

SECTION B – ABSTRACTS**1. GENERAL (INCLUDING LAND USE)**

8038 **Anonymous, 1991.** La lutte contre les trypanosomoses. Des pièges en tissus à la chimiothérapie de pointe. [Trypanosomiasis control. From cloth traps to advanced chemotherapy.] *Afrique Agriculture*, no. 187: 18-20.

This article reports on the 21st meeting of the ISCTRC at Yamoussoukro, Côte d'Ivoire, on 21-25 October 1991. Concern was expressed about the development of trypanosome resistance to chemotherapy and further research was recommended. Imol 881 was seen as a promising candidate drug for the control of both animal and human trypanosomiasis. There was grave concern that international organisations are reducing their support for the prevention and treatment of sleeping sickness. Aerial and ground spraying of organochlorines for tsetse control is being replaced by environmentally safe methods, especially traps and screens. Used with olfactory attractants and impregnated with synthetic pyrethroids, traps have been used successfully by the CRTA in Burkina Faso with greater efficiency and at less cost than other control methods. Direct treatment of cattle with insecticides is also effective, and the CRTA reported a fly mortality of about 90% after contact with treated cattle. Insecticidal activity falls with time and exposure to rain and soil but retains a knock-down effect on the flies. It was recommended that different insecticides be applied at different times of the year to avoid resistance. An important aspect of control is the detection of different trypanosome strains, and the use of CATT, ELISA and DNA probes was recommended.

8039 **Centre de Recherches sur les Trypanosomoses Animales, 1990.**

Présentation du Centre de Recherches sur les Trypanosomoses Animales (CRTA).

[Introduction to the Centre for Research on Animal Trypanosomiasis (CRTA).]

Bobo-Dioulasso, Burkina Faso; CRTA. 12 pp.

CRTA, B.P. 454, Bobo-Dioulasso 01, Burkina Faso.

This report describes the work of the CRTA, which was founded in 1972.

Research into vector control has concentrated on environmentally safe techniques, such as SIT, odour-baited traps and screens, and the direct treatment of cattle with insecticide formulations. The release of about one million irradiated male flies has eradicated three species of *Glossina* from about 3500 km² near Sidéradougou, Burkina Faso. Flies are mass reared using artificial membranes and about 350,000 breeding females are maintained. Studies on bovine trypanotolerance have concentrated on genetic, clinical, immunological and physiological characteristics, and different rearing systems. Diagnostic techniques and drug resistance have also been studied. The CRTA maintains a cryobank of 280 stocks or clones of trypanosomes. Epidemiological studies have concentrated on surveillance, rate of tsetse infection and evaluation of trypanosomiasis risk for planning control campaigns. The location of the CRTA gives it access to numerous ecological zones for comparative studies, ranging from tsetse-free zones with Zebu cattle to zones of high tsetse density which support only resistant Baoulé cattle. It cooperates with numerous other international organisations, including ILRAD, ILCA, ITC and ICIPE.

8040 **Kariuki, D.P., 1985 [1989].** Trypanosomiasis control in Kenya. (Paper presented at the Scientific Meeting of the Kenya Veterinary Association on Field Aspects of Trypanosomiasis in Kenya, Ukunda, Kenya, August 1984.) *Kenya*

Veterinarian, **9** (2): 9-10.

Veterinary Research Laboratories, P.O. Kabete, Kenya.

Nearly 25% of the Kenyan land area is infested with tsetse flies. No new tsetse advances have been recorded except immediately after the rainy seasons and recession has occurred in some areas due to ecological change. Insecticide is applied using a variety of pressurised knapsack sprayers or motor-driven mist-blowers along lanes 100 m apart for *morsitans* group flies and 40 m apart for *palpalis* group flies. Aerial spraying has been used in western Kenya, especially in the Lambwe Valley. Bush clearance has been extensively practised. Animal trypanosomiasis is controlled mainly by curative drugs administered on clinical grounds: only a proportion of cases are confirmed by microscopic diagnosis. Prophylactic drugs are used on some ranches where there is a high degree of risk. Drugs used from 1970-81 included Ethidium, Novidium, Berenil, Samorin, Antrycide prosalt, Antrycide sulphate and Naganol. Berenil is sometimes used as a sanative drug when large numbers of cattle are moving through tsetse-infested areas. A systematic survey should be carried out to investigate reports of drug resistance.

8041 **Lyons, M., 1991.** African sleeping sickness: an historical review.

International Journal of STD and AIDS, **2** (Suppl. 1): 20-25.

Institute of Commonwealth Studies, University of London, 27-28 Russell Square, London WC1B 5DS, UK.

The history of human African trypanosomiasis is reviewed, from the first reports by Portuguese and Arab traders in the 14th century, through the development of tropical medicine in the 19th century, to current progress in understanding the epidemiology of the disease. Sleeping sickness epidemics allowed many colonial authorities to increase their political hegemony through public health measures, which often originated in direct response to this single disease. This resulted in the development of 'vertical' health services aimed at one disease while neglecting other vital public health issues. Devastating epidemics between 1896 and 1906 threatened the entire colonial enterprise and brought about one of the most dramatic control campaigns in the history of medicine. Changing attitudes to the disease are summarised. It was first seen as an enemy to be overcome by superior European technology; the survival strategies evolved by African societies were only recognised much later and were often disrupted or destroyed by the process of colonisation. The development of sleeping sickness control is briefly described, including resettlement of African populations, tsetse eradication and chemotherapy. Present political upheavals are again resulting in epidemics. An estimated 50 million people in 42 countries are at risk, of which only 5-10 million have access to protection or treatment. The most effective means of control are continual surveillance and chemotherapy, and health administrators must be aware of the ease with which history can repeat itself.

8042 **Maille, J.C., 1990.** *Etude des problèmes de fécondité du troupeau bovin.*

Enquête épidémiologique sur la densité des glossines et leur taux d'infestation.

Rapport de mission au ranch OGAPROV (Gabon) Octobre 1988 – Novembre

1989. [Study of fecundity problems in cattle herds. Epidemiological survey of tsetse density and their infection rates. Report of work at the OGAPROV ranch (Gabon) October 1988 – November 1989.] Maisons Alfort, France; IEMVT. 32 pp.

OGAPROV, B.P. 245, Moanda, Gabon.

The population dynamics of tsetse flies on the OGAPROV ranch have been studied, with reference to total trap catches, relative densities, rate of trap capture, rate of trypanosome infection according to species and age of flies, and types of infection. The rates and types of trypanosome infection in the cattle have also been studied, together with parameters relevant to a study programme on trypanotolerance. Drug treatment is described, together with zootechnical data on calving, weaning, selection and mortality.

8043 **Nigatu, W., Abebe, M., Hadis, M. and Lulu, M., 1992.** The effect of resettlement and agricultural activities on tsetse populations in Gambella, south-western Ethiopia. *Insect Science and its Application*, **13** (6): 763-770.

National Research Institute of Health, P.O. Box 1242, Addis Ababa, Ethiopia. The effects of resettlement programmes and agricultural development projects on the tsetse population in Gambella were investigated. Adult tsetse were collected using biconical traps and moving vehicle catches. The species collected were *Glossina pallidipes* (the most frequently encountered species), *G. fuscipes* and *G. tachinoides*. *G. morsitans*, which was earlier reported to be abundant in the area (1968, 1971, 1976), was not collected during the present survey. About 155,000 ha of land, formerly reported as tsetse infested, was found to be free of tsetse. The natural vegetation is being transformed into farmlands and villages, and the wildlife is being hunted out, remaining only in such areas as Demesaye and Gog forest. Under such circumstances tsetse hosts may change from wild mammals to man and his domestic animals and outbreaks of nagana and sleeping sickness are likely to occur throughout the region.

8044 **Toure, S.M., Cuisance, D., Duvallet, M., Euzeby, L., Itard, J., Nantulya, M. and Touratier, M., 1991.** Données nouvelles dans la lutte contre la trypanosomose animale africaine. [New data in the control of African animal trypanosomiasis.] (Round table, 7th Inter-national Congress of Parasitology, Paris, France, 20-24 August 1990.) *Annales de Parasitologie humaine et comparée*, **66** (Suppl. 1): 58-60.

Toure: SODEPRA/GT2/ILCA Joint Project, B.P. 143, Boundiali, Côte d'Ivoire. Recent advances in tsetse control, chemotherapy and chemoprophylaxis, characterisation and mechanism of bovine trypanotolerance and diagnosis of African animal trypanosomiasis are reviewed. Trends in vector control are towards cheaper, ecologically acceptable and easier to use methods, including simple traps employing odour attractants (acetone, 1-octen-3-ol and phenols), traps and targets impregnated with synthetic pyrethroids or chemosterilants such as the juvenile hormone mimic pyriproxyfen, and direct treatment of cattle with pour-on formulations of pyrethroids and ivermectin, or deltamethrin dips. The arsenical derivative Cymelarsan is the only new trypanocide to be developed in 25 years and is effective in camels, cattle and horses infected with *Trypanozoon*. Other drugs still being tested include Imol 881 and Ronidazole, both of which are effective in mice infected by *Trypanosoma evansi*, *T. vivax* and *T. congolense*, and T42 which is effective in cattle and buffalo infected with *T. evansi*. Trypanotolerance in cattle is characterised by better control of parasitaemia and anaemia, dominance of haemoglobin gene A and albumin gene F, better immune response and smaller reduction of PCV. New diagnostic methods include the use of monoclonal antibodies in the microELISA technique to detect antigens of *T.*

brucei, *T. evansi*, *T. congolense* and *T. vivax*.

8045 **Travassos Santos Dias, J.A., 1988 [1989]**. Os aldeamentos rurais como sistema a preconizar nas áreas endémicas de doença-do-sono. [Rural villages as a control system in endemic areas of sleeping sickness.] (Paper presented at the 1st International Workshop on Tropical Medicine, Lisbon, Portugal, 28-30 April 1988.) *Garcia de Orta, Série de Zoologia*, **15** (1): 139-144.

Centro de Zoologia, Instituto de Investigação Científica Tropical, Rua da Junqueira, 14-1300 Lisbon, Portugal.

Human African trypanosomiasis is seen as a major obstacle to socio-economic development in rural areas. The establishment of specially designed villages in endemic areas is proposed to help combat the disease. Each village should consist of a central social zone with a school, health centre and water supply. There should then be a residential zone with people settled on plots of 0.5-1.0 ha, surrounded by concentric communal zones for rearing waterfowl and fish, and horticulture, with an outer pastoral zone about 2 km wide. These should all be ringed by an anti-tsetse barrier of clear felled land between 500 m (for flies in the *palpalis* and *fuscipes* groups) and 2000 m (for flies in the *morsitans* group) in width. This barrier zone could be used for growing cash crops such as sisal and sunflower. Finally, disinfestation stations should be set up at the road entrance to the village and at the edge of the anti-tsetse barrier.

8046 **Williams, B., Dransfield, R., Brightwell, R. and Rogers, D., 1993**.

Where are we now? Trypanosomiasis. *Health Policy and Planning*, **8** (1): 85-93.

LSHTM, Keppel Street, London WC1E 7HT, UK; Olkirimatian and Shompole Development Project, Nguruman, Kenya; *ibid.*; Department of Zoology, University of Oxford, South Parks Road, Oxford OX1 3PS, UK.

Trypanosomiasis research and control are reviewed. Trypanosome morphology, VSG and metacyclic transmission are briefly described. Control of both human and animal trypanosomiasis still depends on surveillance, diagnosis and treatment over much of Africa, but non-availability of drugs coupled with increasing drug resistance have renewed interest in tsetse control. The use of insecticides, traps and targets, insecticide-treated livestock and SIT are discussed. Prospects for trypanotolerant livestock and vaccination are also briefly considered. Cost is the main factor limiting control in many countries. A full course of treatment with melarsoprol costs US \$200 and with DFMO US \$500 per patient. In 1985 passive surveillance cost about US \$1.39 per person tested. Community-organised trapping need cost only US \$0.50 per person protected per year. Tsetse control for livestock protection, using traps, targets and ground spraying, costs about US \$200 per km² per year. If control is to be effective and lasting, local people must be directly involved and epidemics and outbreaks must be closely monitored to prevent their repetition. The long-term approach must be towards control and not eradication.

8047 **Wilson, A.J. and Stevenson, P.W.G., 1985 [1989]**. The non-tsetse-borne trypanosomiasis. (Paper presented at the Scientific Meeting of the Kenya Veterinary Association on Field Aspects of Trypanosomiasis in Kenya, Ukunda, Kenya, August 1984.) *Kenya Veterinarian*, **9** (2): 15-18.

Research Institute for Animal Disease, Bogor, Indonesia; KETRI, P.O. Box 362, Kikuyu, Kenya.

Trypanosoma vivax is transmitted both cyclically by tsetse flies and mechanically

by other arthropod vectors; *T. evansi* is transmitted only mechanically. The morphology, epidemiology, pathogenesis and chemotherapy of these trypanosomes are reviewed. *T. evansi* is most pathogenic in camels, horses and dogs although serious outbreaks can also occur in buffalo and cattle. Diagnosis is by rodent inoculation, HCT and ELISA and treatment is by suramin and quinapyramine, although drug resistance can develop rapidly. *T. evansi* does not normally occur within the tsetse belts: its main vectors are tabanid flies. *T. evansi* infections in camels have been classified into five types and detailed surveillance is required as an apparently enzootically stable situation can change rapidly with the introduction of new parasite strains, bad management, increased vector activity or chemotherapy. *T. vivax* mainly affects cattle, goats and horses. Direct diagnosis is by HCT and drug treatment is by homidium, prothidium, isometamidium and diamidine. *T. vivax* generally has the highest trypanosome infection rates (usually 5-15%) in tsetse flies and often also in the host (about 5%). It occurs throughout the tsetse belts and can adapt to non-tsetse transmission.

2. TSETSE BIOLOGY

(a) REARING OF TSETSE FLIES

8048 **Gaston, K.A. and Randolph, S.E., 1993.** Reproductive under-performance of tsetse flies in the laboratory, related to feeding frequency. *Physiological Entomology*, **18** (2): 130-136.

Department of Zoology, University of Oxford, South Parks Road, Oxford OX1 3PS, UK. (Correspondence to Randolph.)

The rates of development of the eggs and larvae *in utero* and the next two developing ovarioles were measured by ovarian dissection on each day of the pregnancy cycle in tsetse, *Glossina morsitans*, subject to different feeding regimes. Compared with flies fed four times per pregnancy cycle, flies fed three times per cycle showed a lower pupal production rate (70%), the same (zero) adult mortality, a slightly slower growth rate of the larva and second ovariole only from day 8 onwards, but the same growth rate of the first ovariole. Flies fed only twice per pregnancy cycle produced no pupae, suffered 18% adult mortality and showed a significantly slower growth rate of the larva and second ovariole from days 6 and 7 respectively, but still the growth rate of the first ovariole was barely affected. Flies offered food three times or twice per pregnancy cycle engorged fully at every opportunity, but 16.5% of the flies offered food four times per cycle did not feed on every occasion, while 12-22% did not engorge fully on days 3, 5 or 7. In assessing the applicability of these laboratory results to the field situation the following points must be borne in mind: in the laboratory, flies take smaller mean blood meals than in the field; during protein production associated with larval growth, the proportion of the blood meal lost to transformation and excretory costs is less than during normal lipid metabolism; the balance between the known fertility rate and adult and pupal mortality rates reveals that the abortion rate in the field must be extremely low. The high abortion rates usually observed in laboratory colonies, even when flies are offered food daily, would be quite untenable in the field and indicate that laboratory conditions impose physiological stresses on the flies that are quite different from those in the field. These facts indicate that three field-sized meals may be sufficient to meet the

energy demands of normal larval development in the field.

(b) TAXONOMY, ANATOMY, PHYSIOLOGY, BIOCHEMISTRY

[See also 16: no. 8048.]

8049 **D'Amico, F., Geoffroy, B., Cuisance, D. and Bossy, J.P., 1992.** Sites and abundance of chemoreceptors on the legs of tsetse, *Glossina tachinoides* (Diptera: Glossinidae). *Insect Science and its Application*, **13** (6): 781-786. ORSTOM, Département de Santé (D'Amico, Geoffroy) and CIRAD-EMVT (Cuisance), 2051 avenue du Val de Montferrand, B.P. 5045, F-34032 Montpellier Cedex, France; Bossy: INRA-Station de Recherches de Pathologie Comparée, Service de Microscopie Electronique, F-30380 Saint-Christol-lez-Alès, France. Light and scanning electron microscopy investigations were carried out to identify and count the chemoreceptors on the legs of the tsetse, *Glossina tachinoides*, and topographical maps, considered of value in electrophysiological and behavioural research, are presented. The candidate chemoreceptors are located on the femorae, the tibiae and the tarsi and are more abundant on the ventral zone of each segment. The study demonstrates that the prothoracic, mesothoracic and metathoracic legs have a similar number of chemoreceptors and male flies possess more than female (1033 and 570, respectively). The variability of the number of chemoreceptors on the prothoracic legs has been estimated in both sexes.

8050 **Odinokov, V.N., Ishmuratov, G.Y., Kharisov, R.Y., Yakovleva, M.P. and Tolstikov, G.A., 1991.** [Insect pheromones and their analogues. XXIX. Methyl-branched pheromones based on 4-methyltetrahydro-pyran. 4. Synthesis of racemic-15,19,23-trimethylheptatriacontane, the pheromone of *Glossina morsitans morsitans*.] (In Russian.) *Khimiya Prirodnykh Soedinenii*, **1991** (3): 417-419.

Institute of Chemistry, Academy of Sciences, Bashkir Science Centre, Ufa, Russia.

The synthesis of *G. m. morsitans* pheromone based on 1,5-dibromo-3-methylpentane, the product of acidic decomposition of 4-methyltetrahydro-pyran, is described. The structure of the pheromone and intermediate products was confirmed by IR and PMR spectra.

8051 **Osir, E.O., Imbuga, M.O. and Onyango, P., 1993.** Inhibition of *Glossina morsitans* midgut trypsin activity by D-glucosamine. *Parasitology Research*, **79** (2): 93-97.

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

The effect of the amino sugar D-glucosamine on trypsin in crude midgut homogenates of *G. m. morsitans* was studied *in vitro*. The results showed that the midgut trypsin was specifically and competitively inhibited by D-glucosamine. Glucose, fructose, mannose, inositol, galactose, galactosamine, *N*-acetyl-D-glucosamine, and methyl- α -D-glucosamine were ineffective as inhibitors, even at concentrations exceeding 600 mM. D-glucosamine also had a similar inhibitory effect on bovine pancreatic trypsin. In both cases, the inhibition was incomplete as shown by nonlinear Dixon plots. The Michaelis and inhibition constants estimated for the midgut trypsin were $41 \pm 2 \mu\text{M}$ and $68 \pm 3 \mu\text{M}$, respectively. These results suggest that the susceptibility of tsetse flies to trypanosome

infection, which is associated with high midgut glucosamine levels, could be due to inhibition of trypsin or trypsin-like enzymes by this sugar.

8052 **Shaw, M.K. and Moloo, S.K., 1993.** Virus-like particles in Rickettsia within the midgut epithelial cells of *Glossina morsitans centralis* and *Glossina brevipalpis*. *Journal of Invertebrate Pathology*, **61** (2): 162-166.

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

The midgut epithelial cells of both teneral and 30-day-old non-teneral *G. m. centralis* and *G. brevipalpis* contain non-occluded, isometric virus-like particles (VLPs) of 40 nm maximum diameter, within a proportion (< 5.0%) of the intracellular Rickettsia-like organisms (RLOs) present within the midgut cytoplasm. Similar individual VLPs were also occasionally found within the epithelial cell cytoplasm mainly in close proximity to RLOs. Paracrystalline arrays of empty, electron-lucent spheres were also observed within the nucleoplasm of the RLOs. These lucent particles resemble empty nucleocapsids and are thought to represent an earlier stage in the replication of the virus. The presence of large numbers of virus particles results in a significant increase in the size and shape of the infected RLOs.

(c) DISTRIBUTION, ECOLOGY, BEHAVIOUR, POPULATION STUDIES

[See also **16**: nos. 8043, 8073.]

8053 **Baylis, M. and Nambiro, C.O., 1993.** The responses of *Glossina pallidipes* and *G. longipennis* (Diptera: Glossinidae) to odour-baited traps and targets at Galana Ranch, south-eastern Kenya. *Bulletin of Entomological Research*, **83** (2): 145-151.

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

Four designs of trap, all made from identical material, were compared at Galana Ranch, south-eastern Kenya, as sampling devices for *G. pallidipes* and *G. longipennis*. The NG2G and Epsilon traps caught more than twice as many female *G. pallidipes* as the biconical trap, and the F3 was intermediate. A similar pattern was observed for males, although the differences were smaller, and not significant. The NG2G, Epsilon and F3 traps all caught approximately twice as many male and female *G. longipennis* as the biconical trap. Acetone (500 mg/h) significantly increased trap catches of *G. pallidipes*, and there was a synergism between acetone and 4-methylphenol (0.8 mg/h). There was little or no effect with 1-octen-3-ol (0.8 mg/h). Acetone, 1-octen-3-ol, and 4-methylphenol all increased trap catches of *G. longipennis*, and there were no synergisms among them. Cow urine (850 mg/h) increased the catches of both species in traps baited with acetone and 1-octen-3-ol, although not significantly for *G. longipennis*. There was no effect with 3-methylphenol (0.8 mg/h). The addition of 3-propylphenol to traps baited with acetone, 1-octen-3-ol and 4-methylphenol had no effect on the catches of either species. For *G. pallidipes*, a combination of acetone, 1-octen-3-ol, 4-methylphenol and 3-propylphenol was calculated to have a catch index of 6-8 over unbaited traps, a value lower than that reported for Zimbabwe and Nguruman, Kenya, and greater than that reported for Somalia. The catches of *G. longipennis* were approximately three times higher on electrified targets than in F3 traps, although there was no difference in the catch of *G. pallidipes*.

8054 **Vale, G.A., 1993.** Visual responses of tsetse flies (Diptera: Glossinidae) to odour-baited targets. *Bulletin of Entomological Research*, **83** (2): 277-289.

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

Field studies in Zimbabwe showed how targets 1 m tall and 25-400 cm wide, composed of vertical panels of visual material and net and baited with odours of acetone, 1-octen-3-ol, and phenols, could be refined for controlling *Glossina morsitans morsitans* and *G. pallidipes*. Attraction from a distance was not affected by swivelling movement but improved several-fold as the width of visual panels increased from 25 to 200 cm. Blue or blue/black targets were about as effective as black for *G. m. morsitans* but slightly more effective for *G. pallidipes*. Fine and coarse net was unattractive at long range but the flies avoided coarse net when close. The percentage of tsetse alighting on visual panels before flying round increased up to several times when the panels were widened, and when non-shiny black replaced blue or shiny black, but the percentage of flies alighting before departure was not much affected except by panel width, being near 0% at 25 cm and 85% at 2 m. Most tsetse alighted first near the centre of targets, especially where black contrasted with nearby blue. Studies of various fabrics and paints and of restricted deposition of insecticide suggested several disposable targets that could halve the costs of materials and insecticide, with efficacy preserved for *G. m. morsitans* and increased by up to 50% for *G. pallidipes*.

8055 **Wall, R. and Langley, P.A., 1993.** The mating behaviour of tsetse flies (*Glossina*): a review. *Physiological Entomology*, **18** (2): 211-218.

Department of Zoology, University of Bristol, Woodland Road, Bristol BS8 1UG, UK; Insect Investigations, Langford House, Langford, Bristol BS18 7DU, UK.

The mode of reproduction of tsetse flies, by adenotrophic viviparity, is unusual among the Diptera and is associated with many unique aspects of the tsetse's mating system. Tsetse exist at relatively low densities in the environment but a combination of olfactory and visual stimuli brings males and virgin females together on or around host animals. The behavioural repertoire associated with mate location and identification, courtship and copulation is regulated by external physical and chemical stimuli as well as by internal physiological mechanisms. With a view to identifying stimuli that could be used to manipulate tsetse behaviour and exploited for control purposes, much progress has been made in recent years in elucidating the mating behaviour of tsetse and its regulatory mechanisms. This progress and the current state of understanding of tsetse mating behaviour is reviewed.

3. TSETSE CONTROL (INCLUDING ENVIRONMENTAL SIDE EFFECTS)

[See also 16: nos. 8040, 8054.]

8056 **Blanc, F., 1991.** *Lutte antiglossinaire en République centrafricaine.*

[Tsetse control in the Central African Republic.] Montpellier, France; Centre National d'Etudes Agronomiques des Régions Chaudes (CNEARC). 168 pp. ANDE, B.P. 1509, Bangui, Central African Republic.

This report describes tsetse control programmes developed in the Central African Republic from April 1990 to May 1991 to help with livestock improvement. The terrain, vector and trypanosome species, and previous experience suggested that trapping would be the most appropriate method. *Glossina fuscipes fuscipes*

appears to be the main vector of animal trypanosomiasis. A modified bipyramidal (Gouteux-ANDE) trap has been developed and studied. Field trials have shown these traps to be effective in reducing tsetse densities when sited at watering points. In the dry season this reduction was associated with a reduction in the prevalence of trypanosomiasis but its effectiveness during the rainy season remains uncertain. Nevertheless, this method would help improve livestock productivity and could provide extra income for cattle farmers, who could learn to use the traps themselves. The current annual cost of trypanosomiasis, estimated at 3.9 thousand million francs CFA, could be reduced by 1.5 thousand million francs CFA if this method is adopted throughout the country. A study of Mbororo Zebu rearing in the Central African Republic shows this system to be currently in a state of crisis.

8057 **Brady, J., 1991.** Successful control of tsetse flies using attractants. (Meeting abstract no. S20.) *American Journal of Tropical Medicine and Hygiene*, **45** (Suppl. 3): 288-289.

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

The successful use of ox odour components (carbon dioxide, various ketones, octenol, and phenols that are breakdown products of urine) as tsetse attractants in Zimbabwe is briefly reviewed. Traps and targets are baited with acetone, 1-octen-3-ol, 4-methylphenol and 3-*n*-propylphenol, released at around 500 mg h⁻¹ and 400, 800 and 100 µg h⁻¹ respectively. Targets consisting of 1.5 × 0.5 m odour-baited black cloth screens sprayed evenly with 500 ml of 0.1% deltamethrin were tested in 1984 in a 600 km² triangular area in the Zambezi Valley, which contained about 5000 tsetse per km². One side was cleared of flies by spraying, one was partially protected by the 500 m wide river and the third by a dense belt of targets. Elsewhere targets were deployed at 4 per km² and were rebaited and resprayed every 3 months. Average tsetse mortality was 2% per day, which reduced the population by > 99% within 6 months. The targets were selective for tsetse and ecological impact was minimal.

8058 **Douthwaite, R.J., 1992.** Effects of DDT treatments applied for tsetse fly control on White-headed Black Chat (*Thamnolaea arnoti*) populations in Zimbabwe. Part I: population changes. *Ecotoxicology*, **1**: 17-30.

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

Surveys of relative abundance were made in DDT-treated and untreated woodland in north-west Zimbabwe using playback of tape-recorded song. Chats were common in old stands of untreated mopane (*Colophospermum mopane*) and miombo (*Brachystegia* spp.) woodland but were less common in suitable habitat which had been sprayed with DDT at the rate of 200 g ha⁻¹ for tsetse fly control. Population changes in the Siabuwa Communal Area were related to spraying operations over 3.5 years from July 1987 to January 1991. In the 1987-89 treatment area, numbers fell by 88% over 33 months following first treatment, mainly due to a reduction in occupied sites. Groups were smaller and single sex groups more frequent in treated areas compared with an adjacent unsprayed area. Numbers in the unsprayed area fell by 13% over the same period. Total numbers and number of groups at the edge and just within the treated area increased temporarily after each of the first two sprays. At the end of the study, numbers in the 1987 and 1987-89 treatment areas were increasing, and isolated groups were found in the 1984-89 treatment area. In a second study area, a further treatment

of DDT, one year after the first, was followed by a 74% decline in numbers over 9 months. It is concluded that tsetse spraying operations have had a severe, and possibly prolonged, impact on the White-headed Black Chat population of north-west Zimbabwe.

8059 **Douthwaite, R.J., 1992.** Effects of DDT on the Fish Eagle *Haliaeetus vocifer* population of Lake Kariba in Zimbabwe. *Ibis*, **134** (3): 250-258. NRI, Central Avenue, Chatham Maritime, Chatham, Kent ME4 4TB, UK. Twenty clutches were collected from nests of Fish Eagles, *H. vocifer*, at Lake Kariba, Zimbabwe, and a small dam nearby in 1989-90. Unaltered DDT, and metabolites DDD and DDE, were found in every egg. Mean levels of Σ DDT (= DDT + DDD + DDE) generally varied from 14 to 49 mg/kg dry weight per clutch, but 113-223 mg/kg dry weight were found in clutches from the eastern end of the lake and the mouth of the Sengwa River. Σ DDT and DDE levels were significantly correlated with the Ratcliffe Index of eggshell thickness. Comparison with museum specimens showed that the Ratcliffe Index has declined by 11% since 1936-41 due to a significant fall in shell weight. Eggshell thinning exceeded 20% at the eastern end of the lake. Aerial surveys in 1987 and 1990 found that hatching success along the southern lakeshore exceeded 72%, but chicks were seen in fewer than half the nests at the eastern end. However, the density of breeding pairs was greatest here. Residue levels have increased by about 8% since 1980, rising more steeply in areas recently sprayed for tsetse fly control and falling in others. The threat from DDT may now be receding as regional use has declined and will end, for tsetse fly control, by 1995. None was used for this purpose in 1991. Mercury levels in adult birds were very high and may pose a significant risk. The breeding population may be limited by availability of safe nest sites. Chicks are sometimes eaten by people. Settlement along the lakeshore is increasing and safe sites are becoming scarcer as dead trees in the lake collapse and large trees onshore are destroyed by elephants.

8060 **Douthwaite, R.J., Hustler, C.W., Kruger, J. and Renzoni, A., 1992.** DDT residues and mercury levels in Reed Cormorants on Lake Kariba: a hazard assessment. *Ostrich*, **63**: 123-127. NRI, Central Avenue, Chatham Maritime, Chatham, Kent ME4 4TB, UK; Natural History Museum, P.O. Box 240, Bulawayo, Zimbabwe; Institut für Biogeographie, Zentrum für Umwelt-forschung, Universität des Saarlandes, D-6600 Saarbrücken, Germany; Dipartimento di Biologia Ambientale, Università degli Studi di Siena, Via delle Cerchia, 3-53100 Siena, Italy. Samples of liver and visceral fat from 86 Reed Cormorants, *Phalacrocorax africanus*, collected at the eastern end of Lake Kariba between January and October 1986 were analysed for 22 organochlorine compounds. Residues of four insecticides were detected but concentrations of hexachlorobenzene, HCH and lindane in liver did not exceed 0.3 mg kg⁻¹ extractable lipid. Unaltered DDT, or its metabolites DDD and DDE, were found in every sample, almost all as DDE. Levels varied seasonally, with the highest found between May and September. Risk of increased mortality in full-grown birds was negligible but visceral fat of adult females contained DDE levels associated elsewhere with eggshell thinning and breeding failure in a related species. In a separate study, tissues from ten birds were analysed for mercury. Up to 13.6 mg mercury kg⁻¹ dry weight was found in liver tissue but this should not increase risk of mortality significantly.

8061 **Douthwaite, R.J., and Tingle, C.C.D., 1992.** Effects of DDT treatments applied for tsetse fly control on White-headed Black Chat (*Thamnolaea arnoti*) populations in Zimbabwe. Part II: cause of decline. *Ecotoxicology*, **1**: 101-115. NRI, Central Avenue, Chatham Maritime, Chatham, Kent ME4 4TB, UK.

Food supply, breeding success and DDT residue accumulation were investigated as possible causes for the decline of White-headed Black Chat populations in woodland sprayed for tsetse fly control. Gut contents from 21 birds were examined. A variety of invertebrates had been eaten, but ants, especially *Camponotus* spp. and *Pheidole* spp., and termites, especially *Odontotermes* spp., predominated in the dry season. In the early rains, more beetles and fewer termites were eaten. Ant and termite activity at sprayed sites in the study area was as great as or greater than that at unsprayed sites. Ants (*Camponotus* spp.) from sprayed sites held mean residue levels of $8.71 \mu\text{g g}^{-1}$ dry weight (max. $218 \mu\text{g g}^{-1}$ dry weight) total DDT, of which 67% was unaltered DDT. Termites and beetles had mean residues of $3.32 \mu\text{g g}^{-1}$ dry weight (max. $14 \mu\text{g g}^{-1}$ dry weight) and $0.92 \mu\text{g g}^{-1}$ dry weight (max. $8 \mu\text{g g}^{-1}$ dry weight) total DDT, of which 44% and 37% was unaltered DDT, respectively. Fledging success of White-headed Black Chats in adjacent sprayed and unsprayed areas was similar. Residues of DDT, DDD and DDE were found in all 23 chat carcasses examined. Birds collected in the dry season (July) from an area sprayed one month before contained up to $2206 \mu\text{g}$ DDT, $367 \mu\text{g}$ DDD and $578 \mu\text{g}$ DDE, g^{-1} extractable lipid (86, 17 and $27 \mu\text{g g}^{-1}$ dry weight, respectively). On average, residue levels were 50 times higher than in birds from the unsprayed area, and four times higher than in birds taken from another, recently sprayed area in the early rains (November). It is concluded that DDT spraying did not reduce availability of prey or fledging success. Initial population decline in sprayed areas was due to a lethal accumulation of DDT residues from prey, especially *Camponotus* spp. ants. Possible reasons for continued decline for 2-3 years after spraying are discussed.

8062 **Hargrove, J.W., 1993.** Target barriers for tsetse flies (*Glossina* spp.) (Diptera: Glossinidae): quick estimates of optimal target densities and barrier widths. *Bulletin of Entomological Research*, **83** (2): 197-200. ODA IPM Initiative, c/o Tsetse and Trypanosomiasis Control Branch, P.O. Box 8283, Causeway, Harare, Zimbabwe.

The probability that tsetse flies (*Glossina* spp.) cross a barrier of odour-baited targets is calculated for barriers of different widths and target density, and for tsetse flies with varying natural rates of survival, daily step lengths (d) and probabilities of being killed by an odour-baited target. If the barrier is only as wide as d , and for a species which has a 2% natural daily mortality and a further 2% mortality due to each target per unit area, tsetse flies have a probability (P) of c. 0.1 of penetrating the barrier even if the target density is 64 per unit area. To ensure that $P < 0.001$ the barrier must be about $4d$ wide for target densities < 32 per unit area; doubling

the width to $8d$ means that target *densities* could be cut by about 75%, and total *numbers* of targets in the barrier by 50%. These biological considerations and the economic costs of different target barriers suggest that, for all tsetse fly species, a safe and relatively inexpensive barrier is achieved with barrier width $8d$ when the optimum target density is roughly the same as for normal operational areas. This has the important practical consequence that there is no need to treat barriers as a special case. Practical results from research and control operations in Zimbabwe are in accord with the theoretical findings, but further work is required to ascertain whether the safety margin, and hence costs, can be reduced.

8063 **Institut d'Elevage et de Médecine Vétérinaire des Pays Tropicaux, 1990.** Lutte non polluante contre les glossines. [Non-polluting tsetse control.] *Fiches techniques d'Elevage tropical*, no. 1: 16 pp.

CIRAD-EMVT, 10 rue Pierre Curie, 94704 Maisons Alfort Cedex, France.

This is the first in a series of extension leaflets produced in conjunction with the Ministère de la Coopération et du Développement in Paris. A short history of tsetse control is followed by descriptions of the main environmentally safe techniques: SIT, trapping and direct treatment of livestock with insecticides. The advantages and disadvantages of each are discussed. For trapping, visual and olfactory attractants, mode of operation, community participation and preliminary groundwork are described. Brief descriptions, construction diagrams and estimates of costs are given for the following: Challier-Laveissière biconical, Mérot and Laveissière (Vavoua) monoconical, Gouteux-Lancien pyramidal, Flint F3 cubic, Brightwell NG-28 and Epsilon traps; and Challier-Gouteux-Laveissière, Laveissière, Mérot-Filledier and Vale screens. The leaflet is illustrated in colour.

8064 **Knols, B.G.J., Willemse, L., Flint, S. and Mate, A., 1993.** A trial to control the tsetse fly, *Glossina morsitans centralis*, with low densities of odour-baited targets in west Zambia. *Medical and Veterinary Entomology*, 7 (2): 161-169.

Department of Entomology, P.O. Box 8031, 6700 EH, Wageningen, Netherlands; Jan Luykenlaan 112, 2332 DA, Leiden, Netherlands; Department of Veterinary and Tsetse Control Services, P.O. Box 920034, Senanga, Zambia; *ibid.*

A large-scale trial investigated the possibility of eradicating *G. m. centralis* from a traditional cattle rearing area using odour-baited targets at a reduced overall target density from 4 to 0.5-2.3 per km², thus cutting down initial material costs by about 50%. Only the periphery of what was thought to be prime tsetse habitat (dense woodland) was treated with targets. These were all black or blue/black cloth (1.8 × 1 m), sprayed with deltamethrin suspension concentrate and baited with butanone and/or acetone (40-130 mg/h) and 1-octen-3-ol (0.5 mg/h). Although fly catches from traps and flyrounds initially dropped by approximately 3% per day and trypanosomiasis cases declined by 99% within a year, eradication was not achieved, so that more targets were deployed at a later stage. Although initially cheaper, the option of using reduced target densities proved financially unattractive because of prolonged periods of target maintenance prior to eradication. Revised strategies for tsetse control with odour-baited, insecticide-impregnated targets in west Zambia are presented.

8065 **Langley, P.A., Hargrove, J.W., Mauchamp, B., Royer, C. and Oouchi, H., 1993.** Prospects for using pyriproxyfen-treated targets for tsetse control. *Entomologia experimentalis et applicata*, **66** (2): 153-159.

Insect Investigations, Langford House, Langford, Bristol BS18 7DU, UK; ODA IPM Initiative, c/o Tsetse and Trypanosomiasis Control Branch, P.O. Box 8283, Causeway, Harare, Zimbabwe; INRA, Laboratoire de Physiologie de l'Insecte, 78000 Versailles, France; *ibid.*; Plant Protection Division, Sumitomo Chemical Co. Ltd, 5-33, Kitahama 4-Chome, Chuo-Ku, Osaka 541, Japan. Using ¹⁴C cholesterol as a marker, a positive correlation was established between the amount of oil (a chlorinated *n*-alkane containing 43-46% chlorine, 'cereclor S45') picked up by an adult tsetse fly exposed by tarsal contact to a treated surface and the duration of such exposure. Only a poor uptake was achieved from netting surfaces treated with less than 50% oil in acetone. Terylene netting treated with radioactive pyriproxyfen, [1-methyl-2-(4-phenoxyphenoxy)ethoxy] pyridine, dissolved in cereclor was exposed in the field for a year. After 9 months

20% of the original radioactivity remained and was shown to be 95% authentic pyriproxyfen. Brief tarsal contact (up to 5 s) with such netting by adult female *Glossina morsitans morsitans* reduced the viability of their offspring to 28-43% of untreated control values. The effect was greatest in the reproductive cycle immediately following contact. Between 10 and 12 months after treatment of the fabric the radioactivity fell to only 7% of the original level but was associated mainly (> 80%) with intact pyriproxyfen. Exposure of female flies to this netting resulted in a positive correlation between the duration of exposure and the extent of suppression of offspring viability, such that 2 min was sufficient to reduce offspring viability to zero for the life of the female. Traps or targets impregnated with conventional formulations of pyrethroids to kill tsetse would have lost all their activity by this time. Results are discussed in terms of the prospects for using pyriproxyfen-treated targets to sterilise female tsetse directly and also indirectly through the contamination of males prior to mating through contact with such targets.

8066 **Manfré, F., Kern, J.-M. and Biellmann, J.-F., 1992.** Synthesis of proline analogues as potential mechanism-based inhibitors of proline dehydrogenase: 4-methylene-L-, (E)- and (Z)-4-(fluoromethylene)-L-, cis- and trans-5-ethynyl-(□)-, and cis- and trans-5-vinyl-L-proline. *Journal of Organic Chemistry*, **57** (7): 2060-2065.

Biellmann: Laboratoire de Chimie Organique Biologique, URA-CNRS 31, Faculté de Chimie, Université Louis Pasteur, 1 rue Blaise Pascal, 67008 Strasbourg Cedex, France.

In the tsetse fly, proline is the sole energy source for flight. Proline dehydrogenase is the first enzyme involved in this pathway and its inhibition may therefore be a strategy to control this insect. The preparation of several proline analogues, designed to inhibit this enzyme, is described.

8067 **Tingle, C.C.D., 1993.** Bait location by ground foraging ants (Hymenoptera: Formicidae) in mopane woodland selectively sprayed to control tsetse fly (Diptera: Glossinidae) in Zimbabwe. *Bulletin of Entomological Research*, **83** (2): 259-265.

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

Food-baited dishes were used to monitor the impact of ground-sprayed DDT (4% w.p. at c. 200 g/ha) and deltamethrin (0.05% suspension concentrate at 2.6 g/ha)

for tsetse fly (*Glossina* spp.) control, on epigeal ants in mopane woodland in north-western Zimbabwe. Twenty species of ants were recorded at dishes baited with various types of food. *Pheidole* spp. and *Monomorium opacum* were predominant, both in the number of baits attended and in the number of workers present at individual baits. Season apparently had a greater effect on the composition and activity of the ground foraging ant assemblage than did either pesticide. There was a decline in the rate at which baits were found and in species richness of the ant assemblage as the dry season progressed and several species also showed changes in their ability to locate baits. There was no major pesticide induced disruption of the species richness or food finding ability of the diurnal ground foraging ant assemblage sampled. However, foraging success by *Platythyrea cribrinodis* was reduced immediately after spraying with delta-methrin. Subtle effects of either insecticide on rarer species cannot be discounted from the results of this study.

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

[See also **16**: nos. 8043, 8047, 8051, 8078, 8090, 8104.]
8068 **Baker, R.D., 1992.** Modelling trypanosomiasis prevalence and periodic epidemics and epizootics. *IMA Journal of Mathematics Applied in Medicine and Biology*, **9** (4): 269-287.

Centre for Operational Research and Applied Statistics,
Department of Mathematics and Computer Science,
University of Salford, Salford M5 4WT, UK.

Existing mathematical models of trypanosomiasis epidemiology and epizootiology are extended by including some relevant biology of the disease vector *Glossina morsitans*. Rickettsia-like organisms, or RLOs, are a vertically transmitted symbiont of tsetse, which confer an increased susceptibility to trypanosomiasis infection. Tsetse populations are also limited by density-dependent starvation. Modelling leads to the prediction of a stable dimorphism with a fraction of tsetse possessing RLOs. The equilibrium prevalence of trypanosomiasis in the vertebrate hosts is no longer in RLO models determined simply by such traditional parameters as vectorial capacity. Only the RLO-positive tsetse carry infection, and their number is itself regulated by trypanosomiasis prevalence. The result of a naïve model is that controlling tsetse numbers does not decrease prevalence until all tsetse are RLO-positive. However, under the density-dependent

starvation model derived in this paper, the relative mortality of RLO-positive flies is greater at lower tsetse numbers. This tips the balance towards lower equilibrium prevalence of trypanosomiasis as tsetse numbers are decreased. The presence of RLOs also gives rise to long-term oscillations in trypanosomiasis prevalence in humans and animals. However, when another mechanism that can also cause periodic epizootics (of shorter periodicity) is included, namely host immunity, the two epizootic processes combine to produce periodic epizootics (and therefore epidemics) at a single frequency. There are two decaying modes, one in which the tsetse population size quickly reaches equilibrium in a few weeks, and a second very slowly decaying mode in which host immunity and RLO effects interact. The equilibrium reached is shown to be asymptotically stable. In view of the seeming importance of RLOs in trypanosomiasis epidemiology, it is important that field biologists enable RLO models to be validated by measuring the proportion of tsetse with RLOs, in conjunction with vector density and trypanosomiasis prevalence and incidence in tsetse and vertebrate hosts.

8069 **Baylis, M. and Nambiro, C.O., 1993.** The effect of cattle infection by *Trypanosoma congolense* on the attraction, and feeding success, of the tsetse fly *Glossina pallidipes*. *Parasitology*, **106** (4): 357-361.

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

An incomplete ring of electric nets was placed around uninfected cattle and cattle infected with *T. congolense*. The numbers of fed and unfed *G. pallidipes* caught on the nets were used to estimate the attractiveness of infected and uninfected cattle to tsetse, and the feeding success of tsetse on the cattle. There was no difference in the attractiveness of infected and uninfected cattle to *G. pallidipes*. However, the feeding success of *G. pallidipes* on infected cattle was 75% greater than on uninfected cattle. This suggests that certain effects of *T. congolense* on cattle behaviour or physiology act to increase the probability of transmission of the parasite by increasing the feeding success of the vector. The nature of the effects of *T. congolense* on cattle which caused this result is unknown, but several possibilities are discussed.

8070 **Leak, S.G.A., Mulatu, W., Authié, E., d'Ieteren, G.D.M., Peregrine, A.S., Rowlands, G.J. and Trail, J.C.M., 1993.** Epidemiology of bovine trypanosomiasis in the Ghibe valley, southwest Ethiopia. 1. Tsetse challenge and its relationship to

trypanosome prevalence in cattle. *Acta Tropica*, **53** (2): 121-134.

Leak, Authié, Peregrine: ILRAD, P.O. Box 30709, Nairobi, Kenya; Mulatu: ILCA, P.O. Box 5689, Addis Ababa, Ethiopia; d'Ieteren, Rowlands, Trail: ILCA, P.O. Box 46847, Nairobi, Kenya.

In this, the first of a series of papers on the epidemiology of bovine trypanosomiasis in the Ghibe valley, south-west Ethiopia, the tsetse populations and their relationships to the prevalence of trypanosome infections in cattle are described. The tsetse challenge to cattle at two sites in the area was estimated as the product of tsetse relative density and the trypanosome infection rate in flies. The proportion of feeds taken by tsetse from cattle was also considered. Three tsetse species were detected in the area, *Glossina pallidipes*, *G. fuscipes* and *G. morsitans submorsitans*. A significant correlation ($r = 0.60$, $P < 0.001$) was observed between the mean monthly estimates of tsetse challenge due to *G. pallidipes* and the prevalence of trypanosome infections in cattle the following month at one site, whilst, at the other, no significant relationship was observed ($P = 0.08$). The tsetse density at both sites showed seasonal changes which were related to the monthly rainfall. Finally, variations in tsetse density appeared to be the main factor responsible for variation in tsetse challenge and thus trypanosome prevalence in cattle.

8071 **Moloo, S.K., Gettinby, G., Olubayo, R.O., Kabata, J.M. and Okumu, I.O., 1993.** A comparison of African buffalo, N'Dama and Boran cattle as reservoirs of *Trypanosoma vivax* for different *Glossina* species. *Parasitology*, **106** (3): 277-282. Moloo, Kabata, Okumu: ILRAD, P.O. Box 30709, Nairobi, Kenya; Gettinby: Department of Statistics and Modelling Science, University of Strathclyde, Livingstone Tower, Glasgow G1 1XH, UK; Olubayo: National Veterinary Research Centre, KARI, P.O. Box 274, Kabete, Kenya.

Teneral *Glossina morsitans centralis* were fed on the flanks of African buffalo, N'Dama or Boran cattle infected with *T. vivax* IL 2337. The infected tsetse were maintained on goats and on day 25 after the infected feed the surviving tsetse were dissected to determine the infection rates. The mean mature infection rates (% \pm S.E.) in the tsetse fed on buffalo, N'Dama and Boran cattle were 34.3 ± 9.9 , 33.7 ± 13.4 and 58.9 ± 7.1 , respectively. Logistic regression analysis indicated that infection rates in the labrum and hypopharynx of the tsetse were significantly lower when fed on the infected buffalo or N'Dama than on Boran cattle.

Similarly, the risk of infection was significantly lower in male than in female tsetse. When teneral *G. m. centralis*, *G. pallidipes*, *G. palpalis gambiensis*, *G. brevipalpis* and *G. longipennis* were fed simultaneously on either the buffalo cow, the N'Dama bull or the Boran steer infected with *T. vivax* IL 2337, the mature infection rates were higher in the two *morsitans* group than in the two *fusca* group tsetse, whilst *G. p. gambiensis* was relatively refractory to the infection, irrespective of the host species on which the flies fed. Logistic regression analysis indicated that the infection rates in the labrum and hypopharynx were significantly different amongst the five tsetse species for each of the three infected host animals. Nevertheless, the trypanotolerant African buffalo and N'Dama cattle may serve as reservoirs of *T. vivax* infection, as can trypanosusceptible Boran cattle. 8072 **Paling, R.W., 1985 [1989]**. The epidemiology of trypanosomiasis. (Paper presented at the Scientific Meeting of the Kenya Veterinary Association on Field Aspects of Trypanosomiasis in Kenya, Ukunda, Kenya, August 1984.) *Kenya Veterinarian*, **9** (2): 11-12.

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

The high frequency of animal trypanosomiasis in tsetse-infested areas is attributed to the large number of vector species, a wide range of reservoir host species, trypanosome antigenic variation and lack of economic and effective tsetse and trypanosomiasis control measures. Tsetse species, density, infection rate, feeding preferences and population dynamics are important factors influencing the frequency of trypanosomiasis in a given area. Cattle are the preferred hosts of *Glossina morsitans* and a few flies can cause a major epidemic. Tsetse infection rates vary from 5-20% for *Trypanosoma vivax*, 2-8% for *T. congolense* and 1% for *T. brucei*. Older flies have higher infection rates. Habitat changes and control measures can affect tsetse populations. Different species and strains of trypanosomes vary in their pathogenicity and different species and breeds of livestock vary in their susceptibility to infection. Livestock distribution, nutritional level and veterinary care are additional factors. Epidemiological data could be used to predict the productivity capacity of different breeds of livestock living under different levels of tsetse and trypanosomiasis challenge and to evaluate the cost effectiveness and impact of control measures such as drugs, tsetse control and improved management.

8073 **Rogers, D.J. and Williams, B.G., 1993**. Monitoring

trypanosomiasis in space and time. *Parasitology*, **106** (Suppl.) (*Symposia of the British Society for Parasitology*, **30**): S77-S92.

Department of Zoology, South Parks Road, Oxford OX1 3PS, UK; LSHTM, Keppel Street, London WC1E 7HT, UK. The paper examines the possible contributions to be made by geographic information systems (GIS) to studies on human and animal trypanosomiasis in Africa. The epidemiological characteristics of trypanosomiasis are reviewed in the light of the formula for the basic reproductive rate or number of vector-borne diseases. The paper then describes how important biological characteristics of the vectors of trypanosomiasis in West Africa may be monitored using data from the NOAA series of meteorological satellites. This will lead to an understanding of the spatial distribution of both vectors and disease. An alternative, statistical approach to understanding the spatial distribution of tsetse, based on linear discriminant analysis, is illustrated with the example of *Glossina morsitans* in Zimbabwe, Kenya and Tanzania. In the case of Zimbabwe, a single climatic variable, the maximum of the mean monthly temperature, correctly predicts the pre-rinderpest distribution of tsetse over 82% of the country; additional climatic and vegetation variables do not improve considerably on this figure. In the cases of Kenya and Tanzania, however, another variable, the maximum of the mean monthly normalised difference vegetation index (NDVI), is the single most important variable, giving correct predictions over 69% of the area; the other climatic and vegetation variables improve this to 82% overall. Such statistical analyses can guide field work towards the correct biological interpretation of the distributional limits of vectors and may also be used to make predictions about the impact of global change on vector ranges. Examples are given of the areas of Zimbabwe which would become climatically suitable for tsetse given mean temperature increases of 1, 2 and 3°C. Five possible causes for sleeping sickness outbreaks are given, illustrated by the analysis of field data or from the output of mathematical models. One cause is abiotic (variation in rainfall), three are biotic (variation in vectorial potential, host immunity, or parasite virulence) and one is historical (the impact of explorers, colonisers and dictators). The implications for disease monitoring, in order to anticipate sleeping sickness outbreaks, are briefly discussed. It is concluded that

present data are inadequate to distinguish between these hypotheses. The idea that sleeping sickness outbreaks are periodic (i.e. cyclical) is only barely supported by hard data. Hence it is even difficult to conclude whether the major cause of sleeping sickness outbreaks is biotic (which, in model situations, tends to produce cyclical epidemics) or abiotic. The conclusions emphasise that until we understand more about the variation in space and time of tsetse and trypanosomiasis distribution and abundance we shall not be in a position to benefit from the advances made by GIS. The potential is there, however, to reintroduce the spatial and temporal elements into epidemiological studies that are currently often neglected.

8074 **Rowlands, G.J., Mulatu, W., Authié, E., d'Ieteren, G.D.M., Leak, S.G.A., Nagda, S.M. and Peregrine, A.S., 1993.** Epidemiology of bovine trypanosomiasis in the Ghibe valley, southwest Ethiopia. 2. Factors associated with variations in trypanosome prevalence, incidence of new infections and prevalence of recurrent infections. *Acta Tropica*, **53** (2): 135-150.

Rowlands, d'Ieteren, Nagda: ILCA, P.O. Box 46847, Nairobi, Kenya; Mulatu: ILCA, P.O. Box 5689, Addis Ababa, Ethiopia; Authié, Leak, Peregrine: ILRAD, P.O. Box 30709, Nairobi, Kenya.

An average of 840 East African Zebu cattle from nine herds in the Ghibe valley, south-west Ethiopia, were monitored from January 1986 to April 1990. Each month blood samples were collected for analysis of PCV and detection of trypanosomes. Animals found to be parasitaemic and with a PCV less than 26% were treated with diminazene aceturate at a dose of 3.5 mg/kg body weight. The majority of infections were associated with *Trypanosoma congolense* (84% of infections in adult cattle and 71% in cattle less than 24 months of age), and the mean percentage of adult animals detected parasitaemic 1 month after treatment of an infection with *T. congolense* was 27%. In order to assess possible existence of drug resistance, a model was applied which allowed monthly incidences of new infections to be distinguished from recurrent infections. This model showed that the monthly incidence of new infections of *T. congolense* in adult cattle increased significantly from 11% in 1986 to 24% in 1989 following a concomitant increase in the tsetse challenge. The corresponding increase in overall prevalence of *T. congolense* was from

17% to 38% and the mean prevalence of recurrent infections increased significantly from 6% to 14%. These findings ruled out the possibility that the high prevalence of trypanosome infections in cattle was due only to a high tsetse challenge and pointed to the existence of *T. congolense* populations which expressed resistance to diminazene. There were variations associated with season, herd, age and sex in the incidence of new infections, prevalence of recurrent infections and relapse to treatment.

5. HUMAN TRYPANOSOMIASIS

(a) SURVEILLANCE

[See also 16: no. 8076.]

8075 **Jannin, J., Moulia-Pelat, J.P., Chanfreau, B., Penchenier, L., Louis, J.P., Nzaba, P., Elfassi de La Baume, F., Eozenou, P. and Cattand, P., 1993.**

Trypanosomiase humaine africaine: étude d'un score de pré-somption de diagnostic au Congo. [Human African trypanosomiasis: study in the Congo of a scoring system for presumptive diagnosis.] *Bulletin of the World Health Organisation*, **71** (2): 215-222.

Jannin: Programme National de Lutte contre la Trypanosomiase, B.P. 1066, Brazzaville, Congo; Moulia-Pelat: Laboratoire National de Santé Publique, Brazzaville, Congo; Chanfreau, Nzaba, Elfassi de La Baume: Centre Inter Etats d'Enseignement Supérieur de Santé Publique, Brazzaville, Congo; Penchenier: Laboratoire de Parasitologie, ORSTOM, Brazzaville, Congo; Louis: Service d'Epidémiologie, OCEAC, Yaoundé, Cameroon; Eozenou: Service de l'Epidémiologie et des Grandes Endémies, Direction de la Médecine Préventive, Brazzaville, Congo; Cattand: WHO, CH-1211 Geneva 27, Switzerland.

A case-control study was carried out in the Congo to define a scoring system based on a number of clinical and epidemiological criteria of African trypanosomiasis due to *Trypanosoma brucei gambiense* which could be used by peripheral health services to establish a diagnosis. The survey comprised 163 cases and 326 controls. Clinical signs and symptoms were fever, headache, pruritus and skin lesions due to scratching, diarrhoea, oedema, cervical adenopathies, sleep rhythm disturbances, changes in appetite, amenorrhoea or impotence, mental confusion, neurological signs, and other minor clinical disturbances. Other criteria were a history of previous trypanosomiasis and the presence of domestic animals in the home environment. Analysis of the results showed that neither a single criterion

nor a group of criteria is pathognomonic for the disease. The selected criteria do not allow discrimination of sleeping sickness patients among suspected individuals who present themselves. A scoring system is therefore of little use at the peripheral level of health services, particularly when considering the additional workload involved. The low diagnostic value of these clinical signs and symptoms and other indicators in African trypanosomiasis stresses the difficulty in developing an early warning tool for an integrated control strategy in primary health care.

(b) PATHOLOGY AND IMMUNOLOGY

8076 **Blanchot, I., Dabadie, A., Tell, G., Guiguen, C., Faugère, B., Plat-Pelle, A.M. and Roussey, M., 1992.** Accès fébriles à répétition chez un enfant africain: difficultés diagnostiques d'une trypanosomiase en France. [Recurrent fever episodes in an African child: diagnostic difficulties of trypanosomiasis in France.] *Pédiatrie*, **47** (3): 179-183.

Service Pédiatrie-génétique Médicale, CHU de Rennes, Pontchaillou, France.

The case of a young boy from southern Angola, who emigrated to France at the age of 29 months, is described. After a long history of recurrent fever, adenopathies, bronchitis, etc., the development of astheny, drowsiness and encephalographic abnormalities prompted CSF analysis and *Trypanosoma brucei gambiense* infection was eventually diagnosed when the boy was over 4 years old. DFMO therapy (400 mg/kg i.v. for 15 days, then 300 mg/kg orally for 4 weeks) led to clinical and parasitological improvement but severe hepatic cytolysis prompted a reduction in dose on days 20 to 37. Following the end of treatment, parasites reappeared in the CSF and a further course of treatment at double the previous dose was instituted. Side effects included thrombopenia, moderate hepatic cytolysis, venous lesions at the injection site, desquamation of the soles and palms, and alopecia. Two and a half years after treatment the child was clinically and biologically well but remained serologically positive. It is thought that the boy acquired trypanosomiasis at the age of 10 months via a transfusion from a donor who was subsequently treated for the disease.

8077 **Buguet, A., Bert, J., Tapie, P., Tabaraud, F., Doua, F., Lonsdorfer, J., Bogui, P. and Dumas, M., 1993.** Sleep-wake cycle in human

African trypanosomiasis. *Journal of Clinical Neurophysiology*, **10** (2): 190-196.

Buguet: Unité de Physiologie de la Vigilance, Centre de Recherches du Service de Santé des Armées, B.P. 87, 38702 La Tronche Cedex, France; Bert, Tapie, Tabaraud, Dumas: Institut de Neurologie Tropicale, Limoges, France; Doua: PRCT, Daloa, Côte d'Ivoire; Lonsdorfer, Bogui: Faculté de Médecine, Abidjan, Côte d'Ivoire. Sleeping sickness patients are classically described as sleepy by day and restless by night. Prior to this study, we had objectively confirmed this description by recording 24 h sleep patterns in a patient with human African trypanosomiasis. We report 24 h polysomnographic recordings (EEG, electro-oculogram, electromyogram, electrocardiogram, and nasal, buccal and thoracic respiratory traces) performed on two eight-channel electroencephalographs in eight patients with untreated sleeping sickness at an early stage of meningoencephalitis. As in our previously reported patient, there was no hypersomnia. The patients presented mainly a disorganisation of the circadian alternation of sleeping and waking, with no or little alteration in the states of vigilance at this early stage of the disease. The disorganisation was proportional to the degree of severity of the clinical symptoms. It may be due to an alteration in biological clock mechanisms.

8078 **Seed, J.R., Sechelski, J.B., Ortiz, J.C. and Chapman, J.F., 1993.**

Relationship between human serum trypanocidal activity and host resistance to the African trypanosomes.

Journal of Parasitology, **79** (2): 226-232.

Departments of Epidemiology (Seed) and Parasitology and Laboratory Practice (Sechelski, Ortiz), School of Public Health, and Department of Pathology, School of Medicine and Clinical Chemistry Laboratories (Chapman), University of North Carolina, Chapel Hill, NC 27599-7400, USA.

Results reported here show that humans (in New Jersey, USA) have various levels of trypanocidal activity to *Trypanosoma brucei gambiense* in their sera. This difference appeared stable when different samples were taken from the same individuals over time. It was not possible to account for the variability between individuals by obvious differences in health, nutrition or living habits. In addition, the trypanocidal titres did not vary significantly when stored for various lengths of time at -70°C. To examine the relationship between the titre of trypanocidal activity in a host and the degree

of human serum resistance of the challenge trypanosome inoculum, mice (C57BL/6J) were pre-treated with various amounts of different human serum and then infected with clones having different degrees of resistance to human serum. It was demonstrated that host susceptibility to an African trypanosome infection depends upon two variables: the level of trypanocidal activity in individual human serum and the degree of human serum resistance of individual clones of African trypanosomes. Based upon the animal model presented here, it is hypothesised that this relationship is under selective evolutionary pressure and will influence the susceptibility of animals in endemic areas as well as the transmission of human trypanosomiasis.

(c) TREATMENT

8079 **Jennings, F.W., Atougua, J.M. and Murray, M., 1993.** Topical melarsoprol for trypanosomiasis. (Letter.) *Lancet*, **341** (8856): 1341-1342.

Departments of Veterinary Parasitology and Veterinary Medicine, University of Glasgow Veterinary School, Bearsden Road, Glasgow G61 1QH, UK.

An important complication of melarsoprol therapy is damage caused to the vascular system by the injection, which is supplied as a 3.6% solution in propylene glycol. This formulation is irritating and painful side effects, almost certainly due to the solvent, can last for over 2 years. Alternative formulations are not likely to become available. The propylene glycol preparation was absorbed through the skin of mice and early stage trypanosome infections were cleared within 24-48 h using doses equivalent to about 40 mg/kg (two drops of 3.6% melarsoprol); 100% cures were obtained when two consecutive daily applications were given. Mice with CNS involvement were permanently cured when two drops were given for 4 consecutive days. Topical application to the relatively hairless human skin may be even more efficacious and damage to the venous system and risk of septicaemia could be avoided. This method could be used by unskilled personnel in remote and poorly equipped health centres.

8080 **Triolo, N., 1990.** A case of coma due to arsobal in a newborn affected with congenital trypanosomiasis gambiense. *Therapy of Infectious Diseases*, **5** (4): 165-166. Mary Health of Africa General Hospital, Fontem, Cameroon.

A 41-year-old woman gave birth to a baby boy in a hospital in Cameroon. The infant, although apparently healthy, had an enlarged spleen and blood tests showed *Trypanosoma brucei gambiense* infection in both mother and child. The mother was treated successfully with three melarsoprol injections but the baby had convulsions 10 h after his second injection and went into a coma. Despite treatment with Valium and phenobarbital, the convulsions repeated after 1.5 h and, after a further 6.5 h in a coma, the baby died. This is thought to be the first case of haemorrhagic encephalopathy in a newborn infant.

8081 **Triolo, N., Parody, A., Fiorucci, G. and Bazzoli, A., 1990.** Side-effects caused by arsobal therapy in 2052 patients treated in Fontem hospital (Cameroon) from 1970 to 1989. *Therapy of Infectious Diseases*, **5** (2-3): 113-128. Mary Health of Africa General Hospital, Fontem, Cameroon.

The authors report 99 cases of side-effects caused by melarsoprol in 2052 Cameroon patients infected with *Trypanosoma brucei gambiense*. Twenty-four patients died as a result of haemorrhagic encephalopathy. One other patient died from acute poisoning from a therapeutic dose. The authors give guidelines for treatment based on their 20 years' experience, including pre-testing for hypersensitivity to arsenic and pre-treatment of other infections. Encephalopathies are more common after the second and third injections: these can be delayed depending on the condition of the patient. Patients should not be discharged from hospital before the 12th day after the last injection.

6. animal trypanosomiasis

(a) SURVEY AND DISTRIBUTION

[See also **16**: no. 8047.]

8082 **Baumann, M.P.O. and Zessin, K.H., 1992.** Productivity and health of camels (*Camelus dromedarius*) in Somalia: associations with trypanosomiasis and brucellosis. *Tropical Animal Health and Production*, **24** (3): 145-156. GTZ, D-6236 Eschborn 1, Germany.

Using a systems approach, data were collected from 1039 camels in 33 traditionally managed herds for production parameters, environmental factors, management and production systems, and health variables. *Trypanosoma evansi* prevalence ranged from 1.7% in blood smears to 56.4% using the microELISA technique. The microHCT method was the most sensitive test for blood samples, identifying 7.2% as infected with trypanosomes (80.5%

with *T. evansi* and 19.4% unidentified). All tests demonstrated seasonal ($P = 0.00$ to $P = 0.06$) and spatial ($P = 0.00$) differences in the distribution of trypanosome infections which were particularly prevalent in the rainy season and in the riverine zone. Using multiple regression, 15% of the total variation of the general fertility rate was explained by the results of microHCT and microELISA for *T. evansi*, complement fixation tests for brucellosis, herd size and young stock death rate. Positive trypanosomiasis results showed a strong negative correlation with the regression model. Good management keeps herds away from the river and in the bush, where reduced contact between herds diminishes the risk of infection by mechanical transmission. Herd management techniques, in combination with effective chemotherapy, could lower the infection rate and increase herd fertility.

8083 **Institut d'Elevage et de Médecine Vétérinaire des Pays Tropicaux, 1991.** Diagnostic et traitement des trypanosomoses animales en Afrique. I. Le diagnostic. [Diagnosis and treatment of animal trypanosomiasis in Africa. I. Diagnosis.] *Fiches techniques d'Elevage tropical*, no. 3: 8 pp. CIRAD-EMVT, 10 rue Pierre Curie, 94704 Maisons Alfort Cedex, France.

This extension leaflet, produced in conjunction with the Ministère de la Coopération et du Développement, Paris, covers the different diagnostic techniques available for the surveillance of animal trypanosomiasis: clinical, parasitological, immunoparasitological and serological. The preparation and examination of blood samples are described, including Giemsa-stained films, microHCT, double microcentrifugation and DEAE cellulose mini-column filtration. A table is given for the microscopic identification of trypanosome species according to the following characteristics: size, flagellum, undulating membrane, kinetoplast and posterior shape. Other parasitological methods include the inoculation of laboratory animals, *in vitro* culture and DNA probes. Serological techniques include indirect immunofluorescence, ELISA and CATT, which are briefly described.

(b) PATHOLOGY AND IMMUNOLOGY

[See also 16: no. 8103.]

8084 **Adah, M.I., Otesile, E.B. and Joshua, R.A., 1993.**

Susceptibility of Nigerian West African Dwarf and Red

Sokoto goats to a strain of *Trypanosoma congolense*.

Veterinary Parasitology, **47** (3-4): 177-188.

Department of Veterinary Medicine, University of Maiduguri, Maiduguri, Nigeria; Department of Veterinary Medicine, University of Ibadan, Ibadan, Nigeria; *ibid.* West African Dwarf (WAD) and Red Sokoto (RS) goats were experimentally infected with the Kafanchan strain of *T. congolense* and the course of the infection was monitored. The organism was pathogenic and produced fatal disease in the goats, which was characterised by rapid progressive anaemia, leucocytosis, weight loss and death. All RS goats died within 11 days of infection and had a mean reduction in PCV of 11%. In WAD goats, one death occurred on day 13 p.i. with a mean drop in PCV of 9%. Statistically significant ($P < 0.05$) mean reductions in values of PCV, haemoglobin and red blood cell counts were observed between the infected and control animals of both breeds, and also between the infected WAD and infected RS goats. The anaemia produced was macrocytic. Leucocytosis characterised by neutropenia and lymphocytosis was observed among infected WAD goats, but leucopenia characterised by neutrophilia and lymphopenia was observed in infected RS goats. Infected WAD goats recorded some positive unit weight gain in spite of the infection. It was concluded that the RS breed of goats is more susceptible to *T. congolense* infection than the WAD breed. 8085 **Anene, B.M., Chime, A.B., Jibike, G.I. and Anika, S.M., 1991.**

Comparative study of clinical signs, haematology and prevalence of trypanosomiasis in Holstein Friesian and White Fulani Zebu cattle exposed to natural infection in a rain forest zone of Nigeria. *Angewandte Parasitologie*, **32** (2): 99-104.

Faculty of Veterinary Medicine, University of Nigeria, Nsukka, Nigeria.

A comparison of the symptomatology, haematology and prevalence of trypanosomiasis in 81 Holstein Friesian cattle (52 adults, 29 calves) and 20 white Zebu (all adults), exposed to natural infections on a ranch in a rainforest zone of Nigeria, is presented. Twenty-three (44%) of the adult Friesians had trypanosome infections with a generally heavy parasitaemia. Infection was light in the Friesian calves and the Zebus with infection rates of two (6.9%) and three (15%) respectively. *Trypanosoma vivax* was the sole species encountered on the farm. The adult Friesian herd appeared not to be thriving, as well as showing classical signs of trypanosomiasis. The Friesian

calves and Zebus were generally in good condition with an appearance of good health except one each of the infected animals which showed apparent symptoms of the disease. There was a marked reduction in the red cell values of the infected adult Friesian and Zebu cattle. The red cell values of the uninfected adult Friesians were equally depressed suggesting cryptic infections or that they had been cured parasitologically by recently administered trypanocide. The Friesian calves had normal red cell values for both the infected and uninfected. Leukocyte counts were generally high on the farm and higher for the infected animals.

8086 **Bekele, T., Kasali, O.B. and Mulatu, W., 1992.** Reproductive problems in indigenous cattle in the Ghibe valley farming populations in central Ethiopia. *Tropical Agriculture*, **69** (4): 327-328.

ILCA, P.O. Box 5689, Addis Ababa, Ethiopia.

In a study of the reproductive performance of indigenous Zebu cattle in 1988 and 1989 at the Ghibe valley in Ethiopia, the calving interval was 507.5 \pm 9.4 days and days open were 232.4 \pm 13.9. Abortion rates were 16.8 and 16.3% of 179 and 43 cattle in 1988 and 1989, respectively, with significant ($P < 0.01$) seasonal differences. These high rates with seasonal variation may result from a high incidence of trypanosomiasis during and immediately after the long rainy season. The control of the seasonal flare-up of trypanosomiasis and other health management interventions could reduce the incidence of abortion in the future.

8087 **Connor, R.J., 1985 [1989].** The interaction of trypanosomiasis and helminthiasis. (Paper presented at the Scientific Meeting of the Kenya Veterinary Association on Field Aspects of Trypanosomiasis in Kenya, Ukunda, Kenya, August 1984.) *Kenya Veterinarian*, **9** (2): 13-14.

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

Animals with chronic trypanosomiasis may acquire other infections and become more seriously affected than by trypanosomes alone. The clinical signs, diagnosis, treatment and control of simultaneous infections with helminths and trypanosomes are briefly described. The most frequent helminths occurring with trypanosomiasis are *Haemonchus*, *Fasciola* and *Oesophagostomum* in ruminants, *Haemonchus* in camels, *Strongylus* in equids and *Ancylostoma* in dogs. Trypanosome-infected animals show a reduced immune response to helminth infections and animals with dual infections are more severely anaemic than others

with single infections. Exotic Friesian cattle in southern Tanzania with trypanosome infections had consistently higher faecal egg counts than local Zebus. Trypanosomiasis and helminthiasis both produce anaemia, weight loss, reduced growth rate, lethargy, oedema, infertility, reduced milk yield and death. Diagnosis of trypanosomes is usually by blood film examination and HCT; helminths are detected by examination of faecal samples. Other concurrent infections and disorders, such as anaplasmosis, malnutrition and mineral deficiencies, must also be considered. Combined infections require simultaneous treatment and preventive measures must take into account the epidemiology of both diseases.

8088 **Ibebunjo, C., Kene, R.O.C. and Uzoukwu, M., 1992.** Canine lymphadenopathy: difficulties in diagnosis of lymphosarcoma in the presence of trypanosomiasis or extragenital transmissible venereal tumour. *Bulletin of Animal Health and Production in Africa*, **40** (3): 201-203.

Departments of Veterinary Surgery and Obstetrics (Ibebunjo, Kene) and Veterinary Pathology and Microbiology (Uzoukwu), Faculty of Veterinary Medicine, University of Nigeria, Nsukka, Nigeria.

Canine trypanosomiasis, which is prevalent in Nigeria, is caused mainly by *Trypanosoma brucei brucei* and presents clinical signs identical with those of lymphosarcoma. Parasitaemia may not always be detectable, especially in chronic cases and/or following trypanocidal treatment. Histologically, the hyperplastic lymph nodes in trypanosomiasis may be difficult to differentiate from nodes in early stages of lymphosarcoma which have not been disrupted by neoplastic cells. Parasitaemia does not preclude the possibility of the concurrent presence of lymphosarcoma. The coexistence of trypanosomiasis and lymphosarcoma in dogs may therefore complicate and delay diagnosis of the lymphosarcoma.

8089 **Katunguka-Rwakishaya, E., Parkins, J.J., Fishwick, G., Murray, M. and Holmes, P.H., 1993.** The pathophysiology of *Trypanosoma congolense* infection in Scottish Blackface sheep. Influence of dietary protein. *Veterinary Parasitology*, **47** (3-4): 189-204.

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

The intensity of parasitaemia, degree of anaemia, blood biochemical changes and live weight gains were measured in two groups of Scottish Blackface sheep infected experimentally with bloodstream forms of *T. congolense* and

given either a high or a low protein diet. It was observed that infected animals on a high protein diet tended to develop a higher intensity of parasitaemia than those on a low protein diet. Both groups of infected sheep exhibited similar degrees of anaemia, but the erythropoietic activity, as judged by the increase in mean corpuscular volume and appearance of normoblasts in the circulation, was significantly greater in animals on a high protein diet. The infected animals on a high protein diet gained weight at a similar rate to their uninfected controls, while those on a low protein diet gained significantly less than their controls between 0 and 70 days after infection. Following treatment with the trypanocidal drug isometamidium chloride, both infected groups recovered from the anaemia. However, the rate of recovery was faster in animals on a high protein diet than in those on a low protein diet. It was concluded that high protein intake ameliorates the adverse effects arising from infection, as assessed by the severity of anaemia and weight changes, and also enhances the rate of recovery following chemotherapy. 8090 **Mihok, S., Olubayo, R.O. and Molloo, S.K., 1992.**

Trypanosomiasis in the black rhinoceros (*Diceros bicornis* Linnaeus, 1758). *Revue scientifique et technique de l'Office International des Epizooties*, **11** (4): 1169-1173.

Tsetse Research Programme, ICIPE, P.O. Box 30772, Nairobi, Kenya; KARI, National Veterinary Research Centre, P.O. Box Kabete, Nairobi, Kenya; ILRAD, P.O. Box 30709, Nairobi, Kenya.

A black rhinoceros (*Diceros bicornis*) moved from a tsetse-free to a tsetse-infested area in Kenya was monitored for 2 months following translocation. The animal acquired a *Trypanosoma vivax* infection from natural tsetse challenge, but survived without requiring treatment with trypanocides. The infection was characterised by moderately high parasitaemia, with symptoms of anaemia, leukopenia and thrombocytopenia. Although confirmed to be *T. vivax* through DNA hybridisation and parasite development in tsetse in the proboscis only, the parasite had unusual morphology and motility. It also failed to infect normally susceptible hosts such as cows and goats, and produced unusually low infection rates in *Glossina morsitans centralis* and *G. brevipalpis*.

8091 **Ngeranwa, J.J.N., Gathumbi, P.K., Mutiga, E.R. and Agumbah, G.J.O., 1993.** Pathogenesis of *Trypanosoma (brucei) evansi* in Small East African goats. *Research in Veterinary Science*, **54** (3): 283-289.

KARI, P.O. Box 29231, Nairobi, Kenya; Department of Pathology and Microbiology, University of Nairobi, P.O. Box 29053, Nairobi, Kenya; Clinical Studies Department, University of Nairobi, P.O. Box 29053, Nairobi, Kenya; *ibid.*

T. evansi is the cause of surra, a camel disease which is the most important single cause of economic losses in camel rearing areas. Sheep and goats herded with camels are the most likely hosts for *T. evansi*. Upon i.v. infections, goats developed erratic parasitaemia, lost weight and their PCV dropped significantly ($P < 0.001$). Trypanosomes were demonstrated by direct microscopy in extra-vascular locations such as synovial, peritoneal and cerebrospinal fluids and also in lymph by subinoculations into mice. The carcasses were emaciated and pale. Histologically there was lymphatic tissue hyperplasia, muscular atrophy and nephrotic changes. Two animals had necrotic foci in the liver, kidneys, lymph nodes, spleen and lungs and also bronchopneumonia. Histologically there was depopulation of lymphocytes in lymphatic tissues, destruction of hepatocytes in the liver, with infiltration by inflammatory cells in the liver, lymph nodes, spleen and kidneys.

8092 **O'Hara, H.B. and Gombe, S., 1991.** Fertility of the Small East African goat following pre-pubertal infection with *Trypanosoma congolense*. In: IAEA, *Isotope aided studies on sheep and goat production in the tropics* (Proceedings of the Final Research Co-ordination Meeting on improving sheep and goat productivity with the aid of nuclear techniques, organised by the Joint FAO/IAEA Division, and held in Perth, Australia, 20-24 February 1989) (Vienna, Austria; IAEA: STI/PUB/860), pp. 195-201.

Reproductive Biology Unit, College of Biological and Physical Sciences, University of Nairobi, P.O. Box 30197, Nairobi, Kenya.

Pre-pubertal male and female Small East African goats were infected with *T. congolense* at 4-5 months of age. Changes in body weight and haemogram were monitored weekly. Progesterone and testosterone measurements were made three times weekly until the goats reached either puberty or 18 months of age. Onset of puberty was determined from observation of oestrus behaviour, mating or increase in libido; this was confirmed by elevation in plasma progesterone or testosterone levels. Trypanosomiasis affected pre-pubertal goats by reducing body weight gain and delaying onset of puberty. Histological examination of the gonads showed

pronounced pathological changes. These effects were reversed by treatment with isometamidium chloride. It was concluded that early treatment of infected goats before serious gonadal damage could occur allowed full restoration of reproductive function.

8093 **Sekoni, V.O., 1993.** Elevated sperm morphological abnormalities of Yankasa rams consequent to *Trypanosoma vivax* infection. *Animal Reproduction Science*, **31** (3-4): 243-248.

National Animal Production Research Institute, Ahmadu Bello University, P.M.B. 1096, Shika, Zaria, Nigeria. Twelve Yankasa rams from 2.5 to 3 years of age were divided into two groups of six for a study which lasted 15 weeks. All the rams initially had low sperm morphological abnormalities in their semen before the six animals in the treatment group were infected with *T. vivax*. All of the infected rams developed chronic trypanosomiasis. Detailed studies of sperm morphological abnormalities were carried out for a period of 9 weeks p.i. There was a rapid and progressive elevation of all abnormalities in the semen of the infected rams. Typical spermatozoa of infected rams were highly deformed with multiple morphological abnormalities. At 9 weeks p.i. the control group of rams had a mean of 3.9% for total sperm morphological abnormalities which differed ($P < 0.001$) from the mean value of 99.80% for the infected group. Most rams were unfit for breeding at 3 weeks p.i. The result shows that *T. vivax* infection can render rams unfit for breeding within a short period of time.

8094 **Sileghem, M.R., Flynn, J.N., Saya, R. and Williams, D.J.L., 1993.** Secretion of co-stimulatory cytokines by monocytes and macrophages during infection with *Trypanosoma (Nannomonas) congolense* in susceptible and tolerant cattle. *Veterinary Immunology and Immuno-pathology*, **37** (2): 123-134.

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

Bovine macrophages and monocytes were cultured *in vitro* and analysed for their capacity to secrete co-stimulatory cytokines. To this end, the culture medium was titrated on suboptimally stimulated murine thymocytes. A low residual release by normal monocytes was noted which usually remained below the detection limit of the assay. These cells could be induced to secrete high titres following activation with bacterial lipopolysaccharide. When harvested from animals infected with *T. congolense*, the cells released high titres spontaneously. This increase in co-stimulatory cytokine secretion was noted in both peripheral blood

monocytes and splenic macrophages and was amplified by addition of indomethacin. The activation was transient, and the titres had dropped to pre-infection values at the end of the experiment. At that time, the monocytes were, however, still able to respond to external stimuli. Addition of neutralising anti-transforming growth factor β antibodies did not influence the thymocyte co-stimulatory activity of the supernatants. High levels of co-stimulatory cytokine secretion were noted with monocytes from both the susceptible Boran breed and the tolerant N'Dama breed. Early in infection, at day 10 p.i., the production by the N'Dama monocytes was 16 times higher than the production by the Boran monocytes. Later in the infection, the titres were similar in both breeds.

- 8095 **Wernery, U., Seifert, H.S.H., Billah, A.M. and Ali, M., 1991.** Predisposing factors in enterotoxemias of camels (*Camelus dromedarius*) caused by *Clostridium perfringens* type A. *Revue d'Elevage et de Médecine vétérinaire des Pays tropicaux*, **44** (2): 147-152.

Central Veterinary Research Laboratory, P.O.B. 597, Dubai, United Arab Emirates.

Trypanosoma evansi was detected microscopically in wet blood films of 45 (50%) of 90 breeding camels. Antibodies were found by Testryp CATT in 26 of these camels and also in another 19 camels with no parasites detected in the blood, raising the number of positive animals to 64 (71%). Both trypanosomiasis and salmonellosis are thought to be important predisposing factors for *Clostridium* infection which is often fatal.

(c) TRYPANOTOLERANCE

8096 **Anonymous, 1991.** Le bétail trypanotolérant. Difficile intégration dans les élevages commerciaux. [Trypanotolérant livestock. Difficult integration into commercial farming.] *Afrique Agriculture*, no. 187: 20. Many cattle breeders consider trypanotolerant breeds too small and less productive than Zebus, according to reports at the 21st meeting of the ISCTRC at Yamoussoukro, Côte d'Ivoire on 21-25 October 1991. Nevertheless, delegates from Burkina Faso, Ghana, Côte d'Ivoire, Senegal and Zaire confirmed that their respective governments continued to show an interest in trypanotolerant stock as of potential economic importance. Contrary to popular opinion, it was shown that the productivity of trypanotolerant cattle was

comparable to that of Zebus. Trypanotolerant breeds are also resistant to tick-transmitted diseases, helminthiasis and dermatophilosis and it was recommended that national research institutes be established to encourage their large-scale acceptance. In Burkina Faso and Ghana trypanotolerant cattle are not kept by commercial breeders but mostly by a limited number of farmers who keep them for socio-cultural reasons. In Nigeria the government has reconsidered its position concerning the importation of N'Dama cattle on grounds of reduced size and milk production and a preference for Zebus among pastoral farmers, who rely heavily on trypanocidal drugs.

8097 **Amsler, S., 1990.** *Les ranches de bovins trypanotolérants en Afrique centrale: intérêts et problèmes.* [Trypanotolerant cattle ranches in central Africa: advantages and disadvantages.] Synthèse biblio-graphique, Diplôme d'Etudes supérieures spécialisées (Productions animales en Régions chaudes), IEMVT, Maisons Alfort, France. (Unpublished dissertation.) 43 pp.

Tsetse infestation severely restricts the territory available to cattle ranching in Africa. The performance and productivity of the trypanotolerant N'Dama breed under conditions prevailing in Congo, Gabon and Zaire are reviewed, with reference to the socio-economic situation, level of tsetse infestation, the origin and distribution of stock, trypanotolerance and other parameters. Existing ranches are described in the three countries concerned. The advantages and disadvantages of N'Dama ranches are discussed, including meat production, genetic improvement and the distribution of breeding stock. N'Dama cattle appear to be the best choice for cattle ranches in Congo, Gabon and Zaire. This breed adapts well to all conditions and its productivity compares well with larger breeds. However, the ranches would be more profitable if other sectors of the economy were improved, especially agriculture, land management and trade. Other potentially profitable options, such as pig and poultry rearing, should also be investigated.

8098 **Gyawu, P., Kabuga, J.D., Asare, K., Karikari, P.K., Appiah, P., Kwarteng, F.A. and Awunyo, P.K., 1993.** Oestrous response of trypanotolerant N'Dama cows after treatment with prostaglandin F₂α analogue (cloprostenol) in the humid forest zone of Ghana. *Animal Reproduction Science*, **31** (3-4): 167-173.

Animal Science Department (Gyawu, Kabuga, Appiah, Kwarteng) and Dairy/Beef Cattle Research Station

(Asare, Karikari, Awunyo), University of Science and Technology, Kumasi, Ghana.

A study was undertaken to determine the effect of cloprostenol, an analogue of prostaglandin $F_2\alpha$ ($PGF_2\alpha$) on the oestrous response of trypanotolerant N'Dama beef cows in the humid forest zone of Ghana. Fourteen N'Dama cows were selected for use after first being examined and diagnosed as being in the luteal phase of their cycles. The cows were then observed for oestrous response for 7 days following each cloprostenol injection. The proportions of cows which manifested standing oestrus after the first and second $PGF_2\alpha$ injections were 85.7% and 92.9% respectively. The mean post-injection intervals to onset of standing oestrus after the first and second injections were 71.04 \pm 3.2 h and 55.4 \pm 2.0 h respectively ($P < 0.001$). No differences were evident in duration or intensity of oestrus. The first service pregnancy rate for 13 cows which manifested natural oestrus about 24 days after the second treatment was 84.6%. It was concluded that cloprostenol causes effective synchronisation of oestrus in cyclic N'Dama cows.

8099 **Moulin, C.H. and Faugère, O., 1990.** *Les modes d'élevage des petits ruminants trypanotolérants.* [Rearing methods for trypanotolerant small ruminants.] (Paper presented at the FAO/ITC Course on the Production and Health of Trypanotolerant Cattle, Banjul, The Gambia, 7 November 1990.) Dakar-Hann, Senegal; ISRA-LNERV (in conjunction with Maisons Alfort, France; IEMVT). 13 pp. LNERV, B.P. 2057, Dakar-Hann, Senegal.

This working document has been produced as part of a LNERV research programme on the pathology and productivity of small ruminants. Sheep and goats are widespread in areas of West Africa severely affected by animal trypanosomiasis, where they are represented by trypanotolerant races which are well adapted to the environment. A general description of the methods of rearing small ruminants in West Africa serves as a framework for a detailed study which has been carried out on the traditional rearing methods (herd composition, management and exploitation) used by farmers in two regions in the sudanian zone of Senegal. The knowledge gained from such studies will assist in rationalising research and development on these trypanotolerant breeds.

8100 **Sauveroche, B., 1992.** *Physiologie de la reproduction des bovins trypanotolérants. Synthèse des connaissances actuelles.* [Reproductive

physiology of trypanotolerant cattle. Synthesis of current knowledge.] Rome; FAO. (RAF/88/100.) 97 pp. OGAPROV, B.P. 245, Moanda, Gabon.

This report forms part of an FAO project on the promotion of rearing of trypanotolerant livestock in West and Central Africa. Current knowledge of the reproductive physiology of female (puberty, the sexual cycle and its control, gestation, resumption of sexual activity after calving, superovulation) and male (puberty, behavioural and morphological characteristics, sperm production, hormone composition) trypanotolerant cattle is presented. Research indicates that, given some improvements in herd management, trypanotolerant cattle have a reproductive capacity comparable to that of other breeds. The main factor affecting reproduction is nutrition. The effects of trypanosomiasis on reproductive function in trypanotolerant cattle are assessed.

8101 **Traore, M., 1989.** *Etude de la productivité du bétail N'Dama élevé en ranching et dans les troupeaux traditionnels du cercle de Yanfolila (Mali).*

Perspectives d'amélioration. [Study of the productivity of N'Dama cattle raised on ranches and in traditional herds in the Yanfolila area (Mali). Prospects for improvement.] Thèse de Doctorat d'Etat ès Sciences naturelles, Université de Paris XII, Créteil, Val de Marne, France. (Unpublished thesis.) 314 pp.

The objectives of this study were to identify the reasons for the low productivity of N'Dama cattle raised at the Madina Diassa ranch. This was confirmed and linked to a high rate of abortion, late sexual development of cows and a high level of mortality, especially among juveniles. The productivity of animals on the ranch differed little from that of traditional herds. The husbandry at Madina reproduced the main constraints of the traditional system, including restricted feeding for a relatively long period each year and increased risk of trypanosomiasis, and was counterproductive. Despite a slight improvement of some of the parameters studied (fertility and weight of certain age groups), the overall productivity index on the ranch barely exceeded that of traditional herding. The introduction of supplementary feed when weight loss occurred during the cold dry season significantly reduced mortality and improved the maturation rate of heifers.

Trypanosomiasis was found to be extremely prevalent and new data on epidemiology and trypanotolerance have been obtained. The hypothesis that there is a positive

correlation between productivity and trypanotolerance has not been confirmed: individuals identified as most resistant have less than average productivity. The strategic use of chemotherapy greatly improved productivity. The improvements obtained on the ranch are also applicable to traditionally managed herds. 8102 **Wakelin, D., 1992.** Genetic variation in resistance to parasitic infection: experimental approaches and practical applications. (Review.) *Research in Veterinary Science*, **53** (2): 139-147.

Department of Life Science, University of Nottingham, University Park, Nottingham NG7 2RD, UK.

Current views of the mechanisms, control and likely value of genetically determined variation in resistance to parasite infections are reviewed. Differences in skin thickness in cattle have been associated with differences in susceptibility to tsetse-borne trypanosomes. Trypanotolerant dwarf African breeds survive and remain productive despite heavy trypanosome challenge. Trypanotolerance is both physiological and immunological and has been studied using model infections in mice, in which genetically determined trypanotolerance also exists. The genetic control of resistance to *Trypanosoma congolense* may involve only a single background gene. The ability to express resistance, in terms of controlling parasitaemia, correlates with the production of variant-specific IgM antibodies. However, there may be no direct correlation between antibody isotype and survival in mice infected with *T. brucei rhodesiense*, where experiments have shown these parameters to be independently inherited. Genetic differences in susceptibility to trypanosome-induced immunosuppression may exist in mice which lose the ability to support development of plasma cells specific for variant trypanosome antigens. The data obtained from mice support the evidence obtained from larger animals.

(d) TREATMENT

[See also **16**: nos. 8040, 8074.]

8103 **Anonymous, 1991.** Un nouveau traitement pour la trypanosomose du dromadaire: le Cymelarsan. [A new treatment for trypanosomiasis in camels: Cymelarsan.] *Revue d'Appui pour l'Elevage*, no. 2: 13-14.

Trypanosomiasis or surra in dromedary camels, caused by *Trypanosoma evansi* and transmitted by biting insects in the rainy season, is one of the most important diseases of this animal. Surra exists in three forms: hyperacute,

with death taking place rapidly and before the development of recognisable symptoms; acute, with prostration, fever, reduction in milk production, abortion, watering eyes, blood spots on mucous membranes and oedema, with death taking place in several weeks; and chronic, with weight loss, anaemia, fluctuating fever and death within 1-2 years or eventual cure. The chronic disease is the most common form and difficult to recognise, as it resembles haemonchosis. There are few chemoprophylactic or chemotherapeutic drugs, which are not always well tolerated, and trypanosomes have developed resistance to some of them. Cymelarsan is a new curative drug which is very effective against *T. evansi* and *T. brucei*, especially against strains resistant to suramin (Naganol) and quinapyramine (Antrycide, Trypacide). It is well tolerated by camels and can be given to pregnant and weak animals. It is administered i.m. as a 0.5% solution at 0.1 g a.i./20 ml/400 kg.

8104 **Codjia, V., Mulatu, W., Majiwa, P.A.O., Leak, S.G.A., Rowlands, G.J., Authié, E., d'Ieteren, G.D.M. and Peregrine, A.S., 1993.**

Epidemiology of bovine trypanosomiasis in the Ghibe valley, southwest Ethiopia. 3. Occurrence of populations of *Trypanosoma congolense* resistant to diminazene, isometamidium and homidium. *Acta Tropica*, **53** (2): 151-163.

Codjia, Majiwa, Leak, Authié, Peregrine: ILRAD, P.O. Box 30709, Nairobi, Kenya; Mulatu: ILCA, P.O. Box 5689, Addis Ababa, Ethiopia; Rowlands, d'Ieteren: ILCA, P.O. Box 46847, Nairobi, Kenya. (Correspondence to Peregrine.)

In July 1989, blood samples were collected from parasitaemic cattle in the Ghibe valley, Ethiopia, frozen in liquid nitrogen and transported to Nairobi, Kenya. Twelve of the stabilates were inoculated into individual Boran (*Bos indicus*) calves and characterised for their sensitivity, in turn, to diminazene aceturate (Berenil), isometamidium chloride (Samorin) and homidium chloride (Novidium). All 12 stabilates produced infections which were shown to be *Trypanosoma congolense* and resistant to treatment with diminazene aceturate at a dose of 7.0 mg kg⁻¹ body weight (b.w.). Eleven of the infections were also resistant to isometamidium chloride at a dose of 0.5 mg kg⁻¹ b.w. and homidium chloride at a dose of 1.0 mg kg⁻¹ b.w. The drug-sensitivity phenotypes of three of the same isolates were also determined in goats which were each treated with only one of the three trypanocides: all

expressed the same phenotypes as the populations expressed in the Boran calves. Five clones were derived from one of the isolates which expressed a high level of resistance to all three trypanocides; each clone expressed high levels of resistance to all three trypanocides when characterised in mice. Thus, the multi-resistance phenotype of the parental isolate was associated with expression of multi-resistance by individual trypanosomes. Finally, molecular karyotypes and electrophoretic variants of six enzymes were determined for seven and eight of the isolates, respectively. Six different karyotypes were observed and all eight of the latter isolates belonged to different zymodemes, indicating that the multi-resistance phenotype at Ghibe was associated with many genetically distinct populations.

8105 **Dowler, M., Mwenda, G. and Abdirahman, M., 1985 [1989].**

Trypanosomiasis treatment - a coast farmer's view.

(Paper presented at the Scientific Meeting of the Kenya Veterinary Association on Field Aspects of Trypanosomiasis in Kenya, Ukunda, Kenya, August 1984.)
Kenya Veterinarian, **9** (2): 19-20.

Vipingo Estates Ltd, P.O. Box 1, Vipingo, Kenya.

The history of trypanosomiasis treatment and control in a herd of Boran cattle established at Vipingo, Kenya, in 1973-74 is described. In 1975 isometamidium chloride was found to be effective as a prophylactic and diminazene aceturate was used to treat clinical cases. Increased trypanosomiasis incidence was linked to the inadvertent exposure of cattle to tsetse flies while dipping for tick control in the evenings: the flies were thought to have been introduced by the evening offshore breeze. By 1979 prophylactic drugs were found to be adversely affecting the fertility of the herd and only curative drugs were used after 1980, although coastal cattle were given a sanative dose of either diminazene aceturate or Novidium before transfer to the hinterland. By 1984 both diminazene aceturate and isometamidium chloride appeared to be ineffective as curative drugs. It was then found that isometamidium chloride was much more effective when administered i.v. at 1%, rather than i.m. at 2% as previously. The i.v. method had no adverse side effects and the success rate was high.

8106 **Institut d'Élevage et de Médecine Vétérinaire des Pays Tropicaux, 1991.** Diagnostic et traitement des trypanosomoses animales en Afrique. II. Le traitement. [Diagnosis

and treatment of animal trypanosomiasis in Africa. II. Treatment.] *Fiches techniques d'Elevage tropical*, no. 7: 4 pp. CIRAD-EMVT, 10 rue Pierre Curie, 94704 Maisons Alfort Cedex, France.

Chemotherapeutic and chemoprophylactic drugs available for treating animal trypanosomiasis are briefly described in this extension leaflet produced in conjunction with the Ministère de la Coopération et du Développement, Paris. The five main classes of drugs are: phenanthridine derivatives (homidium chloride, homidium bromide, isometamidium chloride), quinapyramine derivatives (quinapyramine sulphate, quinapyramine sulphate-chloride), diamidines (diminazene aceturate), ureic compounds (suramin) and arsenical derivatives (melarsamine). The use of curative and prophylactic drugs is summarised in two tables, which give the aqueous solution, injection route, dose, volume to be injected, trypanosome species affected, host species and, for prophylactic drugs, duration of protection. Drug dose is dependent on host body weight which must be accurately determined; some barymetric methods are given. Problems of drug resistance are discussed.

8107 **Schillinger, D., 1985 [1989]**. The problem of trypanocidal drug resistance. (Paper presented at the Scientific Meeting of the Kenya Veterinary Association on Field Aspects of Trypanosomiasis in Kenya, Ukunda, Kenya, August 1984.) *Kenya Veterinarian*, **9** (2): 21-24.

Chemotherapy of Trypanosomiasis Research Project, Veterinary Research Laboratory, P.O. Kabete, Kenya. Resistance to all trypanocides has become established throughout the tsetse belt and in all species of pathogenic trypanosomes. Factors affecting the success of chemotherapy are briefly reviewed and include depressed host immune responses, extravascular trypanosomes inaccessible to treatment, natural drug tolerance and induced drug resistance. Drug resistance varies but becomes particularly important when the standard curative dose is no longer effective. Cross-resistance occurs when trypanosomes show resistance to a different but chemically related drug. There is no cross-resistance between phenanthridine drugs and diminazene, but the alternate use of a 'sanative pair' of drugs, such as homidium and diminazene, is losing its effectiveness as multiple drug resistance increases. Resistance develops when trypanosomes are exposed to sublethal doses of trypanocides, especially when used as prophylactic drugs. Drugs must be

administered in the appropriate quantities and at the time intervals necessary to maintain a minimum effective concentration in the blood. Methods of assessing drug resistance are described and include careful monitoring, the mouse sensitivity test and analysis *in vitro*. It is recommended that: all field workers should be adequately trained in drug administration; resistance should be surveyed at national and international levels; and the pattern of response to available drugs should be investigated as soon as resistance is detected. New drugs are needed.

7. EXPERIMENTAL TRYPANOSOMIASIS

(a) DIAGNOSTICS

8108 **Bromidge, T., Gibson, W., Hudson, K. and Dukes, P., 1993.**

Identification of *Trypanosoma brucei gambiense* by PCR amplification of variant surface glycoprotein genes. *Acta Tropica*, **53** (2): 107-119.

Gibson: Department of Pathology and Microbiology, University of Bristol Veterinary School, Langford, Bristol BS18 7DU, UK.

8109 **Pellé, R., 1993.** The use of electrophoretic profile of RNA to differentiate *Trypanosoma brucei* from *T. congolense*. (Letter.) *Parasitology Today*, **9** (3): 96.

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

8110 **Qian, Y.J., Sun, J.L., Zhang, H.Y. and Xu, R.S., 1989.** [Use of polyaldehyde polystyrene immuno-microspheres for diagnosing animal parasitic diseases.] [Incl. *T. evansi*.] (In Chinese with English summary.) *Acta Veterinaria et Zootechnica Sinica*, **20** (3): 251-254.

Institute of Animal Schistosomiasis, Shanghai, China.

8111 **Qian, Y.J., Zhang, H.Y. and Sun, J.L., 1989.** [The PAPS immuno-microsphere test for rapid diagnosis of *Trypanosoma evansi* infection.] (In Chinese with English summary.) *Acta Veterinaria et Zootechnica Sinica*, **20** (4): 363-367.

Institute of Animal Schistosomiasis, Shanghai, China.

8112 **Tidey, P.J., Hommel, M. and Smith, D.H., 1993.** Use of immunoplot analysis for the identification of immunodominant non-variant antigens of *Trypanosoma brucei rhodesiense*. *Journal of Immunological Methods*, **161** (2): 223-230.

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

8113 **Wang, X.S. and Hu, L.S., 1991.** [Cryopreservation of *Toxoplasma gondii*, *Trypanosoma theileri* and *Trypanosoma evansi*.]

(In Chinese with English summary.) *Acta Veterinaria et Zootechnica Sinica*, **22** (3): 263-267.

Department of Parasitology, Veterinary College,
People's Liberation Army, China.

(b) PATHOLOGY AND IMMUNOLOGY

[See also **16**: nos. 8102, 8159.]

8114 **Bratteli, J.S. and Reinitz, D.M., 1993.** *Trypanosoma brucei brucei* (*T.b.b.*) infection of class I and class II deficient C57BL/6 mice. (Meeting abstract no. 1340.) *Journal of Immunology*, **150** (8, pt. II): 234A.

Department of Immunology and Microbiology,
University of North Dakota, Grand Forks, ND
58202, USA.

8115 **Dina, O.A. and Arowolo, R.O.A., 1991.** Pharmacological receptors in the ileum of trypanosomal infected guinea pigs (*Cavia porcellus*). [*T. brucei*; *in vitro*.] *Bulletin of Animal Health and Production in Africa*, **39** (2): 219-223.

Department of Veterinary Physiology and
Pharmacology, University of Ibadan, Ibadan,
Nigeria.

8116 **Makumyaviri, A.M., 1993.** Résistance relative et histopathologie chez la souris consanguine infectée avec *Trypanosoma brucei brucei*. [Relative resistance and histopathology in inbred mice infected with *T. b. brucei*.] *Revue de Médecine vétérinaire*, **144** (3): 191-196.

Faculté de Médecine Vétérinaire, UNILU, B.P.
1825, Lubumbashi, Zaire.

8117 **Mansfield, J.M., Schleifer, K.W., Schopf, L.R. and Filutowicz, H., 1993.** T cell-macrophage interactions in experimental African trypano-somiasis: a new view. [*T. b. rhodesiense*; mice.] (Meeting abstract no. 514.) *Journal of Immunology*, **150** (8, pt. II): 93A.

Mansfield: Laboratory of Immunology,
Department of Animal Health and Biomedical
Sciences, 1655 Linden Drive, University of
Wisconsin, Madison, WI 53706, USA.

8118 **Schleifer, K.W., Filutowicz, H., Schopf, L.R. and Mansfield, J.M., 1993.** Characterization of T helper cell responses to the trypanosome variant surface glycoprotein. [*T. b. rhodesiense*; mice.] *Journal of Immunology*, **150** (7): 2910-2919.

Mansfield: Laboratory of Immunology,
Department of Animal Health and Biomedical
Sciences, 1655 Linden Drive, University of
Wisconsin, Madison, WI 53706, USA.

8119 **Schopf, L.R., Schleifer, K.W. and Mansfield, J.M., 1993.** T helper cell cytokine profiles and B cell Ig isotype responses to the trypanosome VSG molecule. [*T. b. rhodesiense*; mice.] (Meeting abstract no. 1341.) *Journal of Immunology*, **150** (8, pt. II): 234A.

Mansfield: Laboratory of Immunology, Department of Animal Health and Biomedical Sciences, 1655 Linden Drive, University of Wisconsin, Madison, WI 53706, USA.

8120 **Simaren, J.O. and Ogunnaiké, M.O., 1989.** Urinary biochemical changes, histopathologic effect of kidney damage observed in rats infected with *Trypanosoma b. brucei*. *Mitteilungen der Österreich-ischen Gesellschaft für Tropenmedizin und Parasitologie*, **11**: 35-46.

Laboratory of Parasitic Diseases, Department of Medical Microbiology and Parasitology, Faculty of Health Sciences, Obafemi Awolowo University, Ile-Ife, Nigeria.

8121 **Toth, L.A. and Krueger, J.M., 1990.** Somnogenic impact of trypano-somiasis in rabbits. (Meeting abstract no. 494.17.) *Society for Neuroscience Abstracts*, **16** (2): 1199.

University of Tennessee, Memphis, TN 38163, USA.

8122 **Uche, U.E. and Jones, T.W., 1993.** Effect of complement (C3) depletion on the generation of memory in rabbits primed with antigens of *Trypanosoma evansi*. *Veterinary Parasitology*, **47** (3-4): 205-213.

Uche: Royal Veterinary College, Royal College Street, London NW1 0TU, UK.

(c) CHEMOTHERAPEUTICS

[See also **16**: nos. 8167, 8169.]

8123 **Chitambo, H. and Arakawa, A., 1992.** *Trypanosoma congolense*: the use of 4,6-diamidino-2-phenylindole (DAPI) in the akinetoplastic induction sensitivity test. [Mice.] *Journal of Veterinary Medical Science*, **54** (4): 773-775.

Department of Veterinary Science, College of Agriculture, University of Osaka Prefecture, 1-1 Gakuen-cho, Sakai City, Osaka 593, Japan.

8124 **Grady, R.W., Bienen, E.J., Dieck, H.A., Saric, M. and Clarkson, A.B., 1993.** N-n-alkyl-3,4-dihydroxybenzamides as inhibitors of the trypanosome alternative oxidase: activity *in vitro* and *in vivo*. [*T. b. brucei*; mice.] *Antimicrobial Agents and Chemotherapy*, **37** (5): 1082-1085.

Clarkson: Department of Medical and Molecular Parasitology, New York University School of Medicine, 550 First Avenue, New York, NY 10016, USA.

8125 **Hirumi, H., Hirumi, K. and Peregrine, A.S., 1993.** Axenic culture of *Trypanosoma congolense*: application to the detection of sensitivity levels of bloodstream trypomastigotes to diminazene aceturate, homidium chloride, isometamidium chloride and quinapyramine sulphate. *Journal of Protozoology Research*, **3** (2): 52-63.

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

8126 **Jennings, F.W., Hunter, C.A., Kennedy, P.G.E. and Murray, M., 1993.** Chemotherapy of *Trypanosoma brucei* infection of the central nervous system: the use of a rapid chemotherapeutic regimen and the development of post-treatment encephalopathies. [Mice; diminazene.] *Transactions of the Royal Society of Tropical Medicine and Hygiene*, **87** (2): 224-226.

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

8127 **Kaminsky, R., Chuma, F. and Zweygarth, E., 1993.** *Trypanosoma congolense*: *in vitro* susceptibility of bloodstream forms to diminazene and isometamidium. *Experimental Parasitology*, **76** (2): 213-215.

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

8128 **Kaminsky, R., Zweygarth, E., Gumm, I.D. and Chuma, F., 1989.** *In vitro*-Assays zur Bestimmung der Medikamentenresistenz bei afrikanischen Trypanosomen. [Determination of drug resistance in African trypanosomes by means of *in vitro* assays.] [*T. b. brucei*; mice.] *Mitteilungen der Österreichischen Gesellschaft für Tropen-medicin und Parasitologie*, **11**: 47-54.

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

8129 **Murphy, N.B., Muthiani, A.M. and Peregrine, A.S., 1993.** Use of an *in vivo* system to determine the G418 resistance phenotype of bloodstream-form *Trypanosoma brucei brucei* transfectants. [Mice.] *Antimicrobial Agents and Chemotherapy*, **37** (5): 1167-1170.

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

8130 **Ndoutamia, G., Moloo, S.K., Murphy, N.B. and Peregrine, A.S., 1993.** Derivation and characterization of a quinapyramine-

- resistant clone of *Trypanosoma congolense*. *Antimicrobial Agents and Chemotherapy*, **37** (5): 1163-1166.
Peregrine: ILRAD, P.O. Box 30709, Nairobi, Kenya.
- 8131 **Zilberstein, D., Wilkes, J., Hirumi, H. and Peregrine, A.S., 1993**. Fluorescence analysis of the interaction of isometamidium with *Trypanosoma congolense*. *Biochemical Journal*, **292** (1): 31-35.
Peregrine: ILRAD, P.O. Box 30709, Nairobi, Kenya.
- 8132 **Zweygarth, E. and Kaminsky, R., 1989**. Chemotherapie Medikamenten-resistenter Trypanosomenstämme (*Trypanosoma brucei brucei*) mit DL- α -Difluormethylornithin. [Chemotherapy of drug-resistant *Trypanosoma* strains (*T. b. brucei*) with DL- α -difluoromethylornithine.] [*In vitro*, mice.] *Mitteilungen der Österreichischen Gesellschaft für Tropenmedizin und Parasitologie*, **11**: 55-64.
Zweygarth: P.O. Box 29231, Nairobi, Kenya.
8. trypanosome research
(a) CULTIVATION OF TRYPANOSOMES
(b) TAXONOMY, CHARACTERISATION OF ISOLATES
- 8133 **Dirie, M.F., Murphy, N.B. and Gardiner, P.R., 1993**. DNA finger-printing of *Trypanosoma vivax* isolates rapidly identifies intraspecific relationships. *Journal of Eukaryotic Microbiology* (formerly *Journal of Protozoology*), **40** (2): 132-134.
Gardiner: ILRAD, P.O. Box 30709, Nairobi, Kenya.
- 8134 **Stevens, J.R. and Cibulskis, R.E., 1990**. Analysing isoenzyme band patterns using similarity coefficients: a personal computer program. *Computer Methods and Programs in Biomedicine*, **33** (4): 205-212.
Laboratoire Génétique Moléculaire des Parasites et des Vecteurs, ORSTOM, B.P. 5045, F-34032, Montpellier, France.
- (c) LIFE CYCLE, MORPHOLOGY, BIOCHEMICAL AND MOLECULAR STUDIES
- 8135 **Alonso, G., Guevara, P. and Ramirez, J.L., 1992**. Trypanosomatidae codon usage and GC distribution. [Incl. *T. brucei*.] *Memórias do Instituto Oswaldo Cruz*, **87** (4): 517-523.
Centro de Biología Celular, Universidad Central de Venezuela, Apartado 47525, Caracas 1041A, Venezuela.
- 8136 **Asbroek, A.L.M.A. ten, Mol, C.A.A.M., Kieft, R. and Borst, P., 1993**. Stable transformation of *Trypanosoma brucei*. *Molecular and Bio-chemical Parasitology*, **59** (1): 133-142.
Borst: Division of Molecular Biology,

- Netherlands Cancer Institute, Plesmanlaan 121,
1066 CX Amsterdam, Netherlands.
- 8137 **Betbeder, D., Perie, J.-J., Baltz, T., Poirot, M. and Faye, J.-C., 1993.** Characterization of a benzyl-phenoxy-ethanamine binding protein in *Trypanosoma equiperdum* and the possible relation between binding affinity and trypanocidal activity. *Molecular and Biochemical Parasitology*, **58** (2): 311-316.
Faye: Département d'Endocrinologie, CHU Ranguéil, 31054 Toulouse Cedex, France.
- 8138 **Blum, M.L., Down, J.A., Gurnett, A.M., Carrington, M., Turner, M.J. and Wiley, D.C., 1993.** A structural motif in the variant surface glycoproteins of *Trypanosoma brucei*. *Nature*, **362** (6421): 603-609.
Blum: Department of Biological Chemistry and Molecular Pharmacology, Harvard Medical School, 240 Longwood Avenue, Boston, MA 02115, USA.
- 8139 **Bringaud, F. and Baltz, T., 1993.** Differential regulation of two distinct families of glucose transporter genes in *Trypanosoma brucei*. *Molecular and Cellular Biology*, **13** (2): 1146-1154.
Baltz: Laboratoire d'Immunologie et de Parasitologie Moléculaire, Université Bordeaux II, 146 rue Léo Saignat, 33076 Bordeaux Cedex, France.
- 8140 **Chung, H.-M.M., Lee, M.G.-S., Dietrich, P., Huang, J. and Ploeg, L.H.T. van der, 1993.** Disruption of largest subunit RNA polymerase II genes in *Trypanosoma brucei*. *Molecular and Cellular Biology*, **13** (6): 3734-3743.
Ploeg: Department of Genetics and Molecular Biology, Merck Research Laboratories, P.O. Box 2000, Rahway, NJ 07065, USA.
- 8141 **Coppens, I., Baudhuin, P., Oppendoes, F.R. and Courtoy, P.J., 1993.** Role of acidic compartments in *Trypanosoma brucei*, with special reference to low-density lipoprotein processing. *Molecular and Biochemical Parasitology*, **58** (2): 223-232.
Coppens: ICP-CELL 75.41, avenue Hippocrate 75, B-1200 Brussels, Belgium.
- 8142 **Divo, A.A., Patton, C.L. and Sartorelli, A.C., 1993.** Evaluation of rhodamine 123 as a probe for monitoring mitochondrial function in *Trypanosoma brucei* spp. *Journal of Eukaryotic Microbiology* (formerly *Journal of Protozoology*), **40** (3): 329-335.
Sartorelli: Comprehensive Cancer Center, Yale University School of Medicine, New Haven, CT 06510, USA.
- 8143 **Doering, T.L., Pessin, M.S., Hoff, E.F., Hart, G.W., Raben, D.M. and**

Englund, P.T., 1993. Trypanosome metabolism of myristate, the fatty acid required for the variant surface glycoprotein membrane anchor. [*T. brucei.*] *Journal of Biological Chemistry*, **268** (13): 9215-9222.

Englund: Department of Biological Chemistry, Johns Hopkins University School of Medicine, 725 N. Wolfe Street, Baltimore, MD 21205, USA.

8144 **Engstler, M. and Schauer, R., 1993.** Sialidases from African trypanosomes. [*T. brucei, T. vivax.*] (Review.) *Parasitology Today*, **9** (6): 222-225.

Biochemisches Institut, Christian-Albrechts-Universität, Olshausen-strasse 40, D-2300 Kiel 1, Germany.

8145 **Ferguson, M.A.J., 1992.** Site of palmitoylation of a phospholipase C-resistant glycosylphosphatidylinositol membrane anchor. [*T. brucei.*] *Biochemical Journal*, **284** (2): 297-300.

Department of Biochemistry, University of Dundee, Dundee DD1 4HN, UK.

8146 **Ferguson, M.A.J., Murray, P., Rutherford, H. and McConville, M.J., 1993.** A simple purification of procyclic acidic repetitive protein and demonstration of a sialylated glycosyl-phosphatidylinositol membrane anchor. [*T. brucei.*] *Biochemical Journal*, **291** (1): 51-55.

Ferguson: Department of Biochemistry, University of Dundee, Dundee DD1 4HN, UK.

8147 **Frevert, U. and Reinwald, E., 1988.** Combined endocytosis and immunoelectron microscopic studies in *Trypanosoma congolense*. *Institute of Physics Conference Series*, no. 93 (volume 3, chapter 11): 303-304.

Veterinary Biochemistry, Free University of Berlin, Königsweg 65, W-1000 Berlin 37, Germany.

8148 **Gale, M. and Parsons, M., 1993.** A *Trypanosoma brucei* gene family encoding protein kinases with catalytic domains structurally related to Nek1 and NIMA. *Molecular and Biochemical Parasitology*, **59** (1): 111-122.

Parsons: Seattle Biomedical Research Institute, 4 Nickerson Street, Seattle, WA 98109-1651, USA.

8149 **Gommers-Ampt, J.H., Teixeira, A.J.R., Werken, G. van der, Dijk, W.J. van and Borst, P., 1993.** The identification of hydroxymethyl-uracil in DNA of *Trypanosoma brucei*. *Nucleic Acids Research*, **21** (9): 2039-2043.

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

8150 **Gottesdiener, K.M., Goriparthi, L., Masucci, J.P. and Ploeg, L.H.T.**

- van der, 1992.** A proposed mechanism for promoter-associated DNA rearrangement events at a variant surface glycoprotein gene expression site. [*T. brucei*.] *Molecular and Cellular Biology*, **12** (10): 4784-4795.
Ploeg: Department of Genetics and Molecular Biology, Merck Research Laboratories, Rahway, NJ 07065, USA.
- 8151 **Hartshorne, T. and Agabian, N., 1993.** RNA B is the major nucleolar trimethylguanosine-capped small nuclear RNA associated with fibrillarin and pre-rRNAs in *Trypanosoma brucei*. *Molecular and Cellular Biology*, **13** (1): 144-154.
Intercampus Program in Molecular Parasitology, School of Pharm-acy, University of California, San Francisco, CA 94143-1204, USA.
- 8152 **Jackson, D.G., Windle, H.J. and Voorheis, H.P., 1993.** The identi-fication, purification, and characterization of two invariant surface glycoproteins located beneath the surface coat barrier of bloodstream forms of *Trypanosoma brucei*. *Journal of Biological Chemistry*, **268** (11): 8085-8095.
Voorheis: Department of Biochemistry, Trinity College, Dublin 2, Ireland.
- 8153 **Kessler, H., Matter, H., Geyer, A., Diehl, H.-J., Köck, M., Kurz, G., Oppendoes, F.R., Callens, M. and Wierenga, R.K., 1992.** Selective inhibition of trypanosomal triosephosphate isomerase by a thiopeptide. [*T. brucei*.] *Angewandte Chemie (International Edition in English)*, **31** (3): 328-330.
Kessler: Organisch-chemisches Institut der Technischen Universität München, Lichtenbergstrasse 4, D-W-8046 Garching, Germany.
- 8154 **L'Hostis, C., Geindre, M. and Deshusses, J., 1993.** Active transport of L-proline in the protozoan parasite *Trypanosoma brucei brucei*. *Biochemical Journal*, **291** (1): 297-301.
Deshusses: Department of Biochemistry, University of Geneva, 30 Quai E.-Ansermet, CH-1211 Geneva 4, Switzerland.
- 8155 **Mburu, P.W. and Beebee, T.J.C., 1993.** Preliminary characterisation and partial purification of ribosomal gene promoter-binding proteins from *Trypanosoma brucei*. *Biochimica et Biophysica Acta*, **1172** (1-2): 5-11.
Beebee: Biochemistry Department, University of Sussex, Falmer, Brighton BN1 9QG. UK.
- 8156 **Medina-Acosta, E. and Cross, G.A.M., 1993.** Rapid isolation of DNA from trypanosomatid protozoa using a simple 'mini-prep' procedure. [Incl. *T. brucei*.] *Molecular and Biochemical Parasitology*, **59** (2): 327-330.
Laboratory of Molecular Parasitology, Rockefeller University, 1230 York Avenue, New

York, NY 10021, USA.

8157 **Menon, A.K., Eppinger, M., Mayor, S. and Schwarz, R.T., 1993.** Phosphatidylethanolamine is the donor of the terminal phospho-ethanolamine group in trypanosome glycosylphosphatidylinositols. [*T. brucei.*] *EMBO Journal*, **12** (5): 1907-1914.

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

8158 **Myler, P.J., 1993.** Molecular variation in trypanosomes. (Review.) *Acta Tropica*, **53** (3-4): 205-225. Seattle Biomedical Research Institute, 4 Nickerson Street, Seattle, WA 98109-1651, USA.

8159 **Nok, A.J., Esievo, K.A.N., Ibrahim, S., Ukoha, A.I. and Ikediobi, C.O., 1993.** Phospholipase A₂ from *Trypanosoma congolense*: character-ization and²haematological properties. *Cell Biochemistry and Function*, **11** (2): 125-130.

Nok: Department of Biochemistry, Ahmadu Bello University, Zaria, Nigeria.

8160 **Parsons, M., Valentine, M. and Carter, V., 1993.** Protein kinases in divergent eukaryotes: identification of protein kinase activities regulated during trypanosome development. [*T. brucei.*] *Proceedings of the National Academy of Sciences of the United States of America*, **90** (7): 2656-2660.

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

8161 **Pellé, R. and Murphy, N.B., 1993.** Stage-specific differential poly-adenylation of mini-exon derived RNA in African trypanosomes. [*T. b. brucei.*] *Molecular and Biochemical Parasitology*, **59** (2): 277-286.

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

8162 **Raper, J., Doering, T.L., Buxbaum, L.U. and Englund, P.T., 1993.** Glycosyl phosphatidylinositols in *Trypanosoma brucei*. (Review.) *Experimental Parasitology*, **76** (2): 216-220.

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

8163 **Smith, J.L., Chapman, A.B. and Agabian, N., 1993.** *Trypanosoma vivax*: evidence for only one RNA polymerase II largest subunit gene in a trypanosome which undergoes antigenic variation. *Experimental Parasitology*, **76** (3): 242-246.

Agabian: Intercampus Program in Molecular Parasitology, University of California, Laurel Heights Campus, San Francisco, CA 94143-1204, USA.

8164 **Ullu, E., Matthews, K.R. and Tschudi, C., 1993.** Temporal

order of RNA-processing reactions in trypanosomes: rapid *trans* splicing precedes polyadenylation of newly synthesized tubulin transcripts. [*T. b. rhodesiense*.]

Molecular and Cellular Biology, **13** (1): 720-725.

Tschudi: Department of Internal Medicine, Yale McArthur Center for Molecular Parasitology, Yale University School of Medicine, 333 Cedar Street, New Haven, CT 06510-8056, USA.

8165 **Vellieux, F.M.D., Hajdu, J., Verlinde, C.L.M.J., Groendijk, H., Read, R.J., Greenhough, T.J., Campbell, J.W., Kalk, K.H., Littlechild, J.A., Watson, H.C. and Hol, W.G.J., 1993.** Structure of glycosomal glyceraldehyde-3-phosphate dehydrogenase from *Trypanosoma brucei* determined from Laue data. *Proceedings of the National Academy of Sciences of the United States of America*, **90** (6): 2355-2359.

Vellieux: IBS/LCCP, 41 avenue des Martyrs, 38027 Grenoble Cedex 1, France.

8166 **Vercesi, A.E., Moreno, S.N.J., Bernardes, C.F., Meinicke, A.R., Fernandes, E.C. and Docampo, R., 1993.** Thapsigargin causes Ca^{2+} release and collapse of the membrane potential of *Trypanosoma brucei* mitochondria *in situ* and of isolated rat liver mitochondria. *Journal of Biological Chemistry*, **268** (12): 8564-8568.

Docampo: Department of Veterinary Pathobiology, University of Illinois, 2001 S. Lincoln Avenue, Urbana, IL 61801, USA.

8167 **Verlinde, C.L.M.J., Rudenko, G. and Hol, W.G.J., 1992.** In search of new lead compounds for trypanosomiasis drug design: a protein structure-based linked-fragment approach. [*T. brucei*.] *Journal of Computer-Aided Molecular Design*, **6** (2): 131-147.

Verlinde: Bioson Research Institute, University of Groningen, Nijenborgh 4, 9747 AG Groningen, Netherlands.

8168 **Wierenga, R.K., Zeelen, J.P. and Noble, M.E.M., 1992.** Crystal transfer experiments carried out with crystals of trypanosomal triosephosphate isomerase (TIM). *Journal of Crystal Growth*, **122** (1-4): 231-234.

European Molecular Biology Laboratory, Meyerhofstrasse 1, D-W-6900 Heidelberg, Germany.

8169 **Willson, M., Callens, M., Kuntz, D.A., Perié, J. and Opperdoes, F.R., 1993.** Synthesis and activity of inhibitors highly specific for the glycolytic enzymes from *Trypanosoma brucei*. *Molecular and Biochemical Parasitology*, **59** (2): 201-210.

Opperdoes: Research Unit for Tropical Diseases, International Institute of Cellular and Molecular Pathology, avenue Hippocrate 74,

B-1200 Brussels, Belgium.

8170 **Wong, S., Kretsinger, R.H. and Campbell, D.A., 1992.**

Identification of a new EF-hand superfamily member from *Trypanosoma brucei*. *Molecular and General Genetics*, **233** (1-2): 225-230.

Campbell: Department of Microbiology and Immunology, University of California, Los Angeles, CA 90024, USA.

8171 **Wong, S., Morales, T.H., Neigel, J.E. and Campbell, D.A., 1993.**

Genomic and transcriptional linkage of the genes for calmodulin, EF-hand 5 protein, and ubiquitin extension protein 52 in *Trypanosoma brucei*. *Molecular and Cellular Biology*, **13** (1): 207-216.

Campbell: Department of Microbiology and Immunology, University of California, Los Angeles, CA 90024, USA.

8172 **Yarlett, N., Garofalo, J., Goldberg, B., Ciminelli, M.A., Ruggiero, V., Sufrin, J.R. and Bacchi, C.J., 1993.** S-adenosylmethionine synthetase in bloodstream *Trypanosoma brucei*. *Biochimica et Biophysica Acta*, **1181** (1): 68-76.

Yarlett: Haskins Laboratories and Biology Department, Pace University, New York, NY 10038, USA.

8173 **Yoshikawa, H., Furuki, J., Takahashi, Y., Morioka, H. and Yoshida, Y., 1992.** Distribution of filipin-sterol complexes in the bloodstream form of *Trypanosoma brucei gambiense*. *Journal of Electron Microscopy*, **41** (5): 364-368.

Yoshikawa: Department of Biology, Faculty of Science, Nara Women's University, Kitauoya-Nishimachi, Nara, 630 Japan.

8174 **Ziegelbauer, K., Stahl, B., Karas, M., Stierhof, Y.-D. and Overath, P., 1993.** Proteolytic release of cell surface proteins during differentiation of *Trypanosoma brucei*. *Biochemistry*, **32** (14): 3737-3742.

Ziegelbauer: Max-Planck-Institut für Biologie, Abteilung Membran-biochemie, Corrensstrasse 38, D-7400 Tübingen, Germany.