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TSETSE AND TRYPANOSOMIASIS INFORMATION QUARTERLY

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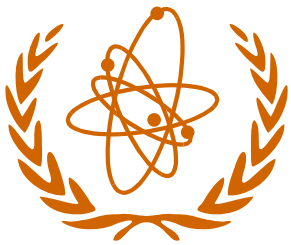

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section b — abstracts
1. general (including land use)
8175 **Chyzyaka, H.G.B., 1991**. The history of trypanosomiasis in Zambia. *Historia Medicinae Veterinariae*, **16** (3-4): 81-98.
Veterinary and Tsetse Control Services, P.O. Box 50060, Lusaka, Zambia.
The history of trypanosomiases in Zambia is reviewed. First described by Livingstone in 1857, trypanosomiasis in domestic animals was studied by Kinghorn and Montgomery from 1907 to 1909. They discovered the main groups of trypanosomes and investigated the incidence of the disease and the infectivity of different species of trypanosomes to different host species. An extensive survey of trypanosome infections in wild animals was carried out by Kinghorn and Yorke in 1911-12. Outbreaks of animal trypanosomiasis in Zambia up to 1978 are briefly described. *Trypanosoma congolense* is ubiquitous in cattle, in contrast to *T.vivax* which causes fewer and less virulent infections. Tsetse infest 32% of the country and 60% of its cattle are at risk. The first case of human *rhodesiense* sleeping sickness in Zambia was recorded in 1908. The original focus was the Zambezi basin, from which the disease spread north to reach epidemic proportions in Tanzania in the 1930s and Uganda in the 1940s. Sleeping sickness was regarded as a minor problem in Zambia until the 1970s, when epidemics were reported in the Luangwa Valley. No cases of *gambiense* sleeping sickness have been reported since the 1936-62 outbreak on the southern shore of Lake Tanganyika. There are 54 references.
8176 **Cook, G.C., 1992**. Effect of global warming on the distribution of parasitic and other infectious diseases: a review. *Journal of the Royal Society of Medicine*, **85** (11): 688-691.
Hospital for Tropical Diseases, St Pancras Way, London NW1 0PE, UK.
The potential impact of climatic change on tropical and subtropical diseases is discussed. Modifications in vector ecology are likely to lead to a significant increase in cases of such diseases, and changes in human-related risk factors and human behaviour would intensify the effect. An increase of 2□C in mean ambient temperature in central Africa would result in tsetse flies disappearing from the middle belt of Africa southwards. They would breed more efficiently in the forest belt where rainfall would be greater, and climatic change would significantly affect the

development of the parasite within the vector. These events could prove disastrous for both human populations and domestic animals in infected areas.

8177 **Dolan, T.T. and Nantulya, V.M. (eds), 1986 [1987].** Tsetse and trypanosomiasis and ticks and tick-borne disease. (Proceedings of the Scientific Meeting of the Nairobi Cluster and Kenya Veterinary Association, Nairobi, Kenya, 21-22 October 1986.) *Kenya Veterinarian*, **10** (2): 1-48.
ILRAD, P.O. Box 30709, Nairobi, Kenya.
The Nairobi Cluster comprises a number of Kenyan institutions which carry out research on tick-borne diseases, trypanosomiasis and their vectors, namely: ICIPE, the Veterinary Research Laboratories, ILRAD, KARI, KETRI, IBAR, ILCA, the Integrated Project in Arid Lands (IPAL), the University of Nairobi, and the Clinical Research Centre of the Kenya Medical Research Institute (KEMRI). This joint meeting with the Kenya Veterinary Association included reviews of current tsetse control strategies; problems of chemotherapy and chemo-prophylaxis with regard to the identification of new trypanocides, the appraisal of the regimen for existing prophylactic drugs, drug assay, drug resistance, and the need for guidelines on drug use; and the value of trypanotolerant cattle. Abstracts of relevant papers are included in this issue of *TTIQ* (see **17**: nos. 8202, 8208, 8213, 8229, 8242, 8244-8246, 8249, 8254, 8255, 8270, 8279).

8178 **Food and Agriculture Organization of the United Nations, 1993.** *Residues of some veterinary drugs in animals and foods.* (Monographs prepared by the Fortieth Meeting of the Joint FAO/WHO Expert Committee on Food Additives, Geneva, 9-18 June 1992.) Rome; FAO (FAO Food and Nutrition Paper, no. 41/5). 177 pp.
FAO, Via delle Terme di Caracalla, 00100 Rome, Italy.
The monographs presented here give slightly more detailed information than that presented in the parallel WHO document. For recommendations regarding isometamidium, see **17**: no. 8188.

8179 **Food and Agriculture Organization of the United Nations, 1993.** *Pesticide residues in food - 1992*. (Report of the Joint Meeting of the FAO Panel of Experts on Pesticide Residues in Food and the Environment and the WHO Expert Group on Pesticide Residues, Rome, 21-30 September 1992.) Rome; FAO (FAO Plant Production and Protection Paper, no. 116). 146 pp. (More detailed *Evaluations* are also available: *Part I - Residues*, from FAO (FAO Plant Production and Protection Paper, no. 118); and *Part II - Toxicology*,

from WHO.)
FAO, Via delle Terme di Caracalla, 00100 Rome, Italy.
This report summarises the evaluations of residues in foods of 46 pesticides. Data for deltamethrin include residues in milk following pour-on and plunge dip application to dairy cows and residues in perirenal fat of beef cattle following pour-on application (France and Australia). Residues in milk reached a peak from day 1 to day 3 after treatment, with wide variations between animals. Residues in beef cattle at day 7 after treatment were either the same as or higher than at day 3, suggesting that observing 3 or 7 days withholding periods would not reduce deltamethrin residues at slaughter.

8180 **International Centre of Insect Physiology and Ecology, 1992**. *Vision and strategic framework for the 1990s*. Nairobi; ICIPE Science Press. 49 pp.
ICIPE, P.O. Box 30772, Nairobi, Kenya.
Past achievements of ICIPE's Tsetse Research Programme include the development of odour-baited and visually attractive traps such as the NG2B trap which has achieved 99% suppression of *Glossina pallidipes* in the Maasai pastoral rangelands in Nguruman, Kenya. In combination with a model for the prediction of population suppression, a realistic control package is being tested in a large-scale control trial in the Kagera Basin, and social science studies are being conducted to determine the social acceptability and economic sustainability of community-based trapping technology. Future research will include work on low-density and peridomestic tsetse populations, socio-economic effects of tsetse infestation, and the increased use of population models developed using geographic information systems and remote sensing data to advise governments on the management of tsetse control measures throughout Africa.

8181 **Joubert, J.J., Schutte, C.H.J., Irons, D.J. and Fripp, P.J., 1993**. Ubombo and the site of David Bruce's discovery of *Trypanosoma brucei*. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, **87** (4): 494-495.
Department of Medical Microbiology, University of Stellenbosch, P.O. Box 19063, Tygerberg 7505, Republic of South Africa; South African Medical Research Council, P.O. Box 634, Nelspruit 1200, Republic of South Africa; P.O. Box 6, Ubombo 035692, Natal, Republic of South Africa; Department of Microbiology, Medical University of Southern Africa, P.O. Medunsa 0204, Republic of South Africa.

The site and remains believed to be those of the camp where Sir David Bruce and his wife Mary worked between 1894 and 1897, and where Bruce discovered the causative agent of nagana and its transmission by the tsetse fly, have recently been discovered at the small village of Ubombo in northern KwaZulu (Zululand), South Africa. The site where these remains were found fits the meagre, albeit significant, information presented by Bruce in his writings on the location of the camp.

8182 **Kuzoe, F.A.S., 1993**. Current situation of African trypanosomiasis. *Acta Tropica*, **54** (3-4): 153-162. TDR, WHO, 1211 Geneva 27, Switzerland.

African trypanosomiasis (sleeping sickness) is fatal, if untreated, and occurs in 36 African countries, south of the Sahara, where some 50 million people are at risk of acquiring the infection. In the absence of adequate control measures epidemics occur, which are costly and difficult to control. The history of sleeping sickness has been characterised by waves of epidemics, resurgences and outbreaks. Nevertheless, sleeping sickness had been brought practically under control in the early 1950s, in West and Central Africa, through systematic surveillance of the population at risk, and in East Africa, mainly by vector control. Following the attainment of independence from colonial rule in subsequent years, failure by national health authorities to give due attention to sleeping sickness control, due to civil and political unrest, lack of adequate resources and competing national health priorities, has resulted in epidemics and the recrudescence of many old foci and the appearance of new ones. Thus, sleeping sickness is currently a major concern among many countries, particularly in East and Central Africa. During the past decade, progress has been achieved through research in the development of new tools for diagnosis, which are simple to use by national health personnel, and for vector control, which can be used at the community level. Eflornithine, a new drug, has been registered for the treatment of *gambiense* sleeping sickness, and although it is expensive, it is relatively safe and provides an alternative therapy to the existing treatment, which may cause severe adverse effects. These tools have raised hopes for improved control, but their integration into health care systems, which could improve surveillance of the population at risk, has been slow. In view of the worsening economic situation of endemic countries, and the focus of attention and

resources on the AIDS pandemic, prospects of any significant improvement in the sleeping sickness situation would largely depend on the successful mobilisation of external resources.

8183 **Maurice, J., 1992**. *France and research on tropical diseases*. (In French and English.) Paris; Ellipses. 159 pp.

French involvement in research into tropical diseases is reviewed in this book. Separate chapters are devoted to major diseases, including human African trypanosomiasis, with a general chapter on vectors. Sleeping sickness ranked as the most serious health problem facing the French African colonial service, affecting 20-90% of local populations. A permanent sleeping sickness prevention mission was created in 1926 under Eugène Jamot, followed by the `Independent General Sleeping Sickness Service' (SGAMS) in 1939. As a result of well organised mobile detection and treatment units devised by Jamot, the disease was largely under control by the 1950s. With independence and the loss of regular surveillance, the incidence has risen again. CIRAD-EMVT carries out applied field and laboratory research into tsetse control, especially SIT. The Institut Pasteur and the University of Bordeaux II focus on more basic research, such as antigenic variation. Several ORSTOM teams are conducting large-scale tsetse control operations in Côte d'Ivoire and Uganda, while the Montpellier team is working on the characterisation of trypanosome strains, reservoir hosts and human trypanotolerance, especially in Pygmy tribes. Limoges University Medical School provides neurological training and uses a sheep model for drug screening and studying trypanosome-induced pathology. French groups have produced improved trapping devices for tsetse control.

8184 **Service, M.W., 1992**. Vector control. Where are we now? (Paper presented at the 7th European Annual SOVE Meeting, Bologna, Italy, 25 August 1992.) *Bulletin of the Society for Vector Ecology*, **17** (2): 94-108.

Vector Biology and Control, Liverpool School of Tropical Medicine, Pembroke Place, Liverpool L3 5QA, UK.

There is considerable evidence for the resurgence of many vector-borne diseases and the current status of sleeping sickness and other diseases is briefly reviewed. Human African trypanosomiasis occurs in 37 sub-Saharan countries and some 50 million people in about 200 foci are at risk. About 25,000 new cases are reported annually but this is considered an

underestimate. Drug toxicity and difficulties of treating advanced stages of the disease remain major problems. Political unrest and worsening economies have made surveillance unreliable and control difficult, although the introduction of cheap and simply constructed traps has revolutionised tsetse control. In the Busoga area of Uganda tsetse populations were reduced by >98% within 9 weeks and the incidence of sleeping sickness by 80% within 3 months. In economic terms, animal trypanosomiasis is now of much greater significance. This limits the number of cattle in Africa to about 20 million whereas the carrying capacity is some 140-200 million; livestock restrictions affect human protein intake and the development of mixed farming systems.

8185 **Tacher, G., Cuisance, D. and Frézil, J.L., 1992**. La lutte contre les trypanosomoses animales pour une production durable. [The control of animal trypanosomiasis for sustainable production.] *In*: Tacher, G. *et al*., *Environnement et développement durable. Contribution de la recherche française dans les pays en développement* [Environment and sustainable development. Contribution of French research in develop-ing countries] (France; Ministère de la Recherche et de l'Espace), pp. 45-47. CIRAD-EMVT, 10 rue Pierre Curie, 94704 Maisons Alfort Cedex, France; ibid.; ORSTOM, Centre de Montpellier, 911 avenue Agropolis, 34032 Montpellier Cedex 1, France.

Tsetse-transmitted trypanosomiasis is a major constraint to the development of productive agricultural systems in sub-Saharan Africa which has been compounded by the movement of traditional herders into tsetse-infested humid and subhumid zones in response to drought and political upheaval. This has resulted in increased competition for land, increased trypanosomiasis risk and practical difficulties in tsetse control. These problems, together with limited funding and the need for environmental protection, have resulted in the development of new methods of trypanosomiasis control, especially by CIRAD-EMVT and ORSTOM in Côte d'Ivoire, Burkina Faso and Congo, which include use of trypanotolerant livestock, and tsetse control by SIT and trapping. Anti-tsetse campaigns require continual control over large areas: the participation of rural communities is essential but not guaranteed. Trypanosomiasis control must be seen as part of a much wider approach to development, including problems of land ownership, management of pasturage and

water resources, transhumance and the presence of other diseases. Careful land management is essential to avoid ecological degradation, and control and conservation must work side by side to achieve sustainable agricultural production.

8186 **Touré, S.M. and Mortelmans, J., 1991**. Impact de la trypanosomose animale africaine (TAA). [Impact of African animal trypanosomosis.] *Bulletin des Séances, Académie royale des Sciences d'Outre-Mer*, **36** (1990) (2): 239-257.

FAO, 01 B.P. 2540, Ouagadougou 01, Burkina Faso; Prince Leopold Institute of Tropical Medicine, Nationalestraat 155, B-2000 Antwerp 1, Belgium.

The effects of African animal trypanosomiases on productivity and development are assessed. Geographical distribution is described, with reference to transmission by tsetse flies (especially *Glossina palpalis* and *G. morsitans*) and the mechanical transmission of *Trypanosoma vivax* and *T. evansi* by Tabanidae and Stomoxyinae. Tables show the estimated areas infested by tsetse according to different ecological zones in countries of West, Central, East and southern Africa respectively. The impact of trypanosomiasis is considered according to different farming systems, such as pastoralism, semi-sedentary pastoralism, small ruminants, intensive and semi-intensive milk and beef production, and mixed farming. The socio-economic impact of animal trypanosomiasis and different control methods (vector control, chemotherapy and use of trypanotolerant livestock) are discussed. It is concluded that effective control and intensive rearing systems could increase the carrying capacity of areas currently infested by tsetse by some 120 million cattle, although the fragility of African pastoral ecosystems must be taken into account.

8187 **Williams, B. and Williams, G., 1992**. Science for development. *Perspectives in Biology and Medicine*, **36** (1): 64-78.

Department of Zoology, University of Oxford, South Parks Road, Oxford OX1 3PS, UK; St Peter's College, University of Oxford, Oxford OX1 2DL, UK.

It is argued that extensive research into vector-borne diseases has not resulted in better animal and human health. Control strategies for tsetse and trypanosomiasis are reviewed and evaluated, and include game and bush clearing, aerial and ground spraying of insecticides, SIT, applying insecticides directly to cattle, using insecticide-impregnated traps and targets in conjunction with odour baits, use of trypanotolerant animals, chemotherapy, and long-term research in

parasitology, immunology and molecular biology aimed at developing vaccines. After 100 years of costly research and intervention, control of African trypanosomiases remains elusive. Failure is attributed to the fact that control measures have been imposed from outside and local people have usually not been consulted. The success of the Olkirimatian and Shompole Community Develop-ment Project in Kenya is described, where Maasai herdsmen have actively participated in tsetse research and control and regular meetings have been held with village elders. In this project, research and control have been used to benefit each other: for example, monitoring for effective control has provided new information on tsetse behaviour. Indigenous knowledge and community participation are essential if control is to succeed.

8188 **World Health Organization, 1993**. *Evaluation of certain veterinary drug residues in food*. (Fortieth report of the Joint FAO/WHO Expert Committee on Food Additives, Geneva, 9-18 June 1992.) Geneva; WHO (WHO Technical Report Series, no. 832). 62 pp.
WHO, 1211 Geneva 27, Switzerland.
For isometamidium, the Committee established an acceptable daily intake (ADI) of 0-100 μg/kg body weight, and recommended maximum residue limits in cattle of 0.1 mg/kg for parent isometamidium in muscle and fat, 0.5 mg/kg in liver, 1.0 mg/kg in kidney, and 0.1 mg/l in milk. From a study in bulls given isometamidium i.m. at 1.0 mg/kg body weight, the Committee concluded that, at 30 days withdrawal time, the maximum theoretical intake of residues would be well below the ADI. (See also **17**: no. 8178.)

2. TSETSE BIOLOGY

(a) REARING OF TSETSE FLIES

(b) TAXONOMY, ANATOMY, PHYSIOLOGY, BIOCHEMISTRY

8189 **Baylis, M. and Nambiro, C.O., 1993**. The nutritional state of male tsetse flies, *Glossina pallidipes*, at the time of feeding. *Medical and Veterinary Entomology*, **7** (4): 316-322.
Tsetse Research Group, Department of Veterinary Medicine, University of Bristol, Langford, Bristol BS18 7DU, UK; KETRI, P.O. Box 362, Kikuyu, Kenya.
The feeding intervals of tsetse flies have been estimated from the nutritional state of flies caught in traps. However, such estimates have been disputed on the grounds that traps catch a biased, hungry sample of the flies which are seeking hosts and will feed. In

this paper, data are presented on the nutritional state of tsetse flies caught approaching and feeding on oxen. Individual oxen were surrounded with an incomplete ring of electric nets which caught G. *pallidipes* that were approaching, departing unfed and departing fed from an ox. Non-teneral males caught in this way were analysed for their fat and haematin contents. The feeding interval was estimated from a comparison of the frequency distributions of the pre- and post-feed haematin contents of the flies which fed. The former was not measured directly, and was deduced from the frequency distributions of the haematin contents of the male flies caught approaching and departing unfed from the oxen, since it is assumed that the departing unfed and fed flies together form a sample of the approaching flies. There was no difference between the frequency distributions of haematin contents of flies caught approaching and departing unfed, and therefore the pre-feed haematin contents of the males which fed should have the same frequency distribution. Comparison of this distribution with that of the post-feed haematin contents of the males which fed indicated that the majority of male *G. pallidipes* were returning to feed after digesting on average 1.4 log haematin units of the previous bloodmeal. From data published elsewhere, this corresponds to a mean feeding interval of 42-60 h. There was a strong, linear, negative relationship between the fat contents of males and their probability of taking a bloodmeal, suggesting that fat content is important in determining the feeding behaviour of tsetse flies.

8190 **Bialota, F., 1992**. *Les chimiorécepteurs de l'aile chez* Glossina pallidipes *(Diptera: Glossinidae) et chez* Stomoxys nigra *(Diptera: Muscidae)*. [Wing chemoreceptors in *G. pallidipes* and *S. nigra*.] Mémoire de Maîtrise de Biologie des Organismes et des Populations, Université des Sciences et Techniques du Languedoc, Languedoc, France. (Unpub-lished dissertation.) 37 pp.

A comparative study has been made of the wing sense organs, particularly the chemoreceptors, of two trypanosome vectors: *G. pallidipes* (cyclic transmission) and *S. nigra* (mechanical transmission). This is seen as one stage of research into vector behaviour which will eventually improve trapping performance. The biology and ecology of the vectors are summarised. Light and electron microscopes were used to investigate wing morphology and the typology and topology of sensory structures in relation to the costal nerve: tactile

bristles and spines, chemoreceptive bristles and mechanoreceptors. The structure, typology, distribution and sensitivity of the chemoreceptors are described, with reference to sexual differences, and intra- and interspecific variation. *G. pallidipes* has a greater number of chemoreceptors than *S. nigra*. Comparisons are made with other *Glossina* spp. and with *Musca domestica*. The role of the chemoreceptors in reproduction, environmental perception and host-finding is discussed.

8191 **Blanchetot, A. and Gooding, R.H., 1993**. Genetic analysis by DNA fingerprinting in tsetse fly genomes. *Insect Biochemistry and Molec-ular Biology*, **23** (8): 937-944.

Department of Biochemistry, University of Saskatchewan, Saskatoon, Saskatchewan S7N 0W0, Canada; Department of Entomology, University of Alberta, Edmonton, Alberta T6G 2E3, Canada.

Genomic DNA from tsetse flies was analysed by hybridisation using the whole M13 phage as a probe to reveal DNA fingerprinting (DNAfp) profiles. Intrapopulation variability, measured by comparison of DNAfp profiles of tsetse flies from a large colony of *Glossina brevipalpis*, showed a high degree of polymorphism similar to that found in other animal species. Different lines of *G. m. morsitans*, *G. m. centralis*, *G. m. submorsitans*, *G. p. palpalis* and *G. p. gambiensis* established from small colonies displayed less genetic variability than the *G. brevipalpis* population. The analysis of pedigree relationships within an inbred line of *G. m. centralis* conformed to a Mendelian inheritance pattern. In the pedigree presented no mutations were observed, one fragment was linked to the X chromosome, and three fragment sets were linked, but most fragments showed independent segregation. M13 revealed no characteristic DNAfp profile differences between the subgenus *Glossina* and the subgenus *Nemorhina*, but a conserved distribution pattern was found in the laboratory colonies within each subspecies. M13 also revealed line specific DNA fragments that may be useful as genetic markers to expand the present linkage map of *G. m. morsitans*.

8192 **Goes van Naters, W.M. van der and Rinkes, T.H.N., 1993**. Taste stimuli for tsetse flies on the human skin. *Chemical Senses*, **18** (4): 437-444.

Sensory Physiology Group, Department of Animal Physiology, University of Groningen, P.O. Box 14, 9750 AA Haren (Gn), Netherlands.

The adequate stimuli for taste receptors on the legs of

tsetse flies (*Glossina* spp.) have hitherto been unknown. This paper presents electrophysiological evidence that for *G. fuscipes fuscipes* human sweat – man is one of the flies' hosts – is an adequate stimulus. The receptor cells which respond to human sweat are located in two sensilla proximal to the base of the empodium at the distal end of the fifth tarsomere. The receptors are sensitive to four of the 14 major components of sweat tested: uric acid, leucine, valine and lactic acid. It is shown that flies display more feeding behaviour on surfaces treated with sweat, uric acid, leucine or valine than on untreated surfaces.

8193 **Leonard, D.E. and Saini, R.K., 1993**. Semiochemicals from anal exudate of larvae of tsetse flies *Glossina morsitans morsitans* Westwood and *G. morsitans centralis* Machado attract gravid females. *Journal of Chemical Ecology*, **19** (9): 2039-2046.

Department of Entomology, University of Massachusetts, Amherst, MA 01003, USA; Sensory Physiology Unit, ICIPE, P.O. Box 30772, Nairobi, Kenya.

Tsetse flies mature their offspring *in utero*, giving birth to mature larvae that burrow into soil and pupariate. During the hot dry seasons, puparia of some species of tsetse are aggregated in areas of deep shade in dense thickets. The presence of a semiochemical from the prepupariation excretions of larvae of *G. m. morsitans* is confirmed and a similar semiochemical is reported in *G. m. centralis*. These semiochemicals are attractive to gravid females and result in the aggregation of puparia. Behavioural studies with *G. m. centralis* showed that a higher percentage of females larviposited over moist sand conditioned by the anal exudate of larvae. Electroantennogram analyses of extracts of sand conditioned by *G. m. centralis* and *G. m. morsitans* confirmed the presence of olfactory receptors on the antennae for the semiochemicals. Both subspecies responded to extracts of the semiochemicals of the other, with *G. m. morsitans* more responsive to lower concentrations of extract of *G. m. centralis* than the converse.

8194 **Ochieng, V.O., Osir, E.O., Ochanda, J.O. and Olembo, N.K., 1993**. Temporal synthesis of cuticle proteins during larval development in *Glossina morsitans*. *Comparative Biochemistry and Physiology (B)*, **105** (2): 309-316.

Ochieng, Ochanda, Olembo: Department of Biochemistry, University of Nairobi, P.O. Box 30197, Nairobi, Kenya; Osir: ICIPE, P.O. Box 30772, Nairobi, Kenya. (Correspondence to Osir.)

Larval development in *Glossina* species occurs *in utero* with the mature third instar larva being deposited after a development period of 7 days. In this study, the patterns of cuticular protein synthesis during larval development were analysed by two-dimensional gel electrophoresis. From the results, four types of cuticle proteins were identified: those specific to larval, pupal and adult cuticles, and others common to all the stages. Few cuticular proteins were synthesised between the first and second larval instars. By the third larval instar (2 days before larviposition), a large number of proteins (M_r < 30 kDa) were induced. These proteins persisted up to the brown pupal stage and showed a rapid decline thereafter. Most of the proteins with molecular weights M_r < 30 kDa were undetectable at apolysis (5 days after larviposition). By day 15 of the pupal stage, the number of cuticle proteins was very small. The protein profile during the pupal stages remained relatively constant. This was probably due to the fact that the pupal cuticle does not provide any protection since it is itself enclosed at all times within the protective puparium.

8195 **O'Neill, S.L., Gooding, R.H. and Aksoy, S., 1993**. Phylogenetically distant symbiotic microorganisms reside in *Glossina* midgut and ovary tissues. *Medical and Veterinary Entomology*, **7** (4): 377-383.

Departments of Epidemiology and Public Health (O'Neill) and Internal Medicine (Aksoy), Yale University School of Medicine, 60 College Street, 700 LEPH, New Haven, CT 06525, USA; Department of Entomology, University of Alberta, Edmonton, Alberta T6G 2E3, Canada. (Correspondence to Aksoy.)

Many blood-feeding insects, including tsetse flies, harbour intracellular bacterial symbionts. Using isolates from tissues of several *Glossina* species and diagnostic DNA oligonucleotide primers, a polymerase chain reaction (PCR) based assay was designed to identify symbiotic bacteria. Those inhabiting the midgut of *Glossina* were found to belong to the gamma subdivision, whereas ovarian Proteobacteria were of the alpha subdivision – probably genus *Wolbachia* (Rickettsiaceae). The presence of *Wolbachia*-like rickettsia in the ovaries of *G. morsitans* subspecies may help to explain the maternally inherited incompatibility of some crosses within this species.

(c) DISTRIBUTION, ECOLOGY, BEHAVIOUR, POPULATION

STUDIES

[See also **17**: nos. 8176, 8189, 8193.]

8196 **Brady, J. and Griffiths, N., 1993**. Upwind flight responses of tsetse flies (*Glossina* spp.) (Diptera: Glossinidae) to acetone, octenol and phenols in nature: a video study. *Bulletin of Entomological Research*, **83** (3): 329-333.
Imperial College, Silwood Park, Ascot, Berks SL5 7PY, UK.

Video observations were made of tsetse flies (mainly *Glossina pallidipes*) as they approached, responded to and left a vertical (1 m square) black target in odour plumes of acetone, or a 4:1:8 mixture of octenol:propylphenol:methyl-phenol, or acetone plus this 4:1:8 mixture, or in no odour. No differences in mean flight speed or turn size in any of these situations were detected. With the odour source 5 m upwind of the target, the flight tracks of tsetse arriving at and leaving the target were significantly biased towards upwind, highly so when 4:1:8 was present, marginally so in acetone alone. With the source 10 m upwind, the same biases were still present but weaker. Circling flights around the black target were more frequent in acetone plus 4:1:8 than in no odour (26% *v*. 15%), but in either odour alone were only just significantly more than in no odour. Upwind turning at the target was more frequent (25% *v*. 17%) in acetone alone than in no odour (though not in 4:1:8 alone). It is concluded that 4:1:8 elicits an upwind anemotactic response comparable in strength to that in CO_2, and that acetone elicits a similar response more weakly, but may be more involved in potentiating visual responses.

8197 **Rogers, D.J. and Randolph, S.E., 1993**. Distribution of tsetse and ticks in Africa: past, present and future. *Parasitology Today*, **9** (7): 266-271.
Department of Zoology, University of Oxford, South Parks Road, Oxford OX1 3PS, UK.

Multivariate analysis can be used to predict the probability of occurrence of vectors over large geographical regions. Combined with satellite-derived meteorological data and normalised difference vegetation indices (NDVI), this method will help determine the relative importance of predictor variables and can be used to show how distributions are likely to change under given scenarios of global change. An analysis of the pre-1890 distribution of *Glossina morsitans* in Zimbabwe shows the maximum of the mean monthly temperature to be the most important predictor

variable. Further north, in Kenya and Tanzania, the maximum of the monthly NDVI is the most important predictor. In contrast, the most important predictor variable for *G. pallidipes* was the minimum NDVI for the year. The probable effect of global warming in Zimbabwe was investigated by increasing the temperature variable by 1-3□C. This showed that *G. morsitans* would probably extend its range into the highland region. The study shows that vector distributions are sensitive to small changes in environmental conditions and that the limiting factor may change from place to place. The distribution of *G. morsitans* is determined by a single variable (temperature) near the edge of its range but by more than one (NDVI, temperature and elevation) near the centre.

8198 **Zdárek, J. and Denlinger, D.L., 1993**. Metamorphosis behaviour and regulation in tsetse flies (*Glossina* spp.) (Diptera: Glossinidae): a review. *Bulletin of Entomological Research*, **83** (3): 447-461.

Insect Chemical Ecology Unit, Institute of Organic Chemistry and Biochemistry, Czech Academy of Sciences, U Salamounky 41, 15800 Praha 5, Czech Republic; Department of Entomology, Ohio State University, 1735 Neil Avenue, Columbus, OH 43210, USA. (Correspondence to Denlinger.)

This review examines the recent literature on tsetse metamorphosis behaviour and its regulation. The behavioural events associated with meta-morphosis are highly specific and most occur only once during the life of the fly. The review begins with the larva's commitment to metamorphosis and then discusses the behaviour associated with parturition, wandering of the third instar larva, pupariation, pupation and adult eclosion. While certain aspects of tsetse metamorphosis behaviour are common to the higher Diptera, the peculiar reproductive strategy of tsetse has dictated many modifications. Most notable of the tsetse peculiarities are the larva's late commitment to metamorphosis, the contribution by the mother in deciding the onset of the wandering period, the brevity of the wandering period, the involvement of the nervous system in co-ordinating puparial tanning, the tight packaging of the pupa within the puparium, the long duration of pharate adult development, and the great expansion of the body that occurs following eclosion. A final section discusses the potential for disrupting tsetse metamorphosis.

3. tsetse control (including environmental side

effects)
[See also **17**: nos. 8179, 8180, 8187.]

8199 **Anonymous, 1992**. Assainir les zones infestées de glossines. Une lutte économique et non polluante. [Clearing tsetse infested areas. Econ-omic and non-pollutant control.] (Fiche technique. [Technical sheet.]) *Afrique Agriculture*, no. 190: 34-40.
Ecological change through farming, herders leaving their traditional pastures and the reduction of wild animals have modified human/tsetse/livestock relationships in recent years. At the same time, environmentally safe and more economic tsetse control techniques have been introduced. The choice between total eradication or control depends on various factors, but the usual choice is control by trapping. This article describes some current control methods: SIT, use of tsetse visual and olfactory attractants for traps and screens, and direct treatment of livestock with insecticide dips and pour-on formulations. Advantages and disadvantages of these methods are summarised. Traps and screens may be impregnated with chemosterilants (bisazir or a juvenile hormone analogue) and pyrethroid insecticides (deltamethrin at 150-200 mg/m^2 of cloth or α-cypermethrin at 300-400 mg/m^2). The general aim is to reduce tsetse density and therefore trypanosomiasis to a level comparable to that achieved by chemotherapy. Non-impregnated traps are preferred for the control of human trypanosomiasis and are more effective against *palpalis* group flies. Cheaper screens are used over larger areas and are reimpregnated with insecticide five times per year. Both are used together to create barriers and for surveillance. Informing and motivating the participation of farmers is important. Construction diagrams are given for the following: the Challier-Laveissière biconical trap, Mérot and Laveissière's Vavoua monoconical traps, and the Gouteux pyramidal trap.

8200 **Anonymous, 1992**. Lutte intégrée contre les trypanosomoses et les vecteurs. [Integrated control of trypanosomiases and vectors.] *Afrique Agriculture*, no. 197: 44-45.
The adoption of an integrated control strategy against animal trypanosomiasis and tsetse flies in Côte d'Ivoire successfully reduced the rate of infection and increased the range of transhumant pastoralists. The three-fold strategy included the introduction of trypanotolerant N'Dama cattle, regular chemoprophylaxis

and an improved tsetse control programme. Berenil and Trypamidium were effective when strictly administered but dependence on two trypanocides could result in the development of cross resistance. The tsetse control programme covered some 60,000 km^2 and used insecticide-impregnated Vavoua traps (made *in situ* by local artisans) and screens. Control began at the start of the rainy season and comprised five phases: preliminary survey (October), setting of traps (November), reimpregnation (March-April), monthly checks and maintenance (December-mid June), and removal of traps and assessment (mid June-mid July). Traps were set at 300 m intervals in gallery forest, 100 m intervals in barrier gallery forest, 100-150 m intervals in forest islands and 300 m intervals along forest-savanna margins. The intervals were increased when tsetse density had fallen by 95-98%. Since 1990 control has been carried out in the Korhogo area in the north, resulting after two campaigns in reductions of about 100% for *Glossina tachinoides* and 97-100% for *G. palpalis* in the eastern zone and about 100% and 85-90% respectively in the western zone near the frontier.

8201 **Cooper, J. and Dobson, H., 1993**. *Aerial spraying for tsetse fly control: a handbook of aerial spray calibration and monitoring for the sequential aerosol technique*. Chatham, UK; NRI (for the European Community).

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

This handbook is intended for tsetse control officers who may need to carry out quality control in aerial spraying operations. The cost benefits of aerial spraying, the purpose of aerial spraying calibration and monitoring, and safety aspects are considered. Procedures for the sequential aerosol technique (SAT) are described, with reference to time of year, spray timing and the tsetse life cycle, meteorological conditions and drop movement, aircraft flight pattern, spraying equipment and drop size. Instructions are given for checking and adjusting spraying equipment to give the required flow rate and drop size, with methods for collecting, counting and sizing drops. The monitoring of spray during a control operation includes meteorological monitoring, the deployment of rotary samplers, and the estimation of spray flux, fly dose and the proportion of insecticide in spray drops. Fly mortality may be predicted from insecticide dose, dose variability and insecticide toxicity.

8202 **Dransfield, R.D., 1986 [1987]**. Overview of tsetse control

strategies: need for a reappraisal. *Kenya Veterinarian*, **10** (2): 4. (See **17**: no. 8177.)
ICIPE, P.O. Box 30772, Nairobi, Kenya.
The distribution of tsetse flies in Africa has remained virtually unchanged despite considerable control efforts over the past 50 years. Any population reductions have usually been temporary, with either rapid resurgence or reinvasion from surrounding areas. A good understanding of tsetse population dynamics is essential for a rational control strategy. Population models incorporating density-dependent mortality factors, such as pupal mortality and the loss rate of nulliparous flies, show that control methods which can impose a sustained mortality rate high enough to overcome compensatory processes are most likely to succeed. Insecticide-impregnated and odour-baited traps and screens can achieve this: the level of mortality imposed will show if eradication is possible or whether the population will stabilise at a lower equilibrium. The dependence of tsetse control on high technology, imported insecticides and visiting experts is considered inappropriate. Refinement of the trapping technique by involving local communities and the effective use of attractants can increase efficiency and reduce the need for insecticides.

8203 **Food and Agriculture Organization of the United Nations, 1991**. *Manual de preparaçao de pessoal de controlo das tsé-tsés. 1º volume: Biologia, sistemática e distribuiçao das tsé-tsés; técnicas. 2º volume: Ecologia das tsé-tsés. 3º volume: Métodos de controlo e efeitos secundários.* [Training manual for tsetse control personnel. Volume 1: Tsetse biology, systematics and distribution; techniques. Volume 2: Ecology and behaviour of tsetse. Volume 3: Control methods and side effects.] (Portuguese translation from original 1982 English version edited by J.N. Pollock.) Lisbon, Portugal; Ediçoes 70 (on behalf of FAO and CTA). 231 + 79 + 119 pp.
FAO, Via delle Terme di Caracalla, 00100 Rome, Italy.
This Portuguese version of FAO's training manual for tsetse control personnel retains the same textual content, layout and illustrations of the original English version (see *TTIQ*, **5** (4): no. 2522). Volume 1 covers the external and internal anatomy and physiology of *Glossina*, life cycle, systematics, distribution, hosts of *Glossina* and transmission, basic techniques for field and laboratory studies, description and species identification keys, and miscellaneous techniques. Volume 2 covers the ecology of the *morsitans*, *palpalis* and *fusca* group species. Volume 3 describes control and

eradication by non-chemical means and by insecticides, with details of ground and aerial spraying, and possible side effects.

8204 **Food and Agriculture Organization of the United Nations, 1992.** *Training manual for tsetse control personnel. Volume 4. Use of attractive devices for tsetse survey and control.* (Written by R.D. Dransfield & R. Brightwell; edited by B.S. Hursey & J.H.W. Slingenbergh.) Rome; FAO. 196 pp.
FAO, Via delle Terme di Caracalla, 00100 Rome, Italy.

This volume, published in English and French, is the fourth in the FAO series of training manuals. Recent technological advances in the field of tsetse control have resulted in a dramatic shift from the previous reliance on bush clearing, animal host destruction and the large-scale use of persistent insecticides to the adaptation of the vector control techniques used by workers earlier this century. These techniques are based on an intimate knowledge of tsetse behaviour and biology, but once developed can be implemented at low cost and with minimal technical support. The re-introduction of tsetse attractive devices, such as traps and targets/screens, now provides the opportunity for control through varying degrees of rural community participation. The introduction to this volume describes early work, recent developments, biological considerations, and control strategies. There follow chapters on: odour attractants (including bait dispensers and attractiveness of odours to different species); traps, targets and electric nets (materials, designs and construction); evaluating attractant devices (methods for comparing response of different species and populations to different devices and components); attractant devices for surveys (including programme design and data recording and analysis); tsetse control and eradication (including choice and use of insecticide, chemosterilisation, density and distribution of traps/targets, reinvasion barriers, trap/target deployment and maintenance, case studies of control of savanna and riverine species, and control by insecticide-treated livestock); choice and integration of control techniques; and economics and management of control (including economics of control *v*. eradication, costs of trap/target operations and of insecticide-treated livestock operations, manage-ment systems and community involvement, and sustainability). A reading list and an appendix giving sample statistical analyses of Latin square design and of rate of decline of tsetse numbers are also included.

8205 **Food and Agriculture Organization of the United Nations, 1993**. *Training manual for tsetse control personnel*. *Volume 5. Insecticides for tsetse and trypanosomiasis control using attractive bait techniques.* (Written by N.J. Alsop; edited by B.S. Hursey.) Rome; FAO. 88 pp. FAO, Via delle Terme di Caracalla, 00100 Rome, Italy.
This volume, published in English and French, is the fifth in the FAO series of training manuals and provides a more comprehensive guide on the use of insecticides on artificial devices and livestock. Gradually and in an increasing number of countries, attractive devices are being introduced. Their use on an increasing scale is facilitated by their low technological demands and practical feasibility for implementation through community participation. Topics covered in this volume include: insecticides for tsetse control (properties and groups); insecticide formulations; synthetic pyrethroids; practical application on traps and targets (including handling precautions, application rates of specific pyrethroids, and choice of insecticide and formulation); and practical application on livestock baits (including specific pyrethroids for dipping, sprayrace and handspraying, and for pour-on application). Addresses of insecticide suppliers are given.

8206 **Hargrove, J.W. and Langley, P.A., 1993**. A field trial of pyriproxyfen-treated targets as an alternative method for controlling tsetse (Diptera: Glossinidae). *Bulletin of Entomological Research*, **83** (3): 361-368.
IPMI Tsetse Project, c/o Tsetse Control Branch, Department of Veterinary Services, P.O. Box 8283, Causeway, Harare, Zimbabwe; Insect Investigations, Langford House, Langford, Bristol BS18 7DU, UK. (Correspondence to Langley.)
A juvenile hormone mimic (pyriproxyfen) was used with odour-baited targets to assess its suitability for controlling tsetse flies (*Glossina* spp.). In August 1991, 41 odour-baited targets, identical to those used with insecticide in tsetse control operations, were each treated with 4 g of pyriproxyfen and deployed near Rekomitjie Research Station, Zambezi Valley, Zimbabwe, in a 12.3 km^2 block of woodland habitat of *G. morsitans morsitans* and *G. pallidipes*. After 3 months, emergence rates from puparia of the two species collected in the block fell to 34% and 20% of control levels; 50% and 70%, respectively, of puparia of the two species collected were found, on dissection, to show arrested development. Changes in mean ovarian age and wing-fray category in the tsetse population during the trial were

due partially to the pyriproxyfen and partially to high mortality, in the larval/pupal stages and in young adult flies, which occurs each year in the hot/dry season. Chemical analysis of cloth samples indicated that after 4 months 68-85% of the pyriproxyfen had been lost, a large proportion apparently dripping off the bottom of the target. If the technical problem of persistence can be solved, pyriproxyfen could substitute for pesticides in target-based tsetse control operations.

8207 **International Atomic Energy Agency, 1992**. *Laboratory training manual on the use of nuclear techniques in insect research and control*. (3rd edition.) (A joint undertaking by FAO and IAEA.) Vienna; IAEA (IAEA Technical Reports Series, no. 336). 183 pp.
IAEA, Wagramerstrasse 5, P.O. Box 100, A-1400 Vienna, Austria.
This manual replaces the *Laboratory training manual on the use of isotopes and radiation in entomology* (IAEA Technical Reports Series, no. 61). Its purpose is to help entomologists and others responsible for the entomological research and control of insects in developing countries to become familiar with the potential use of isotopes and radiation in solving some of their research and insect control problems. The manual covers radiation safety, types of radiation and isotopes, radiation detection and assay of radioactivity, application to entomological problems, and the SIT.

8208 **Kaaya, G.P., 1986 [1987]**. Future prospects of biological control of tsetse. *Kenya Veterinarian*, **10** (2): 5. (See **17**: no. 8177.)
ICIPE, P.O. Box 30772, Nairobi, Kenya.
The use of biological agents for tsetse control is briefly reviewed. The cellular immune responses of tsetse to various microorganisms have been investigated and include phagocytosis, cell aggregate formation, and encapsulation of foreign bodies, with extensive melanisation. Humoral antibacterial factors are also produced. Some bacteria are very pathogenic and *in vitro* assays have shown them to be resistant to tsetse immune factors. Tsetse mortalities obtained after single applications of bacteria to host rabbit ears prior to feeding were: 47% for *Pseudomonas aeruginosa*, 45% for *Serratia marcescens*, 27% for *Bacillus thuringiensis* serotype 1, 4% for *B. thuringiensis* serotype 5 and 4% for *B. thuringiensis* var. *israelensis*. Immunobiological control, based on immunising rabbits with tsetse-derived tissue antigens before allowing tsetse to feed on them, is being

investigated and decreased tsetse fecundity and pupal emergence rates have been obtained.

8209 **Lambert, M.R.K., 1993**. Effects of DDT ground-spraying against tsetse flies on lizards in NW Zimbabwe. *Environmental Pollution*, **82** (3): 231-237.

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

The impact of DDT ground-spraying against tsetse flies on lizards was investigated in north-west Zimbabwe. Nineteen species were recorded, 17 in mopane woodland and 11 on gritstone outcrops: *Mabuya striata wahlbergii* dominated trees and *M. quinquetaeniata margaritifer* dominated rocks. Mean frequency of *M. s. wahlbergii* declined significantly from 76% of lizards at untreated sites (*n* = 8), through 72% after three annual treatments (*n* = 4), to 48% after four to six treatments (*n* = 6). Sighting rates and proportion of trees occupied were also significantly lower at treated than at untreated sites. Numbers on trunks (99% > 15 cm diameter) above 3 m increased significantly with years of treatment relative to those in the spray target area below 3 m. Total DDT loads rose significantly with number of annual treatments and were up to 263 μg g^{-1} lipid (7 μg g^{-1} wet body weight) after 3-6 years. The percentage of unaltered DDT increased with load, which was proportionately higher in thin than in fat lizards. The geometric mean total DDT level in *M. s. wahlbergii* was significantly higher than in outcrop species, and from treated woodland was elevated 21 times above that in lizards from treated outcrops. Frequency and sighting rates of *Lygodactylus chobiensis* in woodland and immature *Agama kirkii* on outcrops were significantly higher in treated than in untreated areas.

8210 **Ott, D., Gouteux, J.P. and Sarda, J., 1992**. Prophylaxie de la trypanosomiase humaine africaine dans les unités séjournant en zone d'endémie. [Prophylaxis of human African trypanosomiasis in troops stationed in an endemic area.] *Médecine et Armées*, **20** (6): 507-509.

EFAO, Bangui, Central African Republic; Centre ORSTOM, Bangui, Central African Republic; Région Sanitaire no. 1, B.P. 300, Bangui, Central African Republic.

A strategy of disease prevention was devised following a study of French troops stationed for 1 week at Nola in the Central African Republic. The Nola-Bilolo focus of *gambiense* sleeping sickness is one of four in the country and the disease is carried by *Glossina palpalis palpalis* and *G. fuscipes fuscipes*. Vector control by u.l.v. spraying of permethrin and use of biconical traps

impregnated with permethrin was carried out for the duration of the camp and the troops were examined by IFAT 21 days later. All the tests were negative suggesting that vector control had been adequate to prevent the disease. Use of IFAT was recommended to ensure the rapid treatment of any cases that might have occurred.

4. epidemiology: vector-host and vector-parasite interactions

[See also **17**: no. 8192.]

8211 **Gouteux, J.P., Kounda Gboumbi, J.C., Noutoua, L., D'Amico, F., Bailly, C. and Roungou, J.B., 1993**. Man-fly contact in the Gambian trypanosomiasis focus of Nola-Bilolo (Central African Republic). *Tropical Medicine and Parasitology*, **44** (3): 213-218.

Gouteux: Place Jean Sénac, F-32170 Miélan, France; D'Amico: Centre ORSTOM, 34032 Montpellier Cedex 1, France; other authors: Direction de la Médecine Préventive et des Grandes Endémies, Bangui, Central African Republic.

A study using bipyramidal tsetse fly traps in the Nola-Bilolo sleeping sickness focus, Central African Republic, reveals ecological and behavioural differences between two vectors, *Glossina palpalis palpalis* and *G. fuscipes fuscipes*. The latter species inhabits mainly open water sites and surrounding forest, whereas *G. p. palpalis* occurs mainly in coffee plantations near villages. Consequently, man-fly contact differs considerably according to the species. The intensity of trypanosomiasis transmission, estimated by the probable distribution of cases, showed significant positive correlation with the density of the flies. Analysis of the fly blood meals in two villages showed that, unlike *G. p. palpalis*, *G. f. fuscipes* feeds on man more than on pigs. *Trypanosoma vivax* infection was observed only in *G. f. fuscipes*. The differences in habitat preference between the two vectors must be taken into account in trapping programmes which may modify this distribution.

8212 **Mihok, S., Olubayo, R.O., Darji, N. and Zweygarth, E., 1993**. The influence of host blood on infection rates in *Glossina morsitans* sspp. infected with *Trypanosoma congolense*, *T. brucei* and *T. simiae*. *Parasitology*, **107** (1): 41-48.

Mihok, Darji: Tsetse Research Programme, ICIPE, P.O. Box 30772, Nairobi, Kenya; Olubayo: KARI, National Veterinary Research Centre, P.O. Box Kabete, Nairobi, Kenya; Zweygarth: KETRI, Kikuyu, Kenya.

Trypanosoma congolense, *T. brucei* and *T. simiae* isolated from

wild-caught *G. pallidipes* were fed to laboratory-reared *G. m. centralis* and *G. m. morsitans* to determine the effect of host blood at the time of the infective feed on infection rates. Bloodstream forms of trypanosomes were membrane-fed to flies either neat, or mixed with blood from cows, goats, pigs, buffalo, eland, waterbuck and oryx. The use of different bloods for the infective feed resulted in differences in infection rates that were repeatable for both tsetse subspecies and most parasite stocks. Goat and, to a lesser extent, pig blood facilitated infection, producing high infection rates at low parasitaemias. Blood from cows and the wildlife species produced low infection rates, with eland blood producing the lowest. Addition of D(+)-glucosamine (an inhibitor of tsetse midgut lectin) increased infection rates in most cases. These results indicate the presence of species-specific factors in blood that affect trypanosome survival in tsetse. In certain hosts, factors actually appear to promote infection. The nature of these factors and how they might interact with midgut lectins and proteases are discussed.

8213 **Moloo, S.K., 1986 [1987]**. Aspects of the vector role of tsetse flies. *Kenya Veterinarian*, **10** (2): 6-7. (See **17**: no. 8177.)

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

The successful establishment of trypanosome infections may depend on the structural and/or physiological characteristics of attachment sites in the tsetse gut and the efficiency of bloodstream trypomastigotes to attach to such sites and undergo transformation. Trypanosome infection rates in tsetse haemolymph were found to be very low (4.7% for *Trypanosoma brucei* and 3.9% for *T. congolense*), suggesting that the invasion of the vector haemocoel is of no significance in trypanosome development. Lowering the crop emptying rate did not increase the incidence of *T. brucei* infection in the tsetse gut and the developmental cycle was completed even when the crop was bypassed by anally injecting infected blood, showing that *T. brucei* does not need to pass slowly through the crop to adapt to conditions in the gut. The presence of trypanosomes in the gut, proboscis and salivary glands did not affect normal feeding of tsetse. *T. brucei* can complete its cycle of development in non-teneral tsetse, showing that the release of non-teneral sterile males would not eliminate the risk of sleeping sickness in affected areas. It is recommended that sterile teneral male

tsetse be given an *in vitro* blood meal containing 15 μg Samorin/ml blood before SIT release; this completely suppresses trypanosome infections in the flies and eliminates them as vectors.

8214 **Moloo, S.K., 1993**. A comparison of susceptibility of two allopatric populations of *Glossina pallidipes* for stocks of *Trypanosoma congolense*. *Medical and Veterinary Entomology*, **7** (4): 369-372.

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

A colony of *G. pallidipes* which originated from Nguruman, Rift Valley Province, Kenya, was significantly more susceptible to infection (19.3%) with a stock of *T. congolense* isolated from *G. pallidipes* in Nguruman than a colony of the same species which originated from Shimba Hills, Coast Province, Kenya (5.6%). Male *G. pallidipes* from Nguruman were significantly more susceptible than females to this *T. congolense* stock whilst the susceptibility of both sexes of *G. pallidipes* from Shimba Hills did not differ significantly. All six goats on which six infected *G. pallidipes* fed singly (three tsetse per colony) became infected. Similarly, the *G. pallidipes* colony of Nguruman origin was significantly more susceptible to infection (16.4%) with a stock of *T. congolense* isolated from *G. pallidipes* in Shimba Hills than the colony of Shimba Hills origin (4.9%). The susceptibility of the sexes of *G. pallidipes* from both the colonies to this stock of *T. congolense* did not differ significantly. Again, all six goats on which six infected *G. pallidipes* fed singly (three tsetse per colony) became infected. If the observed differences in susceptibility of the two *G. pallidipes* colonies reflect transmission of trypanosomes by the two allopatric populations of tsetse in the field, then the epidemiology of *congolense*-trypanosomiasis in livestock must differ between these two areas of Kenya endemic for trypanosomiasis.

8215 **Welburn, S.C., Arnold, K., Maudlin, I. and Gooday, G.W., 1993**. Rickettsia-like organisms and chitinase production in relation to transmission of trypanosomes by tsetse flies. *Parasitology*, **107** (2): 141-145.

Welburn, Maudlin: Tsetse Research Group, Department of Veterinary Medicine, University of Bristol, Langford, Bristol BS18 7DU, UK; Arnold, Gooday: Department of Molecular and Cell Biology, Marischal College, University of Aberdeen, Aberdeen AB9 1AS, UK.

Rickettsia-like organisms (RLO) from tsetse midguts and mosquito cell cultures showed high levels of endochitinase activity. A line of *Glossina morsitans morsitans*

highly susceptible to midgut trypanosome infection and with high incidence of RLO infection showed significantly greater chitinolytic activity than *G. austeni* which had low RLO incidence and were correspondingly refractory to midgut infection. Midgut infection rates of *Trypanosoma brucei rhodesiense* in *G. m. morsitans* showed a dose-related increase when flies were fed *N*-acetyl-D-glucosamine (GlcNAc) in the infective meal and for 4 subsequent days. A model is proposed for susceptibility to trypanosome infection based on the generation of GlcNAc by RLO endochitinase activity in tsetse pupae inhibiting midgut lectin in teneral flies.

8216 **Woolhouse, M.E.J., Hargrove, J.W. and McNamara, J.J., 1993**. Epidemiology of trypanosome infections of the tsetse fly *Glossina pallidipes* in the Zambezi Valley. *Parasitology*, **106** (5): 479-485.

Department of Zoology, University of Oxford, South Parks Road, Oxford OX1 3PS, UK; ODA Insect Pest Management Initiative, c/o Tsetse and Trypanosomiasis Control Branch, Box 8283, Causeway, Zimbabwe; Tsetse Research Group, Department of Veterinary Medicine, University of Bristol, Langford, Bristol BS18 7DU, UK.

The epidemiology of trypanosome infections of *G. pallidipes* was studied at a riverine site in the Zambezi Valley, Zimbabwe, for a period of 13 months. Over 9000 flies were captured using a single trap. These flies were dissected, screened for trypanosome infection, sexed, and aged using both wing fray and (for females) ovarian category indices. Midgut infections were identified to species using recently developed DNA probes. The overall prevalence of mature infections was 5.5%, comprising 3.1% *Trypanosoma vivax*-type and 2.4% *T. congolense*-type (which included very low prevalences of *T. brucei*, *T. simiae* and another *Nannomonas* species). The prevalence of infection increased with age. For *T. vivax*-type infections in flies aged by ovarian category this relationship could be described by a simple `catalytic' model assuming a constant *per capita* rate of infection. For *T. congolense*-type infections this model tended to over-estimate prevalence in older age classes, implying that the rate of infection decreases with age, and/or that infected flies have higher mortality rates, and/or that a significant fraction of the population is resistant to infection. Prevalences of infection also varied between months. This variation was more marked for *T. vivax*-type infections and was negatively correlated with both temperature and rainfall. The

shape of the age-prevalence relationship, however, did not vary significantly between months. These observations are not fully explained by variation in the age-structure of the tsetse population and are consistent with temporal variation in the rate of infection (rather than in the trypanosome developmental period or in effects of infection on fly mortality). Possible causes of this variation are discussed.

5. human trypanosomiasis
(a) SURVEILLANCE
[See also **17**: no. 8210.]

(b) PATHOLOGY AND IMMUNOLOGY

8217 **Braendli, B., Dankwa, E. and Junghanss, T., 1990.** Ostafrikanische Schlafkrankheit (Infektion mit *Trypanosoma rhodesiense*) bei zwei schweizerischen Tropenreisenden. [East African sleeping sickness (*T. b. rhodesiense*) in two Swiss travellers.] *Schweizerische Medizinische Wochenschrift*, **120** (37): 1348-1352.
Poliklinik, Schweizerisches Tropeninstitut, Postfach, CH-4002 Basel, Switzerland.
The case of two Swiss travellers who acquired *rhodesiense* sleeping sickness while visiting the Akagera park in Rwanda is reported. The first patient developed clinical signs of sleeping sickness 8 days after being bitten by a tsetse fly. Trypanosomes were demonstrated in the blood and CSF. The other patient fell ill 13 days after the bite and trypanosomes were found only in blood samples. The first patient (cerebral trypanosomiasis) was treated with melarsoprol. He developed an allergic reaction under treatment but made a good recovery 4 months later. The second patient (haemo-lymphatic trypanosomiasis) was put on suramin, which was well tolerated. He recovered after 2 months.

8218 **Hamon, J.F., Camara, P., Gauthier, P., Arnaud, C. and Gottesmann, C., 1993**. Waking electroencephalograms in the blood-lymph and encephalitic stages of gambian trypanosomiasis. *Annals of Tropical Medicine and Parasitology*, **87** (2): 149-155.

Laboratoire de Psychologie Expérimentale et Comparée, Université de Nice-Sophia Antipolis, 98 boulevard Edouard Herriot, B.P. 209, Nice Cedex 3, France; Laboratoire de Physiologie Animale et de Psychophysiologie, Faculté des Sciences et des Techniques d'Abidjan, 22 B.P. 582, Abidjan, Côte d'Ivoire; Laboratoire de Psychophysiologie, Faculté des

Sciences de Nice, Parc Valrose, 06108 Nice Cedex 2, France; ibid.; ibid.
Waking electroencephalograms (EEG) were recorded from 48 patients infected with *Trypanosoma brucei gambiense*. The EEG of the ten patients with blood-lymph involvement were indistinguishable from those of healthy controls but recordings from the 38 patients with the encephalitic phase of the disease showed three unusual profiles. One profile type, apparently indicative of early cerebral impairment, had a sustained low-voltage background similar to that seen during light sleep. A second profile type, seen in cases with acute cerebral involvement but without focal seizures, showed paroxystic waves. The third unusual EEG pattern was of various types of delta wave (similar to those seen in demyelinating encephalitis) and rapid, intermittent high-voltage delta bursts between periods of lower-voltage delta activity (as often seen in meningo-encephalitis); all types of delta wave were of higher voltage than the spike and wave complexes. Although no definite correlation has been established between the severity of the disease, the results of clinical tests, and waking EEG patterns, it appears that the three types of EEG profile are indicative of the degree of cerebral involvement.

8219 **Herwaldt, B.L. and Juranek, D.D., 1993**. Laboratory-acquired malaria, leishmaniasis, trypanosomiasis, and toxoplasmosis. *American Journal of Tropical Medicine and Hygiene*, **48** (3): 313-323.
Division of Parasitic Diseases, National Center for Infectious Diseases, Centers for Disease Control and Prevention, Atlanta, Georgia, USA.
Laboratory-acquired African trypanosomiasis is generally caused by contact, usually through a break in the skin, with infective blood or tissues from animal or human specimens. This review cites examples of a technician becoming infected with *Trypanosoma brucei gambiense* by scratching his arm with an infected needle and of a student becoming infected with *T. b. rhodesiense*, probably through abrasions on his hands, while separating trypanosomes from the blood of infected rats by column chromatography. Both developed a variety of clinical symptoms associated with trypanosomiasis. Diagnostic techniques are briefly described and include the identification of trypanosomes in blood and lymph node, CSF and bone marrow aspirates, the identification of Mott cells in the CSF, subinoculation and *in vitro* cultivation. Serologic tests are considered more

useful for epidemiological surveys than for diagnosing the disease in individuals. Treatment with melarsoprol or DFMO is effective. Laboratories should have established protocols for handling specimens that may contain viable organisms and for responding to accidents.

8220 **Receveur, M.C., Le Bras, M. and Vincendeau, P., 1993**. Laboratory-acquired gambian trypanosomiasis. (Letter.) *New England Journal of Medicine*, **329** (3): 209-210.
Hôpital Saint André, 33075 Bordeaux, France; ibid.; Université de Bordeaux, 33076 Bordeaux, France.
A 50 year old female technician accidentally pricked her hand with a needle containing *Trypanosoma brucei gambiense* (strain FEO ITMAP-1893) after inoculating mice on 5 March 1992. This strain is not considered to be very pathogenic. The patient developed fever on 13 March and 2 days later part of her hand became swollen. Axillary lymph node involvement and splenomegaly were recorded on 16 March and trypanosomes were isolated from the chancre. Peripheral blood examination was negative but trypanosomes were obtained by concentrating blood on diethylaminoethyl cellulose. Indirect immuno-fluorescence became positive on 23 March. The CSF cell count and proteins were normal. The patient was treated successfully with 280 mg pentamidine by i.m. injection on 16 March and therapy with eflornithine at 400 mg/kg/day for 12 days.

8221 **Soudan, B., Boersma, A., Degand, P. and Tetaert, D., 1993**. Hypogonadism induced by African trypanosomes in humans and animals. (Review.) *Comparative Biochemistry and Physiology (A)*, **104** (4): 757-763.
Unité INSERM No. 16, Place de Verdun, 59045 Lille Cedex, France. (Correspondence to Tetaert.)
The basic knowledge on the hypothalamo-anterior pituitary-gonad axis functions is briefly described. Hypogonadism as a result of trypanosomasis occurs in both men and women as well as in male and female animals and has been extensively documented in publications over the last two decades, providing new insights on the physiopathology of gonadal disorders.

(c) TREATMENT

8222 **Brun, R. (ed.), 1993**. *Advances in chemotherapy of African trypanosomiasis*. *Acta Tropica*, **54** (3-4): 153-308 (special issue).
Swiss Tropical Institute, P.O. Box, CH-4002 Basel, Switzerland.
This special issue gives an overview of the current situation of the disease problem and chemotherapeutic

interventions. It deals with the pharmacokinetics of existing drugs, and with problems of drug resistance and methods for its assessment. In addition, this issue discusses targets for new antitrypanosomal compounds and introduces a new molecule with promising trypanocidal properties. (See **17**: nos. 8182, 8224, 8225, 8248, 8253, 8267, 8271, 8272, 8274, 8277, 8278, 8280, 8284, 8308.)

8223 **Burri, C., Baltz, T., Giroud, C., Doua, F., Welker, H.A. and Brun, R., 1993**. Pharmacokinetic properties of the trypanocidal drug melarso-prol. *Chemotherapy*, **39** (4): 225-234.

Burri, Brun: Swiss Tropical Institute, P.O. Box, CH-4002 Basel, Switzerland; Baltz, Giroud: Laboratoire Immunologie et Parasit-ologie moléculaire, Université Bordeaux II, France; Doua: PRCT, B.P. 1425, Daloa, Côte d'Ivoire; Welker: F. Hoffmann-La Roche Ltd, Basel, Switzerland. (Correspondence to Brun.)

With a biological assay and atomic absorption spectrometry, the level of melarsoprol was determined in the serum and CSF of 19 patients treated with melarsoprol in Daloa, Côte d'Ivoire. Most serum levels were between 2 and 4 μg/ml 24 h after administration, and were still > 0.1 μg/ml after 120 h. Levels in the CSF were between 0 and 0.1 μg/ml. Elimination was biphasic, with a pronounced β_1 phase. Mean terminal elimination half-life of melarsoprol was about 35 h, volume of distribution was about 100 l and total clearance was about 50 ml/min. The results of these first pharmacokinetic studies on melarsoprol were used to simulate possible alternative therapy schemes which might avoid some of the problems that arise with melarsoprol use.

8224 **Doua, F. and Boa Yapo, F., 1993**. Human trypanosomiasis in the Ivory Coast: therapy and problems. *Acta Tropica*, **54** (3-4): 163-168.

PRCT, B.P. 1425, Daloa, Côte d'Ivoire; Service de Neurologie du Centre Hospitalier Universitaire (CHU) de Cocody, Abidjan 01, Côte d'Ivoire.

Human African trypanosomiasis (sleeping sickness) caused by *Trypano-soma brucei gambiense* is recrudescing alarmingly in Côte d'Ivoire. Between 1987 and 1992, 980 new cases were registered. In the Bouaflé District alone, 214 new cases were diagnosed in 1992, with a prevalence reaching 7% in some villages. This situation is a consequence of the neglect of control activities over the last 5 years. The problems linked with treatment of sleeping sickness in 626 patients, using three drugs, are described. The side-effects

vary in severity according to the drug used. Out of 350 patients treated with melarsoprol, 4% developed encephalopathy, 5.7% died during treatment, 2% of encephalopathy. Relapses were noted in 3.7% of patients between 3 and 20 months after treatment. Among 150 patients treated with pentamidine, one case of diabetes mellitus was observed. The patient died of this complication 24 months after treatment. 2% relapses or reinfections were registered after pentamidine treatment. The most frequently encountered side-effects during i.v. plus oral treatment with DFMO were diarrhoea (64.4%) and anaemia (35.5%). This drug was just as effective and better tolerated when treatment was limited to 14 days and administered i.v. only.

8225 **Jennings, F.W., 1993**. Combination chemotherapy of CNS trypano-somiasis. *Acta Tropica*, **54** (3-4): 205-213. Department of Veterinary Parasitology, University of Glasgow, Bearsden Road, Glasgow G61 1QH, UK.

The progress which has been made in the treatment of experimental CNS trypanosomiasis with combination chemotherapy is reviewed. The most significant has been the use of four specific 5-nitroimidazoles in combination with either suramin or the arsenicals. The latter combination of MK 436 and Mel Cy, producing a rapid cure of CNS trypanosomiasis with only a two dose regimen, would make an ideal universal treatment for both early- and late-stage trypanosomiasis. However, the 5-nitroimidazoles, because they are Ames-positive, are unlikely to be developed for use in humans. The combination chemotherapeutic regimen of eflornithine and arsenicals would allow reduced quantities of melarsoprol to be used with similar or increased efficacy. As these drugs are already approved for use in humans, they could be applied immediately to the human disease; however, the quantities of eflornithine required for cures and the basic cost of this compound may limit its use in human medicine. Investigations of the post-treatment reactive encephalopathies (PTRE) which occur after non-curative treatment of trypanosome infections have shown that they are essentially caused by the presence of a residual focus of living trypanosomes in the CNS. If all trypanosomes are eliminated from the CNS (curative treatment) then there are no PTRE and when non-curative treatment is used the reaction can be reduced or ameliorated by supportive treatment with anti-inflammatory drugs such as prednisolone, dexamethasone or azathioprine.

8226 **Milord, F., Loko, L., Ethier, L., Mpia, B. and Pépin, J., 1993**. Eflornithine concentrations in serum and cerebrospinal fluid of 63 patients treated for *Trypanosoma brucei gambiense* sleeping sickness. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, **87** (4): 473-477.
Milord: Département de Santé Communautaire, Hôpital Maison-neuve-Rosemont, 5565 Sherbrooke Est, Montréal, Québec H1N 1A2, Canada; Loko, Mpia: Zone de Santé Rurale de Nioki, Zaire; Ethier, Pépin: Departement de Médecine, Université de Sherbrooke, Sherbrooke, Canada.
Eflornithine (difluoromethylornithine, DFMO) has recently been approved for the treatment of *T. b. gambiense* trypanosomiasis. Treatment failures have been infrequent but have occurred among patients treated with oral DFMO only, and among children. To investigate the higher frequency of failures observed in young patients, DFMO trough concentrations in serum and CSF were measured at the end of treatment in 13 children and 50 adults who had received 200 mg/kg i.v. every 12 h for 14 days. Mean DFMO concentration in CSF was significantly lower among children aged less than 12 years when compared to older patients (25.1 *v*. 68.9 nmol/ml, $P < 0.001$). Mean serum concentration was also lower in children (49.2 *v*. 87.5 nmol/ml, $P = 0.03$). Among patients who received DFMO as initial therapy for sleeping sickness, the mean CSF/serum ratio was lower in children (0.41 *v*. 0.91, $P < 0.005$). The three patients who failed DFMO treatment had CSF trough concentrations around or below 50 nmol/ml. Convulsions and anaemia were associated with higher drug levels and previous therapy with melarsoprol. The lower CSF drug concentrations observed in children could result from higher renal clearance and different CSF pharmacokinetics of DFMO in that age group. To avoid treatment failures, a 6-hourly regimen as well as higher DFMO dosage based on body surface area rather than on weight are recommended for children.

6. animal trypanosomiasis

(a) SURVEY AND DISTRIBUTION

8227 **Fakae, B.B. and Chiejina, S.N., 1993**. The prevalence of concurrent trypanosome and gastrointestinal nematode infections in West African Dwarf sheep and goats in Nsukka area of eastern Nigeria. *Veterinary Parasitology*, **49** (2-4): 313-318.
Department of Veterinary Parasitology and Entomology, University of Nigeria, Nsukka, Nigeria.

The prevalence of concurrent nematode-trypanosome infections in traditionally reared West African Dwarf sheep and goats in eastern Nigeria was monitored over a 12-month period during 1987-1988. The most prevalent nematodes were *Haemonchus contortus* and *Trichostrongylus colubriformis*, which usually occurred together in all nematode infected animals. Their combined prevalence rates ranged from 90 to 100% throughout the year and they accounted for 66 to 98% of the total monthly worm burdens. Of the 107 animals examined, 13.6% were infected with trypanosome species comprising *Trypanosoma brucei* (50%), *T. congolense* (43%) and *T. vivax* (36%). No clear seasonal pattern was observed in the prevalence of concurrent nematode-trypanosome infection but owing to the widespread prevalence of gastrointestinal nematode infections, all trypanosome infected animals were invariably infected with *H. contortus* and *T. colubriformis*.

8228 **Hagebock, J.M., Chieves, L., Frerichs, W.M. and Miller, C.D., 1993**. Evaluation of agar gel immunodiffusion and indirect fluorescent antibody assays as supplemental tests for dourine in equids. *American Journal of Veterinary Research*, **54** (8): 1201-1208.
USDA, Animal and Plant Health Inspection Service, Veterinary Services, National Veterinary Services Laboratories, Ames, IA 50010, USA.
A total of 787 serum and blood samples, obtained from equids before and three times a week after exposure to *Trypanosoma equiperdum*, were tested by the complement fixation (CF), indirect fluorescent antibody (IFA) and agar gel immunodiffusion (AGID) assays. The disease was diagnosed earlier by IFA and CF than by AGID, and IFA was more sensitive than AGID.

8229 **Maloo, S.H., 1986 [1987]**. Trypanosomiasis on the East African coast. *Kenya Veterinarian*, **10** (2): 41-42. (See **17**: no. 8177.)
Veterinary Investigation Laboratory. P.O. Box 204, Mariakani, Kenya.
The health and productivity of Zebu cattle under village management in the Coast Province of Kenya were evaluated and the cost-effectiveness of trypanocidal drugs was assessed. The study area was infested with *Glossina pallidipes*, *G. brevipalpis* and *G. austeni*, with trypanosome infection rates of 0-9.89%, 0-19.2% and 0-12.5% respectively. Trypanosomiasis was the most common disease with an infection rate reaching 10%. All animals were treated with Berenil once a positive case was detected, followed 1 week later by 1.0 mg/kg Samorin to the entire herd. The use of Samorin at 0.5 mg/kg as a prophylactic drug every 83 days resulted in productivity figures comparable to those obtained for Boran cattle reared in tsetse-free areas of Kenya.

8230 **Office International des Epizooties, 1991**. *Manual of recommended diagnostic techniques and requirements for biological products for lists A and B diseases, volume III.* Paris; OIE.
This manual was prepared by the Standards Commission under the sponsorship of OIE and contains standardised protocols, accepted by OIE's 114 member countries, for the laboratory diagnosis of diseases infecting domestic animals involved in international trade. Protocols for the safe handling of biological products such as live vaccines are also included. Volume III covers 28 diseases and includes sections on trypanosomiasis (prepared by P. Finelle) and surra (*T. evansi*) (prepared by P. Kageruka). Dourine is included in volume II (1990). Introductory chapters on sampling methods,

tests for sterility, and safety in the laboratory are included.

8231 **Olaho-Mukani, W., Mukunza, F., Kimani, J.K., Njoka, P.K. and Walubengo, J., 1993**. Evaluation of the *in vitro* transformation technique to distinguish *Trypanosoma evansi* from cyclically transmitted *Trypanozoon* stocks. *Tropical Medicine and Parasitology*, **44** (2): 108-110.
KETRI, P.O. Box 362, Kikuyu, Kenya.
Known *T. evansi* stocks were successfully distinguished from *T. b. brucei*, *T. b. rhodesiense* and *T. b. gambiense* stocks by their inability to transform into procyclic forms *in vitro*. When 64 stocks of monomorphic *brucei* subgroup field isolates from camels were tested by this technique, three transformed into procyclic forms, confirming the existence of *T. b. brucei* infection in camels kept close to tsetse belts.

8232 **Saint-Martin, G., Buron, S. and Le Horgne, J.M., 1992**. *Place de la trypanosomose dans la clinique cameline de quatre projets d'élevage en Mauritanie, au Niger, au Soudan et au Tchad*. [The trypano-somiasis situation in the health of camels in four rearing projects in Mauritania, Niger, Sudan and Chad.] (Paper presented at the First International Seminar on Non-Tsetse Transmitted Animal Trypano-somoses, Annecy, France, 14-16 October 1992.) Veyrier-du-Lac, France; Fondation Marcel Mérieux, Centre Collaborateur OMS. 11 pp.
Saint-Martin, Le Horgne: Unité de Coordination pour l'Elevage Camelin, CIRAD-EMVT, 10 rue Pierre Curie, 94704 Maisons Alfort Cedex, France; Buron: 06 B.P. 9406, Ouagadougou 06, Burkina Faso.
The improvement of the health of dromedary camels was of prime importance in four research and development projects on camel rearing based at Biltine in Chad, Butana in Sudan, Zinder in Niger and South Trarza in Mauritania. The incidence of trypanosomiasis at each of these four centres is discussed, with reference to the main epidemiological features, the unreliability of results obtained using laboratory diagnostic techniques in the field (detection of *Trypanosoma evansi* by thick blood film or microHCT), effective non-toxic trypanocidal drugs and the ability of different pastoral societies to supply the cost of treatment. Some solutions are proposed for obtaining chemotherapy without external support.

8233 **Turkson, P.K., 1993**. Seroepidemiological survey of cattle trypanosom-iasis in coastal savanna zone of Ghana. *Acta Tropica*, **54** (1): 73-76.

Department of Animal Science, School of Agriculture, University of Cape Coast, Cape Coast, Ghana.
The prevalence of bovine trypanosomiasis was studied at four locations in the Winneba district, a humid coastal area with thicket and grassland vegetation. Cattle were managed by sedentary pastoralism and disease control was largely neglected. The level of tsetse challenge was not ascertained but is thought to be low. The double antibody sandwich ELISA technique was used and trypanosome antigens were found in 38% of the sera examined. *Trypanosoma vivax* was most commonly detected (104/340), followed by *T. brucei* (58/340) and *T. congolense* (27/340). There was a high overall prevalence (32%) of mixed infections of two (21 □ 3%) or three (11 □ 3%) trypanosome species. At location I, where the herd consisted predominantly of N'Dama cattle, 60% of the infections were mixed. Trypanocides were being used indiscriminately at some locations. Berenil at 5-7 mg/kg is recommended for *T. brucei* infections but the presence of high proportions of cattle with circulating *T. brucei* antigens and mixed infections involving *T. brucei* suggests a higher dose may be necessary to prevent the development of resistant strains. Chemotherapy is the main control method for trypanosomiasis in Ghana but there is an urgent need for legislation and education in drug use.

8234 **Waitumbi, J.N. and Nantulya, V.M., 1993**. A comparison of the antigen detection ELISA and parasite detection for diagnosis of *Trypanosoma evansi* infections in camels. *Veterinary Parasitology*, **49** (2-4): 159-178.

Biologie Moléculaire et Immunologie de Protozoaires Parasites, Université de Bordeaux II, 146 rue de Léo Saignat, 33076 Bordeaux, France; ILRAD, P.O. Box 30709, Nairobi, Kenya.
Two herds of 60 camels each, living in *T. evansi* endemic areas, were selected and studied for a period of 18 months. Animals in one herd were treated prophylactically with quinapyramine prosalt, while those in the other herd were treated individually with quinapyramine dimethylsulphate when proven parasitaemic. The herd on prophylaxis was sampled for antigen and patent infection monthly. The other herd was sampled weekly for patent infection and fortnightly for antigen. The results obtained could be divided into four categories. The first category comprised cases (52 out of 61) in which the presence of trypanosome antigens could be correlated with parasitological diagnosis. In 80% of these animals the

antigens disappeared from the circulation within a period of 30 days following chemotherapy. The second category comprised those animals with parasitologically proven infections but which did not have antigens in their sera. This was observed in nine camels, seven of which were from the herd that was being examined weekly for the presence of trypanosomes. These were considered to be animals in early infection, as the subsequent sera were also negative for anti-trypanosome antibodies and immune complexes. The third category comprised camels which were antigen-positive but aparasitaemic. Sera from these animals were also positive for anti-trypanosome antibodies, indicating that antigen-positivity was a true reflection of trypanosome infections in these animals. The last category comprised pre-weaned camel calves which appeared to have some form of protection against trypanosomosis, as evidenced by the absence of trypanosomes, antigens and antibodies throughout the early period of their lives. Only occasional antigenaemia was found in a few calves. It is concluded that trypanosome antigen detection may give a more accurate idea of the prevalence of *T. evansi* infections than does whole parasite detection.

(b) PATHOLOGY AND IMMUNOLOGY

[See also **17**: nos. 8221, 8247.]

8235 **Abebe, G., Eley, R.M. and ole-MoiYoi, O.K., 1993**. Reduced responsiveness of the hypothalamic-pituitary-adrenal axis in Boran (*Bos indicus*) cattle infected with *Trypanosoma congolense*. *Acta Endocrinologica*, **129** (1): 75-80.

Faculty of Veterinary Medicine, Addis Ababa University, Debre Zeit, Ethiopia; Institute of Primate Research, National Museums of Kenya, P.O. Box 24481, Nairobi, Kenya; ILRAD, P.O. Box 30709, Nairobi, Kenya. (Correspondence to ole-MoiYoi.)

The response of the pituitary-adrenal axis to corticotrophin-releasing hormone (CRH) and the adrenal response to adrenocorticotrophin hormone (ACTH) stimulation were studied during infection of Boran cattle with *T. congolense*. For CRH, 15 animals were challenged during pre-infection and infection phases, while for ACTH ten animals were challenged during pre-infection, infection and post-treatment phases of the experiments. The axis showed a reduced responsiveness after CRH challenge during patent parasitaemia, manifested by low ($P < 0.05$) plasma ACTH and cortisol concentration as compared to the pre-infection CRH challenge concentrations. Cortisol concentration after

ACTH challenge during pre-infection, infection and post-treatment phases did not differ. The reduced pituitary-adrenal response to CRH challenge and the normal adrenal response to ACTH challenge found during trypanosomiasis indicates pituitary dysfunction due to infection.

8236 **Abebe, G., Shaw, M.K. and Eley, R.M., 1993**. *Trypanosoma congolense* in the microvasculature of the pituitary gland of experimentally infected Boran cattle (*Bos indicus*). *Veterinary Pathology*, **30** (5): 401-409.

ILRAD, P.O. Box 30709, Nairobi, Kenya; ibid.; Institute of Primate Research, National Museums of Kenya, P.O. Box 24481, Nairobi, Kenya.

The pituitary glands of seven Boran cattle, five infected with a clone of *T. congolense* IL 1180 (ILNat 3.1) transmitted by *Glossina morsitans centralis* and two uninfected controls, were examined by light and electron microscopy 43 (experiment 2) or 56 (experiment 1) days after fly challenge. The three cattle used in the first experiment included a 15-month-old female (no. 1), a 24-month-old female (no. 2), and a 21-month-old male (no. 3) as a control. In the second experiment, four cattle were used: two females (nos. 4, 5) and one male (no. 6), all between 15 and 24 months of age, and one female control (no. 7) of similar age. In all the infected animals, dilation of both the sinusoids and the microvasculature was apparent, as was an increase in the thickness of the extracellular matrix between the pituitary lobules. Trypanosomes were found in the microvasculature of the adenohypophysis and neurohypophysis in all the infected animals. Focal degenerative changes were seen in the adenohypophyseal section of glands from the infected animals euthanatised 56 days p.i. These degenerative structural changes were confined to the somatotrophic cells. The possible role that trypanosomes in the microvasculature may play in inducing pituitary damage and dysfunction is discussed.

8237 **Authié, E., Duvallet, G., Robertson, C. and Williams, D.J.L., 1993**. Antibody responses to a 33 kDa cysteine protease of *Trypanosoma congolense*: relationship to `trypanotolerance' in cattle. *Parasite Immunology*, **15** (8): 465-474.

Authié, Williams: ILRAD, P.O. Box 30709, Nairobi, Kenya; Duvallet: CIRDES, Bobo-Dioulasso, Burkina Faso; Robertson: Department of Statistics and Modelling Science, University of Strathclyde, Glasgow G1 1XH, UK.

A cysteine protease of *T. congolense* (congopain) previously elicited IgG1 antibodies in those cattle

which exhibited a degree of resistance to disease during experimental infections. The aim of the present study was to investigate further the association between anti-congopain antibodies and resistance to trypano-somiasis, and to provide a lead into the mechanisms responsible for the differential responses to congopain in cattle. Isotype characteristics and kinetics of the antibody response to congopain were studied in three N'Dama (trypano-resistant) and three Boran (susceptible) cattle during primary infection with *T. congolense* ILNat 3.1. In both groups an IgM response to congopain was elicited, thus demonstrating that congopain is antigenic in both types of cattle. Most of the IgM appeared to be incorporated into immune complexes. IgG was detected as free antibody: IgG1 but not IgG2 was detected. All three N'Dama, but none of the three Boran cattle, mounted a significant IgG response to congopain. Sera from 70 primary-infected cattle belonging to five breeds of differing susceptibility were tested for their reactivity to congopain. High levels of IgG to congopain were observed in the two trypanotolerant breeds, whereas the three susceptible breeds had lower levels of these antibodies. Crosses between N'Dama and Boran cattle, which exhibit an intermediate susceptibility, had intermediate levels of antibodies. Thus, the results from experimental infections confirmed our initial observations. However, under natural tsetse challenge, repeated infections and trypanocidal treatments in Zebu cattle stimulated as high anti-congopain antibody levels as in non-treated trypanotolerant taurine cattle.

8238 **Clausen, P.-H., Sidibé, I., Bassinga, A., Richard, X., Bauer, B. and Pohlit, H., 1993**. Pathogenesis and pathology of African trypano-somosis in Baoulé, N'Dama/Baoulé cross bred and Zebu cattle in Burkina Faso. 1. Clinical performance under high natural tsetse challenge. *Tropical Medicine and Parasitology*, **44** (2): 99-107.

Clausen: Institute for Veterinary Medicine (Robert von Ostertag Institute) of the Federal Health Office, P.O. Box 480 447, D-12254 Berlin, Germany; other authors: CRTA, B.P. 753, Bobo-Dioulasso, Burkina Faso.

The pathogenesis and pathology of African animal trypanosomosis in Baoulé, N'Dama/Baoulé cross bred and Zebu cattle was studied from 1987 to 1991 in a series of experiments conducted under natural and artificial conditions of challenge at CRTA in Burkina Faso. This first paper reports on the clinical performance of 64

Baoulé, ten N'Dama/Baoulé cross bred and 20 Zebu cattle, which were transferred to the pastoral zone of Satiri, 50 km north-east of Bobo-Dioulasso, a zone infested with *Glossina palpalis gambiensis*, *G. morsitans submorsitans* and *G. tachinoides*. Prior to the experiment, the cattle had been raised in a fly-proof stable and at the CRTA breeding station, an area of extremely low incidence of trypanosomosis, or had been exposed at least once to natural trypanosome challenge in an area of high *Glossina* density. The cattle were monitored daily for clinical performance. Blood samples were collected twice weekly and examined on the spot for PCV and parasitaemia. In the blood of 98% of the cattle trypanosomes (*Trypanosoma vivax*, *T. congolense*) were detected. Significant inter- and intra-breed differences with respect to the clinical performance were recorded. Regarding general health, the humpless Baoulé and N'Dama/Baoulé cross bred cattle (*Bos taurus*) proved to be superior to the humped Zebu cattle (*B. indicus*) under this high challenge. Previous exposure to natural challenge had a positive effect on survival for both Baoulé and Zebu cattle. The phenotypic variation in response to trypanosomosis was small in Baoulé previously exposed and large in Baoulé previously not exposed. The repeatability of the former classification was fairly high, indicating the possibility of a genetic basis for this trait. Mechanisms of innate and acquired resistance as well as environmental and management factors should be considered as affecting phenotypic variation in response to trypanosomosis.

8239 **Flynn, J.N. and Sileghem, M., 1993**. Immunosuppression in trypano-tolerant N'Dama cattle following *Trypanosoma congolense* infection. *Parasite Immunology*, **15** (9): 547-552. MRC Retrovirus Laboratory, Department of Veterinary Pathology, University of Glasgow, Bearsden, Glasgow G61 1QH, UK; ILRAD, P.O. Box 30709, Nairobi, Kenya.

Tsetse-transmitted *T. congolense* infection causes an impairment of *in vitro* T cell proliferative responses in Boran (*Bos indicus*) cattle. To assess the importance of this phenomenon as it may relate to the ability of trypanotolerant cattle to control infection with trypanosomes, T cell proliferative responses to mitogenic stimulus with Concanavalin A were measured in N'Dama (*Bos taurus*) cattle throughout infection. The responses of peripheral blood mononuclear cells from Boran and N'Dama cattle were similar. Depressed proliferative responses were observed with cells of both breeds at 12 days p.i., after which the responses

returned to levels similar to those recorded pre-infection. Immunosuppression was also studied in the lymph nodes of a major histocompatibility complex (MHC)-matched pair of N'Dama cattle. Lymph node cells from the infected animal failed to respond to mitogenic stimulus. Co-culture experiments in which the cells from this node were mixed with either lymph node cells or peripheral blood mononuclear cells from the non-infected MHC-compatible animal revealed the presence of suppressor cells, acting in a prostaglandin-independent manner, capable of arresting mitogen-induced T cell proliferation.

8240 **Katunguka-Rwakishaya, E., Parkins, J.J., Fishwick, G., Murray, M. and Holmes, P.H., 1993**. The influence of dietary protein on body weight, anaemia and lipid metabolism in sheep infected with *Trypanosoma congolense*. (Meeting abstract.) *Transactions of the Royal Society of Tropical Medicine and Hygiene*, **87** (1): 121.

Departments of Veterinary Physiology (Katunguka-Rwakishaya, Holmes), Veterinary Animal Husbandry (Parkins, Fishwick) and Veterinary Medicine (Murray), University of Glasgow Veterinary School, Bearsden Road, Glasgow G61 1QH, UK.

The levels of parasitaemia, degree of anaemia, plasma cholesterol concentrations and live weight gains were measured in two groups of sheep infected with *T. congolense* and given a high (cp = 17.6%) and a low (cp = 8.1%) protein diet respectively, and were compared with those of non-infected controls on similar diets. Infected animals on the high protein diet tended to develop higher parasitaemia than those on the low protein diet but both infected groups developed similar degrees of anaemia. Infected and non-infected sheep on the high protein diet grew at the same rate, whereas growth was retarded in infected animals compared with non-infected animals on the low protein diet. Both infected groups developed significant hypocholesterolaemia. Following treatment 70 days p.i., both infected groups showed a recovery in PCV but the rate of recovery was greatest in animals on the high protein diet. The level of protein intake therefore appears to play an important role in the pathogenesis of animal trypanosomiasis and influences the rate of recovery following chemotherapy.

8241 **Seely, C., Mutayoba, B.M., Eckersall, P.D., Gray, C.E. and Holmes, P.H., 1993**. The effects of experimental infection with *Trypanosoma congolense* on the adrenocorticoid responses in Scottish blackface rams. (Meeting abstract.)

Transactions of the Royal Society of Tropical Medicine and Hygiene, **87** (1): 123-124.
Seely, Mutayoba, Eckersall, Holmes: Departments of Veterinary Physiology and Veterinary Biochemistry, University of Glasgow Veterinary School, Bearsden Road, Glasgow G61 1QH, UK; Gray: Glasgow Royal Infirmary, 84 Castle Street, Glasgow G3 7NB, UK.
Ten 6 month old rams were i.v. infected with *T. congolense* while another ten served as uninfected controls. Disease was confirmed by the presence of fluctuating parasitaemia and lowered PCV. Growth rate was depressed in infected animals and rectal temperatures were on average 1□C higher. At 4, 9 and 13 weeks p.i., groups of infected and control animals were injected with corticotrophic releasing hormone and blood was collected at frequent intervals for the next 3 h. Levels of cortisol released and, in samples collected 4 weeks p.i., adrenocorticotrophic hormone (ACTH) were determined. Cortisol levels were not significantly different between infected and control animals 4 weeks p.i. but ACTH was significantly lower in infected animals. At 9 and 13 weeks, levels of cortisol were significantly higher in infected animals. The results suggest that *T. congolense* disturbs the adrenocorticoid responses in sheep and illustrate the complexity of trypanosome pathogenesis in ruminants.
8242 **Whitelaw, D.D., 1986 [l987]**. The goat as a model for the study of cerebral trypanosomiasis: chemotherapeutic implications. *Kenya Veterinarian*, **10** (2): 29. (See **17**: no. 8177.)
ILRAD, P.O. Box 30709, Nairobi, Kenya.
The East African isolate of *Trypanosoma brucei brucei*, which can cause clinical CNS disease in cattle, is particularly virulent in goats. Anaemia, weakness and loss of condition occur rapidly and CNS abnormalities are manifested by unsteady gait, depression, head pressing, circling, opisthotonus and meningitis. Berenil chemotherapy is apparently curative but relapse often occurs 2-3 months later. Clinical CNS symptoms reappear with severe meningo-encephalitis, which also characterises human sleeping sickness. Relapse occurs when sequestered trypanosomes emerge from the CNS after trypanocide levels in the blood drop: no commonly used animal trypanocides cross the blood-brain barrier in sufficient quantities to eliminate the parasites. There is also a CNS phase of infection in *T. vivax* and similar relapses occur after chemotherapy. Relapse in

animals cannot therefore be solely attributed to drug resistance or reinfection.

8243 **Winstanley, F.P., Holmes, P.H., Katunguka-Rwakishaya, E., Parkins, J.J., Fishwick, G. and Murray, M., 1993**. Tumour necrosis factor α receptor activity in ovine trypanosomiasis caused by *Trypanosoma congolense*. (Meeting abstract.) *Transactions of the Royal Society of Tropical Medicine and Hygiene*, **87** (1): 125.

Institute of Biochemistry, University of Glasgow, Glasgow, UK; Departments of Veterinary Physiology (Holmes, Katunguka-Rwakishaya), Veterinary Animal Husbandry (Parkins, Fishwick) and Veterinary Medicine (Murray), University of Glasgow Veterinary School, Bearsden Road, Glasgow G61 1QH, UK.

Tumour necrosis factor α receptor (TNF-R) activity on peripheral blood leucocytes was studied for 72 consecutive days in groups of twin male castrated lambs: one twin of each pair was infected with *T. congolense* and the other served as control. The effects of infection and dietary energy intake on TNF-R activity were studied. The most marked effect of infection was an increase in TNF-R activity on granulocytes; less marked changes were observed with monocytes. The rise and fall in proportion of TNF-R positive granulocytes reflected, but lagged behind, the rise and fall of circulating parasites. Animals on a high energy diet showed marginally greater TNF-R activity than those on low energy intake (P = 0.13), which correlated inversely with the overall parasite burden.

(c) TRYPANOTOLERANCE

[See also **17**: nos. 8237, 8238, 8239.]

8244 **Grootenhuis, J.G., 1986 [1987].** Trypanotolerance in wildlife. *Kenya Veterinarian*, **10** (2): 45-46. (See **17**: no. 8177.)

Veterinary Research Laboratories, Kabete, Kenya.

African wild Bovidae reared trypanosome-free appear to have innate mechanisms for limiting the effects of trypanosomiasis, by controlling either parasite growth or anaemia. Buffalo and cattle had similar rates of tsetse attractiveness and about 20% of the attracted flies would engorge. Waterbuck attracted very few tsetse and none of them engorged; eland and oryx were intermediate between these extremes. Experimental *Trypanosoma congolense*, *T. vivax* and *T. brucei* infections in buffalo showed low levels of parasitaemia, whereas levels in infected waterbuck were close to those in cattle. However, unlike cattle, waterbuck were able to

control anaemia. The first peak of parasitaemia in eland and buffalo apparently induced a parasite growth control mechanism independent of antibody response. Experimental infections in buffalo and Boran cattle showed the prepatent period to be about 21 days in the former and 12 days in the latter. Antibodies were found in buffalo prior to detectable parasitaemia but in cattle approximately 1 week after the first peak of parasitaemia. The buffalo appears to be a suitable model for studying trypano-tolerance in cattle.

8245 **Njogu, A.R., 1986 [1987]**. Trypanotolerance: a look to the future in East Africa. *Kenya Veterinarian*, **10** (2): 47. (See **17**: no. 8177.)

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

Financial and other constraints on trypanosomiasis control indicate that the development of trypanotolerant breeds is essential to increase cattle productivity in Kenya. Comparative studies have shown that birth weights, weaning weights and post-weaning growth rates are generally lower in Orma Boran compared with improved Kenya (Galana) Boran, but under severe trypanosome challenge this is reversed and the Orma Boran perform better. Irrespective of the level of challenge, both pre- and post-weaning mortality due to trypanosomiasis are significantly lower in Orma Boran, which require fewer prophylactic treatments with isometamidium than improved Borans. Trypanotolerant breeds should be surveyed throughout Kenya and their performance under tsetse challenge compared. The large Orma Boran could be developed for beef production, with selection for weight gain and trypanosomiasis resistance.

8246 **Paling, R.W., Maehl, J.H.H., d'Ieteren, G., Leak, S.G.A. and Trail, J.C.M., 1986 [1987]**. The Trypanotolerance Network: objectives and organization. *Kenya Veterinarian*, **10** (2): 43-44. (See **17**: no. 8177).

Paling, Leak: ILRAD, P.O. Box 30709, Nairobi, Kenya; Maehl, d'Ieteren, Trail: ILCA, P.O. Box 46847, Nairobi, Kenya.

The Trypanotolerance Network was established to evaluate the productivity of different breeds of cattle, sheep and goats exposed to different levels of tsetse challenge under various management systems. Its objective is to improve livestock production in tsetse infested areas by achieving a better understanding of genetic resistance, acquired resistance and factors which affect susceptibility and the efficacy of control, and by ensuring a better application of

current knowledge. Baseline data will be provided for economic planners and by applying economic analysis to composite productivity indices it should be possible to evaluate the cost-effectiveness of existing and new methods of control. A network of trypanotolerant livestock projects has been built up in West, Central and East Africa with technical assistance from ILRAD and ILCA.

(d) TREATMENT

[See also **17**: nos. 8178, 8188, 8200, 8222, 8229, 8233, 8242.]

8247 **Egbe-Nwiyi, T.N. and Antia, R.E., 1993**. The effect of trypanocidal drug treatment on the haematological changes in *Trypanosoma brucei brucei* infected splenectomised dogs. *Veterinary Parasitology*, **50** (1-2): 23-33.

Department of Veterinary Pathology, University of Maiduguri, P.M.B. 1069, Maiduguri, Borno State, Nigeria; Department of Veterinary Pathology, University of Ibadan, Ibadan, Nigeria.

Twenty adult mongrel dogs of both sexes were used. Ten of the dogs were splenectomised and the remaining dogs were left intact. Five dogs each from the splenectomised and non-splenectomised (intact) animals were infected i.v. with *T. b. brucei* while the rest served as uninfected controls. All the infected dogs developed trypanosomosis between days 4 and 8 p.i. The PCV, haemoglobin concentration, total red blood cell count and white blood cell count decreased progressively, indicating anaemia and leucopenia. The absolute reticulocyte counts were increased. Splenectomy enhanced fever, reticulocytosis and parasitaemia but delayed the onset of anaemia and leucopenia. It also shortened the prepatent period of the infection. The treatment of the infected dogs with diminazene aceturate at the dose rate of 7.0 mg kg^{-1} body weight on day 21 p.i. cleared the parasites in blood within 24 h and resulted in complete reversal of all the haematological aberrations observed. Splenectomy did not enhance or inhibit the recovery rate in the animals after treatment.

8248 **Kinabo, L.D.B., 1993**. Pharmacology of existing drugs for animal trypanosomiasis. *Acta Tropica*, **54** (3-4): 169-183.

Department of Veterinary Physiology, Biochemistry, Pharmacology and Toxicology, Sokoine University of

Agriculture, P.O. Box 3017, Chuo Kikuu, Morogoro, Tanzania.
Lack of much interest by the pharmaceutical industry to venture into development of new antitrypanosomal drugs has been a major stimulus to an intensification of research into the few existing drugs. Those indicated for animal trypanosomiasis include: isometamidium, homidium and diminazene, used primarily against *Trypanosoma congolense*, *T. vivax* and *T. brucei*; and quinapyramine, mainly indicated for use against *T. evansi* infections. A great deal of research effort has focused on development of pharmacological and parasitological methodologies, which have considerably advanced our understanding of the efficacy, resistance, disposition and toxicological mechanisms of these drugs. While a clinical breakthrough has recently been made, in the field of chemo-therapy of *T. evansi* infections by the introduction of a new arsenic compound, melarsenoxide cysteamine, chemotherapy of *T. simiae* infections in pigs still remains a major challenge because the existing drugs are either ineffective or too toxic for economic use. Further research into the existing drugs is a prerequisite for their optimal usage in the overall effort of improving animal health and productivity through control of trypanosomiasis.

8249 **Kratzer, R.D., 1986 [1987].** Methods for measuring the fate of trypano-cides in the animal body. *Kenya Veterinarian*, **10** (2): 28. (See **17**: no. 8177.)
KETRI/IAEA, P.O. Box 362, Kikuyu, Kenya.
This brief review considers quantitative methods for determining trypano-cide levels in animal tissues. Chromatogram spectrophotometry can be used to detect fluorescent trypanocides in serum at concentrations down to 0.02 μg/ml. High pressure liquid chromatography (HPLC) combined with preconcentration on silica gel columns can reduce the detection limit to 0.001 μg/ml serum. A similar level of sensitivity can be obtained by microscope fluorometry which can measure the drug uptake of single trypanosomes. Trypanocides radiolabelled with either tritium (^{3}H) or radiocarbon (^{14}C) can be detected by a scintillation counter: this is the most sensitive and reliable (but expensive) method and it is used to standardise other techniques, such as HPLC.

8250 **Mamman, M., Aliu, Y.O. and Peregrine, A.S., 1993.**
Comparative pharmacokinetics of diminazene in noninfected Boran (*Bos indicus*) cattle and Boran cattle

infected with *Trypanosoma congolense*. *Antimicrobial Agents and Chemotherapy*, **37** (5): 1050-1055.
Mamman, Peregrine: ILRAD, P.O. Box 30709, Nairobi, Kenya; Aliu: Department of Veterinary Physiology and Pharmacology, Ahmadu Bello University, Zaria, Nigeria. (Correspondence to Peregrine.)
The pharmacokinetics of diminazene in five female Boran cattle before and during acute and chronic phases of experimental infections with *T. congolense* were investigated. A 7.0% (wt/vol) solution of diminazene aceturate (Berenil) was used in all three phases of the study and administered as a single i.m. dose of 3.5 mg of diminazene base per kg of body weight. There were no significant differences between the values of pharmacokinetic parameters for the noninfected cattle and the values for cattle with a chronic *T. congolense* infection. However, the maximum concentration of the drug in plasma during the acute phase of infection (8.25 □ 1.72 μg/ml) was significantly ($P < 0.01$) greater than that during chronic infection (5.04 □ 0.26 μg/ml) and that in the noninfected (4.76 □ 0.76 μg/ml). Similarly, the time to maximum concentration of the drug in plasma when diminazene was administered during the acute phase of infection (18.0 □ 6.71 min) was significantly ($P < 0.02$) shorter than that for noninfected cattle (36.00 □ 8.22 min) and that during chronic infection (33.75 □ 7.50 min). The volume of distribution at steady state during acute infection (1.01 □ 0.31 l/kg) was significantly ($P < 0.01$) smaller than that in the noninfected state (1.37 □ 0.17 l/kg) and that in chronic infection (1.51 □ 0.24 l/kg). Eight hours after the drug had been administered, the concentration-time data profiles for each of the three study phases were very similar. Mean concentrations of diminazene in plasma 48 h after administration of the drug were 0.43 □ 0.07 μg/ml in noninfected cattle, 0.43 □ 0.11 μg/ml during the acute phase of trypanosome infection, and 0.44 □ 0.09 μg/ml during the chronic phase of the infection. Results of the present study indicate that the area under the concentration-time curve for diminazene in trypanosome-infected cattle did not differ significantly from that for noninfected cattle. It therefore appears that the total amount of diminazene attained and maintained in the plasma of cattle is not significantly altered during infection with *T. congolense*.
8251 **Mamman, M., Katende, J., Moloo, S.K. and Peregrine, A.S., 1993**. Variation in sensitivity of *Trypanosoma congolense* to

diminazene during the early phase of tsetse-transmitted infection in goats. *Veterinary Parasitology*, **50** (1-2): 1-14. ILRAD, P.O. Box 30709, Nairobi, Kenya. (Correspondence to Peregrine.)

Twenty-five goats were randomly allocated to five groups of five animals each and infected with *T. congolense* IL 3274 via the bites of infected *Glossina morsitans centralis*. At intervals of 1, 4, 8, 12 or 19 days following infection, each group of five animals was treated i.m. with diminazene aceturate at a dose of 7.0 mg kg^{-1} body weight (b.w.). While treatment on day 1 eliminated infections in all five goats, treatment on day 19 did not cure any of the animals; in groups treated 4, 8 or 12 days following infection, two of five goats in each group were cured. Since the alteration in apparent resistance of *T. congolense* IL 3274 between day 1 and day 19 could have been due to alteration in expression of drug resistance by trypanosomes as the population expanded, the experiment was repeated using trypanosomes that reappeared in the animals that had been treated with diminazene aceturate on day 19. On day 36, when all five animals were parasitaemic, five groups of teneral *G. m. centralis*, each containing 160 flies, were fed on one occasion on each of the five goats (one group of tsetse flies per goat). Thereafter, each group of tsetse flies was maintained on clean rabbits. When infective, five flies from each group were allowed to feed on two naive goats each (i.e. two goats per group of tsetse flies). One animal in each pair was treated 24 h after infection with diminazene aceturate at a dose of 7.0 mg kg^{-1} b.w., the other was treated on day 19, when parasitaemic, with the same drug dosage. As before, treatment 24 h following infection eliminated infections in all animals, but when treatment was delayed until day 19, trypanosomes in all animals were refractory to treatment. Thus, although tsetse flies were infected with trypanosomes that had arisen in infected goats following treatment with diminazene aceturate at a dose of 7.0 mg kg^{-1} b.w., when the same flies were allowed to feed on clean goats, the resultant infections were sensitive to treatment with the same drug dosage when administered 24 h following infection. These data therefore indicate that there is a significant alteration in diminazene sensitivity of IL 3274 between day 1 and day 19 and that this is associated with an alteration in the resistance phenotype of the trypanosomes.

8252 **Mbwambo, H.A., Mella, P.N.P. and Lekaki, K.A., 1988**. Trypanosom-iasis chemotherapy: further observations on a strain of *Trypanosoma congolense*, resistant to diminazene aceturate. *Tanzania Veterinary Bulletin*, **8** (4): 45-51. Tanzania Livestock Research Organization, Animal Diseases Research Institute, P.O. Box 9254, Dar es Salaam, Tanzania.
Twenty-nine cattle from a medium challenge area of Tanzania, naturally infected with *T. congolense* (Kibaha isolate), were treated with diminazene aceturate at four different dosages (3.5, 7.0, 10.5 and 14.0 mg/kg). Nine animals responded positively to a dose of 3.5 mg/kg, 14 to 7.0 mg/kg and six were refractory to treatment at 3.5-14.0 mg/kg. Further treatment of diminazene aceturate-resistant strains with isometamidium chloride at 1.0 mg/kg effected cure in all animals. Corresponding chemotherapeutic trials in mice showed that the isolate was resistant to diminazene aceturate at 5.0, 7.0, 10.5, 14.0, 28.0 and 56.0 mg/kg. Further trials in mice with isometamidium chloride at doses of 0.5, 1.0, 2.0, 4.0, 8.0 and 16.0 mg/kg were characterised by relapses followed by death, whereas 20.0 mg/kg effected cure. Care in treating cattle with this sanative pair of drugs is urged to avoid problems of resistance. The use of isometamidium chloride at 1.0 mg/kg is recommended where diminazene aceturate at 7.0 mg/kg fails to clear *T. congolense* infections.

8253 **Peregrine, A.S. and Mamman, M., 1993**. Pharmacology of diminazene: a review. *Acta Tropica,* **54** (3-4): 185-203. ILRAD, P.O. Box 30709, Nairobi, Kenya.
Chemotherapy for trypanosomiasis in domestic livestock depends on only a few compounds, of which several are chemically closely related. Of these compounds, the most widely used therapeutic agent in cattle, sheep and goats is diminazene aceturate. Diminazene was first described in 1955. Subsequently, a substantial body of data has been generated on various pharmacological aspects of the compound. This review considers the current status of knowledge concerning the therapeutic spectrum of diminazene, resistance to diminazene in trypanosomes, and combination therapeutic regimens in which diminazene has been administered together with other compounds. Analytical techniques for diminazene, the pharmacokinetics of diminazene, data concerning diminazene's toxicity, and the different molecular mechanisms by which diminazene may exhibit trypanocidal action are also considered.

8254 **Peregrine, A.S., Ogunyemi, O., Bell, I.R., Holmes, P.H., Moloo, S.K., Hirumi, H., Murray, M., Urquhart, G.M. and Whitelaw, D.D., 1986 [1987].** Isometamidium chloride (Samorin) chemoprophylaxis: a study into factors that may influence the apparent duration of prophylaxis. *Kenya Veterinarian*, **10** (2): 27. (See **17**: no. 8177.)
Peregrine, Bell, Holmes, Murray, Urquhart: Department of Veterinary Medicine, University of Glasgow, Bearsden Road, Glasgow G61 1QH, UK; Ogunyemi: School of Agriculture and Agricultural Technology, Federal University of Technology, P.M.B. 704, Akure, Nigeria; Moloo, Hirumi, Whitelaw: ILRAD, P.O. Box 30709, Nairobi, Kenya.
Six groups of four Boran steers were given either 0.5 mg/kg or 1.0 mg/kg isometamidium chloride. The duration of prophylaxis produced against *Trypano-soma congolense* was examined with regard to dose, level of metacyclic challenge, influence of previous treatment and occurrence of antigenic priming. The cattle were challenged at monthly intervals, each by five infected *Glossina morsitans centralis*; two groups were also challenged by intradermal inoculation. In all cases complete protection was given for 4 months with a dose of 1.0 mg/kg and for 3 months with 0.5 mg/kg. The weight of metacyclic challenge does not appear to affect the duration of chemoprophylaxis and treating existing infections does not appear to affect subsequent prophylactic activity. Antibodies are unlikely to play a protective role in animals maintained on a prophylactic regime as the size of inoculum required to produce an immune response is larger than that likely to be encountered in the field.

8255 **Schoenefeld, A., Röttcher, D., Schillinger, D. and Gorton, E., 1986 [1987].** Drug sensitivity testing in animals. *Kenya Veterinarian*, **10** (2): 21. (See **17**: no. 8177.)
Chemotherapy of Trypanosomiasis Research Project, Veterinary Research Laboratories, Kabete, Kenya.

Commercially available trypanocidal drugs and experimental compounds have been tested against approximately 100 trypanosome strains and drug profiles have been established for these strains. Most are field isolates from East Africa. Results show that there is an area in the coastal belt of Kenya and Somalia where *Trypanosoma vivax* in cattle is resistant to isometamidium (Samorin) at doses up to 1-2 mg/kg. Homidium (Novidium) and quinapyramine (Trypacide) were partly effective; diminazene aceturate (Berenil) cured

infections and relapses at the standard dose of 3.5 mg/kg. This resistance is attributed to high trypanosome risk, underdosing, inappropriate treatment intervals and irregular veterinary inputs.

7. experimental trypanosomiasis

(a) DIAGNOSTICS

[See **17**: no. 8260.]

(b) PATHOLOGY AND IMMUNOLOGY

8256 **Alafiatayo, R.A., Crawley, B., Oppenheim, B.A. and Pentreath, V.W., 1993**. Endotoxins and the pathogenesis of *Trypanosoma brucei brucei* infection in mice. *Parasitology*, **107** (1): 49-53.

Pentreath: Department of Biological Sciences, University of Salford, Salford M5 4WT, UK.

8257 **Bakhiet, M., Mix, E., Kristensson, K., Wigzell, H. and Olsson, T., 1993**. T cell activation by a *Trypanosoma brucei brucei*-derived lymphocyte triggering factor is dependent on tyrosine protein kinases but not on protein kinase C and A. [Rats, mice.] *European Journal of Immunology*, **23** (7): 1535-1539.

Bakhiet: Department of Neurology, Karolinska Institute, Huddinge University Hospital, S-141 86 Huddinge, Stockholm, Sweden.

8258 **Burke, J.M., Gichuki, C.W., Jennings, F.W., Kennedy, P.G.E. and Murray, M., 1993**. The role of astrocytes in the neuropathogenesis of African trypanosomiasis. [Mice.] (Meeting abstract.) *Transactions of the Royal Society of Tropical Medicine and Hygiene*, **87** (4): 363.

Burke: Department of Veterinary Medicine, University of Glasgow Veterinary School, Bearsden Road, Glasgow G61 1QH, UK.

8259 **Darji, A., Sileghem, M., Heremans, H., Brys, L. and Baetselier, P. de, 1993**. Inhibition of T-cell responsiveness during experimental in-fections with *Trypanosoma brucei*: active involvement of endogenous gamma interferon. [Mice.] *Infection and Immunity*, **61** (7): 3098-3102.

Baetselier: Laboratory of Cellular Immunology, Institute of Molecular Biology, University of Brussels, Paardenstraat 65, B-1640 St-Genesius-Rode, Belgium.

8260 **Dia, M.L., 1992**. *Etude du pouvoir pathogène d'une souche de* Trypanosoma (Trypanozoon) evansi *(Steel, 1885), Balbiani, 1888 isolée de Mauritanie et diagnostic sérologique de la trypanosomose expérimentale par immunofluorescence indirecte et immuno-enzymologie (ELISA)*. [Study of the pathogenic capacity of a strain

of *T. (T.) evansi* isolated in Mauritania and serological diagnosis of experimental trypanosomiasis by indirect immunofluorescence and immuno-enzymology (ELISA).] [Mice, rabbits.] Travail de recherches de Maître-ès-Sciences vétérinaires, Ecole Nationale Vétérinaire de Lyon, France. (Unpublished thesis.) 62 pp.
CNERV, B.P. 167, Nouakchott, Mauretania.

8261 **Fakae, B.B., Harrison, L.J.S. and Sewell, M.M.H., 1993**. Effect of conjoint infection with *Trypanosoma congolense* on protection against challenge infection with *Heligmosomoides polygyrus*. [Mice.] (Meeting abstract.) *Transactions of the Royal Society of Tropical Medicine and Hygiene*, **87** (1): 120-121.
CTVM, Easter Bush, Roslin, Midlothian EH25 9RG, UK.

8262 **McLintock, L.M.L., Turner, C.M.R. and Vickerman, K., 1993**. Comparison of the effects of immune killing mechanisms on *Trypanosoma brucei* parasites of slender and stumpy morphology. [*In vitro*.] *Parasite Immunology*, **15** (8): 475-480.
Turner: Laboratory for Biochemical Parasitology, Department of Zoology, University of Glasgow, Glasgow G12 8QQ, UK.

8263 **Sztein, M.B. and Kierszenbaum, F., 1993**. Mechanisms of development of immunosuppression during *Trypanosoma* infections. (Review.) *Parasitology Today*, **9** (11): 424-428.
Sztein: Center for Vaccine Development, Department of Pediatrics, University of Maryland, Baltimore, MD 21201, USA.

8264 **Uche, U.E. and Jones, T.W., 1993**. Early events following challenge of rabbits with *Trypanosoma evansi* and *T. evansi* components. *Journal of Comparative Pathology*, **109** (1): 1-11.
Uche: Royal Veterinary College, Royal College Street, London NW1 0TU, UK.

(c) CHEMOTHERAPEUTICS

[See also **17**: nos. 8222, 8281, 8284, 8308.]

8265 **Bacchi, C.J., 1993**. Resistance to clinical drugs in African trypanosomes. (Review.) *Parasitology Today*, **9** (5): 190-193.
Haskins Laboratories and Biology Department, Pace University, New York, NY 10038-1502, USA.

8266 **Bacchi, C.J., Garofalo, J., Ciminelli, M., Rattendi, D., Goldberg, B., McCann, P.P. and Yarlett, N., 1993**. Resistance to DL-α-difluoro-methylornithine by clinical isolates of *Trypanosoma brucei rhodesiense*: role of *S*-adenosylmethionine. *Biochemical Pharm-acology*, **46** (3): 471-481.
Bacchi: Haskins Laboratories, Pace Univesity, 41 Park Row, New York, NY 10038-1502, USA.

8267 **Berger, B.J., Carter, N.S. and Fairlamb, A.H., 1993**. Polyamine and pentamidine metabolism in African trypanosomes. [*T. b. brucei*.] *Acta Tropica*, **54** (3-4): 215-224.

Fairlamb: Department of Medical Parasitology, LSHTM, Keppel Street, London WC1E 7HT, UK.

8268 **Dreyfuss, G., and Pénicaut, B., Nicolas, J.A., Craciunescu, D. and Loiseau, P., 1993**. Trypanocidal activity and platinum plasma kinetics of *cis*-Pt pentamidine iodide in *Trypanosoma brucei* sheep model. *Tropical Medicine and Parasitology*, **44** (2): 95-98.

Dreyfuss: Laboratoire de Parasitologie, Faculté de Pharmacie, Université de Limoges, 2 rue du Docteur Marcland, F-87025 Limoges Cedex, France.

8269 **Geerts, S., Deken, R. de, Kageruka, P., Lootens, K. and Schacht, E., 1993**. Evaluation of the efficacy of a slow release device containing homidium bromide in rabbits infected with *Trypanosoma congolense*. *Veterinary Parasitology*, **50** (1-2): 15-21.

Veterinary Department, Institute of Tropical Medicine, Nationalestraat 155, B-2000 Antwerpen 1, Belgium; ibid.; ibid.; Department of Organic Chemistry, State University of Ghent, Krijgslaan 281, B-9000 Ghent, Belgium; ibid.

8270 **Gould, S.S., 1986 [1987]**. Chemotherapy and chemoprophylaxis of trypanosomiasis: a look to the future. *Kenya Veterinarian*, **10** (2): 16-19. (See **17**: no. 8177.)

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

Human trypanocidal drug toxicity and resistance to veterinary drugs are major problems and new approaches to drug design are needed. Trypanosome physiology and biochemistry have been studied to find ways of blocking strategic pathways and a number of active compounds have been produced and tested. These are reviewed under seven headings: inhibitors of polyamine synthesis and function (DFMO and analogues), nitroimidazoles and nitrofurans (MK 436 is the most promising new drug), inhibitors of respiration, purine and pyrimidine analogues, new arsenicals and diamidines (although nothing as effective as established drugs has yet been found), phenothiazines (antipsychotic agents found to be effective *in vitro* against *Trypanosoma brucei*) and inducers of oxidative damage (including the antibiotic Bleomycin, and various quinones and porphyrins).

8271 **Gray, M.A. and Peregrine, A.S., 1993**. An *in vitro* assay for drug sensitivity of *Trypanosoma congolense* using *in vitro*-

derived metacyclic trypanosomes. *Acta Tropica*, **54** (3-4): 291-300.

Peregrine: ILRAD, P.O. Box 30709, Nairobi, Kenya.

8272 **Kaminsky, R. and Brun, R., 1993**. *In vitro* assays to determine drug sensitivities of African trypanosomes: a review. *Acta Tropica*, **54** (3-4): 279-289.

Swiss Tropical Institute, Socinstrasse 57, P.O. Box, CH-4002 Basel, Switzerland.

8273 **Kaminsky, R., Mamman, M., Chuma, F. and Zweygarth, E., 1993**. Time-dose-response of *Trypanosoma brucei brucei* to diminazene aceturate (Berenil$^{\varepsilon}$) and *in vitro* simulation of drug-concentration-time profiles in cattle plasma. *Acta Tropica*, **54** (1): 19-30.

Kaminsky: Swiss Tropical Institute, Socinstrasse 57, P.O. Box, CH-4002 Basel, Switzerland.

8274 **Maes, L., Bajyana Songa, E. and Hamers, R., 1993**. IMOL 881, a new trypanocidal compound. [*T. b. gambiense*, *T. b. rhodesiense*, *T. evansi*, *T. equiperdum*; mice, rabbits, goats.] *Acta Tropica*, **54** (3-4): 261-269.

Institute of Molecular Biology, Vrije Universiteit Brussel, Paarden-straat 65, B-1640 St-Genesius-Rode, Belgium.

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Departments of Veterinary Physiology (Osman, Holmes) and Veterinary Parasitology (Jennings), University of Glasgow Veterinary School, Bearsden Road, Glasgow G61 1QH, UK.

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