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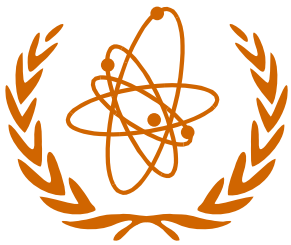

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SECTION B – ABSTRACTS

1. GENERAL (INCLUDING LAND USE)

7082 **Organization of African Unity/Scientific, Technical and Research Commission, 1991.** *Twentieth Meeting of the International Scientific Council for Trypanosomiasis Research and Control, Mombasa, Kenya, [10-14 April] 1989.* Nairobi; OAU/STRC. OAU/STRC Publication no. 115. 529 pp.
OAU/STRC, P.O. Box 30786, Nairobi, Kenya.
The texts and/or abstracts of papers presented at this meeting are published under the following headings: Planning and management of trypanosomiasis control; Protozoology, immunology and biochemistry; Entomology; Human trypanosomiasis; Animal trypanosomiasis; *Glossina* control; and Posters. An introductory chapter includes brief reviews of the relevant activities of international organisations (OAU/IBAR, ICIPE, FAO, WHO, ILRAD, ILCA, CRTA, ITC, IAEA and RTTCP) and also summaries of research carried out under each of the main headings, together with recommendations for future action. This report is dedicated to E.A.H. Friedheim, a pioneer in the development of chemotherapy for trypanosomiasis, and includes a brief appreciation of his work. Abstracts and/or bibliographic details of all the papers published in this report are included in this issue of *TTIQ*.

7083 **Shaw, A.P.M. 1991.** Mathematical models of trypanosomiasis control. *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 106-114.
Veterinary Epidemiology and Economics Research Unit, Department of Agriculture, University of Reading, Earley Gate, P.O. Box 236, Reading RG6 2AT, UK.
A series of mathematical models of cattle herds for microcomputer was devised and used to analyse the potential economic impact of trypanosomiasis control over a wide range of extensive cattle production systems in different parts of the African continent. Results are given for a milk-oriented cattle production system where the disease is assumed to have a relatively modest impact on production, and tsetse control is analysed at two different cost levels. The sensitivity analyses undertaken focus on indicators of the demand for grazing land (cattle numbers present at the start of the operation and numbers brought in subsequent to control). Under the assumptions made, the profitability of tsetse control generally increases as the demand for grazing land becomes greater. The variations in this pattern are discussed. The results demonstrate how a simple analysis based on data

available on the demographic characteristics of livestock populations and a knowledge of the main economic parameters for different production systems can make it possible to define situations when technically feasible trypanosomiasis control options are also economically feasible.

7084 **Toure, S.M, 1991.** Animal trypanosomosis: a review. *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 279-291.
FAO, B.P. 2540, Ouagadougou, Burkina Faso.

It has recently been recommended that the term `trypanosomosis', where the suffix `-osis' denotes a disease caused by a parasitic infection, be used in preference to `trypanosomiasis' to avoid confusion in the use of computerised data bases. This short review of recent achievements in the field of animal trypanosomosis concentrates on papers published between 1986 and 1989. It is divided into the following sections: pathogenesis, clinical signs and physiopathology; improvement of diagnostic techniques; disease survey and epidemiology; chemotherapy and chemoprophylaxis; trypanotolerance in domestic animals; effect and influence of trypanosomosis on productivity; and livestock production under trypanosomosis risk. The reference list includes 122 citations.

2. TSETSE BIOLOGY

(a) REARING OF TSETSE FLIES

7085 **Gao, M.K., Malele, I., Chalo, O.S., Bakuli, B.G., Kitwika, W. and Mramba, F.W., 1991.** Maintenance of *Glossina austeni* Newstead on membranes. (Abstract only.) *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 516-517.
TTRI, P.O. Box 1026, Tanga, Tanzania.

A major constraint to maintaining tsetse flies *in vitro* in the tropics is bacterial contamination. At TTRI *G. austeni* is successfully reared on sterilised cattle blood at 23 □ 1□C and 70 □ 10% r.h. Defibrinated blood is screened for trypanosomes and placed in 1 l containers where it is irradiated and then stored at –18□C. Blood with less than 30% PCV is discarded. Before use, the blood is thawed, divided into 100 ml feeding units, irradiated again and stored at –18□C until required. Membranes and feeding plates are sterilised overnight at 120□C.

(b) TAXONOMY, ANATOMY, PHYSIOLOGY, BIOCHEMISTRY

7086 **Chaudhury, M.F.B., 1991.** Evidence of hormonal control of sexual maturation, receptivity and mating in the male *Glossina pallidipes*. *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 205-209.
ICIPE, P.O. Box 30772, Nairobi, Kenya.

Male *G. pallidipes* were unable to inseminate 8 day old females when only 4-6 days old and very few were capable at 7-9 days old. About 50% were able to inseminate females when 10 days old and this capacity increased up to 15 days old. Surgical removal of the *corpus allatum* within 1 h of emergence had no effect on the duration of sexual maturation or inseminating capability. Microapplication of juvenile hormone analogue (JHA) at low and repeated doses to 1-4 day old males increased the diameter of the male accessory reproductive glands (ARG) but had no effect on mating behaviour or inseminating capacity. The injection of brain extract prepared from 15-20 day old mature males into 2-3 day old males induced increased copulatory behaviour and some insemination. The administration of both brain extract and JHA to 6 day old males resulted in increased mating activity and insemination. The results indicate that both JH and a brain factor influence the sexual maturation process in male *G. pallidipes*, the former probably mediating the maturation process of the ARG and the latter inducing copulatory activity.

7087 **Kaaya, G.P., 1991.** Suppression of fecundity in *Glossina morsitans morsitans* by antibiotics, [and] bacterial and trypanosome infections. *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 210-216.

ICIPE, P.O. Box 30772, Nairobi, Kenya.

Female mated *G. m. morsitans* maintained on rabbits injected intramuscularly with three tetracycline antibiotics (Reverin, Maxitet and Terramycin) had significantly decreased fecundity beginning with their second larval cycle. Longevity was not affected. Terramycin was the most effective and suppressed fecundity by 95% by the fourth larval cycle, followed by Maxitet (86%) and Reverin (78%). Tsetse injected intrahaemocoelically with live *Escherichia coli* also had significantly decreased fecundity. By the first, second and third larval cycles this was 66%, 54% and 42% respectively. Histological sections of mycetomes from bacteria-injected tsetse revealed that the gut symbionts had degenerated, probably due to enhanced antibacterial factors in the tsetse haemolymph. Tsetse with mature infections of *Trypanosoma brucei brucei* and *T. congolense* had significantly decreased fecundity (by 33% and 30% respectively) and also longevity. Mortality increased by 42% in *T. b. brucei*- and 30% in *T. congolense*-infected tsetse, compared to that of controls.

(c) DISTRIBUTION, ECOLOGY, BEHAVIOUR, POPULATION STUDIES

[See also **15**: nos. 7117, 7142.]

7088 **Barreto dos Santos, R.C. and Jaenson, T.G.T., 1991**. Recherches sur les mouches tsé-tsé et la trypanosomiase en 1988 dans le nord-ouest de la Guinée-Bissau. [Research on tsetse and trypanosomiasis during 1988 in north-west Guinea-Bissau.] (Abstract only.) *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 166-167.

Veterinary Services, Zone 1, c/o PDRI, Centro Olof Palme, Bula, Guinea-Bissau; Department of Entomology, Uppsala University, Box 561, S-751 22 Uppsala, Sweden.

Investigations in Zone 1 (north-western) Guinea-Bissau were initiated in February 1988 to determine the distribution and relative abundance of tsetse flies and trypanosomiases, to teach the methodology of trypanosomiasis surveillance and to develop an environmentally sound strategy for trypanosomiasis control in Guinea-Bissau. The prevalence of tsetse and of trypanosome infections in the flies were sampled using 15 biconical traps in each locality for 24 h. By November 1988, 23 localities had been sampled once during the dry season and all 40 once during the rainy season. In about 60% of the localities one or more species of tsetse were captured: *Glossina palpalis gambiensis* was found in 20, *G. longipalpis* in 12, and *G. morsitans submorsitans* in four of the localities sampled. Tsetse flies infected with *Trypanosoma vivax*, *T. congolense* and *T. brucei* were found throughout Zone 1. Overall, trypanosomes were detected in 6% of 172 *G. palpalis* and 28% of 128 *G. longipalpis* dissected.

7089 **Codjia, V., 1991.** Répartition des tsétsé dans la vallée du fleuve Niger. [Tsetse distribution in the Niger river valley.] (Abstract only.) *In*: OAU/STRC, 1991 (see **15**: no. 7082), p. 174.

Division Trypanosomiase Animale, Direction de l'Elevage et des Industries Animales, B.P. 03 - 2036, Cotonou, Benin.

Tsetse and trypanosomiasis surveys have been carried out in an area of 6412 km^2 on the Benin side of the Niger valley. This region has great potential for cattle rearing. The results showed the presence of *Glossina tachinoides*, Hippoboscidae and many Tabanidae. Contrary to preceding studies, no *G. morsitans submorsitans* were detected. The percentage of cattle infected with trypanosomiasis was low. Recommendations for land use are being formulated.

7090 **Dransfield, R.D., Brightwell, R., Kyorku, C. and Williams, B., 1991.** Changes in tsetse species composition after suppression of *G. pallidipes* and *G. longipennis* populations at Nguruman, south-west Kenya. *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 175-185.
ICIPE, P.O. Box 30772, Nairobi, Kenya.
Both *Glossina pallidipes* and *G. longipennis* are present on the Olkeramatian Group Ranch at Nguruman and both have been implicated in the transmission of bovine trypanosomiasis. Of the two, *G. pallidipes* is considered to be the more important vector because of its greater abundance and higher rate of trypanosome infection. In February 1987, 100 NG2B traps, odour-baited with acetone and cow urine, were deployed in the more wooded parts of an area of about 100 km^2. The traps were operated for 6 days/month. By November the *G. pallidipes* population had been reduced by 90-99%, but the rate of decline of the *G. longipennis* population over the same period was much less. The latter then became the dominant species. Reasons for the observed differences in mortality rates for the two species are discussed with reference to interspecific competition among *Glossina* spp. and species replacement after control operations.

7091 **Green, C.H., 1991.** The use of colours in insecticide-impregnated screens for the control of different species of tsetse fly. (Abstract only.) *In*: OAU/STRC, 1991 (see **15**: no. 7082), p. 425.
TRL, University of Bristol, Langford, Bristol BS18 7DU, UK.
The choice of designs of insecticide-impregnated screens is examined in the light of new evidence on the responses of tsetse flies to colours. In the *palpalis* group, evidence shows that blue appears to be more attractive than all other colours, including black, for both *Glossina p. palpalis* and *G. tachinoides*. For some *morsitans* group flies, black is equivalent in attractiveness to blue: since it induces stronger landing responses than blue, however, it is to be preferred for single-coloured screens. For *G. pallidipes* and *G. morsitans*, catches of a black cloth screen can be improved by adding mosquito netting, combining blue with black, or by increasing the size of the screen. *G. longipalpis* is an exception to the other *morsitans* group flies examined in that blue is more attractive than black. The only *fusca* group fly examined, *G. medicorum*, is more attracted to blue than to black. This species is especially

reluctant to land on a cloth surface and the screen requires mosquito netting panels to be effective.

7092 **Langley, P.A., 1991.** Maturation of *Glossina pallidipes* in relation to trap orientated behaviour. (Abstract only.) *In*: OAU/STRC, 1991 (see 5: no. 7082), pp. 200-201.

TRL, University of Bristol, Langford, Bristol BS18 7DU, UK.
Thoracic residual dry weight (TRDW) was found to be a better estimate of the size of mature adults of laboratory-reared *Glossina morsitans morsitans* than the residual dry weight of the whole insect corrected for the presence of a blood meal. The TRDW increased linearly for the first 18 days of adult life in both sexes of *G. pallidipes* in the laboratory. Using ovarian dissection to estimate the ages of nulliparous adult females of *G. pallidipes*, the TRDW was also found to increase linearly for at least 14 days in the field in Zimbabwe. Significant increases in pteridine fluorescence with age were measured in both laboratory-reared males and females of known chronological age and in wild-caught nulliparous females whose ages were estimated by ovarian dissection. A linear relationship existed between pteridine fluorescence and wing fray category for a wide range of ages of field-caught flies of both sexes. Comparisons were made of the age compositions of both sexes of *G. pallidipes* attracted to stationary traps or to mobile electrified nets by plotting TRDW values against pteridine fluorescence. The results showed clearly that nulliparous females were not attracted to stationary traps but were intercepted by mobile baits. Males of all ages appeared to be equally attracted to both. It is concluded that nulliparous females do not respond to host odour stimuli until they are ready to mate.

7093 **Mérot, P. and Filledier, J. 1991.** Résultats obtenus au Burkina Faso sur la recherche d'attractifs olfactifs pour *Glossina tachinoides.* [Results of research on olfactory attractants for *G. tachinoides* in Burkina Faso.] (Abstract only.) *In*: OAU/STRC, 1991 (see 15: no. 7082), pp. 423-424.
CRTA, B.P. 454, Bobo-Dioulasso, Burkina Faso.
Preliminary studies at CRTA on olfactory attractants have shown that some phenolic derivatives isolated from cattle urine were attractive to *G. tachinoides*. Tests showed m-cresol to be the most attractive. This result

differs from those obtained for *G. pallidipes* in East Africa, emphasising the need for specific research on riverine tsetse. The effect of m-cresol is potentiated by octenol, which by itself is not attractive to *G. tachinoides*. The ideal mixture is an m-cresol:octenol ratio of 3:1. Studies showed that the best dispenser was a polyethylene tube closed at each end. The catch size was increased 2.5 times over 10 weeks and the dispenser remained attractive (catches increased 1.5 times) for the next 6 weeks. It is recommended that the dispenser be changed at the same time that the screens are reimpregnated with insecticide during a control project. The cost of the system (dispenser and chemicals) is low.

7094 **Mramba, F., Chuwa, P., Gao, M.K., Tarimo, C.S. and Hafidh, H., 1991.** Distribution of *Glossina austeni* in Zanzibar. (Abstract only.) *In*: OAU/STRC, 1991 (see **15**: no. 7082), p. 165.

Mramba, Chuwa, Gao: TTRI, P.O. Box 1026, Tanga, Tanzania; Tarimo: Tanzania Livestock Research Organization, P.O. Box 6910, Dar-es-Salaam, Tanzania; Hafidh: Livestock Development, P.O. Box 159, Zanzibar, Tanzania.

A tsetse survey was started in Zanzibar in 1981 using different conventional sampling techniques such as traps, fly round patrols and ox bait including the trial use of an olfactory stimulant, in an attempt to initiate tsetse and trypanosomiasis control on the island. The survey work was completed in 1984. All conventional sampling techniques were ineffective and the distribution of *G. austeni* was largely determined on the basis of pupal searching. This survey confirmed previous reports that *G. austeni* is the only species of tsetse fly infesting the island. It is fairly widely distributed, with the densest populations in the Jozani forest and Mangapwani. The use of white and blue sticky targets for trapping *G. austeni* was investigated and studies were carried out on the diurnal activity pattern of the flies.

7095 **Mwangelwa, M.I., Dransfield, R.D. and Otieno, L.H., 1991.** The response of *Glossina fuscipes fuscipes* Newstead to odour baits and trap types on Rusinga Island, Kenya. (Abstract only.) *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 518-519.

ICIPE, P.O. Box 30772, Nairobi, Kenya.

Studies were carried out on Rusinga Island to determine the response of *G. f. fuscipes* to various odours which were potential baits for use in tsetse control programmes.

The odours included cow and human urine, acetone, 1-octen-3-ol and phenols. Four types of trap (biconical, NG2B, NG2G and F3), all known to be efficient with other tsetse species, were also tested. The results showed no significant difference in catches of males in baited or unbaited traps. Females were inconsistent, being alternately attracted and repelled by some of the odour baits. Of the four trap designs used, the biconical trap was the most efficient, followed by the NG2B and NG2G and lastly by the F3 trap. Studies are continuing to identify odour baits attractive to *G. f. fuscipes*.

7096 **Packer, M.J., 1991**. Efficiency of electric nets as sampling devices. (Abstract only.) *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 436-437.

Imperial College, Silwood Park, Ascot, Berkshire SL5 7PY, UK.

A video camera was used to provide objective data on the behaviour of flies around an electric net. Information was available on: (i) the number and behaviour of flies which avoided the net; (ii) the number and behaviour of flies electrocuted and of those which escaped; (iii) the distribution on the ground of electrocuted flies. The three components of an electric net system (net, sparking device and battery) were varied in order to determine any effect on efficiency and an old and a new example of one design of net were videoed. Variation in efficiency was observed: the age of the net had no significant effect on efficiency; the design of the sparking device significantly affected efficiency, which generally decreased with the age of the device; and efficiency was lower with partly charged batteries than with fully charged ones. Full efficiency was about 64% (range 48-73%), considerably lower than the 95% estimated in a previous study. Therefore, when using an electric net as a sampling device, account needs to be taken of the level of, and variation in, efficiency.

7097 **Saini, R.K., 1991.** Behavioural and electrophysiological responses of tsetse flies to various phenols. *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 202-204.

ICIPE, P.O. Box 30772, Nairobi, Kenya.

Behavioural and electrophysiological studies were undertaken to investigate the stimulatory potential of various host urine phenols to *Glossina morsitans morsitans* and *G. pallidipes*. Responses to the isomeric pairs of the phenols and also to sets of homologues of the two

isomer types were compared. The compounds 4-cresol (among the 4-alkylphenols) and 3-n-propylphenol (among the 3-alkylphenols) were found to be the most stimulatory. Responses of both species to 4-alkylphenols increased as the alkyl chain decreased from three carbon atoms to one, while a reverse trend was observed with 3-alkylphenols. The results also showed that responses to various phenols differed according to species and that different mixtures of phenols may be required to attract different species of tsetse.

7098 **Späth, J. and Küpper, W., 1991.** Experiments on olfactory attractants for tsetse flies, *Glossina* spp. (Diptera: Glossinidae) in Ivory Coast. *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 417-422.

Ökologische Station der Universität Würzburg, Glashüttenstrasse 5, D-8602 Rauhenbrach, Germany; Projet de Lutte contre la Trypano-somiase Animale et les Vecteurs, B.P. 3301, Bouaké, Côte d'Ivoire.

The attractiveness of various odours has been tested for *G. longipalpis*, *G. medicorum* and *G. tachinoides* in Côte d'Ivoire by means of biconical trap catches. The substances tested were acetone, 1-octen-3-ol, cattle urine and the eight components of its phenolic fraction. All three tsetse species were attracted by the phenolic fraction of cattle urine. The most potent component was 3-methylphenol followed by 4-methylphenol; 3-propylphenol, known to be a potent attractant for *G. pallidipes* in Zimbabwe, did not have this strong effect on the species investigated in Côte d'Ivoire. By adding acetone and/or octenol the attractiveness of the phenolic fraction increased for *G. longipalpis* and *G. tachinoides* but decreased for *G. medicorum*. Dispensers (sachets of 5 × 5 cm) were made of 100 µm polyethylene sheets for mixtures of phenols and octenol. Dispensers containing 3-methylphenol, 4-methylphenol and octenol in the ratio of 1:1:2 proved best for *G. longipalpis* and *G. tachinoides*; those with pure 3-methylphenol were best for *G. medicorum*. These mixtures increased the catch of the three species significantly by 60%, 40% and 180% respectively.

7099 **Warnes, M.L., 1991.** Responses of *Glossina morsitans morsitans* and *G. pallidipes* to ox sebum. (Abstract only.) *In*: OAU/STRC, 1991 (see **15**: no. 7082), p. 186.

TRL, University of Bristol, Langford, Bristol BS18 7DU, UK.

The behaviour of male *G. m. morsitans* and *G. pallidipes* alighting on targets in the laboratory with or without ox sebum was compared. The presence of ox sebum did not significantly increase the number of flies alighting on the target in either species. However, after contact with the sebum-coated target both species showed an increase in flight activity and a greater tendency to return to the target. This behaviour resulted in a number of short flights which are thought to reflect the search for a feeding site on a host. The duration of each visit to the target was significantly reduced when sebum was present for *G. m. morsitans* but not for *G. pallidipes*. The presence of sebum elicited a probing response in both *G. m. morsitans* and *G. pallidipes*. Field experiments in Zimbabwe with both electric nets and F3 traps showed that the presence of ox sebum significantly increased the catches of both species.

3. TSETSE CONTROL (INCLUDING ENVIRONMENTAL SIDE-EFFECTS)

[See also **15**: nos. 7083, 7091, 7093, 7095, 7117.]

7100 **Barrett, J.C., 1991.** Cost analysis of odour-baited targets used for tsetse control in Zimbabwe. *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 456-465. NRI, Central Avenue, Chatham Maritime, Kent ME4 4TB, UK.

Odour-baited screens (targets) have been deployed extensively in tsetse control operations in Zimbabwe with varying operational objectives and circumstances. This paper presents cost data not only for materials and chemicals used in the production and maintenance of targets, but also provides information on manpower and vehicle costs for deployment and maintenance. The cost of tsetse control using targets is compared with costs of conventional techniques used in Zimbabwe, including ground and aerial spraying with insecticide. Future prospects are assessed for improving the cost-effectiveness of bait technology.

7101 **Bauer, B., Kabore, I., Kourouma, B., Meyer, F., Petrich-Bauer, J., Some, J. and Tamboura, I., 1991.** The use of flumethrin pour-on – simultaneous control of tsetse flies and ticks in cattle in Satiri, Burkina Faso. (Abstract only.) *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 448-449. CRTA, B.P. 286, Bobo-Dioulasso, Burkina Faso.

The incidence of animal trypanosomiasis near Satiri, 45 km north-east of Bobo-Dioulasso, from August 1986 to June 1987 varied from 20-77%, with *Trypanosoma vivax* the

dominant species followed by *T. congolense*. In November 1987 approximately 2000 head of Zebu cattle were treated with flumethrin pour-on and more than 200 were ear-tagged and followed up at monthly intervals. Ear-tagged animals infected with trypanosomes were treated with diminazene aceturate. At a control site at Bossora 30 km away 100 Zebu were ear-tagged and followed up, but were not treated with flumethrin. The fly population was regularly monitored throughout the trial. The risk of trypanosome infection was significantly reduced after three applications of flumethrin and in the following months the infection rate remained well below 5%, whereas at Bossora it sometimes exceeded 30%. Tick counts showed a ten-fold higher incidence at Bossora despite local treatments with different insecticides.

7102 **Coulibaly, L., Diarrasouba, I., d'Ieteren, G.D.M., Gnihan, N., Hecker, P., Itty, P., Kupper, W., Leak, S.G.A., Nagda, S.M., Rarieya, J.M., Schuetterle, A., Thorpe, W., Trail, J.C.M. and Traub, D., 1991.** Effect of tsetse control by means of insecticide impregnated biconical traps on health and productivity of livestock in northern Côte d'Ivoire: preliminary results. *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 445-447.

Coulibaly, Diarrasouba, Gnihan, Hecker, Schuetterle, Traub: SODEPRA/GTZ/CIPEA, B.P. 143, Boundiali, Côte d'Ivoire; d'Ieteren, Itty, Nagda, Rarieya, Thorpe, Trail: ILCA, P.O. Box 46847, Nairobi, Kenya; Kupper: Projet de Lutte Anti Tsetse, Korhogo, Côte d'Ivoire; Leak: ILRAD, P.O. Box 30709, Nairobi, Kenya.

A tsetse control campaign using cypermethrin-impregnated biconical traps is under way in the Boundiali area of northern Côte d'Ivoire. The first phase lasted from December 1987 to July 1988: 542 traps were placed at 300 m intervals along gallery forest and the area was protected against reinvasion by two trap barriers 10 km long with a trap every 100 m. Levels of tsetse relative density were determined each month over 4 days of trap monitoring. Significant reductions of 95% and 99% in the mean average relative density were recorded for *Glossina palpalis* and *G. tachinoides* respectively. However, there was no corresponding reduction in trypanosome prevalence in livestock. This may be due partly to the fact that the animals were not treated to eliminate existing infections at the start of the campaign and partly because livestock was able to move both into and out of tsetse control areas.

7103 **Gouteux, J.-P., Noireau, F., Sinda, D. and Frezil, J.L. 1991.** L'utilisation du piège pyramidal par les communautés

rurales dans la lutte contre la maladie du sommeil. Bilan des essais réalisés au Congo. [The use of the pyramidal trap by rural communities in the control of sleeping sickness. Results of trials conducted in the Congo.] *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 428-435.
Place Jean Sénac, F-32170 Miélan, France; ORSTOM, B.P. 181, Brazzaville, Congo; ibid.; ORSTOM, 2051 avenue du Val Montferrand, B.P. 5045, F-34032 Montpellier, France.
Vector control trials using blue-black pyramidal traps without insecticide were carried out in 55 villages in the Niari sleeping sickness focus in the Bouenza region of Congo. The traps were hung from tree branches by means of a plastic capture bag containing diesel oil and maintained entirely by villagers. A total of 240,514 *Glossina palpalis* was caught. Apparent zero fly density was achieved in nine villages and a 90% reduction was observed in 38. Screening surveys were undertaken to assess the impact of the trials on sleeping sickness incidence. The seroprevalence rate fell to 0.41% and a study of sentinel animals showed that when apparent zero fly density was achieved, detectable parasitaemia cleared after 18 months and the animals became serologically negative after 2 years. The success of the method is dependent on finding the best capture sites and maintaining the interest of the villagers, which tended to decline with the tsetse population. Socio-cultural problems relating to village participation are discussed. A total of 1263 traps was set up and 200 spare traps were used each year over a 3 year period, at a cost of US $17,100.

7104 **Hayball, P.V. and Okoth, J., 1991**. New advances in ground applied tsetse control methods. (Abstract only.) *In*: OAU/STRC, 1991 (see **15**: no. 7082), p. 455.
Hammerfield, Cook Pond Road, Milland, Liphook, Hampshire GU30 7SY, UK; UTRO, P.O. Box 96, Tororo, Uganda.
Lambdacyhalothrin, a new second generation pyrethroid insecticide, combines very high residual activity at low rates with a far more acceptable environmental profile than organochlorine compounds. Laboratory and field work carried out with lambdacyhalothrin for tsetse control included experiments comparing a novel application technique, the Electrodyn, with conventional ground application. Traps and targets were also successfully treated with the Electrodyn technique, which considerably reduces the volume of

insecticide used. It is concluded that these methods using lambdacyhalothrin could have a significant role to play in future tsetse control, including the possible integration of tsetse control techniques into community participation programmes.

7105 **Johnstone, D.R., Cooper, J.F., Casci, F. and Dobson, H.M., 1991.** The interpretation of spray monitoring data in tsetse control operations using aircraft. *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 466-480.
NRI, Central Avenue, Chatham Maritime, Kent ME4 4TB, UK.
Fresh advances in the interpretation of spray monitoring data obtained from rotary slide samplers are outlined and their applications to data collected during recent spray operations in Zimbabwe and Somalia are discussed. Spray monitoring now appears to be capable of providing a useful assessment of the likelihood of an aerial spraying operation achieving success, while giving an indication of the location and nature of possible problem areas. However, the accuracy of this method is dependent on understanding the behaviour of the relevant fly species and taking samples from the sites where resting flies are to be found.

7106 **Kangwagye, T.N. and Latigo, A.A., 1991.** *Glossina fuscipes* control by aerial spraying in the S.E. Uganda Rhodesian trypanosomiasis epidemic. (Abstract only.) *In*: OAU/STRC, 1991 (see **15**: no. 7082), p. 415.
Kangwagye: Tsetse Control Department, P.O. Box 7033, Kampala, Uganda.
Glossina fuscipes fuscipes control was carried out in 1525 km^2 of the major foci of *rhodesiense* sleeping sickness in south-east Uganda. In a five cycle sequential aerosol application during the January to March and June to August dry seasons endosulfan was applied by a Britten Norman fixed-wing aircraft carrying two AU 4000 rotary atomisers spinning at 11,000-12,000 r.p.m., with flow rates of 5.6-6.7 l/min discharging droplets in the size range of 28-30 μm v.m.d. The tsetse apparent density reduction percentage achieved was 76.6% to 100% over the two phases. Cases of sleeping sickness decreased in the treated areas by over 50%.

7107 **Lancien, J., Muguwa, J., Boutes, B. and Lannes, C., 1991.** Contraintes scientifiques et logistiques pour un vaste programme national realiste de piégeage des glossines riveraines: l'example de l'Ouganda. [The scientific and logistic constraints of a wide realistic national programme of trapping riverine tsetse: the example of

Uganda.] (Abstract only.) *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 413-414.
Lancien: WHO, P.O. Box 6, Entebbe, Uganda; Muguwa: Tsetse Control Department, P.O. Box 7033, Kampala, Uganda.
The largest national trapping programme to date has been set up in south-east Uganda to cover the 6000 km^2 threatened by *rhodesiense* sleeping sickness. Preliminary results in the first 6 months from 4000 traps set up in 1000 km^2, covering five subcounties in the total area, showed a reduction in the apparent density of tsetse by over 95%. Despite this initial success, it is considered that the programme will need to maintain constant and efficient pressure against tsetse for at least the first 2 years. The 1000 km^2 trial has shown that success will depend on the use of the simplest, cheapest and most reliable equipment, on the constant monitoring of entomological and medical results, on the use of a simple strategy, and on long-term community participation. However, the key to total sleeping sickness eradication in south-east Uganda is believed to depend on the correct evaluation of wild and domestic animals as reservoir hosts.

7108 **Laveissière, C., Grébaut, P. and Lemasson, J.-J., 1991.** Trypanosomiase humaine africaine: la lutte antivectorielle confiée aux paysans. [African human trypanosomiasis: vector control carried out by villagers.] *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 223-232.
OCCGE, Institut Pierre Richet, B.P. 1500, Bouaké, Côte d'Ivoire.
From the end of the 1987 rainy season onwards 3639 farmers in Vavoua, Côte d'Ivoire, have received 38,412 `black-blue-black' screens, the number allocated to each farmer depending on the size and character of his/her farm. Village margins were protected by 464 insecticide-impregnated Vavoua traps, maintained by a young villager who also collected entomological data. Some 1500 km^2 were covered in under 3 weeks at a cost of about US $1 per hectare. Farmers were supplied with insecticide (K-Othrine 50) to reimpregnate their screens and the traps were resprayed every 6 months. After 7 months *Glossina palpalis palpalis* density was reduced by 99.96% and no recent cases of trypanosomiasis have been reported. Local people were informed about trypanosomiasis through the use of pamphlets, slide shows and discussions and their involvement in vector control is an effective and inexpensive way of reducing the incidence of the disease.

7109 **Mansinga, D.M., Milord, F., Ethier, L. and Pochet, A., 1991.** Essai d'élimination des glossines par piégeage à Nioki, au Zaire. [Trial for control of *Glossina* with traps in Nioki, Zaire.] (Abstract only.) *In*: OAU/STRC, 1991 (see **15**: no. 7082), p. 427.
Zone de Santé Rurale de Nioki, Bandundu, Zaire.
A trial for the control of the vector of African human trypanosomiasis was carried out in Nioki, Zaire, using 101 monopyramidal (Lancien) traps installed in 14 villages. Local people selected by their community helped two persons to install and follow up the traps. After 270 days 14,593 *Glossina* were captured. The reduction of the apparent density of flies by traps was more than 95% after 120 days in most of the villages. Higher apparent densities were found in villages with higher incidences of the disease. A longer follow-up period is necessary to see if there is a relationship between a decrease in the apparent density of flies and the incidence of human trypanosomiasis in this area.

7110 **Muguwa, J., 1991.** A comparative study on aerial spraying and trapping exercises against [*Glossina*] *fuscipes fuscipes* in Busoga, south eastern Uganda. (Abstract only.) *In*: OAU/STRC, 1991 (see **15**: no. 7082), p. 416.

Tsetse Control Department, P.O. Box 7033, Kampala, Uganda.
Several tsetse control methods have been used in the Busoga area of south-east Uganda. Two preferred methods are aerial spraying from fixed-wing aircraft and trapping with Lancien traps. Aerial spraying of endosulfan was carried out over an area of 900 km^2 and 4000 traps were deployed in another area of 900 km^2: these two areas overlapped by 150 km^2. Entomological and medical data from the controlled areas were used to review the advantages and disadvantages of each method for the control of *G. f. fuscipes* and trypanosomiasis.

7111 **Opiyo, E.A., Njogu, A.R., Omuse, J.K. and Mgutu, S.P., 1991.** Tsetse control in Lambwe Valley, South Nyanza District, Kenya. *In*: OAU/ STRC, 1991 (see **15**: no. 7082), pp. 438-442.
KETRI, P.O. Box 362, Kikuyu, Kenya.
Previous tsetse control operations in the Lambwe Valley game park have not been successful and new approaches are sought. This study evaluates the effectiveness and sustainability of deltamethrin-impregnated odour-baited targets. The *Glossina pallidipes* population was previously

surveyed using odour-baited biconical traps. The targets were initially installed at 200 m intervals along the northern game fence and then among the vegetation along the Olambwe River. They were baited with acetone, octenol and natural cow urine. A herd of 35 cattle was used to monitor the effects of control on the incidence of trypanosomiasis. There was a significant reduction in trap catches soon after the installation of targets, reaching 99.72% after 6 months. Dissected flies showed a high trypanosome infection rate, mainly of *Trypanosoma vivax*-type. The Berenil Index clearly showed a reduction in fly challenge to the cattle. Regular maintenance of the targets was necessary; bush fires were a major problem.

7112 **Sebitosi, E., 1991.** The influence of sublethal doses of insecticides on the reproduction of *Glossina pallidipes* (Austen) and *Glossina morsitans morsitans* (Westwood) (Diptera: Glossinidae). (Abstract only.) *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 443-444.

Zoology Department, University of Nairobi, P.O. Box 30197, Nairobi, Kenya.

The influence of sublethal doses of two insecticides, namely deltamethrin and natural pyrethrum extract, on the reproduction of wild-caught *G. pallidipes* and laboratory-reared *G. morsitans* was investigated. Both insecticides caused reproductive abnormalities in various concentrations to both species. Abortions occurred at various doses. Higher doses caused abortions of eggs and larvae within 1 h for deltamethrin-treated females as well as resulting in egg resorption after ovulation and sometimes prevented ovulation altogether. The survival and feeding behaviours of treated female tsetse flies were variable, but generally subdued. The effects on the offspring ranged from low weight non-viable pupae to deformed F1 adults. All these effects contributed to the 50% reduction in fecundity observed. The results suggest a significant contribution of sublethal doses of insecticides to the reduction of the fly population in the field after spraying with insecticides, and that the evaluation of candidate insecticides for tsetse control should not stop with the mortality counts 24 or 48 h after treatment, but should take into account the post-treatment mortality.

7113 **Thomson, J.W. and Wilson, A., 1991.** The control of tsetse flies and trypanosomiasis by the application of deltamethrin to cattle. *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 450-454.

Department of Veterinary Services, P.O. Box 8012, Causeway, Zimbabwe; Cooper (Zimbabwe) Ltd, P.O. Box 2699, Harare, Zimbabwe.
In a 2500 km^2 tsetse-infested area of north-east Zimbabwe 20,000 head of cattle were dipped at fortnightly intervals in deltamethrin at 13 dipping tanks. The disease was eliminated from areas more than 10 km from the international border. At centres closer to the border, from where there was heavy reinvasion pressure, the incidence of the disease was greatly reduced. This proved to be a very simple, effective and cheap method of controlling tsetse flies and trypanosomiasis.

7114 **Willemse, L., 1991**. The use of odour baited insecticide impregnated screens against *Glossina morsitans centralis* Machado (Diptera: Glossinidae) in west Zambia. 1. Results for a 500 km^2 trial block. (Abstract only.) *In*: OAU/STRC, 1991 (see **15**: no. 7082), p. 426.
PAN Livestock Services Ltd, P.O. Box 236, Reading RG6 2AT, UK.
As part of a research project, aimed at examining the effectiveness of odour-baited insecticide-impregnated screens as a means of controlling *G. morsitans centralis* in a 2000 km^2 cattle grazing area in western Zambia, an area of 500 km^2 was treated at a density of four screens per km^2. Prior to, during and after the deployment of screens the fly population within and outside (control area) the treated area was monitored directly by F3 traps, screen fly rounds and a motorbike with an electric net fitted on the back. The fly population was also monitored indirectly by determining the trypanosomiasis challenge in animals of sentinel herds. The results indicate a rapid decline of the fly population at a rate of 2.2% day^{-1} after the deployment of the screens. At such a rate, 99.99% control of the fly population can be achieved after 7 months.

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

[See also **15**: nos. 7136, 7138, 7141, 7142, 7146, 7160.]

7115 **Asonganyi, T., Hengy, C., Louis, J.P. and Ghogomu, N.A. 1991.** Renaissance of an old sleeping sickness focus in Mamfe (Cameroon): epidemiological, immunological and parasitological findings. (Abstract only.) *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 219-221.
Asonganyi: Centre Universitaire des Sciences de la Santé, University of Yaoundé, Yaoundé, Cameroon; Hengy, Louis: OCEAC, Yaoundé, Cameroon; Ghogomu: Directorate

of Preventive Medicine, Ministry of Health, Yaoundé, Cameroon.
Screening of 9827 people in Mamfe showed 137 (1.4%) positive cases, of which 25 were later confirmed as sleeping sickness patients. Inconsistencies in CATT and IFAT results suggest that neither antibodies to the LiTat 1.3 VAT on which the CATT was based nor antibodies to the AnTat 1.8 VAT on which the IFAT was based are prevalent in the sera of patients from Mamfe. It is speculated that an epidemic of swine fever in 1982 forced tsetse flies into closer contact with the human population and resulted in the transmission of trypanosomiasis from relatively few infected people, especially visitors from the nearby Fontem focus, to the local inhabitants. If this is correct, it would tie in with the absence of LiTat 1.3 VAT and the rarity of LiTat 1.6 VAT (an iso-VAT of AnTat 1.8 VAT) in the Fontem focus. Only 27 *Glossina palpalis palpalis* were trapped over a period of 2 weeks, confirming reports of low fly density. The major symptoms of patients on diagnosis are headache, fever and cervical adenopathy: 88% had advanced CNS involvement, confirming reports that CNS involvement occurs very early in Cameroon.

7116 **Leak, S.G.A., Colardelle, C., Coulibaly, L., d'Ieteren, G., Dumont, P., Feron, A., Hecker, P., Jeannin, P., Maloo, S., Minengu, M., Minja, S., Mulatu, W., Mulungu, M., Nankodaba, G., Ngamuna, S., Ordner, G., Sauveroche, B., Schuetterle, A., Tikubet, G., Toure, M., Trail, J.C.M., Tsotsi, E. and Yangari, G., 1991.** Tsetse feeding habits and tsetse challenge at sites of the African Trypanotolerant Livestock Network. *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 523-528.

Leak, Minja: ILRAD, P.O. Box 30709, Nairobi, Kenya; Colardelle, Dumont, Jeannin, Ordner, Sauveroche, Yangari: OGAPROV Ranch, Moanda, Gabon; Coulibaly, Hecker, Nankodaba, Schuetterle, Toure: SODEPRA/GTZ/ILCA Joint Project, B.P. 143, Boundiali, Côte d'Ivoire; d'Ieteren, Trail: ILCA, P.O. Box 46847, Nairobi, Kenya; Feron, Mulungu: Compagnie J. Van Lancker, B.P. 8842, Kinshasa, Zaire; Maloo, Tsotsi: Department of Veterinary Services, Muhaka, Kenya; Minengu, Ngamuna: ILCA, DPP Idiofa, B.P. 8251, Kinshasa, Zaire; Mulatu, Tikubet: ILCA, Ghibe Valley, Ethiopia.
The percentages of blood meals from different hosts taken by different species of *Glossina* at nine ATLN sites are tabulated. A high percentage was taken from cattle by *G. tachinoides* (78.4%) at Boundiali and *G. palpalis* (64.3%) at Tengrela, both in Côte d'Ivoire, and *G. pallidipes* (75.8%) and *G. fuscipes* (62.2%) at Ghibe, Ethiopia.

Tsetse challenge was estimated from these data and tsetse relative densities and trypanosome infection rates. A highly significant relationship between tsetse challenge and trypanosome prevalence in N'Dama cattle was found at sites with *G. tabaniformis* ($P < 0.0001$) and also at sites with susceptible breeds of cattle ($P < 0.01$). The relationships between tsetse challenge and trypanosome prevalence for both susceptible and trypanotolerant cattle are predicted on the basis of the respective regression equations.

7117 **Masaninga, F., Mwanza, L., Ernest, A., Kanyangala, S., Kunda, E., Boatin, B. and Rickman, L.R., 1991.** An attempt to identify high-risk areas of *T. b. rhodesiense* transmission in a Zambian sleeping sickness focus. (Abstract only.) *In*: OAU/STRC, 1991 (see **15**: no. 7082), p. 222.

TDRC, P.O. Box 71769, Ndola, Zambia.
The use of odour-baited insecticide-impregnated targets is a practical approach to community-mediated tsetse and trypanosomiasis control programmes. Their efficiency is dependent on their deployment in `high risk' areas which were determined in one locality by the use of fly rounds in each of three separate habitats: the village itself, the inter-village track and the bush. Each fly round consisted of 30 marked catching stations at 100 m intervals and four goats permanently installed. Sampling procedures were standardised for all three habitats and game animals in the area were sampled for the presence of trypanosomiasis. Fly rounds were walked twice weekly, once with an acetone-baited black screen and once to set acetone-baited F3 and Challier biconical traps. Flies were examined for infection, and the presence of *Trypanosoma brucei rhodesiense* in man, vectors, game and domestic animals was mapped to reveal high risk areas.

7118 **McNamara, J., Snow, W.F. and Gibson, W.C., 1991.** DNA probes for identifying trypanosome infections in tsetse flies. (Abstract only.) *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 128-129.
TRL, University of Bristol, Langford, Bristol BS18 7DU, UK; ITC, P.M.B. 14, Banjul, Gambia; Department of Pathology, School of Veterinary Science, University of Bristol, Langford, Bristol BS18 7DU, UK.
Species- and strain-specific DNA probes were used to identify trypanosomes in midguts from *Glossina morsitans submorsitans* and *G. palpalis gambiensis* captured at four sites in The Gambia. *Trypanosoma (Nannomonas) simiae* accounted for

the majority of identified infections in *G. m. submorsitans*, highlighting the importance of differentiating this species from *T. (N). congolense* when assessing the trypanosomiasis challenge to cattle. However, a large proportion of samples, including several heavy *Nannomonas* type infections, were not identified using the six probes available (specific for: *Trypanozoon*; savanna, riverine forest and Kenya coast forms of *T. congolense*; *T. simiae*; *T. vivax*). These unknowns could be divided into two groups on the basis of DNA hybridisation and behaviour *in vitro*. One group comprised a stercorarian species, perhaps *T. grayi*. The other group shared morphological and behavioural characteristics with *T. congolense* and *T. simiae* but showed little homology with the DNA of either species. The major DNA repeat sequence from this trypanosome was cloned for use as a specific probe. Upon re-examining the original sample collection we were able to show that this trypanosome is abundant and widespread in The Gambia.

7119 **Rawlings, P., Wacher, T.J. and Snow, W.F., 1991.** Spatial and temporal patterns of contact between tsetse and N'Dama cattle in The Gambia. (Abstract only.) *In*: OAU/STRC, 1991 (see **15**: no. 7082), p. 529.
ITC, P.M.B. 14, Banjul, Gambia.

Spatial contact between tsetse and cattle was examined at the village of Keneba. In the early dry season, tsetse were relatively numerous to the north of the village (up to 12 tsetse/trap/day) but the cattle fed on the rice fields to the south, with the result that they were exposed to tsetse for only 6% of the time. In the wet season, tsetse were less numerous to the north of the village (1-2 tsetse/trap/day) but the cattle were also in the north, with the result that they were in contact with tsetse for 46% of the time. Risk may therefore be enhanced, despite reduced tsetse numbers. Diurnal activity of tsetse was recorded in the late dry season at the village of Misira, where *Glossina morsitans submorsitans* showed a morning (75% caught by 10.00 h) and an evening peak of activity (33% caught by 17.00 h). However, tsetse are partly constrained to feeding on cattle in the middle of the day because the herds are typically in unsuitable habitat near the village morning and evening.

7120 **Snow, W.F., Rawlings, P. and Wacher, T.J., 1991.** Estimates of the numbers of trypanosome-infected tsetse biting cattle in The Gambia. *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 187-195.

ITC, P.M.B. 14, Banjul, Gambia.
A major objective of the tsetse programme at ITC is to develop ways of measuring challenge, defined as the number of infective bites an animal receives in unit time, to trypanotolerant N'Dama cattle under village management. *Glossina morsitans submorsitans* was the only species captured during the study. A simple multiplicative model to derive estimates of this biting rate is described, using field data collected in The Gambia. Inputs include the numbers of cattle and tsetse, the grazing area, tsetse feeding patterns and host range and their trypanosome infection rates. The interval between infective bites may range from years in low challenge situations to a few days where tsetse are numerous but trypanotolerant cattle survive and are productive. The final estimate of the number of infective bites received by each animal daily during the dry season (November-March) of 1985-86 was 0.0041. The estimates correspond well with the observed prevalence of trypanosomiasis infection in the village cattle. Shortcomings of the method are discussed.

7121 **Tikubet, G., Dransfield, R.D., Otieno, L.H. and Morgan, H., 1991.** Direct estimation of tsetse `challenge' and trypanosomiasis `risk'. *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 168-173.

Tikubet: Addis Ababa University, P.O. Box 3893, Addis Ababa, Ethiopia; Dransfield, Otieno: ICIPE, P.O. Box 30772, Nairobi, Kenya.
Tsetse challenge to cattle at Toley in south-west Ethiopia was estimated directly using electric screens and indirectly using biconical traps. The electric screens were arranged in 5 m radius circles of six screens each surrounding a small group of cattle. The screens were operated throughout the day for 4 days each month. Electrocuted flies were collected and examined for species, sex, blood meals and trypanosomiasis infections. Trypanosomiasis risk was estimated directly by treating 24 heifers with Berenil to clear any infection, then allowing the animals to graze in known tsetse-infected areas. They were then bled on a daily basis and examined for trypanosome infection. The results were used to quantify tsetse challenge and trypanosomiasis risk, which correlated well with the local prevalence of trypanosomiasis which is slightly over 20%. The main fly species was *Glossina pallidipes* and the major tsetse-transmitted trypanosomes

were *Trypanosoma vivax*, *T. congolense* and *T. brucei*. There was some evidence for different incubation periods representing different serodemes of *T. congolense*.

7122 **Welburn, S.C. and Maudlin, I., 1991.** Lectin mediated stimulation of maturation of trypanosome infections in *Glossina*. *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 196-199.

TRL, University of Bristol, Langford, Bristol BS18 7DU, UK.

The maturation of *Trypanosoma congolense* midgut infections in *Glossina morsitans morsitans* has been shown to be stimulated by a glucosyl lectin secreted in the fly midgut in response to bloodmeal serum. The duration of the lectin signal required to induce maturation was determined by the sequential addition or removal of a specific lectin inhibitor (D-glucosamine) to the diet of infected flies. Three days' exposure of procyclic trypanosomes to midgut lectin was sufficient to induce maturation. Prolonged exposure to midgut lectin increased the frequency of maturation. Established midgut infections retained their ability to mature throughout their life in the fly. When lectin activity in the midgut was inhibited the trypanosomes remained as procyclic forms but when this inhibition was removed they matured. Maturation is lectin dependent and is not predetermined by the trypanosomes undergoing a fixed number of division cycles within the fly gut.

5. HUMAN TRYPANOSOMIASIS

(a) SURVEILLANCE

[See also **15**: nos. 7115, 7172, 7173.]

7123 **Isharaza, W.K., Omollo, P., Kansiime, F.K., Akol, M.N. and Okuna, N.M., 1991.** A modified test for diagnosing *Trypanosoma brucei rhodesiense* in man by lysing red blood cells and concentrating trypanosomes. (Abstract only.) *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 149-150.

UTRO, P.O. Box 96, Tororo, Uganda.

Detection of trypanosomes is made easier by haemolysing red blood cells (RBC) and concentrating the trypanosomes by centrifugation. The sensitivity of this test was increased by haemolysing blood samples in drawn-out and sealed glass pipettes, centrifuging the lysate after 15 min and examining the glass tips for trypanosomes *in situ*. Equal volumes of blood samples from clinically suspected individuals were used for this test and for the mAEC technique. No significant difference in sensitivity was observed. Since the RBC lysis test is cheaper and simpler to manipulate, it

offers a practical alternative for the diagnosis of human trypanosomiasis.

7124 **Kabeya, N.M., Rodriguez, E. and Mullem, E., 1991.** Approche par les soins de santé primaires (SSP) de la prévention/contrôle de la trypanosomiase humaine africaine (THA): expérience de Kasongo-Lunda au Zaire. [The primary health care approach for the prevention/control of African human trypanosomiasis: the case of Kasongo-Lunda in Zaire.] (Abstract only.) *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 103-105.

Kabeya: Bureau Central de la Trypanosomiase, Département de la Santé Publique, B.P. 7782, Kinshasa 1, Zaire.

A research-orientated control programme utilising mobile teams of personnel was begun in a hyperendemic area in 1985, coordinated by the Zaire Bureau Central de la Trypanosomiase and financed jointly by Belgium, Oxfam and USAID. Out of an exposed population of over 30,000, 15% were found to be serologically positive. The objectives of the programme were: to apply diagnostic tests to 90% of the population; to confirm parasitologically all positive cases; to diagnose the stage of the disease by lumbar puncture; to treat 85% of the population with trypanocides and 100% of confirmed cases; to monitor treated cases using lumbar puncture every 6 months for 3 years; to provide at least one trap per village in an area with the highest probability of man-fly contact. Before serological diagnosis, 15,409 people from a cross-section of the population were asked which of 20 clinical symptoms applied to themselves. This served as a diagnostic method and also familiarised the local population with the symptoms of trypanosomiasis. Seminars and demonstrations were also held to increase public awareness. The successes and failures of the programme during the first four years are briefly discussed.

7125 **Simarro, P.P., Ona Sima, F., Meteo, J.M. and Roche, J., 1991.** Evaluation de trois approches pour la lutte contre la trypanosomiase humaine africaine dans le foyer de Luba en Guinée Equatoriale. [Evaluation of three approaches for the control of African human trypanosomiasis in the Luba focus in Equatorial Guinea.] (Abstract only.) *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 115-116.

Simarro, Ona Sima: Centro de Control de la

Tripanosomiasis, Apartado 560, Bata, Equatorial Guinea; Meteo, Roche: Luba Hospital, Luba, Equatorial Guinea. A seroparasitological survey was conducted in 1985 to define the Luba focus, which was then subdivided into three zones according to the incidence of human trypanosomiasis: A (27.5% incidence), B (8.3%) and C (3.0%). In zones A and B an indirect immunofluorescence test was performed on all the inhabitants every 6 months; in addition, an antivector control programme was implemented in zone A. In zone C the population was monitored annually. There was a rapid reduction in the number of confirmed cases in zone A within 6 months but the incidence of disease also dropped in zones B and C. After 2 years the incidence/index of new contamination was 0 in zone A, 0.14 in zone B and 0.17 in zone C. The costs of this programme in 1985 were US $5.12 per person per year in zone A, three times higher than in zone B (US $1.86) and six times higher than in zone C (US $0.93). It is concluded that because of the high cost of combined serological diagnosis, antivector control and a 2 year monitoring period, this method can only be recommended for the control of *Trypanosoma brucei gambiense* sleeping sickness in an epidemiological emergency in foci with a high rate of transmission.

7126 **Vervoort, T. and Dukes, P., 1991.** A new *Trypanosoma brucei gambiense* serodeme in south-west Cameroon? (Abstract only.) *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 132-133.

Institute of Tropical Medicine, Antwerp, Belgium; TRL, University of Bristol, Langford, Bristol BS18 7DU, UK.

The lytic activity of sera from patients from the Fontem focus was examined on nine VATs of the LiTat repertoire. None of the 43 sera, including 17 that were CATT-positive, lysed trypanosomes bearing LiTat 1.3, a VAT previously considered ubiquitous throughout West Africa: LiTat 1.3 is employed in the CATT. Seventeen sera recognised one or more of five of the LiTats employed, including LiTat 1.6. The results suggest that a serodeme circulates in south-west Cameroon that expresses only part of the LiTat repertoire. DNA probe studies confirm that at least two related serodemes exist in Cameroon. Clearly, a survey in the Fontem area employing only LiTat 1.3 antigen cannot be fully effective; the implications for trypanosomiasis control need further investigation.

(b) PATHOLOGY AND IMMUNOLOGY

7127 **Asonganyi, T., 1991.** Serum antibodies against human brain myelin proteins in *gambiense* sleeping sickness. (Abstract only.) *In*: OAU/ STRC, 1991 (see **15**: no. 7082), p. 162.

Centre Universitaire des Sciences de la Santé, University of Yaoundé, Yaoundé, Cameroon.
Myelin proteins were extracted with 0.10 SDS-0.01 M Tris from human myelin floating on 0.88 M sucrose following centrifugation. Using ELISA and immunoblotting, we have shown that antibodies against the myelin proteins exist in sera collected from *gambiense* trypanosomiasis patients. The antibodies were more prevalent in patients with CNS involvement, since of 21 sera from patients with more than four cells/ml CSF, 15 (71.4%) had antimyelin antibodies compared to three of 13 (23.1%) from patients with less than four cells/ml CSF. Thus, of 18 sera that had antimyelin antibodies, 15 (83.3%) were from patients with CNS involvement. Using the immunofluorescence test, selected sera detected antigens in cryocuts of human brain.

7128 **Mbulamberi, D.B., 1991.** Clinical and laboratory features of late stage Rhodesian sleeping sickness in south eastern Uganda. *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 234-244.
National Sleeping Sickness Control Programme, P.O. Box 1241, Jinja, Uganda.
The clinical features of late-stage *rhodesiense* sleeping sickness were studied for diagnostic criteria. Individuals from five different treatment centres in the endemic area of south-eastern Uganda were divided into three categories: early-stage patients (89), late-stage patients (51) and outpatient controls (61). Most of the latter suffered from malaria, the presenting symptoms of which are similar to those of early stage trypanosomiasis. Data collected from all 201 participants included age and sex, history of previous treatment, presenting symptoms, physical signs and laboratory findings. Body weakness, somnolence, inability to stand and walk unaided, disturbance of speech and incontinence were the most constant presenting symptoms among the late-stage patients, while hand and tongue tremors, ataxic gait, Babinski reflex and positive cheiro-oral reflex were the most constant physical findings among the same group of patients. CSF analysis in the laboratory for trypanosomes, white cells and total protein provided

the basis for the definitive diagnosis of late-stage trypanosomiasis. The diagnostic value of CSF IgM and serum IgM, however, remained unclear.

(c) TREATMENT

7129 **Doua, F., Boa, F.Y., Schechter, P.J. and Raadt, P. de, 1991.** Résultats d'une étude randomisée de deux modes de traitement au DFMO portant sur 60 cas de THA à *T. b. gambiense*. [Results of a randomised study of two methods of DFMO treatment of 60 cases of African human trypanosomiasis caused by *T. b. gambiense*.] *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 255-258.
PRCT, B.P. 1425, Daloa, Côte d'Ivoire; CHU Cocody, 11 B.P. 311, Abidjan, Côte d'Ivoire; Merrell Dow Research Institute, 2 rue de Stockholm, 67000 Strasbourg, France; Parasitic Diseases Programme, WHO, 1211 Geneva 27, Switzerland.
Sixty late-stage *gambiense* sleeping sickness patients with nervous system involvement, ranging in age from 5-60 years, were divided into two groups (A and B) of 30. Each patient in group A was given 100 mg/kg DFMO by drip every 6 h for 14 days, followed by 21 days of oral treatment at 75 mg/kg every 6 h. Group B was just given 100 mg/kg DFMO by drip every 6 h for 14 days. In all 60 cases trypanosomes disappeared from the blood and CNS, sometimes within 24-48 h of the start of treatment. This was accompanied by a spectacular improvement of the clinical signs of the disease. The most serious side effects in group A were diarrhoea (21 cases), hyperthermia (six cases), anaemia and vomiting (four cases each) and in group B hyperthermia (six cases), diarrhoea (three cases) and abdominal pain (two cases). All the side effects were reversible, either by treating the symptoms or reducing the dose of DFMO. The shorter treatment (group B) was just as effective as the longer treatment (group A) and caused fewer side effects.

7130 **Friedheim, E. and Distefano, D., 1991.** Melarsoprol in the treatment of African sleeping sickness. *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 245-252.
Rockefeller University, 1230 York Avenue, New York, NY 10021-6399, USA.
The arsenical drug Atoxyl and its derivatives were widely used during the earlier part of this century but caused optic atrophy at the limit of the tolerated dose. The search for a safer derivative led to the development of melarsen and melarsen oxide, the latter a highly active but still relatively toxic trypanocide.

The addition of BAL (`British Anti-Lewisite'), an antidote to the arsenical warfare agent Lewisite, reduced the toxicity by a factor of 100 but the trypanocidal activity by a factor of only 2.5, resulting in melarsoprol with a chemotherapeutic index of 150. This is the only life-saving drug in second stage *rhodesiense* sleeping sickness. It does not affect vision but can result in encephalopathy. The mortality rate of patients treated with melarsoprol can reach 3.3% whereas the cure rate is in excess of 90%. The nature of the encephalopathy and its relationship to melarsoprol dose rate are discussed. Another recently developed melarsen derivative, R7/45Y, appears to have a prophylactic effect against trypanosomiasis in mice.

7131 **Giroud, C., Doua, F., Baltz, D. and Baltz, T., 1991.** Chimiorésistance à l'Arsobal de *T. gambiense* chez l'homme: pharmacologie de la drogue chez l'homme et chimiosensibilité des isolats de trypanosome. [*T. gambiense* chemoresistance to Arsobal in humans: pharmacology of the drug in humans and chemosensitivity of trypanosome isolates.] (Abstract only.) *In*: OAU/STRC, 1991 (see **15**: no. 7082), p. 268.

Giroud, Baltz, Baltz: Laboratoire d'Immunologie et de Biologie Parasitaire, Université de Bordeaux II, 146 rue Léo Saignat, 33076 Bordeaux, France; Doua: PRCT, B.P. 1425, Daloa, Côte d'Ivoire.

The origin of Arsobal resistance observed in patients infected with *Trypanosoma brucei gambiense* remains unknown: it may be due to the selection of drug resistant strains or to variable drug metabolism in the patients. The pharmacology of the drug was studied by determining its trypanocidal activity in the serum and CSF of patients with CNS involvement. Arsenic levels in the serum and CSF of patients receiving drug treatment were also measured. The culture of trypanosomes *in vitro* has enabled the chemosensitivity of different isolates to be compared.

7132 **Jennings, F.W., 1991.** Chemotherapy of chronic trypanosomiasis with arsenicals: combination treatment with DFMO. (Abstract only.) *In*: OAU/STRC, 1991 (see **15**: no. 7082), p. 254.

Department of Veterinary Parasitology, University of Glasgow, Bearsden Road, Glasgow G61 1QH, UK.

Melarsoprol treatment of late-stage trypanosomiasis is associated with reactive encephalopathies. Combination treatment with DFMO and arsenicals allows a

considerable reduction in the amount of arsenical needed for treatment. Part of this increased efficiency could be used to minimise the incidence of relapse infections.

7133 **Nieuwenhove, S. van and Declercq, J., 1991.** Oral eflornithine (DFMO) therapy in late-stage arsenical-refractory *gambiense* sleeping sickness. (Abstract only.) *In*: OAU/STRC, 1991 (see **15**: no. 7082), p. 253.
Nieuwenhove: Sleeping Sickness Control in Southern Sudan, c/o Belgian Embassy, P.O. Box 30461, Nairobi, Kenya.

Oral eflornithine monotherapy was administered to 65 late-stage arsenical-refractory patients in the Sudan at 400 mg/kg bodyweight/day in four divided doses for 4-6 weeks. Eflornithine is able to cure the disease, as was shown by eight cases followed up for about 24 months or more. Results in patients under the age of 14 were disappointing. Because of the high relapse rate, oral monotherapy cannot be recommended for this age group. Although relapses were also observed in adults, oral monotherapy with eflornithine was found to be a useful alternative treatment for late-stage arsenical-refractory *gambiense* sleeping sickness patients.

7134 **Nieuwenhove, S. van and Declercq, J., 1991.** Nifurtimox therapy in late-stage arsenical-refractory *gambiense* sleeping sickness. (Abstract only.) *In*: OAU/STRC, 1991 (see **15**: no. 7082), p. 264.
Nieuwenhove: Sleeping Sickness Control in Southern Sudan, c/o Belgian Embassy, P.O. Box 30461, Nairobi, Kenya.

Nifurtimox was administered orally, at a rate of 15-20 mg/kg/day for 21-45 days, to 115 patients suffering from late-stage, arsenical-refractory trypano-somiasis in the Sudan. A permanent cure was obtained in about 80% of the cases. Nifurtimox also proved effective for several patients who had previously relapsed after oral DFMO monotherapy.

7135 **Schechter, P.J., Tell, G., Hardenberg, J. and Sjoerdsma, A., 1991.** Eflornithine treatment of human *gambiense* trypanosomiasis: efficacy and tolerance in 403 cases. *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 259-263.
Schechter, Tell: Merrell Dow Research Institute, 2 rue de Stockholm, 67000 Strasbourg, France; Sjoerdsma: Merrell Dow Research Institute, 2110 East Galbraith Road, Cincinnati, OH 45215, USA.

Interference with cellular polyamine biosynthesis is a promising approach to the development of new therapies

for the treatment of African trypanosomiasis. Eflornithine (DL-alpha-difluoromethylornithine; DFMO) is a specific inhibitor of ornithine decarboxylase, a key enzyme in the biosynthesis of polyamines, and has been used to treat over 400 patients with *gambiense* trypanosomiasis. The majority of these patients had late-stage disease involving the CNS and were refractory to organic arsenical therapy. In all evaluable cases, eflornithine therapy was associated with a positive response involving the dramatic reversal of biological and clinical manifestations of the disease. Relapses were rare. Seventy-five patients were followed up for at least 24 months post-treatment without relapse, indicating that eflornithine is curative.

6. ANIMAL TRYPANOSOMIASIS

(a) SURVEY AND DISTRIBUTION

[See also **15**: nos. 7089, 7173, 7199.]

7136 **Gaturaga, I.M., Maloo, S.H. and Loehr, K.-F., 1991.** Monitoring of trypanosomiasis on a dairy farm under apparent low tsetse challenge at the Kenyan coast. *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 297-300.
Veterinary Investigation Laboratories, P.O. Box 204, Mariakani, Kenya.
The study area was a commercial dairy farm (80% Fresians, 20% Sahiwal crosses) 10 km south of Mombasa, with a natural vegetation of savanna mosaic with coastal forest. Routine trypanosomiasis control was by use of the prophylactic drug isometamidium chloride (Samorin). The aim was to reduce dependence on expensive chemotherapy by integrated tsetse and trypanosomiasis control. The fly population was monitored using ten odour-baited biconical traps. Only 23 flies (17 *Glossina pallidipes* and six *G. austeni*) were caught over the year, with a maximum of eight flies in December. Trypanosome detection in 40 cattle not protected by Samorin ranged from 5-54% during the study year, with peaks in June, August and December corresponding to the onset of the rainy season. The main species was *Trypanosoma vivax* (79%) with *T. congolense* (13%) and mixed *T. vivax*/*T. congolense* infections (8%). The number of trypanosome-positive cattle (average 22%) was high despite the low tsetse catch. It is concluded that *G. austeni*, which is not caught efficiently with biconical traps, could be the main vector on the farm. The role of mechanical transmission of *T. vivax* by biting flies cannot be entirely ruled out.

7137 **Ilemobade, A.A., Ogunyemi, O., David-West, K.B. and Onyima, V.C.,**

1991. A survey of the continued prevalence and importance of cattle trypanosomiasis in Nigeria. *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 292-294. Federal University of Technology, P.M.B. 704, Akure, Nigeria; ibid.; Federal Livestock Department, Federal Capital Territory, Abuja, Nigeria; ibid.
A questionnaire-based survey of the importance of bovine trypanosomiasis and the methods and costs of control in different parts of Nigeria was carried out in 1987, aimed at chief veterinary officers. Bovine trypanosomiasis was considered to be moderately or very important in 16 of Nigeria's 19 states; only three (Borno, Kano and Rivers) in the Sahel and mangrove swamp zones considered it to be of little importance. Half the respondents did not think trypanosomiasis was a constraint to the use of other livestock. Single-species infection with *Trypanosoma vivax* was more frequent than *T. congolense* although over 75% of the respondents reported multi-species infection. About 20% relied on clinical symptoms alone for diagnosis; others combined various diagnostic techniques. Estimated mortality was 1-10% in most parts of the country. Control strategies varied according to ecological zone: some areas used drugs only, others combinations of drugs, vector control and trypanotolerant cattle. Prophylaxis was not widely used. An estimated annual total of 731,023 doses of trypanocide were administered in 11 of the 19 states at an average cost of N147,361.00 per state per annum. Only one respondent reported drug resistance. The survey showed that bovine trypanosomiasis is still a constraint to livestock production in Nigeria and that the situation justifies the high cost of control.
7138 **Isharaza, W.K., Omollo, P. and Akol, N.M., 1991.** Serodiagnosis of *Trypanosoma brucei rhodesiense* in cattle from a sleeping sickness epidemic area of S.E. Uganda. (Abstract only.) *In*: OAU/STRC, 1991 (see **15**: no. 7082), p. 151. UTRO, P.O. Box 96, Tororo, Uganda.
During active surveillance for *T. b. rhodesiense* in an epidemic sleeping sickness area of south-east Uganda where large numbers of cattle are herded, some animals were randomly bled and serum samples prepared. A smaller number of cattle was screened parasitologically for the presence of trypanosomes. Using sera from cattle positive to *T. brucei* and *T. vivax* and from *T. b. rhodesiense* patients, a clone of one VAT of *T. b. rhodesiense*, UTat 4.1, was used in immunolysis tests to detect VAT-specific lytic antibodies. The VAT was lysed by specific antibodies in most of the control sera from

parasitologically positive *T. brucei*-infected cattle and humans. No reaction was detected in sera from *T. vivax* infections. Of the 219 sera from randomly bled cattle, 58 had lytic antibodies to this VAT. Cattle might therefore play a major role as reservoir hosts in the transmission of the disease to man.

7139 **Mulatu, W., d'Ieteren, G.D.M., Duffera, W., Girma, T., Leak, S.G.A., Maehl, J.H.H., Nagda, S.M., Rarieya, J.M., Rowlands, G.J., Thorpe, W., Tikubet, G. and Trail, J.C.M., 1991.** Factors affecting trypanosome prevalence in Zebu cattle exposed to high trypano-somiasis risk in south west Ethiopia. *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 507-510.

Mulatu, Duffera, Girma, Tikubet: ILCA, Ghibe Valley Site, Ethiopia; d'Ieteren, Maehl, Nagda, Rarieya, Rowlands, Thorpe, Trail: ILCA, P.O. Box 46847, Nairobi, Kenya; Leak: ILRAD, P.O. Box 30709, Nairobi, Kenya.

Seven traditionally managed herds of Zebu cattle in the Ghibe Valley, south-west Ethiopia, were sampled monthly between December 1985 and November 1988. Animals were treated with 3.5 mg/kg Berenil when parasitaemia was detected and PCV was less than 26%, or when clinical signs of trypanosomiasis were present. Trypanosome prevalence was analysed according to age and sex of the cattle; it increased with age up to 36 months and adult males had a slightly higher rate (29.2%) than females (23.0%). This is attributed to greater tsetse exposure and stress during periods of work. The infections were caused by *Trypanosoma congolense* (78%), *T. vivax* (16%) and *T. brucei* (5%), and 1% were mixed infections. The average ratio of *T. congolense* to *T. vivax* infection was twice as great in adult cattle (5:1) than in juveniles (2.5:1). Trypanosome prevalence varied inconsistently from year to year. Infection rates in the months following Berenil treatment were higher and this is attributed to rapid reinfection or relapse, or possibly to Berenil resistance.

7140 **Nyeko, J.H.P., Okuna, N.M., Ociba, P.M., Mayende, J.S.P., Saimo, M.M., Buga, R. and Buloba, A., 1991.** Bovine trypanosomiasis survey in the human sleeping sickness districts of Uganda. (Abstract only.) *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 295-296.

Nyeko, Ociba, Saimo, Buga: Ministry of Animal Industry and Fisheries, P.O. Box 7003, Kampala, Uganda; Okuna, Mayende, Buloba: UTRO, P.O. Box 96, Tororo, Uganda.

Bovine trypanosomiasis surveys were carried out in foci of human trypanosomiasis in south-east Uganda, in Moyo, Arua, Mukono and Tororo districts, using micro-HCT. An infection rate of 6.9% was observed. Based on

morphological identification, the infections consisted of *Trypanosoma vivax* (in 2.3%), *T. congolense* (0.6%), *T. brucei* (3.3%) and mixed infections (1.0%). *T. brucei* isolates from Tororo were shown by BIIT to be *T. b. brucei*. The use of species-specific DNA probes confirmed these identifications. The predominance of *T. congolense* Kilifi-type over savanna-type in Uganda is of particular interest since it was formerly believed to be mainly confined to the Kenyan coast. Some isolates which did not hybridise with any of the DNA probes used may be *T. congolense* forest-type.

7141 **Waitumbi, J.N. and Connor, R.J., 1991.** Epidemiology and control of camel trypanosomiasis in northern Kenya. (Abstract only.) *In*: OAU/ STRC, 1991 (see **15**: no. 7082), p. 301.

KETRI, P.O. Box 362, Kikuyu, Kenya; Regional Tsetse and Trypanosomiasis Control Programme, P.O. Box A560, Avondale, Harare, Zimbabwe.

During a two year study of the epidemiology of camel trypanosomiasis (surra) in northern Kenya, a distinct seasonal pattern in the incidence of infection was observed. In the dry season, 10% of the camels were found to have sub-clinical *Trypanosoma evansi* infections. In contrast, during the two rainy seasons (April to June and November to December) morbidity exceeded 50%; clinical cases occurred and were associated with abortions and deaths. Incidence of infection was age-related: weaner camels were most affected and calves least affected, which in part reflected management practices. On the basis of these epidemiological findings, two chemotherapeutic strategies were applied. One herd was protected with quinapyramine prosalt just before the high risk periods. In another herd, individual parasitaemic camels were treated with quinapyramine sulphate. Initial results indicate that the chemoprophylactic regime provides better control of camel trypanosomiasis in this part of Kenya.

7142 **Winckel, F. van, d'Ieteren, G.D.M., Leak, S.G.A., Maehl, J.H.H., Minengu, M., Nagda, S.M., Ngamuna, S., Rarieya, J.M., Rowlands, G.J., Thorpe, W. and Trail, J.C.M., 1991.** Preliminary results of a study of N'Dama cattle introduced in a metayage system in Idiofa District, Zaire. *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 520-522.

Winckel, Minengu, Ngamuna: ILCA, DPP Idiofa, B.P. 8251, Kinshasa, Zaire; d'Ieteren, Maehl, Nagda, Rarieya, Rowlands, Thorpe, Trail: ILCA, P.O. Box 46847, Nairobi, Kenya; Leak: ILRAD, P.O. Box 30709, Nairobi, Kenya.

Twenty-five herds of N'Dama cattle were monitored for

trypanosomiasis between 1986 and 1988. Tsetse flies were caught in biconical traps and examined for trypanosomes. Two species were identified, *Glossina fuscipes* and *G. tabaniformis*, the latter only in gallery forest and at a relatively low density but high infection rate. Trypanosome prevalence in cattle was very low in grass savanna (0.4%) but higher in savanna woodland (1.5%) and gallery forest (4.2%): this reflected tsetse challenge. Blood meal analysis showed that *G. fuscipes* fed primarily on wild and domestic Suidae (45.7% of blood meals) and humans (38.0%) and to a lesser extent on cattle (7.6%). Nearly all (91%) the parasitaemias detected were due to *Trypanosoma congolense*, 4% to *T. vivax*, 3% to *T. brucei* and 2% to mixed infections. Trypanosome infection in the dams resulted in a significant ($P < 0.05$) reduction in calf weight at 8 months from an average 89 kg to 81 kg.

(b) PATHOLOGY AND IMMUNOLOGY

7143 **Clausen, P.H., Sidibe, I., Bassinga, A., Pobel, T., Richard, X. and Pohlit, H., 1991.** Pathogénicité et pathologie de la trypanosomose africaine chez les taurins et les zébus soumis à une pression glossinaire naturelle au Burkina Faso: étude générale. [Pathogenicity and pathology of African trypanosomosis in taurines and Zebus under natural fly challenge in Burkina Faso: general study.] (Abstract only.) *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 389-390.

CRTA, B.P. 753, Bobo-Dioulasso, Burkina Faso.

In order to study the mechanisms underlying resistance to trypanosomosis, 76 Baoulé or N'Dama/Baoulé crosses (*Bos taurus*) and 20 Zebus (*Bos indicus*) were exposed to natural fly challenge in Burkina Faso. The following parameters were closely monitored: clinical condition (daily); haematocrit and parasitaemia (twice weekly); white blood cell, differential cell count and haemoglobin concentration (weekly); blood parasites (weekly); worm-egg counts (monthly). When animals died a full post-mortem examination was carried out. Animals were weighed twice monthly. Serum and plasma samples were analysed for changes in haemolytic activity and C2 level of complement, anti-trypanosome specific immune responses, progesterone, tracer elements, polyamine oxidase and interferon. A haemotype study and the typing of bovine class I lymphocyte antigens (BoLA) was carried out. Infected animals were treated with Berenil at 7 mg/kg when they were too weak to follow the herd. Tsetse fly surveys

were carried out at monthly intervals and the results will be published elsewhere.

7144 **Dwinger, R.H., Clifford, D.J., Agyemang, K., Grieve, A.S., Kora, S. and Jabang, B., 1991.** Comparative studies on N'Dama and Zebu cattle following experimental infection with *Trypanosoma congolense*. *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 394-401.
ITC, P.M.B. 14, Banjul, Gambia.
Twenty N'Dama and eight Zebu cattle were inoculated intradermally with bloodstream forms of a cloned strain of *T. congolense* originating from East Africa. The animals were kept with four uninfected N'Dama and one uninfected Zebu in a tsetse-free area. All inoculated cattle became parasitaemic after an average of 7 days and in 70% of the animals detection of parasites was preceded by a local skin reaction. The Zebu showed consistently higher levels of parasitaemia and lower PCV percentages than the N'Dama. Three of the Zebu required treatment; none of the N'Dama needed treatment. The experiment demonstrated major differences in disease susceptibility between N'Dama and Zebu cattle with respect to parasitaemia levels, degree of anaemia, weight change and survival. Statistical analysis of the data showed a large random variation among N'Dama cattle in PCV values during infection. This parameter should be evaluated as a selection criterion for trypanotolerance.

7145 **Elhassan, E., Ikede, B.O. and Adeyemo, O., 1991.** Commencement of cyclicity in suckling ewes infected with *Trypanosoma vivax*. (Abstract only.) *In*: OAU/STRC, 1991 (see **15**: no. 7082), p. 511.

Pathology Division, NITR, P.M.B. 2077, Kaduna, Nigeria; Departments of Veterinary Pathology (Ikede) and Anatomy (Adeyemo), University of Ibadan, Ibadan, Nigeria.
Commencement of cyclicity in nine suckling ewes that had been infected with *T. vivax* was investigated by vaginal smear examination, acceptance of the male and progesterone radioimmunoassay. Four of the ewes were infected in the third trimester of pregnancy while five were infected and treated subcuratively before breeding. Three uninfected ewes served as control. The ewes infected in the third trimester commenced cyclicity 13-23 days post-partum (PP). Subsequent cycles were short in one ewe, normal then short in another and prolonged (40 days) in two ewes. The ewes infected before breeding commenced cyclicity 1-13 days

PP. Subsequent cycles were short in one, normal in two and prolonged (30 days) in one. The control ewes resumed cyclicity 14-15 days PP with normal subsequent cycles. The short cycles were due to alteration in the progesterone levels while the prolonged cycles were due to prolonged progesterone depression.

7146 **Ernest, A., Kanyangala, S. and Kunda, E., 1991.** The spontaneous remission of a naturally acquired *T. b. rhodesiense* infection in a sentinel goat in a Zambian sleeping sickness focus. (Abstract only.) *In*: OAU/STRC, 1991 (see **15**: no. 7082), p. 233.

TDRC, P.O. Box 71769, Ndola, Zambia.

As part of the TDRC/EPIAF Trypanosomiasis Research Project in the upper Luangwa Valley, Zambia, goats were used as `sentinels' to monitor trypanosomiasis transmission and to provide additional *Trypanozoon* isolates for characterisation and behavioural studies. One goat, placed at Musenga village on 31 December 1987 and monitored thereafter at weekly intervals, was found to have a *Trypanozoon* infection on 30 March 1988 when its PCV was 28%. The infection was isolated in rats and the goat kept in a fly-screened pen and monitored weekly, as before. The isolated stock gave a positive BIIT response, typical of *Trypanosoma brucei rhodesiense*. By 4 May the goat became aparasitaemic. At this time it weighed 15 kg but by 3 October this had increased to 22.3 kg and its PCV to 33%. On the same day the goat and two rats were challenged with the original isolate. Both rats became parasitaemic and all rats inoculated with the goat's blood on 11, 18 and 25 November also became parasitaemic. Rats inoculated before 3 October or after 5 December remained negative, suggesting that the goat was recovering from this infection also.

7147 **Ismail, A.A., Njogu, A.R., Dolan, R.B. and Opiyo, E.A., 1991.** Haematologic response of two types of Kenya Boran cattle to tsetse transmitted *Trypanosoma vivax* infections. (Abstract only.) *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 512-513.

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

Ten Galana Boran and ten Orma Boran steers were challenged with a stock of *T. vivax* known to be virulent to cattle. Both groups developed febrile episodes, tachycardia and tachypnoea. The onset of anaemia was earlier and more severe in the Galana group than in the Orma, although both had a significant initial drop in PCV values. The Orma cattle were better able to reduce and control subsequent parasitaemia than the Galana. In the latter stages of infection, all eight remaining

Orma exhibited self-cure but none of the four remaining Galana. By the end of the study period, the Galana had an overall mean loss of 9.2 5.6 kg while the Orma had an overall mean gain of 8.9 6.8 kg. Taking the PCV of 15% as an indication of death, six out of the ten Galana animals would have died compared to two out of the ten Orma animals. Immunological screening indicated no previous infection with the *T. vivax* stock used. Therefore the results may reflect an innate difference in susceptibility rather than in acquired immunity. It was concluded that Orma Boran possess some degree of resistance to trypanosomiasis which may be genetic.

7148 **Logan, L.L., Anosa, V.O. and Shaw, M.K., 1991.** Haemopoiesis in Ayrshire-Guernsey calves infected with the Galana stock of *Trypano-soma vivax*. *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 317-322.

Logan, Shaw: ILRAD, P.O. Box 30709, Nairobi, Kenya; Anosa: Department of Veterinary Pathology, University of Ibadan, Ibadan, Nigeria.

A study to evaluate the haemopoietic response during the acute phase of an infection with a haemorrhage-causing Galana stock of *T. vivax* was carried out in 11 Ayrshire-Guernsey calves. Infected calves developed pyrexia 6-7 days p.i., followed by parasitaemias as early as 8 days p.i. which remained high until 26 days p.i. and fluctuated thereafter. Infected calves developed anaemia, leucopenia and thrombocytopenia. Red marrow expanded into the diaphysis and fatty marrow of long bones. Erythroid hyperplasia with a drop in granulocyte precursors resulted in a sequential drop in the myeloid:erythroid ratio. By 12 days p.i. there was a rise in the number of macrophages and lymphocytes in the marrow and discrete lymphoid follicles were detected histologically by 15 days p.i. Transmission electron microscopy studies of the rib and femur marrows revealed extensive phagocytosis by macrophages of mature and immature erythroid and myeloid cells as early as 11-12 days p.i. and throughout the infection until the last animal was killed at 46 days p.i. Trypanosomes were seen in both the marrow and sinusoids from day 11 onward. Macrophages were only rarely observed to have phagocytosed parasites. Calves killed toward the end of the study had fewer macrophages in sinusoids and good erythroid responses.

7149 **Mohammed, G. and McNamara, J., 1991.** Preliminary studies on the pathogenicity of a new trypanosome of the subgenus *Nannomonas*. (Abstract only.) *In*:

OAU/STRC, 1991 (see **15**: no. 7082), pp. 339-340.
TRL, Langford House, Langford, Bristol BS18 7DU, UK.
There are two known species within the subgenus *Nannomonas*: *Trypanosoma (N.) congolense* is infective to a wide range of wild and domestic animals, while *T. (N.) simiae*, with a more restricted host range, causes an acute infection in domestic pigs. In a recent survey in The Gambia, a *Nannomonas*-type infection was isolated which could not be identified by the available *Nannomonas*-specific DNA probes. Experimentally infected tsetse were fed on piglets and sheep. The piglets developed a patent parasitaemia after 7 days. This infection persisted at a sub-acute level for 16 weeks and was not fatal. Neither sheep nor mice, which were subinoculated directly from infected pig blood, developed parasitaemia. In contrast two piglets infected with *T. simiae* became parasitaemic by the fourth day and were killed *in extremis* on day 10. Although genetically distinct, the new stock shares some characteristics with *T. simiae*, notably host range and behaviour *in vitro*, but is markedly less pathogenic in domestic pigs.

7150 **Mwangi, D.M., Hopkins, J. and Luckins, A.G., 1991.** Cellular phenotypes in *Trypanosoma congolense* infected sheep: studies on the local skin reaction and draining lymph nodes. (Abstract only.) *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 302-303.
Mwangi, Luckins: CTVM, Easter Bush, Roslin, Midlothian EH25 9RG, UK; Hopkins: Department of Veterinary Pathology, University of Edinburgh, Summerhall, Edinburgh, UK.
In primary infections, the initial leucocyte infiltration into the dermis to form the chancre at 5 days p.i. consisted histologically of neutrophils and lymphocytes. At the peak of the reaction, between days 7 and 10, there was a preponderance of mononuclear cell infiltration, mainly lymphocytes. SBU-T4 T cells formed the predominant population and were widely distributed, while B cells were present mainly in discrete clusters. Few macrophages were observed but there was a marked expression of MHC class II cells. In the regression phase of the chancre (from day 13) there were fewer B cells, loss of Fc receptor (FcR) expression, marked expression of MHC class II, an increased number of macrophages and the predominant phenotype T cell was SBU-T8. In draining lymph nodes, there were parallel changes in cellular phenotypes. Expression of MHC class II, macrophages and B cells

increased during infection with a concomitant decrease in the numbers of cells expressing SBU-T1 and SBU-T4. The medulla of the lymph node showed an increased presence of SBU-T8 cells and macrophages. Sheep which had been infected, treated with a trypanocidal drug and then challenged with a heterologous serodeme of *T. congolense* showed similar cellular phenotype kinetics to that seen in primary infections.

7151 **Ndung'u, J.M., Eckersall, P.D., Jennings, F.W., Wright, N.G. and Murray, M., 1991.** Changes in lipid metabolism in dogs experi-mentally infected with *Trypanosoma brucei*. *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 304-314. Departments of Veterinary Medicine (Ndung'u, Murray), Biochemistry (Eckersall), Parasitology (Jennings) and Anatomy (Wright), University of Glasgow Veterinary School, Bearsden Road, Glasgow G61 1QH, UK.
Investigations were carried out to establish whether defective lipid metabolism occurred in canine trypanosomiasis and what effects it might have on myocardial damage. Eight 7-month-old beagle dogs were infected with *T. brucei* GVR35/c.1. Before and during the disease, jugular venous blood was collected in heparin and EDTA. Two dogs were euthanised on days 10, 15, 21 and 22 respectively, and samples taken from the heart for histological and EM examination. During week 3 of infection there was a progressive increase in plasma triglycerides and cholesterol. Plasma lipoprotein electro-phoresis demonstrated a marked increase in percentage of low density lipoprotein (LDL) and very low density lipoprotein (VLDL). There was a slight decrease in high density lipoprotein (HDL). At the same time, severe hypoalbuminaemia developed. Tissue samples from dogs euthanised after 15 days of infection showed the presence of large lipid deposits both intracellularly in myocytes and infiltrating macrophages, and extracellularly. Lipid deposits in the myocardium might play a role in the pathogenesis of the severe pancarditis which occurs in canine trypanosomiasis.

7152 **Ndung'u, J.M., Paterson, C.C., Northright, D.B., Jennings, F.W., Wright, N.G., Murray, M. and Dargie, H.J., 1991.** Echo-cardiographic investigations in dogs experimentally infected with *Trypanosoma brucei*. (Abstract only.) *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 315-316.

Ndung'u, Paterson, Jennings, Wright, Murray: University of Glasgow Veterinary School, Bearsden Road, Glasgow G61 1QH, UK; Northright, Dargie: Cardiology Department, Western Infirmary, Glasgow, UK.

Dogs infected with *T. brucei* develop an acute disease syndrome characterised by severe myocardial and valvular damage, resulting in death during the fourth week. This study investigated the echocardiographic changes occurring during such infections. Nine 7-month-old beagles were infected with *T. brucei* GVR35/c.1. A marked increase in left ventricular function (LVF) occurred 10 days after infection. Aortic flow velocity increased from a mean of 1.66 m s^{-1} to 3 m s^{-1}. From day 12, incompetence of the mitral, tricuspid and aortic valves was recorded and increased with time. Towards the end of week 3 and beginning of week 4, LVF and blood flow velocity through the ascending aorta gradually decreased. In some dogs aortic flow became less than 1 m s^{-1} by day 17 of infection. Valvular, myocardial and conduction tissue damage were confirmed histologically and ultrastructurally. These studies demonstrate that valvular and haemodynamic changes occur very early in canine trypanosomiasis, that they are progressive and could be playing a major role in the pathogenesis of the resultant pancarditis.

7153 **Williams, D.J.L., Naessens, J., Moloo, S.K. and Scott, J.R., 1991.** Analysis of peripheral blood leukocyte populations in N'Dama and Boran cattle following *Glossina morsitans centralis*-transmitted *Trypanosoma congolense* infection. *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 152-161.

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

One group of N'Dama and two groups of Boran cattle were infected with *T. congolense*. The N'Dama and one of the Boran groups (group 1) had also been infected 32 months previously; the second Boran group (group 2) served as controls. Group 1 (rechallenged) Borans became parasitaemic and developed chronic anaemia but three out of five eventually self-cured. The N'Dama did not develop anaemia, had low parasitaemia and self-cured. Group 2 Borans experienced high levels of parasitaemia and acute anaemia and all required treatment. Low levels of reticulocytes were detected in all three groups. The neutrophil count declined in the Boran groups but not in the N'Dama. Monocyte and eosinophil levels remained constant and $CD8^+$ T-cells decreased in all three groups. The N'Dama showed a small increase in $CD4^+$ T-cells, which decreased in both Boran groups. B-cell levels increased during infection in all groups.

The CD5 antigen was detected on 50-90% of peripheral blood B-cells in infected animals, compared to 5-10% in normal animals. $CD5^+$ B-cells are associated with autoimmune diseases in humans and mice and these findings may have important implications regarding the autoimmune component in bovine trypanosomiasis.

(c) TRYPANOTOLERANCE

[See also **15**: nos. 7144, 7147, 7153.]

7154 **Kakiese, O., Feron, A., d'Ieteren, G., Durkin, J., Itty, P., Maehl, J.H.H., Mulungo, S.M., Nagda, S.M., Pelo, M., Rarieya, J.M., Sheria, M., Thorpe, W. and Trail, J.C.M., 1991.** Productivity of ranch N'Dama cattle under trypanosomiasis risk. *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 402-405.

Kakiese, Feron, Mulungo, Pelo, Sheria: Compagnie J. Van Lancker, B.P. 199, Kinshasa, Zaire; d'Ieteren, Durkin, Itty, Maehl, Nagda, Rarieya, Thorpe, Trail: ILCA, P.O. Box 46847, Nairobi, Kenya.

The productivity of N'Dama cattle has been compared at two ranches in Zaire with zero and high trypanosomiasis risk respectively. Cow and calf viabilities, parturition intervals, cow parturition and weaning weights and calf weaning weights were recorded during a 3 year period from January 1984 to December 1986. The results show that the production of N'Dama cattle was similar at both ranches despite contrasting trypanosomiasis risk levels, confirming that this is not a major factor affecting the productivity of this trypanotolerant breed. The productivity of N'Dama cattle on these ranches was comparable to that achieved by Boran cattle maintained under chemoprophylaxis in a high trypanosomiasis risk environment in Tanzania.

7155 **Maillard, J.C. and Quéval, R., 1991**. Typage d'antigènes lympho-cytaires (BoLA) de taurins Baoulé et de Zébus soudaniens du Burkina Faso (Afrique occidentale): possibilités d'applications pratiques dans la sélection raciale et la trypanotolérance. [Typing lymphocyte antigens (BoLA) of Baoulé cattle and Sudanese Zebus from Burkina Faso (West Africa): possibilities of practical applications in breed selection and trypanotolerance.] (Abstract only.) *In*: OAU/STRC, 1991 (see **15**: no. 7082), p. 409.

CRTA, B.P. 454, Bobo-Dioulasso, Burkina Faso.

BoLA typing in 294 Baoulé and 106 Zebu cattle demonstrated the genetic frequencies of several class 1 types. A comparison of these frequencies showed that some BoLA types are significant markers of different breeds of cattle and can be used to indicate trypanotolerant cattle with a probability of 95%. They

can also be used to detect cross-breeding within a population.

7156 **Maille, J.C., Authie, E., d'Ieteren, G.D.M., Leak, S.G.A., Maehl, J.H.H., Nagda, S.M., Rarieya, J.M., Rowlands, G.J., Sauveroche, B., Thorpe, W., Trail, J.C.M. and Yangari, G., 1991.** Aspects of trypanotolerance and associations with growth rate in post-weaner N'Dama cattle under high trypanosomiasis risk. *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 391-393.

Maille, Sauveroche, Yangari: OGAPROV, Moanda, Gabon; Authie, Leak: ILRAD, P.O. Box 30709, Nairobi, Kenya; d'Ieteren, Maehl, Nagda, Rarieya, Rowlands, Thorpe, Trail: ILCA, P.O. Box 46847, Nairobi, Kenya.

A group of 120 post-weaner N'Dama cattle was studied for 5 months between November 1987 and April 1988. Every other week the animals were weighed, blood samples were analysed for PCV and the presence of trypanosomes was determined by the dark ground/phase contrast buffy coat technique. Increased frequency of parasitaemia was associated with reduced liveweight gain and reduced PCV. Cattle with detectable parasitaemias showed a linear negative relationship between the length of time they were parasitaemic and growth. There was no significant relationship between the severity of parasitaemia and growth rate, although animals which maintained above-average PCVs showed significantly better growth ($P < 0.001$) than those with below-average PCVs. Eighteen animals had no detected parasitaemia and had the highest growth rate. Seventeen, 19, 18, 30 and 18 animals were parasitaemic for 10, 20, 35, 60 and 80% of the time, respectively.

7157 **Quéval, R., 1991.** Le polymorphisme des protéines comme marqueur de la résistance naturelle à la trypanosomiase chez les bovins en Afrique de l'Ouest. [Protein polymorphism as a marker for natural resistance to trypanosomiasis in West African cattle.] (Abstract only.) *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 407-408.

CRTA, B.P. 454, Bobo-Dioulasso, Burkina Faso.

The polymorphism of four proteins (haemoglobin, phosphoglucomutase, purine nucleoside phosphorylase and albumin) was analysed in Baoulé, Ndama/Baoulé crosses and Zebu cattle in West Africa. These cattle show striking differences in their susceptibility to trypanosomiasis. When exposed to high tsetse challenge, all Zebu are sensitive (high parasitaemia, severe anaemia, death in about ten weeks). Approximately one third of the Baoulé are as sensitive

as the Zebu, while the rest are resistant (no or transient parasitaemia, no anaemia, indefinite survival in good condition). All the N'Dama/Baoulé crosses under investigation were resistant. There is a highly significant difference in the Alb phenotype between trypanoresistant and sensitive cattle. Within the Baoulé breed alone, animals having the Alb FF phenotype were 6.5 times more likely to be resistant to trypanosomiasis than those having either the FS or SS phenotypes. Alb FF can therefore be used as a criterion to select trypanoresistant cattle in West Africa.

(d) TREATMENT

[See also **15**: nos. 7139, 7141.]

7158 **Ainanshe, O.A., Jennings, F.W. and Holmes, P.H., 1991.** Isolation of drug resistant strains of *Trypanosoma congolense* in Somalia. *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 373-378.

NTTCP, P.O. Box 6956, Mogadishu, Somalia; University of Glasgow Veterinary School, Bearsden Road, Glasgow G61 1QH, UK; ibid.

Two isolates of *T. congolense* were obtained from the Lower Shabelle region of southern Somalia which displayed high levels of resistance to therapy with isometamidium chloride (Samorin) and diminazene aceturate (Berenil). The isolates were obtained by injecting blood from infected cattle into a recipient calf. When the calf became parasitaemic it was treated with a standard dose of isometamidium chloride at 0.5 mg/kg. When a relapse infection developed blood was taken and injected into groups of cattle, goats and mice. Once these animals became parasitaemic they were treated with a range of doses of isometamidium and diminazene aceturate to determine the degree of drug resistance. Both isolates showed remarkably high levels of resistance to both drugs. There have been very few reports from Africa of such high levels of resistance to Samorin and Berenil. However, the findings indicate that resistance could be an important constraint on the use of trypanocidal drugs in Somalia.

7159 **Baltz, T., Oukessou, M., Benlamlih, S., Laurentie, M.P. and Toutain, P.L., 1991.** Plasma arsenic concentrations *vs* trypanocidal activity for Cymelarsan$^{\varepsilon}$, camels results. *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 501-506.

Laboratoire d'Immunologie, Université de Bordeaux II, 146 rue Léo Saignat, 33073 Bordeaux, France; Departement de Physiologie, Institut Agronomique et Vétérinaire Hassan II, Rabat, Morocco; ibid.; INRA, Station de Pharmacologie-Toxicologie, Toulouse, France; ibid.

The significance of arsenic as a marker of Cymelarsan activity was evaluated by comparing plasma arsenic concentrations and plasma trypanocidal activity. The drug was administered to five camels at subcutaneous doses of 0.1, 0.2 and 0.3 mg/kg and at one i.v. dose of 0.3 mg/kg. Peak plasma arsenic level and peak plasma trypanocidal activity were observed about 30 min post-injection. There was a high correlation between plasma arsenic concentration and biological activity for 6-10

h following injection, after which discrepancies occurred. This is thought to be due to a progressive increase in plasma arsenic concentration which is not associated with trypanocidal activity. It is concluded that arsenic is a good marker for the kinetic analysis of Cymelarsan only during the first 6-10 h following administration.

7160 **Claxton, J.R., Leperre, P., Rawlings, P., Snow, W.F. and Dwinger, R., 1991.** Trypanosomiasis challenge estimation in The Gambia using the Berenil Index: comparison between Zebu and N'Dama. (Abstract only.) *In*: OAU/STRC, 1991 (see **15**: no. 7082), p. 406.

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

The Berenil Index provides a means of estimating the trypanosomiasis challenge presented to cattle independently of the collection of tsetse data and the rates of infection in cattle. An experimental protocol was applied to sentinel herds of trypanotolerant and trypanosusceptible cattle in three regions of different tsetse challenge in The Gambia. The different challenges as measured by the Berenil Index were compared with those of tsetse-derived data, and compared to the trypanosome prevalence in local cattle. The Berenil Indices produced corresponded well with these methods of estimating challenge. Indices ranged from no treatments per year to in excess of monthly treatments, depending on region and on breed of cattle. Trypanosusceptible animals showed higher indices than trypanotolerant animals.

7161 **Hendy, C.R.C., Mpepo, P., Mponda, C., Kamtande, K., Notley, J.R. and Kitosi, K., 1991.** The effects of trypanosomiasis prophylaxis at two levels of tsetse challenge on the productivity of goats under traditional management in southern Tanzania. *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 323-333.

Land Resources Department, NRI, Central Avenue, Chatham Maritime, Kent ME4 4TB, UK; Ministry of Livestock Development, P.O. Box 9152, Dar es Salaam, Tanzania; ibid.; ibid.; ibid.; ibid.

Trials of trypanosomiasis prophylaxis and anthelmintic treatment were conducted over 3 years in 64 flocks of goats under traditional management in Mtwara and Newala Districts of southern Tanzania. In Mtwara District a 2 ∃ 2 factorial design (with and without both treatments) was employed in areas with two different levels of tsetse infestation (low, < 0.1 flies/trap/day and medium, 0.3-1.0 flies/trap/day. Increased tsetse challenge was associated with small reductions in

overall productivity (−13 to −18%) and depressions of adult liveweights (−4%). Responses to prophylaxis showed significant increases in overall productivity (+23 to +27%). Prophylaxis appeared to depress breeding dam liveweights (−4%) and litter sizes (−8%), but this was associated with shorter parturition intervals and greater offspring birth weight, pre-weaning weights and survival. There was a significant interaction of prophylaxis and tsetse challenge, with much greater responses to prophylaxis under medium than under low challenge. The results suggest that trypanosomiasis prophylaxis may be justifiable under apparently low levels of disease prevalence in goats.

7162 **Kinabo, L.D.B. and McKellar, Q.A., 1991.** Isometamidium residues: assessment of their toxicological potential. *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 365-370.

Department of Veterinary Pharmacology, University of Glasgow Veterinary School, Bearsden Road, Glasgow G61 1QH, UK.

When ^{14}C-isometamidium residues in tissues from a calf were incorporated in a standard diet and fed to rats for 7 and 21 days, no radioactivity was detectable in the tissues examined, including the kidney, liver, spleen, muscle, stomach and small intestine. Cumulative excretion of radioactivity in faeces averaged 90% of the dose. Similarly, following administration of ^{14}C-isometamidium (2.245 mg/kg bodyweight) to rats by oral gavage, no radioactivity was detectable in tissues 48 h after administration, and cumulative excretion of radioactivity in faeces averaged 93% of the dose. Clinical and pathological examinations showed no abnormalities. These results show that isometamidium residues are not bioavailable to any significant extent, and that such residues do not cause clinical or pathological effects after subchronic feeding to rats. It is probable that, in humans, the risk associated with meat containing isometamidium residues is low.

7163 **Kratzer, R.D., Turkson, P.K., Karanja, W.M. and Ondiek, F.O. 1991.** Studies in cattle on the pharmacokinetics, residues and bioavailability of the anti-trypanosomal drug isometamidium. *In*: OAU/STRC, 1991 see **15**: no. 7082), pp. 354-360.

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

Radiolabelled isometamidium was administered i.m. (1 mg kg^{-1}) to two uninfected Boran steers. Levels of radioactivity were determined in blood, plasma, urine, faeces and tissues for 120 and 240 days. Peak plasma

levels of 158 ng/ml and 161 ng/ml were reached 15 to 30 min after administration, followed by a rapid decline with half lives of 1.2 and 1.7 h. The second phase, with a half life of 90 days, continued for 3 to 4 months; the third phase, with half lives of 30 and 60 days, started and continued up to 6 months after administration; the fourth phase, with a half life of 90 days, could be observed up to 240 days after treatment when the experiment was terminated. The main way of excretion was via the bile and faeces with an accumulative excretion of 70% after 120 and 75% after 240 days, whereas 12% and 15% respectively were found in urine giving a total excretion of 82% after 120 and 91% after 240 days. The residue level in tissues was highest in the liver with 0.40 μg/g 120 days and 0.18 μg/g 240 days after treatment, while the skeletal muscle contained 0.01 μg/g and 0.002 μg/g respectively. The results show that a single treatment of 1 mg kg^{-1} isometa-midium is detectable in the blood of cattle for at least 240 days and therefore confirm its use as a prophylactic trypanocidal drug.

7164 **Murilla, G.A. and Kratzer, R.D., 1991.** Sorbent extraction and HPLC of diminazene aceturate in bovine plasma and tissues. *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 347-353.

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

A comparison of HPLC (high performance liquid chromatography) and radiometric analysis of diminazene aceturate (Berenil) in bovine plasma showed that for a period of at least 28 days post-treatment no drug metabolites could be detected. Recoveries of over 90% were established from plasma and between 25 and 85% from tissue (spleen, kidney) samples. The method described is simple, quick, accurate and sufficiently sensitive to determine sub-microgram levels of diminazene aceturate in both plasma and tissues. It could, therefore, be employed for the routine analysis of plasma and tissues for drug residues.

7165 **Raynaud, J.P., Sones, K.R. and Friedheim, E.A.H., 1991.** A review of Cymelarsan® – a new treatment proposed for animal trypanosomiasis due to *T. evansi* and other trypanosomes of the *T. brucei* group. *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 334-338.

Rhône Merieux, 14 Chemin du Calquet, 31057 Toulouse Cedex, France; RMB Animal Health, Rainham Road, South Dagenham, Essex RM10 7XS, UK; Rockefeller University, 1230 York Avenue, New York, NY 10021-6399, USA.

Cymelarsan (Mel Cy, RM-110) is more effective for the

treatment of *Trypanosoma brucei* infections in laboratory mice than its predecessors Arsobal and Trimelarsan. It is also effective against *T. evansi* in horses, cattle and camels. A single dose in the range of 0.25-0.5 mg/kg is curative. The toxicity and plasma kinetics of the drug are discussed. It is thought that Cymelarsan has potential for the treatment of other *T. brucei*-group trypanosome infections and could be used to treat reservoir hosts of *T. b. rhodesiense* (cattle and pigs) and *T. b. gambiense* (cattle, pigs and dogs).

7166 **Raynaud, J.P., Toutain, P.L., Baltz, T. and Sones, K.R., 1991.** Plasma kinetics, toxicity and tolerance of Cymelarsan$^{\varepsilon}$: in horses, cattle and camels. *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 495-500.

Rhône Mérieux, 14 Chemin de Calquet, 31057 Toulouse Cedex, France; INRA, Station de Pharmacologie-Toxicologie, Toulouse, France; Laboratoire d'Immunologie, Université de Bordeaux II, 146 rue Léo Saignat, 33073 Bordeaux, France; RMB Animal Health, Rainham Road, South Dagenham, Essex RM10 7XS, UK.

Cymelarsan is a new trivalent arsenical drug effective against *Trypanosoma evansi*. It is injectable i.m. or subcutaneously. Clinical efficacy is related to systemic availability, achieved plasma concentration and persistence: these parameters are dependent on dose and route of administration. With doses of 3 mg/kg, the kinetics of Cymelarsan were compared in horses, cattle and camels. The results showed good Cymelarsan availability in all three species, reaching a peak about 0.5 h after injection. The calculated absolute bioavailability in camels was 70-80%. The activity of the drug began to decrease 10 h after injection. Trypanocidal activity was apparently higher in horses. Toxicity was low.

7167 **Sones, K.R., 1991.** Isometamidium: tissue distribution, pharmacokinetics and toxicology. *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 361-364.

RMB Animal Health, Rainham Road, South Dagenham, Essex RM10 7XS, UK.

Isometamidium chloride (Samorin, Trypamidium) is a trypanocidal drug with pronounced prophylactic activity. This activity is thought to be associated with very low levels of circulating isometamidium, which are maintained by the gradual release of the compound from the depots which form at the site of injection and in the liver and kidneys. In view of increasing concern for the possible public health risks associated with consuming residues of isometamidium in

animal products, studies relating to the tissue distribution, pharmacokinetics and toxicology of isometamidium are reviewed.

7168 **Sones, K.R., Vangool, F.J. and Raynaud, J.P., 1991**. Cymelarsan$^{\varepsilon}$, a new treatment of trypanosomoses due to *T. evansi* in camels. *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 485-488.

RMB Animal Health, Rainham Road, South Dagenham, Essex RM10 7XS, UK; Rhône Mérieux, 14 Chemin du Calquet, 31057 Toulouse Cedex, France; ibid.

Cymelarsan, a trivalent arsenical injectable drug, is proposed for the treatment of acute, subacute or chronic *Trypanosoma evansi* infections in camels. It is more effective in terms of mg/kg live weight than suramin and diminazene aceturate. In field trials using 0.25-0.50 mg/kg no adverse systemic effects were observed. It is a quick-acting curative drug and has no preventive or long-acting effect. The recommended dose is 0.25 mg/kg.

7169 **Sutherland, I.A., Moloo, S.K., Holmes, P.H. and Peregrine, A.S., 1991.** Studies on the prophylactic and therapeutic activities of isometamidium chloride (Samorin) in Boran cattle against a tsetse-transmitted drug-resistant clone of *T. congolense*. (Abstract only.) *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 514-515.

Sutherland, Moloo, Peregrine: ILRAD, P.O. Box 30709, Nairobi, Kenya; Holmes: University of Glasgow Veterinary School, Bearsden Road, Glasgow G61 1QH, UK.

Five Boran cattle were given 1.0 mg/kg i.m. isometamidium chloride and exposed 28 days later to *Glossina morsitans centralis* infected with the drug-resistant *Trypanosoma congolense* strain IL 3270. All five animals and 19 controls not previously treated with isometamidium developed parasitaemia after exposure to infected tsetse, showing that the drug is no longer prophylactic 28 days after administration. The cattle were then treated with isometamidium at one of the following doses: 1 or 2 mg/kg i.m. or 0.25, 0.5, 0.75 or 1 mg/kg i.v. Infections relapsed in all the animals 12-17 days after treatment, except in the group given 2 mg/kg i.m. which relapsed after a significantly longer period. The results also suggest that the therapeutic activity of the drug against resistant strains of *T. congolense* is not enhanced either by i.v. doses up to 0.5 mg/kg or by repeated i.m. administration at 8 week intervals.

7170 **Whitelaw, D.D., Gault, E.A., Sutherland, I.A., Holmes, P.H., Rowell, F.J., Phillips, A. and Urquhart, G.M., 1991.** Measurement of

isometamidium in cattle serum by ELISA. *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 341-346.
Whitelaw, Gault, Sutherland, Holmes, Urquhart: University of Glasgow Veterinary School, Bearsden Road, Glasgow G61 1QH, UK; Rowell, Phillips: School of Pharmaceutical and Chemical Sciences, Sunderland Polytechnic, Sunderland SR2 7EE, UK.
While isometamidium remains the most effective prophylactic drug for the control of bovine trypanosomiasis, reports on the emergence of drug-resistant strains have underlined the necessity for a method by which drug levels in treated cattle can be easily measured and correlated with the efficacy of treatment. To this end, we have developed a competition micro-ELISA for the estimation of isometamidium in the serum of treated cattle. The assay is performed using only 5 μl of test serum and is specific for isometamidium: no significant cross-reactivity occurs with either homidium bromide (Ethidium) or diminazene aceturate (Berenil). After single i.m. dosage of cattle at 1 mg/kg, levels around 50 pg/ml persisted for 6 weeks, declined to 10 pg/ml by 14 weeks but were still detectable (> 5 pg) 5 months after treatment. The assay offers a means by which easy rapid evaluation of isometamidium levels may be made.

7. EXPERIMENTAL TRYPANOSOMIASIS
(a) DIAGNOSTICS
[See also **15**: nos. 7175, 7196, 7198.]

7171 **Bocquentin, R., Duvallet, G. and Baltz, T., 1991.** Une méthode sensible de détection de *Trypanosoma congolense*: lyse avec détergent/ centrifugation. [A sensitive method for the detection of *T. congolense*: lysis with detergent and centrifugation.] *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 142-148.
Bocquentin: CRTA, B.P. 454, Bobo-Dioulasso 01, Burkina Faso.
The most frequently used method for the parasitological diagnosis of African trypanosomes is centrifugation in capillary tubes. The examination of the blood cell/plasma interface by phase contrast microscope permits, for *T. congolense*, the detection of concentrations of about 10^3 trypanosomes/ml blood. The sensitivity of this test has been increased by the lysis of blood samples with a detergent, sodium dodecyl sulphate. The trypanosomes were then concentrated by centrifugation and the residue examined. This method

has shown a greater sensitivity, to concentrations of about 10^2 trypanosomes/ml blood.

7172 **Mihok, S., Otieno, L.H. and Darji, N., 1991.** Isoenzyme polymorphism and the blood incubation infectivity test (BIIT): contradictory predictions of human infectivity for *Trypanosoma brucei*. *In*: OAU/ STRC, 1991 (see **15**: no. 7082), pp. 137-141.
ICIPE, P.O. Box 30772, Nairobi, Kenya.
Isoenzyme information of *T. brucei* isolates from the Lambwe Valley, Kenya, was used to differentiate between human-infective isolates and isolates of unknown infectivity. Human infectivity was linked to specific banding patterns for the enzymes isocitrate dehydrogenase, peptidase 1, aspartate amino-transferase and alanine aminotransferase. No relationship was found between BIIT results and isoenzyme patterns. These contradictory results probably reflect the unreliability of BIIT information in determining human infectivity.

7173 **Nantulya, V.M. and Lindqvist, K.J., 1991.** The trends in the diagnosis of African human and animal trypanosomiasis. (Abstract only.) *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 134-136.
ILRAD, P.O. Box 30709, Nairobi, Kenya.
Diagnostic tests based on antibody detection are simply measures of previous exposure. They do not distinguish current infections of defined specificity and frequently give a false positive reaction. An alternative approach, the detection of trypanosome species-specific antigens, has recently been developed for the diagnosis of both human and animal trypanosomiasis. This is based on monoclonal antibodies against somatic antigens of the human infective Trypanosoma brucei rhodesiense and the animal infective T. congolense and T. vivax. The anti-T. b. rhodesiense antibody reacts with an antigen common to T. b. gambiense, T. brucei and T. b. evansi, while the antibodies against T. vivax and T. congolense are species-specific. A micro-ELISA plate is coated with the specific monoclonal antibody, the excess unbound antibody washed off, and test and control sera added. After a short incubation, the plate is washed and conjugate (horse radish peroxidase-labelled monoclonal antibody) is added. The plate is washed thoroughly after another short incubation before substrate (hydrogen peroxide) and chromogen (ABTS) are added. The development of a green colour in the test well denotes the presence of trypanosome antigen in the

corresponding test serum (or CSF). This method is suited to the analysis of large numbers of serum samples and to this end a simple antigen-detection tube-ELISA is being evaluated for the diagnosis of human sleeping sickness.

(b) PATHOLOGY AND IMMUNOLOGY

7174 **Ekanem, J.T., 1989.** Extracellular fractions derived from *Trypanosoma brucei* activate erythrocyte Ca^{2+} ATPase. *Medical Science Research*, **17** (17): 739-740.
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Instituut voor Moleculaire Biologie, Vrije Universiteit Brussel, Paardenstraat 65, B-1640 St-Genesius-Rode, Belgium.

(c) CHEMOTHERAPEUTICS

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Institut d'Epidémiologie et de Neurologie Tropicale, Faculté de Médecine, 2 rue du Docteur Marcland, 87025 Limoges, France.

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Research Unit for Tropical Diseases, International Institute of Cellular and Molecular Pathology, avenue Hippocrate 74, B-1200 Brussels, Belgium.

7195 **Wright, C.W. and Phillipson, D.J., 1990.** Natural products and the development of selective antiprotozoal drugs. [Incl. *T. brucei*.] *Phytotherapy Research*, **4** (4): 127-139.

Department of Pharmacognosy, School of Pharmacy, University of London, 29/39 Brunswick Square, London WC1N 1AX, UK.

8. TRYPANOSOME RESEARCH

(a) CULTIVATION OF TRYPANOSOMES

(b) TAXONOMY, CHARACTERISATION OF ISOLATES

[See also **15**: nos. 7118, 7149, 7172.]

7196 **Bajyana Songa, E., Wittouk, E. and Hamers, R., 1991.** Kinetoplastic DNA probes distinguish *T. evansi* isolates from other trypanosomes. (Abstract only.) *In*: OAU/STRC, 1991 (see **15**: no. 7082), p. 126.

Instituut voor Moleculaire Biologie, Vrije Universiteit Brussel, Paardenstraat 65, B-1640 St-Genesius-Rode, Belgium.

Hinf I fragments of 477 bp and 97 bp sequences of the kDNA minicircles from respectively RoTat 2.1 and AnTat 3.3 of *Trypanosoma evansi*, cloned in M13 mp 18 and 32P-radiolabelled or digoxigenin-dUTP labelled (Boehringer Mannheim), were used as probes for kDNA characterisation. Total kDNA from 14 strains of *T. evansi*, three of *T. brucei brucei*, three of *T. b. gambiense*, two of *T. b. rhodesiense*, one of *T. equiperdum* and two of *T. congolense* were either dot-blotted or endonuclease digested, electrophoresed, and analysed by Southern blotting. The hybridisation with the two probes revealed the complete lack of homology of *T. evansi* to any other *T. brucei* group trypanosomes or to *T. congolense*. *In situ* hybridisation allowed the identification of *T. evansi* on blood smears using the cloned Hinf I 97 bp fragment as a non radioactive kDNA probe.

7197 **Gashumba, J.K., Kaukas, A., Lanham, S.M. and Dukes, P., 1991.** Comparison of procyclic and bloodstream *Trypanosoma brucei*

gambiense by isoenzyme electrophoresis. (Abstract only.) *In*: OAU/ STRC, 1991 (see **5**: no. 7082), pp. 130-131.

TRL, University of Bristol, Langford, Bristol BS18 7DU, UK.

7198 **Masiga, D.K. and Gibson, W.C., 1991.** A specific probe for *Trypano-soma (Trypanozoon) evansi* based on kinetoplast DNA mini-circles. (Abstract only.) *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 123-125.

KETRI, P.O. Box 362, Kikuyu, Kenya; Department of Pathology, School of Veterinary Science, University of Bristol, Langford, Bristol BS18 7DU, UK.

Trypanosomes of the subgenus *Trypanozoon* are morphologically indistinguishable. In addition, *T. (T.) evansi* and *T. (T.) brucei* do not differ significantly on the basis of isoenzymes and nuclear DNA polymorphisms. However, the kinetoplast DNA of *T. evansi* differs from that of *T. brucei* sspp. in that it lacks the maxicircles and the heterogeneity of the base sequences characteristic of the minicircles of *T. brucei*. The potential of a DNA probe based on a species-specific minicircle has been assessed. The minicircle was cloned and hybridised with DNA from *T. evansi* and *T. brucei*. The results showed that a fragment of 400 base pairs on this minicircle is unique to *T. evansi* and forms a specific probe. The reactions of this probe with different strains of *T. evansi* and the degree of cross-reaction with different strains of *T. brucei* sspp. are being investigated.

7199 **Waitumbi, J.N., Young, J.R. and Opiyo, E.A., 1991.** Characterisation of *brucei*-type trypanosome isolates from camels in Marsabit, northern Kenya. (Abstract only.) *In*: OAU/STRC, 1991 (see **15**: no. 7082), p. 127.

Waitumbi, Opiyo: KETRI, P.O. Box 362, Kikuyu, Kenya; Young: ILRAD, P.O. Box 30709, Nairobi, Kenya.

Although kinetoplastic DNA (kDNA) restriction polymorphisms have been used for showing differences between *Trypanosoma evansi* isolates, the studies reported here show that pulse field gel electrophoresis (PFGE) may be a more sensitive technique. Forty-seven *brucei*-type trypanosome stocks isolated from naturally infected camels in Marsabit, northern Kenya, were not transmissible by *Glossina morsitans morsitans* and had identical and homogeneous kDNA on digestion with the following restriction endonucleases: Ase 1, Hinf 1, Mbo 1 x Taq 1, Mbo 11 and Mse 1. On PFGE, the trypanosome stocks showed different chromosome-sized DNA molecules (molecular karyotypes). On the basis of their non-

transmissibility by tsetse and homogeneous kDNA, the stocks were identified as *T. evansi*. It remains to be seen whether differences in chromosome patterns can be usefully correlated with significant differences in antigenicity or drug sensitivity.

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

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

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Toulmé: Laboratoire de Biophysique Moléculaire, Université Bordeaux II, 146 rue Léo Saignat, F-33076 Bordeaux, France.

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Research Unit for Tropical Diseases, International Institute of Cellular and Molecular Pathology, avenue Hippocrate 74, B-1200 Brussels, Belgium.

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Ploeg: Department of Genetics and Development, Columbia University, 701 West 168th Street, New York, NY 10032, USA.

7204 **Greef, C. de, Imberechts, H., Matthijssens, G., Meirvenne, N. van and Hamers, R., 1991.** Evidence of 1.5 kb transcripts specific for human serum resistant forms of *T. b. rhodesiense*. *In*: OAU/STRC, 1991 (see **15**: no. 7082), pp. 119-122.

Instituut voor Moleculaire Biologie, Vrije Universiteit Brussel, Paardenstraat 65, B-1640 St-Genesius-Rode, Belgium.

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Bindereif: Max Planck Institut für Molekulare Genetik, Otto-Warburg-Laboratorium, Ihnestrasse 73, D-1000 Berlin 33, Germany.

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Intercampus Program in Molecular Parasitology, School of Pharmacy, University of California at San Francisco, Laurel Heights, CA 94143, USA.

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Swiss Tropical Institute, Socinstrasse 57, CH-4051 Basel, Switzerland.

7210 **Lonsdale-Eccles, J.D., Mpimbaza, G.W.N., Mbawa, Z.M. and Kornblatt, J., 1991.** Characterisation of the proteases of *Trypanosoma congolense* and *T. brucei*. (Meeting abstract no. CH411.) *Journal of Cellular Biochemistry: Supplement*, **15**G: 149.
ILRAD, P.O. Box 30709, Nairobi, Kenya.

7211 **Mbawa, Z.R., Gumm, I.D., Fish, W.R. and Lonsdale-Eccles, J.D., 1991.** Stage-specific expression of endopeptidolytic activity in African trypanosomes. [*T. brucei*, *T. congolense*, *T. vivax*.] (Meeting abstract no. CH412.) *Journal of Cellular Biochemistry: Supplement*, **15**G: 150.
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Swiss Tropical Institute, Socinstrasse 57, CH-4051 Basel, Switzerland.

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Seattle Biomedical Research Institute, Seattle, WA 98109, USA.

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Vandenbussche: Université Libre de Bruxelles, Campus Plaine CP206/2, Boulevard du Triomphe, B-1050 Brussels, Belgium.