided with decreasing national commitment to tsetse control, widespread structural adjustment and the loss of experienced manpower through AIDS (Connor *pers comm*). Nevertheless, the fact remains that Zimbabwe cleared huge areas with ground spraying in the 1960s and 70s and more recently with a combination of ground and aerial spraying but the recovery of infested areas has declined with the switch to targets and cattle dipping. The RTTCP aimed to eradicate tsetse from 320,000km² and clearly considered that this was a possibility. After 10 years and a switch to almost complete reliance on targets the area currently being treated is less than 5% of the common fly-belt. Botswana reduced 20,000km² of tsetse infestation to 5,000km² with 20 years of aerial spraying; too much repetitive spraying for too long perhaps but a significant control achievement. The control impetus which built up 20-30 years ago has not been maintained with targets and in Botswana at least the reasons are not associated with under-funding or lack of manpower.

If traps/targets remain the primary control method throughout eastern and southern Africa and if the number currently reported to be in operation is even remotely correct, there is a danger that tsetse will recover more quickly than areas can be cleared. There is an added danger that having encouraged national control authorities to adopt targets, donors will reach the end of their financing agreements and leave national governments with major maintenance problems long before the job is finished. There are signs that this is happening in the RTTCP where EU financing for tsetse control is being downsized to match national contributions (RTTCP 1997).

In addition to the countries which have responded to the PAAT questionnaire there are other countries which do not participate in such international programmes and for various reasons, such as civil unrest, seldom disseminate information on tsetse and trypanosomiasis. For instance, WHO (Cattand *pers comm*) reports increased incidences of sleeping sickness in Angola and Zaire. The BBC (World News 17 Sept 97) reports major SS outbreaks in southern Sudan.

What can be done to rectify the apparent decline of tsetse control activities in PAAT countries and escalating trypanosomiasis problems in others? Is it realistic to simply do more of the same – i.e. increase the reliance on odour-bait techniques?

Odour-bait techniques may prove to be less environmentally benign and less economically advantageous than has been assumed. They may be slow to achieve results and may not be able to eradicate some populations but if managed properly they do have a significant effect on tsetse. They are also well suited to community projects. However, they do not appear to have made significant progress in the battle against tsetse flies in recent years thus are unlikely to do so in future years if left to work in isolation. Other well tried methods are

available and should be used to complement the targets, to take up some of the slack and to inject a degree of urgency into this persistent and escalating problem.

All the methods mentioned in Part 1 could have a role to play and should be considered by control authorities and donors in appropriate situations.

Cattle dipping is one technique that is currently in use alongside targets but in Zimbabwe it has already been found to be lacking when used as a barrier to prevent tsetse reinvasion (RTTCP 1997). SIT is also used in conjunction with targets despite the cost. Both techniques should however have a role in appropriate situations.

Ground spraying is currently under consideration in Zimbabwe where targets alone are not achieving satisfactory results and the reintroduction of aerial spraying was considered in Botswana in 1994 for an area where tsetse had recovered very strongly. There is unfounded resistance to the reintroduction of such chemical control methods but in reality their credentials are strong and if administered correctly they have much to offer.

Exhaustive environmental monitoring of discriminative ground spraying and non-residual sequential aerial spraying have not revealed major environmental damage – indeed both have been shown to have no long term irreversible effects on non-target organisms. There was no dramatic reduction in the annual cost of control in Botswana when targets replaced aerial spraying because the former is labour intensive and labour – particularly public sector labour – is expensive. In Malawi labour costs account for 87% of the tsetse control budget (RTTCP 1997).

There is a need for realism in strategic planning. The viability and economics of eradication should be carefully assessed. Where the facilities are still available, ground spraying could provide hugely valuable back-stopping to a target programme. Aerial spraying could help to re-establish the livestock production industry in Mozambique and provide massive relief to those with sleeping sickness in Angola, Sudan, Uganda and Zaire.

Donor support and shared regional resources may be the key to the development of large scale complementary tsetse control operations but ‘sustainable’ control must ultimately be a national responsibility; though not necessarily restricted to government. Indeed, there is already considerable and increasing collaboration between government control authorities and the private sector.

Local communities have been involved in tsetse control in Kenya and Uganda for many years. Zambia has taken a major step towards the privatisation of veterinary and tsetse control services in their recently adopted Agricultural Sector Investment Programme. Botswana’s current National Development Plan VIII advocates wider private sector involvement in traditionally public sector activities and, as a small step in this direction, private tour operators are taking more responsibility for tsetse control around their safari camps. Even Zimbabwe, the bastion of central government tsetse control, is investigating options for privatisation.

The few PAAT questionnaires that have been returned do not provide a definitive assessment of the current tsetse control situation in southern and eastern Africa but neither do they suggest that we are making significant progress. There is, however, an indication that it is time to review our objectives, assess our performance, reconsider our options, mobilise all available resources (e.g. including those in the private sector) and perhaps revise our strategies. Where the decline in tsetse control has more to do with national capability or AIDS, this also needs to be addressed and donors must be encouraged to see the wider picture and where necessary provide realistic support for a package of measures that may not be quite so aesthetically comfortable but will achieve the required result.

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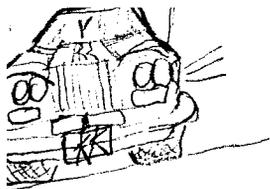
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R.A.H.T.

DRUG MANAGEMENT AND PARASITE RESISTANCE IN ANIMAL TRYPANOSOMIASIS IN AFRICA

S. Geerts and P.H. Holmes

Abstract

Trypanosomiasis

Trypanocidal drugs remain the principal method of control in most African countries. However there is growing concern that their future effectiveness may be severely curtailed by widespread drug resistance. An overview is presented of the current situation of resistance to drugs for the chemotherapy of trypanosomiasis in African livestock. Although the number of case reports on drug resistance is increasing, there is a lack of reliable data at the regional or national level on the true prevalence and impact of drug resistance.

In order to compare data on a temporal and spatial basis across Africa there is an urgent need for better standardisation of tests for the detection of drug resistance. The advantages and disadvantages of the currently available assays are briefly reviewed and measures suggested to improve the situation.

Finally, some guidelines are proposed to delay the development of drug resistance and measures which may be adopted to control drug resistance when it occurs. Although there is still a lack of knowledge about the mechanisms of resistance and the factors responsible for the development of drug resistance, urgent measures need to be taken to maintain the efficacy of the existing drugs. Based on the experience of the control of resistance to other drugs such as antimalarials, antibiotics and anthelmintics it is suggested that reliance on the 'sanative pair' guideline might not be sufficient to control resistance to trypanocides. This guideline needs to be accompanied by other measures, i.e.:

- *Avoidance of underdosing.* Underdosing is an important cause of resistance development and commonly occurs in the field. Measures should be adopted to minimise the risks of underdosing.

Better formulations of the existing prophylactic drugs may help to avoid the subtherapeutic concentrations, which exert a strong selection pressure for resistant clones.

- *Reduction in the number of treatments.* The most efficient way to delay the development of drug resistance is to reduce the selection pressure by these drugs. Exclusive reliance on drugs for the

control of trypanosomiasis, especially in areas of high prevalence, is not recommended.

intervals. More attention should be given to integrated control measures, involving the vector as well as the parasite.

- *Quinapyramine should no longer be used in cattle.* Cross-resistance with the other available trypanocides has now been clearly demonstrated at the level of individual trypanosomes. The use of this drug in cattle is therefore contraindicated.

Introduction

Isometamidium, diminazene and the homidium salts have been in use for more than 35 years and it is estimated that about 35 million doses per year are currently used in Africa. These drugs remain popular with livestock owners and veterinarians because they are generally affordable, available and effective. Since there is no indication that new products will become available in the near future, it is of utmost importance that measures are taken to avoid or delay the development of resistance and to maintain the efficacy of the currently available drugs.

The repeated use of chemicals as pesticides or chemotherapeutic agents inevitably leads to the development of resistance by the target organisms. Table 1 clearly illustrates that resistance systematically occurs within approximately 10 years following the introduction of antimicrobials, insecticides, fungicides and anthelmintics to the market (Waller, 1994). This also occurred with the trypanocidal drugs, such as isometamidium chloride (ISMM), ethidium and diminazene aceturate, which were introduced during the fifties and the first reports of acquired resistance were published during the sixties (Finelle & Yvone, 1962; Jones-Davies & Folkers, 1966; Na'Isa, 1967; Jones-Davies, 1967). Quinapyramine was marketed earlier, but was withdrawn in 1976 because of resistance and toxicity problems although later on it was reintroduced again for use in camels and horses and may still mistakenly be used in cattle in some locations.

In this paper an overview will be given on the current state of knowledge on trypanocide resistance, the current methods of detection and how they may be improved and on more refined guidelines to delay the development of resistance and to control resistance when it occurs.

1. Current situation of resistance against trypanocidal drugs

So far resistance to one or more of the three trypanocidal drugs used in cattle has been reported in

Côte d'Ivoire, Ethiopia, Kenya, Nigeria, Somalia, Sudan, Tanzania, Uganda, Zimbabwe) reported by Peregrine (1994), the Central African Republic (Finelle & Yvone, 1962) and Zambia (Mubanga & Sinyangwe, 1997) should be included. This is probably an underestimation of the true situation, because in several countries surveys for resistance have not yet been carried out or cases of resistance have not been reported officially. In 8 out of the 13 countries multiple resistance has been reported. Most of the currently available information on drug resistance, however, is derived from limited numbers of case reports and does not give any indication of the prevalence of resistance in a region or a country as systemic surveys have not been conducted. There is also considerable variation in the criteria which have been used to diagnose drug resistance. Table 2 summarises the published reports in which a number of trypanosome isolates has been examined.

Very few authors provide information on the method of sampling (randomised or not). There is an urgent need for surveys in which representative numbers of trypanosome isolates are examined for drug resistance. These should be taken at random, preferably in regions with high and regions with low or no use of trypanocides and use agreed methods of diagnosis. These type of surveys should provide more reliable data on the true prevalence of drug resistance in regions and countries. Furthermore, risk analysis should allow to the identification of the factors which influence sensitivity or resistance to trypanocidal drugs.

It is also important to stress that drug resistance is not an 'all or nothing' phenomenon and the degree of drug sensitivity and resistance varies considerably between individual trypanosomes. A further factor which can influence drug effectiveness is the interesting observations of Sones et al (1992) Burudi et al (1994), Silayo et al (1992), Mamman et al (1995a; 1995b), who reported differences in drug sensitivity according to the timing of treatment after infection and the concentration of trypanosomes in the blood.

2. Pathogenicity of drug-resistant parasites and the impact on livestock productivity

Whether or not drug-resistant trypanosomes are less pathogenic than susceptible ones remains a controversial issue. In the past and also more recently several authors (Berger et al., 1995; Mutugi et al., 1995; Silayo & Marandu, 1989; Stephen, 1962; Whiteside, 1962) have observed a loss of virulence and/or a loss of fitness in drug-resistant trypanosomes. *Transmission by tsetse flies, however, seems not to be affected. This was repeatedly shown in the past and confirmed more*

four populations of *T. congolense*, ranging from extremely sensitive to strongly resistant to ISMM found no differences in virulence between them (ILRI, 1996). Only the most resistant one showed a reduced viability, i.e. it took longer to establish parasitaemia than the other three. The loss of fitness in other drug-resistant parasites is a well known phenomenon and is probably also present in trypanosomes. Well designed experiments in non-immune definitive hosts using significant numbers of resistant and sensitive isolates should provide valuable data on this controversial but important topic.

There have been few studies to accurately assess the impact of drug-resistant trypanosomes on livestock productivity although it is generally assumed that uncontrolled infections will have a severe impact on both survival and productivity. Aⁿ useful recent study to assess the impact of drug-resistant trypanosomes on the productivity of the local cattle detailed studies were carried out in the Ghibe valley, Ethiopia, where a high prevalence of multiple drug resistance was reported (Codjia et al., 1993). Rowlands et al. (1994a & b) followed more than 300 East African Zebu calves from birth to 3 years of age together with their dams in this region (between 1986 and 1992). During most of this period animals which were parasitaemic and with a PCV below 26 % or animals with clinical signs of trypanosomiasis were treated with diminazene aceturate at 3.5 mg/kg, although resistance against this drug was known to occur. Some effects on the growth rate of parasitaemic calves were observed, but these were temporary. The authors conclude that regular trypanocidal therapy might have helped to maintain health and productivity of the young cattle. Although calf mortality was rather high, growth rates compared favourably with those in other village-managed systems in Africa. Similarly, reasonable levels of reproduction in terms of calving interval and age at first calving were maintained under regular trypanocidal therapy in the cows which were monitored over the same period (1986-92) (Rowlands et al., 1994b). There was, however, an impact of trypanosome infections on the incidence of abortion. Over 8% of calvings ^{calvings} resulted in abortion or still births and there was a significant increase in the rate of abortion associated with cases of parasitaemia detected during the last trimester of pregnancy. A benefit-cost analysis was carried out by Itty et al (1995) to evaluate the financial and economic returns generated by cattle raised in this area (over 500 cattle belonging to 9 herds from 1986 to 89). The latter authors showed that despite the high level of trypanosomiasis risk, the high prevalence of drug-resistant *T. congolense* and a moderately high average number of diminazene treatments per year (2.2 and 2.3 for animals aged 10-24 and > 24 months respectively) were not sufficient to

attractive economic returns for herd owners. The financial analysis (10 year projections) showed a net benefit-investment ratio varying from 1.1 to 2.4 for the 9 herds and an internal rate of return between 12 and 30%. This case study shows that profitable cattle production is possible in a problem area with high prevalence of drug-resistant *T.congolense*. Similar studies should be carried out in other regions with different resistance problems and under different management conditions.

3. Mechanisms and genetics of resistance to trypanocides

3.1. Isometamidium

In 1990 Shapiro and Englund suggested that the main mode of action of ISMM was the cleavage of kDNA-topoisomerase complexes. This explanation was supported by Wells et al. (1995) who showed that the trypanosome kinetoplast is the primary site of ISMM accumulation. The mechanism of resistance to ISMM, however, is less clear. Decreased levels of drug accumulation have been observed in drug-resistant populations of *T.congolense* (Sutherland et al., 1991) and later work by this group found indirect evidence of an increased efflux of drug from resistant trypanosomes (Sutherland and Holmes, 1993). Recently Mulugeta et al. (1997) showed that the maximal uptake rates (V_{max}) of ISMM in resistant *T.congolense* were significantly lower than in sensitive populations. It remains to be shown whether this is due to a decreased number of protein transporters of ISMM in the plasma membrane and/or to changes in the balance between influx and efflux. The role of nucleoside transporters, in resistance to ISMM by *T. congolense* remains to be examined although changes in these transporters have been associated with resistance to arsenical drugs in *T. brucei*. (Carter & Fairlamb, 1993; Carter et al., 1995; Ross & Barns, 1996). More recently changes in mitochondrial potential have been demonstrated in ISMM-resistant *T. congolense* by Wilkes et al. (in press).

Although contradictory observations have been reported on the genetic stability of ISMM resistance, recent field observations in Ethiopia based on cloned populations showed that the drug-resistant phenotype of *T.congolense* had not altered over a period of 4 years (Mulugeta et al., 1997).

3.2. Ethidium

Although its mutagenic activity has been known for a long time (MacGregor & Johnson, 1977), homidium bromide or ethidium is still widely used as a trypanocidal drug. The mechanism of its antitrypanosomal action is not well understood. However it has been shown that the drug interferes with glycosomal functions, the function of an unusual AMP binding protein, trypanothione metabolism and the replication of kinetoplast minicircles (Wang, 1995). The mechanism of resistance by trypanosomes to this drug is unknown. *There are indications, however, that it is similar to that described for ISMM (Peregrine et al., 1997).*

3.3. Diminazene

Although diminazene probably exerts its action at the level of the kinetoplast DNA, this has not been proven *in vivo* and other mechanisms of action cannot be excluded (Peregrine & Mamman, 1993). Similarly the molecular basis of resistance to diminazene in trypanosomes is not clear. Carter et al (1995) showed that the accumulation of diminazene was markedly reduced in arsenical-resistant *T.b.brucei* due to alterations in the nucleoside transporter system (P2). However, there might be other resistance mechanisms (Zhang et al., 1993).

Similarly to ISMM, contradictory reports have also been published on the stability of resistance to diminazene. Mulugeta et al (1997), however, showed that the phenotype of multiple drug-resistant (including diminazene) *T.congolense* remained stable over a period of 4 years.

In conclusion, it is clear that much more work is required in order to elucidate the mechanism of resistance to the three currently available trypanocidal drugs. Such studies, although of great value in their own right may also provide novel methods for the detection of drug-resistant trypanosomes in the future.

The same is true for the genetics of drug resistance by trypanosomes. Hayes and Wolf (1990) distinguish three major types of genetic change, which are responsible for acquired drug resistance: mutations or amplifications of specific genes directly involved in a protective pathway, mutations in genes which regulate stress-response processes and lead to altered expression of large numbers of proteins or gene transfer. Gene amplification under conditions of drug pressure is well known in *Leishmania* spp. and has also been demonstrated in trypanosomes, but until now there is no evidence that this occurs in the latter parasites as a mechanism of drug resistance (Ross &

insight in the resistance mechanisms (Ten Asbroek et al., 1990; Gaud et al., 1997). Other aspects such as the stability of drug resistance, its mono- or polygenic nature, dominance or recessiveness, also need to be examined, because of their far reaching impact on the control of resistance.

4. Detection of drug resistance

Several methods have been described to identify drug resistance in trypanosomes (reviewed by Peregrine, 1994, 1996). Currently three types of technique are commonly used to identify drug resistance: tests in ruminants, the mouse test and *in vitro* assays. None of them, however, is an ideal test. Other tests are still in the phase of development or validation. The advantages and disadvantages of each of the different techniques are briefly summarised.

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4.1. Tests in Ruminants

This test provides direct information from studies in ruminants using recommended doses of trypanocide. The tests commonly consists of infecting a group of cattle or small ruminants with the isolate under investigation and later when they are parasitaemic treating them with various levels of trypanocide. The animals are then regularly monitored over a prolonged period (up to 100 days) to determine the effective dose (ED), i.e. the dose able to clear ^{temporarily} the parasites from the circulation and the curative dose (CD), i.e. the dose of drug able to provide a permanent cure (Sones et al 1988). For these studies the cattle or small ruminants must be kept in fly-proof accommodation or in a non-tsetse area in order to eliminate the risk of reinfection during the study. A variation on this technique was used by Ainanshe et al., (1992) in Somalia to examine a group of isolates from a district. Blood from a group of infected cattle was inoculated into a single recipient calf, which was monitored and later, when it was parasitaemic, treated with trypanocide at the recommended dose. A breakthrough infection, indicative that one of the inoculated trypanosome populations was drug-resistant, was inoculated into groups of calves and mice to determine the level of drug resistance. This technique is useful in situations where laboratory facilities are very limited but it only allows a qualitative assessment and does not indicate how many of the isolates inoculated into a single calf were resistant.

Self observation / ...

A further constraint to this technique is based on the observation by Sones et al. (1989) that sensitive isolates might overgrow resistant ones when inoculated together. However this is not a consistent observation (Burudi et al., 1994).

An indication of the level of resistance can be obtained from studies in ruminants (and mice) by recording the length of time between treatment and the detection of breakthrough populations of trypanosomes. The shorter the period, the greater the level of resistance (Ainanshe et al., 1992)

The **advantages** of studies in ruminants are that all trypanosome isolates for cattle are able to grow in these hosts and that the data obtained are directly applicable to the field.

The **disadvantages** are the long duration (follow-up of 100 days is necessary to allow the detection of relapses) and the cost (purchase and maintenance of the animals are expensive). Furthermore, if only one isolate per animal is used, it is usually too impractical and expensive to examine a large number of isolates.

4.2. Tests in mice

After expansion of an isolate in a donor mouse, groups of 5 or 6 mice are inoculated with trypanosomes. Twenty four hours later or at the first peak of parasitaemia each group except the control group, is treated with different drug doses. The mice should be monitored three times a week for 60 days.

The ED50 or 95 (effective dose, which gives temporary clearance of the parasites in 50 % or 95 % of the animals) can be calculated as well as the CD50 or 95 (curative dose which gives complete cure in 50 % or 95 % of the animals). Sones et al. (1988) used groups of 5 mice, which allowed an easy calculation of ED80 and CD80 values (one out of 5 mice not cleared or cured). These figures should be compared with those obtained using reference sensitive trypanosome strains.

The **advantage** of the mouse assay is that it is cheaper than the test in cattle. There are several **disadvantages** however: 1. Most *T.vivax* isolates, but also some *T.congolense* isolates do not grow in mice; 2. Although there is reasonable correlation between drug sensitivity data in mice and in cattle, higher doses of drug must be used in mice in order to obtain comparable results to those obtained in cattle because of the vast difference in metabolism size. Normally mice should receive

resistance needs a large number of mice per isolate. This makes it a rather labour intensive test. Identification of a discriminatory dose, above which an isolate should be considered as resistant, could drastically reduce the number of mice and the amount of work to be carried out. 4. Finally, it takes 60 days to evaluate the drug sensitivity of an isolate, which is also quite long. *labour*

4.3. *In vitro* assays

Since the review of Kaminsky and Brun (1993) further progress has been made in the field of *in vitro* assays to determine drug sensitivity of trypanosomes. These authors advised the use of metacyclic or bloodstream forms instead of procyclic forms in such assays. However, it takes up to 40 to 50 days *in vitro* incubation to generate metacyclic trypanosomes (Gray et al., 1993). The **advantage** of this technique is that large numbers of isolates can be examined. Tests with metacyclic trypanosomes correlate well with field observations. However there are several **disadvantages**. *In vitro* cultivation of bloodstream forms is only possible using ^{laboratory} preadapted lines and not using ^{field} isolates directly from naturally infected animals (Hirumi et al., 1993). A simplified axenic culture system has been developed by these authors, but further research is still necessary to study the correlation with field data. *In vitro* assays are expensive to perform and require good laboratory facilities and well trained staff.

If better techniques can be developed in order to adapt isolates more rapidly to grow *in vitro*, these assays may become more popular, especially in those laboratories where culture facilities are already established.

4.4. Trypanocidal drug-ELISAs

As an alternative to the above mentioned tests the use of trypanocidal drug-ELISAs in combination with parasite detection tests has given promising results for the detection of resistant trypanosomes. A competitive ELISA which allowed the detection of small amounts of isometamidium in serum of cattle was first described by Whitelaw et al. (1991). This technique was further improved by Eisler et al. (1993, 1996) and has been validated in cattle under experimental and field conditions (Eisler, 1996). *Field conditions*

the monitoring of drug levels over extended periods and the evaluation of factors influencing drug disappearance rates from the plasma.

The available data indicate that there is a considerable individual variation after i.m. injection of ISMM in cattle (Eisler, 1996). One interesting finding has been that the drug also disappears more rapidly in animals infected with drug-resistant trypanosome isolates than in those infected with sensitive trypanosomes (Eisler et al., 1994). Preliminary observations showed that the presence of trypanosomes in animals with an ISMM concentration of $>5\text{ng/ml}$ strongly suggests resistance.. Further research is necessary, however, in order to confirm these results in a larger number of animals. Similar drug-ELISAs have been developed, which allow the detection of minute amounts of ethidium (Murilla, 1996) and a similar test for diminazene is in development.

The **advantage** of the ISMM-ELISA is that large numbers of sera can be tested within 12 to 24 hours. The **disadvantage** is that further studies are required to confirm the correlation of the parasitological results with the ISMM concentration in the serum and it is not yet possible to draw firm conclusions on the sensitivity or resistance of the trypanosome population at the level of the individual animal. It might however, give some indication of the resistance situation at the level of the herd.

4.5. Longitudinal parasitology data

Longitudinal parasitological data can be used to detect resistance problems, although it is not suitable as a routine test. Rowlands et al. (1993) showed that the application of a computer model to parasitological data collected over a long period on a monthly basis allowed the incidence of new infections to be distinguished from recurrent infections. This analysis showed that the mean prevalence of diminazene-resistant infections in the Ghibe valley, Ethiopia increased from 6% in 1986 to 14% in 1989.

The **advantage** of this kind of data is of course that they are directly applicable to the field. The **disadvantages**, however, are the true prevalence of drug-resistant infections seems to be underestimated; that it is retrospective by at least 6 months; and that the technique is quite

4.6. New tests (in development) for detection of resistance to ISMM

Since it has been shown that the rate of ISMM accumulation in *T. congolense* is a good indicator of the degree of drug resistance and since the mitochondrial potential appears to be closely linked with the rate of drug uptake, it might be possible in the near future to develop a quantitative *in vitro* test to evaluate the mitochondrial potential (ILRI, 1996; Wilkes et al., 1997). If such a test could be carried out using a small number of trypanosomes, it might provide a quick answer about the level of resistance of a given trypanosome isolate. However, it is likely to suffer from the same disadvantages of other *in vitro* tests referred to earlier. A more promising approach in the longer term may be made to identify genetic markers for ISMM resistance, which might be developed into reagents for the identification of resistant trypanosomes using PCR.

Unfortunately it will take several years before such a test is validated and becomes available to potential users. Therefore, standardisation of the existing tests should receive high priority, especially the assays in mice and in the definitive hosts, because these can be carried out in less well equipped laboratories. This should allow the establishment of a resistance monitoring system, to compare data on a temporal and spatial basis across Africa and to avoid the current confusion in the field of drug resistance of trypanosomes.

5. Guidelines to delay drug resistance

Very important to know if
in given situation: individual
resistance (some cases) or overall
resistance

The factors responsible for the development of resistance to antitrypanosomal compounds are not well known. The exposure of parasites to subtherapeutic drug concentrations (due to underdosing) has been considered as the most important factor for the development of resistance. (Whiteside, 1960,1962; Boyt, 1986). Boyt (1986) suggested that the evolution of drug resistance in trypanosomes is fundamentally different from resistance in insects, helminths or micro-organisms. For the latter it is generally accepted that resistance genes are present in a very small proportion of the population and that these pre-existing resistant individuals are selected by drug pressure. Boyt (1986), however, suggested that in a manner similar to antigenic variation, chemoresistance is another example of the remarkable ability of the trypanosome to adapt defensively in the face of unfavourable changes appearing in its environment. However, no concrete evidence has been

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brought forward to show that resistance is indeed an adaptation rather than a selection process. Nevertheless it is possible to take drug sensitive clones and rapidly induce drug resistance by repeated underdosing and passage. Furthermore, Osman et al. (1992) showed that this occurs ^{much} more rapidly in immunosuppressed hosts (mice). *Similar observations were also reported by Hess et al. (1997), who showed that malnourished children (malnutrition indirectly influences the immune status) in a higher socio-economic status were at a higher risk for treatment failures due to drug-resistant Plasmodium falciparum than well-nourished ones.* This findings serves to illustrate the importance of immune responses in drug clearance of parasites.

How do trypanosomes develop resistance to trypanocidal drugs? Selection by drugs takes place during asexual multiplication in the animal or human host. During the passage through the tsetse fly genetic exchange (sexual recombination) may occur at least in *T. brucei* (Jenni et al, 1986; Tait & Turner, 1990). Similar to *Plasmodium* (Thaitong, 1983), populations of trypanosomes in infected animals are polyclonal with different sensitivities to antitrypanosomal drugs (Peregrine et al., 1991; Mutugi et al., 1995). Therefore drug resistance in trypanosomes is likely to occur under the same circumstances as for *Plasmodium* and many other parasites: i.e. 1. under large scale drug use; 2. by using inadequate dosing and 3. by using correct dosing with drugs that are slowly eliminated from the body (White, 1992). Furthermore, some trypanocidal drugs are well known mutagenic compounds and might induce mutations, the most resistant of which are certainly selected under drug pressure (Hayes & Wolf, 1990)

Up to now the most important guidelines to avoid or to delay the development of drug resistance were 1. to use of the "sanative" pair of drugs and 2. to avoid the exposure of trypanosomes to subtherapeutic drug concentrations (Whiteside, 1960) (Boyt, 1986;). It is clear, however, that the application of these guidelines may not be sufficient to maintain the efficacy of the existing drugs.

Based on the current knowledge in the field of trypanocide resistance and on the experience in the control of insecticide-, anthelmintic-, antibiotic and other drug resistances (Boray et al., 1990; Bergogne-Bérézin, 1997; Geerts et al., 1997; Roush, 1993) the following recommendations are proposed in order to delay the development of resistance.

Underdosing is one of the major causes of resistance development. Subtherapeutic drug concentrations exert a strong selective pressure for the emergence of resistant clones that pre-exist in the trypanosome population. Unfortunately, underdosing occurs very frequently. Farmers have the tendency to underestimate the weight of their animals when they have to treat them (Besier & Hopkins, 1988). Sometimes generic products are used, which have a reduced efficacy. This has been shown in the field of anthelmintics (Van Wyk et al., 1995) and anecdotal evidence suggests that it also occurs with trypanocides. Given the fact that in many countries unskilled persons are allowed to administer drugs, undoubtedly many errors occur in calculating the correct doses for the treatment of the animals. Furthermore as the drugs are relatively expensive there is a temptation to overdilute the drug and hence underdose.

Recent data (Eisler, 1996) on the pharmacokinetics of ISMM suggest that the bioavailability of ISMM in goats might be two times less than in cattle. If this is confirmed, higher doses should be used in goats than in cattle. Similar observations were made for benzimidazoles and levamisole, the dosage of which should be 1.5 to 2 times higher in goats than in sheep (Hennesy, 1994).

The use of improved formulations of existing drugs is another possible way to avoid subtherapeutic concentrations. Controlled release devices which provide more stable drug concentrations and a sharper cut off at the end of the release period might have particular advantages in this respect. The polymer devices containing ISMM or ethidium as described by Geerts et al. (1997) are a step into this direction.

5.2. Reduction of the number of treatments by integrating drug usage with other control measures

It is widely agreed that the most efficient way to delay the development of drug resistance remains the reduction of selection pressure by the drugs, i.e. decrease the number of treatments. This is of particular importance in areas of high tsetse challenge, which are commonly associated with reduced periods of chemoprophylaxis (Whiteside, 1960; 1962). In such situations the frequency of drug usage is commonly increased and drug resistance often emerges as a constraint to further drug usage. Very intensive drug treatment schedules as described by Stevenson et al (1995) who administered ISMM 6 to 7 times a year or ethidium even 11 to 12 times a year might be able to

approach inevitably increases the selection pressure and must lead to increased levels of drug resistance. It has been shown in other areas that there is a strong correlation between the treatment frequency and the development of resistance (Conder & Campbell, 1995). It is therefore strongly recommended that in high tsetse challenge areas control of trypanosomiasis should not rely solely on drugs and an integrated approach should be adopted using vector control, to reduce the tsetse challenge, along with reduced frequency of drug dosing. Where such measures have been adopted the results have been impressive (Peregrine et al., 1994; Fox et al., 1993). In situations in West and Central Africa the use of trypanotolerant livestock and drugs may be appropriate in areas of high tsetse challenge (Diall et al., 1992).

5.3. Avoid exposure of the whole parasite population to a drug

Contrary to human sleeping sickness, mass treatments are commonly used to control animal trypanosomiasis and can be highly successful over many years in ranch cattle for example (Trail et al., 1985). However, this form of treatment exerts a strong selection pressure on the trypanosome population. The higher the proportion of the trypanosome population exposed to the drug and the lower the portion in refugia (e.g. the trypanosomes present in the fly population or in other hosts), the higher the selection pressure. The percentage of the total parasite population, which is exposed to the drug at the time of treatment might thus have an impact on resistance development. It has been shown by computer models that leaving 20 % of the herd untreated significantly decreases the rate of development of anthelmintic resistance (Barnes et al., 1995). Although no experimental data are available for trypanocide resistance, experiences with other drugs and pesticides indicate that systematic mass treatments hasten the development of resistance. Therefore in well monitored situations there may be a case for limiting treatment to individual clinical cases. In such situations drug resistance problems can be minimised and acquired immunity encouraged (Scott and Pegram 1974). *A similar approach is currently being used in South-Africa to control anthelmintic-resistant *Haemonchus contortus* in sheep (Van Wyk et al., 1997). Instead of carrying out systematic mass treatments only those sheep, which are strongly anemic, are treated. Identification of animals not able to cope with *H. contortus* was done by clinical appraisal of the colour of the ocular mucous membranes using a colour chart (FAMACHA). It allowed to reduce significantly the number of treatments without increase of the mortality rate.*

5.4. Ban on the use of quinapyramine in cattle

Quinapyramine was widely used in cattle in Africa during the period 1950-70. In 1976 it was withdrawn from sale for cattle use because of problems with toxicity and resistance development. However it is still available for use in camels and it is likely that it is still mistakenly used in cattle in some situations in Africa. There are particular problems with this drug as Ndoutamia et al (1993) showed after artificial induction of resistance to quinapyramine in *T.congolense* multiple resistance to ISMM, homidium and diminazene was expressed at the level of the individual trypanosome and could be transmitted by tsetse flies. This confirms the results obtained in earlier field studies of Whiteside (1962). The use of quinapyramine as a trypanocide in cattle is thus completely contraindicated.

6. Guidelines to control drug resistance once it is present

The above mentioned measures are important to delay the development of resistance. Once resistance is present, however, other interventions become necessary.

6.1. Resistance against one drug at the level of individual trypanosomes

When resistance to diminazene, ISMM or ethidium is present, the use of the other drug of the sanative pair is still possible. This drug should be used with caution in order to avoid resistance development here again. Integrated control measures i.e. reduce vector numbers aiming at reducing the number of drug treatments will be of great importance. The same is true in case multiple resistance associated with mixed infections. Administration of different drugs to which the subpopulations are sensitive, will eliminate the whole trypanosome population (Mulugeta et al., 1997).

Once resistance is present, it is contradictory to increase the dose of the drug. Although some temporary benefits might be obtained, this will inevitably increase the selection pressure and thus the level of resistance. The use of a double dose of diminazene (2 times the normal dose with an interval of 8 or 24 hours) only slightly improved the therapeutic efficacy for resistant *T.congolense* (Silayo

activity of the compound as compared to the intramuscular injection, it was not effective in eliminating resistant parasites (Sutherland et al., 1992).

6.2. Multiple drug resistance at the level of individual trypanosomes

If multiple resistance is expressed at the level of the individual trypanosome chemotherapy can become increasingly ineffectual. To counteract multiple resistance in such a case one has to interfere at the level of the vector. Peregrine et al. (1994) showed that in the Ghibe valley (Ethiopia), multiple drug-resistant trypanosome infections (at the individual level) could be effectively controlled using an integrated approach involving tsetse fly control (targets) and chemotherapy of clinically sick animals (using diminazene). The relative density of the main vector, *G. pallidipes*, fell from an average of 1.9 flies/trap/day before the introduction of tsetse control to 0.4 flies/trap/day during the first year of the control. Simultaneously the prevalence of *T. congolense* infections fell from approximately 30 % before the tsetse control programme to ± 5 % at the end of the first year after the start of the control programme. The prevalence of diminazene resistant infections decreased by about 75 % during the same period. Although this experiment could not be continued due to political instability in the region, it showed that this approach can be successful. A similar level of success was also reported by Fox et al. (1993) at the Mwaja Ranch in Tanzania using a deltamethrin dipping programme to overcome the problem of drug resistance. Interestingly cattle productivity significantly increased and despite the cost of the dip its cost was more than offset by savings on trypanocidal drugs and oxytetracycline, and thereby overall treatment costs were reduced by 50%.

7. Conclusions

Because it is very unlikely that new trypanocidal drugs will be released on the market in the near future, it is essential to try to maintain the efficacy of the currently available drugs. The most important and most efficient measure is to adopt an integrated disease management strategy.

Furthermore, better data are necessary on the true prevalence of trypanocide resistance (instead of case reports) and on its impact on the productivity of livestock. In order to allow a reliable

tests are carried out across Africa according to standardised protocols as is the case for antimalarials, antibiotics, anthelmintics, etc, where these standardised tests have been established. We need also better insight into the ways that farmers and veterinary assistants are using trypanocides. There are indications, for instance, that diminazene is used more and more frequently, whereas the use of ISMM is decreasing. Which criteria farmers use when they decide whether or not to treat an animal and when they select an appropriate trypanocide are not known.

In order to understand the phenomenon of drug resistance, more research is needed into the mechanisms and the genetics of resistance. Computer models which allow the prediction of the efficacy of certain measures to delay resistance are also very useful tools as shown by Cross & Singer (1991), Hastings (1997) or Barnes et al (1995) in the field of malaria and anthelmintic resistance respectively. Finally, there is an urgent need for better surveillance. Currently it is not known whether the increase of the number of resistance reports is due to a higher prevalence of resistance or simply to a growing interest in drug resistance by scientists. Collection of baseline data through well functioning monitoring systems is essential in order to allow to take the right measures at the right time.

→ Diagnosis?
→ Resistance in animal species
→ Chemoprophylaxis

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Nitric oxide production in vervet monkeys infected with *Trypanosoma rhodesiense*: A retrospective study

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Summary

The production of nitric oxide in trypanosomiasis was studied in the vervet monkey (*Cercopithecus aethiops*), model of Rhodesiense sleeping sickness. Sera and cerebrospinal fluid (CSF) samples were obtained from monkeys infected with *T. b. rhodesiense*, KETRI 2537 and assayed for nitrate. Nitrate is the stable oxidation product of nitric oxide *in vivo* and a direct indicator of nitric oxide synthesis in the respective tissues. Prior to infection, no nitrate was detected in CSF as compared to $62.4\mu\text{M}\pm 1.84$, detected in the sera. Following infection, the serum nitrate concentrations increased rapidly with a peak day 28 ($216\mu\text{M}\pm 3.92$) thereafter decreasing to pre-infection levels by day 42. In the CSF, the trend was similar although the values were lower. The nitric oxide peak was related to peak parasitemia, low packed cell volume (PCV) and high body temperature. This study showed that nitric oxide production is increased during trypanosomiasis infections with a strong correlation between nitric oxide production and the clinical disease.

Introduction

Trypanosomosis is associated with a marked increase in several cytokines among them tumor necrosis factor and interferon gamma (Hunter *et al.*, 1994). These cytokines have been reported to be responsible for the activation of nitric oxide production (Green *et al.*, 1991). Nitric oxide levels have been demonstrated to be elevated in murine trypanosomosis. However, unlike in other parasitic infections nitric oxide has no protective role in trypanosomosis (Sternberg *et al.*, 1994). The increased levels of nitric oxide could disrupt other physiological process such as vascular tone and neurotransmission. Earlier studies in murine trypanosomosis, have shown that nitric oxide plays an important role in the pathology caused by the disease (Mabbot and Sternberg 1995) and immunosuppression (Schleifer and Mansifield 1993). Although the antimicrobial and immunopathological role of nitric oxide in the mouse model of trypanosomosis is well studied, the situation in primates is poorly understood. In this study we report the NO profile in the vervet monkey (*Cercopithecus aethiops*) model of human *rhodesiense* sleeping sickness.

Methodology

Twelve vervet monkeys were obtained and housed as described by Gichuki *et al.*, (1994). Ten of the animals were infected with *T.b.rhodesiense*, KETRI 2537, by intravenous injection with 1×10^4 trypanosomes while two were left as controls

Individual variation in nitrate concentration between the animals was noted but the trend were similiar.

The packed cell volume (PCV) levels decreased gradually from 46.89 ± 0.83 (pre-infection level) to 34.00 ± 1.046 by day 42 of infection whereas the rectal temperature increased (figure 2).

Discussion

In this study, nitric oxide levels were observed to increase by upto five times during *T.b.rhodesiense* infection. Nitrate is the stable oxidation product of nitric oxide *in vivo* and a direct indicator of nitri oxide synthesis in the respective tissues. The nitric oxide peak coresponded with peak parasitemia indicating that nitric oxide has no trypanocidal effect on the parasite as earlier demonstrated by Sternberg et al (1994). The PCV levels which are an indicator of anaemia showed an inverse relationship with nitric oxide levels, indicating that nitric oxide maybe important in the anaemia due to trypanosomosis in this monkey model. An earlier study using the mouse model showed that the elevated nitric oxide production in the bone marrow plays an important role in the anaemia resulting from trypanosome infection.

In CSF, nitric oxide was detected at day 28 and 42, when the parasites were found in CSF and when serum NO was at peak. The CSF nitric oxide indicates either permeability of nitric oxide from peripheral system through the blood-

The animals were clinically examined and sampled fortnightly while under general anaesthesia with diazepam (1.0mg/kg) and ketamine (10-15mg/kg). Five millilitres of blood was withdrawn from the femoral vein for serum preparation and haematology while CSF (1-2ml) was obtained by lumbar puncture. Serum and CSF samples diluted at 1:5 and 1:2 in PBS respectively were assayed for nitrates. Nitrates in the samples were reduced with *Aspergillus* nitrate reductase followed by Greiss assay as described by Mabbot *et al* (1994). Sodium nitrate standards of were included in each assay plate. The concentration of nitrates in the test samples was determined by linear regression. All data is presented as mean \pm standard error (SE)

Results

Trypanosomes were detected in blood and CSF on day 14 and 28 of infection respectively. The highest parasitemia in blood occurred 28 days after infection when trypanosomes were first detected in CSF.

Before infection (controls and pre-infection samples), no nitrate was detected in CSF whereas in serum, nitrate concentration was $39.5\mu\text{M}\pm 1.84$. Following infection, the serum nitrate concentrations increased rapidly with a peak at day 28 ($216\mu\text{M}\pm 3.92$), thereafter decreasing to pre-infection levels by day 42 (figure 1). In CSF, nitrate levels had a similar trend although the values were lower.

This infection induced nitric oxide, could be interpreted as being of synaptic origin leading to an overall interference with the orderly neurotransmission (Clark *et al* 1991). In trypanosomosis the severe central nervous system (CNS) disease is characterised by abnormal sleeping behaviour, tremors of tongue and finger, euphoria, manical changes and mental deterioration (Pentreath *et al* 1989). Further studies will be necessary to determine the neurotransmitter activity of nitric oxide in CNS disturbances during late stage disease.

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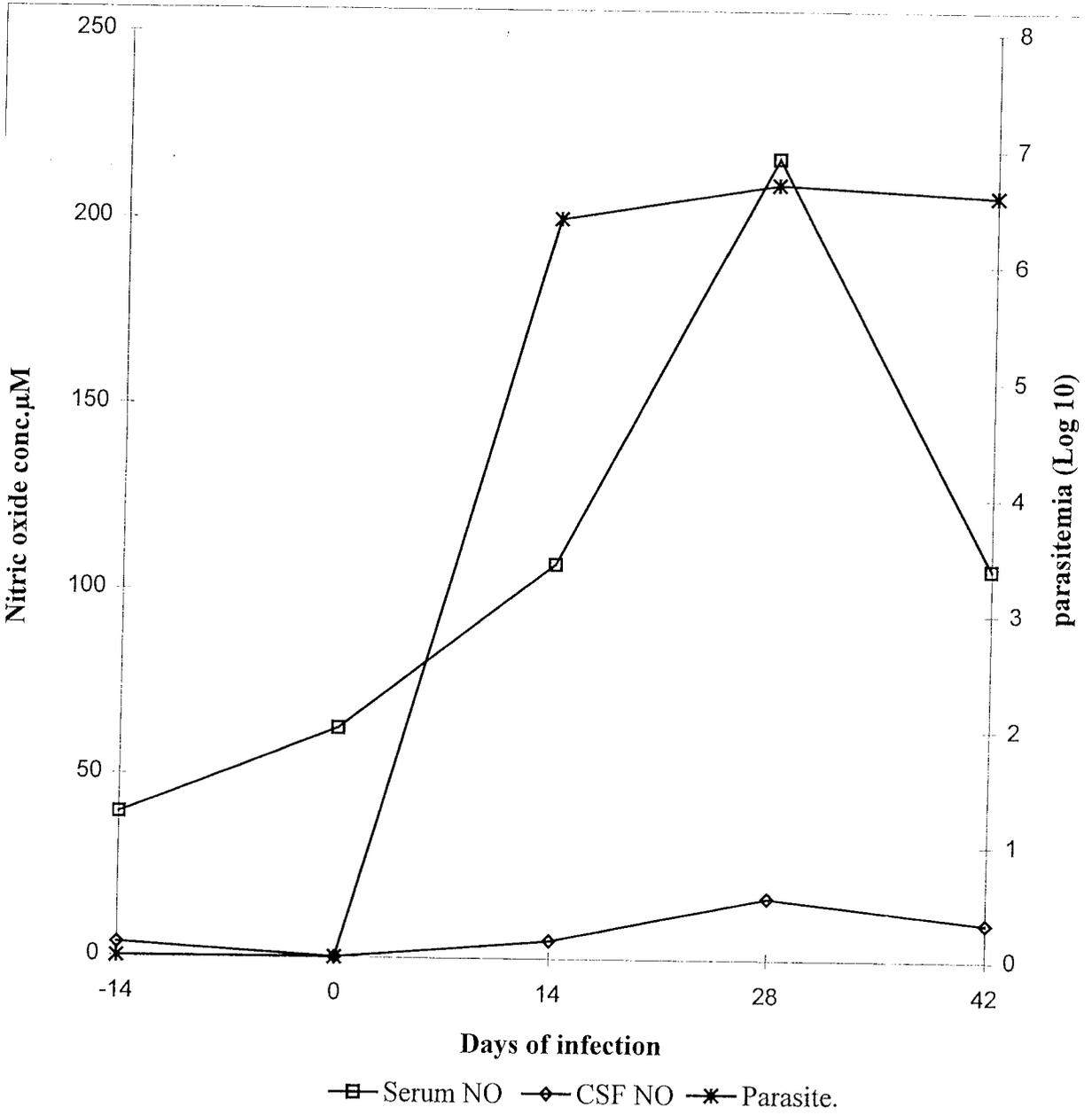
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Production of nitric oxide during infection

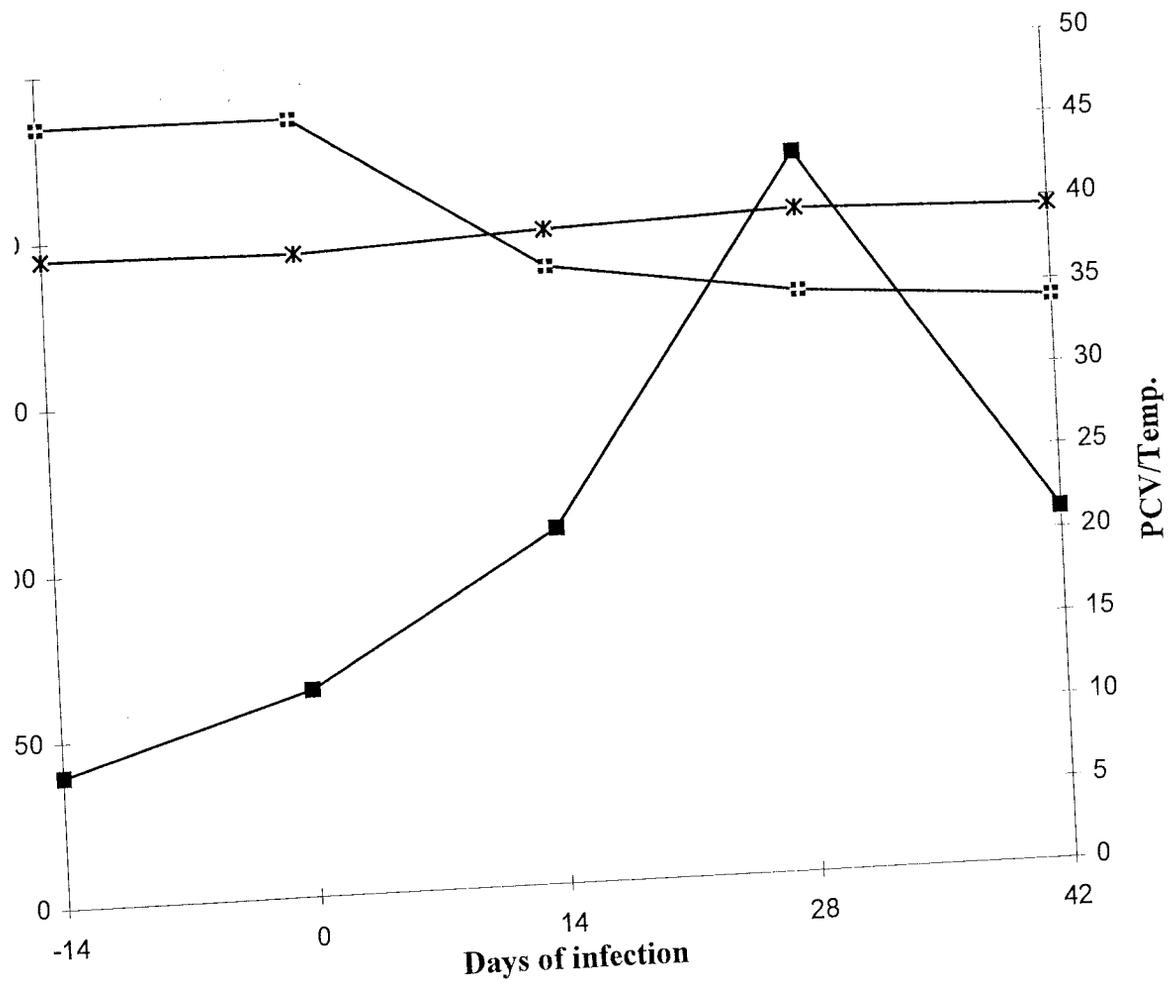
Figure 1



Shows parasitemia levels (log 10), serum nitric oxide conc. (μM) and CSF nitric oxide conc. (μM) in vervet monkeys infected with *T. b. rhodesiense* KETRI 2537 from 14 days prior to infection to 42 days post infection. (mean, n=10).

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Changes in serum nitric oxide conc., PCV and temperature during infection



Serum NO
 PCV
 Temp.

Shows the changes in serum nitric oxide, PCV and temperature in vervet monkeys infected with *T.b.rhodesiense* KETRI 2537 from 14 days prior to infection to 42 days post infection (mean, n=10).

PHAGOCYTAIRE

**IN VITRO PHAGOCYTTIC FUNCTION OF DROMEDARY
POLYMORPHONUCLEAR (PMN) CELLS DURING EXPERIMENTAL
INFECTION WITH *TRYPANOSOMA EVANSI***

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TESTS D'ADHÉRENCE DE LA LAINE DE
VERRE

SUMMARY

To study the effect of *Trypanosoma evansi* infection on the function of camel polymorphonuclear (PMN) cells, glass wool adherence, phagocytosis of zymosan and trypanosomes, and cytochrome C reduction test were used. The aim was to investigate the role of the polymorphonuclear system in ^{immunosuppression} immune suppression/observed in sick camels. Following infection of five camels with *T. evansi*, there was a significant decrease in the ability of the PMN cells to adhere to glass wool ($P < 0.001$), reduce cytochrome C ($P < 0.001$) and enhanced phagocytosis of zymosan ($P < 0.01$) and increased binding of trypanosomes to PMN cells ($P < 0.05$). The observed alterations of PMN functions were restored following the elimination of trypanosomes with melarsomine treatment. It is concluded that *T. evansi* infection in camels ^{inhibe} inhibit some PMN cell activities which contribute to the observed immune suppression. These findings call for a mixed treatment with trypanocides and antibiotics in trypanosomiasis infected camels. DROMADAIRES
TRYPANOSOMES

et deux
INDICE DE FIXA
RESULTATS

INTRODUCTION

Camels suffering from trypanosomiasis show severe immune suppression which is manifested clinically as increased susceptibility of the sick animal to infection by opportunistic micro-organisms. Immune suppression has been shown to result from suppression of cell-mediated immunity and antibody production (Diggs, 1982 ; Mwangi *et al.*, 1990) and impairment of complement cascade (Ouma, 1995). However, in some instances there is no impairment of these factors though immune suppression is observed. Any effective immune response is backed by proper functioning of complement cascade, mononuclear and polymorphonuclear phagocytic systems. In this study, polymorphonuclear (PMN) cells which form the first defense line against infection were assessed in *T. evansi* infected camels. This was to establish their role in immune response.

Materials and methods

Experimental animals

Nine dromedary camels aged between 2-3 years were used in this study. Five animals were inoculated intravenously with 2.0×10^7 trypanosomes while four acted as uninfected control. The animals were monitored daily for trypanosomes using microhaematocrit centrifuge technique and treated once the disease became acute.

TECHNIQUE MICROHEMATOCRIT CENTRIFUGATION

Isolation of PMN cells

Camel PMN cells were isolated as described by Carlson and Kaneko (1973)

Glass wool adherence test TEST D'ADHÉRENCE À LA LAINE DE VERRE

This was an adaptation of nylon wool adherence assay of Nagahata *et al* (1991). Briefly, glass wool columns were constructed from 1 ml disposable tuberculin syringe and 100 mg of glass wool, which was packed to a volume of 0.6 cm^3 . Columns were warmed at 37°C for 15 minutes after which 1 ml of heparinised whole blood was put and allowed to percolate by gravity. Thin blood smears were done on the initial and effluent samples and stained with giemsa. PMN cells adhering to glass wool were expressed as percentage of the total PMN cells.

PRÉLÈVEMENT

Phagocytosis of opsonised zymosan test

Zymosan A was hydrated by boiling for 30 minutes in 0.9% sodium chloride. Hydrated zymosan was then mixed with camel serum, incubated at 37°C for 45 minutes and centrifuged at $500 \times g$ for 10 minutes. Resulting opsonised zymosan was washed three times in PBS pH 7.2 and stored at -196°C . Prior to use, opsonised zymosan was re-suspended in hanks balanced salt solution (HBSS) with Ca^{2+} , Mg^{2+} and glucose, then equal volumes of heparinised whole blood and opsonised zymosan were mixed and incubated at 37°C for 15 minutes. Thin smears were prepared from the mixture, stained with giemsa and observed under $\times 100$ objective. The PMN cells that had phagocytosed zymosan were expressed as percentage total number of PMN cells observed.

HYDROCHLOREURIC CHLORURE DE SODIUM

CONSERVÉ

Binding of trypanosomes test

Binding of trypanosomes procedure was carried out following the method of Ngaira *et al*. (1983). A PMN cell was considered to display binding and hence phagocytosis, if it had at least three trypanosomes attached to it. A total of 200 PMN cells in consecutive microscopic fields were examined and the proportions of the cells that showed binding expressed as percentage of the total number of cells.

Cytochrome C reduction test

Superoxide anion release was determined by superoxide dismutase inhibitable reduction of ferricytochrome C. Phorbol-12-Myristate-13-acetate preparation was used as a stimulant of superoxide anion. Briefly, 2.0×10^7 PMN cells were incubated in presence of horse heart cytochrome C in PBS pH 7.2 containing 1 mM Ca^{2+} , 1 mM Mg^{2+} and 5 mM glucose. The tubes were capped and incubated while being agitated for 30 minutes. 3 ml of cold PBS was added to stop the reaction and the tubes centrifuged at $1500 \times g$ for 10 minutes at 4°C . The amount of superoxide anion produced was monitored spectrophotometrically at 550 nm and then at 468 nm (Bellavite *et al.*, 1983) and the results expressed as nanomoles of superoxide anion produced by 2×10^7 PMN cells.

Statistical analysis

The differences between the infected and uninfected camels were compared using student's t-test. The level of significance was ($P < 0.05$).

Results

Infected camels developed acute trypanosomosis with heavy load of parasitaemia. Leukocytosis was characterised by lymphocytosis, neutrophilia and a mild eosinophilia while monocyte and basophil changes were negligible. There was a significant decrease in the ability of PMN cells to adhere to glass wool (40%) and to produce superoxide anion (>80%). An increase in phagocytic index (20%) and binding index (6%) during the course of infection were observed. Following chemotherapeutic treatment, the altered PMN cell functions were restored to the pre-infection levels by week four post-treatment.

Discussion and conclusion

The evidence of suppression of PMN cell oxidative metabolism may represent a mechanism of trypanosome pathogenicity. The capability of parasites to avoid destruction by phagocytic cells and expression of virulence is a common feature (Kaufmann, 1993) and may represent one way by which parasites evade the host immune system. Results of this study demonstrate that some functions of PMN cells are inhibited during *T. evansi* infection in camels. It is, therefore, likely that inhibition of these functions contribute to the immune suppression observed during trypanosomosis. The finding of these study suggest the need for combination treatment with trypanocides and antibiotics in trypanosomosis infected camels.

Acknowledgments

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**COMPLEMENT (C₃): PURIFICATION, CHARACTERIZATION AND
QUANTITATION IN SERA OF *Trypanosoma evansi* INFECTED
DROMEDARY CAMELS**

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SUMMARY

The third component of the dromedary complement system (C₃) is known to have important effector functions in immune responses. However, its role in camel trypanosomiasis has not been determined. The present study aimed at isolating, characterizing and evaluating the levels of C₃ in *Trypanosoma evansi* infected camels. C₃ was isolated from camel serum by polyethylene glycol precipitation and chromatography. Molecular characterization on SDS-PAGE revealed that the protein has a molecular weight of 185 kilodaltons (kDa). Monospecific antiserum prepared in goats produced single precipitin lines with both the purified form of C₃ and normal camel serum. Following experimental infection of camels with *T. evansi*, serum C₃ levels showed a slight initial increase. The levels dropped one week post-infection, continued to drop as the infection progressed and correlated negatively with parasitaemia levels. The mean C₃ levels of infected animals was significantly lower than that of controls (P<0.05) and only recovered following treatment. The hypocomplementaemia in *T. evansi*-infected camels was attributed to the presence of the trypanosomes, which may be responsible for releasing complement activating factors. It is concluded that camel C₃ is a high molecular weight protein and that its depletion occurs in trypanosome infected camels. In addition, complement may be responsible for the *in vivo* control of parasitaemia and the

hypocomplementaemia reported in the present study could lead to immunosuppression widely reported in animal trypanosomoses.

INTRODUCTION

The third component of the complement system (C_3) plays a central role in the induction of the immune system and is also important in the generation of the B memory cells (Klaus and Humphrey, 1977) which enable the system to recognize a particular antigen during secondary exposure (Irvine, 1979). C_3 has been isolated from the sera of a variety of species including guinea pigs (Meuer *et al.*, 1978), pigs (Paques, 1980) and humans (Hammer *et al.*, 1981). However, camel C_3 has not been isolated and characterized.

Studies on the role of complement in camel trypanosomosis, particularly that of C_3 , have been limited (Ouma *et al.*, in press). Uche and Jones (1992) demonstrated that C_3 levels decrease in the blood of rabbits experimentally infected with *T. evansi*. Nielsen *et al.* (1978) observed a similar condition in cattle chronically infected with *T. congolense* and suggested that reduced complement levels may contribute to the immunodepression generally seen in trypanosomosis. Although decreasing complement levels have sometimes been associated with significant increases in parasitaemia, worsening clinical state and then death of infected animals (Cunningham *et al.*, 1978), Shirazi *et al.* (1980) found no demonstrable differences between the parasitaemias of normal and C_3 -depleted mice. In view of this equivocal results and the central role C_3 plays in activation of the complement cascade, the present study was undertaken first, to isolate and characterize the dromedary C_3 . Secondly, the study was aimed at evaluating the levels of C_3 in camels experimentally infected with *Trypanosoma evansi* and determining the relationship between C_3 level and infection before and after treatment with melarsomine.

MATERIALS AND METHODS

Preparation of camel serum and Zymosan- C_3

Camels were bled from the jugular vein and blood collected aseptically in sterile pre-chilled universal glass bottles. Serum and zymosan were prepared as described by

Ouma *et al.* (in press) and Olaho-Mukani *et al.* (1995), respectively. Zymosan-C₃ was prepared by mixing zymosan with 11 ml of fresh camel serum. This mixture was then incubated at 37°C for 1 hour. The complex was washed six times with barbitone buffered saline and stored at -196°C till used for immunization.

Preparation of rabbit anti-zymosan-C₃

To raise this antiserum two male New Zealand white rabbits aged between 3 and 4 months from the Institute's rabbit colony were immunized every 10 days for 30 days with 14 mg of zymosan-C₃ in Freund's incomplete adjuvant. The primary immunization was done by injecting at 6 sites on the animals back subcutaneously (0.1-0.2 ml/site). The animals were boosted by injecting the same dose of zymosan-C₃ complex in Freund's incomplete adjuvant intramuscularly.

Isolation of camel C₃

Camel C₃ was isolated from fresh serum following a modified method of Menger and Aston (1985). Briefly, 160 ml of serum was precipitated using polyethylene glycol 6000 (PEG) and the resulting precipitate collected by centrifugation at 2000 g for 20 minutes at 4°C. The sample was dissolved in 20 mM phosphate buffer pH 7.0 and purified in three steps by chromatography in columns of DEAE, Sephadex A-50, CM-Sephadex C-50 and Sephacryl S-200, respectively. The C₃ containing fractions were determined by double immunodiffusion and immunoelectrophoresis. The fractions producing a single precipitin line were pooled, concentrated using a lypholysing machine and stored in small aliquots (900 µg/ml) at -196°C. All the chromatography procedures were performed at 4°C and all buffers contained 0.1% sodium azide and 5 mM EDTA.

Partial characterization of camel C₃

One- and two- dimensional immunoelectrophoresis were used to assay for the cleavage products of C₃ (Johnstone and Thorpe, 1987). A 1.5% agarose solution in barbitone buffer, pH 8.6 containing 5 mM EDTA and 0.1% NaN₃ was pipetted onto microscope slides (4 ml per slide) and allowed to set on a levelled surface. A potential difference of

is permanent

150 volts (constant voltage) was then applied for 2-3 hours. The second dimension electrophoresis was run on a glass plate (8 cm x 8 cm) containing anti-camel C₃ at 70 volts overnight.

Sodium dodecyl sulphate polyacrylamide gel electrophoresis (SDS-PAGE)

Slab gel electrophoresis in the presence of sodium dodecyl sulphate (SDS) was performed as previously described by Laemmli (1970). 10% (w/v) total acrylamide gel was used as a compromise between 5% and 20% gradient gels. All runs were done at room temperature.

Experimental camels

Eight somali-type dromedary camels of both sexes aged between 2 and 4 months obtained from the Institute's herd at Athi River in the Machakos District of Kenya were divided into two groups. Group A (n=5) were experimentally infected with 2×10^7 trypanosomes of a clone of *Trypanosoma evansi* KETRI 2455 intramuscular injection. This group of animals remained infected for four weeks before being treated with melarsomine (Rhone Mérieux, France). Group B (n=3) were kept as un-infected controls.

Estimation of parasitaemia

Parasitaemia levels were estimated daily according to the improved estimation method of Paris *et al.* (1982).

Quantitative estimation of C₃ levels in camel sera

Camel C₃ was quantitated following the radial immunodiffusion method of Mancini *et al.* (1965). Diffusion was allowed to take place in 1% agarose, containing 0.1% sodium azide and 5 mM EDTA for 24 hours.

Statistical analysis

For statistical analysis, means were calculated and Student's t-test used to determine differences between the two groups. The significance level used was $p < 0.05$. Multiple regression analysis was done to determine correlation between variables.

RESULTS

Zymosan-C₃ and anti-Zymosan-C₃

The purity and specificity of the antiserum raised against zymosan-C₃ complex was tested using double immunodiffusion and immunoelectrophoresis. This antiserum reacted specifically with the zymosan-C₃ preparation or normal camel serum producing a single precipitin line. This antiserum did not react with camel serum heated at 56°C for 1 hour.

Isolation of camel C₃

Fractions collected following chromatography on DEAE-Sephadex A-50 and CM-Sephadex C-50 were shown by immunoelectrophoresis to be contaminated with other proteins. The C₃ containing fractions obtained from a column of Sephacryl S-200 produced a single precipitin line on immunoelectrophoresis.

Activation products of camel C₃

After carrying out a two-dimensional immunoelectrophoresis on the C₃ sample, purified by column chromatography, two precipitin peaks were observed (Figure 1). One of the peaks (the smaller one) was associated with the smaller C_{3a} sub unit while the larger peak was associated with the large C_{3b} sub unit.

Sodium dodecyl sulphate polyacrylamide gel electrophoresis (SDS-PAGE)

When the material eluted from the Sephacryl S-200 was subjected to an SDS-PAGE analysis under non-reducing conditions, it was observed that this material has a molecular weight of 185 kDa.

Relative serum C₃ levels

There was an initial increase (10%) in the mean circulating C₃ levels by day 7 post-infection, followed by a steady decrease to week 2 and thereafter, a further decrease to week four of infection (Figure 2). The overall maximum decrease in C₃ level up to week four was 40%. During infection, the mean C₃ levels of infected and non-infected animals were 742.5±192.46 µg/ml and 885±30 µg respectively. These values were significantly different from each other (P<0.05). The lowest level of C₃ coincided with the second major parasitaemia peak and it was demonstrated that C₃ levels recovered after drug treatment. This recovery did not reach pre-infection levels and by the end of the study, the C₃ levels of infected animals had not attained the control values (Figure 2). Multiple regression analysis of parasitaemia versus C₃ levels showed a negative correlation (r=-0.577).

DISCUSSION

The third component of the complement system (C₃) has been isolated from the sera of a variety of species including humans (Hammer *et al.*, 1978), guinea pigs (Meur *et al.*, 1978) and pigs (Paques, 1980). However, the cameline C₃ has not been purified and characterized. In this study, a protein isolated from camel serum was identified as C₃ based on its molecular weight, the sub-unit composition and specific reactivity with anti zymosan-C₃. SDS-PAGE analysis of this molecule showed that it had a molecular weight of 185 kDa. This value is not markedly different from those reported for the C₃ isolated from humans and other species. It is particularly close to bovine C₃ which has a molecular weight of 183 kDa (Menger and Aston, 1985).

The specific reactivity with the anti-zymosan C₃ raised in rabbits provided the principle identification assay used throughout the isolation of C₃ protein. This antiserum reacted with normal camel serum. However, the antiserum did not react with camel serum heated at 56°C for 1 hour. It appears that the protein that reacted with the anti-zymosan-C₃ antiserum was heat labile and therefore denatured in the course of heating. Monospecific antiserum raised against this protein in goats showed the same reactivity and

specificity as the rabbit anti-zymosan-C₃ with the purified protein using either double immunodiffusion or immunoelectrophoresis. Since zymosan binds onto the third component of the complement system (C₃), the results suggest that the protein isolated from camel serum was C₃.

A consistent feature observed in all the five camels infected with *T. evansi* was a fall in the serum C₃ levels as the infection progressed. Similar observations have been made on infections with other trypanosome species (Jarvinen and Dalmaso, 1976; Kobayashi and Tizard, 1976; Nielsen, *et al.*, 1978, Uche and Jones, 1992). One possible cause of this fall in C₃ level could be C₃ activation by the antigen-antibody complexes (Musoke and Barbet, 1977) which are produced as parasites are eliminated by the host immune system through complement-dependent effector mechanisms (Murray and Urquhart, 1977). In the present study, the lowest levels of C₃ were observed at the same times as the second major peak of parasitaemia; C₃ levels increased following chemotherapy. Parasite burden and C₃ level therefore seem inversely linked, possibly as the result of trypanosomes releasing large quantities of complement-activating factors (Cunningham *et al.*, 1978). The considerable recovery of C₃ levels after chemotherapeutic elimination of trypanosomes suggests that complement activation ceases with drug treatment. This may indicate the removal of the immunologically active complement fragments and the restoration of native C₃ levels to normal. In this study, C₃ levels did not return to pre-infection levels following chemotherapy. However, by the end of the experiment, C₃ levels still showed signs of further recovery. This finding is in agreement with that of Rurangirwa *et al.* (1979). It appears the synthesis of more C₃ and its equilibration in various tissues and blood would require more days than allowed in this study. This may be partly responsible for the fact that C₃ levels did not return to original values four weeks after drug treatment.

During the initial stages of the infection C₃ levels increased slightly (10%). Similar findings have been observed by Uche and Jones (1992) in rabbits infected with *T. evansi*. Similarly, Shirazi *et al.* (1980) observed a two to three-fold increase in C₃ levels of mice chronically infected with *T. brucei*. This initial rise is caused by the large amounts of C₃ produced during the acute phase of the infection (Horning and Arquembourg, 1965)

and/or the high numbers and levels of activity, particularly in the liver, of mononuclear phagocytes, during the initial stages of trypanosome infection (Longstaffe, 1974). Mononuclear phagocytes are known to secrete C₃, 90% of which is produced in the liver (Lambris, 1988).

The depletion of circulating C₃ by *T. evansi* could not only have far-reaching effects on how the host reacts to an ongoing infection (Staines *et al.*, 1985), but could also compromise the host's ability to respond to subsequent infections, as C₃ has been shown to play an important role in the development of immunological memory (Klaus and Humphrey, 1977). This investigation has extended knowledge of C₃, by examining some of its physicochemical properties in a species from which C₃ has not previously been purified in the native functional form. It has also led to an increased understanding of the dynamics of the dromedary complement (C₃) during experimental *T. evansi* infection.

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Fig 1. *Activation products of camel C₃ following 2-dimensional immunoelectrophoresis.*

Fig 2. Time course of parasitaemia and mean weekly serum C₃ levels of *T. evansi*-infected and non-infected camels

ABSTRACT

Trypanosomiasis and Tsetse Control With Insecticidal Pour-ons: Fact *and* Fiction?

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Pioneering research in the 1970s in West Africa and Zimbabwe led to the development of a new tool for tsetse control: the odour-baited trap or target. Numerous large-scale trials in the 1980s have demonstrated that these devices are effective at the control of tsetse and trypanosomiasis. More recently, insecticidal pour-ons have been widely promoted as an alternative to targets, offering numerous advantages. Pour-on is applied directly to cattle which thus become "living targets", without the use and cost of artificial odour baits; tsetse that land on treated cattle pick up a lethal dose of insecticide and die.

From 1989 - 1996 we undertook a trial of the deltamethrin-containing Spot On™ as a means of controlling the tsetse fly *Glossina pallidipes* at Galana Ranch, Kenya. In the treatment area (Dakabuku) nearly 1200 steers were treated two-weekly with Spot On™ from April 1990. Treatment was reduced to four-weekly in July 1991, and it was stopped altogether in June 1992. Thereafter, until 1996, cattle were maintained without Spot On™. At the control area (Kapangani), steers were maintained without Spot On™ for the entire period. Cattle were sampled regularly and weekly incidences of *Trypanosoma congolense* and *T. vivax* were calculated. Tsetse were monitored from December 1989 to 1996 with odour-baited biconical traps.

For most of the seven years of the trial, tsetse numbers were greater at Dakabuku than at Kapangani. For several months, within the period when Spot On™ was applied at Dakabuku, this situation was reversed, suggesting that there was some pour-on induced tsetse control. However, closer scrutiny of the data suggests that the reversal might in fact have been caused by an unusually extended rainy season at Kapangani. In contrast to the entomological results, there was a very clear effect of Spot On™ on the incidence of trypanosomiasis of the cattle at Dakabuku.

Further analysis of the data clearly shows that the impact of Spot On™ on the incidence of trypanosomiasis exceeds that accountable by any reduction in the tsetse population at Dakabuku. Data for 1992 - 1996, when the use of Spot On™ had stopped, were used to derive a lagged relationship between tsetse numbers and the incidence of trypanosomiasis. This relationship was then used to calculate expected incidences from the observed tsetse numbers during the earlier period when Spot On™ was used. The expected and observed

and observed incidences; however, at Dakabuku the observed incidence was significantly lower than that expected from the observed tsetse numbers (ie., allowing for any effects of Spot On™ on the tsetse population at Dakabuku).

Other pour-on trials have all shown clear reductions in the incidence of trypanosomiasis, yet examination of the data reveals that, in general, effects on tsetse populations were harder to demonstrate. It is suggested that the phenomenon observed at Galana Ranch may have some generality. Four possible reasons for the phenomenon are discussed: repellency of tsetse from treated cattle; an increase in resistance to trypanosomiasis caused by a lower tick burden or less tick-borne disease; an interruption to mechanical transmission of trypanosomes by biting flies (including tsetse); and local depletion of tsetse around the treated cattle that protects from trypanosomiasis, but does not impact on the overall tsetse population. These possibilities all suggest different strategies for the use of pour-ons to control trypanosomiasis, and it is urged that further research into their mode of action be undertaken.

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Trypanosomiasis and Tsetse Control With Insecticidal Pour-ons: Fact *and* Fiction?

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Insecticidal pour-ons that are applied directly to cattle have been widely promoted in the last decade as a new means of controlling tsetse flies in Africa. Tsetse attracted to treated cattle get a lethal dose of insecticide and die. Following a large trial in Kenya, Matthew Baylis and Peter Stevenson argue here that the reduction in trypanosomiasis incidence caused by pour-ons exceeds that expected from the impact - if there is any - on the tsetse population and that certain other, as yet unknown factors, must also be involved.

In Africa in the late 1980s, field trials began of several pyrethroid pour-ons and dips to be marketed as a means of controlling tsetse flies, the vectors of African trypanosomiasis. The use of pour-ons and dips to control tsetse was a logical extension of the tran/target

control method that had been developed a few years earlier. In the 1970s, pioneering research in West Africa¹ and Zimbabwe^{2,3} led to a much-improved understanding of the shapes, colours and odours of trapping devices that are most attractive to certain species of tsetse. Independently, synthetic pyrethroids were developed that have low toxicity to mammals, are lethal to tsetse and yet are stable and persistent in the field⁴. The combination of these two lines of research led to a new tool for tsetse control, radically different from those used previously: the odour-baited, insecticide-impregnated, trap or target⁵. Numerous trials demonstrated that a low density (ie. 4 per km²) of such traps/targets can achieve tsetse control in a cost-effective manner⁶⁻¹². Traps and targets offered advantages over control methods used previously: the environmental impact was judged to be much less severe than with aerial spraying of infested areas, let alone bush clearance and wildlife eradication¹³, and there were opportunities for community involvement^{14,15}.

Despite these advantages and successful field trials, livestock farmers and national governments in Africa have been slow to embrace traps and targets as a means of tsetse control. One reason is that the deployment and maintenance of traps and targets over large, often inaccessible areas, the purchase of odour attractants and insecticides, and the scientifically rigorous approach to the design of the control programme, require a level of infrastructure and organization rarely available to the people whose animals are at risk of disease.

As an alternative to the trap/target approach, in the 1980s several pharmaceutical companies developed formulations of synthetic pyrethroids that are suitable for direct application to cattle either as pour-ons or dips, but are still intended for tsetse control (eg.

Coopers' *Spot On*™, Ciba Geigy's *Ectopor*™, Bayer's *Bayticol*™). Using pour-ons or dips offers numerous advantages over odour-baited traps and targets. Cattle themselves attract tsetse and therefore traps, targets and odours do not need to be purchased. Cattle can be moved to spray races or dips for pyrethroid treatment, rather than staff travelling to widely-dispersed traps and targets. And as cattle are usually sprayed or dipped regularly with acaricides anyway, the necessary infrastructure should already be present. There are also important disadvantages. The objective is to eliminate contact between tsetse and cattle, yet contact is necessary if tsetse are to be controlled. This necessitates providing cattle with alternative means of protection, such as prophylactic drugs, when they are first introduced into a tsetse-infested area, and accepting a low level of disease incidence thereafter, rather than zero incidence. Since cattle may be moved frequently in search of better grazing, this problem can be recurrent. Additionally, tsetse numbers may need to be monitored - using odour-baited traps - to assess the efficacy of the control programme, which reintroduces many of the disadvantages of the original trap and target control methods.

Field trial considerations

The design of field trials to test the efficacy of pour-ons and dips is fraught with difficulty. Tsetse numbers tend to fluctuate widely both within and between years and therefore, in an ideal situation, such trials should be performed in areas for which there is already long-term data on tsetse abundance. Sadly, such information is rarely available and, where it is, one is not usually allowed to interrupt data collection with a control programme. Most trials have therefore involved tsetse monitoring in two areas: an experimental area and a control (non-experimental) area. Ideally, such areas should be

sufficiently close to present similar habitats and tsetse populations, but sufficiently far apart that changes in the tsetse population in one area do not affect that of the other. In practice, trials are often under way before any problems become clear.

Pour-on trial at Galana Ranch

In 1989 we began a pour-on trial at the tsetse-infested Galana Ranch, located in the coastal hinterland of south-eastern Kenya (Fig. 1). At approximately 6000 km² the ranch is one of the largest in Africa, with an estimated capacity of up to 30000 cattle. Its size, infrastructure of pumped water and proximity to Tsavo East National Park ensure that the ranch also supports large numbers of game animals. Trypanosomiasis (*Trypanosoma congolense* and *T. vivax*), transmitted by the tsetse fly *Glossina pallidipes* and to a lesser extent *G. longipennis*, are the most important cattle diseases on the ranch.

Monitoring of tsetse began in December 1989 in two areas of the ranch, Dakabuku and Kapangani, separated by approximately 10 km. In April 1990, nearly 1200 steers were introduced into Dakabuku (the experimental area) and treated at two-weekly intervals with Cooper's Spot On™ (deltamethrin 1% w/v). At Kapangani (the non-experimental, control area) a herd of 100 steers were sprayed regularly with acaricide but not Spot On™. The acaricide used is not known to have any effect on tsetse flies. Other cattle maintained at Kapangani ensured that the overall cattle density was similar to that of Dakabuku. In both areas all cattle were initially treated with the prophylactic drug Novidium to provide short-term protection from trypanosomiasis.

Later, the application rate of Spot On™ at Dakabuku was reduced to four-weekly, and it was stopped altogether in June 1992. At both sites, new cattle were introduced in

August 1992 and were maintained without Spot On™ at either site until 1996, although all cattle were removed from Dakabuku from September 1993 to January 1995.

The apparent density (mean daily trap catch) of *G. pallidipes* over the duration of the experiment is shown in Fig. 2. There is a strong seasonality, with the timing influenced by rainfall. For much of the six years, the apparent density of *G. pallidipes* at Dakabuku was marginally or considerably greater than that at Kapangani. An exception was for a few months in 1991 when the relationship was reversed. This period was during the time when Spot On™ was applied to cattle at Dakabuku and, since a similar pattern has not recurred, it is strong evidence that there was Spot On™-induced tsetse control at Dakabuku. Or is it? Closer scrutiny reveals certain perplexing complications in that interpretation.

Examining the evidence

First, there is a period of about a year between starting the application of Spot On™ at Dakabuku and any obvious difference in tsetse abundance. Second, considering the seasonality in fly numbers, the apparent density of *G. pallidipes* at Dakabuku in 1991 was not surprisingly low for that time of year. Rather, that at Kapangani was surprisingly high, with little evidence of the expected seasonal decline in June or July. Why there was no seasonal decline at Kapangani is not clear, although it might be related to the extended rainy season observed in 1991 (Fig. 2). The rainfall distribution in Galana Ranch is highly localized and it is possible that the extended rains recorded by the weather station at Tank E (Fig. 1) occurred also at Kapangani, but not Dakabuku. We do not know.

The apparent density of a second tsetse species, *G. longipennis*, was much lower than that of *G. pallidipes*. There is no evidence for a change in its abundance at Dakabuku

during the time that Spot On™ was applied.

In other words, despite the use of more than 50000 doses of Spot On™ at Dakabuku, the entomological results of the trial are surprisingly equivocal. This contrasts sharply with concurrent studies of the incidence of trypanosomiasis (both *T. congolense* and *T. vivax*) in 40 steers at each site. At Dakabuku, trypanosomiasis incidence was low throughout the trial, but increased sharply after Spot On™ application stopped. At Kapangani, trypanosomiasis incidence was at a relatively high level throughout the trial and continued at similar levels afterwards. Similar results were found with other measures of herd health: soon after the application of Spot On™ started, the cattle at Dakabuku maintained higher packed cell volumes and had higher rates of weight gain than the cattle at Kapangani.

It therefore appears that at Galana Ranch, the application of Spot On™ had a greater effect on cattle health than on the tsetse population. This suggestion is supported by a further analysis of the data from Galana Ranch. An attempt was made to relate the apparent densities of the two tsetse species to the incidence of trypanosomiasis for the four year period that untreated cattle were kept at both Dakabuku and Kapangani (August 1992 - June 1996), excluding the period (September 1993 - January 1995) when no cattle were kept at Dakabuku. Since tsetse were monitored two-weekly, and trypanosomiasis incidence weekly, incidences from sequential weeks were averaged; the apparent densities of *G. pallidipes* and *G. longipennis* were then compared to the trypanosomiasis incidence 0-1, 1-2, 2-3, 3-4 and 4-5 weeks later with a multiple regression model. At both sites, the best relationships were between the apparent density of the tsetse flies and the incidence of trypanosomiasis 2-3 weeks later (the incubation period of trypanosomes is about two weeks). The regression equations from these relationships were then used to calculate

predicted incidences of trypanosomiasis for the previous period, when Spot On™ was being applied at Dakabuku, based on the observed apparent densities of tsetse. Comparison of predicted and observed incidences is startling (Fig. 3). At Kapangani, for the first few weeks while *Novidium* offered protection, the observed incidence was much lower than predicted, but thereafter the observed and predicted incidences were similar (observed: mean = 13.2% infected per week; predicted: mean = 15.4%; One-way ANOVA, $F_{1,76} = 1.24$, $P = 0.27$). At Dakabuku, even after the protective effect of *Novidium* should have worn off, the observed incidence was much lower than that predicted (observed: mean = 4.2% infected per week; predicted: mean = 14.1%; One-way ANOVA, $F_{1,76} = 31.7$, $P < 0.001$).

Other field trials

Other field trials have demonstrated variable effects of pour-on or dips on tsetse populations. Another trial in Kenya found little evidence for an effect of cypermethrin application to cattle on the local tsetse population (L. Munga, Report^{*}). In contrast, a field trial of Spot On™ in Burkina Faso demonstrated a large reduction in the tsetse population after pour-on application began¹⁶. In several other studies an effect of pour-on or dip on the tsetse population is concluded but the results are less clear. For example, in a trial of cypermethrin in Ethiopia the tsetse population began to decline two years before pour-on was applied, and it continued to decline at an equal rate thereafter¹⁷. In other trials the tsetse populations in both control and experimental areas appear to have declined abruptly

^{*}Munga, L.K. *et al.* (1995) Evaluation of the efficacy of cypermethrin dip formulation (Ectomin) in the control of tsetse and trypanosomiasis in the coastal region of Kenya. Kenya Trypanosomiasis Research Institute Report No 60

just before¹⁸ or after¹⁹ pour-on application or dipping began. In a trial of flumethrin in Burkina Faso, tsetse numbers declined more in the experimental than the control area but the one tsetse species common to both declined in both²⁰.

Variability in the degree of tsetse control

A major cause of the variability in the degree of tsetse control in these trials may be the proportion of bloodmeals that the tsetse seek from cattle. Wildlife is abundant at Galana Ranch and cattle may form only a small part of the tsetse diet such that most tsetse do not come into contact with insecticide-treated animals. In the pastoral area of Burkina Faso, where a reduction in tsetse was clearly demonstrated¹⁶, wildlife may be comparatively rare. This suggests that analyses to identify the sources of tsetse bloodmeals, giving the proportion of bloodmeals taken from cattle, may be an important first step before launching a pour-on or dip-based tsetse control operation. A second factor to be considered is the tsetse reinvasion pressure, which will be affected by the nature of the area surrounding the pour-on trial, as well as the size and shape of the trial area itself (Glyn Vale, personal communication).

Despite the variation in the entomological results, all of the above trials reported clear improvements to cattle health in terms of trypanosomiasis incidence or prevalence rates, mortality rates from trypanosomiasis, the required frequency of use of trypanocidal drugs, and the packed cell volumes and weight gains of the animals.

In effect, most of these studies have demonstrated positive effects on herd health more easily than they demonstrated effects on tsetse populations, suggesting that there may be some generality to our observations at Galana Ranch, that pour-ons affect

trypanosomiasis more than is expected from changes in the tsetse population. Why might this occur?

Repellency of tsetse

One possibility is that pyrethroid pour-ons and dips are repellent to tsetse. Under this scenario, tsetse numbers are relatively little affected because few come into contact with the insecticide, but trypanosome transmission is interrupted nonetheless. The evidence for repellency of tsetse by pour-ons is mixed²¹⁻²⁴, but our own results suggest it does not occur in the field. We and co-workers looked for tsetse repellency by pour-ons containing either deltamethrin or cypermethrin by surrounding treated or untreated cattle with electrocuting devices that intercept approaching and departing tsetse under field conditions. We observed large numbers of engorged *G. pallidipes* leaving cattle of all three treatments, and there was no evidence for any difference in tsetse feeding success²⁵. That said, our experiment cannot exclude the possibility that the probing frequency of tsetse on the treated animals was lower.

Tick control

A second possibility is that pour-on application or dipping improves herd health via other changes and that improvements to herd health increase the resistance of the cattle to trypanosomiasis. A candidate mechanism here is tick control. In most, if not all, of the trials mentioned here, the control (pour-on untreated) cattle were regularly sprayed or dipped with acaricides, yet it is clear that the pour-ons were far more effective at controlling ticks. For example, in Burkina Faso flumethrin treatment of cattle led to tick

infestations only 10-33% of those found on the control, acaricide-treated animals²⁰. In Tanzania, despite the pre-trial weekly or twice-weekly application of acaricide, cattle deaths from tick-borne anaplasmosis decreased to 17% that of the pre-trial level once Spot On™ application began¹⁸. At Galana Ranch we also observed highly effective tick control on the Spot On™-treated cattle. Of course, this hypothesis assumes that cattle with a lower tick burden are more resistant to trypanosomiasis. While this has not been demonstrated, there is evidence that physiological stress, caused by pregnancy²⁶ or poor nutrition (Jamie Bennison, personal communication), lowers the resistance of trypanotolerant cattle to infection by trypanosomes. The Tanzanian study provides further evidence that pour-on treatment may have effects beyond tsetse control: death rates from unrelated causes, such as hyaenas, also decreased significantly after Spot On™ was applied. This effect was presumably caused by an overall increase in fitness in animals no longer challenged by ticks, tsetse, or the diseases they carry.

Interruption of mechanical transmission

A third possibility is that mechanical transmission of trypanosomes, by either tsetse or other biting flies such as tabanids²⁷ and *Stomoxys*²⁸, may be playing a larger role in the spread of infection than has previously been assumed²⁹, and that treatment of cattle with pour-ons may stop this means of spread. Contact with Spot On™ generally causes death, or “knock-down” (paralysis) of tsetse within a few minutes, and behavioural aberrations, such as uncontrollable activity, are usually apparent within one minute (M. Baylis, unpublished data). Mechanical transmission requires interrupted feeding on an infected animal, followed soon after by probing, or feeding, on another animal; the rapid effect of Spot On™

on tsetse and other biting flies might effectively prevent this second step occurring among a herd of pour-on-treated cattle. However, while *T. vivax* undoubtedly can be and is spread by both mechanical and cyclical transmission, there is little or no evidence for a significant amount of mechanical transmission of *T. congolense* in the field, and yet at Galana Ranch we observed a lower than expected incidence of disease caused by both parasites. This suggests that while mechanical transmission might have been prevented, other factors must also have been involved.

Local depletion of tsetse

A fourth possibility is that the observed improvements to herd health are, after all, related to a reduction in tsetse challenge, but this reduction is local to the cattle - in other words, there is local depletion of tsetse around the treated cattle, but this depletion is not sufficient for population control and is not detected in trap catches. At Galana Ranch, the traps used for monitoring the tsetse populations were distributed over relatively large areas (several kilometres) while each herd of treated cattle, at any one time, occupied only a small area. Tsetse in the neighbourhood of the cattle may have died but, after the cattle moved on, tsetse numbers may have rapidly built up again. A critical difference between the pour-on and trap/target control methods is that traps or targets are usually evenly distributed over large areas, while the same number of pour-on treated cattle, as a herd, occupy only a small area at any time. Traps and targets cause a small increase in the mortality rate of tsetse, but over large areas and to a large proportion of the tsetse population, while pour-ons presumably present a very high risk, but to only a few tsetse at any one time. The low reproductive rate of tsetse ensures that population control is

achievable with the small increases in daily mortality rate caused by traps and targets³⁰; it is less clear that pour-ons can be as effective at control at the population level. Adding to this effect, the main activity times of tsetse at Galana Ranch are just after dawn and before dusk, when most cattle are either in, or near, the corrals in which they spend the night. In the grazing areas to which cattle are taken during the day, the tsetse populations may be little affected by treating cattle with pour-ons because few flies are active, while there may be effective tsetse control, and little trypanosomiasis transmission, at the corrals.

Recommendations

It is clear that pour-ons are an effective means of controlling trypanosomiasis in cattle in Africa, and their use should be encouraged. It is equally clear that their mode of action is little understood, or may have been misunderstood. It is remarkable that very little basic research appears to have been published on how pour-ons affect tsetse and trypanosomiasis, yet the lives and wellbeing of many people in Africa are already affected by them. This situation has arisen, almost certainly, from the assumption of both pharmaceutical companies and researchers that pour-ons are a simple development from traps and targets, and that their modes of action (reduction in the incidence of trypanosomiasis because of tsetse control) are identical. The reality may be somewhat different. If the evidence from Galana Ranch is correct, and the mode of action of pour-ons involves certain other factors, then the strategic use of pour-ons will be affected. The issue of repellency is crucial. If tsetse are killed but not repelled by pour-on treated cattle, then some other means of protection must be used when the animals are first introduced into tsetse-infested areas; if tsetse are repelled but not killed, then the effectiveness of pour-ons

must be questioned where farmers cannot guarantee a continuous supply. If improved tick control has led to a greater-than-expected impact of pour-ons on trypanosomiasis incidence, the potential of ticks developing pyrethroid resistance³¹ carries a double-threat: increase in tick burden *and* a reduced effect of pour-ons as a means of controlling trypanosomiasis. If pour-ons stop mechanical transmission, they may be especially effective at controlling those trypanosomes exclusively transmitted this way, such as *T. evansi* among camels and other livestock in Africa and Asia³², or *T. vivax* among cattle in South America³³. Finally, if local tsetse control at the corral where cattle spend the night is sufficient to cause a large reduction in the incidence of trypanosomiasis, costs may be significantly reduced by reverting to traps and targets for tsetse control, but in the immediate vicinity of the corral only. The exact mechanism of action of pour-ons should now be investigated, with some urgency, in order to tailor their use for maximum impact on the trypanosomiasis.

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LEGENDS

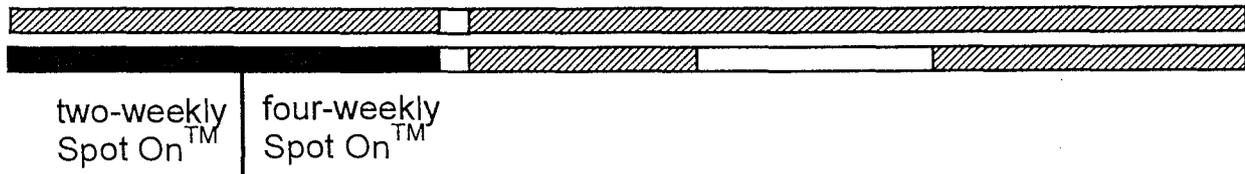
Fig. 1. Location of the control and treatment areas of the Spot On™ trial at Galana Ranch.

Kapangani, cattle untreated; Dakabuku, cattle treated with Spot On™. Rainfall was recorded at Tank E. Large populations of *Glossina pallidipes* occupy the wetter, eastern half of Galana ranch, with a restricted dry-season (lightest shading) and extended wet-season (darker shading) distribution. Thin lines show seasonal rivers.

Fig. 2. The apparent density (mean daily trap catch) of *Glossina pallidipes* at two areas (approx 10 km apart) of Galana Ranch where cattle either were (Dakabuku; open triangle, dashed line) or were not (Kapangani; closed triangle, solid line) treated with Spot On™. *Glossina pallidipes* were collected using odour-baited biconical traps for two days per fortnight at six sites at Kapangani, and eight sites at Dakabuku. Trap catches were halved, log transformed and averaged for each area. Detransformed catches were then averaged for each month. Bars at the top indicate the timing of events. Solid bars at the bottom show the total monthly rainfall at a site approximately 20 km from Kapangani and Dakabuku.

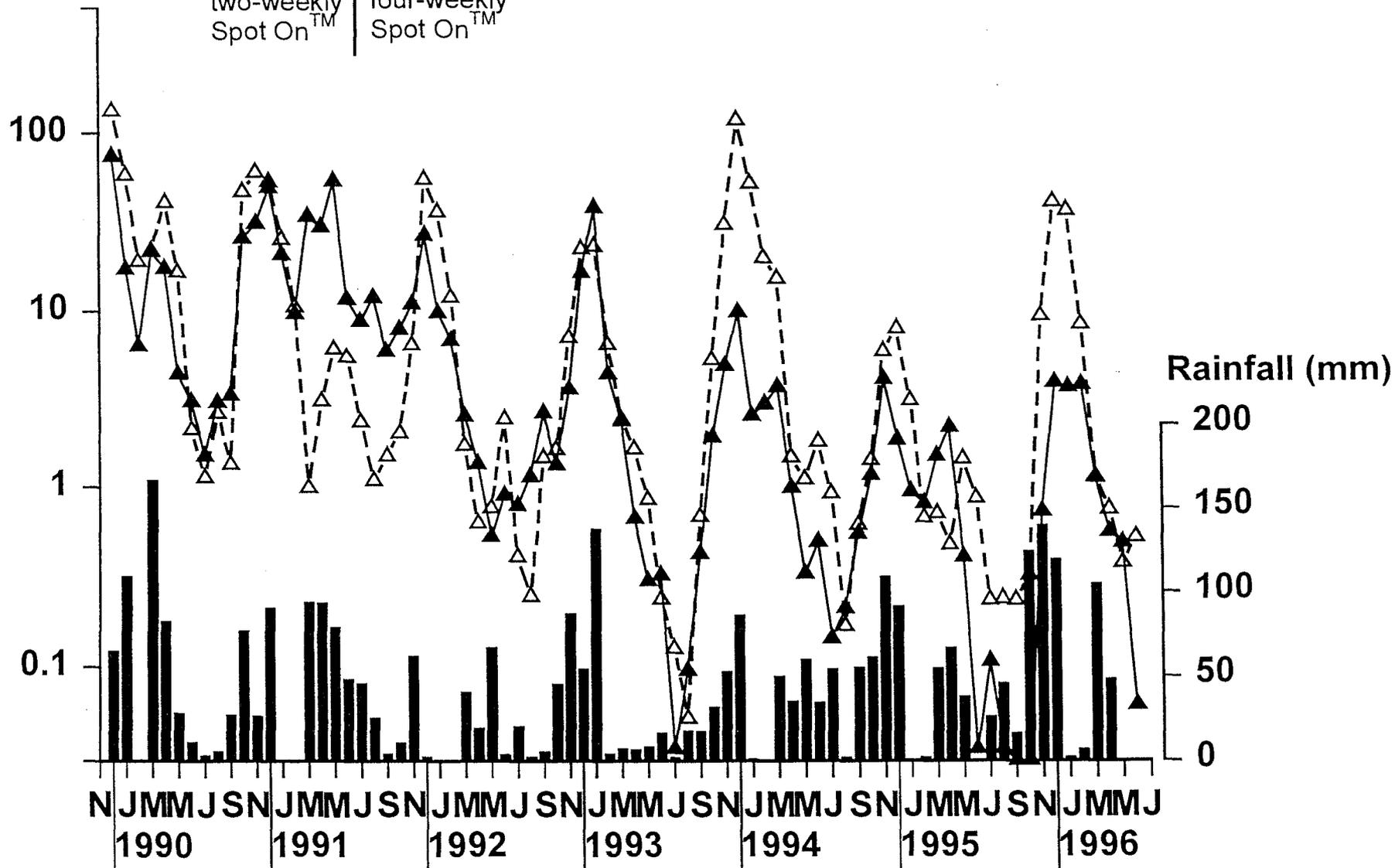
Fig. 3. The observed (upper bars) and predicted (lower bars) incidences of trypanosomiasis from April 1990 to June 1996 at two areas of Galana Ranch, Kenya where cattle either were (Kapangani) (a) or were not (Dakabuku) (b) treated with Spot On™ until June 1992. Incidence (% infected per week) was recorded weekly by sampling 40 cattle at each area. The apparent densities of *Glossina pallidipes* and *G. longipennis* were recorded at two-weekly intervals. For the period when cattle were in both areas but no Spot On™ was used at Dakabuku (August 1992 - September 1993 and January 1995 - June 1996) the apparent densities were compared with the two-weekly moving average of incidence 0-1, 1-2, 2-3, 3-4 and 4-5 weeks later. At both sites, the strongest relationship was between (log) apparent density and incidence 2-3 weeks later (Kapangani: $\text{Incidence}_{2,3} = 0.14 + 5.0 \cdot \ln Gp + 5.9 \cdot \ln Gl$; $r^2 = 60.5\%$. Dakabuku: $\text{Incidence}_{2,3} = -1.1 + 7.3 \cdot \ln Gp + 2.5 \cdot \ln Gl$; $r^2 = 72.3\%$). These regression equations were then used to calculate predicted incidences of trypanosomiasis for the entire period.

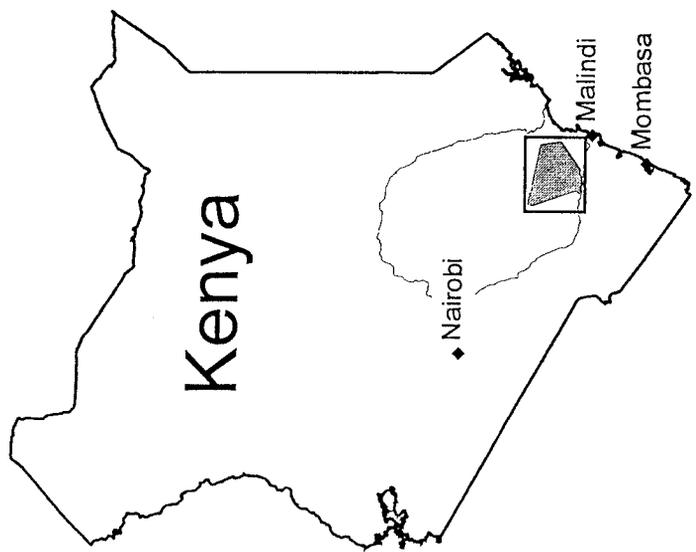
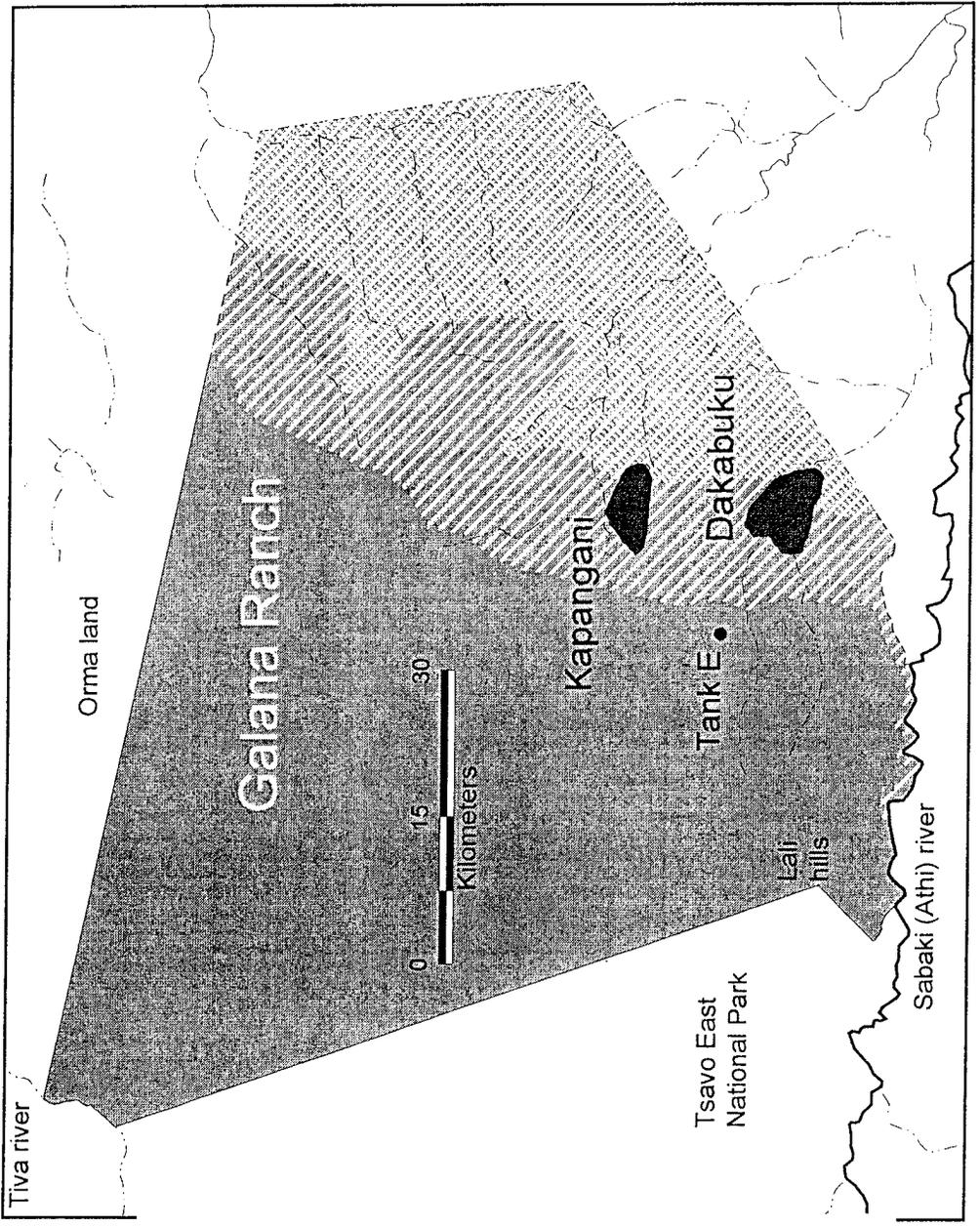
▲ Kapangani
△ Dakabuku



■ Cattle + Spot On^T
▨ Cattle not treated
□ No cattle

G. pallidipes/trap/day





ERADICATION OF *GLOSSINA MORSITANS MORSITANS* AND *GLOSSINA PALLIDIPE* IN THE KARIBA HILLS OF SIAVONGA, SOUTHERN ZAMBIA.

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Abstract

Eradication of G. M. Morsitans and G. Pallidipes in the Kariba hills of Siavonga, southern Zambia was realised when similar and complimentary control operations were carried out in Zimbabwe.

Initial efforts were made to control tsetse flies on the Zambian side without doing so on the neighbouring Zimbabwe during a period of 36 months (November 1991-November, 1994) using odour-baited, insecticide impregnated screens or targets. In 1991, an initial 3.6 targets/Km² were deployed in an area of 90 Km². This figure was increased to 6.8 targets/Km² in 1993 and the area was expanded to 165Km². However, these changes made on the density of targets did not reduce the tsetse population apparent density. Instead, an opposite trend was observed so that apparent density of the tsetse flies increased with increase in target density. Tsetse fly density rose from 0.005 flies/trap/day prior to control in July 1991 to a maximum of 0.238 flies/trap/day in April 1994. This gradual increase in fly population was consistent with that of trypanosomiasis disease incidence. Four months after embarking on a similar complementary control in the adjacent area of Zimbabwe, the apparent fly density dropped to zero. No tsetse or trypanosomiasis disease cases have been reported (on the Zambian side) ever since.

BACKGROUND

Kariba hills forms part of the Zambezi escarpment. It rises from an altitude of about 150m to 900m. Mean monthly temperatures range from 26.5 C in June to a maximum 42.5 C in October. It is characterised by low rainfall figures of about 400mm annually. The vegetation mainly consists of mopane woodland, *Acacia*, *Tamarindus* and *combretum* species. The area is divided into 2 and deeply cut by Lake Kariba on its south-western limits and by the Zambezi thereafter along the north east direction. The 2 divisions are shared by Zambia on one hand and Zimbabwe on the other. An International boundary runs along the Kariba and Zambezi to assume separate sovereignty of the divided area. It is characterised by a highly broken terrain with steep hills and deep valleys underlying most of its lower parts. Tsetse control in the surrounding areas of the Kariba hills was started as far back as 1988. No control operations would be undertaken in the Kariba hills then since it was believed the weather conditions in the area were too severe for tsetse flies to survive and for another reason that the game and livestock population is too low for the tsetse flies to survive. In contrast, the Zimbabwe side has abundant food source (game). The area is sparsely populated with virtually

In 1991, tsetse flies were almost eradicated from the surrounding areas of the Kariba hills. It was during this time that it was realised a “time bomb” could be left behind with which, once detonated, would re-infest the cleared areas of the whole Gwembe Valley. A total of 2 *G. pallidipes* were caught from 360 trap days done, thus, giving a total of 0.006 flies/trap/day. In view of this, we decided to deploy targets, charge them with odours and insecticide and leave them to wipe out the remnant tsetse population. However, it was later on realised that the tsetse problem in this area was grossly underestimated as will be shown below.

INTRODUCTION

The advent of the odour-baited, insecticide-impregnated screens commonly known as targets have provided ultimate solutions in tsetse control undertakings. Vale and Hargrove (1986) demonstrated that, both *G.m. morsitans* and *G. Pallidipes* were killed by contact on the treated surface after being attracted to it. Compared to other conventional control techniques, they are cheaper, environmentally friendly and have proven technically and practically feasible for use in a wide range of terrain (Shereni, 1990). Efforts made to eradicate tsetse flies have been enormous and wide spread and at most frustrating due to failure to achieve anticipated results. Some of the reasons which have been attributed to these failures are; inappropriate techniques and other limitations associated with them, lack of effective planning and management capabilities among tsetse control organisations (V. Chadenga, 1995) and above all, difficulties associated with protecting gains especially in areas with high invasion pressures and wide tsetse distribution. Such is true of most of the tsetse infested areas of Zambia and other central, eastern and southern African states. It is for this reason that eradication of tsetse flies has remained elusive despite huge financial investments made to eradicate tsetse flies during recent years (V. Chadenga, 1995).

Use de cas réussis de pulvérisation
 Successful stories recorded on eradication of tsetse flies are few compared to the number of attempts made to eradicate them. Targets have proved to be ultimate tools for tsetse eradication of the *G.morsitans* and *G. Pallidipes* (Vale and Hargrove, 1986). The earliest eradication success stories include that of the Rifa Triangle in Zimbabwe where both *G.m. morsitans* and *G. Pallidipes* were reduced by 99.99% after a period of 18 months when targets were deployed at 4 targets/Km² (Vale, et. al., 1988). In addition, *G. Pallidipes* was eradicated from Gokwe, north west Zimbabwe when both targets and cattle dipping (with Deltamethrin) were used (Shereni, 1990). In Ghibe Valley, Ethiopia, *G. Pallidipes* population was brought down to between 78.9%-95.3% using targets within a period of 3 months (Mulata, W., et al., 1991). Similarly, S-Targets were used on the Galana ranch in Kenya against *G.pallidipes*, *G. Longipennis*, *G. Austeni* and *G. Brevipalpis* where 87.63% and 99.95% reduction were achieved from blocks A and B respectively on all spp except *G. Longipennis* (Opiyo, E.A. et al.). In addition to targets, traps have had successful eradication stories on riverine spp of tsetse when used on their own or impregnated with an insecticide. *G. Tachnoides* population was reduced to 99.98% using biconical traps after 4 months where as on the hand, the same sp and *G. palpalis gambiensis* were reduced to 98.7% and 92% respectively after a period of 4 months using blue targets impregnated with Decamethrine (Laveissiere, C. And Couret, D., 1981).

Materials and Methods

Tsetse monitoring

The first tsetse surveys were conducted in July and August, 1991. A total of 53 linear black screen fly rounds baited with acetone and phenols were conducted. These tsetse surveys covered a total of 225 Km². During this same period, a total of 40 Epsilon traps baited with acetone and phenols were used to complement the black screen fly rounds from which a total of 1,760 trap days were done. In both cases, acetone was dispensed from a 500 ml bottle without a lid where as on the other hand, a 4 gm phenol sachet consisting of 3-n-propylphenol, 1-octen-3-ol and 4-methylphenol in the ratios of 1:4:8 respectively was used.

Results of the tsetse surveys described above necessitated the establishment of permanent marked fly rounds (using traps) in December, 1991. As a starting point, 3 permanent marked fly rounds were established though these were increased to 4 in March of the same year. In all cases, traps were deployed about 500m apart from each other. Tsetse catches from traps were collected every other day. More traps were added to the existing ones until in 1994 when a maximum of 106 traps were deployed.

Target deployment

Deployment of targets started in September, 1991 so that by November, of the same year, a total of 320 all black Swinger type targets were deployed randomly in an area of 90 Km² giving a density of 3.6 targets/Km². In view of the rough terrain, aerial photographs were used to identify sites which would be deployed with targets. All targets were deployed on sites which were thought would be accessible by the deployment team. All targets were treated with 0.6% Glossinex (Deltamethrin) 20% SC. They were baited with acetone and phenol sachets similar to those used during tsetse monitoring. They were maintained once every 9 months, that is from June-August, 1992. Both government and the RTTCP staff were used to undertake this work.

Between July-November, 1993, a totally different target deployment pattern was used. Targets deployed earlier on were discarded as a result. The new targets were deployed in relatively accessible parts of the hills along drainages. Where as, they were placed at 250m apart along the main drainages, they were deployed at 150m intervals along the subsidiary drainages. A total of 1,127 targets were deployed in an area of 165Km², hence, maintaining a density of 6.8 targets/Km². The application rates and odour baits used were the same as those used earlier on in 1991 except, the ratio combination of the odour baits changed to 1:6:12. The first maintenance of these targets were carried out from June-September, 1994 when initially, Glossinex was applied on targets at 0.1% and later substituted for Fastac (Alpha-Cypermethrin 10% SC) at 0.15% in August, 1994. A 3 month target maintenance interval followed thereafter. Complimentary control efforts were made on the adjacent lying areas of Zimbabwe where in November, of the same year, a total of 1,463 targets were deployed.

From January, 1995 onwards, government/project staff were substituted for privately contracted teams. In addition, target maintenance intervals were extended from 3 to 6 months.

Trypanosomiasis monitoring

Trypanosomiasis monitoring using sentinel herds of 20 cattle were set up in August, 1988. There was only one herd at this time. The number of herds increased through the years to a maximum of 5 in 1995. All sentinel herds were eartagged. These herds were spread around the margins of the Kariba hills except for one which was right in the hills. Trypanosomiasis monitoring was carried out once every month. All cattle were administered with an initial dose of berenil at 7mg/Kg body wt. The same dose was used during subsequent visits except only sick animals were treated this time. A direct diagnostic detection technique was used to determine the presence/absence of trypanosomes. Blood was collected from the marginal ear vein. Blood was collected using a micro capillary tube. A drop of blood was transferred to a slide in order to prepare a thick dry blood smear. The resulting smear was stored in a slide box for onward examination at the station. The capillary tube was then transferred to a centrifuge and spun for 5 minutes. The capillary tube was broken between the buffy coat and the plasma. A drop of blood from the buffy coat was transferred to a slide for a wet smear examination of trypanosomes. A X 40 objective was used to examine presence/absence of trypanosomiasis disease. A total of 20 fields were examined for every slide. On average, 2 sentinel herds were attended to per day. All sampling work was carried out in the morning between 8:00-11:00 hrs.

Results

The initial tsetse surveys which were conducted in July and August, 1991 revealed very low tsetse fly density. A total of 4 *G.pallidipes* female tsetse flies were caught giving an apparent fly density of 0.005 Flies/trap/day. From this time on, the population declined until February of the following year when it reached 0.0655 flies/trap/day. As was the case during the previous year, the population again dropped to its lowest level in September of the same year before it picked up again to assume a maximum peak of 0.067 flies/trap/day in March, 1993. A similar trend was repeated during the preceding year until the fly density reached the highest peak of 0.2375 flies/trap/day in April, 1994 during the control period. Similarly, *G. m. morsitans* reached a maximum apparent tsetse density of 0.0067 flies/trap/day during this same period. Compared to *G.pallidipes*, the *G.m.morsitans* population was very low throughout with the result that a 1:9 sp ratio was recorded. The males:females sex ratio of *G.m.m.* and *G.p* was 2:8 and 3:7 respectively. Most tsetse flies were caught from 2 trap lines only.

From April, 1994 onwards, the tsetse apparent density for both spp continued dropping and reached zero in November, 1994 for *G. morsitans* and in July, 1995 for *G. pallidipes*.

A similar trend of results were observed on the trypanosomiasis disease situation so that in general terms, the incidence always reached a yearly maximum during March to April of each year. No tryps disease case has been recorded since April, 1996.

Discussion

field for about 9 months to wipe out what was considered at the time, “a remnant pocket of tsetse flies.” However, it was not long before it was realised that the tsetse situation in the area was not as low as we had earlier thought. It is for this reason that a different approach to target deployment was used so that unlike during the first deployment stage when targets were deployed in relatively accessible areas, this one was restricted to suspected tsetse habitat areas along river drainages. In addition, target density was increased to 6.8 targets/Km².

The number of tsetse flies caught increased with time due to improvements in tsetse trapping techniques. In addition, the persistent drought during the late 1980s may have greatly affected fly survival. Both tsetse population density and trypanosomiasis disease situation were not reduced despite changes made in deployment patterns and an associated increase in density due to the fact that there was heavy re invasion pressure from Zimbabwe just across the Zambezi river. Tsetse flies thrived in Zimbabwe due to abundant food resource. Whilst on the other hand, they failed to establish themselves on the Zambian side due to inadequate food. Invading tsetse flies may have got killed 2-3 days following invasion. However, the population would not be reduced due to continuous replenishment into the control area. However, that tsetse could be caught from 2 trap lines clearly shows that their movement can be highly localised and restricted to particular habitats/routes. In addition, these are clear signals that it is so easy to miss out tsetse flies in localised tsetse infested areas. The fact that tsetse fly population dropped to zero following complimentary control efforts made by Zimbabwe shows just how effective targets can be. This work provides evidence to support and recommend control of tsetse starting from the source of invasion towards migratory or expansion direction and not from fly front. This work provides evidence to support and recommend control of tsetse starting from the source of invasion towards migratory or expansion direction and not from the fly front.

Clearly, huge financial investments are lost through inappropriate planning and management of tsetse control operations. Indeed a good amount of resources would have been saved had we realised the source of the problem. In addition, this is clear testimony that, it is impossible to eradicate tsetse flies whose infestation is shared by more than one country. Situations of this nature should call for regional collaboration and integration of tsetse and trypanosomiasis disease control efforts. There is need to identify priorities, co-ordinate them with neighbouring stake holders and identify those which can commonly be harmonised.

Acknowledgements

We are indebted to the government of the republic of Zambia and the European Union who provided financial assistance to undertake this work. In addition, the support given by the Field Assistants; Messrs Beezer Njovu, Harding Chisanga, the late John Shabaiche and Bradwell Cheemu is greatly appreciated.

CONTROL OF TSETSE AND TRYPANOSOMOSIS USING A COMBINATION OF TSETSE TRAPPING, POUR-ON AND CHEMOTHERAPY ALONG THE UGANDA-KENYA BORDER

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ABSTRACT

A Joint tsetse and trypanosomosis control programme has been going-on along the Uganda-Kenya border since July 1991. A combination of tsetse trapping, pour-on and chemotherapy was used. Implementing departments in Uganda and Kenya harmonized control strategies on either side of the border. To facilitate harmonization of control strategies, the project area was subdivided into zones A, B and C. Monitoring of the prevalence of animal trypanosomosis and tsetse apparent density was carried out from January 1992 to March 1997. Control strategies adopted varied according to zones. In zone A, large-scale application of pour-on on cattle was done initially then followed by regular trapping and selective chemotherapy. In zone B, trapping of tsetse flies and regular selective chemotherapy were carried out throughout the control period. While in zone C, block treatment of cattle with diminazene aceturate (Beremil, Hoechst) in the entire zone, and small-scale trapping of tsetse flies were carried out initially. Thereafter, trapping was maintained and regular chemotherapy carried out. To monitor the success of control, a total of 400 cattle in each zone were screened every three month and tsetse apparent density determined every month. In zone A, an initial reduction of 94% and 99.5% in the prevalence of animal trypanosomosis and tsetse apparent density, respectively, was achieved and maintained from July 1991 to June 1995. From June 1995 to March 1997, the prevalence of animal trypanosomosis declined gradually but persistently by 89% from July 1991 to June 1996 then it increased and remained high up to March 1997. Tsetse apparent density dropped by 99.5% and was maintained low up to December 1995 when it increased slightly until March 1997. In zone C, the prevalence of animal trypanosomosis and the tsetse apparent density dropped by 79% and 95%, respectively, from July 1991 to December 1992. From December 1992 to March 1993, there was an upsurge in both the prevalence of trypanosomosis and tsetse apparent density. A single application of pour-on followed by reinforced trapping and regular selective chemotherapy led to the decline of both prevalence of animal trypanosomosis and tsetse apparent density from March 1993 to June 1995. From June 1995 to March 1997 the tsetse apparent density was kept low but the incidence of animal trypanosomosis increased beyond pre-control levels. During control, the commonest *Trypanosoma* species found were: *T. vivax* in zone A, *T. vivax* and *T. congolense* in zone B and *T. vivax*, *T. congolense* and *T. brucei* in zone C. *Glossina fuscipe fuscipe* was the only tsetse fly species caught.

The most effective control strategy was large-scale application of pour-on initially, followed by trapping and regular selective chemotherapy. However, the effectiveness of control seemed to be influenced by the level trypanosome challenge in the area, speed of initial reduction in tsetse density and sustainability of supply of tsetse and trypanosomosis control inputs during the campaign.

INTRODUCTION

Tsetse flies (*Glossina spp.*) infest approximately 40% (9.5 million km²) of the land resources of Tropical Africa (Jahnke and Tacher, 1988), covering 37 countries (Holmes, 1991). Tsetse belts and therefore the distribution of trypanosomosis often transverse National boundaries.

Currently, no effective vaccine against trypanosomosis has been developed and natural infection generally fails to result into protective immunity. Control of animal trypanosomosis therefore relies on vector control, use of trypanocidal drugs and keeping of genetically resistant or trypanotolerant breeds of livestock. Effective implementation of chemoprophylaxis and chemotherapy requires accurate diagnosis of trypanosomosis based on modern diagnostic tools (Alsop, 1994).

All available control methods have their advantages and disadvantages. Hence, no single control method is the best option in every situation. The choice of method for use in a given area is influenced by the local situation, availability and cost-effectiveness of the method, and the epidemiology of the disease. There is need, therefore, to develop integrated control strategies involving vector control, chemotherapy and chemoprophylaxis, and keeping of trypanotolerant breeds of livestock. Since the distribution of tsetse and trypanosomosis is independent of National boundaries, implementing of the integrated control strategies should be carried out through regional campaigns involving two or more countries. This paper gives the outcome on the Ugandan side of a tsetse and trypanosomosis programme jointly carried out by Uganda and Kenya along the common border.

MATERIALS AND METHODS

Study area

The project area is located in Tororo district of Uganda between latitudes 0° and 0° 45' North and longitudes 34° and 34° 15' East. It covers an area of about 90 km long and 15 km wide. At the beginning of the control programme in 1991 the livestock population in the project area was estimated to be 50 000

1500 mm of rainfall annually . The rainfall pattern is bimodal with two wet seasons (March -June) and (October-November), and two dry seasons (December-February) and (July-September). The mean relative humidity is 65% and daily mean temperature is between 29^o C (min.) and 36^o C (max.). The vegetation cover is mainly Savannah grassland. *Glossina f. fuscipes* is the commonest tsetse species infesting the area especially along vegetation fringing rivers and streams.

Tsetse and trypanosomosis control

The project area was subdivided into zones A, B, C and D for purposes of harmonization of control strategies applied on either side of the Uganda-Kenya border. Various tsetse control methods were integrated with treatment of livestock (cattle, goats, sheep and pigs) for trypanosomosis depending on whatever combinations were deemed appropriate for a particular situation. However, use of deltamethrin impregnated traps and chemotherapy were the methods most applied, mainly for maintaining tsetse and trypanosomosis control in the entire project area. Different strategies were tried out in zones A, B and C at the beginning of the control programme for purposes of obtaining a quick suppression of both tsetse and trypanosomosis.

In zone A, initially deltamethrin Pour-on was applied on cattle at a rate of 10 ml per 100 kg body weight in the entire zone followed by deployment of deltamethrin impregnated traps (Lancien and Gouteaux, 1987) at rate of 8-10 traps per square km. and livestock regularly screened for trypanosomosis using the Haematocrit Centrifugation Technique (HCT) (Woo, 1969) and Thin and thick blood smears, and those detected positive for trypanosomosis were treated with diminazene aceturate at 7.0 mg/kg body weight.

In zone B, deltamethrin impregnated pyramidal traps were deployed at 8-10 traps per square km in the entire zone and livestock were screened regularly and treated as in zone A.

In zone C, initially block treatment of cattle was carried out followed by deployment of deltamethrin impregnated pyramidal traps at a rate of 4-5 traps per square km and regular examination of livestock for trypanosomosis and

Monitoring of tsetse and trypanosomosis control

To monitor animal trypanosomosis, 400 cattle from each of zones A, B and C were examined every 3 months for trypanosomosis, using the Buffy Coat Technique (BCT) and the prevalence determined. Trypanosoma species identification was confirmed by stained thin blood smear.

To monitor tsetse apparent density, tsetse trapping was done monthly in each of the zones A, B and C. Twenty biconical traps were deployed in the field and left for 48 hours but checked twice per day. Tsetse apparent density was calculated according to number of tsetse flies caught.

RESULTS

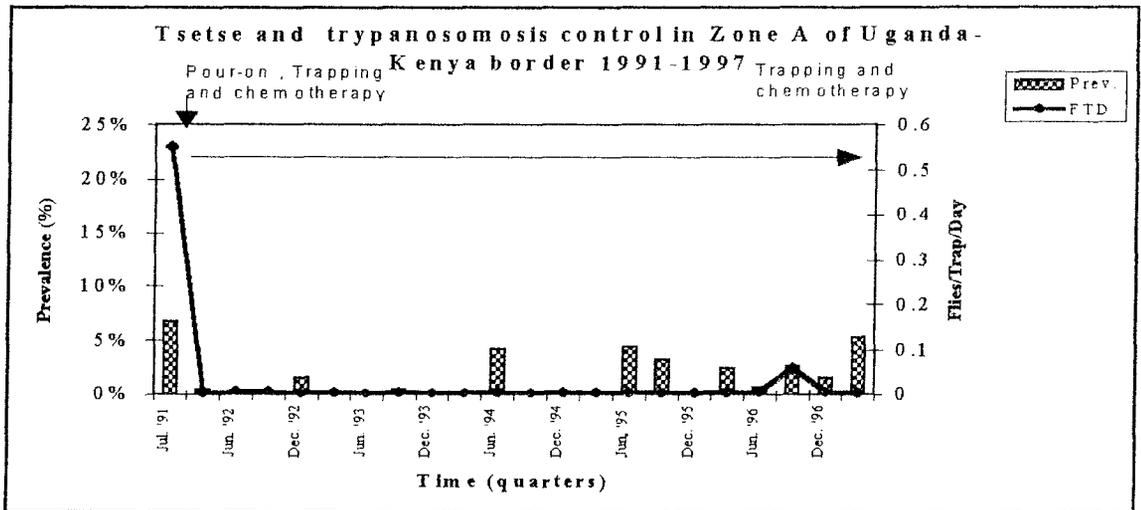


Fig. 1: Prevalence of trypanosomosis in cattle ($n = 400$) and tsetse apparent density in zone A of the Uganda-Kenya border, 1991-1997

In zone A, an initial reduction of 94 % (6.7%→ 0.4%) and 99.5% (0.55→ 0.003 F/T/D) in the prevalence of trypanosomosis and tsetse apparent, respectively, was achieved and maintained from July 1991 to June 1995. From June 1995 to March 1997, the prevalence of animal trypanosomosis increased slightly but tsetse population was maintained low (Fig.1).

In zone B, the prevalence of animal trypanosomosis declined gradually but persistently by 89% (12% → 1.3% from July 1991 to June 1996 then it rose and remained high until March 1997. Tsetse apparent density dropped by 99.3% (0.44 → 0.003 F/T/D) and remained low up to December 1995 when it increased slightly until March, 1997 (Fig. 2)

In zone C (Fig. 3), the prevalence of animal trypanosomosis and tsetse apparent density dropped by 79% (17% → 3.0%) and 95% (0.65 → 0.03 F/T/D), respectively, from July 1991 to December, 1992. From December 1992 to March 1993 there was upsurge in both prevalence and tsetse apparent density. A single application of pour-on followed by re-inforced trapping at rate of 8-10 traps per square km coupled with chemotherapy led to a decline in the prevalence of trypanosomosis and tsetse apparent density from March 1993 to June 1995. Tsetse apparent density remained low but the prevalence of trypanosomosis increased beyond pre-control levels.

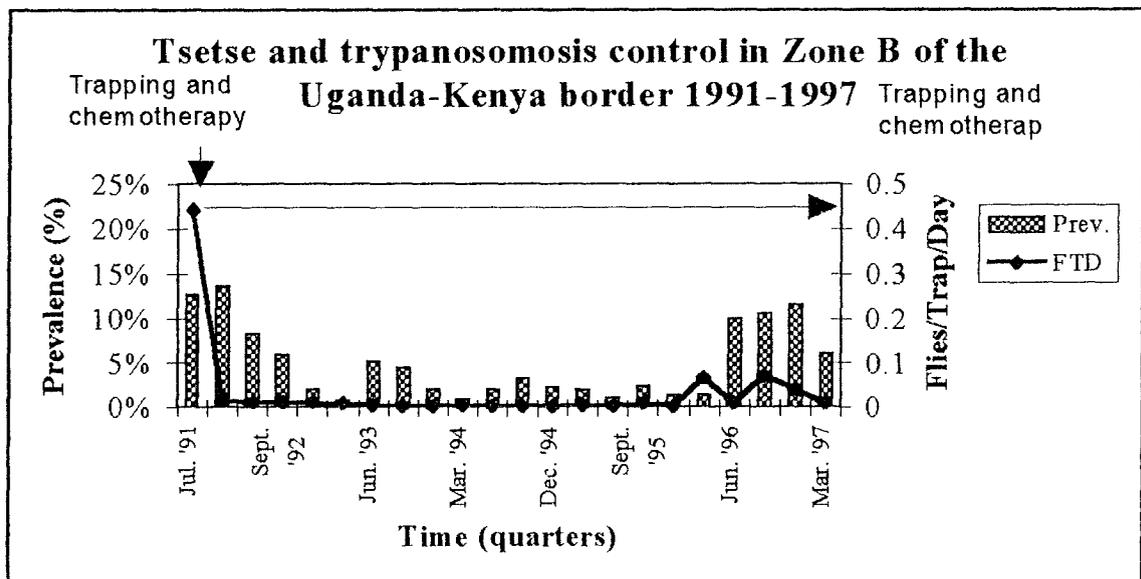


Fig 2: Prevalence of trypanosomosis in cattle (n = 400) and tsetse apparent

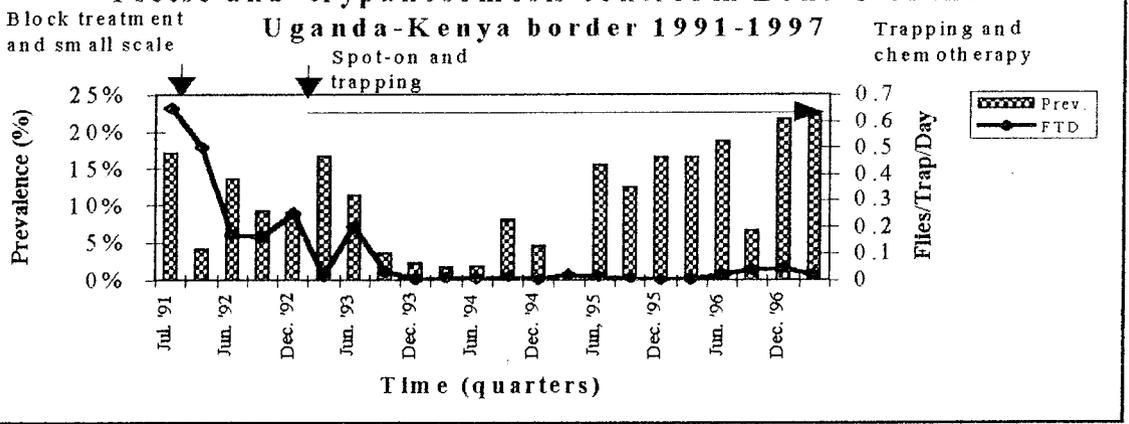


Fig. 3: Prevalence of trypanosomosis in cattle (n = 400) and tsetse apparent density in zone C of the Uganda-Kenya border, 199-1997

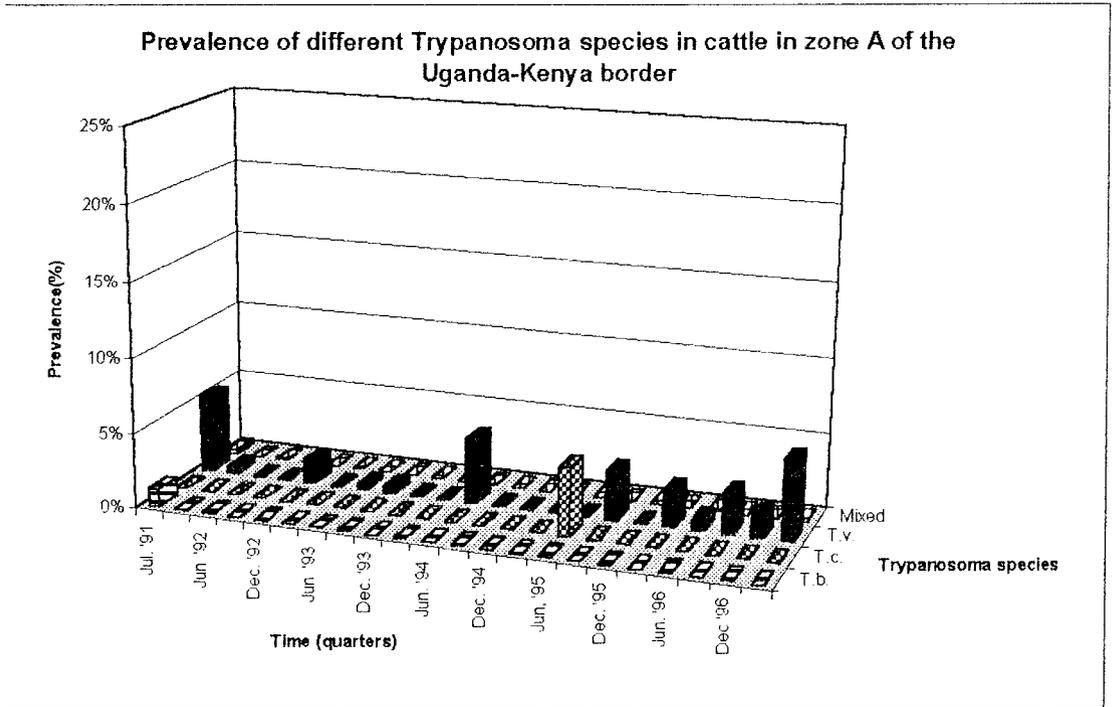


Fig. 4: Prevalence of different trypanosoma species in zone A of the Uganda-Kenya border during control

Trypanosoma vivax was the most predominant in zone A, during control (Fig. 4). However, in zone B, both *T. vivax* and *T. congolense* were common (Fig. 5) and in zone C, all the three trypanosoma species (*T. vivax*, *T. congolense* and *T. brucei*) were observed.

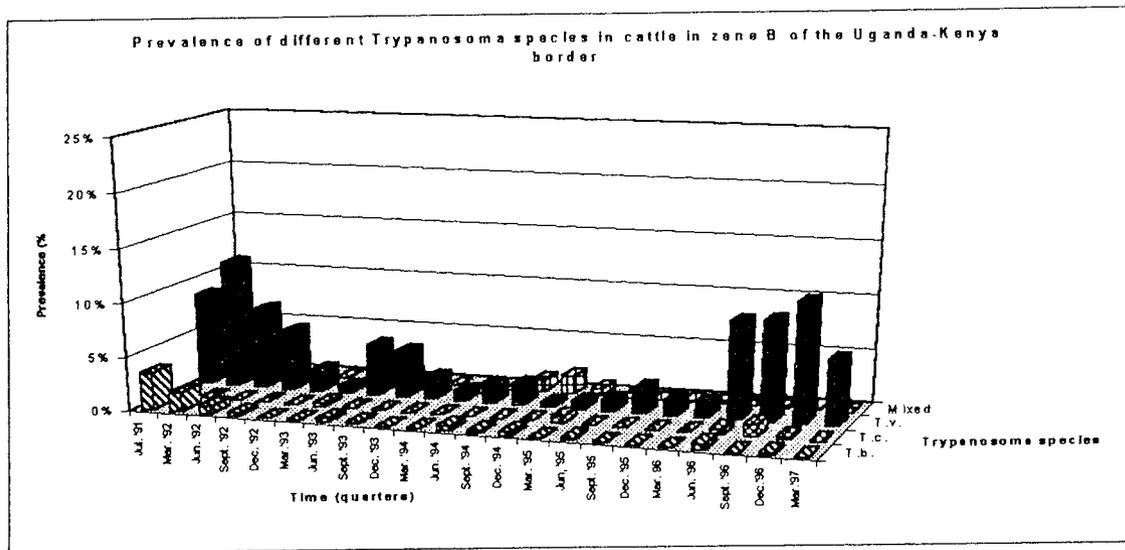


Fig 5: Prevalence of different Trypanosoma species in zone B of the Uganda-Kenya border during control

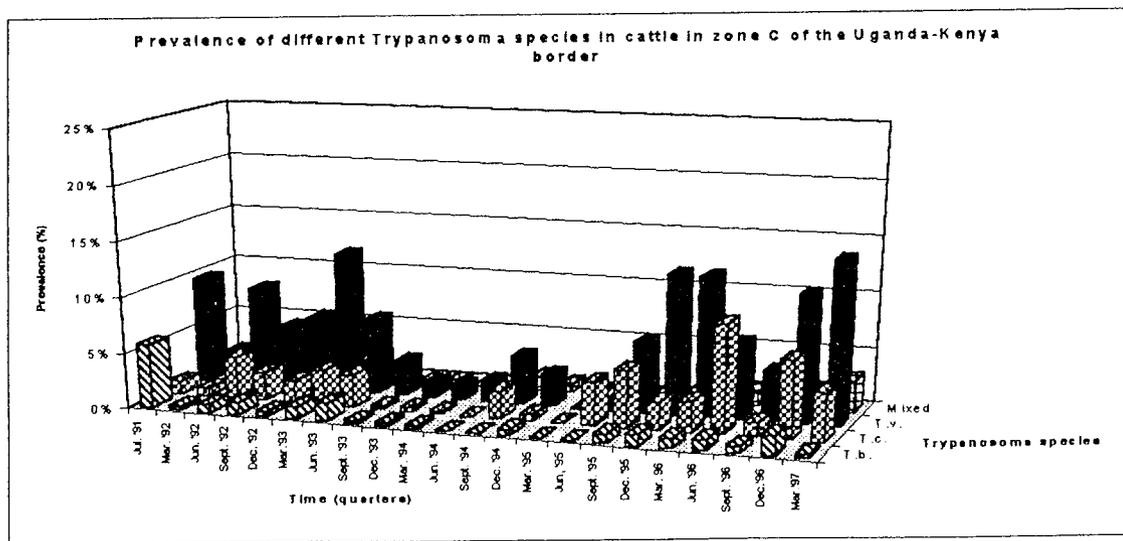


Fig 6: Prevalence of different trypanosoma species in zon C of the Uganda-Kenya border during control

DISCUSSION

The tsetse and trypanosomosis control programme was initially effectively implemented but starting from late 1995 there was shortage of control inputs (drugs, cloth for trapping making, and funds for logistics) so the prevalence of trypanosomosis and tsetse apparent density increased. It is observed that as tsetse trapping goes on and animals are treated, *T.vivax* becomes increasing predominant while *T. congolense* and *T. brucei* infections become fewer. It appears tsetse flies are sooner or later killed within few days of life that only *T.vivax* which needs the least number of days for development in the fly will have reached infective stages and therefore get chance of being transmitted to the animal hosts.

CONCLUSION

Results show that initial large-scale application of pour-on followed by trapping and regular treatment of livestock appeared to be the most effective control strategy. However, the effectiveness of the control programme seemed to be influenced by the level of trypanosome challenge in the area, speed of initial reduction in tsetse density and sustainability of tsetse and trypanosomosis control inputs during the campaign.

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Presentation for ISCTRC, Maputo

The successful application of the sterile insect technique (SIT) for the eradication of *Glossina austeni* (Diptera: Glossinidae) from Unguja island (Zanzibar)

L'éradication de *Glossina austeni* (Diptera: Glossinidae) de l'île d' Unguja (Zanzibar) à l'aide de la technique d'insectes stériles

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l'application réussie de la technique
 d'insectes stériles pour l'éradication
 de Glossina austeni Newstead
 (Diptera : Glossinidae) de l'île de
 Unguja au Zanzibar

SLIDE Title

The debilitating disease trypanosomosis was first diagnosed on the island of Zanzibar in 1908. It was however, only in 1945 that the vector of the disease was discovered; the tsetse fly *Glossina austeni*. An island wide survey, conducted in the early fifties, revealed that *G. austeni* was widespread but that no other tsetse species were present on the island. On average 17% of the screened cattle were infected with predominantly *Trypanosoma congolense* and to a lesser extent *T. vivax*. It has been estimated that 2 million US\$ is annually lost in terms of milk and meat production and in terms of veterinary services for disease control. In addition, the use of draught oxen and the upgrading of local cattle through breeding with exotic breeds have always been impossible.

SLIDE Unguja island - Cow

Unguja island is situated in the Indian ocean, 35 km off the coast of East Africa and covers a total land area of 1,650 square km. of which 900 square km is considered to be suitable tsetse habitat.

SLIDE Spot on

In view of the isolated location of the island, the government of Zanzibar favoured complete elimination of the vector as re-invasion from mainland Tanzania is highly unlikely. From 1988 till 1993, the Government embarked on an island wide eradication effort using pour-on insecticides on livestock and blue cotton insecticide impregnated screens in those

areas where cattle was absent. All these efforts resulted in good suppression of the fly population but eradication was not achieved.

SLIDE IIS

In important tsetse areas, such as the Jozani forest, blue cotton screens had to be deployed for 18 months at densities of 30 -70 screens per square km to reduce the fly population by 80 - 90 %.

SLIDE IAEA AIEA

Therefore, a project was initiated in January 1994, with the technical assistance of the International Atomic Energy Agency to integrate the sterile insect technique with the already ongoing fly suppression programmes.

SLIDE Airport Tanga

The sterile flies were produced at the Tsetse and Trypanosomiasis Research Institute located in Tanga ~~on~~ Tanzania mainland. A poster dealing with the rearing and male handling procedures is presented in this meeting.

SLIDE Loading cartons

The sterile flies were packed in release cartons, containing between 50 and 200 flies each. They were collected at Tanga airport every Tuesday and Friday and dispersed by air using both single and twin-engine aircraft.
bimoteur

SLIDE Chute

All aircraft were equipped with a special licensed chute for easy dispersal of the boxes.

SLIDE Disperser

The release of the fly boxes was carried out by a disperser assisted by the release co-ordinator. The interval of dropping the boxes through the chute varied from 2 - 30 seconds, depending on the habitat. Flies were released at an altitude of 700-900 feet at a speed of 100-130 miles per hour.
oppose'

SLIDE flight lines

The dispersal of the flies was done along specific flight paths which were separated by 1 to 2 km swaths. All dispersal flights were navigated using the global positioning system allowing very accurate navigation and easy modification when required.

SLIDE plane over Jozani

On Tuesday morning, releases were conducted in the southern half of the island, whereas on Thursday afternoon or Friday morning, the middle and northern part were covered.

SLIDE LP

Sampling of the *austeni* population was done with sticky blue-white legpanels as conventional tsetse traps are inefficient for monitoring populations of *austeni*. To trap the flies, all panels were made sticky with a non-setting adhesive. The panels were checked from once every day to once a week and replaced every week. The sampled females were dissected for assessment of their reproductive status and to determine the proportion of females having mated with a sterile fly.

n^o couples

SLIDE Map FMS

A total of 55 fixed monitoring sites were established on the island as representative sampling areas. Each fixed monitoring site comprised an area of approximately 1 km² and contained at least 5 sticky panels. More than 500 sticky panels were deployed on the island at any given time.

SLIDE Map Vet Blocks

In addition to the entomological monitoring activities, an extensive parasitological monitoring programme was established whereby the entire

island was divided into 38 blocks, each containing a sentinel herd of 30-40 animals. Blood samples were taken every 2-5 months and examined for the presence of trypanosomes using the Micro Haematocrit Centrifuge Technique and the more sensitive Dark Ground Expressed Buffy Coat. Animals which were found to be positive received immediately a treatment of Berenil.

SLIDE Numbers flies released

This slide presents the weekly numbers of sterile males released by air over Unguja since the initiation of the aerial release programme in August 94. A total of 7.8 million sterile male flies have so far been dispersed by air over the island with a peak distribution of 110,000 males per week in mid 1996.

SLIDE ratio

The ratio of sterile: wild male flies in the Jozani forest is presented in this graph. Until mid-April 1995, the ratio of sterile to wild males remained below 10:1. As we have noticed in the previous graph, the number of flies released increased dramatically thereafter, and since the 3rd week of August '95, the ratio of sterile:wild males was consistently higher than 50:1.

SLIDE IS

This slide presents the proportion of young female flies showing evidence of having mated with a sterile male. During the period when the ratio of sterile:wild males remained below 10:1, between 20 and 26% of the young sampled females were induced sterile. Five to 15 weeks after reaching a ratio of 50 sterile to 1 wild males, this rate of induced sterility increased to on average 72%. In 1996, only 8 young females were sampled and 6 of them had mated with a sterile male.

SLIDE AD

This last graph presents the fluctuations of the wild fly population on Unguja island since the initiation of the aerial release programme in August 94. Initially, the fly population remained fairly stable and fluctuated around 0.04 flies/panel/day. The population density declined dramatically during the last quarter of 1995, followed by a population crash in the beginning of 1996. The last wild fly was caught in the first week of September 1996.

SLIDE Bleeding cow

In 1994, monitoring of the disease in the northern half of the island revealed very low trypan incidence: less than 0.1% for *Trypanosoma congolense* and less than 0.4% for *T. vivax*. In 1995-1997, no positive cases of *T. congolense* were found, and very few cases of *T. vivax* were

observed in the sentinel cattle. In the southern half of the island, the monthly incidence for *T. congolense* was below 1% in 1995, and no positive cases were found in the following two years. The monthly incidence of *T. vivax*, which fluctuated between 2 and 4% at the beginning of 1995, was below 1% in 1996 and 1997.

SLIDE Logo

The following conclusions can be made:

A 10:1 ratio of sterile:wild males was not sufficient to reduce the fly population. The competitiveness of the released sterile males was however evident since with these ratios, 20-26% of young female flies were induced sterile. One year after ratios of ≥ 50 sterile to 1 wild were obtained, the last indigenous fly was trapped on Unguja island.

The declining wild tsetse fly population resulted in a negligible disease incidence. Even the release of sterilized male flies did not cause the incidence to increase.

In view of the isolated location of the island, fly eradication is expected to sustain itself. No problems are anticipated with immigration of flies from the mainland. Follow-up fly and disease monitoring will be conducted in the next years and will indicate the progress of the disease and confirm fly eradication.

The results of this programme have shown the potential for area-wide tsetse control programmes using SIT as a tool to eradicate fly populations. The need for isolated situations is, however, a prerequisite.

MUHAMMADI | NADEL

***ICIPE* Tropical Insect Science for Development**

Development of a new tsetse production system for use under field condition by local communities based on the

Lethal Insect Technique

Les lâchers de mâles stériles continueront jusqu'à la fin de l'année 1997, c.à.d., \pm 6 générations de mouches après la capture de la dernière mouche indigène.

SUMMARY

In 1994, the Governments of Tanzania and Zanzibar with the technical assistance of the International Atomic Energy Agency, embarked on a programme to eradicate the tsetse fly *Glossina austeni* Newstead from Unguja island of Zanzibar. Suppression of the fly population was done by application of persistent insecticides on cattle and by deployment of blue insecticide impregnated screens. This was followed by the dispersal of gamma sterilised male flies by light aircraft, initially over the southern half of the island, later (since July 1996) over the entire island. Monitoring of the eradication effort was done with > 500 sticky panels, positioned in strategic areas and by sequential screening of the disease incidence in 38 sentinel herds.

More than 7.8 million sterile male flies have been dispersed by aircraft over the island reaching an average of > 70,000 males released per week in 1996. Ratio's of sterile:wild male flies remained below 20:1 until mid '95. Thereafter, ratio's of > 100:1 were obtained over the entire southern part of the island. This resulted in a rapid increase in the proportion of female flies showing evidence of mating with a sterile male fly i.e. from < 25% to > 70% by the end of '95. The apparent density of the indigenous male and female fly population declined rapidly by the end of 1995 followed by a population crash in the beginning of 1996. The last wild male and female flies were trapped in week 32 and week 36 1996, respectively. The disease incidence in the sentinel animals, as measured by the Buffy Coat Technique, was < 1% (January '97) and limited to *T. vivax*. Fly releases will continue until the end of 1997 i.e. \pm 6 fly generations after the last wild fly has been trapped.

INTRODUCTION

Zanzibar comprises the islands of Unguja and Pemba, situated 35 km off the eastern coast of Tanzania. Trypanosomosis was first discovered on the island of Unguja in 1908, whereas Pemba has remained free of this disease. The late discovery in 1945 of the vector of the disease, the tsetse fly *Glossina austeni*, is an apt illustration of its elusive behaviour. The first island-wide survey revealed that the fly was widespread and that *G. austeni* was the only species present (Johns, 1952). The prevalence of the disease was established at an average of 17%, being predominantly *Trypanosoma congolense* and to a lesser extent *T. vivax*. The economic implications of the disease were considerable and annual losses were estimated at US\$ 2 million. In view of the isolated location of the island, the government of Zanzibar favoured complete elimination of the vector as re-invasion from mainland Tanzania was highly unlikely. Since the eighties, various control efforts have been undertaken with the technical support of international agencies such as the Food and Agriculture Organization of the United Nations (FAO), the United Nations Development Programme (UNDP) and the International Atomic Energy Agency

(IAEA). A first successful tsetse control trial was conducted in the Mangapwani area (north of Zanzibar town, fig 1a), by treating domestic livestock with a pour-on formulation of a persistent synthetic pyrethroid. Application of the insecticide on the cattle and small ruminant population in 5 cycles, with 15-day intervals, decreased the apparent density of the tsetse fly from 1 fly/trap/day to undetectable levels (A. Schönefeld, unpublished data). Similarly, the disease prevalence, assessed with the Micro Haematocrit Centrifuge Technique, was reduced from 46% to 0%. As a result, the government embarked in 1988 on an island wide eradication effort using the same technology which resulted in good suppression of the fly population. The main obstacle remained the large forested areas in the southern part of the island where cattle were absent. Therefore, a project was initiated with the technical assistance of the IAEA in January 1994 to eradicate the fly from the entire island, integrating the sterile insect technique (SIT) with the use of pour-on insecticides on cattle and the deployment of insecticide impregnated screens in those areas where cattle were scarce or absent. Results of the eradication programme are presented in this paper with emphasis on the progress made since the initiation of the aerial releases in August 1994.

MATERIALS AND METHODS

The island of Unguja

Unguja island, situated at latitude 6° S and longitude 39.5° E, is 85 km long and covers a total area of 1,650 km² (fig 1a). The climate is warm and humid with mean minimum and maximum temperatures of 25°C and 29°C respectively. The rainfall pattern is bi-modal, with the main rainy season in March - June, and a short rainy season in November - December. The average annual precipitation is \pm 1,600 mm. According to a cattle census in 1993, 45,750 cattle, 26,472 goats and 375 sheep were present on Unguja island. The cattle are mainly East African Zebu crossed with Boran and Sahiwal breeds and are owned by small holders who leave their cattle grazing on native grasses in clove and coconut plantations. The only remaining primary forest is the Jozani Forest Reserve, and secondary coral rag thickets can be found in the southern (Muyuni forests) and middle-eastern (Kiwengwa forest) parts of the island.

The eradication strategy

Fly populations have been continuously suppressed from 1988 till the end of 1993, mainly in the middle fly belt of Unguja using pour-on insecticides (Höreth-Böntgen, 1992). Suppression in the Jozani forest reserve, known to harbour the flies in the highest densities, was initiated in 1990 with blue cotton insecticide impregnated screens (Höreth-Böntgen, 1992). Pilot releases of sterile male flies were carried out in

1991 and indicated the feasibility of using the technique on the island (Vreysen *et al.*, 1992). After suppression of the fly population, ground releases of sterile male flies were initiated in the southern and northern part of the forest in July 1992 and July 1993, respectively. The ground releases were terminated in August 1994 and dispersal of the sterile flies was done by aircraft. A 2-phase approach was adopted since insufficient sterile males were available in 1994; initially fly releases were carried out in the southern half of the island, whereas suppression of the fly population with insecticides applied as pour-on formulations on livestock or in cattle dips located in certain strategic areas continued in the northern half of the island. Sufficient flies became available in mid-1996 and the release area was expanded to incorporate the middle and extreme northern part of the island. In January 1997, biweekly releases were started over the 12 small islands around Unguja (each $\pm 1 \text{ km}^2$).

The release of sterile males

Flies were produced at the Tsetse and Trypanosomiasis Research Institute in Tanga (Tanzania) as described by Msangi *et al.*, (in press) and prepared for release (Vreysen *et al.*, in press). The marked (fluorescent dye) gamma-sterilised flies were collected at Tanga twice a week and dispersed over Unguja using single- (Cherokee) and twin-engine aircraft (Partenavia, Navajo and Chieftain). Dispersal of the flies was done along specific flight paths (fig. 1b) separated by 1-2 km swaths using the global positioning system (GPS) which allowed accurate navigation. Flies were released at an altitude of 700-900 feet at a speed of 100-130 miles per hour. Releases were conducted on Tuesday morning and Thursday afternoon (Friday morning as of week 44, 1996). A sample box was taken during each release and parameters related to quality of the sterile males assessed.

Monitoring of the fly population

Sampling of the *G. austeni* population was done with sticky blue-white leg-panel traps (Vreysen *et al.*, 1996). A total of 23 fixed monitoring sites (FMS) was established in August 1994 as representative areas for the entire southern half of the island. In the first half of 1996, 32 additional FMS were established in the northern half of the island (Fig. 1a). Each FMS comprised an area of $\pm 1 \text{ km}^2$ and contained at least 5 sticky panels. As of early 1996, more than 500 sticky panels were deployed at any given time. These traps were supplemented in early 1996 by additional monitoring sites in the Jozani, Mapopwe and Kwebona forests using experimental crossed-shaped sticky panels (XT and XLP) to increase the probability of trapping females (Vreysen *et al.*, in preparation). The blue-white leg-panels in the northern part were replaced by XLP in week 12, 1997. All panels were made sticky with the non-setting adhesive Temooacid[®] (Kollant, Italy), suspended from overhanging branches to allow

free rotation. The panels were checked from once every day to once a week and replaced every week. The sampled females were dissected for assessment of their reproductive status (Challier, 1965) and females showing imbalances between the uterus content and the development stage of the follicle next in ovulation sequence A.C.B.D. were classified as having mated with a sterile male (Van der Vloedt *et al.*, 1978). All flies were checked for presence of fluorescent dye in the head capsule using an ultraviolet microscope to distinguish released from indigenous flies (Vreysen *et al.*, in press).

Monitoring of the disease

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. All animals were given an initial treatment of 7 mg of diminazene aceturate (Berenil[®]) per kg before becoming enlisted as a sentinel animal. Blood samples were taken every 2-5 months and examined for the presence of trypanosomes using the Micro Haematocrit Centrifuge Technique (MHCT) and the more sensitive Dark Ground Expressed Buffy Coat (Paris & Murray, 1982). Animals which were found to be positive received immediately a treatment of Berenil[®].

RESULTS

Sterile male releases

More than 7.8 million sterile male flies were dispersed by air over Unguja island from August 1994 to September 1997 (fig 2). The average weekly number of sterile males released increased from 12,381 in 1994 to 35,180 and 71,405 in 1995 and 1996, respectively. The output of excess males decreased in 1997 and on average 56,223 sterile males were dispersed per week. The southern half of Unguja island received the majority (64%) of all male flies available.

Quality assessment of the flies was carried out before and after the release. Fly mortality attributed to the transport and aerial dispersal was very small, only about 1.2%. The proportion of non-fliers increased only between 0.2 to 1.6% after the transport (Zhu *et al.*, in preparation).

Relative abundance of the indigenous tsetse fly population

Table 1 presents data on the apparent fly density in the northern part of the Jozani forest before and during the period of control i.e. intervention with insecticide impregnated screens, ground releases and aerial releases of sterile males. An average of 3.2 females and 2.8 males were trapped per panel per day before

intervention was initiated. Female and male catches were reduced by 97.7% and 77.9% respectively, after deployment of insecticide impregnated screens for 17 months. During the period of ground releases (August '93 - August '94), the fly densities did not decrease.

Fig. 3 presents the fluctuations of the wild fly population (females plus males) on Unguja island since the initiation of the aerial release programme. During the first 3 months, the fly population remained stable at an average of 0.04 flies/panel/day. During the first quarter of 1995, the fly population increased slightly, but then decreased to an average of 0.03 flies/panel/day during the second and third quarters of 1995. The population density declined more in the last quarter of 1995 (average 0.01 flies/panel/day). The population crashed in the beginning of 1996, with an average of 0.003 and 0.0009 flies trapped per panel per day in the first and second quarters, respectively. The last wild fly was caught in week 36 (first week of September) of 1996.

Ratio sterile:wild male flies

The ratio of sterile: wild male flies in the Jozani forest (FMS 4-5) is presented in figure 4. Until mid-April 1995, when few sterile males were available, the ratio of sterile:wild males remained below 10:1. Thereafter, the number of flies released increased dramatically (fig 2) and the ratio of sterile:wild males reached 100:1 in the middle of June '95 (week 24). Since week 34 (3rd week of August) and week 42 of 1995 (3rd week of October), the ratio of sterile:wild males was consistently > 50:1 and > 100:1, respectively. No more wild male flies were trapped after week 18, 1996 in FMS 4 and 5.

Induced sterility in the indigenous female fly population

Figure 5 presents the proportion of young female flies (1-2 ovulations) which showed evidence of having mated with a sterile male. On average 20 and 26% of the young sampled females were induced sterile in the last quarter of 1994 and first quarter of 1995, respectively, i.e the period when the ratio of sterile:wild males did not exceed 10:1. During the second and third quarter of 1995, the average rate of induced sterility increased to 32 and 48%, respectively. During the last quarter of 1995 i.e between 5 and 15 weeks after reaching a ratio of 50 sterile to 1 wild male, 72% of the sampled young females had an empty uterus due to abortion or an egg *in utero* in embryonic arrest. In 1996, only 8 young females were sampled and 6 of them had mated with a sterile male. The two young females trapped in weeks 5 and 16 of 1996 (fig 5) both had a recently ovulated egg *in utero*. As it was too early for the possible

degeneration process in the egg to become visible, it could therefore not be determined if the female had mated with a sterile or a wild male.

Disease incidence

The disease monthly incidence in the northern half of the island, where there probably were very few flies, was very low in 1994, 0.0 - 0.1% for *Trypanosoma congolense* and 0.0 - 0.4% for *T. vivax*. In 1995-1997, no positive cases of *T. congolense* were found, and very few or no positive cases of *T. vivax* were observed, in the sentinel cattle. Monthly incidence in the southern half was very low for *T. congolense*, 1% or less, in 1995, and no positive cases were found in 1996-1997. The monthly incidence of *T. vivax*, about 2-4% at the beginning in 1995, was very low in 1996 and < 1% in 1997.

DISCUSSION AND CONCLUSIONS

1. Suppression techniques such as pour-on insecticides and the deployment of insecticide impregnated screens could reduce the *G. austeni* population to low levels, but failed to eradicate it.
2. A 10:1 ratio of sterile:wild males was not sufficient to reduce the fly population. The competitiveness of the released sterile males was still evident since with these ratios 20-26% of young female flies were induced sterile. One year after ratios of ≥ 50 sterile to 1 wild were obtained, the last indigenous fly was trapped on Unguja island.
3. The declining wild tsetse fly population resulted in a negligible disease incidence. Even the release of sterilized male flies did not cause the incidence to increase.
4. The aerial dispersal of sterile flies was proven to be an efficient way to distribute tsetse flies. The male fly handling and release methodologies were satisfactory, when compared with releases from the ground, resulting in good fly distribution in hard to access habitats.
5. In view of the isolated location of the island, fly eradication is expected to be sustainable. No problems are anticipated with immigration of flies from the mainland. Follow-up fly and disease monitoring will be conducted in the next years and will confirm fly eradication and indicate the status of the disease.
6. The results of this programme in an isolated situation have shown the potential for area-wide tsetse control programmes using SIT as a tool to eradicate the fly population.

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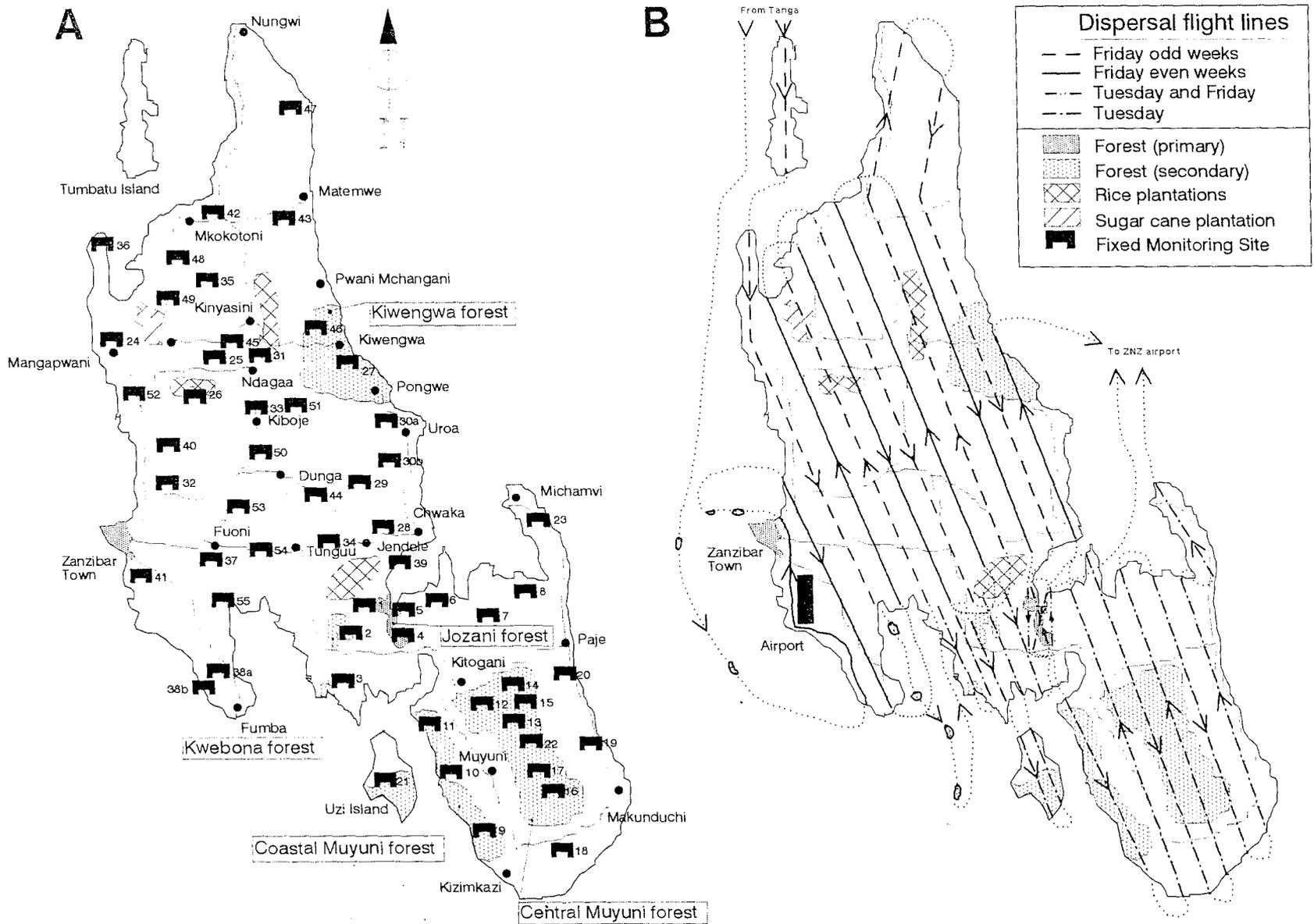


Fig. 1 The island of Unguja indicating the forested habitats and fixed monitoring sites (A) and flight lines for the dispersal of sterile males (B)

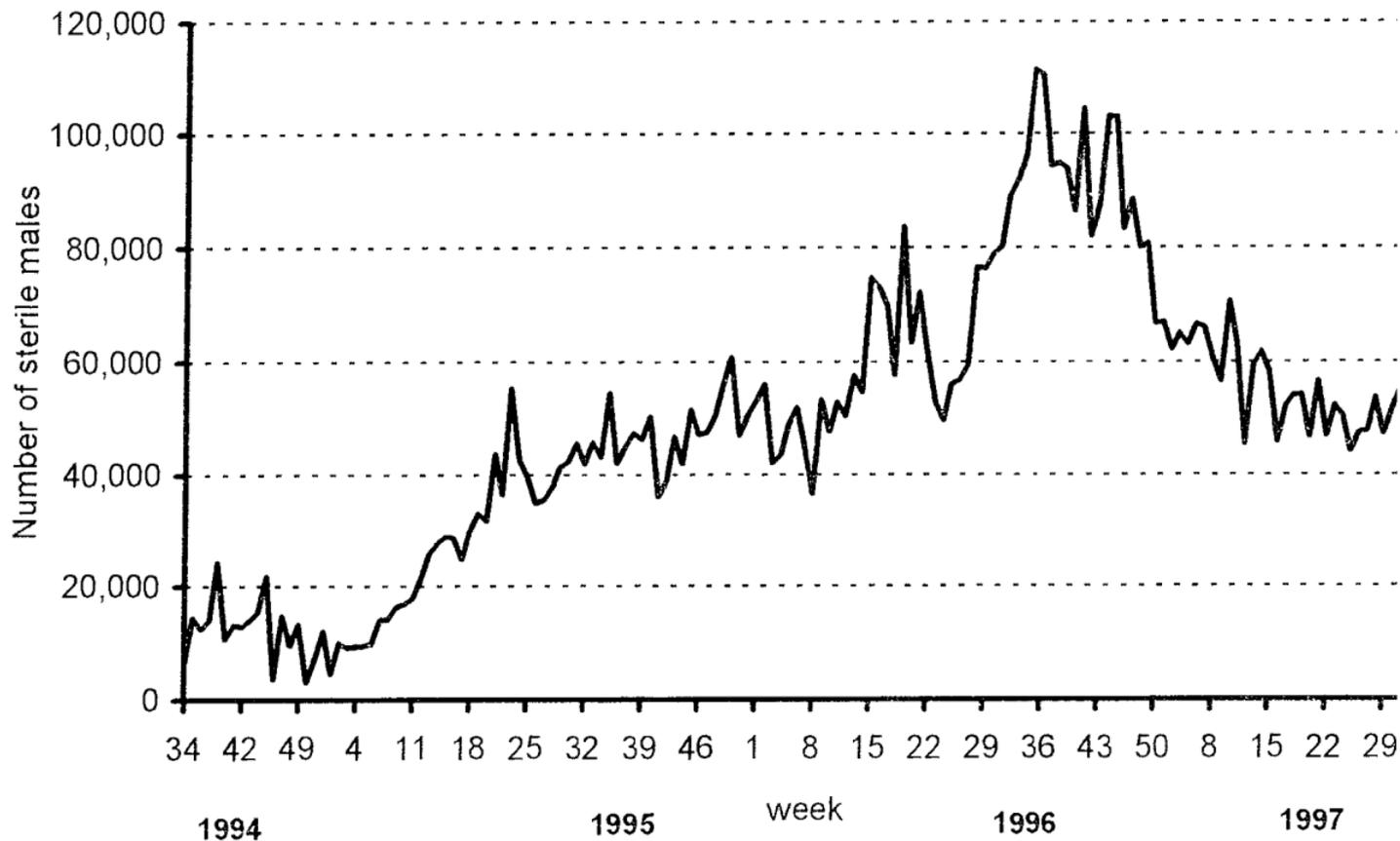


Fig. 2 Weekly numbers of sterile male *G. austeni* released over Unguja by air

Table 1: Apparent density (A.D.)(no. flies/panel/day) in Jozani forest during the pre-intervention period, period of insecticide impregnated screens (IIS) ground and aerial releases of sterile males

	Females		Males	
	A.D.	% reduction since pre-control	A.D.	% reduction since pre-control
<i>Pre-control</i>				
April '91	3.22		3.38	
June '91	2.87		2.49	
Sept. '91	3.42		2.67	
Average	3.17		2.84	
<i>IIS</i>				
Dec '91(+1 month)	2.38	25.0	4.07	-43.0
Feb '92 (+ 3 months)	1.50	52.7	2.36	17.0
Feb '93 (+ 15 months)	0.19	94.2	0.85	70.1
Mar '93 (+16 months)	0.07	97.7	0.63	77.9
<i>Ground releases</i>				
August '93	0.19	94.2	0.48	83.1
Sep '93	0.59	81.3	0.48	83.1
Oct. '93	0.63	80.1	1.04	63.5
Nov. '93	0.41	87.1	0.33	88.3
Jan. - Apr. '94 *	0.42	86.8	1.04**	63.4
<i>Aerial releases</i>				
Oct. - Dec. '94	0.21	93.5	0.17	93.9
Jan. - Mar. '95	0.28	91.3	0.40	85.8
Apr. - Jun. '95	0.15	95.1	0.19	93.4
Jul. - Sept. '95	0.05	98.5	0.06	97.9
Oct. - Dec. '95	0.01	99.6	0.03	99.0
Jan. - Mar. '96	0.00	100	0.00	100

* average of 4 months

** calculated A.D. as released flies were only proportionally marked

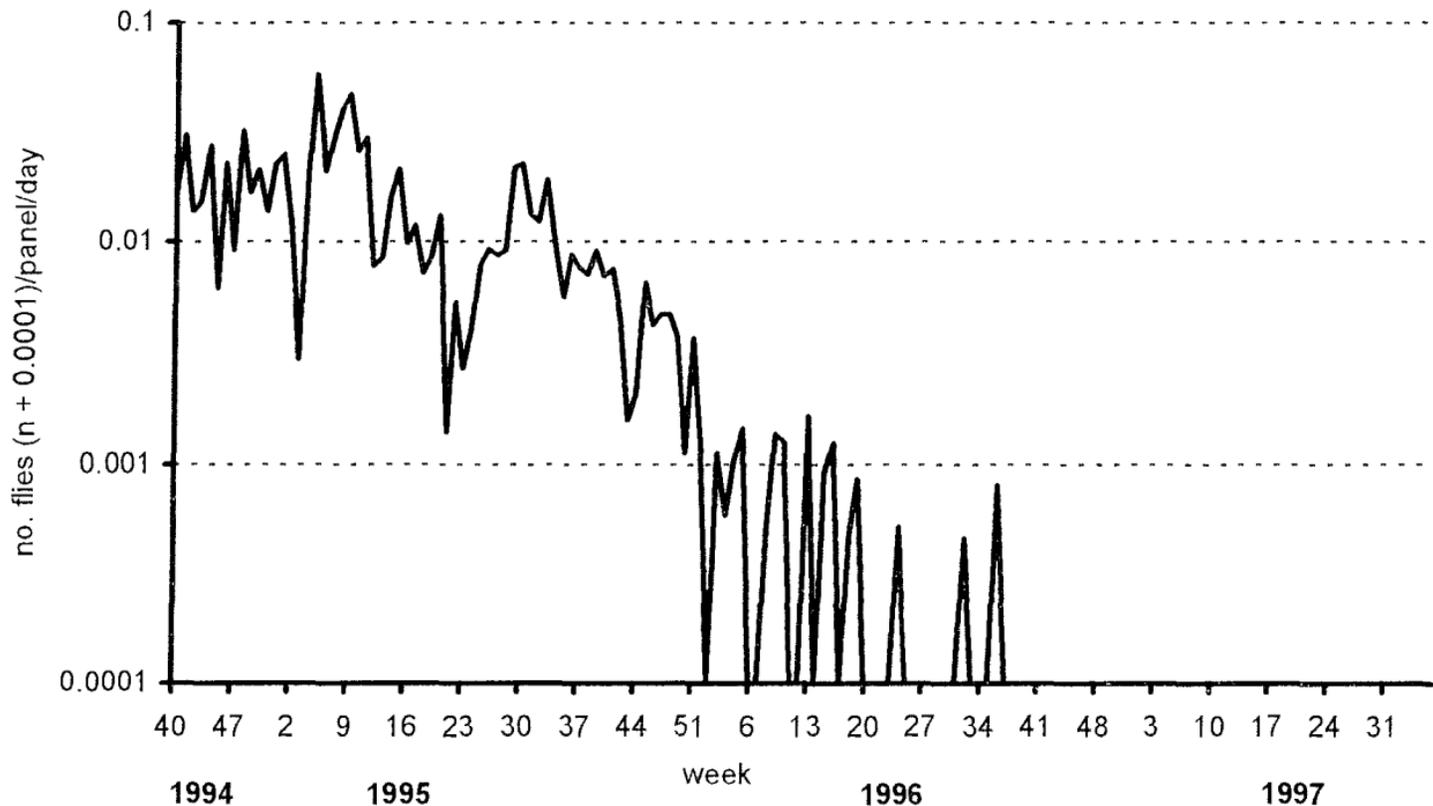


Fig. 3 Apparent density (no. flies (n + 0.0001)/panel/day) of indigenous flies on Unguja island from August 1994 to September 1997

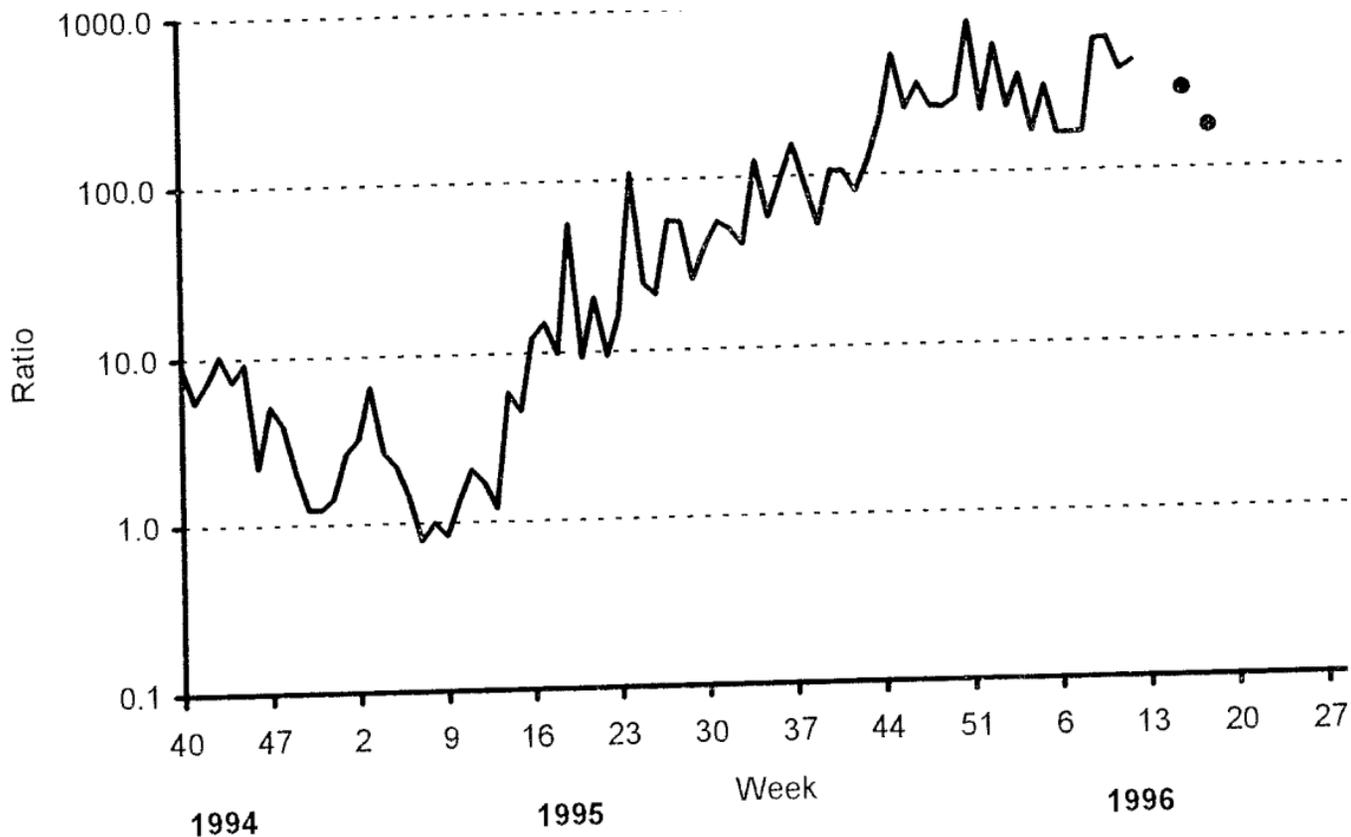


Fig 4 The sterile:wild ratio of male *G. austeni* in the Jozani forest

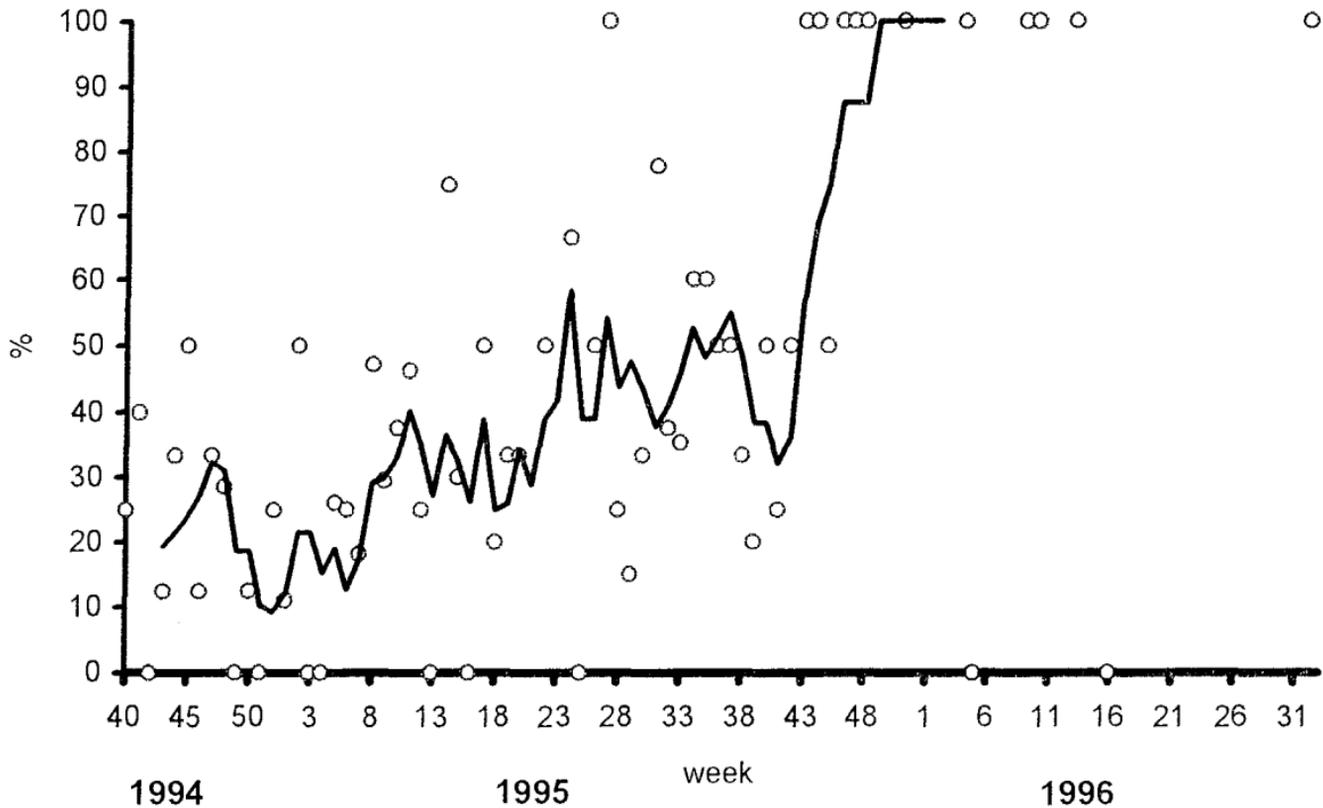


Fig 5 Induced sterility as proportion of total young (1-2 ovulations) parous females. Line represents 4-week moving average

Introduction

Large colonies of tsetse flies are being established to produce insects, which could be used:

- As part of an integrated tsetse control strategy based on the Lethal Insect technique (LIT), The Lethal Insect Technique (LIT) has been conceived in two versions : (i) continuous release of tsetse attracted to traps equipped with contaminating devices (CDs) reported elsewhere, and (ii) sequential repetitive releases of mass-reared and contaminated male and female flies
- For research (supply ICIPE scientists and other institutions)
- For training purpose

ICIPE Tropical Insect Science for Development

Tsetse flies *Glossina fuscipes* (collected from Mbita area on the shore of Lake Victoria) and *G. austeni* (Vienna) are fed on fresh blood obtained locally from “donor” cattle held at ICIPE.

The “donor” animals are kept under zero grazing condition. The possibility of the use of donor cattle by-products (biogas, fertilizer, etc.) is being considered for a wider approach based concept the “biovillage” including LIT. This paper summarises practical experiences of the “new” rearing - feeding tsetse fly technology. It will focus ~~is~~ mainly on *G. austeni*.

Materials and Methods

Glossina austeni pupae were shipped from Vienna whereas pupae from *G. fuscipes* were from flies collected locally from the field and reared at an insectary at ICIPE Mbita Point Field Station. Flies kept at Mbita were fed on goat. Pupae collected were then sent to ICIPE Nairobi.

The emergence of pupae took place on a specially designed emergence box on top of which a new ICIPE - cage, which is either of aluminum or PVC (3.5 cm high and 25-cm diam.) covered with mesh netting, was placed. The pupae were placed according to the time larviposition occurred so that sexing was made easy during emergence. The emerged flies were kept under the following conditions: Temperature 24 ± 1 °C, RH 60 - 70 % and a photoperiod cycle of 12 h dark and 12 light.

200 female and 24 male tsetse flies were put in one cage compared to the old Geigy-cage, which can take 20 females and 4 males. Furthermore a new system based on fixed rack and feeding trolley (for the new ICIPE - cages is being tested).

Donor cattle were kept at ICIPE Large Animal Unit. They were fed on hay and Ranch cubes (cattle concentrate). Salt was provided weekly and water was provided *ad-libitum*. Blood was collected (600 ml) from the “donor” cattle according to a specific schedule/roster so that each animal had a rest of 10 - 15 d after the last bleeding. The PCV of all animals was monitored so that any anemic animal was taken out of the roster. Freshly collected blood was defibrinated (Fig. 7) and then poured on a polythene sheet placed on a heating mat set at 36 °C. Silicon feeding membranes were then placed on the blood. Flies were allowed to feed when the temperature of the membrane reached between 35.4 - 36 °C.

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Primary results based on the new feeding system:

Experimental *Glossina austeni* males and females were allowed to take a meal either daily or on alternate days except Sundays. The total amount of blood consumed by the flies using membrane feeding (daily or on alternate day basis) and their performance (fecundity, longevity, etc.) was compared with that of flies fed on rabbits only.

Table 1. Comparison of quantity of blood taken by alternate fed versus daily fed *Glossina austeni* and its effects on female fly's reproductive performance (complete cycle)

Group	Number of flies	Treatment	T.blood taken in g	mg Blood per fly	Pupal Weight mg	Fecundity	% Mortality
004	506	Daily	704.9	184.4	3.30	21.4	0.90
	505	Alternate	435.4	144.8	2.29	20.0	0.97
006	462	Daily	651.7	184.6	2.52	20.6	1.01
	462	Alternate	429.0	140.5	1.82	19.6	1.19

Table 2. Comparison of the number of pupae per introduced female (PPIF) and pupal weight of *Glossina austeni* fed on membrane (daily and on alternate days) and those fed daily on rabbit (complete cycle)

Group	# of flies	Treatment	PPIF	Pupal weight mg
004	506	Daily	3.30	21.4
	505	Alternate	2.29	20.0
006	462	Daily	2.52	20.6
	462	Alternate	1.82	19.6
001	960	Rabbits	1.82	25.5

Conclusion

- The ICIPE tsetse cage has helped reduce the number of cages to be handled by a technician.
- Alternate day fed tsetse flies showed equally good performance as daily fed flies. Alternate day feeding will help increase the interval of number of days donor animals are bled
- The integration of the new rearing and feeding system of is being tested at ICIPE
- Based on zero - grazing of donor cattle (by products such as biogas, fertilizers, etc.) and how successful the rearing/feeding system is, a new approach to manage insects could be exploited to help resource poor farmers to improve the quality of their life and to get more income



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The system based on fresh blood collected from “Donor” cattle can work and needs to be improved. We are planning, to make use of by-products (manure) of “Donors” kept under zero grazing and their nutritional requirement to involve the farmers into insect management as follows:

ESSAIS COMPARATIFS DE DIFFERENTS MODELES DE PIEGES ET DE SUBSTANCES OLFACTIVES POUR LA CAPTURE DE *GLOSSINA LONGIPALPIS*, WIEDEMANN,1840 (DIPTERA:GLOSSINIDAE) EN COTE D'IVOIRE.

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RESUME

L'efficacité de différents modèles de pièges mis au point aussi bien en Afrique occidentale (piège biconique challier-Laveissière, piège monoconique Vavoua, piège pyramidal, piège Mérot) qu'en Afrique Orientale (Pièges N'GU NG2G) et Australe (piège Epsilon) a été testé pour la capture de *G. longipalpis* en Côte d'Ivoire. Les résultats de ces essais ont été analysés en prenant comme référence le piège biconique challier-Laveissière couramment utilisé pour les prospections entomologiques dans le cadre du programme de lutte anti-tsété.

Il en ressort que pour cette espèce, les modèles monoconiques sont plus efficaces que le biconique, le pyramidal, l'épsilon et le N'Gu.

Pour les monoconiques, le piège vavoua et ses variantes sont les meilleures. Ils sont 7 fois plus efficaces que le biconique.

Par ailleurs, un raccourcissement des écrans à 30 cm ne modifie pas l'attractivité de ce modèle tout en permettant des économies appréciables de tissu.

Le rendement de ce modèle modifié (Ecrans Courts) du piège vavoua se situe entre 21,9 % et 35,8 % contre 13,8 % et 15,5 % pour le piège biconique selon le mode de calcul.

Avec ce modèle modifié du Vavoua, nous avons testé des substances olfactives telles que le 4-Méthylphénol et le 3- Méthylphénol qui sont des composants essentiels de la fraction phénolique de l'urine de boeuf, de même que l'acétone, et l'octenol (1-octen-3-ol).

Les résultats de ces essais montrent que :

- Les phénols agissant seuls ou en combinaison n'améliorent pas significativement les captures du piège même si la combinaison 3-méthylphénol / 4- méthylphénol (1/5) augmente les captures de 80 %.

Le mélange phénols/octenol n'est pas nécessaire pour *G. longipalpis* car la combinaison des deux types de substances n'est pas meilleure que quand elles agissent séparément.

Par contre l'association de l'acétone au mélange phénolique permet de tripler les captures du piège, le niveau de diffusion de l'acétone n'ayant pas d'importance.

En présence d'acétone, les meilleures combinaisons de 3- méthylphénol et de 4- méthylphénol sont 1/0,5 et 1/1.

En conclusion, le piège vavoua ou son modèle à écrans raccourcis à 30 cm, associé à la combinaison olfactive 3- méthylphénol + 4- méthylphénol et acétone à 100 mg/h constitue un dispositif hautement plus performant pour la capture de *G. longipalpis* que le piège biconique couramment utilisé.

SUMMARY

The efficiency of different trap models: Biconical trap Challier-Laveissiere, Monoconical Vavoua trap, Pyramidal trap, Mérot trap, N'Gu Trap NG2G and Epsilon trap has been tested for *G. longipalpis* in the preforest area.

Results have been analyzed by taking as reference the biconical trap Challier-Laveissiere commonly used for tsetse monitoring in control operations in Côte d'Ivoire.

It came out that monoconical models are the most efficient for that fly.

Indeed the monoconical Vavoua trap is best. It is 7 times more efficient than the Biconical trap, and shortening the inferior screens has no effect on its attractiveness.

The efficiency of that modified model (Shorter Screens) of the Vavoua trap range from 21,2 % to 37,8 % versus 13,8 % to 15,5 % for the biconical trap.

With that modified model (shorter screens) of the Vavoua trap, we have tested olfactory attractants such as 4-Methylphenol and 3-Methylphenol which are essential components of the phenolic fraction of ox urine, and also Acetone, and Octenol.

Results showed that the two phenols acting alone or together are not significantly different from the control without attractants even though the mix 3-methylphenol and 4-methylphenol(1/5) increase the catches for 80 percents.

For *G. longipalpis* it is not necessary to associate phenols and octenol.

But the association of acetone and phenols increase the catches three times independently of the releasing rate of acetone.

The best proportions of 3-methylphenol and 4-methylphenol in presence of acetone at a releasing rate of 100 mg/h are 1/0,5 and 1/1.

In conclusion, the modified Vavoua with shorter screens associate to a mix of 3-Methylphenol and 4-Methylphenol working with acetone is highly more efficient for catching *G. longipalpis* than the biconical trap commonly used for tsetse monitoring in Côte d'Ivoire which can lead to underestimate of *G. longipalpis* populations which heavily infest the preforest area.

INTRODUCTION

Avec l'extension du programme national de lutte contre la trypanosomiase animale et les vecteurs vers les régions du Centre de la Côte d'Ivoire, les activités prennent en compte désormais l'aire de distribution de *G. longipalpis*. A la pratique, il s'est avéré que le piège biconique challier-Laveissière utilisé comme piège de référence pour l'échantillonnage des populations glossiniennes présente un faible niveau de capture par rapport aux populations observées de *G. longipalpis*, ce qui conduit à une sous-estimation de ces populations avant et pendant les opérations de lutte.

L'objectif de cette étude est donc de déterminer parmi les modèles de pièges existants et régulièrement utilisés en Afrique de l'Ouest, du Centre et en Afrique Australe, celui qui présente la meilleure efficacité pour la capture de *G. longipalpis*. Ce modèle pouvant être amélioré soit par des modifications ou par association d'attractif olfactifs.

MATERIEL ET METHODES

Les différents modèles de pièges testés sont : le piège biconique (Challier-Laveissière 1973 ; 1977), le piège pyramidal (Gouteux et Lancien, 1985), le piège Mérot (Com. pers.), le piège Epsilon (Vale, 1988), le piège Vavoua (Laveissière et Grébaud, 1990) et le piège N'Gu (NG2G) (Brightwell et al, 1991).

Lors des tests comparatifs, les modifications ont porté sur la nature des matériaux utilisés dans la confection des pièges et les dimensions de différentes parties du piège : écrans et cônes supérieurs.

Les attractifs olfactifs testés sont les suivants : 3- méthylphénol, 4- méthylphénol, acétone et Octénol. Ces attractifs olfactifs ont été testés, seul, en combinaison ou en association. Les composés phénoliques et l'octenol ont été préparés dans des sachets en polyéthylène de 3ml de contenance et 50 cm² de surface. L'acétone a été diffusé en bouteille avec une ouverture dans la capsule permettant de diffuser 100 mg/h.

La méthode expérimentale utilisée pour tous les essais est la méthode des carrés latins. Toutes les expériences pour lesquelles la taille du carré latin n'excédait pas 6 ont été répétées au moins une fois.

Les résultats ont été soumis à l'analyse de variance après transformation logarithmique. Le logiciel utilisé est Minitab sous Windows. Pour tenir compte de la répétition des carrés latins, nous avons introduit un facteur appelé "Block" qui a autant de niveaux que de répétition des carrés latins. Toute interaction entre les traitements et ce facteur "Block" entraîne le rejet de la série.

L'indice de capture est calculé à partir des moyennes détransformées en prenant le piège biconique comme référence pour les tests de piège et le piège sans odeur pour les tests d'attractifs olfactifs.

Pour étudier le rendement du piège Vavoua et du piège biconique, nous avons utilisé la méthode du cercle incomplet de Vale et Hargrove (1979). Le piège étant placé au centre d'un cercle dont 1/3 de la circonférence est occupé par des grilles électriques.

La capture du piège central considéré comme un pourcentage des glossines qui ont pénétré à l'intérieur du cercle, exprime le rendement qui peut être calculé en prenant en compte soit les captures faites sur la face externe ou sur la face interne des grilles.

RESULTATS

Comparaison de différents modèles de pièges

L'expérience 1 a mis en comparaison, le piège biconique, le piège pyramidal, le piège Vavoua et des variantes de ce dernier.

Il ressort que le piège Vavoua et ces variantes à écrans en tissu coton-polyester bleu/noir ou tout bleu sont identiques et nettement supérieurs au piège biconique et au piège pyramidal.

L'expérience 2 compare le piège biconique, le piège Vavoua et le piège N'Gu (NG2G). Il ressort une différence significative très nette en faveur du modèle Vavoua, par rapport aux deux autres modèles.

L'expérience 3 met en comparaison le piège biconique, le piège Vavoua et des variantes de ce dernier obtenu par modification de la hauteur du cône supérieur et de la longueur des écrans inférieurs.

Il en ressort que l'allongement du cône supérieur ou des écrans inférieurs de même que le raccourcissement des écrans inférieurs ne modifient pas l'efficacité du piège Vavoua qui présente une différence significative nette avec le piège biconique.

Par contre, le raccourcissement du cône supérieur déprécie de façon très significative les captures du piège Vavoua.

Tableau 1 : Résultats des tests comparatifs des différents modèles de pièges.

Modèles de pièges	Moyenne. détransformée males + femelles	Indice de capture	Signifiante
Expérience 1			F = 19,
Biconique	5,2 b	1,00	P < 0,0
Vavoua tissu	15,1 a	2,88	Différen
Vavoua Ecrans noirs	3,6 b	0,69	significa
Vavoua Ecrans bleus	9,9 a	1,89	
Pyramidal	3,8 b	0,73	
Expérience 2			
Biconique	3,3 b	1,00	P < 0,0
Vavoua	25,3 a	7,74	Différen
N'Gu (NG2G)	3,6 b	1,09	significa
Expérience 3			F = 18
Biconique	2,2 b	1,00	P < 0,0
Vavoua	15,7 a	7,12	Différen
Vavoua Ecrans longs (60 cm)	12,9 a	5,87	significa
Vavoua Ecrans courts (30 cm)	15,7 a	7,09	
Vavoua Cônes longs (85 cm)	18,9 a	8,57	
Vavoua Cônes courts (50 cm)	2,3 b	1,05	
Expérience 4			F = 27,
Biconique	1,5 b	1,00	P < 0,0
Vavoua	14,0 a	9,44	Différen
Vavoua bleu interne	16,9 a	11,35	significa
Vavoua Cône long/Ecran court(CL/EC)	19,3 a	12,99	
Mérot	9,1 a	6,11	
Mérot noir	11,6 a	7,78	
Expérience 5			F = 27,
Biconique	5,4 b	1,00	P < 0,0
Vavoua	38,0 a	7,17	Différen
Vavoua CL/EC	39,0 a	7,33	significa
Epsilon	1,9 b	0,29	

Les moyennes portant les mêmes lettres ne sont pas significativement différentes à 5% Test de TUCHEY'S.

Dans l'expérience 4, nous avons comparé le Biconique, le Vavoua, le Mérot et sa variante à écrans noirs, de même que le Vavoua et sa variante à cônes allongés et écrans courts, et celle à écrans à bandes bleues au centre et noires à l'extérieur.

Il ressort une différence significative nette entre le piège biconique et les modèles monoconiques (Vavoua et Mérot) qui sont statistiquement identiques. Néanmoins le modèles Vavoua présente un avantage à la moyenne.

La dernière expérience met en comparaison le biconique, le vavoua, la vavoua CL/EC et le piège Epsilon.

Il en ressort que le Vavoua et sa variante CL/EC sont identiques et significativement différents du piège biconique et du piège Epsilon.

Etude du rendement des pièges

Tableau 2 : Résultats de l'étude du rendement des pièges Vavoua et biconique
Capture sur 10 jours consécutifs

Modèle	Captures Males + femelles	Grille A	Grille B	Grille C	Re	Ri
					%	%
Vavoua (E. C.)	344	184 (e)	140 (e)	157 (e)	35,8	21,9
		109 (i)	158 (i)	140 (i)		
Biconique	77	53 (e)	107 (e)	89 (e)	15,5	13,8
		39 (i)	56 (i)	65 (i)		

(e) capture sur la face externe des grilles

(i) capture sur la face interne des grilles

(Re) Rendement calculé à partir des captures sur la face externe des grilles

(Ri) Rendement calculé à partir des captures sur la face interne des grilles.

Le modèle vavoua a un rendement qui se situe entre 21,9% et 35,8% selon le mode de calcul et est deux fois plus élevé que celui du piège biconique.

Essais sur les attractifs olfactifs (Tableau 3)

Dans cette série d'expériences, le piège testé est le piège Vavoua à écrans courts.

Dans l'expérience 1, il a été testé l'effet du 3-méthylphenol et du 4-méthylphenol agissant seul ou en combinaison sur les captures du piège Vavoua à écran court.

Il ressort que ces deux phenols agissant en combinaison sont plus attractifs que chacun agissant seul.

Néanmoins l'analyse ne fait pas ressortir de différence significative avec le piège sans odeur, même si la combinaison 3-Méthylphenol /4- méthylphenol (1/5) augmente les captures de 80 %.

L'expérience 2 a permis de tester l'effet de l'octenol sur la combinaison phénolique : 3 méthylphenol + 4 méthylphenol (1/5).

Le piège opérant avec des olfactifs est significativement différent du piège sans olfactif.

Les phenols et l'octenol présente le même niveau d'attractivité qu'ils agissent séparément ou en combinaison. Leur combinaison ne semble donc pas nécessaire.

L'expérience 3 étudie l'effet de la combinaison phenols-octenol-Acétone.

Il ressort une différence significative nette entre le piège seul et le piège associé aux substances olfactives.

Néanmoins, les trois substances agissant ensemble ne donnent pas de meilleurs résultats que les deux phénols associés à l'acétone ou que l'octenol associé à l'acétone.

Tableau 3 : Capture du piège Vavoua (E.C.) en présence de différentes combinaisons olfactives

Traitements	Moyenne Détransf. Males + femelles	Indice de capture	Sig
Expérience 1 : Phénols			
Sans odeur	18,6	1,00	F
3-MP seul	21,8	1,17	F
3-MP + 4-MP (1/0,1)	29,2	1,56	
3-MP + 4-MP (1/0,5)	30,2	1,62	
3-MP + 4-MP (1/1)	26,9	1,45	
3-MP + 4-MP (1/5)	33,5	1,79	
3-MP + 4-MP (1/9)	24,6	1,32	
4-MP seul	21,2	1,14	
Expérience 2 : Phénols + octénol			
Sans odeur	19,6 b	1,00	F
3-MP + 4-MP (1/5)	34,2 a	1,74	P
Phénols + octénol (1/0,1)	38,2 a	1,95	D
Phénols + octénol (1/0,5)	36,3 a	1,85	sig
Phénols + octénol (1/1)	36,3 a	1,85	
Phénols + octénol (1/2)	37,5 a	1,91	
Phénols + octénol (1/10)	38,7 a	1,97	
Octénol seul	31,1 a	1,60	
Expérience 3 : Phenols+Octenol+acetone			
Sans odeurs	26,7 c	1,00	F
Phénols (1/5) + Acétone (100 mg/h)	56,8 a	3,39	P
Phénols + octénol (1/0,5) " "	31,5 b	1,88	Di
Phénols + octénol (1/1) " "	25,3 b	1,51	
Phénols + octénol (1/2) " "	56,8 a	3,38	
Phénols + octénol (1/5) " "	53,2 a	3,17	
Phénols + octénol (1/10) " "	49,7 a	2,96	
Octénol + Acétone (100 mg/h)	52 a	3,10	
Expérience 4 : Effet dose acetone			
Sans odeur	22,5 b	1,00	F
Phénols + octénol + Acétone (100 mg/h)	56,5 a	2,50	P
Phénols + octénol + Acétone (130 mg/h)	55,3 a	2,45	Di
Phénols + octénol + Acétone (400 mg/h)	59,3 a	2,62	
Phénols + octénol + Acétone (1000 mg/h)	49 a	2,17	
Expérience 5 : Phenol +acetone			
Sans odeur	9,9 d	1,00	F
3-MP seul + Acétone (100 mg/h)	15,3 c d	1,54	P
3-MP + 4-MP (1/0,1) + Acétone (100 mg/h)	20,1 b	2,02	Di
3-MP + 4-MP (1/0,5) " "	30 a	3,02	
3-MP + 4-MP (1/1) " "	33,1 a	3,33	
3-MP + 4-MP (1/5) " "	25,6 a b	2,57	
3-MP + 4-MP (1/10) " "	21,4 b	2,15	
4-MP + Acétone (100 mg/h)	15,9 c d	1,59	

Les moyennes portant les mêmes lettres ne sont pas significativement différents à 5%.

L'expérience 4 permet de tester l'effet du niveau de diffusion de l'acétone. Il n'y a pas de différence significative entre l'acétone diffusant à 100 mg/h ou à 130, 400 ou 1000 mg/h.

Dans l'expérience 5, nous avons recherché la meilleure combinaison de 3-méthylphénol et de 4-méthylphénol en association avec l'acétone diffusant à 100 mg/h.

Il est ressorti qu'en association avec l'acétone, les meilleures combinaisons de 3-méthylphénol et de 4-méthylphénol sont données par les proportions 1/0,5 et 1/1. Elles augmentent les captures du piège Vavoua de 3 fois.

DISCUSSIONS

Les résultats de ces essais permettent de classer les pièges en deux groupes par rapport à leur efficacité pour la capture de *G. longipalpis*.

Les pièges à efficacité très élevée sont les modèles monoconiques Vavoua et Mèrot, alors que les pièges Biconique, Epsilon, Pyramidal et N°GU présentent un niveau d'efficacité très faible pour cette espèce.

Cette différence d'efficacité peut s'expliquer par la structure différente des pièges qui sont faits avec les mêmes matériaux.

En effet les pièges Biconique, Epsilon, et N°GU sont des pièges à structure relativement fermée comparativement aux modèles monoconiques plus ouverts, ce qui insisterait plus

G. longipalpis à y entrer.

Le piège Vavoua a un niveau d'efficacité relativement constant et se situe dans un rapport de 7 à 9 avec le piège Biconique.

Le raccourcissement des écrans inférieurs à 30 cm n'affectent pas le fonctionnement du piège et permet donc de faire des économies de tissu.

Cependant, le raccourcissement du cône supérieur tout en supprimant l'effet tunnel, déprécie significativement l'efficacité du piège Vavoua.

Le rendement de ce piège quoique supérieur à celui du biconique reste relativement bas car plus de 60% des glossines qui approchent le piège repartent sans être capturées même avec le calcul le plus optimiste.

Les phénols agissant seuls présentent un léger effet attractif mais qui ne n'améliore pas significativement les captures du piège Vavoua(E.C.) pour *G. longipalpis*.

Il est apparu clairement que l'association phénols/octenol n'est pas nécessaire car cette association n'améliore pas significativement les capture par rapport aux deux produits agissants séparément.

Par contre l'association 3-Méthylphénol/4-Méthylphénol / Acétone (100 mg/h) est très attractive pour *G. longipalpis*. Les meilleures combinaisons phénoliques sont alors 1/0,5 et 1/1

Le niveau de diffusion de l'acétone n'a pas d'importance. La diffusion à 100mg/h est convenable.

CONCLUSION

Ces essais ont confirmé les observations faites sur le terrain concernant la faible efficacité du piège Biconique pour évaluer les populations de *G. longipalpis*.

D'après les résultats, le piège Vavoua associé à la combinaison olfactive 3-Methylphenol / 4-Methylphenol(1/0,5 ou 1/1) et acétone (100 mg/h) constitue un moyen d'échantillonnage nettement supérieur au piège biconique.

Ce piège étant conçu à l'origine pour *G. palpalis*, il permet ainsi de conduire simultanément les enquêtes entomologiques en même temps pour les deux espèces par un choix judicieux des sites

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Trial to investigate the efficacy of insecticide-treated cattle as a barrier to re-invasion of tsetse to cleared areas in northern Zimbabwe.

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Introduction

In Zimbabwe a large proportion of the tsetse control budget (20%) is spent maintaining barriers to tsetse re-invasion from neighbouring countries. These barriers consist of insecticide treated targets in a band approximately 8 km wide, at an operational density of 4 per km² (Hargrove, 1993). Such barriers are supported by treatment of all cattle adjacent to the barrier with either deltamethrin dip (Decatix[®], Coopers) at two weekly intervals, or pour-on (Spoton[®], Coopers) at monthly intervals (Shereni, 1990).

To investigate if this two vined (belt and braces) approach was necessary a trial was undertaken, to establish if one could rely on the insecticide treated cattle alone to stem re-invasion of tsetse. If this were the case considerable cost savings would be made.

Methods

The area chosen for the trial (Fig. 1) was 40 km long and 10-15 km wide, adjacent to the Mozambique border, to the south and west of the Tete road in north-east Zimbabwe. Archived data showed that this area suffered a high invasion pressure from both *Glossina morsitans.morsitans* and *G.pallidipes*. Much of the area is heavily settled, and cattle census reveals a population of between 8-12 cattle per km².

The trial commenced in January 1996. Tsetse populations were monitored from 53 permanent Epsilon traps (Hargrove and Langley, 1990) (triangles on Fig. 1) and ox-fly-round teams (Vale, 1974), five of which operated every month, between 450-500 km of fly-round giving an even cover over the trial area. Trypanosomosis was monitored every month in nine sentinel herds each consisting of ten head of adult cattle. The sentinel herds were situated at various distances from the tsetse invasion front (wigwams on Fig. 1). Three at the edge of the tsetse invasion front, three five kilometre inside the trial area and three ten kilometre inside the trial area. All sentinel cattle were given diminazene aceturate (Berenil[®], Hoechst) at 7 mg/kg of body weight at the start of the trial. Trypanosomosis incidence in all herds was calculated at monthly interval. On each occasion, ear vein blood of all animals was examined for trypanosomes using the haematocrit centrifugation technique

treated with insecticide. Periodically, trypanosomosis prevalence was recorded in local cattle from the three dip-tanks in the trial area situated at distances similar to those of the sentinel herds (at 6 km, 10 km inside and 15 km inside the trial area).

Both the target barrier and the cattle treatments were maintained for eight months until September 1996, when the targets were removed, leaving only the insecticide-treatment of the local cattle to stem the re-invasion of tsetse. When it became apparent that insecticide treated cattle would not stem invasion of tsetse, the targets were replaced and tsetse population monitoring, as well as trypanosomiasis monitoring continued.

Results

G.m.morsitans accounted for 90% of all flies caught, and therefore the discussion will be restricted to data from ox-fly-rounds (the best sampling method for this species).

The tsetse catch showed a dramatic increase in both the number and distribution of fly's caught in the trial area after the targets were removed. The position of each catch was recorded, and the euclidean distance from the re-invasion front calculated. Fig. 2 shows the position of all ox-fly-round catches for the three months before the removal of targets (triangles Fig. 2) and the three months after the removal of targets (circles Fig. 2). Here it is clear that the removal of targets allowed the flies to move into the trial area, and also that the decreased pressure on the adjacent invading tsetse population was decreased (due to the removal of targets) allowing the breath of the front to broaden. Monitoring continued without the target barrier until April 1997, when we replaced the targets. Fig. 3 shows the position of all ox-fly-round catches for the three months before the replacement of targets (circles Fig. 3), and the three months after (triangles Fig. 3). It is clear that the targets readily get the situation under control.

The experiment was terminated earlier than planned due to the disturbing prevalence of trypanosomosis, in local cattle. Prevalence was recorded at three dip-tanks in the trial area. The grazing areas for these dip tanks were Zano (*ca.* 6 km inside the trial area), Kapotesa (*ca.* 10 km inside the trial area) and Nyamvu (*ca.* 15 km inside the trial area) from the tsetse invasion front. By February 1997 the situation at Zano was serious, and more worrying was the first detection of disease at Nyamvu (Fig. 4). After analysis of these results in March 1997, the insecticide treated targets were re-deployed in April 1997.

Monitoring trypanosomosis incidence in the sentinel herds (Fig. 5) revealed that while the targets were in place, a low incidence was experienced close to the re-invasion front, with some seasonality. No cases were recorded in sentinel herds at more than 4 km from the re-invasion front. Two months

the trial area, reflecting the recorded tsetse distribution. This situation continued until after the targets were redeployed in April, 1997.

Conclusions

Trial results indicate that, in Zimbabwe a target barrier needs to be maintained to prevent tsetse re-invasion. Whether or not deltamethrin cattle treatments needs to continue for tsetse control in these areas requires further investigation. Results clearly show that deltamethrin treatments do not deter tsetse from feeding, resulting in a high trypanosomosis incidence in deltamethrin-treated cattle.

It is difficult to draw conclusions on the efficacy of cattle treatments, either generally or as a barrier, as we had no control of cattle movement and grazing areas. However, during the problem period (the wet season in Zimbabwe) few cattle will have grazed up to within 2 km from the re-invasion front. If cattle treatments are to be used as a barrier to tsetse re-invasion, then the barrier needs to be wider than our control area, and a high level of trypanosomosis prevalence in the local stock must be tolerated near to the re-invasion front.

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Figure captions.

Fig. 1: Trial area. The chained line is the international boundary. Epsilon traps (triangles) were distributed throughout the area, and nine sentinel herds (wigwams) were grazed in the area.

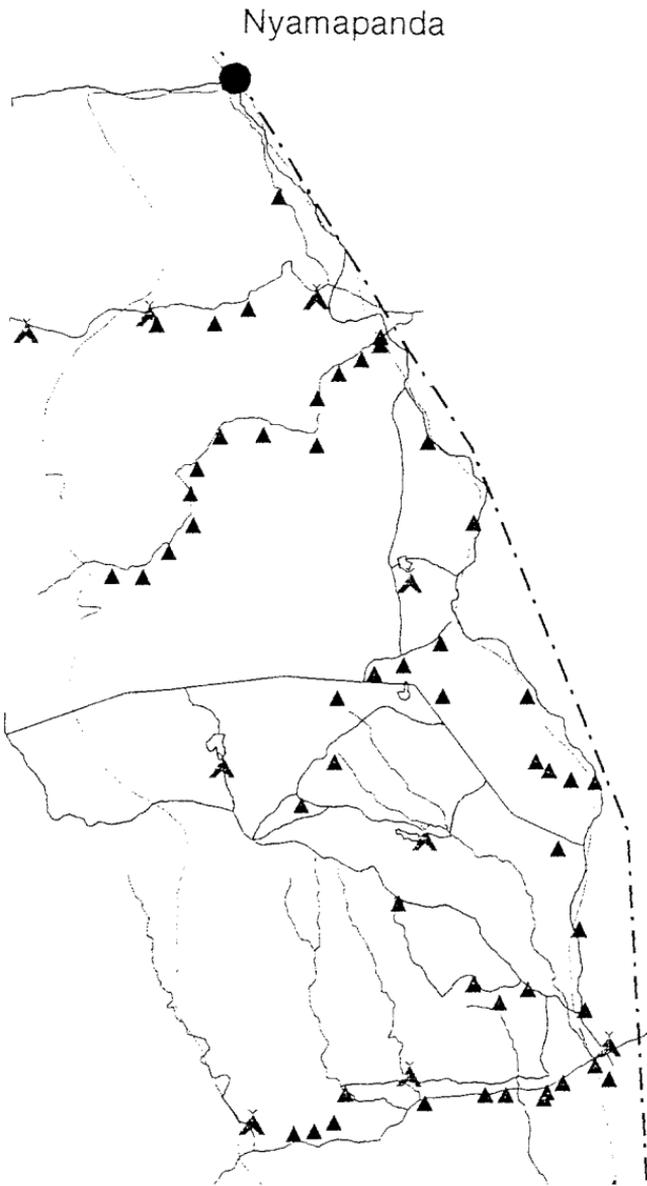
Fig. 2: Position of ox-fly-round catches of tsetse for three months prior to removal of targets (triangles) and three months after removal of targets (circles).

Fig. 3: Position of ox-fly-round catches of tsetse for three months prior to the redeployment of targets (circles) and three months after redeployment of targets (triangles).

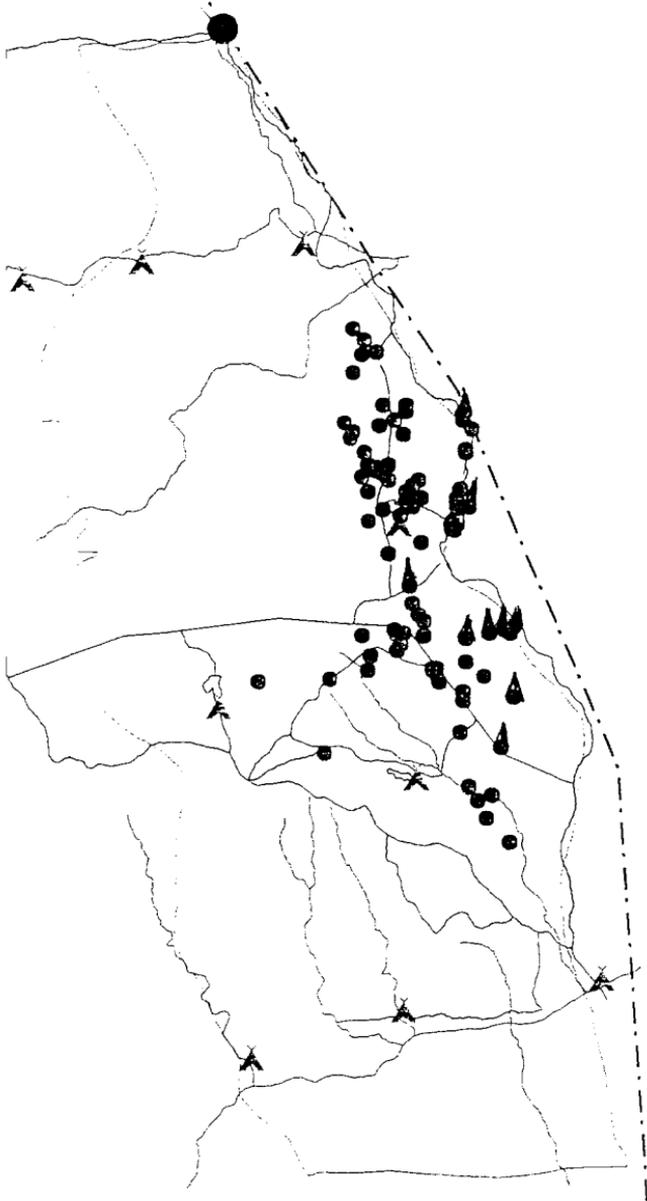
Fig. 4: Trypanosomosis prevalence at three dip-tanks/ inspection races in the trial area.

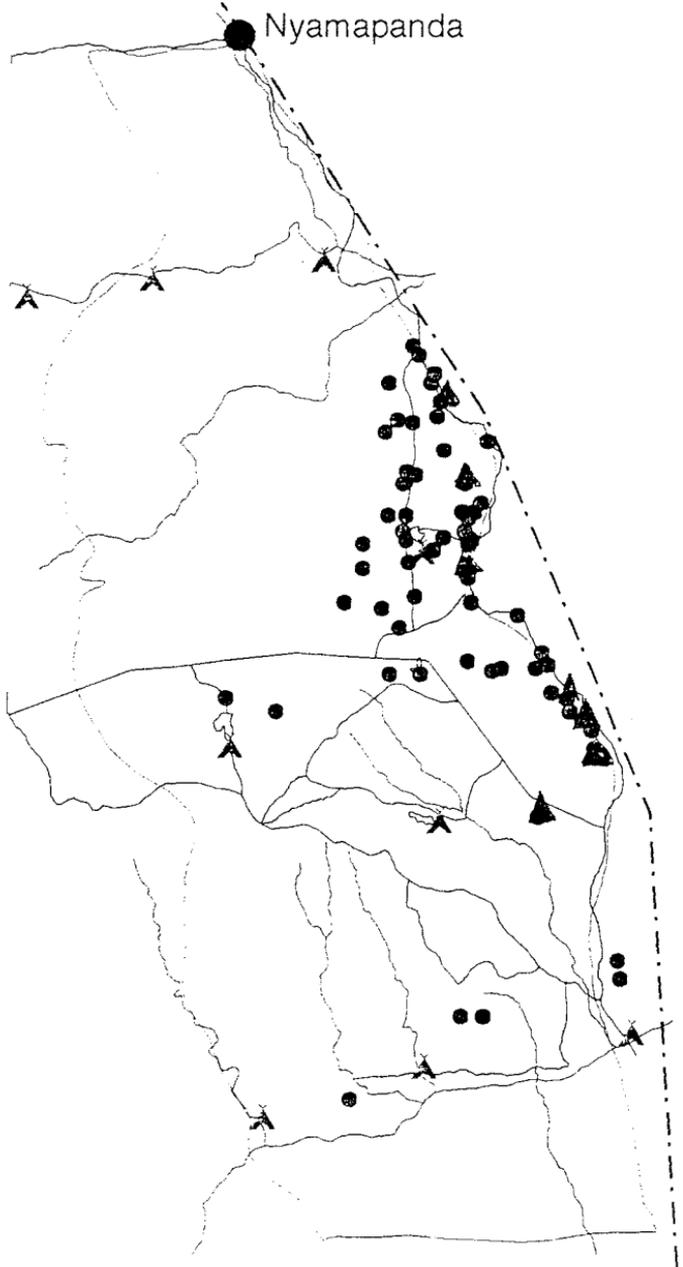
Fig. 5: Monthly Trypanosomosis incidence in sentinel cattle grazed in the trial area.

Traps

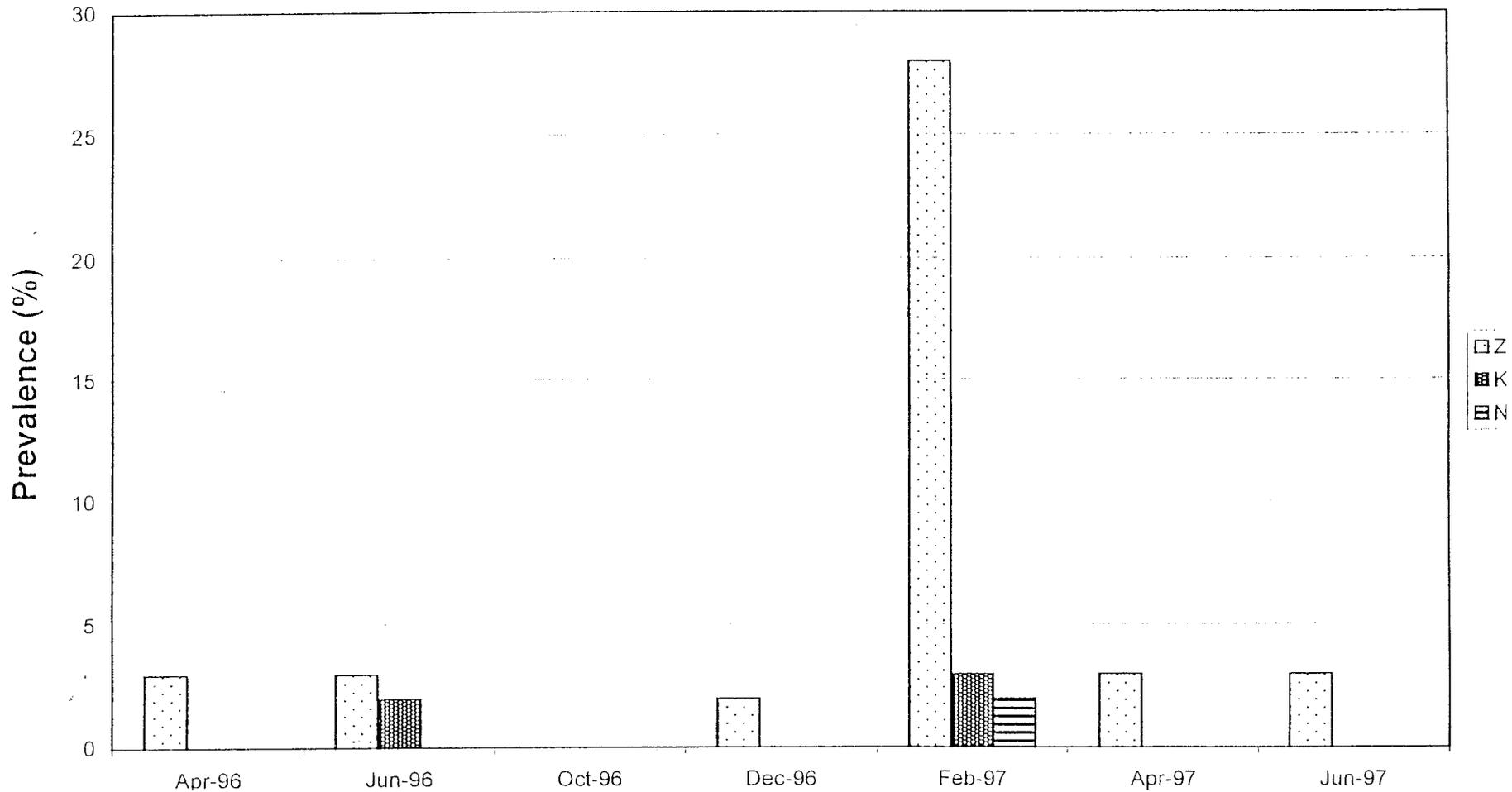


Nyamapanda

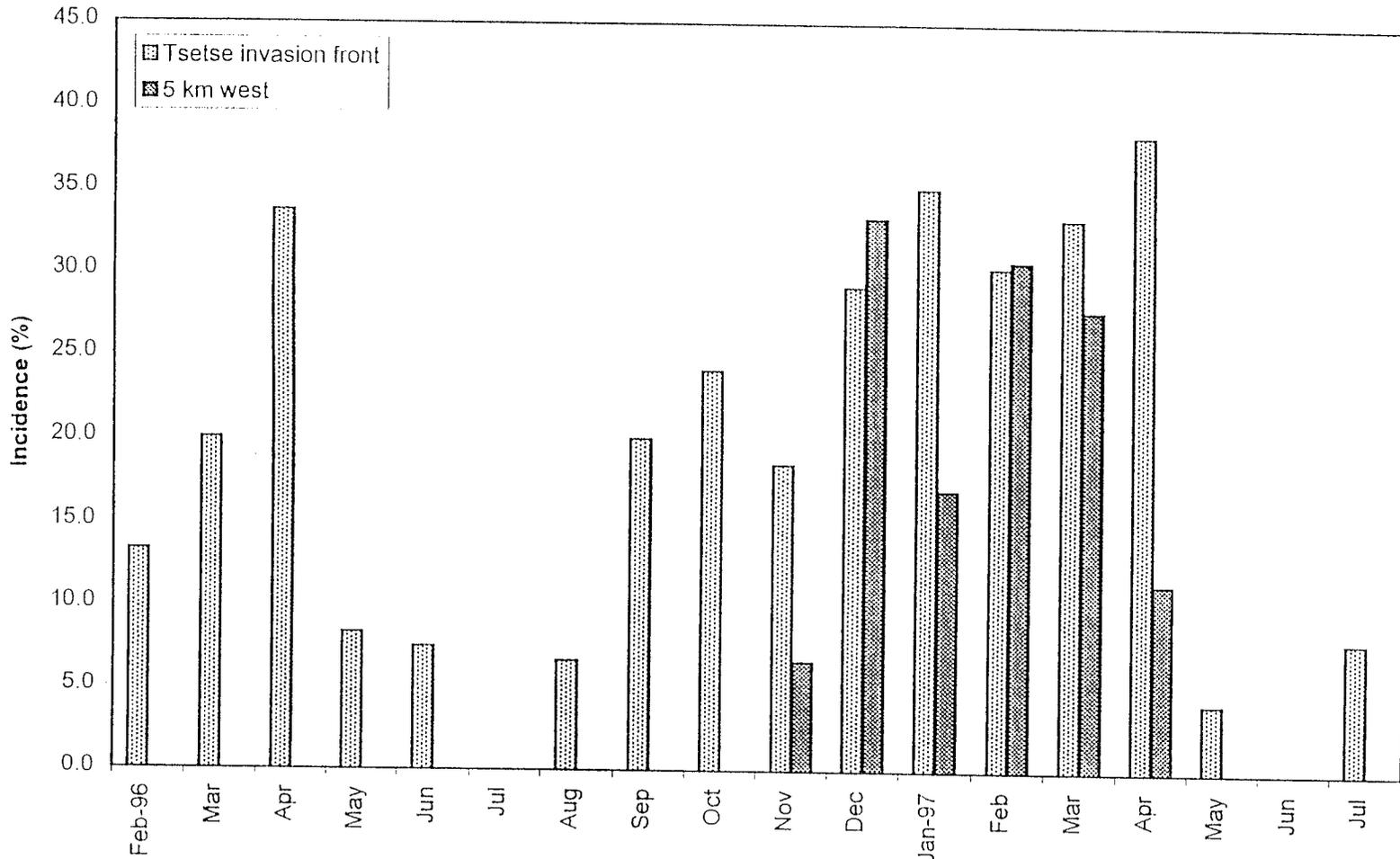




Trypanosomosis prevalence



Trypanosomosis incidence



INTRODUCTION

The serodiagnosis of *T.b.gambiense* by ImmunoFluorescent Antibody Test (IFAT) has been used successfully for long time. Earlier workers used various methods of antigens preparations. Sadun et al., (1963) used *T. b. gambiense*, *T. b. rhodesiense*, *T. cruzi* and *T. Lewis* as antigen and found out that there were a few cross-reactions with sera from individuals with other parasitic diseases. Courtois and Bideau (1966) used smears of *T. b. gambiense* trypanosomes from albino rats as antigen. Wery et al., (1970) used *T.gambiense*, *T. brucei* and *T.congolense* maintained in guinea pigs and albino rats as antigen in serodiagnosis of *T. gambiense* sleeping sickness in the Republic of Congo. IFAT has also been used in South Eastern Uganda as a routine screening test for *T.b.rhodesiense* Kansiime et al., (1993).

The diagnosis by the standard tests such as wet films, thick films, Haematocrit Centrifugation Technique (HCT), Mini-Anion Exchange Column (MAEC) and rat sub-inoculations (RI) of blood and CSF are less sensitive because of the nature of the gambiense sleeping sickness which has low and fluctuating parasitaemia. The specificity and sensitivity in serodiagnostic test depends on the suitability of the antigen used. Litat 1.3 Antigen used in the commercially available Card Agglutination Test for Trypanosomiasis (CATT) has been shown to test negative in some *T.b.gambiense* sleeping sickness cases, Dukes et al., (1989) and Kanmogne., et al (1996). This study attempts to adapt some of the *T.b. gambiense* isolates from N. W. Uganda for the production of specific antigen for use in IFAT and other serological tests.

OBJECTIVES

1. To prepare *T. b.gambiense* antigen for improving IFAT technique and other serological tests in the diagnosis of sleeping sickness caused by *T.b. gambiense*.
2. To test the specificity and sensitivity of the antigen for the diagnosis of *T.b. gambiense* sleeping sickness.

MATERIALS AND METHODS

Trypanosomes used in antigen preparation

UTRO 270396A, 270396B, 010496A and 240696 are *T. b. gambiense* isolated from sleeping sickness patients in Arua, N. W. Uganda in 1995. UTat 4.1 is a *T. b. rhodesiense* isolated from a sleeping sickness patient in Busoga, S. E. Uganda in 1982. Dal 1402 and STIB 754B were *T. b. gambiense* stocks isolated from W. Africa and maintained at the Swiss Tropical Institute (STI), Basel.

Preparation of antigen.

A. In *Mastomys natalensis* rats

Four isolates from North West Uganda and two from West Africa were inoculated intraperitoneally or intravenously into *Mastomys natalensis* rats which had been previously immunosuppressed with cyclophosphamide (200 mg/kg per rat). The stocks were sub-passaged several times in order to adapt them to *Mastomys* and obtain higher parasitaemia for culture initiation and for making smears. The rats were then bled by cardiac puncture and smears were prepared from whole blood with high parasitaemia ($\geq 10^7$ /ml). Alternatively, if the parasitemia was lower ($< 10^7$ /ml) the trypanosomes were concentrated by either differential centrifugation or by passing whole blood through DEAE 52 cellulose column. The resulting trypanosomes pellet was suspended into phosphate saline glucose (PSG, PH 8.0) or into 5% Foetal Calf Serum (FCS) in PSG. Smears were prepared from this suspension of trypanosomes, fixed in acetone/chloroform in the ratio of 1:1 and stored in silica gel at 4°C for further analysis.

B. In Culture

The medium used was minimum essential medium as modified by Baltz et al., (1985) with 15% inactivated human serum and 5% FCS. This was further supplemented with 1.5 mM L-cysteine, 0.5 mM Bathocuproine sulphonate and 20 mM L- glutamine.

Following purification of blood through cellulose, the trypanosome pellet was suspended into 500µL of medium and transferred into 24-well plates. The cultures were incubated at 37⁰C in 5% CO₂ atmosphere. They were maintained in growth phase by continued passages into fresh medium for one month. The wells were then pooled, followed by centrifugation and suspension of pellet in 5%FCS in PBS PH 7.3. The suspension was diluted with buffer up to 20 trypanosomes per field at x400 magnification. Smears were then made, dried and fixed in acetone/chloroform and stored in silica gel at 4°C for IFAT analysis.

Testing of antigen against dry blood samples

One hundred and twenty blood samples (20 positive samples from confirmed sleeping sickness cases, and 20 from non- infected persons and 20 blood samples collected from each cases of the 4 parasitic diseases) were punched out from filter papers. The discs were each placed into separate wells of 96-well microtitre plates containing 100µL of PBS buffer (PH 7.3) to give a 1:10 dilution. They were soaked for 15 minutes in order to extract antibody. Twenty five microliters from each well were used for testing for the antibody against the adapted antigen by IFAT.

Each of the three antigens prepared was tested against the 120 dry blood samples collected on filter paper. The specificity of the antigens prepared was determined by testing against 20 blood samples collected from each cases of malaria, filariasis, schistomiasis and hookworms.

RESULTS

Of the four trypanosome stocks from N. W. Uganda, one (UTRO 270396A) was successfully adapted to *Mastomys* and subsequently to bloodstream form cultures (Table I). This together with the two stocks from West Africa (DAL 1402 and STIB 754B) and UTat 4.1 were used in IFAT.

Table I: Adaptation of trypanosome stocks

Trypanosome stock	<i>Mastomys</i>	BSF culture
UTRO 270396A	+	+
UTRO 279396B	+/-	-
UTRO 010496A	+/-	-
UTRO 240696	+/-	-
UTat 4.1	+	+
Dal 1402	+	+
STIB 754B	+	+

+ = Developed high parasitaemia (10^5 - 10^7)

+/- = Developed low parasitaemia ($<10^5$)

- = Failed to grow in culture

Out of a total of 20 *T. b.gambiense* proven samples , 19 were positive to UTRO 270396A, 18 to Dal 1402 and 18 to STIB 754B and 17 to Utat 4.1(table II).

The results of the IFAT test using the different antigens on blood samples each from malaria, schistomiasis, filariasis hookworm cases and negative trypanosomiasis controls are summarised in table II.

Table II: IFAT using various antigens

Diagnostic status	Number screened	IFAT Positives			
		UTRO 270396A	Utat 4.1	STIB 754B	Dal
		<i>T.b.g</i>	<i>T.b.r</i>	<i>T.b.g</i>	<i>T.b.</i>
<i>T. b.gambiense</i>	20	19	17	18	18
Healthy control	20	1	2	1	1
Malaria	20	2	3	2	2
Filariasis	20	2	2	2	2
Schistomiasis	20	1	2	2	2
Hookworm	20	1	2	2	2
Total	120	26	28	27	27

Withstanding the limitations of the parasitological tests as a gold standard, the specificity (sp), sensitivity (s) and positive predictive value (ppv) were calculated basing on IFAT results. The results obtained show that UTRO 270396A had the highest sensitivity (95%), specificity (98,9%) and positive

Table 111: Apparent specificity and sensitivity of IFAT using various antigens

Antigens	Sensitivity %	Specificity %	Positive predictive value(PPV) %
UTat 4.1	85	96.7	60.7
UTRO 270396A	95	98.9	73.0
STIB 754	90	97.8	66.6
DAL 1402	90	92.0	69.2

DISCUSSION

We have presented preliminary results of laboratory testing of candidate antigens for use in IFAT in the diagnosis of cases in N. W. Uganda. As expected it is observed that *T.b. gambiense* antigen was more specific than *T.b. rhodesiense* antigen when used in IFAT for the diagnosis of *T.b.gambiense* sleeping sickness in North West Uganda. The UTRO 270396A antigen from N. W. Uganda gave better results than STIB 754B and Dal 1402, which are *T. b. gambiense* from West Africa. However, we note that only a few proven cases of gambian sleeping sickness were tested by IFAT in this study. Determination of the role of IFAT using the suggested antigen in case detection in N. W. Uganda should await a more extensive study. But basing on these preliminary results, the UTRO 270396A *T.b.gambiense* antigen is likely to be suitable for the IFAT technique and possibly other serological tests.

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Further evaluation of a LATEX/IgM assay for IgM quantification in cerebrospinal fluid of sleeping sickness patients

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Abstract

Human infection with *T.b. gambiense* is characterized by an early stage with trypanosomes proliferating in blood, lymph and other tissues followed by a second stage with trypanosomes invading the central nervous system.

Diagnostic differentiation between both stages is essential to select an optimal treatment and is currently performed by examining the cerebrospinal fluid (CSF) for cell number, protein concentration and presence of trypanosomes. It is known that second stage trypanosomiasis is also accompanied by occurrence of IgM in CSF. IgM measurement, however, is difficult to realize under field conditions due to the lack of suitable tests and stable reagents.

Recently (XVIIIème Conférence Technique de l'OCEAC, Yaoundé) we have reported on a card agglutination test "LATEX/IgM", to enable IgM measurements in CSF under field conditions. The reagent consists of IgM-specific antibodies covalently coupled to latex particles. The test takes only 10 minutes, is performed on serial dilutions of CSF and results are comparable to those obtained by nephelometry. In its freeze-dried form, the reagent remains stable for at least 12 months, even at 45°C.

Results obtained with CSF samples from 142 *T.b. gambiense* patients before treatment are reported. These suggest that "LATEX/IgM" can be useful in stage determination.

Résumé

Evaluation ultérieure du test LATEX/IgM pour le dosage d'IgM dans le liquide céphalo-rachidien de patients trypanosés

La Trypanosomose Humaine Africaine à *T.b. gambiense* évolue d'un stade précoce avec des trypanosomes proliférants dans le sang, la lymphe et d'autres tissus, à un stade neurologique avec invasion du système nerveux central.

et la présence de trypanosomes. Le stade neurologique est également caractérisé par la présence d'IgM dans le LCR. Cependant, le dosage d'IgM est difficile à exécuter sur le terrain par manque de tests appropriés et de réactifs stables.

Récemment (XVIIIème Conférence Technique de l'OCEAC, Yaoundé), nous avons rapporté un test d'agglutination "LATEX/IgM" pour le dosage d'IgM dans le LCR sur le terrain. Le réactif consiste d'anticorps IgM-spécifiques couplés de manière covalente à des particules de latex. Le test est exécuté sur des dilutions sérielles du LCR, ne prend que 10 minutes et donne des résultats comparables à ceux obtenus par néphélométrie. Sous forme lyophilisée, le réactif reste stable à 45°C pendant au moins 12 mois.

Des résultats obtenus avec des échantillons de LCR de 142 patients à *T.b. gambiense* sont présentés. Ces résultats montrent que le "LATEX/IgM" puisse être utilisé pour la détermination du stade.

Introduction

Two consecutive disease stages can be discerned in Human African Trypanosomiasis (HAT) caused by *T.b. gambiense* (Dumas & Girard, 1979):

1. The haemolymphatic phase or first stage characterized by proliferation of trypanosomes in blood and lymphoid tissues.
2. The meningo-encephalitic phase or second stage which is initiated with the spread of trypanosomes into the central nervous system (CNS). The meningo-encephalitis observed is characterized by parasite invasion of the meninges and choroid plexus, infiltration of the leptomeninges and perivascular areas by IgM producing plasma cells, Mott cells and T-helper/inducer cells and activation of glial cells in white matter (Adams et al., 1986, Anthoons et al., 1989, Poltera et al., 1980, Schultzberg et al., 1988, Van Bogaert & Janssen, 1957,).

Since it is directly related to the choice of an optimal treatment with minimal risk for the patient, a correct stage determination is indispensable. This is currently carried out by examining the cerebrospinal fluid (CSF) for cell number, protein concentration and presence of trypanosomes.

The IgM concentration in CSF has been described as a helpful alternative parameter for stage determination (Mattern, 1968, Whittle et al., 1977). Second stage patients can have abnormally high IgM concentrations in their CSF, sometimes exceeding the normal CSF concentration of 0.36 mg/l (Blennow et al., 1996) almost 1000 times (Knobloch et al., 1984, Lambert et al., 1981).

Although its diagnostic potential for stage determination in sleeping sickness has been demonstrated clearly, IgM detection in CSF is not currently carried out in the field. This can be explained by the lack of IgM quantification tests, adapted to field conditions.

Relatively simple test systems for IgM quantification, such as radial immunodiffusion (RID) and latex agglutination are commercially available. However, radial immunodiffusion needs a long incubation time and is therefore difficult to apply in the field. A commercial latex agglutination test, Rapi Tex IgM (Behring), exists, but has been developed for detection of IgM in serum of neonates. In the past it has been used for IgM detection in CSF of sleeping sickness patients and encouraging results were obtained (Van Nieuwenhove et al., personal communication). Its detection limit of 33 mg/l is, however, far above normal CSF values for IgM and its stability is limited.

Our laboratory developed a latex agglutination test, LATEX/IgM, for detection of IgM in CSF of sleeping sickness patients under field conditions, which fulfills the following characteristics:

1. Reagent sufficiently stable for storage at relatively high temperatures

4. Low price

This presentation reports on the evaluation of the LATEX/IgM with 142 CSF samples of *T.b. gambiense* patients before treatment.

Materials and Methods

LATEX/IgM

The reagent consists of polyclonal, anti-human IgM, covalently coupled to latex particles, and is stabilized by lyophilization.

Test Procedure

The lyophilized reagent is reconstituted with 1 ml of PBS. Twofold serial dilutions of CSF in PBS are prepared. 40 µl of diluted CSF is mixed with 20 µl of LATEX/IgM reagent on an agglutination card. After 10 minutes of rocking on a CATT rotator at 70 rpm, the agglutination is scored macroscopically. The end titer of a sample is the highest dilution factor still showing agglutination.

Results

Stability of the LATEX/IgM reagent

LATEX/IgM reagent was stored at 4°C and 45°C for 7, 30, 98, 189, 273 and 358 days. After reconstitution, the reagent was checked for auto-agglutination by microscopic examination, and the end titer of 5 IgM containing samples was determined. Auto-agglutination was never observed and samples have stable end titers (allowing a variation of 1 dilution) for at least 12 months (Table 1).

The end titer obtained in LATEX/IgM corresponds to the concentration obtained by nephelometry

The CSF IgM concentration was measured by nephelometry (Behring) and by latex agglutination in 4 CSF samples from non sleeping sickness persons, 5 CSF samples of serologically positive, but parasitologically unconfirmed persons and 34 CSF samples of untreated, parasitologically confirmed *T.b. gambiense* patients, all originating from Equateur, R.D Congo.

Results obtained with both systems are comparable (Fig 1), which indicates that in both tests the same component, i.e. IgM, is detected. 4 CSF samples with IgM concentrations below the detection limit of nephelometry (5 mg/l IgM), are positive in LATEX/IgM. It can be concluded that the detection limit for LATEX/IgM is lower than 5 mg/l. By nephelometry, IgM concentrations up to 418 mg/l are found in the CSF samples of trypanosomiasis patients, confirming the concentrations found in earlier studies (Bisser, 1996, Lejon et al., 1995) and corresponding to a LATEX/IgM end titer of 128.

LATEX/IgM results in function of stage determination

One out of 4 CSF samples of first stage patients (≤ 5 cells/ μ l, a protein concentration < 300 mg/l and no trypanosomes observed in CSF), is positive with end titer of 2. All CSF samples of second stage patients are positive in LATEX/IgM, with end titers up to 128.

Following the encouraging results obtained with the limited group of CSF samples from Congo, the LATEX/IgM was tested on a larger number of samples from 8 controls without sleeping sickness and 108 parasitologically confirmed *T. b. gambiense* patients before treatment, originating from Daloa, Ivory Coast. Protein concentration, cell number, and presence of trypanosomes in CSF of these persons are presented in Fig 3. 18 trypanosomiasis patients have cell numbers ≤ 5 / μ l, a protein concentration < 300 mg/l and no trypanosomes in CSF and can therefore be classified in first stage, 90 patients are in second stage. End titers in LATEX/IgM in function of the stage are presented in Fig 4. 6 controls remain negative in LATEX/IgM, 2 controls have an end titer of respectively 2 and 4. End titers found in first stage patients range from 0 (or negative) up to 16, the value for the median is 2. End titers in second stage patients go from 2 up to 2048, with a median of 128. However, for the second stage group, end titers are clearly not normally distributed. Therefore we decided to subdivide the second stage group into early and advanced second stage (Fig 3). A higher limit of at least 20 cells/ μ l or 400 mg/l of protein is now used as criterium for advanced second stage (Bisser, 1996, Doua & Boa, 1994, Pepin & Milord, 1994). Four groups are thus differentiated; controls, first stage patients, early second stage patients and advanced second stage patients. The end titers obtained with “early” second stage samples are grouped around the median of 4, while the advanced stage sample group are more or less separated from the early second stage group with a median of 256 (Fig 5).

Prozone effect

In most CSF samples containing high IgM concentrations a prozone effect was observed i.e. a reduced agglutination due to antigen (IgM) excess in the in lower CSF dilutions (results not shown).

Discussion

With the LATEX/IgM we developed a reagent for detection of IgM in CSF of sleeping sickness patients suited for field application. The test is stable, sensitive, rapid and simple to execute. In its experimental form it will be modified in function of the results obtained.

In first instance, the reagent will be improved by replacing the polyclonal antibody presently used with a monoclonal in order to minimize batch to batch variation. As seen from the results, it might also be necessary to fine tune the cut-off in order to obtain a test which

1. remains negative with “normal” CSF IgM concentrations.
2. only needs a limited titration of CSF
3. is devoid of prozone effect.

Although we don't know the kinetics of IgM in CSF during pathogenesis and after treatment, some conclusions can already be drawn from the results obtained with the LATEX/IgM in its present version.

1. End titers of more than 1000 (approximately 1000 mg/l) confirm that IgM concentrations in CSF of second stage sleeping sickness patients can be extremely high.

confirms the findings of other groups (Bisser, 1996, Doua & Boa, 1994, Pepin & Milord, 1994) and strengthens the hypothesis that an upper limit of 20 cells/ μl might be more appropriate for stage determination.

3. The LATEX/IgM remains to be evaluated on a larger scale, both for stage determination as for follow-up after treatment. It remains also to be determined if and how fast IgM titers drop after successful treatment.

In addition, the reagent might also be used for determination of the IgM concentration in CSF of patients suffering from other CNS infections inducing intrathecal synthesis of IgM such as HIV, neurosyphilis, neuroborreliosis, ...

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Table 1: End titers of 5 IgM containing samples obtained after storage of the Latex/IgM reagent at 45°C for 7, 30, 98, 189, 273 and 358 days.

	day 0	day 7	day 30	day 98	day 189	day 273	day 358
Sample 1	800	800	800	800	800	400	800
Sample 2	400	400	400	400	400	400	400
Sample 3	400	400	800	800	800	800	800
Sample 4	800	800	800	800	800	800	800
Sample 5	800	400	800	800	800	400	800

Fig 1: End titers of 43 CSF samples in LATEX/IgM compared with their respective IgM concentrations measured by nephelometry.

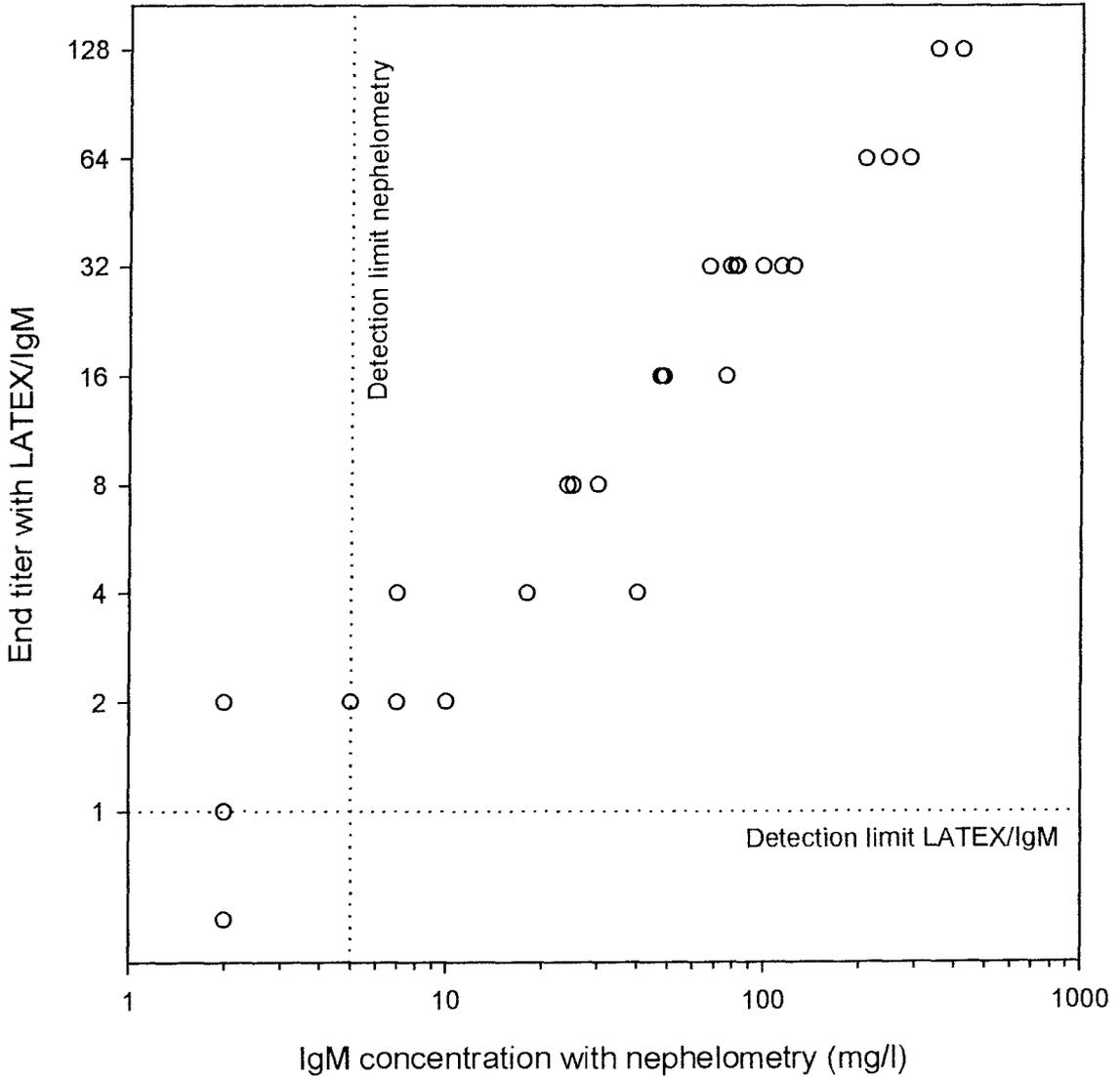


Fig 3 : Protein concentration, cell number and presence of trypanosomes in CSF of 108 trypanosomiasis patients and 8 controls.

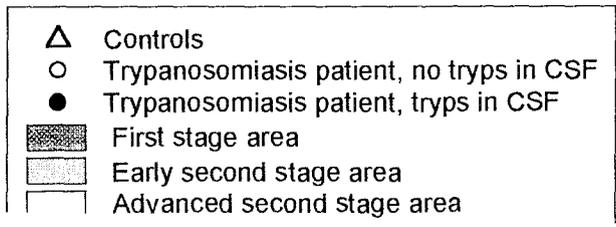
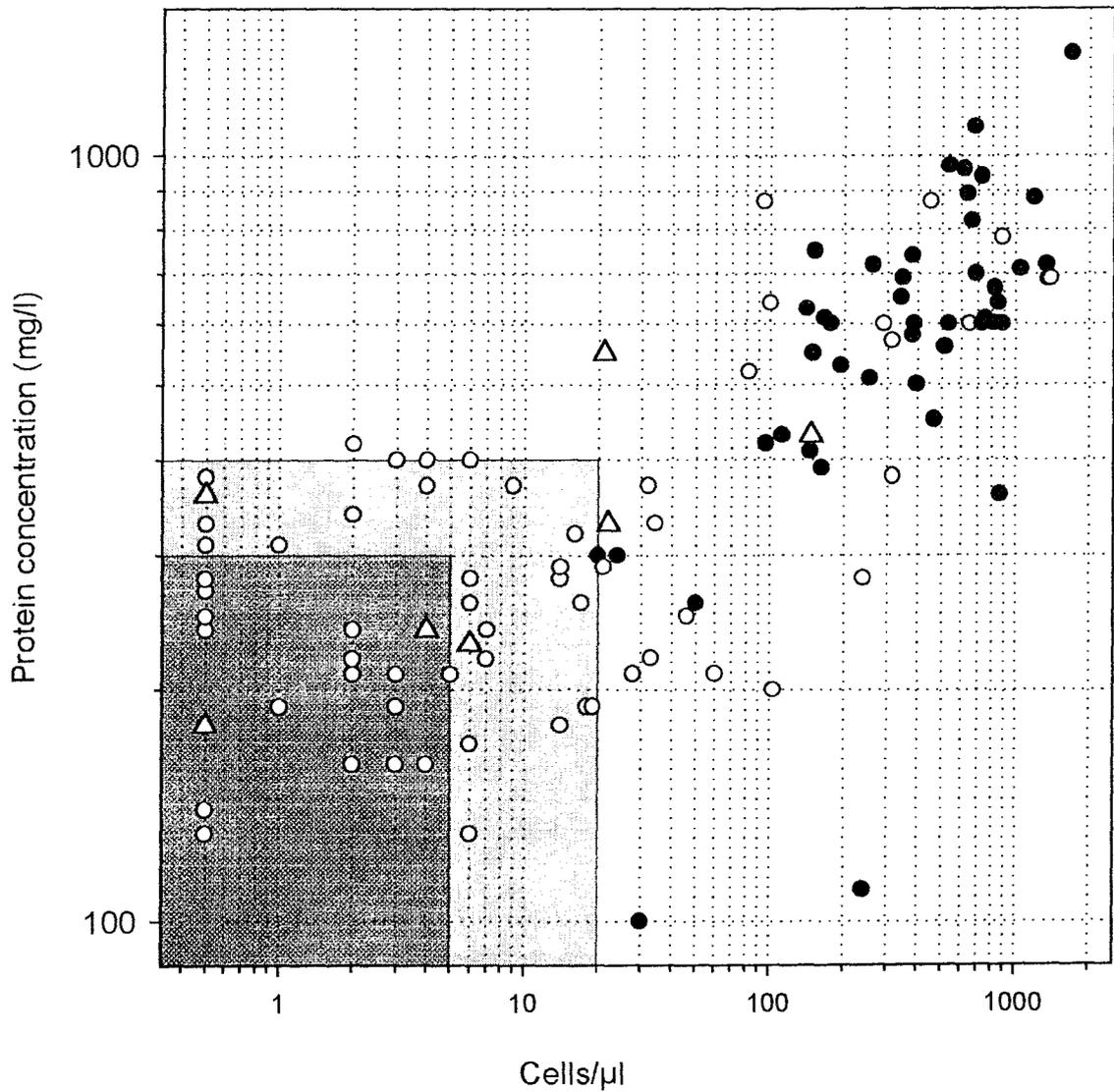
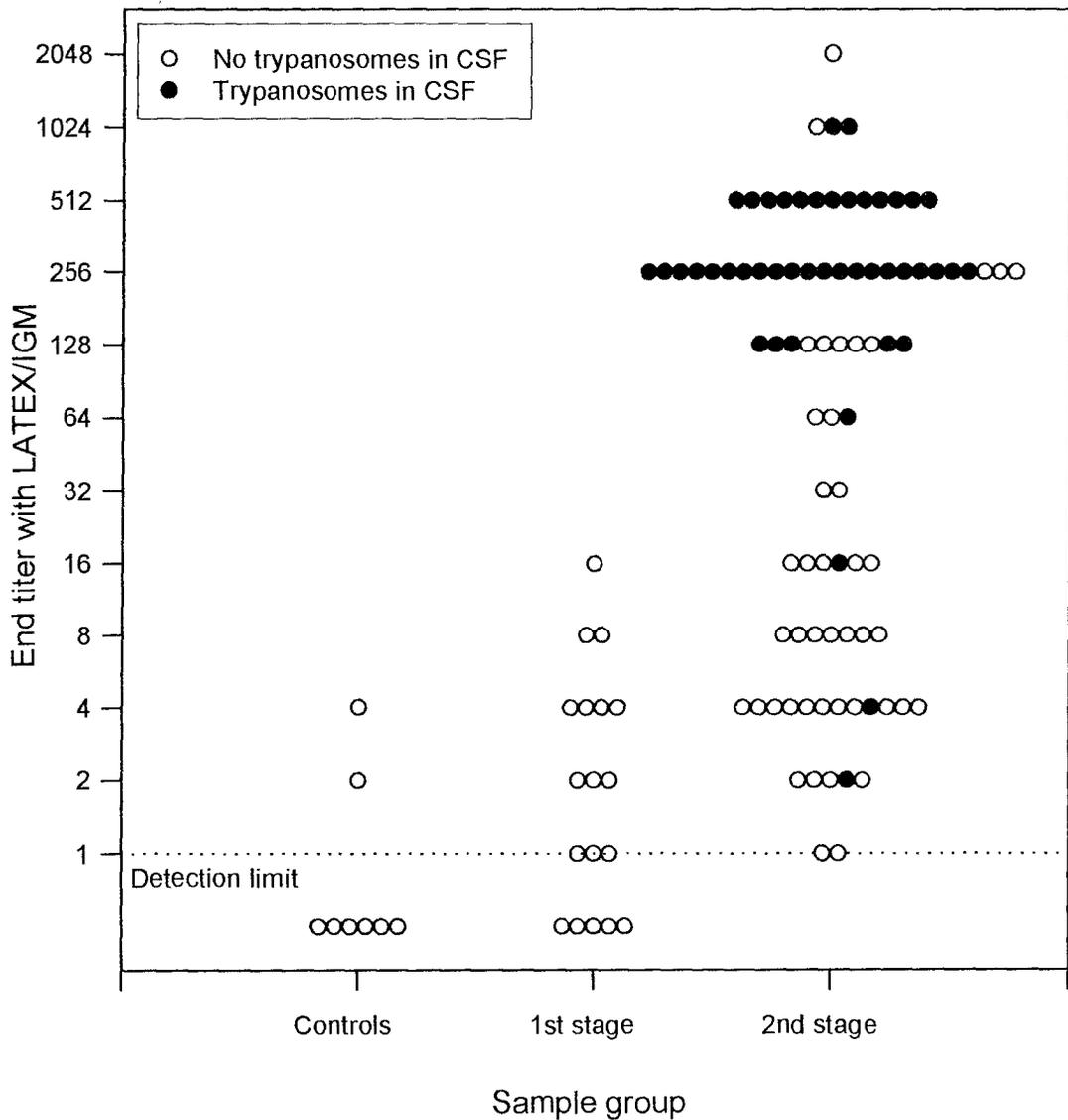


Fig 4: LATEX/IgM end titer of CSF samples from 8 controls and 108 sleeping sickness patients



Re-evaluation of Card Agglutination Test for trypanosomiasis (CATT) for the diagnosis of *Trypanosoma brucei gambiense* in North West Uganda

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Abstract

A total of 45 parasitologically confirmed cases of sleeping sickness patients were diagnosed in North West Uganda of which 40 were positive by CATT and 4 were negative, while 1 was not screened by CATT. The 4 sleeping sickness cases which gave negative CATT results have very important implications in the diagnosis of *T.b.gambiense* using CATT because it implies that CATT test misses out some patients which remain as human reservoir hosts for continuous infection of the population. Trypanosomes isolated from these CATT negative, but parasitologically positive sleeping sickness patients were propagated for detailed biochemical genetic analysis in order to demonstrate whether these trypanosomes lack LiTat 1.3 gene used in CATT test. Some of these 45 sleeping sickness cases were detected by a combination of two or three techniques. All the DNA extracts isolated from the 10 *T.b.gambiense* stocks so far prepared were targeted for amplification by the three variable surface glycoprotein genes thought to be ubiquitous in *T.b.gambiense*. The LiTat 1.3 gene which encodes the antigen chosen for the Card Agglutination Test for Trypanosomiasis (CATT) was shown to be present in the 10 isolates including the four isolated from CATT-negative patients. The extent of false CATT-negative individuals (due to non-expressor LiTat 1.3 populations or low sensitivity of the CATT) is unknown because CATT-negative individuals are rarely examined further. This study demonstrates the value of a coordinated use of serological and parasitological techniques in the diagnosis of *T.b.gambiense* sleeping sickness.

Introduction

Epidemic of sleeping sickness caused by *Trypanosoma brucei gambiense* have occurred periodically in the north west Uganda since the beginning of this century. The districts affected most are Moyo, Arua and Gulu. Furthermore, the return of Ugandan refugees from southern Sudan where there is an epidemic of Gambian sleeping sickness to northern Uganda has compounded the problem, hence the increase in annual incidence of sleeping sickness to 1,371 cases in 1991 in Moyo district alone.

Trypanosomiasis case detection in north west Uganda is by screening of population using Card Agglutination Test for Trypanosomiasis (CATT) on whole blood and plasma diluted 1:4 (Bailey and Smith, 1992). All individuals positive by both tests are parasitologically investigated using microhaematocrit centrifugation technique.

Medicines Sans Frontieres (MSF) working in Moyo and Adjumani found that trypanosomes could not be demonstrated in approximately 25% of the CATT positive individuals (Bailey and Smith, 1992). Data from the National Sleeping Sickness Control Programme (NSSCP) showed that in 1991, out of 6,910 persons examined in Moyo district, 1,670 were positive by CATT and 897 had trypanosomes in their blood samples. However, blood samples which were CATT negative were not examined for the presence of trypanosomes by parasitological methods. It is known that the gene coding for the antigen LiTat 1.3 used in the CATT is absent in some isolates of *T. b. gambiense* (Dukes et al., 1992, Kanmogne et al., 1996). It is imperative to determine whether CATT misses some patients due to the presence of LiTat 1.3 non-expressors. The undetected cases, if present, will remain sources of trypanosomes for subsequent epidemics.

Materials and methods

Trypanosomes

Trypanosomes were isolated from sleeping sickness cases diagnosed by inoculation of infected blood, cerebrospinal fluid or gland aspirate into *Mastomys natalensis* rats.

Blood samples from suspects were examined for the presence of trypanosomes by the wet blood film method, the microhaematocrit centrifugation technique and the CATT.

Wet blood film method

About ten microlitres of blood obtained from a finger prick or lymph gland aspirate placed on a microscope slide was covered with a cover slip and examined by light microscopy for the presence of trypanosomes. Forty to fifty microscope fields were examined under the 400x magnification.

Microhaematocrit centrifugation technique (HCT)

The microhaematocrit centrifugation technique was carried out as described by Woo (1970). Heparinized haematocrit capillary tubes were filled with about 0.06 ml of blood, sealed at one end and centrifuged at 12,000 r.p.m. for 5 minutes. The capillary tubes were then removed and placed in a centrifuge holder and examined under a microscope at 100x magnification. Trypanosomes were

Card agglutination test for trypanosomiasis (CATT)

The Card Agglutination Test for Trypanosomiasis (using Testryp reagent) was performed as described by the manufacturer, Smith-Kline-RIT (1982). Blood samples from sleeping sickness suspects were collected in heparinized capillary tubes. In each test area on the card was added one drop of a well homogenized CATT reagent and a drop of blood sample from a suspected sleeping sickness case. The mixture was spread to within 1 mm of the edge of the test area using a stirring rod. The card was then rotated for 5 minutes on a rotator after which the test result was read.

Polymerase chain reaction (PCR)

The DNAs from *T.b.gambiense* isolates were amplified for variant surface glycoprotein (VSG) genes by polymerase chain reaction as described by Bromidge et al., (1993) using AnTat 11.17, LiTat 1.3, and VSG 117 set of primers. The PCR amplifications were carried out in 25 microlitres reaction mixture containing final concentrations of 10 mM Tris-HCL, pH 8.3, 50 mM KCL, 1.5 mM MgCL 0.1% (v/v) tritonX-100, 200 uM each dATP, dGTP, dCTP and dTTP, 0.1 uM each the 5' and 3' primers, 100 ng DNA template and 1 unit of Taq DNA polymerase. The mixture was overlaid with one drop of mineral oil and then amplified in a Hybaid Thermal Cycler with the initial denaturation step at 94°C for 3 min and subjected to 30 cycles involving denaturation for 1 min at 94°C, annealing at 50°C for 2 min and extension at 72°C for 1 min. The absence of contaminants was routinely checked by inclusion of negative control in which the DNA samples were replaced with sterile distilled water. Fifteen microlitres of each PCR reaction was electrophoresed in 1.5% agarose containing 0.5 ug/ml ethidium bromide. The amplified products were observed by UV transillumination.

Results

Two trypanosomiasis field surveys were carried out in Terego county, Arua district, during which 1,266 persons were screened by the card agglutination test for trypanosomiasis of which 331 (26.1%) were positive by CATT. There were 287 (22.6%) blood samples which were positive by CATT, but trypanosomes could not be demonstrated in them, suggesting that either the parasitaemias were too low to be detected by the wet blood film and the microhaematocrit centrifugation techniques or they were false positives due to crossreaction of *T.b.gambiense* variable surface glycoprotein LiTat 1.3 antigens or other glycoproteins with other antibodies present in the blood samples. A total of 45 parasitologically confirmed sleeping sickness patients were diagnosed of which 40 were positive by CATT and 4 were negative, while 1 was not screened by CATT (Table 1). The 4 sleeping sickness cases which gave negative CATT results have very important implications in the diagnosis of *T.b.gambiense* using CATT because it implies that CATT misses out some patients which remain as human reservoir hosts for the continuous infection of the population.

Three variant surface glycoprotein genes (LiTat 1.3, AnTat 11.17 and VSG 117) and a *T.brucei* specific primer set (TBR 1& TBR2) were used for PCR amplification. The LiTat 1.3 gene which encodes the antigen chosen for the Card Agglutination Test for Trypanosomiasis (CATT) because it was thought to be commonly expressed by *T.b.gambiense* (Magnus et al. 1984) was

previously reported in isolates from north-west Uganda (Enyaru et al., 1993) while VSG 117 was absent in some *T.b.gambiense* Type II from west Africa and some *T.b.rhodesiense* and *T.b.brucei* isolates (Bromidge et al., 1993).

Table 1. Results of card agglutination test for trypanosomiasis (CATT) in the diagnosis of sleeping sickness in North West Uganda

No of persons screened by CATT	No of persons positive by CATT (%)	SS cases		
		CATT +ve	CATT -ve	ND
556	113 (20.3)	19	0	0
710	218 (30.7)	21	4	1
1,266	331 (26.1)	40	4	1

Table 2: PCR results of DNAs from trypanosome stocks isolated from humans in North West Uganda using TBR 1&2, LiTat 1.3A&B, AnTat 11.17A&B and VSG 117A&B primer sets.

+ signifies amplified product and - signifies no product of expected size

Stock	TBR 1 &2	LiTat 1.3 A &B	AnTat 11.17 A &B	VSG117 A &B
MHOM/UG/95/NW4	+	+	-	+
MHOM/UG/95/NW8	+	+	+	-
MHOM/UG/95/NW11	+	+	+	+
MHOM/UG/95/NW12	+	+	+	+
MHOM/UG/95/NW13	+	+	+	+
MHOM/UG/95/NW14	+	+	+	+
MHOM/UG/95/NW15	+	+	-	+
MHOM/UG/95/NW16	+	+	+	+
MHOM/UG/95/NW17	+	+	+	+
MHOM/UG/95/NW18	+	+	+	+

Discussion

All DNA extracts isolated from the 10 *T.b.gambiense* stocks including the 4 from sleeping sickness patients which were negative by CATT were amplified by TBR 1 &2 primers specific for *T.brucei* subgroup (Moser et al., 1989; Masiga,1994) to confirm their identity as *T.brucei*. As expected , all trypanosome isolates were detected with the TBR 1&2 primer set and thus confirmed as belonging to the *T.brucei* subgroup. This primer was found to be very sensitive that it required quite low concentrations of DNA to be amplified.

Furthermore, all the DNA extracts were subjected to PCR amplification using primers from LiTat 1.3, AnTat 11.17 and VSG 117 variable surface glycoprotein genes in order to assess whether the trypanosomes have these genes. Although LiTat 1.3 and AnTat 11.17 genes are considered to be characteristic of Type I *Trypanosoma brucei gambiense*, LiTat 1.3 gene (which encodes the antigen used in CATT) was shown to be present in all the 10 isolates, while AnTat 11.17 was

the 8 Ugandan isolates did not have the gene. However, the VSG 117 gene which was present in all previous stocks from north west Uganda was absent in one stock NW8 (Table 2). The various kinds of *T.b.gambiense* may also have some bearing on the epidemiology of the disease in the light of the preliminary findings that Uganda was having the highest number (10%) of post eflornithine relapses (Maiso et al.,1995) and about 20% melarsoprol relapses in Arua hospital (MSF, May 1997).

Lack of some VSG genes among *T.b.gambiense* stocks from north west Uganda demonstrates that *T.b.gambiense* is not a single, static entity (Bromidge et al., 1993).

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