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REPORT AND RECOMMENDATIONS OF THE SIXTEENTH  
INTERNATIONAL SCIENTIFIC COUNCIL FOR TRYPANOSO-  
MIASIS, RESEARCH AND CONTROL (ISCTRC)



CM-1062

MICROFICHE

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AGENDA FOR THE 16TH ISOTRC MEETING

1. Reviews of International Organizations Activities :

OAU/STRC, FAO, WHO and ILRAD

2. Protozoology, Immunology and Biochemistry

2.1 Identification of trypanosomes

2.2 Life cycle and in vitro cultivation of trypanosomes

2.3 Physiology of trypanosomes

2.4 Immunological methods of diagnosis

2.5 Immune response

2.5.1 Vaccination

3. Entomology

3.1 Geographical distribution of Glossina

3.1.1 The effect of physical and climatic changes on tsetse populations

3.2 Biology of Glossina

3.2.1 Behaviour of tsetse populations in relation to resting, breeding and feeding habits

3.2.2 Survey techniques and trapping

3.2.3 Laboratory colonies of tsetse flies

3.3 Taxonomic studies (conventional, cytotaxonomy, isoenzyme studies, etc)

4. Human Trypanosomiasis

4.1 Epidemiology

4.2 Clinical signs and pathology

4.3 Diagnosis

4.4 Chemotherapy



5. Animal Trypanosomiasis

- 5.1 Epizootiology including mechanical transmission
- 5.2 Clinical signs and pathology
- 5.3 Diagnosis
- 5.4 Chemotherapy, chemoprophylaxis and chemoresistance
- 5.5 Trypanotolerance

6. Glossina Control

- 6.1 By insecticides
  - 6.1.1 Residual applications
  - 6.1.2 Non-residual applications.
  - 6.1.3 Effect of insecticide treatments on the environment
- 6.2 By genetic methods
- 6.3 By other methods

7. Training

WORKING PAPERSI. REVIEWS

| TITLE                                                                                                                                                                                 | AUTHOR(S)  |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| Activities of the Organization of African Unity, Scientific, Technical and Research Commission (OAU/STRC) on Testes and Trypanosomiasis during the Period April 1977 to October 1979. | P.G. Atang |
| Activities of the FAO During the Period April 1977 to October 1979.                                                                                                                   | P. Finelle |
| Activities of the WHO During the Period April 1977 to October 1979.                                                                                                                   |            |
| Activities of ILRAD during the period April 1977 to October 1979                                                                                                                      | Max Murray |

II. PROTOZOOLOGY, IMMUNOLOGY AND BIPOHEMISTRY

| T I T L E                                                                                                                                                                                            | AUTHOR(S)                                     |
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| <u>In vitro</u> Cultivation of Infective Forms of <u>Trypanosoma brucei</u> from the midgut and Salivary Glands of <u>Glossina morsitans morsitans</u> .                                             | Mramba Nyindo                                 |
| <u>In vitro</u> Cultivation of <u>Trypanosoma evansi</u> .                                                                                                                                           | M.M. Mahamoud & L. Cunningham                 |
| Coloration Virale Fluorescente du Trypanosome procede Rapid de Defection du Parasite dans le Sang.                                                                                                   | J. Carrie                                     |
| Des differents examens sero-immunologiques: diagnostic de la trypanosomiase africaine a <u>T. gambiense</u> .                                                                                        | J. Carrie                                     |
| Comparison of the Electrophoretic Mobilities of Tyrosine Amino transferase and two other Aminotransferases of three Trypanosome Species.                                                             | James K. Gashumba<br>V. Kilgour & S.M. Lanham |
| The Sequential EIT-Testing of Successive Variable Antigen Types Produced in Clone-induced <u>Trypanosoma</u> (Trypanozoon) <u>brucei</u> Complex Infection. Serially Syringe-passaged in White Rats. | Laurence Rickman & F. Kolala                  |

III. HUMAN TRYPANOSOMIASIS

| T I T L E                                                                                                                                                                                                                             | AUTHOR(S)                                                        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|
| The .Remaining Foci of Human Sleeping Sickness in Kenya, Homa Bay District and Busia District - 1968 to 1978.                                                                                                                         | T. Ogada                                                         |
| Les problemes du controle de la trypanosomiase en Angola.                                                                                                                                                                             | Rosario Pinto                                                    |
| Human Trypanosomiasis in the Southern Sudan: Present Situation and Control Measures.                                                                                                                                                  | O.m. Duku                                                        |
| La Trypanosomiase dans les Etats de l'OCEAC en 1978.                                                                                                                                                                                  | J. Carrie                                                        |
| La trypanosomiase a l'OCCGE.                                                                                                                                                                                                          | Duvallet G.<br>Mangenot M.<br>Desfontaine M. &<br>Moreau J.P.    |
| Le depistage et le diagnostic de la trypanosomiase humaine dans les Etats Membres de l'OCCGE.                                                                                                                                         | Duvallet G.<br>Mangenot M. &<br>Moreau J.P.                      |
| Contribution a l'etude des caracteristiques de densite de la trypanosomiose humaine au Congo Kinshasa.                                                                                                                                | L. Haller<br>M. Blanc &<br>P. de Raadt                           |
| L Adrenaline dans la prevention et le traitement des accidents de l'Arsobal-therapie. A propos de 728 cas de trypanosomiase humaine Africaine a <u>T. gambiense</u> traites dans les formations sanitaires de fortem (R.U. Cameroun). | Sina Gian Carlo<br>T. Nicasio<br>C. Bernard et<br>Sub. B. Martin |

| T I T L E                                                                                                      | AUTHOR(S)                                |
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| Epidemiologie de la Trypanosomiose humaine au Congo : les déplacements des glossines dans le foyer du couloir. | Eouzan J.P.<br>Frezil J.L.<br>Lancien J. |
| Evaluation of Diagnostic Methods in Human Trypanosomiasis                                                      | Simon van<br>Nieuwenhove                 |
| Human Trypanosomiasis in Tanzania: Epidemiology and Control.                                                   | S.E. Temu                                |

IV. ANIMAL TRYPANOSOMIASIS

| T I T L E                                                                                                                                                | AUTHOR(S)                                                     |
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| Review of Present situation in human and animal Trypanosomiasis in Kenya.                                                                                | D.R.A. Maina                                                  |
| Resultants des passages aux animaux de Laboratoire de la souche <u>Trypanosoma congolese</u> isolee a l'office du Ranch de la Diheresse.                 | D. Boussafou-Malonga<br>V.V. Petovski                         |
| Pathological Change Associated with 4 Experimental <u>Trypanosoma vivax</u> Infection in Zebu Cattle.                                                    | A. Sannusi                                                    |
| Some Changes in the Host's Carbohydrate Metabolism Associated with Experimental <u>Trypanosoma vivax</u> Infection.                                      | A. Sannusi                                                    |
| Variations and Significance of the Erythrocyte Surface Sialic Acid in the Aetiology of the Anaemia or Animal Trypanosomiasis.                            | K.A.N. Esievo<br>E.I. Saror<br>A.A. Ilemobade & M.H. Hallaway |
| Pathological Change in Microcirculation of Tissues and Organs of Cattle Experimentally infected with <u>Trypanosoma vivax</u> and <u>T. congolense</u> : | P.M. Mwambu & G.J. Losos                                      |
| Chemotherapy and Chemoprophylaxis in the Control of Trypanosomiasis : A Review with Particular Reference to Isometamidium.                               | D.A. Hutchings                                                |

| T I T L E                                                                                                                                          | AUTHOR (S)                                                                       |
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| Studies on Isometamidium chloride (Samorin) Serum and Tissue Concentrations in Goats After Intramuscular and Intravenous Administration.           | K.I. Enghianeuba<br>& M.O. Uduebholo                                             |
| Isometamidium-dextran complex: Therapeutic Activity Against <u>Trypanosoma vivax</u> Infection in Zebu cattle                                      | Y. Otaru Aliu &<br>Abdülrahim Sannusi                                            |
| Observations on Maintaining Zebu Maure Cattle in a Tsetse Infested Area of Mali.                                                                   | L.L. Logan<br>J.T. Goddwin<br>S. Tembely                                         |
| Drug Sensitivity of Mouse-infective <u>Trypanosoma vivax</u> Isolates in Cattle and Sheep                                                          | A.A. Ilembade                                                                    |
| Drug Trial in Mice on <u>T. evansi</u> -like Organisms Isolated from Camels in Kenya.                                                              | S.K. Gitatha                                                                     |
| <u>T. congolense</u> (Shimba Hills) Resistant to Various Trypanocidal Drugs.                                                                       | S.K. Gitatha                                                                     |
| Susceptibility to African Trypanosomiasis - studies in Cattle and Mice.                                                                            | Max Murray<br>W.I. Morrison<br>D.J. Clifford<br>P.K. Murray &<br>W.I.M. McIntyre |
| Summary of Results from an Experiment of Comparative Pathology between Zebu and N'Dama Cattle During General Infection by Pathogenic Trypanosomes. | S.M. Toure                                                                       |
| Initial Progress on Establishment of a Network of Trypanotolerant Livestock herds                                                                  | C.H. Hoste<br>Y.J. Wisoq &<br>H.C.M. Trail,                                      |

| T I T L E                                                                                                                                                       | AUTHOR(S)                                               |
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| Research on Trypanotolerance<br>Performed at CREAT.                                                                                                             | E. Karbe<br>A. Dovie &<br>H.O. Fimmen                   |
| Limited Trypanotolerance in a Cattle<br>Herd Exposed to Natural Tsetse fly<br>Challenge.                                                                        | H.O. Fimmen<br>K. Mawuenka<br>S. Dillmann &<br>E. Karbe |
| The Haematology of N'Dama and Zebu Cattle<br>Experimentally Infected with <u>Trypanosoma</u><br><u>vivax</u> .                                                  | D.I. Saror<br>A.A. Ilemobade<br>& S. Nuru               |
| Un foyer de trypanosomiase sur du bétail<br>trypanotolerant à l'office du Ranch de<br>la Dièssé au Congo.                                                       | B. Boussafou-<br>Malonga<br>V.V. Petrovski              |
| Lutte contre les trypanosomiases africaines<br>du détail: quelques réflexions.                                                                                  | A. Ferriot                                              |
| Intérêt de l'utilisation du chlorure<br>d'isometamidium dans la lutte contre<br>certaines trypanosomiases animales.                                             | L. Touratier                                            |
| Méthodes d'étude épidémiologique des<br>trypanosomiases africaines - Résultats<br>obtenus au Sénégal en 1979.                                                   | S.M. Toure &<br>M. Seye                                 |
| Note sur les obstacles d'une utilisation<br>pratique de l'association glycérol-<br>Acide salicylhydroamique dans le traitement<br>des Trypanosomiases animales. | S.M. Toure                                              |
| Fraudes sur les trypanocides Végétariens                                                                                                                        | S.M. Toure                                              |



V. ENTOMOLOGY

| T I T L E                                                                                                                            | AUTHOR(S)                                                           |
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| Observations on an Apparent population extension of <u>Glossina tachinoides</u> Westwood in Southern Ivory Coast.                    | F.A.S. Kuzoe<br>D.A.T. Baldry<br>A. Van der Vloedt<br>& J.R. Cullen |
| A preliminary Appraisal of X-Ray Energy-Dispersive Spectroscopy for Studying Tsetse Dispersal.                                       | D.A.T. Baldry &<br>R.B. Bannett                                     |
| Tsetse Distribution in the Republic for Mali : an Interim Report.                                                                    | D.R. Ashton<br>J.T. Goodwin<br>A. Ba &<br>A. Ciese                  |
| Geographical Distribution of <u>Glossina</u> in Sierra Leone.                                                                        | H.R. Sessay                                                         |
| Some Records of <u>Syntomosphyrum</u> (NYM., Eulophidae) Parasitizing <u>Glossina palpalis</u> in Nigeria.                           | D.A.T. Baldry                                                       |
| Observations on the Daytime Resting Behaviour of <u>Glossina morsitans sub-morsitans</u> in South-Western Nigeria.                   | D.A.T. Baldry                                                       |
| Optimum Light Intensity required for Choice of a Breeding site by <u>Glossina fuscipes</u> Newstead and <u>G. pallidipes</u> Austen. | Josue O. Okoth                                                      |
| Tsetse Ecology and Epidemiology of Trypanosomiasis in the Gambia and on the South Kenya Coast: a comparison.                         | W.F. Snow                                                           |

| T I T L E                                                                                                                                                                                | AUTHOR(S)                                                                                            |
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| The Maintenance of a Colony of <u>Glossina pallidipes</u> Austen at Tororo, Uganda: Problems during and after the Liberation War.                                                        | A. Katabazi &<br>R.W. Kapaata                                                                        |
| An attempt to Colonise <u>Glossina pallidipes</u> Austen at Kenya Trypanosomiasis Research Institute.                                                                                    | Elizabeth. A.<br>Opiyo                                                                               |
| Performances de deux colonies de <u>Glossina palpalis gambiensis</u> Vanderplank nourries l'une sur lapins, l'autre sur cobayes, dans l'elevage de Bobo-Dioulasso (Haute Volta) en 1978. | Selin, E<br>Bourdoiseau, G<br>Clair, D.<br>Cuisance, D.<br>Fevrier, J.<br>Politzar, H. &<br>Taze, Y. |
| An investigation of Electric Traps for surveying Tsetse ( <u>Glossina morsitans centralis</u> ) Populations in Botswana.                                                                 | Mohammed I. Ali<br>& Reginald Allsopp                                                                |
| Influence de l'eau permanente et de la vegetation ligneuse sur les ecoclimats.                                                                                                           | M. Terrible                                                                                          |
| Les enquetes tse-tse de l'activite terres nouvelles du Project Mali II.                                                                                                                  | S.N. Okiwelu<br>P. Van Wettere<br>S. Maiga                                                           |

VI.. GLOSSINA CONTROL

| T I T L E                                                                                                                                 | AUTHOR(S)                                                                              |
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| Experimental Application of Insecticides by Helicopter to Control Vectors of Trypanosomiasis in the Ivory Coast.                          | F.A.S. Kuzae<br>D.A.T. Baldry<br>J.R. Cullen &<br>P. de Raadt                          |
| Tsetse fly Eradication by Means of Helicopters in the Adamaoua highlands, Cameroon.                                                       | E. Scholz                                                                              |
| Application of Low Dosage of Insecticides by Helicopter for the Control of Riverine Tsetse flies in West Africa.                          | C.W. Lee<br>J.D. Parker<br>H. Kulzer<br>D.A.T. Baldry<br>B.W. Bettany &<br>J. Tunstall |
| The evolution of Tsetse and Trypanosomiasis control in Cameroon.                                                                          | John T. Baner                                                                          |
| The status and progress of control of the 1976 Rhodesian Sleeping Sickness outbreak in Luuk and Kigulu countries, South Busoga, Uganda.   | Mukasa Lawrence<br>Semakula                                                            |
| A review of successive reclamation work on the Tsetse, <u>Glossina morsitans centralis</u> (MACHADO 1970), Infestation in Ankole, Uganda. | T.N. Kangwagye                                                                         |
| Recent Results of the Sterile Insect technique for the control of <u>Glossina palpalis gambiensis</u> .                                   | H. Politzar<br>D. Cuisance<br>G. Bourdoiseau<br>J. Fevrier<br>E. Cellin                |

| T I T L E                                                                                                                                        | AUTHOR(S)                                                               |
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| Efficiency of chemical and mechanical barriers against <u>Glossina palpalis gambiensis</u> .                                                     | D. Cuisance<br>H. Politzar<br>G. Bourdoiseau<br>J. Fevrier<br>E. Sellin |
| Le piège beconique imprégné d'insecticide pour la lutte contre les Glossines riveraines.                                                         | C. Laveissiere<br>& D. Couret                                           |
| Essais de lutte contre <u>Glossina palpalis</u> S.L. dans le foyer de trypanosomiase humaine de Vovoua en secteur preforestier de Cote d'Ivoire. | Laveissiere G.<br>J.P. Coutex &<br>D. Couret                            |
| The current status of studies on the effects of insect growth regulators on Tsetse flies ( <u>Glossina</u> spp.).                                | A.M. Jordan &<br>L. Clarke                                              |
| Prospects for use of specific sexpheromones for Tsetse Control.                                                                                  | P. A. Langley<br>D.A. Carlson<br>P.M. Huyton &<br>T.W. Coates.          |
| Chemical and Insecticide induction of abortion in <u>Glossina palpalis</u> R.D.                                                                  | E.K. Riordan<br>(formerly K.<br>Riordan)                                |

VII. TRAINING

| TITRE                                                                                                                                                                                                                                                            | AUTHOR(S)     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| Rapport sur le cours FAO/IEMVI/CTZ de formation de spécialiste sur la trypanosomiase animale et de la lutte contre cette maladie                                                                                                                                 | J. Itard      |
| Possibilities for insect control training of Anglophone personnel through the UNDP/FAO Regional Project for Animal Trypanosomiasis control: economic Assessment, training and applied research on <u>Glossina</u> control in the dry Savanna Zones (FAF 75/001). | D.A.T. Baldry |

## I. R E V I E W S

Discussion Leader: J.N. Songwe

Rapporteur : M.M. Katondo

Representatives of four International organizations (OAU, FAO, WHO and ILRAD) described their on-going and proposed activities for trypanosomiasis research and control since the last ISCTRC meeting in Banjul in April 1977.

### OAU/STRC/ISCTRC Activities

P. ATANG reviewed the activities of the OAU/STRC/ISCTRC. An account of the 15th ISCTRC meeting, which was held in Banjul, the Gambia, was given; This meeting attracted over 70 scientific papers and was attended by 100 experts.

During the period under review, the OAU also participated in a number of Conferences and Meetings, and some of the conclusions and recommendations of these meetings of particular importance were given. Among these were the conclusion and recommendations contained in the Report of the Task Force on Tsetse and Trypanosomiasis. One of these recommendations calls for the strengthening and expansion of the ISCTRC Executive Committee and its Secretariat as well as the provision for this purpose a budget of US\$250,000, increasing to US\$600,000 in five years. Another recommendation approves the contribution of the ISCTRC as the international structure for the promotion, integration and coordination of activities for trypanosomiasis control. A third recommendation appeals to national governments and international organizations and agencies as well as bilateral and multilateral assistance agencies to assist in collaboration with the OAU in the establishment of national and sub-regional trypanosomiasis control units.

Another meeting which was reported upon is the 10th FAO Regional Conference for Africa which was held in Arusha, Tanzania, in September 1978. At this Conference a resolution was adopted calling for the strengthening of the OAU capacity by technical assistance, and for FAO and OAU to co-operate fully in the execution of the trypanosomiasis control programme. This resolution was endorsed at the Second FAO Consultation which was held in Lusaka Zambia in December 1978.

Other activities included two training seminars organized jointly by FAO/OAU/WHO in collaboration with certain institutes such as ILRAD, OCGE, etc. The first was a Leadership Training Seminar for Trypanosomiasis Field Workers, and was attended by 69 participants comprising of 36 veterinarians, 12 doctors, 16 entomologists and 5 senior technicians in related fields. The second seminar was for entomologists concerned with tsetse control activities, and was attended by 27 participants drawn from 20 African countries. The sponsors of these seminars intend to continue with training of this nature to fill the very acute void in expertise for tsetse control to prepare for continent-wide attack on tsetse and trypanosomiasis problems.

In this connection it was observed that the OAU /STRC Tsetse Distribution Map of Africa published recently would be useful. However, noting that this map requires regular up-dating it was recommended that preparations for its revision be initiated.

Finally, P. ATANG described the recently launched Tsetse and Trypanosomiasis Information Quarterly sponsored jointly by FAO, OAU, WHO, IEMV and the Centre for Overseas Pest Research (COPR) of the British Ministry for Overseas Development. This medium has, as its main objectives, dissemination of news and views on tsetse and trypanosomiasis control activities, and the establishment of a bibliographic reference source.

F.A.O. Activities

P. FINELLE reported that the preparatory phase of the FAO programme for the control of African Animal Trypanosomiasis is now completed. During this phase emphasis was laid on the training of personnel at all levels aimed at strengthening the national structures and establishing in each country specialised multidisciplinary trypanosomiasis control units. In addition to the various activities carried out jointly with the OAU and WHO, three specialised training courses were successfully conducted in co-operation with I.E.M.V.T., France, GTZ Federal Republic of Germany, ODA and United Kingdom.

During the period under review feasibility studies were carried out in 16 countries, and various institutes were given contracts aimed at stimulating applied research on the control of trypanosomiasis and tsetse; three experts consultations were held for research on trypanosomiasis, trypanotolerance and on the economic aspects of trypanosomiasis and its control. One meeting was held in Lusaka to advise on the co-ordination and planning of this programme; a manual on tsetse control is under preparation; and a study on trypanotolerant livestock is being undertaken in co-operation with ILCA and UNFP.

The operational phase of the programme will commence in 1980 with the organization of multidisciplinary missions to countries to prepare national control campaigns and related development programmes. Development support units will be set up at sub-regional level, beginning with West Africa where requirements are imperatives. Co-ordination structures will be established to allow the active participation of all interested countries and institutions in both the control and development projects.



W.H.O. Activities

P. DE RAADT reported on the two major components of the World Health Organization Programme. These are applied research on the optimal use of current control tools and the long term programme on the development of new control techniques and principles.

The activities related to the improved and extended use of current tools are concentrated at a WHO field project located in Ivory Coast where applied research and training are carried out in collaboration with various research groups in and outside Africa. As a result of these joint studies progress was made recently in aerial insecticide spraying techniques, in evaluation of new experimental sero-diagnostic tests, and field adapted systems for parasite detection. Two of the most significant advances made as part of these studies were the observation that the flight range of tsetse can be as long as 15 km. This is obviously important for tsetse control operations. Secondly the detection of trypanosomes in domestic pigs similar to those in sleeping sickness patients. This implies that T.b. gambiense disease is a zoonosis like T.b. rhodesiense sleeping sickness.

WHO has also developed a Test Kit for rapid diagnosis of Sleeping Sickness which is now available for technicians in the field.

The long term research programme is now principally carried out under the UNDP/World Bank/WHO Special Programme for Research and Training in Tropical Diseases which has been operational since late 1977. This programme includes :-

- (1) Epidemiology for which includes the present priorities are reservoir host studies, transmission cycle and applied research as described above.
- (2) Chemotherapy which includes fundamental bio-chemistry; studies on mode of action of drugs and the establishment of a drug screening centre at Muguga, Kenya, in Africa. So far three new leads have become available for testing: a new diamidine, an arsenical compound and one unspecified coded compound.
- (3) Immunology/Pathology programme for which the main activity is the establishment of a clinical network in Africa for parallel autopsy studies. In addition there are projects on antigenic variation and on experimental pathology.

The Special Programme operational budget for African Trypanosomiasis amounts to a total of US\$1.7 million for 1979 and is expected to remain at the same level in 1980.

The Training and Research Strengthening provided as a part of the Special Programme is organised through a separate transdisease programme activity which includes visiting research workers, grants to individual applicants for research appointments outside their country. The Research/Programme is also providing financial and technical support for training seminars and workshops.

ILRAD Activities.

MAX MURRAY gave a resume of the on-going and proposed activities of the International Laboratory for Research on Animal Diseases (ILRAD) whose mandate is to carry out research on the immunology of African animal trypanosomiasis and East Coast Fever in cattle with the objective of developing a vaccine. The other major aspect of its role is training scientists from the developing countries.

Since its establishment ILRAD has made significant contribution to the knowledge of trypanosomiasis. With regard to cell biology, infective forms of T. brucei were grown in tissue culture for the first time while workers in molecular biology and parasitology are making in-depth studies on antigenic variation using recombinant DNA technology, monoclonal antibodies and 2 dimensional gel techniques. To date they have succeeded in isolating a gene responsible for the production of a variant surface antigen. At the same time work is going on to examine the antigenic characteristics of metacyclic trypanosome.

Workers in biochemistry unit have been purifying and characterising various subcellular fractions of the trypanosome including the variant surface antigen, the trypanosome membrane and the flagella with a view to identifying a fraction which might be used for vaccination or diagnosis.

In the immunology section in collaboration with pathology the bovine immune system is being studied e.g., the development of lymphocyte markers, structural and functional changes produced by trypanosome infections and adjuvants. Workers in immunology have now developed some 90 hybridomas, monoclonal antibody cell lines, against a whole range of parasite antigens. Those hybridomas specificity never before possible.

In the pathology section, studies are being carried on the early events following the bite of an infected tsetse-fly. As in man, this produces a chancre lesion which almost certainly acts as the site for antigen priming of the draining lymph node (s).

The pathogenesis of the disease in cattle is being evaluated with T.(N). congolense, T.(D) vivax and T.(b) ~~serrei~~ infections.

Another major area of interest is that of trypano-tolerance which is being investigated in both cattle and mice. The results have confirmed that trypanotolerance does exist as an innate characteristic in cattle although it can be supplemented by such factors as previous exposure or reduced by the stress of parturition or the level of challenge. Work in mice has shown that it is an incompletely dominant trait, is under complex genetic control and may, at least in part, be related to the immune response.

To support this research ILRAD has created excellent tsetse and tick facilities and at present is expanding its cattle facilities in order to supply a sufficient number of parasite-free cattle which are essential for the continued implementation of the studies described above.

The second major activity ILRAD, after research, is training. With the appointment of a full time Training and Outreach Officer this activity will be expanded in the coming year. ILRAD will undertake a co-operative training programme for laboratory technologists with the Kenya Agricultural Research Institute, Muguga, the Veterinary Faculty, University of Nairobi and the Veterinary Laboratories, Kabete. Moreover, ILRAD plans to arrange courses and research programmes leading to higher degrees for 20 graduates from various parts of Africa, including those countries where the European language spoken is French or Portuguese. ILRAD would welcome the collaboration of IBAR in identifying high calibre graduates in veterinary science or biological science who would benefit from postgraduate training in parasitology, parasite immunology or parasite biochemistry. Applications, with curriculum vitae and names of two referees, should be sent to:

The Training and Outreach Officer  
ILRAD,  
P.O.Box 30709  
NAIROBI, Kenya

ILRAD has also hosted a number of training seminars. These include the Leadership Training Seminar on African Trypanosomiasis in September 1977. This was jointly sponsored by OAU/WHO/FAO/ILRAD. In addition, ILRAD has held a training course on the use of radioactive isotopes in parasitology and immunology sponsored by IAEA in February-March 1979, and a training seminar held by the International Union of Immunology Societies in October 1979.

## II. PROTOZOOLOGY, IMMUNOLOGY AND BIOCHEMISTRY

Discussion Leader: P. de Raadt

Rapporteur: Thomas Ogada

MRAMBA NYINDO'S paper showed that infective forms of T.b. Brucei can be cultured at 28°C from midgut of tsetse for 12-14 hours after flies have fed on infected rats at first peak parasitaemia. He also showed that metacyclic trypanosomes of T.b. brucei can be cultivated in continuous culture at 25°-30°C. The parasites did not grow well at 37°C.

M.M. MAHMOUD and I. CUNNINGHAM grew Trypanosoma (T) evansi from stock NS in in vitro cultures. The culture was maintained at 28°C for about 15 days. It transformed at 15 days at 28°C into Glossina midgut forms. The midgut forms were established in culture for several months only in the presence of Glossina explants. Occasional infections were obtained in mice with these culture forms a month after inoculation of the blood stream forms into culture media. The culture was eliminated gradually except in flasks containing bovine embryonic kidney where they were maintained for 5-9 days. The culture failed to grow and multiply at 37°C.

J. CARRIE described in his paper a quick method for the detection of parasites in blood samples containing trypanosomes to which a drop of 1/60,000 acridine orange was added. The coloured motile parasites were then easily identified. In another paper he compared different sero-immunological tests used in the diagnosis of Gambian human trypanosomiasis. Only the ELISA tests was found to give satisfactory results.

2. Further work should be carried out in vitro culture of infective trypanosomes as this will provide valuable material for the study of physiology and structure of trypanosome from the vector. It is hoped that this work and the rapidly developing studies on genetic engineering may lead to the development of more precise diagnostics, new examples of treatment and vaccine material for use against the disease in animals and human beings.
3. Work on sequential BITT testing of success variable antigen types produced in clone-induced T.b. brucei sub-species infections should be extended to natural hosts such as the waterbuck (instead of white rats) and then later work should be carried out in an area known to have T.b. brucei without T.b. rhodesiensis infections in humans.
4. Work on the comparison of electrophoretic mobilities of isoenzymes of trypanosomes of many strains and species of the parasites should be done so as to collect data on this aspect of trypanosome biochemistry.
5. In Gambiense human trypanosomiasis areas a simple, inexpensive highly sensitive test with satisfactory specificity should be developed for field use.

J.K. GASHUMBA, V. KILGOUR and S.M. LANHAN presented the method and results obtained when comparing the electrophoretic mobilities of tyrosine aminotransferase (TAT) and two other isoenzymes, aspartate aminotransferase (ASAT) and alanine amino transferase (ALAT) of the three trypanosome species T.(E.) lewis, T.(N) congolense and T. (T) brucei. Starch gel-electrophoresis on crude extracts of the trypanosomes was carried out to analyse the iso-enzymes ASAT, TAT and ALAT. The results showed complete identity between ASAT and TAT and no identity between ASAT and ALAT or between ALAT and TAT.

L.RICHMAN and FULBERITO KIDALA tested sequentially by BLIT, six different T. (T) brucei species clone isolates from game and domestic animals, syringe-passaged at 10-day intervals in white rats. Three clones gave 6 positive BLIT response typical of T.b. rhodesiense. One T.b. brucei species from a horse gave 1 negative response and eight successive BLIT -- positive response out of 7 tests. Neutralisation tests confirmed that the trypanosomes had undergone antigenic variation between the tests. It was concluded that T.b. brucei and T.b. rhodesiense were identical and that the non-infectivity or infectivity to humans depended on the human serum sensitivity or resistance of the surface coat antigen of the organism at a particular time

#### RECOMMENDATIONS

1. The supra vital fluorescent staining of blood smears so that the parasite can be seen easily should be carried out more often especially on the immunological suspects.



### III. HUMAN TRYPANOSOMIASIS

Discussion Leader : P. de Raadt  
Rapporteur: L. Haller

A number of papers listed under this session dealt with the prevalence of human trypanosomiasis in different African countries, problems relating to diagnosis techniques and some therapeutic experiments aimed at reducing mortality during treatment.

A summary of frequency of human trypanosomiasis in Kenya was given by T. Q. A while R. PINTO gave that of Angola. O. M. DUKO and S. VAN NIEUWENHOVE gave a summary of the situation in Sudan. The situation of the disease in OCEAC and OCCGE countries were given by J. GARRIE and G. DUVALLET respectively.

All the papers confirmed that incidence of trypanosomiasis was far from stable. This is evidenced by the eradication of former foci in Niger and Senegal, and by the persistence of some foci in Upper Volta, Mali, Benin, Togo, Cameroon, Chad, Gabon and Ivory Coast, and the fact that the situation was becoming increasingly alarming in some Angolan provinces bordering on Zaire and in Southern Sudan.

G. DUVALLET et al underscored in his paper the advantages of rapid and simple sero-immunological methods which could be used to replace diagnosis through puncturing of the lymph nodes. This paper also described in detail the pros and cons of these immunological tests used both in laboratory and field investigations. In his paper R. PINTO also stressed the need for such tests to be used for diagnosis.

S.VAN NIEUWENHOVE reported the results obtained from haemagglutination test in capillary tubes (Bone - Brussels); he observed that 95% sensitivity was obtained in Southern Sudan. Without this test, however, 48% of the cases would have escaped diagnosis. The test can easily be used for field activities.

L.HALLER et al laid emphasis on the selective trypanosome distribution in an Ivory Coast village where trypanosomiasis is highly prevalent. Only the farmers working on distant farms in the village were infected with trypanosomiasis; the remaining non-agricultural populations were not infected. Without the IFAT test, half of the cases would have escaped diagnoses even after the application of indirect immunofluorescent test and the puncturing of the lymph nodes techniques.

J.CARRIE enumerated the different well known techniques used for the detection of trypanosomes; methods which were often tedious and uncertain, and proposed the detection of the trypanosome in fresh blood using a vital staining method with orange acridine to facilitate parasitological diagnosis.

SUH et al reported their findings in 720 cases of human trypanosomiasis due to T.b. gambiensis treated in the sanitary training centres in Fontem (Cameroon). They observed that administration of 1 cc. of adrenalim (adult dose) could prevent and treat effectively complications caused as a result of arsenic treatment.

In the ensuing discussion, P.DE RAADT agreed that as far as methods of diagnosis are concerned, the ELISA method has more advantages than indirect immunofluorescence, especially with

regard to the precision of titration; but he drew attention to simpler tests being assessed or developed, such as indirect haemagglutination (cellognost - Behringwerke) and card agglutination (Van Meirvenne - Antwerp).

It was observed that indirect immunofluorescence, the ELISA test or the use of the miniature - Anion - Exchange - Centrifugation-Technique - are of course choice tests, but should be earmarked for use in laboratories or by technically, well equipped mobile teams. However, this is not the case; consequently these techniques cannot be recommended for routine purposes.

BLANC also urgently called for the application of simple and rapid serological tests in the field in view of the difficulties encountered in the detection of immunological suspects following a long interval between survey and diagnosis.

SUH enumerated the advantages to be obtained from mobile teams and supported his claim by the favourable impact made on incidence of trypanosomiasis in the Fortem (Cameroon) sector following the establishment of 3 mobile units in the area.

P.MWAMBU pointed out that in some papers it would appear that the incidence of infections was predominately among the females. In reply, T.OGADA maintained that these were either domestic infections or infections at water supply points.

W.SNOW noted the absence of trypanosomiasis in Coastal Kenya in spite of the presence of tsetse flies. This was probably due to the particular food habits of the flies in this region of low livestock density, and high density of game animals.

With regard to the prevention of arsenical cerebral complications with adrenaline, OGADA informed the council about the use of other anti-convulsive drugs. SINA mentioned the application of corticosteroids, diazepam and phenobarbitone where it was necessary. P.DE RAADT observed that research in this field was rare; the aetiology of cerebral complications during arsenic treatment was far from clear; it could be the direct result of Hexrheimer reaction, an idiosyncrasy; or alternatively, an arsenic toxic action compounded with Hexrheimer type reaction.

The disturbance in carbohydrate metabolism is shown by the fact that infected animals become more sensitive to insulin injection than normal animals. As a result, such animals show prolonged and marked hypoglycaemia which the normal animals do not show. In the second paper, SANNUSI points out that the most marked pathological lesions in chronic T. (D) vivax infection in cattle are in the heart. He adds that these lesions give rise to trypanosomal cardiomyopathy. It is also suggested that these heart changes coupled with anaemia may interfere with effective delivery of nutrients in the body and this could be the cause of emaciation.

K.A.N. ESIEVO reported on studies made on the in vitro production of the enzyme neuraminidase by T. (D) vivax and its effect on the host response. A relationship between this enzyme and a similar one produced in human viral influenza was made. Since the viral neuraminidase produced in man diverted T. and B lymphocytes from being transported to lymphoid tissues to the liver where they are destroyed, it was suggested that in T. (D) vivax infected hosts this enzyme might be the cause of immunosuppression. ESIEVO further reported that a cleaving of the erythrocyte surface sialic acid by the neuraminidase takes place and he suggested that this might lead to an early ageing of erythrocytes, since these cells would be prematurely diverted to the liver where they would be destroyed. During the discussion, it was pointed out that the neuraminidase, produced could have been a contamination from the host serum. ESIEVO replied that by his method of eluting trypanosomes from blood and washing them with buffer, the contamination, could not have taken place. It was, therefore, suggested that this work should be repeated to confirm these results since trypanosomes do not have sialic acid.

#### IV. ANIMAL TRYPANOSOMIASIS

Discussion Leaders: P. Atang  
E. Crouch  
I. McIntyre  
M. Murray

Rapporteurs: A.A. Ilembade  
P.M. Mwambu  
A.R. Njogu  
Y.J. Wissocq.

A total of 25 papers were listed under this title, but only 21 were presented and discussed. The papers covered various aspects of Animal Trypanosomiasis which included epizootiology, clinical, pathology and chemotherapy. Five papers of those presented covered studies on the trypanotolerant livestock.

##### Epidemiology and Pathology

In the session of epidemiology and pathology, A. MAINA reviewed the present situation in animal and human trypanosomiasis in Kenya and pointed out that tsetse control coupled with chemotherapy had led to the eradication of gambian trypanosomiasis, markedly confined rhodesian trypanosomiasis to small foci and had led to an effective control of the animal disease.

D. BOUSSAFOU-MALONGA presented results of T. (N) congolense strains which had been isolated from cattle on a ranch and their virulence to laboratory rodents. A. SANNUSI, in two papers on T. (D) vivax infection in cattle, reported in one paper that in addition to anaemia in the chronic disease, infection precipitates malnutrition and causes a disturbance in carbohydrate metabolism.

P.M. MWAMBU and G.J. LOSÔS in their studies on the pathological changes which take place in microcirculation of cattle infected with T. (D) vivax and T. (N) congolense, showed that the main changes were observed in the kidney glomeruli, brain, skeletal muscle and heart ventricular muscle blood capillaries. The changes are mainly dilatation of these vessels and an infiltration of mononuclear cells. They suggested that this dilatation might lead to a pooling of blood in the microcirculation, leading to a poor exchange of food nutrients from the vessels to the tissues and vice versa. The pooling of blood in the microcirculation might also lead to overworking of the heart and hence myocarditis. It was observed that these changes are likely to aggravate the anaemia present and may lead to heart failure.

#### Chemotherapy, Chemoprophylaxis and Chemoresistance

In the chemotherapy presentation, D.A. HUTCHINGS reviewed the chemotherapy and chemoprophylaxis control with particular reference to isometamidium. Although earlier work with the drug complexes with Suramin did not show particular advantage over the original drug, recent work with isometamidium-Dextran complex has shown promise and it was suggested that this should be studied further. It was pointed out that for all trypanocidal drugs there is need for them to be used correctly in accordance with the regimens established for each country. The economic benefits derived from chemoprophylaxis should be evaluated by careful studies using cattle, sheep and goats. Such studies should also include evaluation of chemoimmunisation. If in addition to the work suggested above, additional information is obtained on drug resistance, careful usage of the existing drugs would make them effective weapons of disease control.

As chemoprophylaxis depends on the slow release of the drug into the tissue fluids, there is a need for information on tissue residues of these drugs. K.I. EGHIANEUWA and M.O. UDUEBHOLU reported on preliminary tissue residue studies on isometamidium in goats treated intramuscularly and intravenously. The drug was apparently lodged in the liver and kidney only and not in other tissues or organs. Y.O. OTARU ALIU and A.SANNUSI described therapeutic activity of isometamidium-dextran complex against T. (D) vivax in cattle. The complex was effective therapeutically and had better prophylaxis, but a subcutaneous nodule formed at the site of injection. There is need for a field evaluation of this complex.

L.LOGAN, J.T. GOODWIN and S. TEMBELLY presented a year's observations on the maintenance of Zebu cattle under therapeutic diminazene aceturate (Berenil) treatment and isometamidium prophylaxis in a Glossina palpalis gambiensis infested area in Mali. T.(D) vivax trypanosomiasis was the most frequent disease in animals under berenil treatment. Although the direct cost for drugs under the two regimes was almost identical, the use of prophylaxis resulted in greater annual weight gain, prevented loss of animals from trypanosomiasis and resulted in healthier and better marketable animals. During the discussion I.MACENTYRE reported that since the meeting in Banjul in 1977, he had obtained further information on the trials comparing Berenil and Samorin on the Mukwaja Ranch in Tanzania which tended to confirm that chemoprophylaxis was beneficial.



In order to obtain additional characterization data of the mouse infective T.(D) vivax isolate maintained in the laboratory at Zaria in Nigeria, A.A. ILEMOBADE reported on the sensitivity of these organisms to the existing trypanocides.

S.K. GITATHA in two papers reviewed the work that has been carried out in Shimba Hills settlement Scheme in Kenya since 1971 on monitoring the sensitivity of strains to the trypanocides used in that area. The aim of this was to detect the onset of drug resistance so that the drug regimens could be changed when necessary. Such sensitivity tests revealed a T.(N) congolense isolate that is resistant to Antrycide Prosalt, Ethidium, Novidium and Samorin. Similar work on T. (T) evansi like isolates from camels have shown them to be resistant, in mice, to Berenil, Samorin, Ethidium and Novidium. In view of the lack of trypanocides for use in camels, it is necessary to assess the extent of this problem and its importance in camel trypanosomiasis.

#### Trypanotolerance

Papers on trypanotolerant livestock included the following. M.MURRAY and co-workers presented information on the degree of susceptibility of different breeds of cattle and strains of mice to trypanosomiasis. These results were found to confirm previous observations that N'Dama cattle are more resistant to trypanosomiasis than Zebu irrespective of the mode of transmission whether by tsetse flies, or by needle. This difference was shown to be related to the superior ability the N'Dama have to control levels of parasitaemia. It was concluded that trypanotolerance is an innate characteristic and studies on inbred strains of mice indicated that it is inherited as incompletely dominant trait, is under a complex genetic control and is related, at least in part, to the immune response.

S.M. TOURÉ in a paper presented on his behalf by W.I.M. McIntyre brought out several points on differences in the pathology of trypanosomiasis caused by T. (N) congolense and T. (D) vivax in N'Dama and Zebu cattle, naturally infected in an area infested with tsetse flies. Among the differences mentioned are levels of total globulins which were higher in N'Dama than in the Zebu; premature births in Zebus and the greater susceptibility of the ZEB to the disease. Some N'Dama were highly resistant to the diseases when kept under permanent tsetse challenge whereas Zebu could not survive under similar conditions. It was observed that the differences observed within could be due to different family lines in the cattle herds.

Other papers presented were on studies on the trypanotolerant breeds of livestock and their crosses in West and Central African countries. C.H. HOSTE, Y.J. WISSOCQ and J.C.M. TRAIL reported on investigations carried out jointly by FAO, ILCA and UNEP on trypanotolerant cattle, sheep and goats. Productivity was evaluated under a variety of challenges, management systems and environmental influences. Preliminary findings indicate that trypanotolerant breeds are at least as productive as indigenous breeds.

E. KARBE, A. DOWIE and H.O. FIMMEN estimated trypanotolerance, using clinical, serological and body weight parameters, in various cattle breeds and their crosses. The animals were under experiment and included calves reared on colostrum from dams exposed and from dams not exposed to trypanosomiasis; and animals reared in flyproof stables and then challenged and treated repeatedly. H.O. FIMMEN, K. MAWUENA, S. DILLMANN and E. KARBE showed evidence that a significant age immunity exists under certain circumstances.

D.I. SAROR, A.A. ILEMOBADE and S.NURU using N'Dama and Zebu cattle experimentally infected with T. (D) vivax showed that N'Dama previously exposed to the disease show greater tolerance than N'Dama and Zebu cattle not previously exposed. Further more they pointed out that N'Dama are capable of controlling the levels of parasitaemia to a greater extent than Zebus and therefore present a less severe anaemia than the latter. D.Boussafou MALONGA and V.V. PETROVSKI showed that trypanotolerance is not an absolute resistance.

In the ensuing discussion, P.FINELLE said that FAO plans to be associated with the ILCA programme on trypanotolerant livestock study at least in two fields: preparation of protocols for the evaluation of trypanosomiasis risk, and organization of training seminars. These would include the following activities: diagnostic techniques of trypanosomiasis which could probably be held in Dakar and evaluation of tsetse fly challenge which could be held in Bobo-Dioulasso.

In reply to J. ITARD's question who wanted to know which Glossina are found on the Dihesse Ranch in Congo in view of the fact that most frequent flies on the ranch are G. palpalis which are reputed to be poor vectors of T.congolense, J.R. EOUZAN said the flies found at the Dihesse Ranch are G. palpalis. He added that in forest areas of South Cameroon, infection rate with T.congolense up to 4% were found in G. palpalis.

In another reply by H.FIMMEN to Y.O.ALIU who wanted to know which parameters were more relevant for measuring immune response to trypanosomiasis, it was stated that results were not yet available to answer the question.

M.M. MAHMOUD enquired what the feasibility of meat production and trypanotolerance studies on wild life was like and whether this trypanotolerance could be compared to that in cattle. In reply MAX MURRAY said that the work of Ashcroft in 1959 on the susceptibility of wild game to trypanosomiasis has brought out some information although this work has been carried out on a small number of animals. Studies on wild game would bring highly interesting information on trypanotolerance mechanism and therefore should be recommended.

W.I.M. MCINTYRE recommended strongly that pleas should be made to ILCA and others to establish a N'Dama centre to concentrate on village studies and small farms in the region of the Gambia basin. Gambia has now got a record of six years work in the epidemiology, including production studies, and experimental work with the N'Dama. Natural links and extensions could be made with Senegal and Mali where studies are well established and with Sierra Leone where a programme is imminent, and with Guinea, also the accepted home of the N'Dama. Such a centre would include studies on the nutrition and water requirements of the N'Dama under village conditions and when used as drought oxen. A large number of farmers in Africa stand to benefit from such studies.

He added that studies on the N'Dama under ranching conditions should be based in countries where there are already a number of large N'Dama ranches such as Zaire. With regard to the apparent trypanotolerant Zebu he suggested that studies should be carried out in East Africa to assess the degree of resistance, if any, to

trypanosomiasis in the small Zebu cattle in that part of Africa. He observed that Tanzania with its large cattle population and a large proportion of the land mass being infested with tsetse would appear to be an ideal centre for such studies using the facilities of the new Veterinary School developing in Morogoro Region which is in the heart of the tsetse belt. He also suggested that the N'Dama must be looked for resistance to other diseases and to its production per hectare compared to the Zebus. He pointed out interesting results that Samorin protected Zebu on a ranch in Tanzania weighed less at 3½ years than unprotected steers reared under low tsetse challenge in Kolo, Zaire.

With regard to the treatment of individual sick animals chosen within a herd because they showed parasitaemia, it was pointed out that the veterinarian must always remember that at least half of the herd will be anaemic or have a non-detectable parasitaemia.

In reply to M.M. MAHMOUD who wanted to know how much extension work would be involved to convince traditional breeders to use trypanotolerant animals, P. FINELLE said that to convince breeders to adopt trypanotolerant animals implies certainly the solution of human problems. But these problems are not specific to this case and are not greater than the problems occurring while introducing, for example, new breeding and management practices. More difficult human problems were encountered when cattle were introduced in villages of Gabon, Congo, Zaire and Central African Republic where people had never handled or even seen cattle before. But even in such areas, problems were solved when sufficient training and information were provided.

To conclude the discussion on trypanotolerance, M.MURRAY observed that it was clear that more information is required on trypanotolerant livestock and its productivity and that to obtain these data it will be necessary to apply a wide range of scientific expertise encompassing the fields of clinical medicine, parasitology, immunology, entomology, genetics, animal production and socio-economics. Only by this multidisciplinary approach will the knowledge required be obtained.

#### RECOMMENDATIONS

1. The Council commends the progress made by the Kenya Government Veterinary and Medical Services in the Control of tsetse and trypanosomiasis and RECOMMENDS that efforts should continue to be made to prevent re-infestation of areas reclaimed from tsetse and to minimise the risk of drug resistance in trypanosomiasis by judicious use of chemotherapeutics and chemoprophylactics.
2. The Council re-emphasises the need to monitor the disease and therefore RECOMMENDS that epizootiological surveys should be encouraged and that trypanosome isolates made be tested for their response to current drugs available on the field. It further RECOMMENDS that studies should be carried out with the existing trypanocides regarding their range of activity and route of administration where applicable; and that treatment regimens be determined with regard to the type of drug dosage and frequency of administration, depending on local conditions.

3. The Council notes the importance of the camels as a source of animal protein and, therefore, RECOMMENDS that more information be obtained on the economic importance of T. (T) evansi in these animals and on the use of chemotherapy and chemoprophylaxis.
4. The Council RECOMMENDS that more quantitative information be obtained on the beneficial effects on productivity when using chemoprophylaxis.
5. The Council notes with delight that some of its recommendations on trypanotolerant cattle made at the Banjul meeting are being implemented. The Council recognizes that for some years to come, the N'Dama cattle would be one of the breeds likely to provide needed animal protein in areas of West and Central Africa where Zebu cannot thrive due to trypanosomiasis. The Council, therefore, RECOMMENDS that further work should be encouraged on trypanotolerant livestock with particular regard to productivity, heritability underlying mechanisms and factors which might influence this trypanotolerant characteristic. For example the level of challenge, stress of parturition and previous exposure. It is also RECOMMENDED that studies should be instituted on the question of trypanotolerance in the East African Zebu, as well as in goats, sheep and game. The Council further notes that the tolerance characteristic is probably not confined only to trypanosomiasis, but may extend to other infections such as tick borne diseases and skin conditions.

6. The Council RECOMMENDS that a N'Dama centre be set up in the Gambia to continue the six years' study already carried out on the immunology and epidemiology of the N'Dama. The studies should include production and nutrition of the N'Dama. The centre should be linked closely to the present operations in Senegal and Mali and to developing programmes in Sierra Leone and Guinea.
7. The Council RECOMMENDS that work should be encouraged to define and quantify what is meant by level of tsetse challenge in terms of the degree of trypanosomiasis risk. It further RECOMMENDS that investigations be carried out on the early events following the bite of an infected tsetse fly (CHANCRE), and that comparative studies be made between breeds of different susceptibilities.
8. The Council notes that for proper control of animal trypanosomiasis, it is necessary to understand the pathology of the disease. It, therefore, RECOMMENDS that studies on the pathology of animal trypanosomiasis be intensified with emphasis on the mechanism (s) and kinetics of anaemia, the changes that take place in tissues and organs and evaluation of immunological competence with special reference to immunodepression of trypanosome infected livestock. The studies should be carried out using T. (N) congolense, T. (D) vivax, T.b brucei and mixed infections. The relationship between anaemia and



the pathological changes in tissues and organs should be looked into and special attention should be paid to the anaemia found in longstanding cases which apparently progress in the absence of detectable parasitaemia.

9. The Council notes the effect of trypanosome byproducts, such as neuraminidase, might have on the host tissues and, therefore RECOMMENDS that detailed studies on such byproducts be encouraged and followed up as necessary.

V. ENTOMOLOGY

Discussion Leaders: J. Itard

F. Kuzoe

Rapporteurs:

A.M. Jordan

D. Moloo

F. KUZOE et al presented a paper describing an extension eastwards and southwards of the range of G. tachnoides in the Bouafle area of Ivory Coast. Flies were concentrated in locations where domestic pigs were kept. In the discussion following this paper a similar southward extension of G. tachinoides in Togo was reported.

D. BALDRY and R. BENNETT reported on preliminary work using X-ray energy dispersive spectroscopy for studying movements of Glossina. Chemoprints of G. tachinoides from five localities in West Africa were readily distinguishable, whereas chemoprints of G. tachinoides and G. palpalis from the same locality were virtually the same. The method is very sensitive for phytophagous insects and can determine the area of origin of insect to within 100 m. The sensitivity of the method for an active, haemotophagous insect is unknown and it was emphasized during the discussion that the chemoprint of tsetse must be affected by the source of bloodmeals of both the insect itself and its female parent. Determination hosts, could assist in the interpretation of field data.

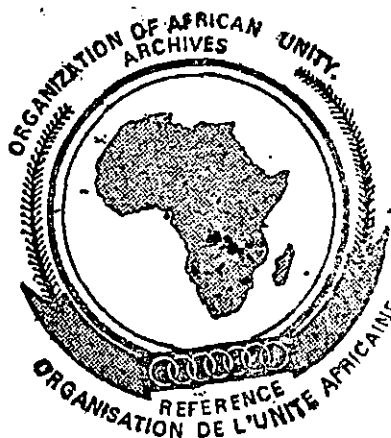
D. ASHTON et al described recent surveys, using biconical traps, in the Republic of Mali. G. morsitans submorsitans, G. palpalis and G. tachinoides were recorded. The recent disappearance of G.m. submorsitans from some formerly infested areas has been associated with increased human activity and this point was returned to during the discussion. B.m.submorsitans is disappearing from many areas of densely populated West Africa as human settlement and other activities (such as felling trees for firewood) increase in areas infested with this species. The same process is occurring in some parts of eastern and southern Africa, but there, human population densities are generally much lower, and in countries such as Zambia areas infested with G.morsitans are static or even increasing. In West Africa riverine tsetse will probably become increasingly important in the epidemiology of animal trypanosomiasis.

H. SESSAY described a survey carried out over a period of 49 days in Sierra Leone. G. palpalis was widely distributed and G. Fusca was found in two localities. During the discussion it was stated that sleeping sickness is very rare and that G. palpalis is the only vector. Other Glossina spp previously found in Sierra Leone were probably not detected because only human catchers were employed in the survey. No one was able to assist Mr. Sessay in interpretation of his view that flies were much easier to catch near the ocean than inland.

In the absence of the authors (ALI, AISOPP), C. LEE introduced a paper on the use of electric traps for catching G. morsitans centralis in Botswana. The traps proved of value when mounted on a vehicle, as a back pack on man and when free standing.

D. BALDREY presented two papers, on some records of Syntomosphyron from Nigeria and on the daytime resting sites of G. morsitans submorsitans along a trade cattle route in the south of that country. In a third, unlisted, presentation the distribution of G. morsitans in Zambia was described and illustrated with maps. It was concluded that this species permanently infests certain areas whereas elsewhere there are "dispersal areas" where periodic advances and recessions take place over the years.

In a general discussion on the papers dealing with tsetse distribution, the importance of the OAU distribution maps was emphasised. Sufficient new data are now available from some countries to warrant a revision of the maps and all participants were requested to send all new information to the Secretariat. The possibility of computer storage of data on tsetse distribution was also discussed.



J. ONYIAH presented a paper on ecological studies on G. morsitans and G. longipalpis in an area of derived savannah vegetation in Nigeria where it is proposed to establish a model cattle ranch. Hand catches were made; biconical traps were of limited use, although further research in Nigeria they have been very effective. In the ensuing discussion the expense of maintaining a cattle ranch as an enclave in vegetation heavily infested with Glossina spp was pointed out. Cattle ranches have existed in Southern Nigeria for many years and reference was made to the successful Upper Ogun ranch. However, the tsetse challenge to the cattle on this ranch is relatively low and it is not located in the derived savannah zone, where the grazing potential is much higher but where the tsetse challenge is also much greater.

OKOTH described field and laboratory studies on the light intensities in which G. fuscipes fuscipes and G. pallidipes develop their larvae. The optimum intensity was 1.6 units. In reply to a question it was stated that in the field experiments light intensity in the breeding sites was not measured at the time of larviposition but was averaged over a number of readings during the day.

W. SNOW described studies on the distribution of Glossina spp in Gambia and on the Kenya coast, near Mombasa. G. Morsitans, submorsitans and G. palpalis occur in the Gambia and G. pallidipes, G. brevipalpis, G. austeni and G. longipennis near Mombasa. In both areas the influence of man on the distribution of the flies was emphasised. G. morsitans, G. brevipalpis and G. austeni are disappearing from many areas as a result of man activities but G. palpalis and G. pallidipes are much more resilient and can adapt to man-made habitats. In recent years the incidence of sleeping sickness in the Gambia has been much reduced and this may be partly due to the disturbance of the habitat of the flies. In the discussion it was proposed as an alternative explanation

that the local Gambian people have developed a degree of immunity to the disease, a view supported by recent cases which have occurred only in tourists visiting Gambia. Also in the discussion it was emphasised that human settlement does not always reduce the extent of suitable habitat for Glossina spp and can, in fact, create new habitat.

Two papers were presented on the laboratory rearing of G. pallidipes by P. KATABAZI and E. OPIYO. In the former the difficulties of maintaining this species during the 1979 war in Uganda were described. In the latter, rearing methods employed in Kenya were outlined. Productivity in both colonies was low. The species' reluctance to mate in the laboratory and a poor insemination rate are at least part of the reasons for the low productivity. During the discussion it was pointed out that G. pallidipes have been successfully colonised in Amsterdam, although laboratories have had limited success. It was speculated that there may have been insecticidal contamination of the colonies or that the sex pheromone of another species in the same insectary might have been a disturbing influence on the mating behaviour of G. pallidipes.

J. ITARD presented a paper (by Sellin, Bourdoiseau, Clair, Guisance, Fevrier, Politzar, Taze) describing the success achieved in rearing G. palpalis gambiensis for the sterile male release campaign in Upper Volta. A total of 50,000 reproductive females was maintained; flies performed better when fed on rabbits than on guinea-pigs. During the discussion it was stated that only limited success has been achieved with rearing G. palpalis palpalis at NITR, Nigeria and that improvements are anticipated when a new insectary has been built.

1. RECOMMENDATIONS

As a follow-up to a suggestion made in the Report of joint WHO Expert Committee and FAO Expert Consultation (Rome, 8 - 12 November 1976) Para 1.1.1) it is recommended that the OAU/IBBRC establish a computer storage species system for information on the distribution of tsetse of major socio-economic importance. Such a computerized system would need to be organized in such a way that information could be stored and recovered in relation to a map grid system, upon which periodic print-out could be superimposed.

It has been suggested that a grid system involving 18 km x 18 km. square might be appropriate. On this basis, each square bounded by one degree of latitude and one degree of longitude would contain 36 small squares, each embracing an area of 338 km<sup>2</sup>. Approximately 29,800-32,400 of these small squares would be required to cover the existing 10,000,000 km<sup>2</sup> tsetse belt and adjacent areas which might become infested in the future.

Alternatively it might be more useful to sub-divide each of the one degree squares into 121 small squares each measuring 10 km x 10 km and each embracing an area of 100 km<sup>2</sup>. Using this system 100,000 - 109,000 small squares would probably be required.

It is further recommended that the OAU/IBBRC should make early contact with a computer expert with good experience in computerized mapping systems of disease vectors and/or agricultural pests (possibly from COPR, WHO and FAO) with a view to ascertaining.

- the modality of establishing such a service,
- the coding system to use by both the computer operator and the generators of tsetse distribution data,
- the most appropriate means of providing print-out tsetse distribution data to tsetse experts in the field (conventional paper print-outs for interpretation by means of map overlays, microfilms, etc.).

The type of coded information which should be considered for computer storage includes:

- Latitude orientation - whether north, equator or south, (in single figure series)
- Latitude identity - in two figure series
- Longitude orientation - whether west, Greenwich or east (in single figure series)
- Longitude identity - in two figures series (N.B. lines of latitude and longitude would form the bottom and left-hand margins of the reference square measuring 1 x 1 square: 01 - 121 (reading from left to right, top to bottom)
- Additional fraction of data
- Tsetse group (palpalis, morsitans and fusca) in single figure series



- Code number for the required tsetse species within the species group previously defined.

2. New data on tsetse distribution should be sent to OAU/IBAR in order that a revision of the tsetse distribution maps can be prepared.
3. Further studies on the effects of man's activities on tsetse distribution are required throughout Africa. It is emphasised that these effects can be either beneficial by destroying tsetse habitat and/or hosts, or adverse, by creating new habitats.
4. Great improvements in techniques for trapping Glossina spp have been made in recent years. Methods employed in surveys should be standardized as much as possible.
5. Laboratory colonies of all economically important Glossina spp should be maintained in order to provide a surplus of material for research work. G. pallidipes can be reared in the laboratory but particularly intensive efforts are required to improve the productivity of this species.

## VI. TSETSE CONTROL

Discussion Leader: K. Politzar

Rapporteur: G. Laveissiere

During the session on the control of vectors of trypanosomiasis, various techniques and their uses were described. Aerial spraying as a control method against tsetse flies belonging to the morsitans group or those found near rivers was found to be more rapid, although it is still financially costly. Solutions will have to be found to solve the many existing problems, notably the lack of specific information on the influence of climatic factors on the penetration of insecticides into the treated sites.

For the first time in the Cameroon, a control programme aimed at reclaiming wooded grassland has been carried out in a Guinean Zone. Other control operations were reported in Uganda.

The control method involving release of sterile males used against G. p. gambiensis at Bobo-Dioulasso, Upper Volta, has already been used in carrying out a medium-scale project in a forest gallery of the Sudan-Guinean savannah. The rate of reduction in the fly populations already shows that this method is very effective and could result in the eradication of the flies from isolated sites.

Like all the other methods, the sterile male technique is now faced with the problem of reinvasion. Observations made in Upper Volta by Scientists at the CRTA/IEMVT/GTZ have already demonstrated the fly's flying capability and its ability to disperse unhindered by either chemical or physical barriers.

In the human trypanosomiasis focus at Vavoua in Ivory Coast, two new tsetse control methods have been studied: screens of blue tissue impregnated with insecticide, and very selective spraying with residual insecticides. Short and long-term assessments have led to the conclusion that the combined use of both methods could disrupt trypanosome transmission and slow reinvasion at trypanosomiasis foci.

In the savannah zone of West Africa it has been demonstrated that catching of flies with biconical traps impregnated with insecticide could quickly and economically eliminate the fly populations along the rivers, without causing any adverse effects on the environment. Moreover, this technique does not require the establishment of chemical or mechanical barriers since the traps themselves act as barriers.

Highly toxic insecticides applied at ultra-low volume from a helicopter could be replaced, for example, by growth regulator. The use of sex pheromones could have an interesting effect on the fly populations by changing their pattern of behaviour. These two programmes are being studied in the light of recommendations made at the last meeting of the Council. It is likely that very interesting changes in tsetse fly control strategy could be achieved.

#### RECOMMENDATIONS:

Considering the discussions and results obtained during this session and considering the advantages of the different control methods and the difficulties encountered in their application,

1. Studies on fly distribution, dispersal and behaviour should be intensified and co-ordinated towards a national application of the different techniques in order to enhance a quick reduction in the fly populations and to reduce operational costs.
2. Study of climatic factors should be continued, especially in forest zones in order to overcome the difficulties encountered during aerial spraying in these areas.
3. Research should be carried out on the effectiveness of control methods with due consideration to non-target fauna and flora. Impact of large-scale control methods on the environment should be studied.
4. The use of compounds other than insecticides, such as growth regulators or sex pheromone should be tested in the field.
5. Research on new insecticides should also be conducted.
6. Quick and easy control techniques should be instituted and an attempt should be made to cut down their cost in order to enhance their application in tsetse-infested communities. These studies should be co-ordinated, since best results are obtained through a combination of many techniques.

## VII. TRAINING

Discussion Leader: I. McIntyre

Rapporteur: D. A. T. Baldry

Various activities and achievements in the training of personnel at different levels, to prepare them for deeper involvement in the fields of tsetse and trypanosomiasis control and research were presented in three working papers, by P. Atang, J. Itard and D. A. T. Baldry. Valuable contributions were also made by a number of the participants during a plenary session.

P. ATANG drew particular attention to the FAO/OAU/WHO Leadership Training Seminars which were held in Nairobi in 1977 with the co-operation of the ILRAD and in Bobo-Dioulasso in 1979, with the collaboration of the OCCGE. P. ATANG and M. MURRAY also explained the ILRAD proposals for intensified training of technical and scientific personnel at ILRAD. It is proposed that the ILRAD will provide post-graduate in-service training which will enable diligent students to obtain an M.Sc. or Ph.D degree in their field of specialization. The opportunities will be open to 20 students from English, French and Portuguese countries, provided they have suitable graduate qualifications and working knowledge of the English language. The OAU, in close collaboration with the ILRAD Training Officer, the University of Nairobi and other universities will assist in the first level screening of candidates. Final selection of candidates will be made by an ILRAD/OAU screening committee. Funding for such training will be sought from both the ILRAD and from other sponsoring agencies.

P. ATANG also noted that one of the recommended actions of the Trypanosomiasis Task Force, concerned the creation of operational field units, which would be set up by appropriate experts, who, would train the staff required to operate such units after the termination of the experts assignment.

The working paper of J. Itard was concerned with the involvement of the IEMVT, France, in collaboration with the FAO and the GTZ of the Federal Republic of Germany, in the training of mainly veterinary orientated personnel. One type of course caters for Francophone personnel with veterinary qualifications and involves formal theoretical and practical instructions at the IEMVT Headquarters, and field exercise in Upper Volta, with the collaboration of the ELAT, at Bobo-Dioulasso. The other type of course, for Francophone technical personnel in the agricultural sector, is run by the ELAT at Bobo-Dioulasso, and is nearby tsetse infected field study areas.

A. M. JORDAN described the post graduate training courses run by the U.K. and ODN and the FAO for English speaking countries, along the same lines as the IEMVT/GTZ/FAO courses. Formal instruction and practical sessions in protozoology, entomology and veterinary medicine are provided in the U.K., while field exercises are conducted in suitable locations in West Africa.

In reviewing the various training activities described above D.A.T. BALDREY drew attention to the urgent need to provide training facilities for English-speaking technical (mid-level) personnel in eastern and southern Africa. Consequently the UNDP/FAO Tsetse Applied Research and Training Project (RAF 75/001), with headquarters in Lusaka, Zambia, is giving particular attention to this aspect for training, although facilities will also be made available for post-graduate fellowships and for the provision of field demonstrations for senior tsetse control personnel. Two 7-month courses for technical personnel are proposed, commencing in April 1980 and April 1981. Each course will involve at least two months of lectures, laboratory practicals and round-table discussions at the Project's Training Centre, at Mazabuka, and up to 5 months of field exercises in a tsetse infested area to the

West of Lusaka. For the latter activities trainees will be housed at the Project's Lubalo Operational Base Camp. Although these courses are specifically designed for trainees from Eastern Africa, persons from Western Africa will be accepted provided that sponsors appreciate that there are appreciable bio-climatic differences between the two regions.

A lively discussion ensued from these presentations, the main points of which are summarized below.

Many persons have now received training by one or more of the training courses referred to above, but little is known of the use to which these persons have been put, and thus, whether or not they and their governments have benefited from the training. As W. I. M. MCINTYRE stressed, it is important an effective follow-up machinery be established to keep track of such people and to provide them with continued encouragement. They should not become dispersed, isolated and discouraged by the problems facing them in their home countries. It might therefore be useful for a joint FAO/OAU/WHO team of experts to be appointed who could visit trainees in their own environment, to provide encouragement and to assist with the solving of pressing problems. ISCTRC Meetings are not always sufficiently field orientated and it might therefore be appropriate to extend the allotted time for such meetings so that previously trained personnel could hold in-depth field-orientated discussions with a limited number of experts, for a few days prior to the normal ISCTRC multi-disciplinary sessions. At the same time it is recognized that more well-founded field projects are required for the in-service training of the leadership cadre of young African graduates.

Several participants referred to the poor career possibilities of tsetse and trypanosomiasis control personnel. Too often persons with post-graduate training and post-graduate qualifications receive accelerated promotion in ministries and research institutions, while those persons without such training but who provide the core of the control effort and who live and work under difficult field conditions, are often forgotten. They can easily be left to stagnate in the civil service, or forced to accept administrative posts where prospects for advancement are marginally better. While acknowledging that conditions of service and career prospects very much depend on individual government and departmental policies, the OAU is nevertheless urged to do all in its power to persuade Member States to make available improved conditions of service and promotion prospects for their field-based control personnel.

Participants from Angola pointed out that Angola and Mozambique are large countries with a joint human population in excess of 15 million people. Yet limitations are imposed upon Portuguese control and research personnel by the fact that scientific meetings and training activities, never make linguistic provision for them. The OAU/ISCERC is therefore urged to do everything possible to alleviate the language barrier, by providing Portuguese translation and interpretation facilities during its meetings, and training activities. With regard to the language barrier in general, D. A. T. BALDREY said that the UNDP/FAO Project RAF 75/001 was currently preparing an English/French and French/English dictionary for tsetse control personnel. If this proved successful, consideration could be given to the preparation of either an English/Portuguese or French/Portuguese version.



C. W. LEE stressed the importance of trainees being required to pass an appropriate examination at the end of the training period. It is not enough for persons to be able to claim that they have attended a course. They must be able to show that they have indeed acquired the knowledge and skills taught to them, if they are to be reliable and well equipped to cope with the problems of their own environment.

J. BANSER in describing the training given to Cameroonian tsetse control personnel stressed the need for well orientated field training with great emphasis on the practical aspects of tsetse control. Initially training of this type was not possible in Cameroon, so personnel were trained in the adjacent state of Nigeria, in an identical environment where well qualified and experienced experts were available to impart their knowledge: knowledge gained in one country but immediately applicable to a friendly collaborating neighbour state.

D. A. T. BALDRY drew attention to some of the short-comings of sending personnel from one part of the continent to another, where the training they receive may not be totally appropriate to the conditions encountered in their home country. More emphasis should therefore be given to establishing a core of experts who could visit a particular country and provide inservice training which would be completely orientated and appropriate to the special circumstances facing local control personnel.

### POST GRADUATE TRAINING

In endorsing the recommendation of W.I.M. McIntyre that career structure within Tsetse Control Organisation could be improved by establishing courses leading to the award of an M.Sc. degree, the following reservations should be borne in mind:

1. There is a conceptual difference between Francophone and Anglophone countries as to the value of the M.Sc. and Ph.D. degree. Some uniformity must be sought here.
2. The M.Sc. can be and is awarded in the United Kingdom and the United States of America after following a prescribed course of study for one year, and this is readily adaptable to the training of field personnel in Tsetse Control Operations.
3. Conversely, a Ph.D. degree is awarded for original research in a particular field and may not equip the holder in any way to undertake field work in Tsetse Control.

It was concluded that the design of the M.Sc. course is appropriate for English speaking personnel but that this course should be undertaken only after consultation with colleagues in French and Portuguese speaking countries to ensure that equivalent training gains equal recognition in the relevant countries.

### RECOMMENDATIONS

#### Manpower Needs in Tsetse and Trypanosomiasis Control

The council RE-EMPHASIZES the urgent need in Africa for more manpower at all levels in the field of Trypanosomiasis and Tsetse

Control. It CONGRATULATES the OAU, FAO, WHO and other International and National Organizations and Institutions for successfully holding a number of training seminars and courses and RECOMMENDS that the OAU, FAO and WHO should draw up concrete training programmes and that training should be systematically and regularly carried out at National, Regional and Continental levels. Ideally this should result in the award of an appropriate qualification which has its equivalent in English, French and Portuguese speaking countries and which will enable the Field Worker to enter a career structure which holds similar prospects of advancement to that of those holding other professional qualifications.

The Council FURTHER RECOMMENDS that:

1. The OAU with the assistance of the FAO and WHO, should draw up an up-to-date inventory of workers in all fields of Tsetse and Trypanosomiasis Research and Control.
2. As a matter of urgency the secretariat should, with appropriate external assistance, prepare a complete inventory of the capability of each country in terms of manpower, facilities and annual expenditure on Tsetse and Trypanosomiasis Control. This could be carried out by appropriate teams visiting each country.
3. The secretariat should explore the possibility of developing 12-month university post-graduate course on Tsetse and Trypanosomiasis. Such course should be specially designed for field staff.
4. The secretariat should seriously consider holding a multidisciplinary, up-dating session for field workers during the week before the next ISCTRC meeting using

as instructors experts who would be attending the conference. Trainees participating in this scheme would then be invited to stay on for the conference and participate fully in its proceedings.

5. As a matter of urgency the secretariat should follow up the Task Force recommendation concerning funding by taking the initiative of visiting the various donor agencies. Alternatively the secretariat should consider convening a meeting with the international group of donor agencies.

GENERAL RECOMMENDATIONSRECOMMENDATION I:Message of Thanks

The 16th Meeting of the OAU/ISCTRC expresses its profound thanks and sincere gratitude to His Excellency President Ahmadou Ahidjo, President of the United Republic of Cameroon, the Government and the people of Cameroon for the excellent facilities placed at the disposal of the meeting and for the generous hospitality extended to all participants, and REQUESTS the Executive Secretary of OAU/STRC to convey this expression of gratitude to the President, the Government and the People of Cameroon.

RECOMMENDATION II:OAU/STRC Tsetse Distribution Map of Africa

The Council CONGRATULATES the Executive Secretariat for successfully publishing the revised map of Tsetse Distribution in Africa and EXPRESSES its gratitude to the Federal Government of Nigeria for financial assistance. It NOTES that it is over five years since the map was prepared and therefore needs updating.

CONSIDERING the possibility of using a computerised data system, the Council APPEALS to all African Governments and International Organizations and Institutes to assist in facilitating this as soon as possible.

RECOMMENDATION III:United Nations Environment Programme Participation in  
Future ISCTRC Meeting

It is recommended that the United Nations Environment Programme (UNEP) be invited to send a representative to future ISCTRC Meetings and any other meetings organized by the OAU concerned with tsetse and trypanosomiasis control.

RECOMMENDATION IV:Field Control of Tsetse and Trypanosomiasis

The Council notes the very slow progress achieved in the control of African Trypanosomiasis in some member countries despite several years of research and field control activities. It EMPHASISES that better results can be achieved by under-taking systematic. It NOTES the progress the FAO has so far made in the preparatory stages in its long terms programme on the control of African Animal Trypanosomiasis. It also NOTES the WHO activities in Applied Research on Human Trypanosomiasis and the particular emphasis laid on research by the UNDP/World Bank/WHO Special Programme for Research and Training on Tropical Diseases, and RECOMMENDS that the OAU/STRC co-operates with the FAO and WHO and all interested Agencies and that African Governments give these programmes their full support. It FURTHER RECOMMENDS that an inventory of areas under active field control be made with a view to determining if the impact of the disease is diminishing. To execute control programmes, the Council APPEALS to National and International donors for increased financial support.

RECOMMENDATION V:OAU/FAO/WHO Trypanosomiasis Advisory Team

The Council RECOGNISES the need to assist OAU Member States in several aspects of Tsetse and Trypanosomiasis control. It RECOMMENDS that a multidisciplinary Advisory Team be formed by the OAU, FAO and WHO to assist African countries in developing and realising National and International Programmes in Field control, research, training etc. and to assist them in any other way in the control of this disease.

RECOMMENDATION VIDiagnosis of Rural Trypanosomiasis

The Council EMPHASISED the definite need for continuation or re-institution of regular systematic surveillance of the human population at risk; being aware of the overwhelming quantity and diversity of health problems actually faced by the public health services and of the lack of trained personnel and equipment, the Council RECOMMENDS;



1980-06-18

# Report and Recommendations of the Sixteenth International Scientific Council for Trypanosomiasis , Research and Control (ISCTRC)

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