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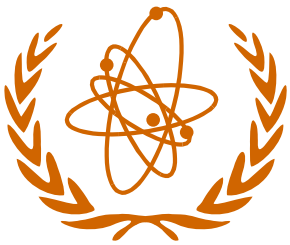

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SECTION A – NEWS

PROGRAMME AGAINST AFRICAN TRYPANOSOMIASIS

Fourth Meeting of PAAT Programme Committee

The fourth meeting of the PAAT Programme Committee was convened at IAEA Headquarters, Vienna, Austria, from 25 to 27 November 1998. The objective of meetings of the PAAT Committee is, on the basis of technical and scientific advice forwarded from the Advisory Group Co-ordinators and the Liaison Officers, to provide the focus for collaborative efforts to alleviate trypanosomiasis in Africa. Discussions at the current meeting were largely devoted to matters arising from the meeting of the PAAT Advisory Group Co-ordinators convened in Harare, Zimbabwe, October 1998 (see *TTIQ*, **21** (4)).

Progress since the last meeting was reviewed. This included: ISCTRC representation on the Programme Committee and increased donor involvement; considerable progress on the development of the information systems for both animal and human trypanosomiasis (both the prototype PAAT-IS for animal trypanosomiasis and the CD-ROM-based information system developed by WHO for the human disease were demonstrated and the need for cross-linkages between the two was stressed); evaluation of the socio-economic impact of trypanosomiasis and the identification of priority control strategies; development of position papers on technical and policy aspects of the PAAT following open discussion via e-mail (that on drug resistance having been published as the first in the new *PAAT Technical and Scientific Series*); production and distribution of a glossy brochure announcing PAAT; and initiation of a quarterly PAAT Newsletter.

Plan of Action against animal trypanosomiasis

The meeting recognised two approaches to tsetse and trypanosomiasis management, endorsed by the Advisory Group Co-ordinators, one being farmer/community based (small scale), the other based on area-wide disease management; there was some discussion on the division between the two and the technologies appropriate to them. Greater emphasis on the application of area-wide pest management principles was recommended. A position paper on the SIT was presented.

The meeting endorsed the criteria for identification of priority areas, outlined by the meeting of Advisory Group Co-ordinators, and two priority areas – in West Africa (the common cotton production areas of Burkina Faso/Mali/Côte d'Ivoire) and in East Africa (river valleys in West/South-West Ethiopia) – put forward by the Advisory Group Co-ordinators, were also endorsed.

The results of some 40 work years of scientific studies into the environmental impact of various tsetse control techniques were presented by the EC Scientific Environmental Monitoring Group: both sequential aerial spraying (SAT) using endosulfan or deltamethrin and discriminate ground spraying using a synthetic pyrethroid are environmentally acceptable, while the impact of artificial odour baits and of insecticides on domestic animal hosts (via residues in dung) requires further study. SAT and SIT should therefore both be considered as offering a significant potential contribution to tsetse control/eradication. Further studies should be undertaken to establish which mixes of techniques and modes of implementation best fit the different community and/or farmer based scenarios.

Summary reviews were presented of the three on-going or proposed EC regional programmes, i.e. West Africa (concern was expressed over delays in implementation), East Africa (FITCA, see p. 4) and southern Africa (RTTCP).

There was some discussion of the position papers currently under development, and the secretariat was reminded of the need for one on privatisation of tsetse control.

Other conclusions and recommendations

Sleeping sickness representation should be strengthened at all PAAT meetings; control actions for the human and animal diseases need to be integrated; more financial and technical support is needed to contain sleeping sickness epidemics in Central Africa.

Governments need greater awareness of the socio-economic and ecological impact of the trypanosomiasis problem and related land utilisation constraints. They should also be urged to facilitate private sector involvement in tsetse and trypanosomiasis control, ensure quality control and licensing of drugs and other products, and reduce import taxes on these essential items. The secretariat should make efforts to ensure effective quality control of commercial tsetse and trypanosomiasis control products.

Collaboration with the EU Concerted Action should be strengthened. IAEA representation and participation within the PAAT secretariat should include both the Joint FAO/IAEA Division and the Technical Co-operation Department. The profile and responsibilities of OAU/IBAR within PAAT should be enhanced by assuming the secretariat responsibilities for the Policy, Planning and Implementation module. The involvement of ISCTRC should also be strengthened.

The PPI module should undertake an assessment of training needs at all levels, particularly technical and middle level, and propose necessary actions.

Late news item

We are happy to announce, as this issue of *TTIQ* goes to press (more details will be given in the next issue), that the PAAT web site is now live at:

http://www.fao.org/WAICENT/Faoinfo/Agricult/AGA/AGAH/PD/Paat_l/index.htm

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This landmark event coincides with the retirement of Brian Hursey from his post as Senior Animal Health Officer in FAO. Brian was the driving force behind the creation of PAAT and everyone concerned with African trypanosomiasis owes him an enormous debt of gratitude for his unstinting dedication to PAAT. We send him our grateful thanks and warmest wishes for a happy retirement. The FAO contact point for PAAT Secretariat responsibilities is now Jan Slingenbergh, FAO AGAH Animal Health Officer (Jan.Slingenbergh@fao.org).

INTERNATIONAL TRYPANOTOLERANCE CENTRE

ITC Research Strategies, Activities and Recent Achievements

The region covered by ITC's Mission and Strategy, which includes Guinea, Guinea Bissau, Liberia, Senegal, Sierra Leone and The Gambia, is located in the humid and sub-humid zones of West Africa where the indigenous domestic livestock populations consist mainly of trypanotolerant breeds. This zone has a very high livestock development potential. Recently, the mandate of ITC, which focused originally on trypanosomosis and

trypanotolerance, extended to embrace wider regional actions in the field of livestock research in the general context of agricultural development in tsetse-infested areas in West Africa.

Implementation of the ITC Research Programme is accomplished through constant contacts with village livestock owners in collaboration with the NARS of the concerned countries, giving due consideration to national and regional policy orientations and priorities in the agriculture and livestock sectors. In addition, very specific research themes are investigated through studies conducted on-station under strict experimental conditions. ITC also enjoys close collaboration with international (FAO, IAEA, ILRI), regional (CIRDES, MRU, OMVG) and European institutions. The general research policy of ITC embraces both the traditional low-input farming system and the commercially oriented system.

The research activities of the Centre focus on: genetic improvement of trypano-tolerant N'Dama and small ruminant village animals; health and productivity; assessment of animal health constraints and development of sustainable health management packages integrated into the different ecological farming systems; nutrition; animal management; and socio-economics of production systems.

In addition, training of NARS personnel through seminars, courses, field and laboratory work is provided jointly with other organisations, such as FAO (see report, below).

Research achievements include the use of the Rapid Rural Appraisal technique to assess and define the problems and priority needs facing the rural communities; the elaboration and testing of strategies for economic and locally sustainable pathogen control; and genetic improvement of N'Dama cattle and small ruminants by selection of the best males and females which compose the active breeding nucleus. Investigations on the impact of trypanosomosis in village-managed animals revealed that infection can impair productivity even in trypanotolerant N'Dama cattle and small ruminants; moreover, while trypanosomosis depresses total dry matter intake, N'Dama cattle better utilise and metabolise feed during the infection. Results of socio-economic surveys revealed an important interaction between portfolio management, livestock management and trypanosomosis risk, households in areas of higher risk having fewer total livestock; in particular, trypanosomosis precludes or renders difficult the use of draught power of donkeys and horses.

FAO/ITC Trypanosomosis Training Course for Graduate/Senior Technician Level Personnel

A regional training course, jointly organised by FAO (Regional Office for Africa, Accra, Ghana and FAO Representative in The Gambia) and the International Trypanotolerance Centre (ITC), was held in May 1998 at ITC, Banjul, The Gambia. The two-week course was attended by 14 graduate and middle level NARS Personnel from Guinea, Guinea Bissau, Liberia, Senegal and The Gambia.

Technical and socio-economic aspects related to trypanosomosis, as well as development policies within the wider context of reinforcement of rural economy and food security in general were covered. In particular, attention was devoted to: recently developed techniques for assessment of trypanosomosis constraint in the context of rural development; different methods and their inter-relations in, and for, sustainability of

trypanosomosis control programmes, i.e. strategic use of curative and therapeutic drugs, various and recently developed techniques for vector control and use of trypanotolerant animals; the concept that the beneficiaries, i.e. rural communities in general and farmers and livestock dealers in particular, should perceive actions against trypanosomosis as an integral part of the production systems for an economic sustainability of the livestock industry: hence, the proposed techniques must be accepted and adopted by the majority of communities contributing to the production systems. Sessions of practical work in the laboratory and in the field were also held.

The participants made several recommendations which are generally in line with those put forward by recent meetings of the FAO Liaison Officers and the PAAT Advisory Group Co-ordinators held in October 1998 in Harare, Zimbabwe.

A further course is therefore planned in 1999 which will take account of these recommendations. Participants, being veterinarians and/or technicians, generally have a good basic knowledge of the vector and the micro-organism. Consequently, emphasis will be placed on: socio-economic implications of trypanosomosis and its control; the use of recently developed tools, i.e. geographic information systems (GIS), rapid rural appraisal (RRA), for trypanosomosis management in the context of more general disease/pest management policies (e.g. ticks, tick-borne diseases, preservation of enzootic stability); epidemiology, data collection and their exploitation; and the use of the different techniques for trypanosomosis control, their integration and sustainability in the context of rural development.

EU-FUNDED PROJECTS AND CONCERTED ACTION PROGRAMME

Farming in Tsetse Control Areas of East Africa (FITCA)

The 14th East African Co-ordination Meeting on FITCA took place in Arusha on 7-8 December 1998. The EU-funded project is about to get under way in Kenya. The Technical Assistance tender has been awarded to a consortium led by the Dublin-based group Rural Development International and the TA will be Julian Hopkins, who formerly worked on the RTTCP; he will take up his post during January. It is expected that announcements will be made shortly regarding the Technical Assistance tenders for Uganda and for the Regional Co-ordinator for Eastern Africa. The Tanzanian project document has now been finalised and a team from RTTCP are expected in Ethiopia soon to help finalise their project document.

Workshop on 'Improved Epidemiological Methods including Diagnostics'

A workshop on 'Improved Epidemiological Methods including Diagnostics' was held in Entebbe, Uganda, from 5 to 9 October 1998 under the EU-funded Concerted Action 'Integrated Control of Pathogenic Trypanosomes and their Vectors' in conjunction with the Third FAO/IAEA Research Co-ordination Meeting on 'Use of Immunoassay Methods for Improved Diagnosis of Trypanosomosis and Monitoring Tsetse and Trypanosomosis Control Programmes'.

This was the first of a series of seven workshops to be held under the Concerted Action, and was attended by 31 participants from African, Latin American, European and international research institutes. Sessions were held on serological methods including

immunoassay, PCR and nucleic acid-based methods, and epidemiology of tsetse-transmitted and non-tsetse transmitted trypanosomiasis. During subsequent discussion sessions major research and development needs were identified. These included requirements for particular diagnostic systems in priority target species, for establishment of centralised banks of reference reagents for diagnostic test development, and for basic training in epidemiological methods for trypanosomiasis field workers. Strategies for achieving these objectives were formulated and individuals willing to take the necessary action to implement these were identified.

The proceedings of the workshop will be published in the forthcoming first edition of the Concerted Action Newsletter. 'Integrated Control of Pathogenic Trypanosomes and their Vectors' is being conducted in close association with the PAAT Research and Development Module. For further information, contact Mark Eisler, P.O. Box 30709, Nairobi, Kenya (m.eisler@vet.gla.ac.uk). See also news item in *TTIQ*, **21** (3).

CURRENT RESEARCH

Improved enzyme-linked immunoassay methods for diagnosis and control of African trypanosomosis

In response to some of the conclusions and recommendations made at a workshop on the evaluation of antigen ELISAs for trypanosome detection, held at ILRI in December 1996, the FAO/IAEA Animal Production and Health Subprogramme of the Joint FAO/IAEA Division initiated research activities focusing on the development and validation of a new generation of ELISAs for the detection of *Trypanosoma congolense* and *T. vivax* antibodies and antigens (Coordinated Research Programme 313.D3.20.13).

A progress report was presented at the FAO/IAEA Research Co-ordination Meeting and the EU Concerted Action workshop, held in Entebbe, Uganda, in October 1998 (see above, p. 4), outlining the scientific approach and results since January 1997.

Earlier results indicated problems with the stability of crude trypanosome lysates kept as liquids, resulting in poor diagnostic proficiency. New prototype i-ELISAs for detection of *T. congolense* and *T. vivax* antibodies have therefore been developed, based on microplates precoated with denatured antigens. These are now being evaluated at 16 counterpart laboratories. The stability of immobilised non-denatured antigen preparations is also being examined at three counterpart laboratories. Each set of reagents consists of three defined IQC (internal quality control) sera, and enzyme conjugated antibody; this is sufficient for testing 1000 serum samples in two replicates.

The results obtained to date indicate that precoated, air-dried plates will contribute to an improved assay standardisation procedure for a new generation of trypanosomosis ELISAs and will provide a measure of confidence with respect to laboratory proficiency by minimising operator errors during coating. It is stressed that validation of immunoassays for trypanosomosis should be considered as a continuous process requiring constant vigilance with rigorous re-assessment of assay performance characteristics. (Results will be published in *Memórias do Instituto Oswaldo Cruz*, **94** (2) and in the proceedings of the 9th international conference of the Association of Institutions of Tropical Veterinary Medicine (AITVM), Harare, Zimbabwe, 14-18 September 1998.)

For more information, contact D.E. Rebeski, Animal Production Unit, FAO/IAEA Agriculture and Biotechnology Laboratory, IAEA, P.O. Box 100, A-1400 Vienna, Austria (tel. +43 1 2600 28318; fax: +43 1 2600 28222; e-mail D.Rebeski@iaea.org).

Trials of insecticide applied to cattle in Zimbabwe

In April 1997 the RTTCP, in conjunction with three insecticide manufacturers, began a trial of various pyrethroids applied to cattle. The pyrethroids were formulations of delta-methrin (Decatix, Spot On, and an experimental variant of Spot On), alphacypermethrin (Renegade) and cyfluthrin (Cylence), applied at doses recommended by the manufacturers. Each insecticide was tested on four oxen, using mainly females of *Glossina pallidipes* as test insects. Each ox was given an initial treatment and one or two re-treatments when the average daily knockdowns of fed flies caught from all of the treated animals had dropped consistently below 50%. In the days before this decline in average efficacy the mean knockdowns in all treatment periods were 59% with cyfluthrin, 74% with alpha-cypermethrin and 77-86% with the deltamethrin formulations. However, the relative performance was too variable to prove any true difference between the efficacies of the insecticides at the recommended doses.

The persistence periods of each insecticide were much less than the 100 days commonly accepted for Spot On. The pooled data for all insecticides demonstrated that from April to August 1997/8 the knockdowns remained above 50% for 24-55 days. In other months the persistence was only 5-24 days. Persistence was not correlated with rain, but declined by five days for every 1°C increase in daily maximum temperature.

None of the insecticides repelled flies at a distance or inhibited alighting responses. This accords with accepted wisdom. However, contrary to common belief, the insecticides did not stop flies from feeding. Insecticide occurred at variable levels in the dung from insecticide-treated animals, at up to 0.2 ppm. Many dead beetles were sometimes found in and near the dung.

The trials confirm that the insecticide treatment of cattle promises to be a widely applicable aid to tsetse control in farming areas. However, more research is required to optimise treatment regimes and to predict the impact on tsetse and other creatures.

For further information, contact Glyn Vale, RTTCP, P.O. Box A560, Harare, Zimbabwe (tel. 263 4 707683; fax 263 4 722684; e-mail jhargrove@rttcp.org.zw).

MEETINGS

International Scientific Council for Trypanosomiasis Research and Control: Golden Jubilee Meeting

The 25th Meeting of the ISCTRC, under the auspices of the OAU/STRC, will be held in Mombasa, Kenya, from 27 September to 1 October 1999. This will also be the 50th Anniversary of the establishment of the ISCTRC, and OAU/IBAR calls upon friends and supporters of ISCTRC to contribute towards the success of this special conference by actively participating in this historic occasion.

The draft agenda includes: Review of research and control activities; Protozoology, immunology and diagnosis; Entomology; Human trypanosomiasis; Animal

trypanosomiasis; and *Glossina* control. The working languages of the meeting will be English and French with simultaneous interpretation.

Scientific articles for oral presentation should not exceed 3000 words and should contain a summary not exceeding 250 words. Poster sessions with brief oral presentation will be organised in the poster room: posters should be 1.25 m × 1 m, with concise title followed by author(s) name(s) and their affiliations, and should be comfortably readable from a distance of 1 m (recommended character heights: title at least 2 cm, subtitles at least 1 cm, text at least 0.75 cm).

Abstracts (not exceeding 250 words) of scientific articles in duplicate in English and French should be mailed so as to reach the Secretariat not later than 30 April 1999.

For further information, please contact: OAU/IBAR, ISCTRC Secretariat, P.O. Box 30786, Nairobi, Kenya (tel. 254-2-338544; fax 332046/220546; telex 22893; e-mail parcibar@africaonline.co.ke).

Symposium 'Drugs against Parasitic Diseases'

This meeting, which is being organised with EU/TDR involvement, will take place in Montpellier, France, from 24 to 26 May 1999. For further information and registration, see http://162.38.196.39/drug-symposium/ or contact the Conference Secretariat (e-mail symposia@univ-montp2.fr; tel. (33) 4.67.14.42.87; fax (33) 4.67.14.42.86).

Fourth International Meeting on Molecular Epidemiology and Evolutionary Genetics of Infectious Diseases

This meeting, co-sponsored by IRD, CNRS and CDC, will be held in Dakar, Senegal, from 21 to 24 June 1999. For more information, see http://cepm.mpl.orstom.fr/ or contact Michel Tibayrenc (tel. 33 4 67 41 61 97; fax 33 4 67 41 62 99; e-mail Michel.Tibayrenc@ cepm.mpl.orstom.fr) or Vincent Robert (tel. 221-849 33 10/221-832 09 62; fax 221-832 16 75; e-mail Vincent.Robert@orstom.sn).

International Symposium 'Candidate Genes for Animal Health'

This will be held in Rostock, Germany, from 25 to 27 August 1999. For further information, see http://www.fbn.uni-rostock.de/fb3/Symp99.htm.

SECTION B – ABSTRACTS

1. GENERAL (INCLUDING LAND USE)

10713 **Brunhes, J., Cuisance, D., Cuny, G., Manguin, S., La Rocque, S. de and Geoffroy, B., 1998.** Entomologie médicale: l'explosion technologique. [Medical entomology: the technological explosion.] *Médecine tropicale*, **58** (1): 15-20.

Brunhes: Laboratoire de Taxonomie des Vecteurs, UER des Maladies Transmissibles, Centre ORSTOM, B.P. 5045, 34032 Montpellier Cedex, France.

This article gives an account of recent technological developments which have revolutionised the work of medical entomologists. These include computer-assisted identification of vector insects (incorporating, for example, ecological and behavioural data), the scanning and transmission electron microscopes (to reveal new characters such as receptors on the antennae and to help in deducing their probable functions), cytogenetics and biochemistry (to study chromosomes and isoenzymes of different populations), high resolution SPOT satellites (to locate likely vector habitats), geographic information systems (GIS) (to analyse data and evaluate epidemiological risk), video cameras (to study vector behaviour around targets), new traps to catch, kill or sterilise vectors, SIT, new types of insecticides (pyrethroids and pour-on formulations), and molecular biology (molecular probes, PCR, microsatellite markers, RAPD, to improve specificity and sensitivity of parasite and vector identification and help define parasite-vector relationships).

10714 **Greenwood, B., 1998.** Traditional medicine to DNA vaccines: the advance of medical research in West Africa. *Tropical Medicine and International Health*, **3** (3): 166-176.

Department of Infectious and Tropical Diseases, LSHTM, Keppel Street, London WC1E 7HT, UK.

West Africa has a rich medical history. Herbal medicine has been practised for hundreds of years. Arabic medicine was practised in the countries of the Sahel in the 15th and 16th centuries. The coming of the Europeans focused research on infectious diseases such as malaria, yellow fever and sleeping sickness, to which Europeans were very suscept-ible and which caused devastating epidemics among the populations of their new colonies. Following the colonial era, the few large, expensive, well equipped teaching hospitals gave way to medical schools based on more modest government hospitals and a change in the focus of research to conditions such as the common infectious diseases seen more frequently in district hospitals. The advent of the primary health care movement in the 1970s was followed by an increased emphasis on community studies. Molecular biology is likely to have an enormous impact on medicine in general in the coming years and one of the main challenges facing medical researchers in West Africa is how these

new tech-nologies can be used most effectively to improve health in countries with limited resources.

10715 **Jongejan, F., Goff, W. and Camus, E. (eds), 1998.** *Tropical veterinary medicine: molecular epidemiology, hemoparasites and their vectors, and general topics. Annals of the New York Academy of Sciences*, **849**: 503 pp.

This volume contains papers from the Fourth Biennial Meeting of the Society for Tropical Veterinary Medicine which was held at CIRAD, Montpellier, France, from 5 to 9 May 1997. For papers relating to trypanosomiasis, see **22**: nos. 10728, 10735, 10737, 10738, 10751, 10765, 10766.

10716 **Kitron, U., 1998.** Landscape ecology and epidemiology of vector-borne diseases: tools for spatial analysis. *Journal of Medical Entomology*, **35** (4): 435-445.

Department of Veterinary Pathobiology, College of Veterinary Medicine, University of Illinois, 2001 South Lincoln Avenue, Urbana, IL 61801, USA.

Geographic information systems (GIS), global positioning systems (GPS), remote sensing and spatial statistics are tools to analyse and integrate the spatial component in the epidemiology of vector-borne disease into research, surveillance and control programmes based on a landscape ecology approach. Landscape ecology, which deals with the mosaic structure of landscapes and ecosystems, considers the spatial heterogeneity of biotic and abiotic components as the underlying mechanism which determines the structure of ecosystems. The methodologies of GIS, GPS, satellite imagery and spatial statistics, and the landscape ecology-epidemiology approach are described, and applications of these methodologies to vector-borne diseases are reviewed. Collaborative studies by the author and colleagues on malaria in Israel and tsetse flies in Kenya (distribution during 1988-1990 in Lambwe Valley, ICIPE data) and Lyme disease, LaCrosse encephalitis and eastern equine encephalitis in the north-central United States are presented as examples for application of these tools to research and disease surveillance. The relevance of spatial tools and landscape ecology to emerging infectious diseases and to studies of global change effects on vector-borne diseases are discussed.

10717 **Molyneux, D.H., 1998.** Vector-borne parasitic diseases – an overview of recent changes. *International Journal for Parasitology*, **28** (6): 927-934.

Liverpool School of Tropical Medicine, Pembroke Place, Liverpool L3 5QA, UK.

This paper summarises the impact of different changes (environmental, ecological, developmental) on the one hand, with the impact of control measures on the other. The former group of changes have tended to exacerbate the incidence and prevalence of vector-borne parasitic diseases while the reduced public funds available for the health sector have reduced disease surveillance systems. However, some vector control/eradication pro-grammes have been successful. Vector control in onchocerciasis and Chagas' disease and intermediate host control in Guinea worm have reduced the public health importance of these diseases. This contrasts with malaria, where the

complexity of different ecological situations and the variable vector ecology have made control difficult and epidemics frequent and unpredictable. Advances in our knowledge of how to implement and sustain insecticide-impregnated bednets which reduce morbidity and mortality in under 5-year olds will be a key issue for the coming years. In African trypanosomiasis and leishmaniasis, where control is dependent on effective diagnosis and surveillance followed by high-cost drug treatment, the health services are faced with major challenges – lack of drug availability and diagnostics, no vector control – the diseases in some areas assuming epidemic status, yet health services are unable to respond. Human African trypanosomiasis and visceral leishmaniasis are fatal if untreated, and require an emergency response approach. Changing vector distribution of *Glossina* is related to the ability of *palpalis* group riverine flies to adapt to new vegetation patterns. In leishmaniasis changes have occurred in the distribution of the disease associated with development impact, urbanisation, civil unrest and changed agroforestry practice.

10718 **Pettigrew, M.M. and O'Neill, S.L., 1997.** Control of vector-borne disease by genetic manipulation of insect populations: technological requirements and research priorities. *Australian Journal of Entomology*, **36** (4): 309-317.

Department of Epidemiology and Public Health, Yale University School of Medicine, 60 College Street, New Haven, CT 06510, USA.

The possibility of controlling vector-borne disease through the development and release of transgenic insect vectors has recently gained popular support and is being actively pursued by a number of research laboratories around the world. Several technical problems must be solved before such a strategy could be implemented: genes encoding refractory traits (traits that render the insect unable to transmit the pathogen) must be identified, a transformation system for important vector species has to be developed, and a strategy to spread the refractory trait into natural vector populations must be designed. Recent advances in this field of research make it seem likely that this technology will be available in the near future. The authors review recent progress in this area, as well as argue that care should be taken in selecting the most appropriate disease system with which to first attempt this form of intervention. Much attention is currently being given to the application of this technology to the control of malaria transmitted by *Anopheles gambiae* in Africa. However, the complex epidemiology of malaria together with the intense transmission rates in Africa may make it unsuitable for the first application of this technology. Diseases such as African trypanosomiasis, transmitted by the tsetse fly, or unstable malaria in India may provide more appropriate initial targets to evaluate the potential of this form of intervention.

10719 **Smith, D.H., Pépin, J. and Stich, A.H.R., 1998.** Human African trypanosomiasis: an emerging public health crisis. *British Medical Bulletin*, **54** (2): 341-355.

Smith: Division of Tropical Medicine, Liverpool School of Tropical Medicine, Pembroke Place, Liverpool L3 5QA, UK.

There is a dramatic resurgence of human African trypanosomiasis (HAT) in sub-Saharan Africa. *Trypanosoma brucei gambiense* is spreading epidemically in large areas of Central Africa, especially the southern Sudan, Congo-Zaire, Angola, Uganda and the Central African Republic. Devastating epidemics of *T. b. rhodesiense* have occurred in south-eastern Uganda. The causes of the re-emergence of sleeping sickness as a public health problem include widespread civil disturbance and war, declining economies, reduced health financing and the dismantling of disease control programmes. Despite the inevitably fatal outcome without treatment, HAT is often given low priority by donors and national governments. The advances made in diagnosis, treatment and vector control have not been sufficiently implemented. To limit the human impact in some of the poorest communities in Africa, endemic countries will require external support to implement strategies for disease control. Donor agencies, NGOs and mission organisations could play an important role in supporting control efforts. National authorities will need to control and co-ordinate these efforts with assistance from WHO and the international community.

10720 **Teale, A., 1997.** Biotechnology: a key element in the CGIAR's livestock research programme. *Outlook on Agriculture*, **26** (4): 217-225.

ILRI, P.O. Box 30709, Nairobi, Kenya.

The unique potential of biotechnology to provide new solutions to old problems constraining the contribution of livestock to farming systems in the developing world is emphasised. An overview of biotechnological aspects of livestock research within the CGIAR, including a description of the research approaches being adopted at ILRI, is provided. The products of the research are then identified, and their potential applications in disease diagnosis and vaccination, as well as in the fields of animal breeding and genetic improvement, are described. For trypanosomiasis, the recognition of trypanosome antigens by trypanotolerant cattle, which could lead to the development of a vaccine, and genetic mapping to identify genes for trypanotolerance (genetic markers) are discussed.

10721 **Warrell, D.A. (ed.), 1998.** *Tropical medicine: achievements and prospects. British Medical Bulletin*, **54** (2): 265-519.

Centre for Tropical Medicine, Nuffield Department of Clinical Medicine, University of Oxford, John Radcliffe Hospital, Headington, Oxford OX3 9DU, UK.

This special issue of the *British Medical Bulletin* marks the centenaries in 1998 of the Liverpool School of Tropical Medicine and the London School of Hygiene and Tropical Medicine by reviewing the recent history of tropical medicine, its current challenges and future prospects. Subjects covered are as follows: Tropical medicine: 100 years of progress; The London and Liverpool Schools of Tropical Medicine 1898-1998; two papers on Malaria epidemiology and control; Onchocerciasis and Chagas' disease control; Human African trypanosomiasis (see **22**: no. 10719); Human schistosomiasis; HIV/AIDS; Bacterial infections and HIV; Dengue vaccine design; Diarrhoeal diseases; Helminths; Oedematous malnutrition; Immunisation programme; Emergence of Western

diseases in the tropical world: Chronic cardiovascular diseases; Impacts of global environmental change on future health and health care; Future role of molecular and cell biology in medical practice in the tropical countries; Health policy reforms and impact on practice of tropical medicine.

2. TSETSE BIOLOGY

(a) REARING OF TSETSE FLIES

(b) TAXONOMY, ANATOMY, PHYSIOLOGY, BIOCHEMISTRY

[See also **22**: no. 10718.]

10722 **Beard, C.B. and Aksoy, S., 1997.** Genetic manipulation of insect symbionts. *In*: Crampton, J.M. *et al*. (eds), 1997 (see **22**: no. 10724), pp. 555-560.

Beard: Centers for Disease Control and Prevention, Division of Parasitic Diseases, Mail Stop F-12, 4770 Buford Highway, Atlanta, GA 30341-3724, USA.

This chapter includes the actinomycete symbiont *Rhodococcus rhodnii* from the Chagas' disease vector *Rhodnius prolixus* as well as tsetse endosymbionts. The Introduction discusses the use of symbionts to introduce foreign genes into their arthropod host that could potentially alter the host's ability to transmit a disease pathogen. The Materials and Methods used for the transformation of *Rhodococcus* and tsetse *S* (secondary)-endosymbionts are described.

10723 **Carlson, D.A., Offor, I.I., El Messoussi, S., Matsuyama, K., Mori, K. and Jallon, J.-M., 1998.** Sex pheromone of *Glossina tachinoides*: isolation, identification, and synthesis. *Journal of Chemical Ecology*, **24** (9): 1563-1575.

Carlson: USDA-ARS-Centre for Medical, Agricultural and Veterinary Entomology, Gainesville, FL 32604, USA.

Study of lipids from male and female laboratory-reared flies led to the demonstration of a potent contact sex stimulant in extracts and cuticular hydrocarbons of the female tsetse fly *G. tachinoides* against conspecific males. Thin-layer and column chromatography indicated that extracts contained hydrocarbons and saponifiable lipids. Biological activity was found in the alkanes from females, including prominent branched-chain alkanes that were detected by gas chromatography (GC). The alkanes were separated and collected by preparative GC, and only the 37-carbon region showed biological activity. GC-mass spectrometry showed the major peak contained a mixture of isomeric 11,23-, 13,25- plus a minor amount of 11,21-dimethylheptatriacontane. Two racemic isomers were synthesised, and bioassays showed that the greatest activity was possessed by the 11,23-isomer with somewhat less activity in 13,25-dimethylheptatriacontane. Dose-response data showed ED_{50} at 5 μg per decoy with

solvent-washed males, nonspecific females or corks as decoys. These alkanes released sexual activity in males that comprised most of the behaviours released by a female fly of the same species.

10724 **Crampton, J.M., Beard, C.B. and Louis, C. (eds), 1997.** *The molecular biology of insect disease vectors: a methods manual.* London, UK; Chapman & Hall. xxv + 578 pp. (ISBN 0 412 73660 8.)

Crampton: Wolfson Unit of Molecular Genetics, Liverpool School of Tropical Medicine, Pembroke Place, Liverpool L3 5QA, UK.

This comprehensive handbook of laboratory methods covers all aspects of molecular entomology, and each chapter is written in such a way that a competent scientist who is unfamiliar with the method described can carry out the technique. Methods are described in a simple, yet detailed, step-by-step manner incorporating lists of materials and explanatory notes. The book is divided into eight parts entitled: Care and maintenance of insect colonies; Experimental infection of insect vectors; Basic methods in isolating, cloning and characterising nucleic acids and their products; Genome mapping techniques; Insect identification techniques; Transformation techniques and viral systems; Cell and organ culture; and Insect symbionts. Four of the 46 chapters deal specifically with tsetse: Care and maintenance of tsetse colonies (R.H. Gooding, U. Feldmann and A.S. Robinson) (see *TTIQ*, **20** (2): no. 9903); Infection of tsetse with *Trypanosoma brucei rhodesiense* and *T. b. gambiense* (see **22**: no. 10727); Isolation and culture of tsetse secondary endosymbionts (see **22**: no. 10729); and Genetic manipulation of insect symbionts (see **22**: no. 10722).

10725 **Goes van Naters, W.M. van der and Otter, C.J. den, 1998.** Amino acids as taste stimuli for tsetse flies. *Physiological Entomology*, **23** (3): 278-284.

Goes van Naters: Department of Animal Physiology, University of Groningen, P.O. Box 14, 9750 AA Haren, Netherlands.

This paper reports the responses of taste cells on the legs of *Glossina fuscipes fuscipes* to twenty protein amino acids and to their mixture as it is present in human sweat. It was investigated whether the mixture is sensed differently than the amino acids singly. The taste cells were most sensitive to phenylalanine ($K \approx 1$ μM) and tyrosine, and they responded in a lesser degree to methionine, valine, isoleucine, cysteine, tryptophan, histidine, alanine and threonine. The amino acids serine, proline, asparagine, arginine, glutamine, lysine, aspartic acid, glutamic acid and glycine gave little or no response even at 10 mM. As the succession of effectiveness of the amino acids appears to be the same for all cells, it is deduced that the flies are unable to discriminate the amino acids by comparing responses across sensory cells. A temporal coding of quality does not seem feasible either. Thus, the properties of the taste cells limit the sense to assessing the intensity of an amino acid stimulus and not its identity. Although several parameters in the response adaptation curves are concentration-dependent, it is suggested that the flies judge intensity of a stimulus only from the first 50 or so milliseconds. Although other studies as well as these indicate that a multiplicity of binding sites may be responsible for

the reception of amino acids, the response to the mixture can be predicted from a no-interaction model, whereby each ligand's access to the binding sites is proportional to its mole fraction. It is argued that this may be the case for more of the naturally occurring mixtures which comprise structurally similar ligands. The responses to the mixture and to phenylalanine alone are equally susceptible to inhibition by sodium chloride. It is suggested that, although discrimination of hosts probably requires another sense, the sense of taste is an excellent tool to detect a host underfoot during the local search for a feeding site.

10726 **Klingenberg, C.P., McIntyre, G.S. and Zaklan, S.D., 1998.** Left-right asymmetry of fly wings and the evolution of body axes. *Proceedings of the Royal Society of London (B)*, **265** (1402): 1255-1259.

Klingenberg: Department of Zoology, Duke University, Durham, NC 27708-0325, USA.

The body plan of *Drosophila*, and presumably that of other insects, develops under the control of anterior-posterior and dorsal-ventral axes, but no evidence for a left-right axis has yet been found. We used geometric morphometrics to study the wings in three species of flies: *Drosophila melanogaster*, *Musca domestica* and *Glossina palpalis gambiensis*. In all three species, we found that both size and shape showed subtle, but statistically significant, directional asymmetry. For size, these asymmetries were somewhat inconsistent within and between species, but for shape, highly significant directional asymmetry was found in all samples examined. These systematic left-right differences imply the existence of a left-right axis that conveys distinct positional identities to the wing imaginal discs on either body side. Hence, the wing discs of *Drosophila* may be a new model to study the developmental genetics of left-right asymmetry. The asymmetries of shape were similar among species, suggesting that directional asymmetry has been evolutionarily conserved since the three lineages diverged. The implications of this evolutionary conservatism are discussed in conjunction with results from earlier studies that showed a lack of genetic variation for directional asymmetry in *Drosophila*.

10727 **Maudlin, I., 1997.** Infection of tsetse with *Trypanosoma brucei rhodesiense* and *T. b. gambiense*. *In*: Crampton, J.M. *et al*. (eds), 1997 (see **22**: no. 10724), pp. 136-145.

Institute for Biological and Life Sciences, Anderson College, University of Glasgow, Glasgow G12 8QQ, UK.

This account consists of three sections: Introduction (establishment of trypanosome infections in the midgut of tsetse; maturation of trypanosome infections in the tsetse; infection of tsetse in the laboratory with *T. b. rhodesiense*; infection of tsetse in the laboratory with *T. b. gambiense*), Materials (procurement of tsetse flies; *in vitro* cultivation and cryopreservation of trypanosomes; fly feeding using *in vitro* technique) and Methods (preparation of Cunningham's medium; preparation and cryopreservation of bloodstream form trypanosomes; preparation of procyclic form trypanosomes; preparation

of an infective feed for tsetse; experimental infection of flies – handling newly emerged flies, infection of flies through an artificial membrane; dissection of infected tsetse; routine feeding of flies and issues relating to biosafety). Additional notes are provided on *in vitro* feeding of tsetse, on artificially increasing infection rates in tsetse, on maximising numbers of salivary gland infections, and on infection of older flies.

10728 **Solano, P., Duvallet, G., Dumas, V., Cuisance, D., Cuny, G. and Touré, S.M., 1998.** Microsatellite markers for genetic population studies in *Glossina palpalis gambiensis* (Diptera: Glossinidae). *Annals of the New York Academy of Sciences*, **849** (*Tropical veterinary medicine*): 39-43.

Solano: c/o Duvallet, Division de l'Enseignement, CIRAD-EMVT, Campus de Baillarguet, B.P. 5035, F-34032 Montpellier Cedex, France.

Little is known about intraspecific variability in tsetse flies and its consequences for vectorial capacity. Microsatellite markers have been developed for *G. p. gambiensis*. Three loci have been identified and showed size polymorphisms for insectarium samples. *G. p. gambiensis* from Burkina Faso were also subjected to PCR to investigate their genetic variability. Amplifications were observed in different species belonging to the *palpalis* group. These molecular markers will be useful for estimating gene flow within *G. p. gambiensis* populations and analysis could be extended to related species.

10729 **Welburn, S.C. and Dale, C., 1997.** Isolation and culture of tsetse secondary endosymbionts. *In*: Crampton, J.M. *et al*. (eds), 1997 (see **22**: no. 10724), pp. 547-554.

Welburn: Institute for Biological and Life Sciences, Anderson College, University of Glasgow, Glasgow G12 8QQ, UK.

This account consists of three sections: Introduction, Materials (reagents for isolation and culture of endosymbionts; reagents for staining endosymbionts; reagents for isolation of plasmid DNA from endosymbionts) and Methods (isolation and cultivation of endosymbionts – primary cultivation of RLO, separation of RLO and host cells, axenic cultivation of RLO; staining techniques – Gimenez stain, Gram stain; extrachromosomal DNA analysis – preparation of extrachromosomal DNA, agarose gel electrophoresis).

10730 **Wimmer, Z., Tykva, R., Bennettová, B., Vlasáková, V. and Elbert, T., 1997.** Degradation of a radiolabeled juvenile hormone analog using two insect species. *Invertebrate Neuroscience*, **3** (2-3): 193-197.

Wimmer: Institute of Organic Chemistry and Biochemistry, Academy of Sciences of the Czech Republic, Flemingovo námestí 2, 16610 Prague 6, Czech Republic.

A synthetic insect juvenile hormone analogue (a juvenoid), ethyl *N*-[2-[4-[[2,2-(ethylenedioxy)cyclo-hexyl]methyl]phenox]ethyl]carbamate, which has displayed high biological activity against different insect species and high stability under field conditions,

was selected as a biologically active model compound for a study of a juvenile hormone analogue degradation. The biologically active compound itself and its three diversely radiolabelled derivatives were applied topically to the flesh fly, *Sarcophaga bullata*, or the tsetse fly, *Glossina palpalis*, < 24 h old. Monitoring of the fate of the applied juvenile hormone analogue was carried out using a detection method of the radioactivity microdistribution within the whole insect body in combination with radio high performance liquid chromatography (radio-HPLC), both of whole-body extracts made in different, but in advance scheduled, time intervals, and of extracts of insect excreta accumulated over an 8 day experiment. Considerable differences in quantities of radiolabelled compounds and/or metabolites were seen in different insect body parts, and radioactivity levels were higher in *S. bullata* than in *G. palpalis*. This may be explained by the relative speed with which the blood meal passes through the body.

(c) DISTRIBUTION, ECOLOGY, BEHAVIOUR, POPULATION STUDIES

[See also **22**: no. 10716.]

10731 **Goes van Naters, W.M. van der, Otter, C.J. den and Cuisance, D., 1998.** The interaction of taste and heat on the biting response of the tsetse fly *Glossina fuscipes fuscipes*. *Physiological Entomology*, **23** (3): 285-288.

Goes van Naters: Department of Animal Physiology, University of Groningen, P.O. Box 14, 9750 AA Haren, Netherlands.

Tsetse flies probe more on a heated surface with a trace of uric acid than on one without. Uric acid is one of the components of human sweat and it elicits spike responses from taste hairs on the flies' legs. This paper examines how heat from the surface and taste interact to affect the biting behaviour of *G. f. fuscipes* over successive days of food deprivation. The biting behaviour consisted of bouts of probing, both ambulatory and stationary, intercalated with short hops of flight. The number of bouts increased over successive days, whereas the average bout duration did not. Although uric acid alone could not induce the flies to probe, in combination with surface heat it affected the flies greatly. Average bout duration was two-fold that on a heated surface not treated with uric acid. The frequency of bouts was not affected by uric acid. These experiments and auxiliary ones on mechanoreceptive input and odours lead to the insight that the factors which affect biting behaviour can be viewed as a hierarchy. The hierarchy extends from those that affect the onset of biting to those that affect its course.

10732 **Hargrove, J.W. and Williams, B.G., 1998.** Optimized simulation as an aid to modelling, with an application to the study of a population of tsetse flies, *Glossina morsitans morsitans* (Diptera: Glossinidae). *Bulletin of Entomological Research*, **88** (4): 425-435.

Hargrove: Tsetse Control Branch, Department of Veterinary Services, Box CY52, Harare, Zimbabwe.

A method is described for optimising models by linking simulation procedures with a non-linear regression programme. It is then possible to work towards a parsimonious model which contains those, and only those, variables required for an optimum fit. Using the observed values, and the predicted values from each simulation, the optimising routine calculates the value of an appropriate loss function. It then makes small changes in the parameters governing the simulation, recalculates the predicted values and the first and second derivative of the loss function with respect to each parameter. The algorithm uses this information to minimise the loss function for a given formulation of the model. The model is improved by adding variables which can be shown statistically to improve the fit, and by removing those which do not. The use of the technique is illustrated with reference to a series of weekly estimates of the total numbers, births and survival probabilities of a population of male and female *G. m. morsitans* previously studied in 1980-1983 on Antelope Island, Lake Kariba, Zimbabwe. Simulation involved following the lives of cohorts of flies, and of all their progeny, from the time they were deposited as larvae. Development and reproduction were regarded as fixed functions of temperature, but mortality rates of pupae and of adult flies depended on meteorological and biological variables, plus the level of trapping imposed on the population. Potential factors were added singly and the model thereby improved in an objective, stepwise manner. The best fit was achieved when effects on adult survival due to maximum temperature, various modes of trapping and an annual cycle were included in the model. The optimised simulation technique has been used here in improving a model which describes a biological population but it could equally be used to improve models in any situation where data are fitted using simulation procedures.

3. TSETSE CONTROL (INCLUDING ENVIRONMENTAL SIDE-EFFECTS)

10733 **Barrett, K. and Okali, C., 1998.** Partnerships for tsetse control – community participation and other options. *World Animal Review*, no. 90: 39-46.

Barrett: Overseas Development Group, School of Development Studies, University of East Anglia, Norwich NR4 7TJ, UK.

The objective of this paper is to stimulate debate on the factors that determine when, where and how it might be appropriate to involve communities in tsetse control operations. Its purpose is not, therefore, to advocate community participation in all situations but rather to provide a framework to facilitate decision-making. In recent years the participation of local communities in tsetse control has been widely promoted but little attention has been paid to the context within which community participation is expected to operate and to the appropriateness of participation as a strategy in different contexts. The discussion has focused on technical issues, and not only have community aspects been overlooked but the role and capacity of other partners which are necessarily involved in any control exercise have also been ignored and/or taken for granted. This article explores these issues in cases where traps and targets are the principal technologies being proposed for tsetse control since their specific properties and their use raise a number of unique issues, such as the necessity for a co-ordinated group effort. Particular attention is given to how programmes have approached this problem, although much of the discussion is

equally applicable to other situations where community involvement is under consideration. It begins with a brief overview of programmes with an element of community participation, followed by a discussion of variables to be considered in determining appropriate strategies and development action plans based on task sharing by the various partners involved. It concludes by highlighting major concerns and suggests how the planning process might move forward.

10734 **Baylis, M. and Stevenson, P., 1998.** Trypanosomiasis and tsetse control with insecticidal pour-ons – fact and fiction? *Parasitology Today*, **14** (2): 77-82.

Baylis: Deparment of Arbovirology, Institute for Animal Health, Ash Road, Surrey GU24 0NF, UK.

Insecticidal pour-ons that are applied directly to cattle have been promoted widely in the last decade as a new means of controlling tsetse flies. Tsetse attracted to treated cattle get a lethal dose of insecticide and die. A large trial of 1% w/v deltamethrin (Spot On) against *Glossina pallidipes* (and *G. longipennis*) feeding on cattle was conducted at Galana Ranch, Kenya, between 1990 and 1996. Although a reduction in the incidence of trypanosomiasis, due to *Trypanosoma vivax* and *T. congolense*, was seen, this was not accompanied by a concomitant decrease in the apparent density of either tsetse species. Results of other field trials elsewhere have demonstrated variable effects of pour-ons or dips on tsetse populations, although most have demonstrated positive effects on herd health. A major cause of this variability may be the proportion of blood meals that tsetse seek from cattle in different areas. Several possibilities for the discrepancies at Galana Ranch can be put forward: (i) pour-ons may be repellent to tsetse; (ii) tick control may improve cattle herd health, making them more resistant to trypanosome infection; (iii) mechanical transmission of trypanosomes by tabanids and *Stomoxys* may be more important than previously thought, and pour-ons may stop this method of transmission; (iv) there is only a local depletion of the tsetse population, the main tsetse activity at Galana Ranch being just after dawn and before dusk when cattle are in or near the corrals in which they spend the night. Further research is urgently needed to resolve these uncertainties.

10735 **Deken, R. de, Bossche, P. van den and Hees, J. van, 1998.** Susceptibility of tsetse flies to topical applications of deltamethrin. *Annals of the New York Academy of Sciences*, **849** (*Tropical veterinary medicine*): 450-455.

Deken: Institute of Tropical Medicine, Nationalestraat 155, B-2000 Antwerp, Belgium.

Published results and the authors' unpublished data on the susceptibility of tsetse to topical deltamethrin are reviewed. LD_{50}s varied significantly between *Glossina* species. Their degree of tolerance was ranked as follows: *G. palpalis gambiensis* > *G. p. palpalis* > *G. austeni* > *G. morsitans morsitans* (using acetone or butanone as solvent); *G. pallidipes* > *G. tachinoides* > *G. m. morsitans* (using 2-ethoxy-ethanol); *G. p. palpalis* > *G. austeni* > *G. m. morsitans* (using di-isobutylketone). Mortality was also influenced by the following parameters: (a) solvent (higher LD_{50}s using acetone or butanone than with

di-isobutylketone, lower with 2-ethoxy-ethanol); (b) temperature (negative correlation between temperature and toxicity); (c) age (age-related increase in tolerance in *palpalis* group species but not in *morsitans* group); (d) nutritional status (in *G. tachinoides* tolerance shown to decrease with increasing starvation period, correlated with reduction in body fat level); (e) sex and reproductive state (no differences in susceptibility observed between teneral males and females, but pregnant flies more tolerant than non-pregnant); (f) trypanosomal infections (increased sensitivity in infected flies).

10736 **Kinley, D.H., 1998.** Aerial assault on the tsetse fly. *Environment*, **40** (7): 14-18, 40-41.

IAEA, Wagramerstrasse 5, P.O. Box 100, A-1400 Vienna, Austria.

This article describes the programme launched in 1994 by the governments of Tanzania and Zanzibar with the assistance of the IAEA and other donors to use mass breeding and release of sterilised tsetse flies to eradicate *Glossina austeni* from Unguja island, Zanzibar. The various approaches to tsetse control that have been tried over the years are described briefly. Initial efforts in 1983 to control tsetse on Zanzibar involved pour-on insecticides applied to cattle: this method yielded considerable gains in northern Unguja where more of the cattle were kept but failed in the densely forested southern areas. Progress was also made in developing new trapping techniques for *G. austeni* using blue/white sticky traps and insecticide-impregnated blue cloth screens, which reduced the fly population substantially but failed to achieve eradication. In 1994, efforts to apply the SIT began with the building up of a colony of *G. austeni* at TTRI. Aerial release of sterile males averaged over 50,000 per week between 1995 and 1997. The fly population density declined continuously from mid-1995 and the last wild fly was captured in September 1996. The socioeconomic benefits of this project are already pronounced. The feasibility of extending SIT to mainland Africa, where the absence of natural boundaries makes eradication difficult to sustain, is discussed. In a new project adopted recently by the Ethiopian government, Ethiopia will develop a national SIT capacity which will be applied in an integrated pest management approach across the Southern Rift Valley. Some of the environmental concerns of tsetse control (pollution, ecological changes, land degradation) are discussed: SIT may be regarded as the most environmentally friendly technology currently available.

4. EPIDEMIOLOGY: VECTOR-HOST AND VECTOR-PARASITE INTERACTIONS

[See also **22**: nos. 10722, 10727, 10754, 10757.]

10737 **Dia, M.L., Elsen, P., Cuisance, D., Diop, C., Thiam, A. and Chollet, J.Y., 1998.** Abundance and seasonal variations of tabanids in southern Trarza (Mauritania). *Annals of the New York Academy of Sciences*, **849** (*Tropical veterinary medicine*): 456-460.

Dia: Laboratoire de Parasitologie, CNERV, B.P. 167, Nouakchott, Mauritania.

This study, which aimed to clarify the apparent link between *Trypanosoma evansi* infection in dromedary camels and tabanid and/or stomoxyid populations, was carried out in 1994-1996 mainly in the R'Kiz region around R'Kiz lake using bipyramidal traps (unbaited) and hand net sweeping of camels. A total of 1040 tabanids was collected, 63.2% by trapping, 33.6% by hand inside the vehicle following on slowly behind the camels, and 3.2% by hand net. *Atylotus agrestis* was the most abundant species caught (67.5%), followed by *Tabanus taeniola* (23.4%) and *T. sufis* (9.1%). Most were collected between October and November, corresponding to the end of the rainy season and beginning of the dry and cold season. Trap catches peaked between midday and 3 p.m. Substantial numbers of Stomoxyinae were collected (70% by trapping) but many escaped; of 185 examined, 85% were *Haematobia minuta* and 15% were *H. irritans*. They were very abundant on animals at the end of the rainy season, especially at sunrise and sunset. About 50 *Hippobosca camelina* and *H. variegata* (Hippoboscidae) were netted on animals. This study suggests that the increased serological prevalence of *T. evansi* seen in southern Trarza at the beginning of the dry and cold season results from infection during the period of tabanid abundance.

10738 **La Rocque, S. de, Lefrançois, T., Reifenberg, J.M., Solano, P., Kabore, I., Bengaly, Z., Augusseau, X. and Cuisance, D., 1998.** PCR analysis and spatial repartition of trypanosomes infecting tsetse flies in Sidéradougou area of Burkina Faso. *Annals of the New York Academy of Sciences*, **849** (*Tropical veterinary medicine*): 32-38.

La Rocque: CIRDES, 01 B.P. 454, Bobo Dioulasso 01, Burkina Faso.

A parasitological and entomological survey was conducted in the Sidéradougou area (south of Bobo Dioulasso, Burkina Faso) in order to identify transmission factors of African trypanosomosis. More than 3600 tsetse flies (*Glossina tachinoides, G. palpalis gambiensis*) were captured along 120 km of linear gallery forest and half of them were dissected. PCR analysis was undertaken on parasitologically positive flies (161 *G. tachinoides*, 92 *G. p. gambiensis*) to characterise the different trypanosomes. Tsetse distribution had changed since a similar survey carried out in 1982. Two zones had high densitites of tsetse flies/trap/day (5.3 and 9.3) and high percentages of infected flies (30%). In the first zone (upstream area of hydrographic network), PCR analysis on 84 parasitologically positive *G. tachinoides* identified 33 infections with the three main pathogenic trypanosomes (*Trypanosoma vivax*, *T. congolense* 'savanna' and 'forest' types, *T. brucei* s.l.) while 51 flies tested negative. In the second zone (downstream area), PCR identified 53 pathogenic infections in 66 parasitologically positive *G. tachinoides*, while 13 were negative. Blood meal analysis showed a host preference for monitor lizards and crocodiles in the first zone, suggesting the presence of reptile trypanosomes, and for suids and ruminants in the second zone. All the results were integrated in a GIS to facilitate analysis of the relation between tsetse distribution and vegetation and land use, and to examine the impact of environmental changes on the distribution and density of the tsetse population. This should permit a clearer understanding of the epidemiology and better identification of high-risk areas.

10739 **Lefrançois, T., Solano, P., La Rocque, S. de, Bengaly, Z., Reifenberg, J.M., Kabore, I. and Cuisance, D., 1998.** New epidemiological features on animal trypanosomiasis by molecular analysis in the pastoral zone of Sidéradougou, Burkina Faso. *Molecular Ecology*, **7** (7): 897-904.

Solano: CIRAD-EMVT, B.P. 5045, 34032 Montpellier Cedex, France.

A multidisciplinary study was undertaken in the agropastoral zone of Sidéradougou, Burkina Faso, to try to elucidate the key factors determining the presence of tsetse flies. PCR was used to characterise trypanosomes infecting the vector (*Glossina tachinoides* and *G. palpalis gambiensis*) and the host (cattle). A 2-year survey involved dissecting 2211 tsetse of the two species, of which 298 parasitologically infected tsetse were analysed by PCR. *Trypanosoma vivax* was the most frequently identified trypanosome followed by the savanna type of *T. congolense* and, to a lesser extent, the riverine forest type of *T. congolense*, and by *T. brucei*. No cases of *T. simiae* were found. Of the 107 identified infections in cattle, the taxa were the same, but *T. congolense* savanna type was more frequent, whereas *T. vivax* and *T. congolense* riverine forest type were found less frequently. A correlation was found between midgut infection rates of tsetse, non-identified infections and reptile blood meals. These rates were higher in *G. p. gambiensis*, and in the western part of the study area. *T. vivax* infections were related to cattle blood meals, and were more frequent in *G. tachinoides* and in the eastern study area. The PCR results combined with blood meal analysis helped us to establish the relationships between the vector and the host, to assess the trypanosome challenge in the two parts of the area, to elucidate the differences between the two types of *T. congolense*, and to suspect that most midgut infections were originating from reptilian trypanosomes.

10740 **Morlais, I., Grebaut, P., Bodo, J.M., Djoha, S., Cuny, G. and Herder, S., 1998.** Detection and identification of trypanosomes by polymerase chain reaction in wild tsetse flies in Cameroon. *Acta Tropica*, **70** (1): 109-117.

Morlais: Laboratoire d'Epidémiologie des Maladies à Vecteurs, Centre ORSTOM, B.P. 5045, F-34032 Montpellier Cedex, France.

The prevalence of various species and subgroups of trypanosomes in infected flies from three sleeping sickness foci in Cameroon was determined by PCR. The predominant tsetse species found was *Glossina palpalis palpalis*. Microscopical examination of 943 non-teneral tsetse flies revealed an average infection rate of 10.4%. A total of 90 flies were analysed for trypanosome identification with primer sets specific for *Trypanosoma (Trypanozoon) brucei* s.l., *T. (Duttonella) vivax*, *T. (Nannomonas) simiae*, and forest type *T. (Nannomonas) congolense*. PCR succeeded in identifying 52 of the 90 infected flies. Other primers were also tested on microscope-positive/PCR-negative infections, and trypanosome subgroups were detected (Kilifi type and savanna type *T. congolense*). PCR amplification allowed identification of immature infections and revealed mixed infections. However, the technique failed to identify 42.2% (38/90) of the parasitologically positive flies; the reasons for this failure are discussed.

10741 **Msangi, A.R., Whitaker, C.J. and Lehane, M.J., 1998.** Factors influencing the prevalence of trypanosome infection of *Glossina pallidipes* on the Ruvu flood plain of Eastern Tanzania. *Acta Tropica*, **70** (2): 143-155.

Lehane: School of Biological Sciences, University of Wales, Bangor LL57 2UW, UK.

The pattern of infection of *G. pallidipes* with *Trypanosoma vivax* and *T. congolense* at a site in the Coast region of eastern Tanzania, was studied between November 1993 and December 1994. Of the 2315 flies dissected, 114 (4.9%) were *T. congolense* positive, 77 (3.3%) were *T. vivax* positive and 2 (0.1%) were *T. brucei* positive. Fly age was determined by the pteridine fluorescence method. Prevalence of infection was most strongly affected by month and the linear effect of age, with the interaction of month and age having an effect for *T. congolense*-type infections. Sex and sex by month also have some predictive capacity when data for *T. congolense* and *T. vivax*-type infections are combined. In contrast to other similar studies, these results suggest that the infection rate is non-linearly related to age of the tsetse fly, with older flies having progressively more chance of infection. The potential biological factors underpinning these interactions are discussed.

5. HUMAN TRYPANOSOMIASIS

(a) SURVEILLANCE

10742 **Miezan, T.W., Meda, H.A., Doua, F., Yapo, F.B. and Baltz, T., 1998.** Assessment of central nervous system involvement in *gambiense* trypanosomiasis: value of the cerebro-spinal white cell count. *Tropical Medicine and International Health*, **3** (7): 571-575.

Meda: OCCGE – Centre Muraz 01, B.P. 153, Bobo Dioulasso, Burkina Faso.

The objective of this study was to assess, in a clinical setting, the comparative values of conventional criteria used in the diagnosis of CNS involvement in *Trypanosoma brucei gambiense* sleeping sickness: white cell count (WCC) in CSF > 5×10^6 cells/l; total protein concentration in CSF > 40 mg/100 ml); evidence of trypanosomes in CSF following double centrifugation (DC). *In vitro* culture of CSF was used as the gold standard. The study, on samples from 90 patients in Côte d'Ivoire, showed that WCC is, by itself, as sensitive for the diagnosis of CNS involvement as the usually recommended combination of three conventional criteria. The specificity of WCC is improved, while the sensitivity is reduced, when the cut-off point is set at a higher value (WCC > 10×10^6 cells/l). It is concluded that, in poorly equipped laboratories, the diagnosis of CNS involvement in patients with confirmed systemic infection should be based only on the WCC. However, a pilot study is needed to assess the feasibility and reliability of the WCC handled by 'front line' personnel, for different cut-off values.

10743 **Pansaerts, R., Meirvenne, N. van, Magnus, E. and Verhelst, L., 1998.** Increased sensitivity of the card agglutination test CATT/*Trypanosoma brucei gambiense* by inhibition of complement. *Acta Tropica*, **70** (3): 349-354.

Magnus: Institute of Tropical Medicine, Nationalestraat 155, B-2000 Antwerp, Belgium.

CATT/*T. b. gambiense* is an antibody detection test currently used in field surveys on Gambian sleeping sickness. The screening test is usually performed on a drop of freshly collected heparinised blood, followed by a more specific confirmation test on diluted blood, plasma or serum. This approach may be biased by the occurrence of a complement-mediated prozone phenomenon causing lower test sensitivity at lower sample dilutions. A simple remedy is by addition of a Ca^{2+} chelating agent such as EDTA.

10744 **Paugam, A., Ancelle, T., Bourlioux, F., Merad, A. and Vigier, J.P., 1997.** Apport de la technique du quantitative buffy coat (QBC®) dans le diagnostic de la trypanosomose humaine africaine. Evaluation expérimentale par l'étude de sang humain mélange avec *Trypanosoma brucei gambiense* à des concentrations decroissantes. [Contribution of the quantitative buffy coat technique (QBC®) to the diagnosis of human African trypanosomiasis. Experimental evaluation using decreasing concentrations of *T. b. gambiense* mixed with human blood.] *Bulletin de la Société française de Parasitologie*, **15** (2): 135-140.

Paugam: Laboratoire de Parasitologie, Hôpital Cochin, 27 rue du Faubourg Saint-Jacques, 75014 Paris, France.

The quantitative buffy coat (QBC) test was compared with the Woo test for the diagnosis of human African trypanosomiasis, using cultured *T. b. gambiense* mixed with human blood to give different concentrations of trypanosomes. The QBC test was about 17 times more sensitive than the Woo test, but became much less sensitive if centrifugation and microscopic examination were carried out more than 2 h after sampling. The high sensitivity and ease of use of the QBC test make it suitable for screening programmes in the field.

10745 **Truc, P., Jamonneau, V., N'Guessan, P., Diallo, P.B. and Garcia, A., 1998.** Parasitological diagnosis of human African trypanosomiasis: a comparison of the QBC® and miniature anion-exchange centrifugation techniques. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, **92** (3): 288-289.

Truc: Laboratoire de Biologie des Parasites et des Vecteurs, IPR, OCCGE, 01 B.P. 1500, Bouaké, Côte d'Ivoire.

The miniature anion-exchange centrifugation technique (mAECT) and the quantitative buffy coat method (QBC) were compared for the diagnosis of human African trypanosomiasis (*Trypanosoma brucei gambiense*) using blood collected by venepuncture

and finger-prick methods. Blood samples were collected by both techniques from 38 individuals in the Bouaflé-Sinfra focus, Côte d'Ivoire, who had shown strong positive CATT results. Of the 38 patients tested, 33 and 27 positive results were detected by mAECT and QBC, respectively, using blood collected by venepuncture; 15 and 14 positive results by mAECT and QBC, respectively, using blood collected by finger-prick. It is recommended that blood collection for the diagnosis of HAT should be by venepuncture.

(b) PATHOLOGY AND IMMUNOLOGY

10746 **Reincke, M., Arlt, W., Heppner, C., Petzke, F., Chrousos, G.P. and Allolio, B., 1998.** Neuroendocrine dysfunction in African trypanosomiasis – the role of cytokines. *Annals of the New York Academy of Sciences*, **840** (*Neuroimmuno-modulation*): 809-821.

Reincke: Medizinische Universitätsklinik, Josef-Schneider-Strasse 2, D-97080 Würzburg, Germany.

Infection with *Trypanosoma brucei* sspp. in humans is associated with adynamia, lethargy, anorexia, and more specifically amenorrhea/infertility in women and loss of libido/impotence in men. Recent evidence suggests that experimental *T. brucei* infection in animals causes polyglandular endocrine failure by local inflammation of the pituitary, thyroid, adrenal and gonadal glands. In a cross-sectional study, the prevalence and significance of neuroendocrine abnormalities in 137 Ugandan sleeping sickness patients were investigated. In the untreated stage of the disease, there was a high prevalence of adrenal insufficiency (27%), hypothyroidism (50%) and hypogonadism (85%). Pituitary function tests suggested an unusual combined central (hypothalamic/pituitary) and peripheral defect in hormone secretion. Specific therapy resulted in a rapid recovery of adrenal/thyroid function, whereas hypogonadism persisted for years in a substantial portion of patients. Pituitary, thyroid, adrenal and gonadal autoantibodies were not detected in patients with endocrine dysfunction, ruling out an autoimmune origin of the endocrine abnormalities. However, the presence of hypopituitarism correlated with high cytokine concentrations (TNF-α, IL-6) which, together with direct parasitic infiltration of the endocrine glands, are involved in the pathogenesis of sleeping sickness-associated endocrine dysfunction.

(c) TREATMENT

10747 **Clerinx, J., Taelman, H., Bogaerts, J. and Vervoort, T., 1998.** Treatment of late stage *rhodesiense* trypanosomiasis using suramin and eflornithine: report of six cases. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, **92** (4): 449-450.

Clerinx: Instituut voor Tropische Geneeskunde, Kronenburgstraat 43/3, B-2018 Antwerp, Belgium.

After an outbreak of *Trypanosoma brucei rhodesiense* trypanosomiasis in the Akagera national park, Rwanda, in 1993, six patients aged 20-22 years, showing evidence of cerebromeningeal trypanosomal infection, were treated with suramin and eflornithine, or eflornithine alone. Four patients on combination therapy were treated with i.v. suramin (1 g weekly for 5 weeks); after 1 week of this treatment, they also received i.v. eflornithine as a continuous perfusion (800 mg/kg/day) for 14 days followed by oral eflornithine in 4 divided doses at 300 mg/kg/day for 21 days. In these patients, ECG recordings had returned to normal by the end of treatment (day 35). Trypanosomes were cleared quickly from the blood but two patients still had trypanosomes in the CSF at day 35, and another showed increased CSF leucocyte count. The two other patients received i.v. eflornithine alone for 21 days followed by oral administration for 14 days. Trypanosomes were cleared from their CSF by the end of treatment but their CSF leucocyte count remained abnormal. Complications were usually mild and resolved spontaneously. Despite the fact that follow-up was limited to 3 months because of disruption by civil war, it is clear that the treatment was ineffective in at least 3 of the 6 patients. Eflornithine cannot therefore be considered a suitable alternative to melarsoprol for the treatment of late stage *rhodesiense* trypano-somiasis.

6. ANIMAL TRYPANOSOMIASIS

(a) SURVEY AND DISTRIBUTION

[See also **22**: no. 10737.]

10748 **Almeida, P.P. de, Ndao, M., Meirvenne, N. van and Geerts, S., 1998.** Diagnostic evaluation of PCR on dried blood samples from goats experimentally infected with *Trypanosoma brucei brucei*. *Acta Tropica*, **70** (3): 269-276.

Meirvenne: Institute of Tropical Medicine, Nationalestraat 155, B-2000 Antwerp, Belgium.

In seven goats experimentally infected with a pleomorphic clone of *T. b. brucei*, parasitaemia was monitored weekly for 6 weeks by wet blood film and microhaematocrit buffy coat examination. Dried blood samples on filter paper were concomitantly collected and tested by PCR using three different primer sets, putatively specific for *Trypanozoon*, *T. vivax* and *T. congolense*. With the originally designed ORPHON5J *Trypanozoon* primers, PCR tests became positive after 1 week (six animals) or 2 weeks (one animal) of infection and remained consistently positive until the end of the experiments, thus yielding an overall positivity rate of 97%, as compared with 74% for all parasitological tests together. The *T. vivax* and *T. congolense* primers yielded no positive PCR results.

10749 **Bhatnagar, C.S., Pathak, K.M.L., Kapoor, M. and Yadav, M.P., 1997.** Evaluation of various diagnostic techniques in donkeys experimentally infected with *Trypanosoma evansi*. *Indian Journal of Animal Sciences*, **67** (10): 836-838.

Bhatnagar: Veterinary Hospital, Rajsamand, Rajasthan, India.

Various diagnostic tests – parasitological (wet blood film, WBF), biological (mouse subinoculation, MSI) and immunodiagnostic, based on antibody detection (double immunodiffusion test, DID) and antigen detection (Ag-ELISA) – were evaluated in donkeys experimentally infected with *T. evansi*. WBF and MSI detected the infection as early as 96 h and 48 h p.i., respectively. Antibodies were detected as early as 13 days p.i., while trypanosomal antigens were detected as early as 7 days p.i. The diagnostic efficacy of MSI was 100%, followed by Ag-ELISA, WBF and DID.

10750 **Bossche, P. van den and Mudenge, D., 1997.** Prevalence of tsetse-transmitted trypanosomosis along the eastern/north eastern border of Zimbabwe. *Zimbabwe Veterinary Journal*, **28** (2): 49-59.

RTTCP, P.O. Box A560, Avondale, Harare, Zimbabwe.

A survey was conducted between November 1994 and December 1995 to determine the prevalence of trypanosomiasis in cattle along the eastern and north-eastern borders of Zimbabwe. Blood from 2092 animals at 36 sites was examined using a direct parasitological technique; trypanosomes were detected in 33 animals (19 infections with *Trypanosoma congolense*, 3 with *T. vivax* and 11 with *T. brucei*; 1 with *T. brucei* and *T. congolense*). The highest prevalence was observed in Mudzi and Nyanga Districts. The high prevalence in Mudzi District was in accordance with the catches of tsetse flies, probably invading from Mozambique. In Nyanga District, however, where few tsetse flies were caught, the prevalence of trypanosomiasis was attributed to chronic trypanosomal infections. The average PCV of herds increased significantly as the distance between the grazing area and the tsetse front increased. The number of apparently uninfected animals which nevertheless had a PCV lower than the mean PCV of infected animals was about 68% higher in areas where some infected animals were detected than in areas where none were, suggesting that these apparently uninfected cattle were also under tsetse challenge.

10751 **Clausen, P.-H., Wiemann, A., Patzelt, R., Kakaire, D., Poetzsch, C., Peregrine, A. and Mehlitz, D., 1998.** Use of a PCR assay for the specific and sensitive detection of *Trypanosoma* spp. in naturally infected dairy cattle in peri-urban Kampala, Uganda. *Annals of the New York Academy of Sciences*, **849** (*Tropical veterinary medicine*): 21-31.

Clausen: Institute for Parasitology and Tropical Veterinary Medicine, Freie Universität Berlin, Königsweg 67, D-14163 Berlin, Germany.

The objective of this study was to compare the sensitivity and specificity of the polymerase chain reaction (PCR) with the haematocrit centrifugation technique (HCT) and the mini-anion-exchange centrifugation technique (m-AECT) for diagnosis of trypanosome infections in livestock. In a cross-sectional study, 486 cattle from 50 randomly selected farms in Mukono County, Uganda, were investigated in June 1994. The direct parasitological techniques were performed in the field, resulting in 45 (9.3%)

animals positive by HCT and 78 (16%) positive by m-AECT. The total prevalence (combined evidence of HCT and m-AECT) was 18.9%, with 78.2% *Trypanosoma brucei* only, 10.9% *T. vivax* and 10.9% mixed (*T. brucei*/*T. vivax*) infections. Trypanosomes of the subgenus *Nannomonas* were not detected. DNA was prepared by lysis from 181 randomly selected blood samples and amplified by PCR using species-specific oligonucleotide primers. Overall, the PCR gave positive results in 63 (34.8%) blood samples (76.2% *T. brucei*, 20.6% *T. vivax*, 3.2% mixed *T. brucei*/*T. vivax*). The preliminary results from this study demonstrate that the detection rate of PCR is about two times higher than that of the direct parasitological techniques, suggesting a higher sensitivity. The higher proportion of *T. vivax* infections detected by PCR as compared to HCT/m-AECT is likely to be due to false parasitological classifications which might occur under field conditions.

10752 **Dadah, A.J., Duhlinska-Popova, D.D., Daniel, A.D. and Dede, P.M., 1997.** Trypanosomosis among sheep and goats at slaughter in Jos abattoir, Nigeria. *Revue d'Elevage et de Médecine vétérinaire des Pays tropicaux*, **50** (3): 214-216.

Dadah: Parasitology Division, NITR, P.M.B. 03, Vom, Plateau State, Nigeria.

The prevalence of trypanosomosis in Yankasa sheep and Red Sokoto goats from northern Nigeria was studied by blood examination at the municipal abattoir of Jos, central Nigeria, between March and August 1990. Blood samples were collected from 522 sheep and 601 goats and examined by buffy coat and stained smear methods. Twenty sheep (3.83%) and 11 goats (1.83%) were infected with trypanosomes. *Trypanosoma vivax* and *T. congolense* were the only trypanosomes encountered in this study. *T. vivax* was found in 15 (2.87%) and 7 (1.16%) of the sheep and goats, respectively; *T. congolense* was found in 5 (0.97%) and 4 (0.67%), respectively. The prevalence of infection was higher during the wet season than during the dry season, but the difference was not statistically significant. Sheep and goats should therefore be included in any therapeutic or prophylactic programme of trypanosomosis control to prevent their becoming reservoirs of infection for the economically more important cattle.

10753 **Desquesnes, M., 1996.** Evaluation of three antigen detection tests (monoclonal trapping ELISA) for African trypanosomes, with an isolate of *Trypanosoma vivax* from French Guiana. *Annals of the New York Academy of Sciences*, **791** (*Vector-borne pathogens*): 172-184.

CIRAD-EMVT, c/o Institut Pasteur, B.P. 6010, Cayenne 97306, French Guiana.

Three Ag-ELISA tests developed with species-specific monoclonal antibodies for *T. vivax*, *T. brucei* and *T. congolense* were re-evaluated. Blood samples were taken daily from four calves inoculated at ILRI with *T. vivax* (French Guiana stock, IL 4007) for 51 days p.i. and examined directly on blood smears and buffy coat, and using the Ag-ELISA. Of 158 tests performed on the four calves, 66% of samples were positive by buffy coat; using the Ag-ELISA, 3.8% of samples were positive for *T. vivax*, 4.4% for *T. brucei* and

3.1% for *T. congolense*. Only *T. vivax* was identified by blood smears. The specificities of the Ag-ELISA for *T. brucei* and for *T. congolense* were 95.6% and 96.9%, respectively. It is concluded that new monoclonal antibodies are required to develop more specific and sensitive tests.

10754 **Dia, M.L., Diop, C., Thiam, A., Aminetou, M. and Jacquiet, P., 1997.** Importance of camel trypanosomosis and its vectors in Mauritania. *Journal of Camel Practice and Research*, **4** (2): 271-276.

Dia: Laboratoire de Parasitologie, CNERV, B.P. 167, Nouakchott, Mauritania.

Physical, climatic and socio-economic conditions of Mauritania make it a country highly favourable to camel breeding. An epidemiological survey of trypanosomosis was conducted on 2062 dromedaries of all ages (528 males and 1534 females) from 82 herds in four provinces (Trarza, Gorgol, Adrar, Hodh Chargui) presenting different climatic and ecological conditions. The prevalence of the infection was determined through blood smear examination and serological tests: CATT, IFAT and Ag-ELISA. Tabanids were collected by trapping (hand nets on animals, car moving slowly). The overall parasitological prevalence of the disease was 1.4%. Seropositivity rates were 16.5% with CATT, 24.3% with IFAT and 14.0% with Ag-ELISA. Variations were observed depending upon region, herd management strategy and age of the animals. The biting flies trapped were the horse flies *Atylotus agrestis* (63.8 ± 4%), *Tabanus taeniola* (24.4 ± 4%), *T. sufis* (11.8 ± 3%) and the stable flies *Haematobia minuta* and Hippoboscidae *Hippobosca camelina* and *H. variegata*. These species were particularly abundant during the end of the rainy season but could be found throughout the year. *T. taeniola* and *A. agrestis* were caught in the pasture while *T. sufis* was caught by traps placed near the water.

10755 **Mattioli, R.C., Jaitner, J., Clifford, D.J., Pandey, V.S. and Verhulst, A., 1998.** Trypanosome infections and tick infestations: susceptibility in N'Dama, Gobra zebu and Gobra × N'Dama crossbred cattle exposed to natural challenge and maintained under high and low surveillance of trypanosome infections. *Acta Tropica*, **71** (1): 57-71.

Mattioli: ITC, P.M.B. 14, Banjul, Gambia.

Susceptibility to trypanosome infections and tick infestations was assessed in 51 N'Dama, 48 Gobra zebu and 37 Gobra × N'Dama crossbred (F1) cattle exposed to field-tick infestations and natural high tsetse challenge over more than one year. From these cattle, 12 animals of each breed were randomly selected and examined parasitologically for trypanosome infections and for PCV twice a week (high surveillance, group HS). In the remaining 100 cattle, trypanosome infection and PCV were monitored monthly (low surveillance, group LS). Mortality rates were recorded in both groups. Tick infestation was quantified fortnightly from all animals in group HS and from four to seven randomly selected animals of each breed in group LS. In both HS and LS groups, trypanocidal drug treatment was administered to trypanosome-positive animals with PCV equal to or less than 20% or when they showed clinical evidence (dullness, weight loss) of

trypanosomosis. In both groups, N'Dama cattle exhibited a superior capacity to control trypanosome infections and limit tick burdens. Particularly in group HS, N'Dama cattle showed lower trypanosome infection rate, higher mean PCV value, lower requirement for trypanocide treatments and lower tick load than crossbred and Gobra cattle in the corresponding group ($P < 0.05$ or greater). This was also true in N'Damas in comparison with crossbreds in group LS. Unfortunately, the high mortality occurring in Gobra cattle in group LS did not allow within-group comparative analysis between N'Dama, Gobra and crossbred cattle over all the study period. In group HS, no death occurred in N'Dama cattle, while approximately 8% of crossbreds and 50% of Gobras died of trypanosomosis. In group LS, all Gobra and more than 70% of crossbred cattle died. In this group, mortality in N'Dama was limited to less than 16%. In both groups, differences in mortality were significantly higher ($P < 0.01$) in Gobras than in N'Damas. Within breed, animals of the three breeds in group HS showed higher mean PCV values, lower tick burdens and required proportionally less trypanocide treatments than corresponding cattle in group LS. The infection rate in group HS N'Dama was lower than in group LS N'Dama. There was no significant difference in mortality between groups within the N'Dama breed. Conversely, mortality rates were lower in crossbred and Gobra in group HS than in respective cattle in group LS. It is concluded that cattle of the three breeds suffered from trypanosomosis and that trypanosome infections affected tick susceptibility. However, N'Dama showed a superior ability to limit both the pathological effects of trypanosomosis and the level of tick infestations. Therefore, considering the cost of labour and consumable equipment required for high surveillance, use of multi-disease resistant N'Dama cattle is recommended for the low-input traditional African farming systems in areas where trypanosomosis, ticks and tick-borne diseases are constraints to livestock production. Additional comparative investigations are needed to assess the impact of high surveillance schemes in different production systems in trypanotolerant and trypanosusceptible cattle exposed to different gradients of tsetse challenge.

10756 **Olaho-Mukani, W., Mboloi, M.M., Muriuki, S.P., Ouma, J.O., Guya, S.O. and Ndung'u, J.M., 1997.** Application of pen-side diagnosis in the control of surra in dromedary camels in Kenya. *Journal of Camel Practice and Research*, **4** (2): 281-282.

Olaho-Mukani: KETRI, P.O. Box 362, Kikuyu, Kenya.

Trypanosomiasis due to *Trypanosoma evansi* infection (surra) is the most important disease affecting camels in most of the arid and semi-arid parts of Kenya. Due to the non-sedentary nature of the camel rearing communities in these areas, quick and sensitive diagnosis is an important prerequisite for prompt institution of chemotherapeutic control of surra. Under field conditions, parasitological diagnosis is slow and has been found to miss 50-88% of real infections, necessitating a quicker and more sensitive diagnostic test. Recently, a monoclonal-dependent card latex agglutination test (Suratex) which detects trypanocidal antigens in the blood of infected camels was compared with HCT and mouse inoculation (MI) for detection of trypanosomes in 203 camels from four herds in Kenya. Of 28 patent infections detected by MI, Suratex detected 25 (89%) and HCT only 5 (18%). All positive camels, and others with a PCV of 20% or less (130 camels in all), were treated with melarsomine or quinapyramine and were tested again 7 and 30 days later.

HCT indicated a 100% reduction in positivity on both days; MI indicated a 100% reduction after 7 days but showed 4 camels to be positive (86% reduction) after 30 days; taking all 130 camels to be positive, Suratex showed a 32% reduction in positivity after 7 days, increasing to 72% after 30 days. These results indicate that Suratex is much more sensitive than HCT, and demonstrate the usefulness of combining Suratex and parasitological tests for pen-side diagnosis and for monitoring the efficacy of chemotherapeutic control of surra.

10757 **Solano, P., Desquesnes, M. and Sidibe, I., 1997.** Le diagnostic de *Trypanosoma vivax*: un problème non résolu dans l'épidémiologie des trypanosomoses. [*T. vivax* diagnosis: an unresolved problem in the epidemiology of trypanosomes.] *Revue d'Elevage et de Médecine vétérinaire des Pays tropicaux,* **50** (3): 209-213.

Solano: CIRDES, B.P. 454, Bobo-Dioulasso, Burkina Faso.

Various diagnostic techniques used in *T. vivax* detection in the field, such as standard parasitological examinations, serological tests and molecular techniques (PCR), are reviewed. The most sensitive and specific technique appeared to be PCR, used at CIRDES. The results obtained with this technique to identify *T. vivax* in cattle and tsetse mouthparts were compared to parasitological results from recent studies in West Africa. The most striking fact was that in some areas a significant number of tsetse flies, infected in the proboscis only (*T. vivax* cycle), gave no amplification signal with any of the sets of primers used. Several hypotheses are examined to explain these results. The most probable is the presence of strains of the subgenus *Duttonella* that are not recognised by the markers used. It would be worthwhile to carry out studies on the genetic variability and pathogenicity of local strains isolated in the field.

(b) PATHOLOGY AND IMMUNOLOGY

10758 **Bennison, J.J., Clemence, R.G., Archibald, R.F., Hendy, C.R.C. and Dempfle, L., 1998.** The effects of work and two planes of nutrition on trypanotolerant draught cattle infected with *Trypanosoma congolense*. *Animal Science*, **66** (3): 595-605.

Bennison: NRI, Central Avenue, Chatham Maritime, Chatham, Kent ME4 4TB, UK.

Thirty-two N'Dama bulls aged 3-4 years were used to study the interactions between work, trypanosomosis and nutrition. The bulls were randomly allocated to two treatments, working (W) and non-working (N). Half in each treatment were placed on an andropogon hay basal diet (B), the other half on a better quality groundnut hay diet (H). Five days a week, four pairs of animals in the BW group and four pairs in the HW group pulled weighted sledges four times around a 2056 m track. Loads were set to ensure energy expenditure was equivalent to 1.4 times maintenance. After 4 weeks all 32 bulls were injected intradermally with 10^4 *T. congolense* organisms. The trial continued for a further 8 weeks. Trypanosome infection caused a significant ($P < 0.001$) decline in PCV,

and the anaemia was more severe ($P < 0.05$) in working animals; three pairs in the HW group and two pairs in the BW group were withdrawn because PCV fell below 17%. Diet had no effect on PCV or parasitaemia. Infection caused a decline in food intake ($P < 0.001$) but with significant interactions between diet and work. Intake patterns were similar in the BN and BW groups whilst the HW animals consumed significantly more groundnut hay compared with the HN group ($P < 0.01$). However, nutrition had no significant effect on lap times or on the team's ability to work under trypanosomosis challenge. Post-infection, diet was the dominant factor determining weight change: HN and HW animals weighed significantly more than BN and BW animals ($P < 0.01$) and the interaction between period, diet and work demonstrated that BW had the lowest weights in the latter stages of the trial ($P < 0.05$). The results suggest that supplementation with better quality forages confers no benefit to an animal infected with trypanosomes. Nor can trypanotolerant cattle sustain long periods of work if subjected to a primary challenge of trypanosomes.

10759 **Bennison, J.J., Sherington, J., Wacher, T.J., Dempfle, L. and Leaver, J.D., 1998.** Effects of *Trypanosoma congolense* infection and groundnut (*Arachis hypogaea*) hay supplementation on ranging, activity, and diet selection of N'Dama cows. *Applied Animal Behaviour Science*, **58** (1-2): 1-12.

Bennison: NRI, Central Avenue, Chatham Maritime, Chatham, Kent ME4 4TB, UK.

The objective was to study effects of groundnut hay (GNH) supplementation and trypanosomosis infection on diet selection and grazing behaviour of N'Dama cattle in the late dry season in The Gambia. Twenty multiparous lactating cows were allocated to two groups: infected and control. The 10 cows in the infected group were intradermally injected with *T. congolense* (clone ITC 84). Supplementary feeding with GNH commenced 14 days p.i. and continued for 10 weeks. The start of supplementation coincided with peak parasitaemia, when the infected and control groups were each divided in two sub-groups of five. Animals received either 0 or 2 kg per day of fresh GNH. Each of the 10 infected cows (five supplemented and five non-supplemented) was paired with a comparable control for the duration of the trial and followed at least three times (range 3-5). Every 5 min, throughout the 9-10 h grazing day, a record was made of four activities and, if the animal was feeding, the food item identified. The distance travelled was also measured. The cattle spent 78% of their time feeding on grasses, of which *Hyparrhenia rufa* and *Andropogon gayanus* were the dominant species. Neither infection nor GNH supplementation had any effect on the diet selected. Based on the mean distance travelled, the energetic cost of walking was estimated to be 10% of the metabolisable energy (ME) required for maintenance. Trypanosomosis infection had no significant effect on grazing behaviour. However, cows supplemented with GNH spent a greater proportion of the day resting ($P < 0.01$); this was particularly evident in the final two grazing periods of the day. There was also a significant interaction ($P < 0.05$) between GNH supplementation and infection in the early afternoon when the infected group supplemented with GNH spent a greater proportion of time resting and less time feeding.

10760 **Njiru, Z.K., Olaho-Mukani, W., Ochieng, R.S., Khaemba, B.M., Guya, S.O. and Omukuba, J., 1997.** *In vitro* function of dromedary granulocytes during experimental infection with *Trypanosoma evansi*. *Journal of Camel Practice and Research*, **4** (2): 283-286.

Njiru: KETRI, P.O. Box 362, Kikuyu, Kenya.

The aim of this study was to investigate the role of the polymorphonuclear (PMN) system in the immune suppression observed in camels with *T. evansi* infection. The function of camel PMN cells was investigated by observing their *in vitro* ability to adhere to glass wool, to phagocytose zymosan and trypanosomes, and to reduce cytochrome C. Following infection of five camels with *T. evansi*, there was a significant decrease in the ability of their PMN cells to adhere to glass wool ($P < 0.001$) and reduce cytochrome C ($P < 0.001$) compared to controls, but there was enhanced phagocytosis of zymosan ($P < 0.01$) and increased binding of trypanosomes to PMN cells ($P < 0.05$). All PMN functions were restored to normal following the elimination of trypanosomes with melarsomine treat-ment. It is concluded that *T. evansi* infection in camels inhibits some PMN cell activities, contributing to the observed immune suppression.

10761 **Onah, D.N., Hopkins, J. and Luckins, A.G., 1998.** Proliferative responses of peripheral blood leucocytes of sheep infected with *Trypanosoma evansi*. *Scandinavian Journal of Immunology*, **48** (2): 170-176.

Onah: Department of Veterinary Parasitology and Entomology, University of Nigeria, Nsukka, Enugu State, Nigeria.

The effects of *T. evansi* on the proliferative responses of ovine peripheral blood leucocytes (PBL) were examined in *in vitro* cell culture systems. Sheep were vaccinated against pneumonic pasteurellosis with a monovalent *Pasteurella haemolytica* vaccine and then infected with *T. evansi* TREU 2143. From 1 week p.i., the PBL were separated and stimulated in cultures with either Concanavalin A (Con A), bacterial lipopolysaccharide (LPS), pasteurella antigen (P.ag) or homologous trypanosome antigen (T.ag). The proliferative responses of the cells to Con A and LPS were significantly ($P < 0.001$) suppressed by the infection. This suppression was associated with active infection, as treatment of the sheep with a trypanocide restored the proliferative ability of the cells to both mitogens. Similarly, active infection significantly ($P < 0.001$) suppressed specific responses to P.ag and T.ag but although treatment resulted in full specific proliferative responsiveness to the homologous trypanosome antigen, the same was not true of P.ag, in which the responsiveness of cells from uninfected vaccinated sheep to it was still significantly higher ($P < 0.001$) than that of cells from infected sheep.

10762 **Onah, D.N., Hopkins, J. and Luckins, A.G., 1998.** Induction of $CD4^+CD8^+$ double positive T cells and increase in $CD5^+$ B cells in efferent lymph in sheep infected with *Trypanosoma evansi*. *Parasite Immunology*, **20** (3): 121-134.

Onah: Department of Veterinary Parasitology and Entomology, University of Nigeria, Nsukka, Enugu State, Nigeria.

The effects of *T. evansi* on efferent lymphocyte phenotypes draining from a lymph node primed with *Pasteurella haemolytica* vaccine were studied in sheep. The prefemoral efferent lymphatic ducts of the infected sheep along with those of two uninfected sheep were surgically cannulated. Lymph was collected and lymphocytes recovered from it analysed by two-colour indirect immunofluorescence staining and cytofluorometry in a fluorescence activated cell analyser (FACSCAN). The study showed the appearance and persistence of *T. evansi* in the efferent lymph for a long period of time and the appearance of $CD4^+CD8^+$ (double positive, DP) T lymphocytes in the efferent lymph of infected animals. The infection also resulted in increases in $CD5^+$ B cells in the prefemoral efferent lymph. In addition, there were decreases in the output of conventional B cells, $CD5^+$ and $CD4^+$ T cell subsets but large increases in $CD8^+$ cells followed by terminal depletion of all cell subsets. In contrast, inoculation of sheep with pasteurella vaccine antigen alone produced little alteration in the proportions, but large increases in the numbers of all T cell subsets except that of $CD8^+$ cells which also showed little variation; and there was a concurrent increase in the numbers and proportions of efferent B cells. In addition, the abnormal expression of DP and $CD5^+$ B cells did not occur in the uninfected vaccinated sheep. It is concluded that these abnormal changes in the kinetics of efferent lymphocyte phenotypes are likely to play a role in the genesis of the generalised immunosuppression seen in trypanosome-infected hosts.

(c) TRYPANOTOLERANCE

[See also **22**: no. 10755.]

10763 **d'Ieteren, G.D.M., Authié, E., Wissocq, N. and Murray, M., 1998.** Trypanotolerance, an option for sustainable livestock production in areas at risk from trypanosomosis. (Review.) *Revue scientifique et technique de l'Office International des Epizooties*, **17** (1): 154-175.

d'Ieteren: ILRI, P.O. Box 30709, Nairobi, Kenya.

Options for the control of trypanosomosis are discussed. The decreasing efficacy of available trypanocidal drugs and the difficulties of sustaining tsetse control increase the imperative need to enhance trypanotolerance through selective breeding, either within breeds or through cross-breeding. Trypanotolerance has been defined as the relative capacity of an animal to control the development of the parasites and to limit their pathological effects, the most prominent of which is anaemia. A major constraint on selection for trypanotolerance in cattle, for both within-breed and cross-breeding programmes, has been the absence of practical reliable markers of resistance or susceptibility. Distinct humoral immune response to trypanosome infection is the major feature of bovine trypanotolerance. The role that these responses play in the control of infection or disease is being addressed by ongoing research, but remains a matter of speculation at present. Results in recent years have shown that PCV in particular and parasitaemia, the two principal indicators of trypanotolerance, are strongly correlated to animal performance. However, although direct effects of trypanosome infections on PCV and growth are obvious, more sensitive diagnostic methods for reflecting parasite control

are required so that individual animals can be categorised reliably for their parasite control capability. One key finding is the major contribution made by each of the indicators evaluated to the overall trypanotolerance variance. Preliminary genetic parameters for PCV provide evidence that trypanotolerance is not only a breed characteristic but is also a heritable trait within the N'Dama population; this brings new opportunities for improved productivity through selection for trypanotolerance. More reliable estimation of genetic parameters of the indicators may well show that these parameters must be handled simultaneously for optimal progress. This would require diagnostics for assessing parasite control capability that identify trypanosome species more accurately, especially in mixed infections. A major advantage of trypanotolerant livestock, particularly N'Dama cattle, is the resistance or adaptation of this breed to many of the important pathogens which prevail in the sub-humid and humid tropics. Research on practical indicators of resistance to these conditions will be required to establish relevant integrated strategies based on disease-resistant livestock. Selective breeding will require the integration of the traits that farmers hold important for their production systems.

10764 **Mattioli, R.C., Dampha, K., Bah, M., Verhulst, A. and Pandey, V.S., 1998.** Effect of controlling natural field-tick infestation on the growth of N'Dama and Gobra zebu cattle in the Gambia. *Preventive Veterinary Medicine*, **34** (2-3): 137-146.

Mattioli: ITC, P.M.B. 14, Banjul, Gambia.

The effect of tick infestations on liveweight gain (LWG) was assessed by comparison of weight changes in flumethrin-treated N'Dama and Gobra zebu cattle and in untreated control groups submitted to natural tick challenge over 1 year in The Gambia. Preventive treatments against anaplasmosis, babesiosis and trypanosomiasis were given. In both treated and control animals, significantly fewer *Hyalomma* spp. and *Amblyomma variegatum* were found on N'Dama than on Gobra zebu cattle; both breeds were equally susceptible to *Rhipicephalus senegalensis* infestation. No significant differences in LWG between acaricide-treated and control cattle were seen in either breed, even during or after the annual peak of tick infestation. Equally high mortality (35%), due to unidentified causes, was recorded in acaricide-treated and control Gobra cattle; mortality in N'Dama cattle was 7.5%. In both breeds, 90% of mortality occurred at the end of the dry season. The breed differences in tick burden seen in this study confirm previous studies.

10765 **Missohou, A., Nguyen, T.C., Dorchies, P., Gueye, A. and Sow, R.S., 1998.** Note on transferrin, hemoglobin types, and packed cell volume in Senegalese trypanotolerant Djallonké sheep. *Annals of the New York Academy of Sciences*, **849** (*Tropical veterinary medicine*): 209-212.

Missohou: Service de Zootechnie-Alimentation, Ecole Inter-Etats des Sciences et Médecine Vétérinaires (EISVM), B.P. 5077, Dakar, Senegal.

In this study we examined transferrin (Tf) and haemoglobin (Hb) types and frequencies and their relationship with PCV, which is considered as a selection criterion for the trypanotolerance trait. Blood samples were collected from 96 Djallonké sheep and

were typed for Tf and Hb. The frequencies of the alleles TfA, TfB, TfC and TfD were respectively 0.276, 0.005, 0.109 and 0.609. At the locus Hb, all animals were monomorphic B. The lowest PCV value was observed in animals homozygous for TfC, while the highest value was found in heterozygous (CD) animals; however, the difference was not significant.

10766 **Mwangi, E.K., Stevenson, P., Ndung'u, J.M., Stear, M.J., Reid, S.W.J., Gettinby, G. and Murray, M., 1998.** Studies on host resistance to tick infestations among trypanotolerant *Bos indicus* cattle breeds in East Africa. *Annals of the New York Academy of Sciences*, **849** (*Tropical veterinary medicine*): 195-208.

Mwangi: KETRI, P.O. Box 362, Kikuyu, Kenya.

Recent epidemiological studies carried out in East Africa have indicated that some *Bos indicus* cattle breeds such as the Orma Boran and Maasai Zebu have a degree of trypanotolerance worth exploitation by their introduction into trypanosomosis endemic areas where other cattle breeds cannot survive. However, in most areas of East Africa, trypanosomosis, ticks and tick-borne diseases occur together. It is therefore important to obtain information on the susceptibility of these breeds to tick infestation and tick-borne diseases. This study was therefore designed to determine the susceptibility of these cattle breeds to tick infestations. They were compared with the Galana Boran (trypano-susceptible) and the Friesian (susceptible to tick infestations, tick-borne diseases and trypanosomosis). The four breeds of cattle were exposed to natural tick challenge for a period of 7 months and whole body weekly tick counts were done on each animal. Significant differences to tick infestations among the four breeds were observed. For both *Rhipicephalus appendiculatus* and *Boophilus decoloratus*, susceptibility to infestation increased in the order Maasai Zebu, Orma Boran, Galana Boran and Friesian. These results suggest that utilisation of the trypanotolerant Orma Boran and Maasai Zebu cattle breeds could be feasible even in the face of tick challenge and should therefore be considered when planning integrated trypanosomosis and tick control strategies.

(d) TREATMENT

10767 **Anene, B.M., Anika, S.M. and Chukwu, C.C., 1997.** Effects of difluoromethyl-ornithine after intravenous administration and its combination with diminazene aceturate against *Trypanosoma brucei* in experimentally infected dogs in Nigeria. *Revue d'Elevage et de Médecine vétérinaire des Pays tropicaux*, **50** (3): 221-225.

Anene: Department of Veterinary Medicine, University of Nigeria, Nsukka, Nigeria.

Fourteen young local dogs were infected experimentally with *T. brucei* (local strains) and treated with diminazene aceturate and/or difluoromethylornithine (DFMO, eflornithine). DFMO administered i.v. at a dosage of 400 mg/kg/day in three divided doses daily for either 7 days (primary infection) or 21 days (relapse) was not curative. Treatment of both primary and relapse infections was characterised by slow induction of action (parasite clearance achieved in 4-5 days) and short aparasitaemic periods (6 days). A single i.m. injection of diminazene aceturate at 7 mg/kg was not curative either. Simultaneous administration of DFMO and diminazene aceturate (immediately following initial DFMO treatment) was more effective than monotherapy in primary infections as no relapses followed, but less successful in relapse infections. Oral dosing of DFMO, following 5 days i.v. treatment, caused anorexia, vomiting, profuse diarrhoea and severe dehydration within 4 days of administration and had to be discontinued.

10768 **Geerts, S. and Holmes, P.H., 1998.** Drug management and parasite resistance in bovine trypanosomiasis in Africa. *PAAT Technical and Scientific Series*, no. 1: 31 pp. (Rome, Italy; FAO. ISBN 92 5 104185 7.)

Geerts: Institute of Tropical Medicine, Nationalestraat 155, B-2000 Antwerp, Belgium.

Trypanocidal drugs remain the principal method of animal trypanosomiasis control in most African countries. However, there is growing concern that their future effectiveness may be severely curtailed by widespread drug resistance. This document presents an over-view of the current situation of resistance to drugs for the chemotherapy of trypanosomiasis in African livestock. Although the number of case reports on drug resistance is increasing, there is a lack of reliable data at the regional or national level on the true prevalence and impact of drug resistance. In order to compare data on a temporal and spatial basis across Africa there is an urgent need for better standardisation of tests for the detection of drug resistance. The advantages and disadvantages of the currently available assays are briefly reviewed and measures suggested to improve the situation. Finally, some guidelines on delaying the development of drug resistance are proposed and measures which may be adopted to control drug resistance when it occurs are recommended. Although there is still a lack of knowledge about the mechanisms of resistance and the factors responsible for the development of drug resistance, urgent measures are needed to maintain the efficacy of the existing drugs. Based on experiences of the control of resistance to other drugs such as antimalarials, antibiotics and anthelmintics it is suggested that reliance on the 'sanative pair' guideline might not be sufficient to control resistance to trypanocides. This guideline needs to be accompanied by the following additional measures: (i) Reduction in the number of treatments. The most efficient way to delay the development of drug resistance is to reduce the selection pressure caused by these drugs. Exclusive reliance on drugs for the control of trypanosomiasis, especially in areas of high challenge, and mass treatments at short intervals should be avoided. More attention should be given to integrated control measures involving the vector as well as the parasite. (ii) Avoidance of underdosing. Underdosing commonly occurs in the field and is an important cause of resistance development. Measures should be adopted to minimise underdosing. Better formulations of the existing prophylactic drugs may help to avoid subtherapeutic concentrations, which

exert a strong selection pressure for resistant clones. (iii) Quinapyramine should no longer be used in cattle. Cross-resistance with the other available trypanocides has now been clearly demonstrated at the level of individual trypanosomes. The use of this drug in cattle is therefore contra-indicated.

10769 **Wesongah, J.O., Olaho-Mukani, W., Mukunza, F. and Mutugi, M., 1997.** Drug sensitivity of some stocks of *Trypanosoma evansi* isolated from camels in Eastern Africa. *Journal of Camel Practice and Research*, **4** (2): 277-280.

Wesongah: KETRI, P.O. Box 362, Kikuyu, Kenya.

The sensitivity of five stocks of *T. evansi* from camels in Kenya and Sudan to three drugs was determined by *in vivo* and *in vitro* assays. The drugs tested were suramin (Naganol), melarsomine (Cymelarsan) and quinapyramine sulphate (Trypacide). The activity of each drug was expressed as: (i) *In vitro*: minimal effective concentration which killed 100% of trypanosome population within 5 days of drug exposure (MEC_{100}); the maximum tolerated concentration in which trypanosomes survived 5 days of drug exposure (MTC_{100}); (ii) *In vivo*: the curative dosage in 100% of infected mice (CD_{100}); the highest ineffective dosage at which 100% of infected mice remained infected (ID_{100}). Comparable *in vitro* MEC_{100} values for the three trypanocides tested were 0.005-0.05 μg/ml for melarsomine, 0.005-0.5 μg/ml for quinapyramine sulphate and 5 mg/kg for suramin. The *in vivo* ID_{100} values for the three drugs were 0.2 mg/kg for melarsomine, 3.7 mg/kg for quinapyramine sulphate and 5 mg/kg for suramin. One *T. evansi* stock, KETRI 3136, was resistant to suramin at 160 mg/kg *in vivo* and 50 μg/ml *in vitro*. A positive correlation between *in vitro* and *in vivo* drug assays was observed. There was no significant difference between *in vivo* and *in vitro* sensitivities observed in this study.

7. EXPERIMENTAL TRYPANOSOMIASIS

(a) DIAGNOSTICS

10770 **Kashiwazaki, Y. and Thammasart, S., 1998.** Effect of anti-immunoglobulin antibodies produced in cattle infected with *Trypanosoma evansi* on antigen detection ELISA. *International Journal for Parasitology*, **28** (9): 1353-1360.

Kashiwazaki: National Institute of Animal Health, Bangkok 10900, Thailand.

10771 **Sarmah, P.C., 1998.** Observation on survival of *Trypanosoma evansi* after death of the host. [Rats.] *Journal of Veterinary Parasitology*, **12** (1): 62-63.

Department of Parasitology, College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati 781 022, India.

10772 **Watanapokasin, Y., Tananyutthawongese, C., Uthaisang, W., Chansiri, K., Boonmatit, C. and Sarataphan, N., 1998.** Intra-species differentiation of

Trypanosoma evansi by DNA fingerprinting with arbitrary primered polymerase chain reaction. *Veterinary Parasitology*, **78** (4): 259-264.

Watanapokasin: Department of Biochemistry, Faculty of Medicine, Srinakharinwirot University, Sukhumvit 23, Bangkok 10110, Thailand.

(b) PATHOLOGY AND IMMUNOLOGY

[See also **22**: no. 10817.]

10773 **Gobert, A.P., Semballa, S., Daulouède, S., Lesthelle, S., Taxile, M., Veyret, B. and Vincendeau, P., 1998.** Murine macrophages use oxygen- and nitric oxide-dependent mechanisms to synthesize *S*-nitroso-albumin and to kill extracellular trypanosomes. [*T. b. brucei*.] *Infection and Immunity*, **66** (9): 4068-4072.

Vincendeau: Laboratoire de Parasitologie, Université de Bordeaux II, 146 rue Léo Saignat, F-33076 Bordeaux, France.

10774 **Mabbott, N.A., Coulson, P.S., Smythies, L.E., Wilson, R.A. and Sternberg, J.M., 1998.** African trypanosome infections in mice that lack the interferon-γ receptor gene: nitric oxide-dependent and -independent suppression of T-cell proliferative responses and the development of anaemia. [*T. b. rhodesiense.*] *Immunology*, **94** (4): 476-480.

Sternberg: Department of Zoology, University of Aberdeen, Tillydrone Avenue, Aberdeen AB24 2TZ, UK.

10775 **Magez, S., Beschin, A., Radwanska, M., Stylemans, B., Favero, H. del, Dijck, E. van and Baetselier, P. de, 1998.** Tumor necrosis factor α plays a key role in the regulation of the experimental infection with *Trypanosoma brucei*. [*In vitro*; mice.] (Meeting abstract no. 5.32.) *Journal of Interferon and Cytokine Research*, **18** (5): A102.

Magez: Unit of Cellular Immunology/Parasitology, Free University of Brussels, Paardenstraat 65, 1640 Sint Genesius Rode, Belgium.

10776 **Sarmah, P.C. and Bhattacharyulu, Y., 1998.** Immunogenicity of irradiated *Trypanosoma evansi*. [Mice.] *Journal of Veterinary Parasitology*, **12** (1): 40-42.

Sarmah: Department of Parasitology, College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati 781 022, India.

10777 **Sternberg, J.M., Maina, N.N., Gichuki, C.W. and Ndung'u, J.M., 1998.** Nitric oxide production in vervet monkeys (*Cercopithecus aethiops*) infected with *Trypanosoma brucei*. *Parasite Immunology*, **20** (8): 395-397.

Sternberg: Department of Zoology, University of Aberdeen, Tillydrone Avenue, Aberdeen AB29 2TZ, UK.

10778 **Tomlinson, S. and Raper, J., 1998**. Natural human immunity to trypanosomes. *Parasitology Today*, **14** (9): 354-359.

Tomlinson: New York University Medical Centre, Department of Pathology, New York, NY 10016, USA.

Complement-dependent destruction of invading micro-organisms is a crucial first-line defence against infection, yet both African and American trypanosomes are able to resist attack by complement. African trypanosomes resist non-specific complement attack by virtue of a thick glycoprotein surface coat, and the host range of certain African trypanosomes is believed to be defined by their susceptibility to a subclass of human high density lipoprotein (HDL) and/or a high molecular weight protein complex present in human serum. In this review, the properties and mechanisms of action of these trypanolytic factors on *Trypanosoma brucei brucei*, and the possible mechanisms whereby the human pathogenic species *T. b. gambiense* and *T. b. rhodesiense* resist lysis by human serum, are discussed. The mechanisms of resistance of *T. cruzi* are also considered.

10779 **Uzonna, J.E., Kaushik, R.S., Gordon, J.R. and Tabel, H., 1998.** Immuno-regulation in experimental murine *Trypanosoma congolense* infection: anti-IL-10 antibodies reverse trypanosome-mediated suppression of lymphocyte proliferation *in vitro* and moderately prolong the lifespan of genetically susceptible BALB/c mice. *Parasite Immunology*, **20** (6): 293-302.

Uzonna: Department of Veterinary Microbiology, University of Saskatchewan, Saskatoon, SK S7N 5B4, Canada.

10780 **Xie, C., Sun, E.-G., Liu, J.-H. and Wang, X.-S., 1997.** [Analysis of specific components of excreted/secreted antigens from *Trypanosoma evansi*.] (In Chinese.) *Chinese Journal of Veterinary Science and Technology*, **27** (9): 25-26.

Military Veterinary Institute, University of Agriculture and Animal Husbandry, Changchun, Jilin 130062, China.

10781 **Xie, C., Sun, E.-G., Liu, J.-H., Wang, X.-S. and Yang, F.-Q., 1997.** [A preliminary study on the immunogenicity of excretion-secretion antigens of *Trypanosoma evansi*.] [Mice.] (In Chinese with English summary.) *Journal of Nanjing Agricultural University*, **20** (2): 87-89.

Military Veterinary Institute, University of Agriculture and Animal Sciences, Changchun 130062, China.

(c) CHEMOTHERAPEUTICS

[See also **22**: nos. 10769, 10813, 10822.]

10782 **Enanga, B., Keita, M., Chauvière, G., Dumas, M. and Bouteille, B., 1998.** Megazol combined with suramin: a chemotherapy regimen which reversed the CNS pathology in a model of human African trypanosomiasis in mice. [*T. b. brucei*.] *Tropical Medicine and International Health*, **3** (9): 736-741.

Bouteille: Institut d'Epidémiologie Neurologique et Neurologie Tropicale, Faculté de Médecine, 2 rue du Dr Marcland, F-87025 Limoges Cedex, France.

10783 **Loiseau, P.M., Czok, M., Chauffert, O., Bourass, J. and Letourneux, Y., 1998.** Studies on lipidomimetic derivatives of α-difluoromethylornithine (DFMO) to enhance the bioavailability in a *Trypanosoma b. brucei* murine trypanosomiasis model. *Parasite*, **5** (3): 239-246.

Loiseau: Biologie et Contrôle des Organismes Parasites, Faculté de Pharmacie, Université de Paris XI, F-92296 Châtenay Malabry Cedex, France.

10784 **Morty, R.E., Troeberg, L., Pike, R.N., Jones, R., Nickel, P., Lonsdale-Eccles, J.D. and Coetzer, T.H.T., 1998.** A trypanosome oligopeptidase as a target for the trypanocidal agents pentamidine, diminazene and suramin. [*T. b. brucei*.] *FEBS Letters*, **433** (3): 251-256.

Coetzer: Department of Biochemistry, University of Natal, Private Bag X01, 3209 Scottsville, South Africa.

10785 **Nose, M., Koide, T., Ogihara, Y., Yabu, Y. and Ohta, N., 1998.** Trypanocidal effects of curcumin *in vitro*. *Biological and Pharmaceutical Bulletin*, **21** (6): 643-645.

Ogihara: Department of Pharmacognosy and Plant Chemistry, Faculty of Pharmaceutical Sciences, Nagoya City University, 3-1 Tanabe-dori, Mizuho-ku, Nagoya 467, Japan.

The natural compound, curcumin, showed cytotoxicity against African trypanosomes *in vitro*. The LD_{50} values of curcumin were 4.77 ± 0.91 μM for bloodstream forms and 46.52 ± 4.94 μM for procyclic forms of *Trypanosoma brucei brucei* (GUTat 3.1 clone).

10786 **Seley, K.L., Schneller, S.W., Clercq, E. de, Rattendi, D., Lane, S., Bacchi, C.J. and Korba, B., 1998.** The importance of the 4′-hydroxyl hydrogen for the anti-trypanosomal and antiviral properties of (+)-5′-noraristeromycin and two 7-

deaza analogues. [*T. b. brucei*.] *Bioorganic and Medicinal Chemistry*, **6** (6): 797-801.

Schneller: Department of Chemistry, Auburn University, Auburn, AL 36849-5312, USA.

8. TRYPANOSOME RESEARCH

(a) CULTIVATION OF TRYPANOSOMES

[See **22**: no. 10811.]

(b) TAXONOMY, CHARACTERISATION OF ISOLATES

10787 **Maslov, D.A. and Lukeš, J., 1998.** Searching for a tree that can be trusted. (Letter.) *Parasitology Today*, **14** (8): 334.

Maslov: Department of Biology, University of California, Riverside, CA 92521, USA.

10788 **Melville, S.E., 1998.** The African trypanosome genome project: focus on the future. (Meeting report.) *Parasitology Today*, **14** (4): 129-131.

Department of Pathology, University of Cambridge, Tennis Court Road, Cambridge CB2 1QP, UK.

10789 **Melville, S.E., Majiwa, P. and Donelson, J., 1998.** Resources available from the African trypanosome genome project. *Parasitology Today*, **14** (1): 3-4.

Melville: Department of Pathology, University of Cambridge, Tennis Court Road, Cambridge CB2 1QP, UK.

Results of research conducted during the first two years of the African trypanosome genome project, funded in part by TDR, are summarised (cDNA analysis, karyotyping, large-insert genomic libraries) and access to this information on databases and websites is discussed.

10790 **Noyes, H., 1998.** Can *Trypanosoma* trees be trusted? *Parasitology Today*, **14** (2): 49-50.

Liverpool School of Tropical Medicine, Pembroke Place, Liverpool L3 5QA, UK.

The author discusses the issues raised by the publication of three nuclear small subunit ribosomal RNA (SSU rRNA) gene trees which, although resolving a number of questions, have unexpectedly indicated that the salivarian and stercorarian *Trypanosoma*

species occurring in mammals are on quite distinct lineages. (For further comments, see **22**: nos. 10787, 10791, 10792.)

10791 **Noyes, H.A. and Rambaut, A., 1998.** A key to understanding *Trypanosoma* trees – Reply. (Letter.) *Parasitology Today*, **14** (8): 335.

Noyes: Liverpool School of Tropical Medicine, Pembroke Place, Liverpool L3 5QA, UK.

10792 **Stevens, J. and Gibson, W., 1998.** A key to understanding *Trypanosoma* trees. (Letter.) *Parasitology Today*, **14** (8): 334-335.

Stevens: School of Biological Sciences, University of Bristol, Woodland Road, Bristol BS8 1UG, UK.

10793 **Stevens, J., Noyes, H. and Gibson, W., 1998.** The evolution of trypanosomes infecting humans and primates. *Memorias do Instituto Oswaldo Cruz*, **93** (5): 669-676.

Stevens: School of Biological Sciences, University of Bristol, Woodland Road, Bristol BS8 1UG, UK.

Based on phylogenetic analysis of 18S rRNA sequences and clade taxon composition, this paper adopts a biogeographical approach to understanding the evolutionary relationships of the human and primate infective trypanosomes, *Trypanosoma cruzi*, *T. brucei*, *T. rangeli* and *T. cyclops*. Results indicate that these parasites have divergent origins and fundamentally different patterns of evolution. *T. cruzi* is placed in a clade with *T. rangeli* and trypanosomes specific to bats and a kangaroo. The predominantly South American and Australian origins of parasites within this clade suggest an ancient southern super-continent origin for ancestral *T. cruzi*, possibly in marsupials. *T. brucei* clusters exclusively with mammalian, salivarian trypanosomes of African origin, suggesting an evolutionary history confined to Africa, while *T. cyclops*, from an Asian primate, appears to have evolved separately and is placed in a clade with *T. (Megatrypanum)* species. Relating clade taxon composition to palaeogeographic evidence, the divergence of *T. brucei* and *T. cruzi* can be dated to the mid-Cretaceous, around 100 million years before present, following the separation of Africa, South America and Euramerica. Such an estimate of divergence time is considerably more recent than those of most previous studies based on molecular clock methods. Perhaps significantly, salivarian trypanosomes appear, from these data, to be evolving several times faster than *Schizotrypanum* species, a factor which may have contributed to previous anomalous estimates of divergence times.

10794 **Tibayrenc, M., 1998.** Beyond strain typing and molecular epidemiology: integrated genetic epidemiology of infectious diseases. [Incl. *T. brucei* sspp.] *Parasitology Today*, **14** (8): 323-329.

Centre d'Etudes sur le Polymorphisme des Microorganismes (CEPM), UMR CNRS/ORSTOM 9926, ORSTOM, B.P. 5045, 34032 Montpellier Cedex 1, France.

In the past 20 years, genetic and molecular methods for characterising pathogen strains have taken a major place in modern approaches to epidemiology of parasitic and other infectious diseases. The main concepts used in this field of research are explained, with special emphasis on the approaches developed by the author's team, and future avenues of exploration are suggested.

(c) LIFE CYCLE, MORPHOLOGY, BIOCHEMICAL AND MOLECULAR STUDIES

[See also **22**: no. 10780.]

10795 **Acosta-Serrano, A., Mehlert, A., Ferguson, M.A.J. and Englund, P.T., 1998.** The structural basis of ConA-resistance in *Trypanosoma brucei* glycosylation mutants. (Meeting abstract no. 9.) *Glycobiology*, **8** (11): [1106-1107].

Acosta-Serrano: Department of Biological Chemistry, Johns Hopkins University School of Medicine, 725 North Wolfe Street, Baltimore, MD 21205, USA.

10796 **Bangs, J.D., 1998.** Surface coats and secretory trafficking in African trypanosomes. [*T. brucei.*] (Review.) *Current Opinion in Microbiology*, **1** (4): 448-454.

Bangs: Department of Medical Microbiology and Immunology, University of Wisconsin, 1300 University Avenue, Madison, WI 53706, USA.

10797 **Blattner, J., Helfert, S., Michels, P. and Clayton, C., 1998.** Compartmentation of phosphoglycerate kinase in *Trypanosoma brucei* plays a critical role in parasite energy metabolism. *Proceedings of the National Academy of Sciences of the United States of America*, **95** (20): 11596-11600.

Clayton: Zentrum für Molekulare Biologie, Im Neuenheimer Feld 282, D-69120 Heidelberg, Germany.

10798 **Blundell, P.A. and Borst, P., 1998.** Analysis of a variant surface glycoprotein gene expression site promoter of *Trypanosoma brucei* by remodelling the promoter region. *Molecular and Biochemical Parasitology*, **94** (1): 67-85.

Borst: Division of Molecular Biology, Netherlands Cancer Institute, Plesmanlaan 121, 1066 CX Amsterdam, Netherlands.

10799 **Brekken, D.L. and Phillips, M.A., 1998.** *Trypanosoma brucei* γ-glutamylcysteine synthetase: characterization of the kinetic mechanism and the

role of Cys-319 in cystamine inactivation. *Journal of Biological Chemistry*, **273** (41): 26317-26322.

Phillips: Department of Pharmacology, Southwestern Medical Centre, University of Texas, 5323 Harry Hines Boulevard, Dallas, TX 75235, USA.

10800 **Bringaud, F., Vedrenne, C., Cuvillier, A., Parzy, D., Baltz, D., Tetaud, E., Pays, E., Venegas, J., Merlin, G. and Baltz, T., 1998.** Conserved organization of genes in trypanosomatids. [Incl. *T. brucei*, *T. congolense*, *T. vivax*.] *Molecular and Biochemical Parasitology*, **94** (2): 249-264.

Bringaud: Laboratoire de Parasitologie Moléculaire, Université de Bordeaux II, UPRESA-5016, CNRS, 146 rue Léo Saignat, F-33076 Bordeaux, France.

10801 **Chaves, I., Zomerdijk, J., Dirks-Mulder, A., Dirks, R.W., Raap, A.K. and Borst, P., 1998.** Subnuclear localization of the active variant surface glycoprotein gene expression site in *Trypanosoma brucei*. *Proceedings of the National Academy of Sciences of the United States of America*, **95** (21): 12328-12333.

Borst: Department of Molecular Biology, Netherlands Cancer Institute, Plesmanlaan 121, 1066 CX Amsterdam, Netherlands.

10802 **Cruz-Reyes, J., Rusché, L.N. and Sollner-Webb, B., 1998.** *Trypanosoma brucei* U insertion and U deletion activities co-purify with an enzymatic editing complex but are differentially optimized. *Nucleic Acids Research*, **26** (16): 3634-3639.

Sollner-Webb: Department of Biological Chemistry, Johns Hopkins University School of Medicine, 725 North Wolfe Street, Baltimore, MD 21205, USA.

10803 **Das, A., Park, J.-H., Hagen, C.B. and Parsons, M., 1998.** Distinct domains of a nucleolar protein mediate protein kinase binding, interaction with nucleic acids and nucleolar localization. *Journal of Cell Science*, **111** (17): 2615-2623.

Parsons: Seattle Biomedical Research Institute, 4 Nickerson Street, Seattle, WA 98109, USA.

10804 **Dávila, A.M.R., Ramirez, L. and Silva, R.A.M.S., 1998.** Biometrical alterations of *Trypanosoma evansi* isolate in laboratory rodents. [Mice, rats.] *Veterinary Parasitology*, **76** (1-2): 149-152.

Dávila: Laboratory of Animal Health, CPAP, EMBRAPA, Rua 21 de Setembro 1880, CEP-79320-900 Corumbá, MS, Brazil.

10805 **Gull, K., Alsford, S. and Ersfeld, K., 1998.** Segregation of minichromosomes in trypanosomes: implications for mitotic mechanisms. [*T. brucei*.] (Review.) *Trends in Microbiology*, **6** (8): 319-323.

Gull: School of Biological Sciences, University of Manchester, Oxford Road, Manchester M13 9PT, UK.

10806 **Lalmanach, G., Lecaille, F., Chagas, J.R., Authié, E., Scharfstein, J., Juliano, M.A. and Gauthier, F., 1998.** Inhibition of trypanosomal cysteine proteinases by their propeptides. [*T. congolense*.] *Journal of Biological Chemistry*, **273** (39): 25112-25116.

Lalmanach: Laboratory of Enzymology and Protein Chemistry, Faculty of Medicine, Université François Rabelais, 2bis Boulevard Tonnellé, F-37032 Tours Cedex, France.

10807 **Leeuwen, F. van, Dirks-Mulder, A., Dirks, R.W., Borst, P. and Gibson, W., 1998.** The modified DNA base β-D-glucosyl-hydroxymethyluracil is not found in the tsetse fly stages of *Trypanosoma brucei*. *Molecular and Biochemical Parasitology*, **94** (1): 127-130.

Borst: Division of Molecular Biology, Netherlands Cancer Institute, Plesmanlaan 121, 1066 CX Amsterdam, Netherlands.

10808 **Marchetti, M.A., Tschudi, C., Silva, E. and Ullu, E., 1998.** Physical and transcriptional analysis of the *Trypanosoma brucei* genome reveals a typical eukaryotic arrangement with close interspersion of RNA polymerase II- and III-transcribed genes. *Nucleic Acids Research*, **26** (15): 3591-3598.

Ullu: Department of Internal Medicine, Yale University School of Medicine, 333 Cedar Street, New Haven, CT 06520-2088, USA.

10809 **McAndrew, M., Graham, S., Hartmann, C. and Clayton, C., 1998.** Testing promoter activity in the trypanosome genome: isolation of a metacyclic-type VSG promoter, and unexpected insights into RNA polymerase II transcription. *Experimental Parasitology*, **90** (1): 65-76.

Clayton: Zentrum für Molekulare Biologie, Im Neuenheimer Feld 282, D-69120 Heidelberg, Germany.

10810 **Melville, S.E., Leech, V., Gerrard, C.S., Tait, A. and Blackwell, J.M., 1998.** The molecular karyotype of the megabase chromosomes of *Trypanosoma brucei* and the assignment of chromosome markers. *Molecular and Biochemical Parasitology*, **94** (2): 155-173.

Melville: Department of Pathology, University of Cambridge, Tennis Court Road, Cambridge CB2 1QP, UK.

10811 **Milne, K.G., Prescott, A.R. and Ferguson, M.A.J., 1998.** Transformation of monomorphic *Trypanosoma brucei* bloodstream form trypomastigotes into procyclic forms at 37°C by removing glucose from the culture medium. *Molecular and Biochemical Parasitology*, **94** (1): 99-112.

Milne: Department of Biochemistry, Division of Molecular Parasitology and Biological Chemistry, Wellcome Trust Building, University of Dundee, Dundee DD1 4HN, UK.

10812 **Navarro, M. and Cross, G.A.M., 1998.** *In situ* analysis of a variant surface glycoprotein expression-site promoter region in *Trypanosoma brucei*. *Molecular and Biochemical Parasitology*, **94** (1): 53-66.

Cross: Laboratory of Molecular Parasitology, Rockefeller University, 1230 York Avenue, New York, NY 10021-6399, USA.

10813 **Nose, M., Koide, T., Morikawa, K., Inoue, M., Ogihara, Y., Yabu, Y. and Ohta, N., 1998.** Formation of reactive oxygen intermediates might be involved in the trypanocidal activity of gallic acid. [*T. b. brucei.*] *Biological and Pharmaceutical Bulletin*, **21** (6): 583-587.

Ogihara: Department of Pharmacognosy and Plant Chemistry, Faculty of Pharmaceutical Sciences, Nagoya City University, 3-1 Tanabe-dori, Mizuho-ku, Nagoya 467, Japan.

10814 **Redpath, M.B., Carnall, N., Webb, H., Courel, M., Amorim, A., Güther, M.L.S., Cardoso de Almeida, M.L. and Carrington, M., 1998.** Conservation of genetic linkage between heat shock protein 100 and glycosylphosphatidyl-inositol-specific phospholipase C in *Trypanosoma brucei* and *Trypanosoma cruzi*. *Molecular and Biochemical Parasitology*, **94** (1): 113-121.

Carrington: Department of Biochemistry, University of Cambridge, 80 Tennis Court Road, Cambridge CB2 1GA, UK.

10815 **Tielens, A.G.M. and Hellemond, J.J. van, 1998.** Differences in energy metabolism between Trypanosomatidae. [Incl. *T. brucei*.] (Review.) *Parasitology Today*, **14** (7): 265-271.

Tielens: Laboratory of Veterinary Biochemistry, University of Utrecht, P.O. Box 80176, 3508 TD Utrecht, Netherlands.

10816 **Vanhamme, L., Perez-Morga, D., Marchal, C., Speijer, D., Lambert, L., Geuskens, M., Alexandre, S., Ismaïli, N., Göringer, U., Benne, R. and Pays, E., 1998.** *Trypanosoma brucei* TBRGG1, a mitochondrial oligo(U)-binding protein that co-localizes with an *in vitro* RNA editing activity. *Journal of Biological Chemistry*, **273** (34): 21825-21833.

Pays: Department of Molecular Biology, Free University of Brussels, 67 rue des Chevaux, B-1640 Rhode St Genèse, Belgium.

10817 **Verhulst, C., Büscher, P. and Moens, L., 1997.** Identification of immunological determinants on the variable surface glycoprotein LITat 1.3 from *Trypanosoma brucei gambiense*. (Meeting abstract.) *Cell Biology International*, **21** (8): 534-535.

Verhulst: Department of Parasitology, Institute of Tropical Medicine, Nationalestraat 155, B-2000 Antwerp, Belgium.

10818 **Verlinde, C., Bernstein, B., Kim, H.-D., Chudzik, D., Baca, A., Wooden, J., Li, R.-B., Choe, J.-W., Bressi, J., Gelb, M., Blackburn, M., Fan, E. and Hol, W.G.J., 1998.** Structure-based design of inhibitors of key proteins in *Trypanosoma brucei* and *Plasmodium falciparum*. (Meeting abstract no. W 10.5.). *Naunyn-Schmiedebergs Archives of Pharmacology*, **358** (1, Suppl. 1): R27.

Verlinde: Department of Biological Structure, University of Washington, Seattle, WA 98195, USA.

10819 **Vieira, L.L., 1998.** pH and volume homeostasis in trypanosomatids: current views and perspectives. [Incl. *T. brucei*.] (Review). *Biochimica et Biophysica Acta*, **1376** (2): 221-241.

Department of Cell Biology, Institute of Experimental Biology, Faculty of Science, Universidad Central de Venezuela, Caracas 47069, Venezuela.

10820 **Wille, U., Schade, B. and Duszenko, M., 1998.** Characterization of glycerol uptake in bloodstream and procyclic forms of *Trypanosoma brucei*. *European Journal of Biochemistry*, **256** (1): 245-250.

Duszenko: Physiologisch-chemisches Institut, Universität Tübingen, Hoppe-Seyler-Strasse 4, D-72076 Tübingen, Germany.

10821 **Yokoyama, K., Trobridge, P., Buckner, F.S., Scholten, J., Stuart, K.D., Voorhis, W.C. van and Gelb, M.H., 1998.** The effects of protein farnesyl-transferase inhibitors on trypanosomatids: inhibition of protein farnesylation and cell growth. [Incl. *T. brucei*.] *Molecular and Biochemical Parasitology*, **94** (1): 87-97.

Gelb: Departments of Chemistry and Biochemistry, Box 351700, University of Washington, Seattle, WA 98195-1700, USA.

10822 **Yokoyama, K., Trobridge, P., Buckner, F.S., Voorhis, W.C. van, Stuart, K.D. and Gelb, M.H., 1998.** Protein farnesyltransferase from *Trypanosoma brucei*:

a heterodimer of 61- and 65-kDa subunits as a new target for antiparasite therapeutics. *Journal of Biological Chemistry*, **273** (41): 26497-26505.

Gelb: Departments of Chemistry and Biochemistry, Box 351700, University of Washington, Seattle, WA 98195-1700, USA.

10823 **Zomer, A.W.M., Allert, S., Chevalier, N., Callens, M., Opperdoes, F.R. and Michels, P.A.M., 1998.** Purification and characterisation of the phospho-glycerate kinase isoenzymes of *Trypanosoma brucei* expressed in *Escherichia coli*. *Biochimica et Biophysica Acta*, **1386** (1): 179-188.

Michels: Research Unit for Tropical Diseases, Institute of Cellular Pathology, Avenue Hippocrate 74, B-1200 Brussels, Belgium.