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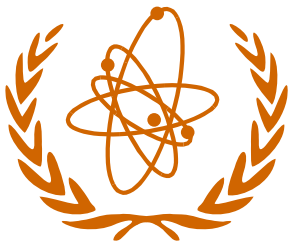

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SECTION B — ABSTRACTS

1. GENERAL (INCLUDING LAND USE)

6945 **Habtemariam, T., Ghartey-Tagoe, A., Mamo, E. and Robnett, V., 1988**. Epidemiologic modelling of diseases – a case example using *Schistosoma* and *Trypanosoma*. *Mathematical and Computer Modelling*, **11**: 244-249.

Biomedical Information Modelling Systems (BIMS), School of Vet-erinary Medicine, Tuskegee University, Tuskegee, AL 36088, USA.

Research to develop dynamic computer simulation models of two host-parasite systems involving *Trypanosoma* and *Schistosoma* were initiated in 1986. A knowledge base system for the two parasites was developed from published field data from the tropics. Systems analysis and simulation modelling were applied to describe the quantitative epidemiology of the parasites. Based on mechanistic decomposition of the components of the bio-epidemiologic systems, Forrester's flow diagrams were developed. Interactions between factors in the systems and variables required in the models were estimated from existing data resident in the computer based knowledge base system. Appropriate first order differential equations were set up to describe the dynamics of the models based on mass action theory. Simulation involved integrating birth and death rates, infection and recovery rates and other variables as they relate to population and resource changes, and fluctuations in environmental temperature and rainfall. Both C and FORTRAN languages were utilised in developing the computer models. Simulation studies of several alternatives for the control of the parasitic diseases are now being studied. Ultimately recommendations for the best strategy for the control of the two diseases will be provided. It is expected that the methodology developed in this research will be applied to comparable types of processes.

6946 **International Laboratory for Research on Animal Diseases, 1991**. *Annual scientific report 1990*. Nairobi; ILRAD. 111 pp.

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

Individual summaries of research work carried out by ILRAD staff and their collaborators during 1990 are presented. The trypanosomiasis research programme is divided into four project areas: epidemiology (22 summaries), biology and biochemistry (20 summaries), immunology (15 summaries), and resistance and pathogenesis (nine summaries). This report also lists the scientific publications and the papers presented by

staff at international meetings as well as the names, affiliations and research topics of visiting scientists who worked at ILRAD during the year.

6947 **Malawi Ministry of Health, 1987**. Trypanosomiasis. *Malawi Epidemio-logical Quarterly*, no. 1: 38 pp.
Ministry of Health, P.O. Box 30377, Capital City, Lilongwe 3, Malawi.

The importance of human and bovine trypanosomiasis is increasing in Malawi. International cooperation is vital and Malawi has joined a regional tsetse and trypanosomiasis control programme together with Mozambique, Zambia and Zimbabwe, with support from the EEC. *Glossina morsitans* is the predominant vector and the resurgence of the tsetse threat in Malawi is discussed (see no. 6949). Habitat alteration is seen as one of the most effective control measures although current programmes are based on intensive surveys and trials of odour-baited traps. *Trypanosoma brucei*, *T. congolense* and *T. vivax* infect cattle, the latter also occurring outside the tsetse belt where it is mechanically transmitted by other biting flies such as *Tabanus*. The pathological effects of bovine trypanosomiasis are briefly described. The trypanocides diminazene aceturate (Berenil) and isometamidium chloride (Samorin) are commonly used although vector control is seen as the most cost-effective means of combatting the disease. Game animals, especially waterbuck, kudu, reedbuck, eland and bushbuck, are important reservoir hosts. Wide-ranging animals, such as buffalo, commonly disperse the parasites to other areas. The occurrence, diagnosis and management of human trypanosomiasis are considered (see nos. 6978, 6979, 6981) and methods for field diagnosis by the examination of blood films and the microhaematocrit centrifugation test are described.

6948 **Overseas Development Administration and University of Bristol, 1991**. *Tsetse Research Laboratory annual report 1990*. Bristol; ODA and University of Bristol. 77 pp.
TRL, Langford House, Langford, Bristol BS18 7DU, UK.

The four main objectives of TRL are to undertake research into tsetse biology to improve or develop new methods of control, to maintain colonies of flies for research purposes, to provide facilities for visiting scientists and for training, and to advise ODA and other organisations on the provision of aid for tsetse research and control. Laboratory studies on the durability of pyriproxyfen and its fate once it enters the fly have supported the field trial in Zimbabwe

where pyriproxyfen-treated traps reduced tsetse populations. Attempts are being made to identify immunologically active substances which might be introduced into the host and have insecticidal activity when ingested by the fly. Specific aspects of behavioural research include landing behaviour, responses to ox skin secretion, possible learning or conditioning to host odours, trap- and target-related behaviour in the field, and possible changes in host attractiveness once infected with trypanosomes. The distribution of *Glossina medicorum* in Uganda is discussed. The number of rickettsia-like organisms in tsetse, and hence tsetse susceptibility to trypanosome infection, is affected by small temperature changes and global warming could exacerbate disease transmission. Studies on transmission are being carried out in Uganda (the role of domestic livestock as reservoir hosts), Zimbabwe (tsetse infection rates) and Kenya (the role of *G. longipennis* in the epidemiology of bovine trypanosomiasis). Other studies have concerned the characterisation and culture of *Trypanozoon* and *Nannomonas* trypanosomes, the pathogenicity of the three types of *Trypanosoma congolense* and the significance of the warthog as a reservoir host in The Gambia.

6949 **Pugh, R.N.H., 1987**. Resurgence of the tsetse threat in Malawi. *Malawi Epidemiological Quarterly*, no. 1: 6-10. (Article also submitted to the *Journal of the Medical Association of Malawi*.) (See also **14**: no. 6947.)

Queen Elizabeth Central Hospital, Blantyre, Malawi.

Sleeping sickness is under-reported in Malawi and more intensive surveys are required. The creation of game reserves earlier this century, to separate reservoir hosts from the human population, was initially effective but increasing population pressure has resulted in an encroachment into tsetse habitats and a concomitant increase in the numbers and range of the flies and the incidence of disease. A national tsetse and trypanosomiasis control project has been initiated as part of a regional programme involving Malawi, Mozambique, Zambia and Zimbabwe. Beginning in 1986, the first three years were to include surveys, training to improve diagnosis and treatment, epidemiological studies to assess the nature of symptomless *Trypanosoma brucei rhodesiense* infections, a study of reservoir hosts, and vector control methods including a major trial of odour-baited targets impregnated with residual insecticide. In the interim, livestock were to be protected with an improved supply of trypanocides.

2. TSETSE BIOLOGY

(a) REARING OF TSETSE FLIES

(b) TAXONOMY, ANATOMY, PHYSIOLOGY, BIOCHEMISTRY

[See also **14**: nos. 6965, 6973.]

6950 **Denlinger, D.L. and Zdárek, J., 1991**. Commitment to metamorphosis in tsetse (*Glossina morsitans centralis*): temporal, nutritional and hormonal aspects of the decision. *Journal of Insect Physiology*, **37** (5): 333-338. ICIPE, P.O. Box 30772, Nairobi, Kenya; Denlinger: also Department of Entomology, Ohio State University, 1735 Neil Avenue, Columbus, OH 43210, USA; Zdárek: also Institute of Organic Chemistry and Biochemistry, Czechoslovak Academy of Sciences, U Salamounky 41, 158 00 Prague 5, Czechoslovakia.

Larvae of *G. m. centralis* were manually extruded from the uterus of the female at different times during the third (final) larval instar to evaluate their competence to initiate metamorphosis. Parturition is a gated response in tsetse, and in this species the peak of activity occurred 8.7 h after the onset of the daily 12 h photophase. Larvae aborted a few hours prematurely were completely competent to crawl and pupariated within 1-2 h, but a portion of the puparia blackened before tanning. Younger larvae (22.9 mg *v.* full grown weight of 33.6 mg) were also competent to crawl, but after 1-2 h they became immobile and they performed retractory movements with their anterior segments for up to several days before eventually pupariating. The youngest category of larvae (17.5 mg) were incapable of crawling but continuously performed retractory movements with their anterior segments. Such larvae never succeeded in pupariating. The commitment to various components of metamorphosis is thus made at different stages of ontogenetic development. Some behavioural components such as retraction of the anterior segments are established relatively early, but the integument is fully competent for normal phenolic tanning only near the end of the instar. Commitment to metamorphosis is thus made much later in tsetse larvae than in free-living larvae of other species of Diptera, presumably as an adaptation to the vagaries imposed by adenotrophic viviparity. Pupariation could be accelerated in aborted larvae by injection of 20-hydroxyecdysone, thus implying that the delay in pupariation of aborted larvae may be, at least partially, the consequence of moulting hormone deficiency.

6951 **Gibson, G. and Young, S., 1991**. The optics of tsetse fly

eyes in relation to their behaviour and ecology. *Physiological Entomology*, **16** (3): 273-282.
Department of Medical Parasitology, LSHTM, Keppel Street, London WC1E 7HT, UK; Imperial College, Silwood Park, Ascot, Berkshire SL5 7PY, UK.
The visual acuity of two species of tsetse flies, *Glossina morsitans morsitans* and *G. pallidipes*, was investigated. Male *G. morsitans* eyes have an acute zone in the forward region, with large hexagonal lenses (mean minimum diameter, D = 33, SE □ 0.7 μm), relatively small interommatidial angle ($\Delta\phi$ = 1.08□) and angular receptive field of individual ommatidia ($\Delta\rho$) of not less than 1.14□. A narrow band of square lenses, with intermediate diameter and $\Delta\phi$, merges with smaller hexagonal lenses in the periphery (24 □ 0.7 μm), with relatively large interommatidial angle ($\Delta\phi$ = 3.7□) and small angular receptive field ($\Delta\rho$ = *c*. 1.6□). *G. pallidipes* eyes are similar, except that the lenses in the acute zone are larger than those of *G. morsitans*, in proportion to their larger body size. Female eyes are not significantly different from male eyes, except that they have a narrower region of binocular overlap (maximum for males = 24□, for females = 18□). The eye parameter ($p = D\Delta\phi$) in the acute zone of male *G. morsitans* = 0.62, and in the peripheral zone = 1.56. These relatively high values are consistent with fast flight, visual detection of drift due to low wind speeds, mating chases and discrimination of cryptic host animals at high light intensities. The extended region of binocular overlap in males may serve as an early warning system of the approach of potential females. From our estimates, tsetse flies ought to be able to detect small objects against the sky *c*. 30 min before sunrise and after sunset, and to use their peripheral vision perhaps 15 min earlier and later than this.
6952 **Gooding, R.H., Moloo, S.K. and Rolseth, B.M., 1991**. Genetic variation in *Glossina brevipalpis*, *G. longipennis* and *G. pallidipes*, and the phenetic relationships of *Glossina* species. *Medical and Veterinary Entomology*, **5** (2): 165-173.
Gooding, Rolseth: Department of Entomology, University of Alberta, Edmonton, Alberta, T6G 2E3 Canada; Moloo: ILRAD, P.O. Box 30709, Nairobi, Kenya.
G. brevipalpis, *G. longipennis* and *G. pallidipes*, maintained at ILRAD, Nairobi, Kenya, were examined for genetic variation of 14 enzyme loci, using polyacrylamide gel electrophoresis. *G. brevipalpis* had six polymorphic loci, an average of 1.46 effective alleles per locus and a mean heterozygosity per locus of 20.0□ 7.1%. The

figures for the same parameters in *G. longipennis* were 3, 1.16 and 8.2 4.9%, and for *G. pallidipes* the figures were 7, 1.40 and 22.3 6.3%. Seven rare alleles were lost from the *G. brevipalpis* colony during a 1-year period, but no statistically significant changes were observed in the genetics of the colony during this period. Using allele frequency data for ten of the enzymes studied, and frequencies for these enzymes in other taxa, a phenogram was constructed that indicated that the subgenus *Austenina* (i.e. the *fusca* group) is the oldest of the three subgenera within the genus *Glossina*, and that the subgenus *Glossina s.str*. (i.e. the *morsitans* group) may be paraphyletic.

6953 **Howe, M.A., 1987**. *Thermoregulation in blood-sucking flies*. Ph.D. thesis, University of Wales, Bangor, UK. (Unpublished thesis.) 433 pp.

Post-feed buzzing in *Glossina morsitans morsitans* is an endothermic mechanism. The increase generated in thoracic temperature (Tth) is three times greater than the increase in abdominal temperature (Tab). The mean rate of thoracic warm-up is 8.3C min^{-1}, with a maximum of 15C min^{-1}. Rate is affected by ambient temperature (Ta). Tth is raised to the optimum for flight of 32C and increases the lift which the fly can produce by between 4.66 and 30.64%, depending upon Ta. Physiological heat transfer is implied by the concentration of heat in the thorax during warm-up, the increase in Tab occurring after Tth starts to fall, facilitated cooling rates and the heating traces of live and dead flies. Shunting of heat to the abdomen may explain why buzzing flies excrete excess water from the bloodmeal more rapidly than non-buzzing flies. Rapid excretion will reduce the wing-load but achieving a temperature excess (Tex) in the thorax appears to be more important. Cooling rates are lower than predicted and the energetic costs of endothermy are small. When Tth equals Ta, flight results in an increase in Tth, although the actual rise and the rate of increase are much less than those achieved by endothermy.

6954 **Otter, C.J. den, Tchicaya, T. and Schutte, A.M., 1991**. Effects of age, sex and hunger on the antennal olfactory sensitivity of tsetse flies. *Physiological Entomology*, **16** (2): 173-182.

Otter, Schutte: Department of Animal Physiology, University of Groningen, P.O. Box 14, 9750 AA Haren, Netherlands; Tchicaya: IEMVT, 10 rue Pierre Curie, 94704 Maisons-Alfort Cedex, France.

The effects of age on electroantennogram (EAG)

responses were investigated in male and female *Glossina morsitans morsitans* and comparative studies on the effects of starvation and sex on the EAG in *G. m. morsitans*, *G. austeni*, *G. tachinoides* and *G. fuscipes fuscipes* were made. Stimuli were the vapours of 1-octen-3-ol, 4-heptanone, 3-nonanone and acetone. EAG decreased with age in both sexes of *G. m. morsitans*, responses in 5-day-old flies already being significantly lower than those in 1-day-old flies. In *G. m. morsitans* and *G. tachinoides*, EAG responses of males were higher than those of females. In *G. austeni* and *G. f. fuscipes*, however, the reverse was found. With increasing starvation EAG sensitivity increased in both sexes of *G. m. morsitans* and *G. tachinoides*. In *G. austeni* and in *G. f. fuscipes* no clear effects of starvation were observed. Response spectra of the individual species to the four odour substances did not change with increasing hunger. It is concluded that receptor sensitivity may be modulated depending on the insect's needs. Possible mechanisms of regulation and significance of this modulation are discussed.

6955 **Robert, A., Strambi, A. and Strambi, C., 1990**. Ecdysteroids in tsetse fly. (Meeting abstract.) *Invertebrate Reproduction and Development*, **18** (1-2): 126.

Université de Masuku, Gabon; CNRS, LNB5, Marseille, France; ibid.

In the haemolymph of this viviparous insect, we observed a small increase of RIA (radio-immunoassay) immunoreactive compounds during vitellogenesis and a large peak at the end of pregnancy, a few hours before larviposition. According to HPLC data, the immunoreactive material corresponds to ecdysone, 20-hydroxyecdysone and unidentified highly polar and apolar products. In the ovaries only highly polar compounds are detectable. The relative proportions of the different immunoreactive compounds varied in the haemolymph according to the physiological condition of the females; at the time of parturition, the proportion of ecdysone increased noticeably. An *in vitro* study revealed opposite effects of ecdysone and 20-hydroxyecdysone on the motility of the isolated uterus. A specific action of ecdysteroids on a nerve-muscle target is involved in this species.

6956 **Samie, M., 1989**. *Carbohydrate analysis in* Phlebotomus papatasi *and* Glossina palpalis palpalis *using high performance liquid chromatography (HPLC)*. M.Sc. thesis, University of Salford, UK. (Unpublished thesis.)

A mixture of male and female *G. p. palpalis* was divided into equal groups of four flies each and fed on rabbit

blood for 10 minutes. Immediately after feeding, and for up to 5 days subsequent starvation, the carbohydrate content of the flies was analysed by HPLC. One (unfed) group was used as a control. Sugar phosphates, lactic acid and glucose were detected in rabbit blood and in most of the flies fed on rabbit blood. Pyruvate and fructose, which were not present in the rabbit blood, were observed in some fed flies. Peaks with relative retention time similar to trisaccharides were also demonstrated in unfed flies and in most of the flies starved for up to 5 days after feeding, although they were not detected in rabbit blood. In some instances compounds were present that eluted with relative retention times between those of di- and trisaccharides.

6957 **Stiles, J.K., Wallbanks, K.R. and Molyneux, D.H., 1991**. The use of casein substrate gels for determining trypsin-like activity in the midgut of *Glossina palpalis* spp. (Diptera: Glossinidae). *Journal of Insect Physiology*, **37** (4): 247-254. Department of Biological Sciences, University of Salford, Salford M5 4WT, UK.

Trypsin-like activities in the midguts of *Glossina palpalis* subspecies fed on different diets or exposed to 130 Gy (13 krad) γ-irradiation (Co^{60}) were determined by measuring their casein-lytic activity in casein substrate gels. Proteases were detected only in the posterior midguts of the flies examined, with generally higher levels in *G. p. palpalis*. The anterior midgut contained a subspecies-specific inhibitor of trypsin-like activity. Peaks of protease activity occurred later and were lower in irradiated flies than in control flies. The significance of the casein method in determining midgut proteases of blood-feeding Diptera is described.

6958 **Tarimo Nesbitt, S.A., 1991**. Enzyme polymorphism in *Glossina longi-pennis* (Diptera: Glossinidae). *Canadian Journal of Zoology*, **69** (3): 807-808. ICIPE, P.O. Box 30772, Nairobi, Kenya.

Adult *G. longipennis*, collected at Nguruman, Kenya, were examined electrophoretically for variation in esterase, octanol dehydrogenase, malate dehydrogenase, manganese-stimulated malate dehydrogenase, arginine phospho-kinase, and hexokinase. Variation was found in the first two enzymes, and the banding patterns indicated that the loci for these enzymes are on autosomes. The mean heterozygosity per locus was 4.5%.

6959 **Weyda, F., Soldán, T. and Matha, V., 1991**. Structural and quantitative changes in *Glossina palpalis palpalis* mycetome

after gamma irradiation (Diptera, Glossinidae). *Acta Entomologica Bohemoslovaca*, **88** (2): 95-102.
Institute of Entomology, Czechoslovak Academy of Sciences, Branisovská 31, 370 05 Ceské Budejovice, Czechoslovakia.
Puparia of *G. p. palpalis* were irradiated with 14 krad of gamma rays at 7 days old and the mycetomes (groups of specialised midgut cells containing endosymbiotic bacterioids) of the adult flies were examined 1, 3, 6, 10, 14, 18 and 22 days post-emergence. The endosymbionts in some parts of the mycetome became increased in diameter and randomly distributed, in contrast to the regular transverse rows seen in non-irradiated controls. No ultrastructural differences between enlarged and unaffected endosymbionts were observed. The number of endosymbionts was slightly but significantly reduced in irradiated flies, although rickettsia-like organisms in mycetomes and some other organs appeared to become more numerous. These changes were apparent 3 days post-emergence and were similar in young and older flies of both sexes. It is concluded that irradiation at the dosage currently used in SIT does not seriously damage mycetomes and mycetome disintegration observed in laboratory stocks should be attributed to other factors.

(c) DISTRIBUTION, ECOLOGY, BEHAVIOUR, POPULATION STUDIES

[See also **14**: no. 6951.]

6960 **Blanc, F., Gouteux, J.P., Cuisance, D., Pounekrozou, E., N'Dokoué, F. and Le Gall, F., 1991**. Etude de la répartition des tsé tsé (Diptera: Glossinidae) en zone de savane humide (République Centrafricaine). Evaluation de techniques de prospection entomologique. [Study of tsetse distribution in the humid savanna zone (Central African Republic): evaluation of entomological survey techniques.] *Tropical Medicine and Parasitology*, **42** (2): 127-130.
Blanc, Pounekrozou, N'Dokoué, Le Gall: Agence Nationale de Développement de l'Elevage, Bangui, Central African Republic; Gouteux: ANDE/ORSTOM, Service de l'Entomo-Protozoologie, B.P. 893, Bangui, Central African Republic; Cuisance: IEMVT/CIRAD, Centre ORSTOM de Montpellier, France. (Correspondence to Gouteux.)
Two trapping methods were compared during a survey of the distribution of tsetse flies (*Glossina fuscipes fuscipes*) in the Mbororo cattle breeding area of the Central African Republic: (a) several traps dispersed

throughout the riverine forest galleries and remaining only one day at each site; (b) one sentinel trap placed at the cattle drinking point and remaining for several days. The latter method was more reliable and is therefore recommended. The concentration of tsetse flies at the drinking points was negligible during the rainy season.

6961 **Brady, J., 1991**. Seeing flies from space. *Nature*, **351** (6329): 695.

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

Recent attempts to accelerate the development of effective tsetse control in Africa are briefly reviewed. Rainfall data from meteorological satellites expressed as the normalised difference vegetation index (NDVI), which indicates the level of photosynthetic activity and thus vegetation cover, have been used to reveal areas of maximum tsetse infestation (see no. 6966). NDVIs averaged over several years in the 1980s correlate well with long-term tsetse surveys carried out in the 1970s and earlier. Seasonally changing NDVIs relate to the tsetse population of each following month, and annually averaged NDVIs indicate geographically where tsetse survival rate will be highest. Large-scale use of pyrethroid insecticide-impregnated targets is planned for tsetse eradication in the fly belt which runs through countries south of Malawi. The use of NDVIs to identify high infestation zones will help to optimise target placement.

6962 **Brady, J., 1991**. Flying mate detection and chasing by tsetse flies (*Glossina*). *Physiological Entomology*, **16** (2): 153-161.

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

Male tsetse flies, probably *Glossina morsitans morsitans*, were video-recorded in the field as they took off and chased other tsetse flies. Chasers responded (took off) to a target fly at a maximum distance of *c*. 55 cm, when it subtended *c*. 1.6° to their eye (1 foveal ommatidial subtense). Chased targets were always within this range (mean subtense at take-off = 3.2°) and approaching the chaser. The most significant difference between chased and non-chased targets was in the rate of approach of the target fly in terms of the increase in its image size immediately before the chaser took off (x 21° s^{-1}), especially as its relative increase (x 690% s^{-1}, $P < 0.005$). No feature of the target's translational velocity, nor any relationship between that and the image size, approached this level of significance. Chasers seemed to `slipstream' their target at *c*. 20 cm directly behind it, perhaps suggesting target identification by speed matching. Chases were apparently abandoned when the target image shrank from covering at least two of the chaser's

foveal ommatidia to covering only one. Parallax-free measurements of flight speeds indicated a preferred, stable mean groundspeed of 4.8 □ 0.1 m s^{-1} (SE), at a mean wing-beat frequency of 209 □ 3 Hz.

6963 **Jaenson, T.G.T., Barreto dos Santos, R.C. and Hall, D.R., 1991**. Attraction of *Glossina longipalpis* (Diptera: Glossinidae) in Guinea-Bissau to odor-baited biconical traps. *Journal of Medical Entomology*, **28** (2): 284-286.

Section of Entomology, Department of Zoology, University of Uppsala, Box 561, S-75122 Uppsala, Sweden; Programa Desenvolvimento Rural Integrado da Zona 1, Centro Olof Palme, Bula, Guinea-Bissau; NRI, Central Avenue, Chatham Maritime, Chatham, Kent ME4 4TB, UK.

The catches of tsetse flies, *Stomoxys* and tabanids in biconical traps baited with different synthetic odours were compared in the Jopá-Cobiana Forest, north-western Guinea-Bissau. Thirty-six traps, the baits of which were randomly interchanged each of 10 sampling days, were baited either with (a) 1-octen-3-ol (octenol) + phenols [4-methylphenol + 3-propylphenol] + acetone + N'Dama cow urine (`urine'), (b) octenol + phenols + acetone, (c) octenol + phenols, (d) acetone, (e) acetone + urine, or (f) urine. Six of the traps were not baited (controls). A total of 3172 tsetse flies (96% *G. longipalpis*, 3% *G. morsitans submorsitans* and 1% *G. palpalis gambiensis*), 286 *Stomoxys* and 571 Tabanidae was captured. *G. longipalpis* was caught in statistically greater numbers in traps baited with octenol + phenols + acetone. Traps baited with octenol + phenols, with or without acetone, caught the greatest numbers of tabanids. N'Dama urine did not increase the catch of *G. longipalpis*. *Stomoxys* was not significantly attracted to any of the odours.

6964 **Msangi, A. and Lehane, M.J., 1991**. A method for determining the age of very young tsetse flies (Diptera: Glossinidae) and an investigation of the factors determining head fluorescent levels in newly emerged adults. *Bulletin of Entomological Research*, **81** (2): 185-188.

School of Biological Sciences, University of Wales, Bangor, Gwynedd LL57 2UW, UK. (Correspondence to Lehane.)

The new age determination technique for tsetse flies based on the accumulation of fluorescent pigments in the head capsule has the minor problem that it is not possible to identify accurately very young flies. In this paper we describe a technique for the

identification of very young *Glossina morsitans morsitans* based on their high levels of abdominal fluorescence. Under our holding conditions these fall back in a linear fashion to a minimum at 5 days post-emergence. The variability in the levels of head fluorescence at eclosion is influenced mainly by the size of the emerging fly, with the number of blood meals taken by the female parent, and intra-uterine larval and puparial periods of the emerging flies, also playing a part.

6965 **Randolph, S.E., Rogers, D.J. and Kiilu, J., 1991**. The feeding behaviour, activity and trappability of wild female *Glossina pallidipes* in relation to their pregnancy cycle. *Medical and Veterinary Entomology*, 5 (3): 335-350.
Department of Zoology, University of Oxford, South Parks Road, Oxford OX1 3PS, UK; ibid.; ICIPE, P.O. Box 30772, Nairobi, Kenya.

Female *G. pallidipes* trapped with baited NG2B traps were subjected both to detailed ovarian dissection and to nutritional analysis. Using a calibration curve derived from dissected wild-caught, laboratory-held flies, the field females were assigned by discriminant analysis to each day of the pregnancy cycle. Field females were most available to NG2B traps while carrying the first-instar larva. The nutritional characteristics of trapped field females over the pregnancy cycle lead to the following main conclusions. (i) Fat levels increase most rapidly during the egg *in utero* stage, while corrected residual dry weight increases significantly only during the larval stages, culminating in a 4 mg increase during the last day of the third larval instar. (ii) The haematin content of the flies indicates that females feed at approximately 3-day intervals and may feed on any day of the pregnancy cycle. (iii) The estimated time of feeding during the day corresponds with the observed time of peak activity, both of which are earlier in the day later in the pregnancy cycle. (iv) The rate of fat usage reveals significantly greater flight activity on day 5 of the cycle than on other days, agreeing with the high trappability on this day, and overall females appear to use fat at twice the rate of males. Reproductive data provide a much more accurate picture of the relative sampling efficiency than do nutritional data, although the latter reveal the general trends correctly.

6966 **Rogers, D.J. and Randolph, S.E., 1991.** Mortality rates and population density of tsetse flies correlated with

satellite imagery. *Nature*, **351** (6329): 739-741.
Department of Zoology, University of Oxford, South Parks Road, Oxford OX1 3PS, UK.
Meteorological satellites can be used to produce normalised difference vegetation indices (NDVIs) related to photosynthetically active radiation and vegetation type on continental scales. A correlation is shown between the mortality rate of *Glossina morsitans* and the NDVI of the previous month in Nigeria. *G. palpalis* was studied along a 700 km north-south transect in Côte d'Ivoire and Burkina Faso in the wet and dry seasons of 1983-84. Fly populations were sampled at eight sites using biconical traps and analysed for size, age and nutritional condition. There was a significant relationship between size and NDVI in the dry season when the more northerly sites had smaller flies. Decreases in tsetse size are associated with increased mortality. A survey carried out in the savanna zone of Côte d'Ivoire during 1979-80 showed a relationship between the abundance of *G. palpalis* and *G. tachinoides* and NDVI values. *G. palpalis* numbers peaked in the mid to high part of the NDVI range whereas those of *G. tachinoides* were highest at the low end of the NDVI range. This analysis suggests that remote sensing can be used to predict levels of tsetse mortality and abundance and to produce maps of high risk areas of disease transmission.

3. TSETSE CONTROL (INCLUDING ENVIRONMENTAL SIDE-EFFECTS)

[See also **14**: nos. 6945, 6959, 6961.]

6967 **Brightwell, R., Dransfield, R.D. and Kyorku, C., 1991**.
Development of a low-cost tsetse trap and odour baits for *Glossina pallidipes* and *G. longipennis* in Kenya. *Medical and Veterinary Entomology*, **5** (2): 153-164.
Department of Zoology, University of Oxford, South Parks Road, Oxford OX1 3PS, UK; ICIPE, P.O. Box 30772, Nairobi, Kenya; ibid.
Experiments were carried out to improve the NG2B tsetse trap, baited with acetone and cow urine, for use by rural communities to control *G. pallidipes* and *G. longipennis*. Modifications included a lower dose rate of acetone, a new cage design and raising the trap about 15-20 cm. Research on different trap cone materials showed that the degree of light transmission of the netting, rather than its colour, was the crucial factor affecting the catch of *G. pallidipes*. Adding an additional metre of blue cloth to one side of the trap increased catches of

females of both species by about 60%. Traps with synthetic phenols yielded similar numbers of *G. pallidipes* and significantly more *G. longipennis* than those baited with natural cow urine. The latter difference was not apparent when octenol was also used, so cow urine was retained as one of the odour baits in preference to the imported phenols. Although octenol increased catches of *G. pallidipes* by only about 30%, catches of *G. longipennis* were increased 2-4-fold, making it a very useful attractant for the latter species. The cost of the trap/odour-bait system was estimated to be US$8.5 per unit per annum. The economics of this method of tsetse control are discussed.

6968 **Löhr, K.-F., Omukuba, J.N., Njogu, A.R., Maloo, S.H., Gisemba, F., Okedi, T. and Mwongela, S., 1991**. Investigation of the efficacy of flumethrin pour-on for the control of high tsetse and trypanosomiasis challenge in Kenya. *Tropical Medicine and Parasitology*, **42** (2): 131-134.

Löhr, Omukuba, Maloo, Gisemba, Mwongela: Department of Veterinary Services, Veterinary Investigation Laboratory, P.O. Box 204, Mariakani, Kenya; Njogu, Okedi: KETRI, P.O. Box 362, Kikuyu, Kenya.

The effects of bi-weekly flumethrin pour-on treatments at 1 mg/kg bodyweight on tsetse fly population and trypanosome infection rates were monitored over a one-year period (February 1989 to February 1990) in 2000 head of cattle on a trial farm, located in the Lamu District in East Kenya, an adjacent control farm and a transecting road for additional fly monitoring. The tsetse fly population on the trial farm dropped from pre-treatment counts of 118 flies/trap/week in February 1989 to 13 in June 1989 and 32 in January 1990. During the same period and months the fly population on the control farm was 90, 34 and 87 flies/trap/week. Fly counts on the transecting road, however, increased from 72, 53 to 163 flies/trap/week. The impact of tsetse fly control is clearly reflected in the reduction of trypanosome infection rates on the trial farm, e.g. 37% (pre-treatment infection rate), 10% and 11% in January, June and December 1989 respectively. On the control farm the infection rates remained at distinctly higher levels of 34%, 17% and 24% during the same period. Mean weekly weight gains were 66% higher in the treated herd as compared to the untreated control herd.

6969 **Wall, R. and Langley, P., 1991**. From behaviour to control: the development of trap and target techniques for tsetse fly population management. *Agricultural Zoology Reviews*, **4**: 137-159.

TRL, University of Bristol, Langford, Bristol BS18 7DU, UK.
Tsetse control is seen as one of the primary long-term means of controlling African human and animal trypanosomiasis. In this review article the advantages and disadvantages of different control methods are assessed. Cost, effectiveness, environmental acceptability and appropriate technology have motivated a recent return to favour of traps and targets. The relative merits of different designs are discussed, including biconical and monoconical traps, the cubic `F3' trap, the triangular `epsilon' trap, the R-type target with protective roof and counterbalanced pivot and the simpler and more efficient S-type target. The exploitation of tsetse olfactory responses, vision, food acquisition and mating behaviour for the construction of efficient traps and targets is reviewed, including the use of pyriproxyfen as an effective chemosterilant. Traps and targets offer the possibility of continuously suppressing tsetse populations to the point where the transmission of trypanosomiasis is minimised. Costs can be reduced by involving rural communities in their construction and maintenance.

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

[See also **14**: nos. 6957, 6963, 6982, 6983, 6995, 7034.]

6970 **Khot'ko, N.I., 1988**. [Some epidemiological aspects of *gambiense* trypanosomiasis in southern Africa.] (In Russian.) *Meditsinskaya Parazitologiya i Parazitarnye Bolezni*, **1988** (5): 15-19.

All-Union Anti-Plague Research Institute, `Mikrob', Saratov, USSR.

The author presents an analysis of the literature on *gambiense* trypanosomiasis in southern Africa. Epidemiological and transmission data, including tsetse distribution, for Angola are given. Analysis of the number of cases detected in relation to the number of individuals investigated showed that intensified screening does not lead to increased case detection. Age-, sex- and occupation-related differences in the prevalence and risk of infection are described. These data were used to prepare and implement a control programme.

6971 **Rawlings, P., Dwinger, R.H. and Snow, W.F., 1991**. An analysis of survey measurements of tsetse challenge to trypanotolerant cattle in relation to aspects of

analytical models of trypanosomiasis. *Parasitology*, **102** (3): 371-377.
48 St John's Road, Bristol BS8 2HG, UK; ITC, P.M.B. 14, Banjul, Gambia; ibid.
The recent development of analytical models of trypanosomiasis has increased the general applicability of models to the strategic control of the disease. An analysis of detailed data on tsetse abundance and infection rates and trypanosome prevalence in village-based trypanotolerant cattle over 4 years in The Gambia showed that seasonal patterns of abundance in *Glossina morsitans*-infested areas were consistent, and that the rates of trypanosome infection remained relatively unchanging. However, there were two distinct seasonal trypanosome prevalence patterns in cattle, with peaks occurring either in May/June/July or November/December. The peaks of trypanosome prevalence therefore occurred either 4 months before or after the times of peak challenge from *G. morsitans*; not 1 or 2 months after as predicted by analytical models. In *G. palpalis*-infested areas there was little seasonal variation in abundance or trypanosome infections, but peak trypanosome prevalence still occurred mostly in June/July. Despite the incongruity between the months of peak prevalence and challenge, the overall annual prevalence rates and tsetse challenge indices showed a significant linear relationship. It is concluded that existing analytical models need to be refined to take into account trypanotolerance and the various influences on the expression of this trait.
6972 **Shaw, M.K. and Moloo, S.K., 1991**. Comparative study on Rickettsia-like organisms in the midgut epithelial cells of different *Glossina* species. *Parasitology*, **102** (2): 193-199.
ILRAD, P.O. Box 30709, Nairobi, Kenya.
The midgut epithelium of *Glossina morsitans centralis*, *G. austeni*, *G. pallidipes*, *G. palpalis palpalis*, *G. p. gambiensis*, *G. fuscipes fuscipes*, *G. tachinoides* and *G. brevipalpis* from ILRAD-bred colonies was examined, by electron microscopy, for the presence and distribution of rickettsia-like organisms (RLOs). RLOs were present in the midgut epithelial cells of all non-teneral tsetse. In *G. m. centralis*, *G. pallidipes* and, to a much lesser extent, *G. brevipalpis*, RLOs were numerous and were present in all the specimens examined. RLOs were present in fewer numbers in the epithelial cells of tenerals of these three tsetse species. In contrast, RLOs occurred in very much lower numbers within the midgut cells of non-teneral *G. austeni*, *G. p. palpalis*, *G. p.*

gambiensis, *G. f. fuscipes* and *G. tachinoides*, were not seen in every specimen, and were rarely observed in the midgut cells of teneral tsetse. The RLOs were typical rod-shaped bacteria with an inner and outer membrane, which occurred free within the host cell cytoplasm and appeared to cause no obvious pathology. The micro-organisms divided by binary fission and at least two distinct morphological forms plus a range of intermediate forms were seen in the midgut cells. A comparison of the presence and numbers of RLOs within the midgut and the midgut infection rates of both *Trypanosoma congolense* and *T. b. brucei*, both between *Glossina* species and also within the same stock of tsetse, clearly indicates that the ability of trypanosomes to establish and develop to mature infections is unlikely to be correlated solely with the presence of RLOs within the tsetse midgut.

6973 **Stiles, J.K., 1990**. *Studies on* Glossina-*trypanosome interactions*. Ph.D. thesis, University of Salford, UK. (Unpublished thesis.)

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

The midgut ultrastructure was examined in normal and γ-irradiated *Glossina palpalis* sspp. The ultrastructure of trypanosomes and intracellular endosymbionts, rickettsia-like organisms and virus-like particles was also studied in both groups of flies. Midgut biochemistry, particularly proteases trypano-agglutinins and trypanolysin, was studied using casein substrate gels, fast protein liquid chromatography (FPLC) and SDS polyacrylamide gel electrophoresis. The characteristics of these biochemicals and their influence on *Trypanosoma brucei brucei* and *T. congolense* development *in vitro* and *in vivo* were determined and are discussed. The effects of γ-irradiation at SIT levels on these substances were also assessed. A study of the interaction of *T. vivax* and *T. congolense* in axenic culture, or with mosquito cell (os 60) culture with or without acetyl chitosan gel, was undertaken. The relevance of the results to current knowledge of trypanosome transmission and tsetse susceptibility is discussed.

6974 **Welburn, S.C. and Maudlin, I., 1991**. Rickettsia-like organisms, puparial temperature and susceptibility to trypanosome infection in *Glossina morsitans*. *Parasitology*, **102** (2): 201-206.

TRL, ODA/University of Bristol, Langford House, Langford, Bristol BS18 7DU, UK. (Reprint requests to Maudlin.)

Maintaining the puparial stage of successive generations of a population of tsetse 3□C lower than normal reduced the numbers of rickettsia-like organisms (RLOs) carried by emerging flies. The susceptibility of these flies to midgut infection with *Trypanosoma congolense* was also significantly reduced compared with control flies held at normal temperature. These results support the view that the relationship between RLOs and susceptibility is quantitative, teneral flies with heavier RLO infections being more susceptible to trypanosome infection.

5. HUMAN TRYPANOSOMIASIS

(a) SURVEILLANCE

6975 **Cattand, P.D., 1987**. *Human African trypanosomiasis: assessment of serological methods in* T. b. gambiense *sleeping sickness*. M.Sc. thesis, University of Salford, UK. (Unpublished thesis.)

Parasitic Diseases Programme, WHO, CH-1211 Geneva 27, Switzerland.

It has been demonstrated that a theoretical `predictive value' of serological assays, based on the sensitivity and specificity of serological reactions, can be used for the evaluation of sleeping sickness prevalence using serological results obtained in the field. A comparative evaluation was made of three serological tests developed for mass surveys, two based on indirect haemagglutination and one on direct agglutination. Three groups of 200 individuals were each tested by one of these methods in the field. Samples collected from the same individuals were then tested by each method in the laboratory and also by two different immunofluorescence techniques. Results from the serological tests were compared in the field and laboratory and with the results of parasitological examinations. The three field tests showed high sensitivity (94-98%) in the laboratory. Taking into account the shortcomings of parasitological techniques, `relative' specificity was acceptable for CATT at 95.5%. Other tests gave less satisfactory results, especially the immunofluorescence tests. All three sero-logical tests were also evaluated for their ease of implementation in the field. The intrinsic immunoserological value of CATT was considered acceptable and, although it did not perform best in each individual category, its simplicity and practicality recommended it for field use.

6976 **Khot'ko, N.I., 1990**. [Experience in improving the effectiveness of diagnosis of *gambiense*

trypanosomiasis.] (In Russian.) *Meditsinskaya Parazitologiya i Parazitarnye Bolezni*, **1990** (1): 51-53.
All-Union Anti-Plague Research Institute, `Mikrob', Saratov, USSR.
A method for detecting low concentrations of trypanosomes in blood using DEAE cellulose column chromatography is described and compared with other laboratory diagnostic techniques. 250 Angolan patients, suspected of having trypanosomiasis from preliminary serological and clinical screening, were investigated. The DEAE method revealed more cases of infection (44.2%) than the study of lymph node punctate (37.5%), blood (24%) or cerebrospinal fluid (13%).

6977 **Mbulamberi, D.B., 1991**. *Uganda Ministry of Health. National Sleeping Sickness Control Programme. First quarterly report 1991*. 19 pp.
National Sleeping Sickness Control Programme, P.O. Box 1241, Jinja, Uganda.
In the Busoga region there was a 10.3% increase in the incidence of *rhodesiense* sleeping sickness since the previous quarter but in Mukono and Tororo districts there were decreases of 15.0% and 15.9% respectively. A northward expansion of *rhodesiense* sleeping sickness into Pallisa and Mbale districts was detected. The North-Western region reported a 0.9% increase in the incidence of *gambiense* sleeping sickness. An integrated approach to trypano-somiasis control was implemented in some areas, which involved vector control and screening both humans and animals at the same time and place. The work of medical surveillance teams is reported with details of the number of cases detected and treated in different areas. The cases are analysed according to age group, sex ratio, stage of the disease and numbers of relapses and fatalities. Constraints include lack of CATT kits, external funding and trained staff and inadequate facilities for CSF analyses. An appendix lists the sleeping sickness incidence per 100,000 population during January-March 1991 for counties and subcounties in south-east Uganda for which current population figures are available, and also for some parishes and villages in Moyo district.

6978 **Nyasulu, Y.Z. and Pugh, R.N.H., 1987**. Medical aspects [of trypano-somiasis]. *Malawi Epidemiological Quarterly*, no. 1: 20-23. (See also **14**: no. 6947.)
Ministry of Health, P.O. Box 30377, Capital City, Lilongwe 3, Malawi; Queen Elizabeth Central Hospital, Blantyre, Malawi.
Most if not all cases of human trypanosomiasis in the Rumphi District of northern Malawi originate from the

area surrounding the Vwaza Marsh Game Reserve. A proposed medical programme in this area will include human population surveillance and a stratified random sample survey to validate asymptomatic cases of disease. Related studies will include tsetse dispersal in settlement areas and the potential of livestock to act as a reservoir for human infection. A similar programme is planned for the area around Lengwe National Park and Majete Game Reserve, and this will include a study of nyala antelope as a potential reservoir host. Diagnostic studies will include tests of ELISA, mAEC in kit form and CATT. Odour-baited and insecticide-impregnated targets will be used to reduce disease risks around game lodges and viewing hides in wildlife parks. Priority will be given to creating awareness, making proper diagnosis, providing effective treatment and ensuring adequate follow-up.

6979 **Pugh, R.N.H., 1987**. Diagnosis and management of sleeping sickness. *Malawi Epidemiological Quarterly*, no. 1: 26-36. (Article also submitted to the *Journal of the Medical Association of Malawi*.) (See also **14**: no. 6947.)
Queen Elizabeth Central Hospital, Blantyre, Malawi.

Trypanosoma brucei rhodesiense sleeping sickness occurs in both an acute and a chronic form and in general now tends to be less sudden and severe in its onset than when it was first recognised in Malawi and Tanzania about 70 years ago. There is no set pattern of clinical presentation. The more acute form tends to occur in children and visitors whereas the chronic form is typical of adults living in endemic areas. Asymptomatic cases can occur and if not treated these will act as reservoirs for further infection. The clinical features of the disease are described. Laboratory diagnosis should be based on repeated blood samples, HCT, mAEC and lumbar puncture for CSF examination. Supplementary methods include the examination for trypanosomes of serous fluid from the chancre which may develop at the site of the bite and testing for increased erythrocyte sedimentation rate and raised IgM level. Suramin is recommended for treatment if the CSF is normal, and suramin and melarsoprol if the CSF contains trypanosomes. A table shows the WHO-recommended dosage rates of these drugs throughout the course of treatment and possible side effects are described. Regular follow-ups to check for relapse are essential.

6980 **Rozman, M., Brugués, R., Feliu, E. and Rozman, C., 1986**.
Células de Mott, signo de sospecha de la

tripanosomiasis africana. [Mott cells, a diagnostic sign of African trypanosomiasis.] *Sangre*, **13** (3): 367-369.
Escuela de Hematología `Farreras Valentí', Hospital Clínico y Provincial, Universidad de Barcelona, Barcelona, Spain.
Mott cells were found to be abundant in the CSF of two patients with suspected *gambiense*-type trypanosomiasis and subsequently an extensive search was able to reveal the presence of a few trypanosomes. Mott cells are plasmocytes which contain abundant droplets of proteinaceous material in their cytoplasm. These give the cells a characteristic vacuolated appearance. Mott cells are also associated with several other diseases which are accompanied by plasmocytosis, including malaria and kala-azar, but their presence should always raise the suspicion of trypanosomiasis which can then be confirmed by other diagnostic methods.

(b) PATHOLOGY AND IMMUNOLOGY

[See also **14**: no. 6980.]

6981 **Courtney, P.T. and Courtney, M.E., 1987**. Abstract article of the sleeping sickness situation in the Vwaza Marsh area. *Malawi Epidemiological Quarterly*, no. 1: 24-25. (Original article published in 1985 as: Trypanosomiasis in the Rumphi District, *Journal of the Medical Association of Malawi*, **2**: 58-61.) (See also **14**: no. 6947.)
Of 21 patients admitted to Rumphi Hospital in northern Malawi in 1984, 85% were under 30 years old and 38% under ten years old. The disease is more rapid in children, who had symptoms for an average of 18 days prior to admission. Adults usually experienced symptoms for an average of seven months before admission. Common presenting symptoms are fever, excessive daytime sleeping, insomnia, headaches, behavioural changes and convulsions. Trypanosomes were found in the peripheral blood of 12 patients and in the CSF of nine. Multiple blood films and lumbar punctures are essential for diagnosis. At the same time, 719 villagers near the Vwaza Marsh Game Reserve were screened by single blood smears and 34 (4.3%) were positive. Most cases were asymptomatic although headache and fever were commonly reported. It is suggested that these non-specific symptoms should arouse suspicion in an endemic area for trypanosomiasis and that other diagnostic techniques would probably show a higher rate of infection.

6982 **Louis, J.P., Jannin, J., Hengy, C., Moulia-Pelat, J.P., Makuwa, M., Asonganyi, T., Noutoua, L., Fadat, G., Nguerenemo, P., Cattand, P. and**

Trebucq, A., 1991. Absence d'inter-relations épidémiologiques entre l'infection rétrovirale à VIH et la trypanosomaise humaine africaine (THA). Analyse de trois enquêtes cas-témoins réalisées en 1989 et 1990 en Afrique centrale. [Absence of inter-relationships between sleeping sickness and retroviral infection. Analysis of three case control studies undertaken in 1989 and 1990 in central Africa.] *Bulletin de la Société de Pathologie exotique et de ses Filiales*, **84** (1): 25-29.
Louis, Hengy, Fadat, Trebucq: OCEAC, B.P. 288, Yaoundé, Cameroon; Jannin, Moulia-Pelat, Makuwa: Services de Santé Nationaux, Brazzaville, Congo; Asonganyi: Services de Santé Nationaux, Yaoundé, Cameroon; Noutoua, Nguerenemo: Services de Santé Nationaux, Bangui, Central African Republic; Cattand: WHO, CH-1211 Geneva 27, Switzerland.
The authors report the results of three case control studies undertaken in sleeping sickness foci in Cameroon, Central African Republic and Congo. HIV seroprevalence rates were comparable among sleeping sickness patients and trypanonegative controls, indicating an absence of inter-relationship between sleeping sickness and retroviral infection.

6983 **Louis, J.P., Moulia-Pelat, J.P., Jannin, J., Asonganyi, T., Hengy, C., Trebucq, A., Noutoua, J. and Cattand, P., 1991**. Absence of epidemiological inter-relations between HIV infection and African human trypanosomiasis in Central Africa. *Tropical Medicine and Parasitology*, **42** (2): 155.
Louis, Asonganyi, Hengy, Trebucq: OCEAC, B.P. 288, Yaoundé, Cameroon; Moulia-Pelat, Jannin: Ministry of Health, Brazzaville, Congo; Noutoua: Ministry of Health, Bangui, Central African Republic; Cattand: WHO, CH-1211 Geneva 27, Switzerland.
Three endemic areas of human trypanosomiasis were studied: the urban areas of Mamfe, south-west Cameroon, and Batangafo, north-west Central African Republic, and the rural area of Bouenza, south-west Congo. Trypanosomiasis cases (21 from Mamfe, 17 from Batangafo, 163 from Bouenza) were each paired with two matched controls (three in Mamfe) with no evidence of trypanosomiasis, and their sera screened for anti-HIV antibodies. The difference in prevalence of HIV seropositivity in cases and controls was not statistically significant.

6984 **Pentreath, V.W., 1991**. The search for primary events causing the pathology in African sleeping sickness. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, **85** (2): 145-147.

Department of Biological Sciences, University of Salford, Salford M5 4WT, UK.
This review article considers the mechanisms inducing pathological changes in human trypanosomiasis. Substances or cell types produced or modified by the parasite need to be identified and separated from other effects. These primary biochemical or cellular lesions are in turn followed by many subsequent pathological events. The immune response is complex and not fully understood. Macrophages are involved in progressive immunosuppression in mice and appear to be an important source of pathogenesis. The mechanisms by which macrophages mediate their suppressive activity on the immune effector cells are discussed. The levels of many cytokines and other mediators, especially prostaglandins, are seriously disturbed but their roles in the initiation of pathology are not yet clear.

(c) TREATMENT

6985 **Kirchhoff, L.V. and Wilson, M.E., 1991**. Chagas' disease, African trypanosomiasis, and leishmaniasis. *Current Opinion in Infectious Diseases*, **4** (3): 273-281.
University of Iowa College of Medicine and Department of Veterans Affairs Medical Center, Iowa City, IA 52242, USA.
The authors very briefly review some recent research on the biology of trypanosomes and the treatment of trypanosomiasis with eflornithine.

6986 **Pepin, J. and Milord, F., 1991**. African trypanosomiasis and drug-induced encephalopathy: risk factors and pathogenesis. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, **85** (2): 222-224.

Medical Research Council Laboratories, Fajara, Gambia; University of Sherbrooke, Sherbrooke, Canada and Zone de Santé Rurale de Nioki, Nioki, Zaire.
Data on 598 patients with *Trypanosoma brucei gambiense* sleeping sickness, with abnormal cerebrospinal fluid (CSF) and treated with melarsoprol, were reviewed to determine risk factors for drug-induced encephalopathy. The incidence of melarsoprol-induced encephalopathy was increased in patients with trypanosomes present in the CSF, in patients with a high CSF lymphocyte count, and among patients in whom no trypanosomes were found in either the blood or the lymph node aspirate. Among patients with trypanosomes in the CSF, the risk of encephalopathy was similar whether or not they also had trypanosomes seen in the haemolymphatic system. Dimercaprol, a heavy metal chelator, did not reduce the

case-fatality rate of patients with encephalopathy. These observations and others are compatible with the hypothesis that an immune phenomenon is involved in the pathogenesis of melarsoprol-induced encephalopathy. Whether the basic mechanism relates to deposits of immune complexes in the central nervous system or to the release of trypanosomal antigens which subsequently bind to brain cells and attract antibodies or T lymphocytes, the rapidity with which trypanosomal antigens are released may be critical, and very aggressive therapeutic schemes may result in higher toxicity, especially in patients with an impaired blood-brain barrier.

6. ANIMAL TRYPANOSOMIASIS

(a) SURVEY AND DISTRIBUTION

[See also **14**: no. 7002.]

6987 **Masake, R.A. and Nantulya, V.M., 1991**. Sensitivity of an antigen detection enzyme immunoassay for diagnosis of *Trypanosoma congolense* infections in goats and cattle. *Journal of Parasitology*, **77** (2): 231-236.
ILRAD, P.O. Box 30709, Nairobi, Kenya.

The sensitivity of a monoclonal antibody-based antigen-detection enzyme immunoassay (antigen-ELISA) for the diagnosis of *T. congolense* was evaluated using sera from experimentally infected goats and cattle. Ten goats (Galla ∃ East African Masai) and seven steers (*Bos indicus*) were infected with different clones of *T. congolense* and left to run a chronic course for 46 and 24 months, respectively. During this period, monthly blood samples were collected and analysed for the presence of trypanosomes and antigens in peripheral blood. Of 383 caprine blood samples, 361 (94.3%) were positive for circulating antigens whereas only 42 (10.9%) had demonstrable trypanosomes as revealed by the microhaematocrit centrifugation technique. In cattle, 570 (82.5%) of 691 blood samples were antigen-ELISA positive compared to 136 (19.7%) samples with detectable trypanosomes. In an analysis of serum samples from goats in an area known to be endemic for trypanosomiasis, 106 (80.9%) of 131 were positive for *T. congolense* antigens whereas none of the corresponding blood samples had detectable trypanosomes. Control sera from 24 goats in a trypanosomiasis-free region were all antigen-ELISA negative. Hence, the antigen-ELISA was at least four times more sensitive than the microhaematocrit centrifugation technique in monitoring *T. congolense* infections in goats and cattle.

6988 **Saeed, K., Afzal, M., Mian, M.S., Rabbani, A. and Rizvi, A.R., 1988**. A comparative study of indirect haemagglutination test with traditional diagnostic methods for *Trypanosoma evansi* infection in horses. *Pakistan Veterinary Journal*, **8** (2): 82-84.
College of Veterinary Sciences, Lahore, Pakistan.
A study was conducted to compare the reliability of IHAT with traditional methods (examination of wet preparations and thin blood smears) for the diagnosis of *T. evansi* infection in horses. Blood samples were collected from 100 suspected cases on the basis of history and clinical symptoms. The antigen was prepared from the blood of mice experimentally infected with *T. evansi*. Tanned sheep red blood cells were sensitised with the antigen. Suspected sera were inactivated and prediluted, and serial two-fold serum dilutions were prepared in microtitre `U' plates. Sensitised sheep red blood cells were then added and plates were incubated at room temperature in a humid chamber for 16 h. A titre of more than or equal to 1:40 was considered as positive. Five, 11 and 13% of cases were positive by wet preparation, blood smear and IHAT respectively.

6989 **Unger, H., 1989**. *Vergleichsstudie zur Bewertung der Diagnosemethoden bei der* Trypanosoma brucei-*Infektion*. [Comparative study to evaluate diagnostic methods for *T. brucei* infection.] Ph.D. thesis, Veterinär-medizinische Universität Wien, Austria. (Unpublished thesis.) 68 pp.
Institut für Parasitologie und Allgemeine Zoologie, Veterinär-medizinische Universität Wein, Austria.
The buffy coat double centrifugation technique appears to be the most sensitive microscopic procedure of all concentration techniques and also permits species diagnosis to a certain extent. ELISA tests for the detection of antibodies or antigens are difficult to interpret. Antigen concentrations in bovine sera vary considerably and sometimes show no titre during an infection due to immuno-logical reactions. Antibody titres remain high for a time after treatment and are not species-specific. Monoclonal antibodies may ease the situation and help to improve the results of epidemiological surveys. The DNA hybridisation technique has great advantages over other methods in terms of high specificity and sensitivity, although the necessary procedures still restrict this technique to highly specialised laboratories. With changes in the detection system, this method could become a valuable

tool for diagnosis.

6990 **Very, P., Bocquentin, R. and Duvallet, G., 1990**. Sensibilité de la double microcentrifugation pour la recherche des trypanosomes. [Sensitivity of double microcentrifugation for parasitological diagnosis of trypanosomes.] *Revue d'Elevage et de Médecine vétérinaire des Pays tropicaux*, **43** (3): 325-329.

CRTA, 01 B.P. 454, Bobo-Dioulasso 01, Burkina Faso.
The double microcentrifugation technique, described by Kratzer and Ondiek (20th ISCTRC Meeting, Mombasa, 1989) for the parasitological diagnosis of trypanosomes, has been tested both in the laboratory and in the field. The limits of detection obtained here were not as low as those described in the original experiment, but the sensitivity of this technique for the detection of *Trypanosoma brucei*, *T. congolense* and *T. vivax* was better than the phase contrast buffy coat method. This technique, which is easy to apply in the field, is highly recommended, especially for epidemiological surveys. A protocol and a list of equipment are included.

(b) PATHOLOGY AND IMMUNOLOGY

6991 **Losos, G.J., 1986**. *Infectious tropical diseases of domestic animals*. Harlow, UK; Longman Scientific and Technical. 938 pp.
Bio-Research Laboratories Inc., 87 Senneville Road, Senneville, Quebec H9X 3R3, Canada.
The book provides detailed descriptions of 25 protozoal, viral, bacterial, rickettsial and helminthic diseases of domestic animals which are of major importance in tropical and sub-tropical countries, with comprehensive bibliographies covering the three decades up to 1983. The chapter on trypanosomiasis (text pp. 182-262; bibliography pp. 263-318) covers etiology, epizootiology, infection, clinical signs, pathology, immunology, diagnosis, and chemotherapy and chemoprophylaxis.

6992 **Luckins, A.G., Llewelyn, C., Munro, C.D. and Murray, M., 1986**. Effects of pathogenic trypanosomes on the mammalian reproductive system. *In*: IAEA, *Nuclear and related techniques in animal production and health* (Proceedings of an international symposium on the use of nuclear techniques in studies of animal production and health in different environments, jointly organised by IAEA and FAO, and held in Vienna, 17-21 March 1986) (Vienna, Austria; IAEA: STI/PUB/717), pp. 351-363.

CTVM, Easter Bush, Roslin, Midlothian EH25 9RG, UK; ibid.; Royal (Dick) School of Veterinary Studies, University of Edinburgh, Edinburgh, UK; Department of Veterinary Medicine, University of Glasgow Veterinary School, Bearsden Road, Glasgow G61 1QH, UK.
Trypanosomiasis is known to cause infertility and abortion in susceptible livestock in tsetse-infested areas and there are reports that trypanosomiasis can exert long-lasting effects on ovarian function. Although there is considerable evidence for disruption of the oestrous cycle in the female, the causes of these changes are not fully understood. The aim of the present investigation therefore was to study the pathogenic effects of infection with *Trypanosoma congolense* on the ruminant reproductive system with particular emphasis on the hormonal control of oestrus. In particular, the effects of infection were monitored with specific regard to the reproduction of plasma progesterone and the sexual behaviour of the animals. Initially, experiments were carried out using goats infected by the bites of *Glossina morsitans* carrying *T. congolense*. To establish chronic infections it was necessary to administer subcurative doses of diminazene aceturate to the infected animals on a number of occasions during the experiment. Control, uninfected but drug-treated goats showed regular oestrous cycles during the experiments, with cycle lengths of between 19 and 23 days. In contrast, in the infected goats, three out of four animals did not show regular oestrous cycles. The periods without oestrus activity varied between 53 and 97 days. Determination of plasma progesterone levels suggested that in these animals the luteal phase of oestrus was prolonged, indicating a persistent corpus luteum. In further experiments using Boran cattle, a group of 22 animals was selected, 12 of which were infected with *T. congolense* IL1180. The PCV in infected cattle fell to < 20% and most of the animals showed loss in body weight. Two animals died and of the remainder five were treated with trypanocidal drug 60 days after infection and five 90 days after infection. In the remaining ten infected cows, nine stopped cyclical activity: in five there was a prolonged luteal phase with elevated progesterone levels and in the remainder progesterone levels fell to basal values for up to 100 days. After treatment these infected cows resumed cyclical activity and within three or four cycles were cycling normally. These results have confirmed that trypanosomes adversely

affect ovarian activity but it is not known if more long-term damage might have resulted which could affect subsequent fertility.

6993 **Mutayoba, B.M., Meyer, H.H.D., Osaso, J. and Gombe, S., 1989**. Trypanosome-induced increase in prostaglandin $F_{2\alpha}$ and its relationship with corpus luteum function in the goat. *Theriogenology*, **32** (4): 545-555.

Sokoine University of Agriculture, Faculty of Veterinary Medicine, P.O. Box 3017, Morogoro, Tanzania; Institute for Physiology, Technical University of Munich, 8050 Freising-Weihenstephan, Germany; Reproductive Biology Unit, University of Nairobi, P.O. Box 30197, Nairobi, Kenya; ibid.

Plasma progesterone and 13,14-dihydro-15-keto prostaglandin $F_{2\alpha}$ (PGFM) were measured in normal (uninfected) and *Trypanosoma congolense*-infected adult goats for a period of 121 days from May to August, during the breeding season in Kenya. Chronic trypanosomiasis rapidly increased the baseline plasma PGFM levels and the occurrence of irregular PGFM peaks in several infected goats. Progesterone luteal levels declined rapidly from the second and subsequent cycles post patency. Oestrous cycles also became irregular but predominantly shorter (8 to 19 days) before cessation from the second to fourth cycle following infection. The PGFM levels were still high during the acyclic period in all goats when progesterone levels were very low (1.4 to 2.4 nmol/l). The reciprocal increase in peripheral PGFM and decline in progesterone in these goats would suggest, in part, a trypanosome-induced $PGF_{2\alpha}$ mediated luteolysis, and the possible involvement of prostaglandins in trypanosome-induced infertility in female goats.

6994 **Mwamachi, D.M., Rurangirwa, F.R., Musoke, A.J. and McGuire, T.C., 1991.** Clone-specific immune colostrum induces increased resistance in goat kids challenged with *Trypanosoma congolense*. *Acta Tropica*, **49** (1): 27-36.

Ministry of Livestock Development, Veterinary Laboratory, P.O. Kabete, Kenya; Small Ruminant Collaborative Research Support Program, P.O. Box 58137, Nairobi, Kenya; ILRAD, P.O. Box 30709, Nairobi, Kenya; Department of Veterinary Microbiology and Pathology, Washington State University, Pullman, WA, USA. (Correspondence to Rurangirwa.)

The course of infection and the humoral immune response to *T. congolense* clone ILNat 3.1 were studied in test goat kids receiving colostrum from dams immunised with the surface coat of ILNat 3.1 and control kids that

received colostrum from non-immunised dams. At 24-48 h after birth, all test kids had detectable serum antibodies to the trypanosome clone. There was no difference in the prepatent period between the test and control kids following challenge with 10^3 *T. congolense* ILNat 3.1 trypanosomes 8 days after birth. After the first 7 days of the experimental period, significantly lower parasitaemia was recorded in test kids than in control kids. The mean PCV of test kids was not significantly different from that of control kids 7 days after infection. The test kids gained as much weight as noninfected control kids; both groups gained twice as much weight as infected control kids. Following infection, all kids developed antibodies against the infecting trypanosome clone. Fifteen test kids had titres equal to or greater than 1280 compared to only two control kids. The test kids survived longer after infection compared to control kids. The results suggest that colostrum from dams immunised with the surface of a *T. congolense* clone did not prevent infection, but decreased parasitaemia and prolonged survival of kids challenged with the same clone.

6995 **Schöning, B., 1990**. *Der Hund als Reservoir für* Trypanosoma (Trypanozoon) brucei gambiense: *Vergleichende Untersuchungen zur Empfänglichkeit für* T. b. gambiense *Dutton, 1902 und* T. b. brucei *Plimmer & Bradford, 1899 und zum Infektionsverlauf bei einer europaischen und einer westafrikanischen Hunderasse*. [The dog as reservoir host of *T. (T.) b. gambiense*: a comparative study on the susceptibility of European and West African dogs to *T. b. gambiense* and *T. b. brucei* and on the course of infection.] Inaugural-Dissertation, Fachbereich Veterinärmedizin, Freie Universität Berlin, Germany. (Unpublished thesis.) 113 pp.
Bernhard-Nocht-Institut für Tropenmedizin, Bernhard-Nocht-Strasse 74, D-2000 Hamburg 36, Germany.
Teneral *Glossina palpalis gambiensis* were infected with *T. b. gambiense* via *Mastomys natalensis* and flies with mature infections were then allowed to feed on two West African pariah dogs and two European beagles. When the dogs became infected, new teneral *G. p. gambiensis* were allowed to feed on them and flies with mature infections from each group were then used to infect one new pariah dog and one new beagle, respectively. The experiments were repeated using *T. b. brucei* and showed that both *T. b. gambiense* and *T. b. brucei* were cyclically transmissible to and between dogs. Infection rates in

G. p. gambiensis were 1.0% (mature infections) and 3.7% (immature infections) for *T. b. gambiense* and 2.7% and 7.6% respectively for *T. b. brucei*. The dogs were monitored for 180 days p.i., using parasitological, serological and clinical parameters. *T. b. brucei*-infected beagles developed a severe acute infection whereas the pariah dogs developed a milder chronic form. All the dogs had fluctuating parasitaemias, with higher levels in the beagles. All dogs infected with *T. b gambiense* had fluctuating parasitaemias but these were distinctly lower than in the *T. b. brucei* infections. *T. b. brucei*-infected pariah dogs exhibited distinct trypanotolerance and, although differences between infected pariah dogs and beagles were less pronounced, this also appears to be the case with *T. b. gambiense*. The results confirm that dogs in West Africa can act as reservoir hosts for *T. b. gambiense*.

6996 **Sekoni, V.O., Saror, D.I., Njoku, C.O. and Kumi-Diaka, J., 1990**. Elevation of morphological abnormalities of spermatozoa in the semen of Zebu bulls consequent to *Trypanosoma vivax* and *Trypanosoma congolense* infections. *Theriogenology*, **33** (4): 925-936.

National Animal Production Research Institute, Ahmadu Bello University, P.M.B. 1096, Shika, Zaria, Nigeria; Faculty of Veterinary Medicine, Ahmadu Bello University, Zaria, Nigeria; ibid.; ibid.

Twenty-four Zebu bulls were used in a 12-week long study. Eight bulls were infected with *T. vivax*, eight others with *T. congolense* and eight served as controls. All the infected bulls developed chronic trypanosomiasis. Mean percentage base-line values prior to infection for acrosomal, sperm-head, detached heads, proximal cytoplasmic droplets, distal cytoplasmic droplets, sperm-tail, midpiece and total sperm morphological abnormalities ranged between 0.1 □ 0.1 for acrosomal and 8.7 □ 3.4 for total morphological abnormalities in the semen of the bulls. These values were very low and within the range of those for fertile bulls. Following infection, there was a progressive increase in the mean values of all the abnormalities. Peak percentage mean values recorded for total sperm morphological abnormalities in the course of the investigation in the bulls infected with *T. vivax* and *T. congolense* and in the controls were 95 □ 7.2, 100 □ 0 and 7.9 □ 5.0, respectively. Mean percentage values throughout the duration of the investigation for control bulls were low and within the normal range for fertile bulls. These values differed significantly (*P*

< 0.001) from the elevated values of the infected bulls. The results indicate that trypanosomiasis due to either *T. vivax* or *T. congolense* infections can cause a marked increase in morphological abnormalities of spermatozoa to levels exceeding maximum permissible values in bulls considered to be fertile.

6997 **Singh, B.P. and Misra, S.K., 1988**. A study on the clinical course of *Trypanosoma evansi* in experimentally infected cow-calves. *Indian Veterinary Medical Journal*, **12** (2): 127-128. Department of Veterinary Medicine, Bihar Veterinary College, Patna 800014 Bihar, India.

Ten healthy cross-bred male calves, aged 1-1.5 years, procured from local breeders in India, were used in a study on the different behaviours of different strains of trypanosomes in cattle. *T. evansi* from an infected pony was maintained in albino mice for experimental work. Five calves received *T. evansi* ($5 \exists 10^6$) subcutaneously, and five others acted as noninfected controls. The degree of parasitaemia, temperature, bodyweight and clinical manifestation were recorded regularly for 56 days. The prepatent period varied between 3 and 5 days. In general, the course of disease remained at sub-acute to chronic. The major clinical observations included a mild rise of temperature on day 4 p.i., taking an afebrile course afterwards. Enlargement of prescapular lymph nodes, progressive reduction in bodyweight, conjunctivitis, bilateral mucopurulent discharge from eyes, coupled with sunken eyes and testicular swelling in two of the five calves were observed. The parasitaemia appeared to be related to the rise in body temperature.

6998 **Taracha, E.L.N., Irvin, A.D., Morzaria, S.P., Moloo, S.K., Katende, J.M. and Kiarie, J.N., 1988**. Immunization against East Coast fever: effect of chronic trypanosomiasis on the development of immunity. *In*: IAEA, *Nuclear techniques in the study and control of parasitic diseases of livestock* (Proceedings of the Final Research Co-ordination Meeting on the use of nuclear techniques in the study and control of parasitic diseases of farm animals, organised by the Joint FAO/IAEA Division, and held in Vienna, 11-14 May 1987) (Vienna, Austria; IAEA: STI/PUB/792), pp. 195-202.

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

Two experiments were carried out in which clean cattle, or cattle chronically infected with *Trypanosoma congolense*, were immunised by the infection and treatment method against East Coast fever (ECF, *Theileria parva* infection). Chronic trypanosomiasis did not prevent cattle from

mounting an effective immunological response to ECF immunisation and resisting subsequent lethal challenge. There appeared to be no difference in the level or quality of immunity between clean cattle and trypanosome-infected cattle. Thus, *T. congolense* infection on its own does not appear to provide a constraint to ECF immunisation in the field.

6999 **Vos, G.J., 1989**. Trypanosoma vivax *in herkauwers: de gevoeligheid van de gastheer en de antilichaam respons tijdens infectie*. [*T. vivax* in ruminants: susceptibility of the host and antibody responses during infection.] Thesis, Rijksuniversiteit Utrecht, Netherlands. (Unpub-lished thesis.) 159 pp.
ILRAD, P.O. Box 30709, Nairobi, Kenya.
This thesis contains seven chapters: general introduction; infectivity of different stocks of *T. vivax* for goats; induction of immunity to *T. vivax* in goats; antibody responses of goats after infection with *T. vivax* stocks of different pathogenicity; parasite specific antibody responses of goats infected with *T. vivax*; antigenic relatedness of stocks and clones of *T. vivax* from East to West Africa; and general discussion and summary.

7000 **Williams, D.J.L., Naessens, J., Scott, J.R. and McOdimba, F.A., 1991**. Analysis of peripheral leucocyte populations in N'Dama and Boran cattle following a rechallenge infection with *Trypanosoma congolense*. *Parasite Immunology*, **13** (2): 171-185.
ILRAD, P.O. Box 30709, Nairobi, Kenya.
Monoclonal antibodies, flow cytometry and routine haematological techniques were used to analyse circulating leucocyte populations in trypanotolerant (N'Dama) and trypanosusceptible (Boran) cattle following a homologous rechallenge with *T. congolense* clone IL13-E3. The N'Damas developed a low, transient parasitaemia and did not develop anaemia. The Borans became parasitaemic and developed chronic anaemia but three of the five animals eventually self-cured, whilst a group of primary-challenged Borans experienced a severe infection characterised by high levels of parasitaemia and acute anaemia. During infection the numbers of circulating B-cells increased in all three groups from day 21 onwards. The proportion of B-cells expressing the CD5 antigen increased from pre-infection levels of 5-10% of B-cells to 49-90% by day 19 post-infection in all three groups. The neutrophil count declined in both Boran groups but not in the N'Damas. The $CD4^+$ T-cell and $\gamma\delta$ T-cell populations decreased in both Boran groups but did not alter significantly in

the N'Damas. Although it was not possible to infer from the data that the $CD4^+$, γδ T-cell, neutrophil and erythrocyte populations were directly responsible for the differential control of the disease by the two breeds, it was possible to correlate alterations in these cell populations with the severity of the disease.

7001 **Zielinski, L., 1988**. *Unspezifische Abwehrmechanismen empfänglicher und nichtempfänglicher Hunde im Verlauf einer Infektion mit* Trypanosoma congolense *(Broden, 1904)*. [Non-specific defence mechanisms in susceptible and non-susceptible dogs during infection with *T. congolense*.] Inaugural-Dissertation, Fachbereich Veterinär-medizin, Freie Universität Berlin, Germany. (Unpublished thesis.) 79 pp.
Institut für Parasitologie und Tropenveterinärmedizin, Veterinär-medizin, Freie Universität, Königsweg 65, 1000 Berlin, Germany.
Phagocytosis by polymorphonuclear leucocytes (PNL) in *T. congolense*-infected trypanotolerant West African pariah dogs (from Liberia) and susceptible beagles of laboratory stock was similar both before and during experimental infection. Opsonisation of zymosan with sera from both groups intensified the chemiluminescence of PNL cells. Serum from beagles 53 days p.i. had a reduced opsonisation effect on zymosan but a similar change was not seen with sera from the Liberian dogs. Before the infection both groups had similar concentrations of the third complement component (C3). Infection reduced the C3 concentration in both groups but the concentration in beagles was more evident than in Liberian dogs. Complement haemolytic activity was greater in Liberian dogs before infection, and declined less during infection, than in beagles. Infection did not influence lysozyme activity, which remained higher in Liberian dogs than in beagles.

(c) TRYPANOTOLERANCE
[See **14**: nos. 6971, 7000, 7003.]

(d) TREATMENT
7002 **Ainanshe, O.A., 1989**. *Some aspects of animal trypanosomiasis in Somalia*. Ph.D. thesis, University of Glasgow, UK. (Unpublished thesis.)
The different species of pathogenic trypanosomes occurring in Somalia are described together with the clinical signs they produce in different species of livestock. Particular emphasis is given to *Trypanosoma*

congolense, *T. vivax* and *T. evansi*. The various chemotherapeutic and chemoprophylactic drugs used to control trypanosomiasis in Somalia are described and their advantages and disadvantages are discussed. Cattle trypanosomiasis along the Jubba and Shabelle rivers was surveyed and a total of 4152 cattle in 54 herds was examined. There was an overall infection level of 10% and the incidence of *T. congolense* infection showed a significantly increasing trend with the level of tsetse challenge. *T. vivax* did not show this trend but there was no evidence for mechanically transmitted *T. vivax* infection outside the tsetse belt. This survey showed that trypanosomiasis is widespread along tsetse-infested riverine areas in Somalia and is regarded as a major problem by cattle owners. Two drug-resistant strains of *T. congolense* were isolated from the lower Shabelle. An attempt to overcome drug resistance by i.v. as opposed to i.m. administration of isometamidium chloride to goats infected with a Samorin-resistant strain of *T. congolense* showed no clear advantage, although i.v. administration resulted in higher blood concentrations of the drug 4 h p.i.. Studies on the chemotherapy of *T. evansi* infection in mice included sensitivity tests of two stabilates, *T. evansi* GRVPS 13 and GRVPS 19, to six trypanocidal drugs: quinapyramine sulphate/ prosalt, isometamidium, diminazene aceturate, melarsoprol, DFMO and suramin. *T. evansi* GRVPS 13 was resistant to the maximum dose of suramin (160 mg/kg) and GRVPS 19 was resistant to diminazene aceturate but both were sensitive to all the other drugs. The suramin-resistant strain GRVPS 13 was highly sensitive to a new arsenical drug Mel Cy and Trimelarsan (Mel W) but the prophylactic activity of Mel Cy against *T. evansi* GRVPS 13 infection gave no protection after 3 days. Mel Cy administered at a dose rate of 0.25 mg/kg to goats infected with *T. evansi* was not curative. A significant decrease in drug sensitivity developed when irradiated and normal groups of mice infected with *T. evansi* were treated with increasing doses of isometamidium and drug resistance was promoted more readily in immunosuppressed animals.

7003 **Dehoux, J.P., 1990**. Chimioprophylaxie antitrypanosomienne de bovins N'Dama importés de Sénégambie et du Zaïre au Gabon. [Anti-trypanosomal chemoprophylaxis in N'Dama cattle imported from Senegambia and Zaire into Gabon.] *Revue d'Elevage et de Médecine vétérinaire des Pays tropicaux*, **43** (3): 337-341. 59 rue Grande, 5141 Andoy-Wierde, Belgium.

Gabon imports N'Dama cattle from Senegal, Gambia and Zaire in order to develop its cattle industry. The Ngounié ranch received 2467 imported cattle between 1984 and 1987. The stress of transportation and adaptation to a new region reduces the trypanotolerance of such animals and, in 1985, 19.8% died in the first year, 88.6% (70) of these from trypanosomiasis and, as a result of immunosuppression, from cowdriosis and anaplasmosis. A protocol of trypano-cidal treatment was introduced consiting of i.m. injections of diminazene aceturate (3.5 mg/kg live weight) and isometamidium chloride (0.5 mg/kg) on arrival and twice a year thereafter in June (end of rainy season) and October (end of dry season). This reduced the first-year mortality of cattle imported in 1986 and 1987 to 3.3% and 2.9% respectively, only five (16.1%) of the deaths in 1987 being due to trypanosomiasis, cowdriosis and anaplasmosis.

7004 **Kinabo, L.D.B., McKellar, Q.A. and Eckersall, P.D., 1991**. Isometamidium in pigs: disposition kinetics, tissue residues and adverse reactions. *Research in Veterinary Science*, **50** (1): 6-13.

Departments of Veterinary Pharmacology (Kinabo, McKellar) and Veterinary Clinical Biochemistry (Eckersall), University of Glas-gow Veterinary School, Bearsden Road, Glasgow G61 1QH, UK.

The disposition and adverse effects of the anti-trypanosomal drug isometamidium in pigs were evaluated. Following i.m. administration at doses of 0.5, 15 and 35 mg kg^{-1}, the drug was rapidly absorbed within 15-30 min to reach maximum plasma concentrations of 12-477 (n = 6), 302-655 (n = 4) and 1620 (n = 1) ng ml^{-1}, respectively. No drug was detectable in plasma (less than 5 ng ml^{-1}) 24 h after drug administration at the three doses used. The half-lives of disappearance of the drug from plasma during the terminal phase were 7.12 h for the pigs given a dose of 15 mg kg^{-1} and 7.20 h for the pig which received a dose of 35 mg kg^{-1}. At all the i.m. injection sites, high drug concentrations were found 6 weeks after administration. The most dramatic adverse reactions observed were: one death after i.m. administration at a dose of 35 mg kg^{-1} to two animals, and two deaths after i.v. administration at a dose of 2 mg kg^{-1} to two animals. For all these cases, the immediate cause of death was acute cardiovascular collapse. Biochemical analyses and gross and histological examinations showed that the animals that tolerated the high doses of 15 and 35 mg kg^{-1} given i.m.

had extensive and severe tissue damage at the injection sites. Significant increases in plasma γ-glutamyltransferase and alanine aminotransferase following drug administration suggested a degree of hepatobiliary damage.

7005 **Onyeyili, P.A. and Anika, S.M., 1991**. Diminazene aceturate residues in the tissues of healthy, *Trypanosoma congolense* and *Trypanosoma brucei brucei* infected dogs. *British Veterinary Journal*, **147** (2): 155-162.

Department of Veterinary Physiology and Pharmacology, Faculty of Veterinary Medicine, University of Maiduguri, P.M.B. 1069, Maiduguri, Nigeria; Department of Veterinary Physiology and Pharmacology, Faculty of Veterinary Medicine, University of Nigeria, Nsukka, Nigeria.

The tissue distribution and residue profile of diminazene aceturate was investigated in healthy dogs and in dogs infected with *T. congolense* and *T. b. brucei*. The drug was administered at 3.5 mg/kg i.m. and tissue samples were taken *post mortem* from the animals at 48, 72, 120, 168 and 240 h after injection. The drug was distributed to various organs and tissues of the body with the highest concentrations occurring in liver and kidney. Higher drug levels were obtained in the tissues of healthy dogs compared with trypanosome-infected animals except in the brain. The levels of residues in the healthy animals were significantly different ($P < 0.05$) from those of the infected dogs. The drug residues were still detectable in the tissues of the animals 10 days after drug administration.

7006 **Sekoni, V.O., Saror, D.I., Njoku, C.O. and Kumi-Diaka, J., 1991**. Effect of Novidium (homidium chloride) chemotherapy on elevated spermatozoa morphological abnormalities in the semen of Zebu bulls infected with *Trypanosoma vivax* and *Trypanosoma congolense*. *Animal Reproduction Science*, **24** (3-4): 249-258.

National Animal Production Research Institute, P.M.B. 1096, Ahmadu Bello University, Shika, Zaria, Nigeria; Faculty of Veterinary Medicine, Ahmadu Bello University, Zaria, Nigeria; ibid.; ibid.

The effect of Novidium chemotherapy on elevated values of spermatozoa morphological abnormalities consequent to *T. vivax* or *T. congolense* infection was investigated in Zebu bulls. Six of the 12 infected animals were treated with Novidium at the end of the twelfth week p.i. and studied for a period of 12 weeks post-chemotherapy. Parasites disappeared from the bloodstream within 3 days post-chemotherapy, but

although elevated values of spermatozoa morphological abnormalities decreased gradually within a period of 12 weeks post-chemotherapy they were still significantly ($P < 0.001$) higher than the pre-infection values, values for control bulls and also considerably higher than the optimum value of 20% for most fertile bulls, showing that the infected bulls might still be sub-fertile 12 weeks after Novidium chemotherapy.

7007 **Sones, K.R., 1988**. *Chemotherapy of African bovine trypanosomiasis: aspects of resistance of* Trypanosoma congolense *to isometamidium*. Ph.D. thesis, University of Glasgow, UK. (Unpublished thesis.)

RMB Animal Health, Dagenham, Essex RM10 7XS, UK.

The isometamidium sensitivity of strains of *T. congolense* was studied in tests with mice or cattle as hosts and in *in vitro* tests. The results showed that the method of choice should be tests performed on the definitive host (cattle) and that tests to assess the duration of prophylaxis should be carried out in addition to those to test therapeutic activity. A study of the apparent aparasitaemic interval following subcurative treatment of *T. congolense* infections in mice suggested that trypanosomes survived in the bloodstream in low numbers, rather than in cryptic foci as described for *T. b. brucei*. Attempts to induce changes in sensitivity by repeated subcurative treatment failed to alter significantly the isometamidium sensitivities of strains of *T. congolense* in both mice and goats. A relatively isometamidium-resistant strain of *T. congolense* was apparently unable to establish an infection in the presence of an existing infection of a sensitive strain, although in the reverse situation the sensitive strain became established and suppressed the resistant strain. These findings may help to explain the apparent scarcity of isometamidium resistance in the field.

7008 **Sutherland, I.A., Moloo, S.K., Holmes, P.H. and Peregrine, A.S., 1991**. Therapeutic and prophylactic activity of isometamidium chloride against a tsetse-transmitted drug-resistant clone of *Trypanosoma congolense* in Boran cattle. *Acta Tropica*, **49** (1): 57-64.

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

An investigation was conducted on the therapeutic and prophylactic activity of isometamidium chloride (Samorin) in Boran (*Bos indicus*) cattle against a *T. congolense* clone, IL 3270. This clone was derived,

without drug selection, from a stock originally isolated in Burkina Faso and has previously been shown to be resistant to isometamidium in both cattle and mice using an infection and treatment regimen. A group of five cattle was treated i.m. with 1.0 mg kg^{-1} isometamidium chloride and 28 days later challenged with *Glossina morsitans centralis* infected with *T. congolense* IL 3270. All five cattle and 17 untreated cattle challenged on the same day became parasitaemic by day 16 post-challenge, indicating that prophylaxis did not extend to 28 days post-treatment. The cattle were then treated with isometamidium chloride at one of the following doses and by different routes of administration: 1.0 or 2.0 mg kg^{-1} i.m., 0.25, 0.5, 0.75 or 1.0 mg kg^{-1} i.v. Infections relapsed in all cattle at an interval of 12-21 days following treatment, with the exception of those treated with 2.0 mg kg^{-1} i.m. in which the development of relapse infections was delayed. Similar studies were also conducted with a highly sensitive clone of *T. congolense*, IL 1180. Infections in cattle with this clone were eliminated by i.v. treatment with 0.25 mg kg^{-1} isometamidium chloride or i.m. treatment with 0.5 mg kg^{-1} isometamidium chloride. Thus, although i.v. administration of isometamidium eliminated a fully sensitive infection, treatment by this route appeared not to enhance the therapeutic efficacy of the drug in the treatment of a *T. congolense* clone which expresses a high level of resistance.

7009 **Whitelaw, D.D., Gault, E.A., Holmes, P.H., Sutherland, I.A., Rowell, F.J., Phillips, A. and Urquhart, G.M., 1991**. Development of an enzyme-linked immunosorbent assay for the detection and measurement of the trypanocidal drug isometamidium chloride in cattle. *Research in Veterinary Science*, **50** (2): 185-189.

Whitelaw: British Council, 203 New South Head Road, P.O. Box 2027, Australia; Gault, Holmes, Sutherland, Urquhart: University of Glasgow Veterinary School, Bearsden Road, Glasgow G61 1QH, UK; Rowell, Phillips: School of Pharmaceutical and Chemical Sciences, Sunderland Polytechnic, Sunderland SR2 7EE, UK.

An enzyme-linked immunosorbent assay (ELISA) was developed to measure accurately levels of the trypanocidal drug isometamidium in the serum of treated cattle. The assay requires only 5 μl of test serum, is sensitive to a level of 0.5 pg ml^{-1} and is highly specific. Cross reactivity does not occur with the two other widely used trypanocidal drugs diminazene

aceturate and homidium bromide. Serum drug levels are detectable for up to 6 months in cattle after a single dose of 1 mg kg^{-1} i.m., the maximum period under field conditions for which effective prophylaxis can be maintained against tsetse challenge. Application of the assay will aid the rationalisation of treatment campaigns and assist in assessing the occurrence of drug-resistant trypanosome populations.

7. EXPERIMENTAL TRYPANOSOMIASIS

(a) DIAGNOSTICS

7010 **Borowy, N.K., Schell, D., Schäfer, C. and Overath, P., 1991**. Diagnosis of human African trypanosomiasis and visceral leishmaniasis based on the detection of anti-parasite-enzyme antibodies. *Journal of Infectious Diseases*, **164** (2): 422-425.

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

(b) PATHOLOGY AND IMMUNOLOGY

7011 **Gould, S.S. and Castro, G.A., 1991**. Suppression of intestinal anaphylaxis by infection with *Trypanosoma brucei*. (Meeting abstract no. 7297.) *FASEB Journal*, **5** (6): A1627.

University of Texas Medical School, Houston, TX 77030, USA.

7012 **Ikeme, M.M. and Adelaja, A.O., 1990**. Effects of the timing of antigen stimulation on parasitaemia profile and subsequent immunodepression in an experimentally induced *Trypanosoma brucei* infection. [Rats.] *Revue d'Elevage et de Médecine vétérinaire des Pays tropicaux*, **43** (3): 331-336.

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

7013 **Kierszenbaum, F., Muthukkumar, S., Beltz, L.A. and Sztein, M.B., 1991**. Mechanisms of *Trypanosoma brucei rhodesiense*-induced immunosuppression: inhibition of human T cell proliferation and IL-2R expression. (Meeting abstract no. 7739.) *FASEB Journal*, **5** (6): A1704.

Kierszenbaum: Department of Microbiology, Michigan State University, East Lansing, MI 48824, USA.

7014 **Rifkin, M.R., 1991**. Role of phospholipids in the cytotoxic action of high density lipoprotein on trypanosomes. [*T. brucei*; human, baboon, rabbit, rat.] *Journal of Lipid Research*, **32** (4): 639-647.

Rockefeller University, 1230 York Avenue, New York, NY 10021, USA.

7015 **Sileghem, M., Darji, A. and Baetselier, P. de, 1991**. *In vitro* simulation of immunosuppression caused by *Trypanosoma brucei*. *Immunology*, **73** (2): 246-248.
Baetselier: Unit of Cellular Immunology, Institute of Molecular Biology, Vrije Universiteit Brussel, Paardenstraat 65, B-1640 Sint Genesius Rode, Belgium.

7016 **Sztein, M.B. and Kierszenbaum, F., 1991**. A soluble factor from *Trypanosoma brucei rhodesiense* which prevents progression of activated human T lymphocytes through the cell cycle. (Meeting abstract no. 7740.) *FASEB Journal*, **5** (6): A1704.
Sztein: Center for Vaccine Development, Department of Pediatrics, University of Maryland School of Medicine, 10 South Pine Street, Baltimore, MD 21201, USA.

7017 **Sztein, M.B. and Kierszenbaum, F., 1991**. A soluble factor from *Trypanosoma brucei rhodesiense* that prevents progression of activated human T lymphocytes through the cell cycle. *Immunology*, **73** (2): 180-185.
Sztein: Center for Vaccine Development, Department of Pediatrics, University of Maryland School of Medicine, 10 South Pine Street, Baltimore, MD 21201, USA.

(c) CHEMOTHERAPEUTICS
[See also **14**: no. 7045.]

7018 **Brun, R. and Rab, S., 1991**. *In vitro* drug sensitivity of *Trypanosoma congolense* isolates. *Parasitology Research*, **77** (4): 341-345.
Swiss Tropical Institute, P.O. Box, CH-4002 Basel, Switzerland.
Bloodstream forms of various *T. congolense* isolates exhibited variation in their sensitivity to diminazene and isometamidium which correlated well with the *in vivo* drug response. Procyclic forms, however, showed no such correlation and are therefore unsuitable for *in vitro* drug testing.

7019 **Buddhu, S., Penketh, P.G., Divo, A.A., Shyam, K., Patton, C.L. and Sartorelli, A.C., 1991**. Enhancement of the trypanocidal activity of methyltriazenes in an animal model by the addition of an amidino group. [*T. b. rhodesiense*; mice.] *Acta Tropica*, **49** (1): 69-72.
Sartorelli: MacArthur Center for Molecular Parasitology, Yale University School of Medicine, New Haven, CT 06510, USA.

7020 **Craciunescu, D.G., Scarcia, V., Furlani, A., Parrondo Iglesias, E., Ravalico, L. and Doadrio, A., 1990**. Synthesis, chemical character-ization and biological evaluation of new

platinum (II)-sulfonamide complexes. [*T. brucei*, *T. congolense*, *T. cruzi*.] *Arzneimittel-forschung*, **40** (II) (1): 183-187.

Craciunescu: Departamento de Química Inorgánica y Bioinorgánica, Facultad de Farmacia, UCM, 28040 Madrid, Spain.

7021 **Fairlamb, A.H., 1991**. Trypanothione metabolism in the chemotherapy of leishmaniasis and trypanosomiasis. [Incl. *T. brucei*, *T. congolense*.] *In*: Wang, C.C. (ed.), *Molecular and immunological aspects of parasitism* (Washington, USA; American Association for the Advancement of Science), pp. 107-121.

Department of Medical Protozoology, LSHTM, Keppel Street, London WC1E 7HT, UK.

7022 **Jennings, F.W., 1991**. Chemotherapy of trypanosomiasis: the potenti-ation of antimonial compounds by difluoromethylornithine (DFMO). [*T. brucei*; mice.] *Tropical Medicine and Parasitology*, **42** (2): 135-138.

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

7023 **Jennings, F.W., 1991**. Chemotherapy of CNS-trypanosomiasis: the combined use of the arsenicals and nitro-compounds. [*T. brucei*; mice.] *Tropical Medicine and Parasitology*, **42** (2): 139-142.

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

7024 **Kumar, A., Dhuley, J.N. and Naik, S.R., 1991**. Evaluation of microbial metabolites for trypanocidal activity: significance of biochemical and biological parameters in the mouse model of trypanosomiasis. [*T. evansi*.] *Japanese Journal of Medical Science and Biology*, **44** (1): 7-16.

Naik: Laboratory of Parasitology and Immunodiagnostics, Research Center, Hindustan Antibiotics Ltd, Pimpri, Pune 411018, India.

7025 **Onyeyili, P.A. and Onwualu, J.E., 1991**. Efficacy of combination of DFMO and diminazene aceturate in the treatment of late stage *Trypanosoma brucei brucei* infection in rats. *Tropical Medicine and Parasitology*, **42** (2): 143-145.

Department of Veterinary Physiology and Pharmacology, Faculty of Veterinary Medicine, University of Maiduguri, P.M.B. 1069, Maiduguri, Nigeria.

7026 **Ruiz, M.L. and Williamson, J., 1991**. Lipid peroxidation as

a component in trypanocidal drug action. [*T. b. rhodesiense*.] *Annals of Tropical Medicine and Parasitology*, **85** (1): 43-48.

Facultad de Farmacia, Universidad Central de Venezuela, Caracas, Venezuela; Division of Parasitology, National Institute for Medical Research, Mill Hill, London NW7 1AA, UK.

7027 **Zinsstag, J., Brun, R., Craciunescu, D.G. and Parrondo Iglesias, E., 1991**. *In vitro* activity of organometallic complexes of Ir, Pt and Rh on *Trypanosoma b. gambiense*, *T. b. rhodesiense* and *T. b. brucei*. *Tropical Medicine and Parasitology*, **42** (1): 41-44.
Brun: Swiss Tropical Institute, P.O. Box, CH-4002 Basel, Switzerland.

8. TRYPANOSOME RESEARCH

(a) CULTIVATION OF TRYPANOSOMES

7028 **Brun, R. and Jenni, L., 1987**. Salivarian trypanosomes: bloodstream forms (trypomastigotes). *In*: Taylor, A.E.R. and Baker, J.R. (eds), In vitro *methods for parasite cultivation* (London; Academic Press), pp. 94-117.

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

7029 **Gray, M.A., Hirumi, H. and Gardiner, P.R., 1987**. Salivarian trypanosomes: insect forms. *In*: Taylor, A.E.R. and Baker, J.R. (eds), In vitro *methods for parasite cultivation* (London; Academic Press), pp. 118-152.

CTVM, University of Edinburgh, Easter Bush, Roslin, Midlothian EH25 9RG, UK; ILRAD, P.O. Box 30709, Nairobi, Kenya; ibid.

7030 **Gumm, I.D., 1991**. The axenic cultivation of insect forms of *Trypanosoma (Duttonella) vivax* and development to the infective metacyclic stage. *Journal of Protozoology*, **38** (3): 163-171.

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

7031 **Hirumi, H. and Hirumi, K., 1991**. *In vitro* cultivation of *Trypanosoma congolense* bloodstream forms in the absence of feeder cell layers. *Parasitology*, **102** (2): 225-236.

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

7032 **Zweygarth, E., Gray, M.A. and Kaminsky, R., 1991**. Axenic *in vitro* cultivation of *Trypanosoma vivax* trypomastigote forms. *Tropical Medicine and Parasitology*, **42** (1): 45-48.
Zweygarth: KETRI, P.O. Box 362, Kikuyu, Kenya.

(b) TAXONOMY, CHARACTERISATION OF ISOLATES

7033 **Hide, G., Buchanan, N., Welburn, S., Maudlin, I., Barry, J.D. and Tait, A., 1991**. *Trypanosoma brucei rhodesiense*: characterisation of stocks from Zambia, Kenya, and Uganda using

repetitive DNA probes. *Experimental Parasitology*, **72** (4): 430-439.
Hide, Buchanan, Tait: Wellcome Unit of Molecular Parasitology, Department of Veterinary Parasitology, Glasgow University, Bearsden Road, Glasgow G61 1QH, UK; Welburn, Maudlin: TRL, ODA/University of Bristol, Langford House, Langford, Bristol BS18 7DU, UK; Barry: Wellcome Unit of Molecular Parasitology, Department of Genetics, Glasgow University, Church Street, Glasgow G11 5JS, UK.
We have previously described a system for characterising the relationships between trypanosome stocks of the *T. brucei* group based on Southern blotting with repetitive DNA probes followed by cluster analysis of resultant banding patterns (see *TTIQ*, **13**: no. 6390). In this study, we extend this analysis to examine the relationships between trypanosome stocks isolated from major sleeping sickness foci in Zambia, Kenya and Uganda. We show that the trypanosome strains responsible for disease in Zambia are quite distinct from those sampled from the Kenya/Uganda foci. Furthermore, the human serum resistant stocks isolated from the Kenya/Uganda foci which were isolated from man (or from animals) were found to form a tight group in the cluster analysis, while stocks isolated from nonhuman sources in the same area or stocks from elsewhere were found in separate groups. Thus, the human infective trypanosome strains found in these foci may have common origins and have, perhaps, arisen by clonal selection from a common source.

7034 **Toft, C.A. and Karter, A.J., 1990**. Parasite-host coevolution. *Trends in Ecology and Evolution*, **5** (10): 326-329.
Department of Zoology (Toft) and Department of Epidemiology and Preventive Medicine, School of Veterinary Medicine (Karter), University of California, Davis, CA 95616, USA.
This review article on the evolution of virulence includes a reference to African human trypanosomiasis. *Trypanosoma brucei gambiense* and *T. b. rhodesiense* were considered to cause an older (chronic) and a more recent (acute) form of the disease respectively. This scenario has spread in ecological literature as a classic example of the coevolutionary attenuation of virulence, but it is not supported by recent enzyme analysis. This has shown that *T. brucei* consists of six clusters of zymodemes. The original *gambiense* form can be identified enzymatically. While usually causing chronic disease, it varies in virulence and some

strains may have been identified as `*rhodesiense*' in the past. It also occurs in wild and domestic animals. Two zymodeme clusters, Zambezi and Busoga, correspond to northern and southern strains of *T. b. rhodesiense* and others correspond to *T. b. brucei* and *T. b. evansi*. Studies have shown that gene flow between these strains invalidates subspecific status for all except *T. b. gambiense*. The *T. brucei* complex and also *T. vivax*, which varies geographically in its virulence, offer prime opportunities to test hypotheses about the evolution of virulence.

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

7035 **Aboagye-Kwarteng, T., ole-MoiYoi, O.K. and Lonsdale-Eccles, J.D., 1991**. Phosphorylation differences among proteins of bloodstream developmental stages of *Trypanosoma brucei brucei*. *Biochemical Journal*, **275** (1): 7-14.
Lonsdale-Eccles: ILRAD, P.O. Box 30709, Nairobi, Kenya.

7036 **Baltz, T., Giroud, C., Bringaud, F., Eisen, H., Jacquemot, C. and Roth, C.W., 1991**. Exposed epitopes on a *Trypanosoma equiperdum* variant surface glycoprotein altered by point mutations. *EMBO Journal*, **10** (7): 1653-1659.
Roth: Unité d'Immunoparasitologie, URA 361, CNRS, Institut Pasteur, 25 rue du Dr Roux, F-75724 Paris Cedex 15, France.

7037 **Barry, J.D. and Turner, C.M.R., 1991**. The dynamics of antigenic variation and growth of African trypanosomes. *Parasitology Today*, **7** (8): 207-211.
Wellcome Unit of Molecular Parasitology and Institute of Genetics, University of Glasgow, Church Street, Glasgow G11 5JS, UK; Laboratory for Biochemical Parasitology, Department of Zoology, University of Glasgow, Glasgow G12 8QQ, UK.

7038 **Borst, P., 1991**. Molecular genetics of antigenic variation. [Incl. *T. brucei*.] *Parasitology Today*, **7** (3)/*Immunology Today*, **12** (3) (com-bined issue): A29-33.
Netherlands Cancer Institute, Plesmanlaan 121, 1066 CX Amsterdam, Netherlands.

7039 **Bradley, M., Bücheler, U.S. and Walsh, C.T., 1991**. Redox enzyme engineering: conversion of human glutathione reductase into a trypanothione reductase. *Biochemistry*, **30** (25): 6124-6127.
Walsh: Department of Biological Chemistry and Molecular Pharmacology, Harvard Medical School, Boston, MA 02115, USA.

7040 **Callens, M., Kuntz, D.A. and Opperdoes, F.R., 1991**. Kinetic properties of fructose bisphosphate aldolase from *Trypanosoma brucei* compared to aldolase from rabbit muscle and *Staphylococcus aureus*. *Molecular and Biochemical Parasitology*, **47** (1): 1-9.

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

7041 **Callens, M., Kuntz, D.A. and Opperdoes, F.R., 1991**. Characterization of pyruvate kinase of *Trypanosoma brucei* and its role in the regulation of carbohydrate metabolism. *Molecular and Biochemical Parasit-ology*, **47** (1): 19-29.

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

7042 **Callens, M. and Opperdoes, F.R., 1991**. Chemical modification of fructose bisphosphate aldolase from *Trypanosoma brucei* compared to aldolase from rabbit muscle and *Staphyloccus aureus*. *Molecular and Biochemical Parasitology*, **47** (1): 11-17.

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

7043 **Clayton, C., Fueri, J. and Mowatt, M., 1991**. The procyclic surface protein of *Trypanosoma brucei*. *In*: Wang, C.C. (ed.), *Molecular and immunological aspects of parasitism* (Washington, USA; American Association for the Advancement of Science), pp. 55-63.

Clayton: ZMBH, Heidelberg, Germany.

7044 **Coppens, I., Bastin, P., Courtoy, P.J., Baudhuin, P. and Opperdoes, F.R., 1991**. A rapid method purifies a glycoprotein of M_r 145,000 as the LDL receptor of *Trypanosoma brucei brucei*. *Biochemical and Biophysical Research Communications*, **178** (1): 185-191.

Coppens: Cell Biology Unit, University of Louvain School of Medicine and International Institute of Cellular and Molecular Pathology, Avenue Hippocrate 74, B-1200 Brussels, Belgium.

7045 **Doering, T.L., Raper, J., Buxbaum, L.U., Adams, S.P., Gordon, J.I., Hart, G.W. and Englund, P.T., 1991**. An analog of myristic acid with selective toxicity for African trypanosomes. [*T. brucei*.] *Science*, **252** (5014): 1851-1854.

Doering: Department of Biological Chemistry,

Johns Hopkins University School of Medicine, Baltimore, MD 21210, USA.

7046 **Down, J.A., Garman, S.C., Gurnett, A.M., Turner, M.J. and Wiley, D.C., 1991**. Crystallization and preliminary X-ray analysis of an intact soluble-form variant surface glycoprotein from the African trypanosome, *Trypanosoma brucei*. *Journal of Molecular Biology*, **218** (4): 679-683.

Down: Becton Dickinson & Co., Research Center, P.O. Box 12016, Research Triangle, NC 27709, USA.

7047 **Englund, P., Doering, T., Raper, J., Buxbaum, L., Hart, G. and Gordon, J., 1991**. Fatty acid remodeling of trypanosome GPI protein anchors: effect of myristate analogs. (Meeting abstract no. 8101.) *FASEB Journal*, **5** (6): A1766.

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

7048 **Field, M.C., Menon, A.K. and Cross, G.A.M., 1991**. Developmental variation of glycosylphosphatidylinositol membrane anchors in *Trypanosoma brucei*: identification of a candidate biosynthetic precursor of the glycosylphosphatidylinositol anchor of the major procyclic stage surface glycoprotein. *Journal of Biological Chemistry*, **266** (13): 8392-8400.

Field: Laboratory of Molecular Parasitology, Rockefeller Uni-versity, New York, NY 10021, USA.

7049 **Gommers-Ampt, J., Lutgerink, J. and Borst, P., 1991**. A novel DNA nucleotide in *Trypanosoma brucei* only present in the mammalian phase of the life-cycle. *Nucleic Acids Research*, **19** (8): 1745-1751.

Gommers-Ampt: Division of Molecular Biology, Netherlands Cancer Institute, Plesmanlaan 121, 1066 CX Amsterdam, Netherlands.

7050 **Graham, S.V. and Barry, J.D., 1991**. Expression site-associated genes transcribed independently of variant surface glycoprotein genes in *Trypanosoma brucei*. *Molecular and Biochemical Parasitology*, **47** (1): 31-41.

Institute of Genetics and Wellcome Unit of Molecular Parasitology, University of Glasgow, Church Street, Glasgow G11 5JS, UK.

7051 **Huang, J. and Ploeg, L.H.T. van der, 1991**. Maturation of polycistronic pre-mRNA in *Trypanosoma brucei*: analysis of *trans* splicing and poly (A) addition at nascent RNA transcripts from the *hsp70* locus. *Molecular and Cellular Biology*, **11** (6): 3180-3190.

Ploeg: Department of Genetics and Development, College of Physicians and Surgeons, Columbia

University, New York, NY 10032, USA.

7052 **Lambeir, A.-M., Loiseau, A.M., Kuntz, D.A., Vellieux, F.M., Michels, P.A.M. and Opperdoes, F.R., 1991**. The cytosolic and glycosomal glyceraldehyde-3-phosphate dehydrogenase from *Trypanosoma brucei*: kinetic properties and comparison with homologous enzymes. *European Journal of Biochemistry*, **198** (2): 429-435.

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

7053 **Masterson, W.J. and Ferguson, M.A.J., 1991**. Phenylmethanesulphonyl fluoride inhibits GPI anchor biosynthesis in the African trypanosome. [*T. brucei*.] *EMBO Journal*, **10** (8): 2041-2045.

Department of Biochemistry, Medical Sciences Institute, University of Dundee, Dundee DD1 4HN, UK.

7054 **Mensa-Wilmot, K., Doering, T.L., Raper, J., Buxbaum, L., Hart, G.W. and Englund, P.T., 1991**. Glycosyl phosphatidylinositol membrane anchors in African trypanosomes. [*T. brucei*.] *In*: Wang, C.C. (ed.), *Molecular and immunological aspects of parasitism* (Washington, USA; American Association for the Advancement of Science), pp. 43-54.

Department of Biological Chemistry, Johns Hopkins University School of Medicine, Baltimore, MD 21205, USA.

7055 **Michels, P.A.M., Marchand, M., Kohl, L., Allert, S., Wierenga, R.K. and Opperdoes, F.R., 1991**. The cytosolic and glycosomal isoenzymes of glyceraldehyde-3-phosphate dehydrogenase in *Trypanosoma brucei* have a distant evolutionary relationship. *European Journal of Biochemistry*, **198** (2): 421-428.

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

7056 **Michels, P.A.M. and Opperdoes, F.R., 1991**. The evolutionary origin of glycosomes. [Incl. *T. brucei*.] *Parasitology Today*, **7** (5): 105-109.

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

7057 **Moreno, S.N.J, Ip, H.S. and Cross, G.A.M., 1991**. An mRNA-dependent *in vitro* translation system from *Trypanosoma brucei*. *Molecular and Biochemical Parasitology*, **46** (2): 265-274.

Cross: Rockefeller University, 1230 York

Avenue, New York, NY 10021, USA.

7058 **Mottram, J.C., Shafi, Y. and Barry, J.D., 1991**. Sequence of a tRNA gene cluster in *Trypanosoma brucei*. *Nucleic Acids Research*, **19** (14): 3995.
Wellcome Unit of Molecular Parasitology, Institute of Genetics, University of Glasgow, Church Street, Glasgow G11 5JS, UK.

7059 **Munoz-Antonia, T., Richards, F.F. and Ullu, E., 1991**. Differences in glucose transport between bloodstream and procyclic forms of *Trypanosoma brucei rhodesiense*. *Molecular and Biochemical Parasitology*, **47** (1): 73-81.
Department of Internal Medicine, Yale MacArthur Center for Molecular Parasitology, Yale University School of Medicine, 333 Cedar Street, New Haven, CT 06510, USA.

7060 **Noble, M.E.M., Wierenga, R.K., Lambeir, A.-M., Opperdoes, F.R., Thunnissen, A.-M.W.H., Kalk, K.H., Groendijk, H. and Hol, W.G.J., 1991**. The adaptability of the active site of trypanosomal triosephosphate isomerase as observed in the crystal structures of three different complexes. [*T. b. brucei*.] *Proteins*, **10** (1): 50-69.
Wierenga: European Molecular Biology Laboratory, Meyerhof-strasse 1, D-6900 Heidelberg, Germany.

7061 **Ou, Y.C., Giroud, C. and Baltz, T., 1991**. Kinetoplast DNA analysis of four *Trypanosoma evansi* strains. *Molecular and Biochemical Parasitology*, **46** (1): 97-102.
Laboratoire d'Immunologie et de Biologie Parasitaire, Université de Bordeaux II, F-33076 Bordeaux Cedex, France.

7062 **Parsons, M., Stuart, K. and Smiley, B.L., 1991**. *Trypanosoma brucei*: analysis of codon usage and nucleotide composition of nuclear genes. *Experimental Parasitology*, **73** (1): 101-105.
Parsons: Seattle Biomedical Research Institute, 4 Nickerson Street, Seattle, WA 98109, USA.

7063 **Penketh, P.G., Divo, A.A., Shyam, K., Patton, C.L. and Sartorelli, A.C., 1991**. The effects of the methylating agent 1,2-bis-(methylsulfonyl)-1-methylhydrazine on morphology, DNA content and mitochondrial function of *Trypanosoma brucei* subspecies. *Journal of Protozoology*, **38** (3): 172-177.
Penketh: MacArthur Center for Molecular Parasitology, Yale University School of Medicine, New Haven, CT 06510, USA.

7064 **Pingel, S., Mecke, D. and Duszenko, M., 1990**. Nachweis und Charakterisierung von Galaktosyltransferasen in *Trypanosoma brucei brucei*. [Demonstration and

characterisation of galactosyltransferase in *T. b. brucei*.] *Mitteilungen der Österreichischen Gesellschaft für Tropenmedizin und Parasitologie*, **12**: 163-169.

Physiologische-Chemie Institut, Universität Tübingen, Hoppe-Seyler-Strasse 4, D-7400 Tübingen, Germany.

7065 **Revelard, P. and Pays, E., 1991**. Structure and transcription of a P-ATPase gene from *Trypanosoma brucei*. *Molecular and Biochem-ical Parasitology*, **46** (2): 241-251.

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

7066 **Robinson, D., Beattie, P., Sherwin, T. and Gull, K., 1991**. Microtubules, tubulin, and microtubule-associated proteins of trypanosomes. [*T. brucei*.] (Review.) *Methods in Enzymology*, **196**: 285-299.

Department of Biochemistry and Molecular Biology, Medical School, University of Manchester, Manchester M13 9PT, UK.

7067 **Rogers, M.V., 1991**. Do parasites express receptors for host lipoproteins? [Incl. *T. brucei*.] *Parasitology Today*, **7** (5): 117-120.

Department of Cell Biology, Wellcome Research Laboratories, Langley Court, Beckenham BR3 3BS, UK.

7068 **Ross, D.T., Raibaud, A., Florent, I.C., Sather, S., Gross, M.K., Storm, D.R. and Eisen, H., 1991**. The trypanosome VSG expression site encodes adenylate cyclase and a leucine-rich putative regulatory gene. [*T. equiperdum*.] *EMBO Journal*, **10** (8): 2047-2053.

Ross: Division of Basic Sciences, Fred Hutchinson Cancer Research Center, 1124 Columbia Street, Seattle, WA 98104, USA.

7069 **Ruben, L., Ridgley, E.L., Haghighat, N.G. and Chan, E., 1991**. Variant surface glycoprotein from *Trypanosoma brucei* clone YTat 1.1 contains a latent calmodulin-binding domain. *Molecular and Biochemical Parasitology*, **46** (1): 123-136.

Ruben: Department of Biological Sciences, Southern Methodist University, Dallas, TX 75275, USA.

7070 **Schell, D., Evers, R., Preis, D., Ziegelbauer, K., Kiefer, H., Lottspeich, F., Cornelissen, A.W.C.A. and Overath, P., 1991**. A transferrin-binding protein of *Trypanosoma brucei* is encoded by one of the genes in the variant surface glycoprotein gene expression site. *EMBO Journal*, **10** (5): 1061-1066.

Max-Planck-Institut für Biologie, Correnssstrasse 38 and Spemann-strasse 34, D-

7400 Tübingen, Germany.

7071 **Stadnyk, A.W., Myler, P.J., Lodes, M. and Stuart, K., 1991**. Characterization of expression site associated genes (ESAGs) of *Trypanosoma brucei*. (Meeting abstract no. 6741.) *FASEB Journal*, **5** (6): A1533.
Stadnyk: Dalhousie University, Halifax, Nova Scotia, B3H 4J3, Canada.

7072 **Tetley, L. and Vickerman, K., 1991**. The glycosomes of trypanosomes: number and distribution as revealed by electron spectroscopic imaging and 3-D reconstruction. [*T. brucei*, *T. evansi*.] *Journal of Microscopy*, **162** (1): 83-90.
Department of Zoology, University of Glasgow, Glasgow G12 8QQ, UK.

7073 **Thissen, J.A. and Wang, C.C., 1991**. Maintenance of internal pH and an electrochemical gradient in *Trypanosoma brucei*. *Experimental Parasitology*, **72** (3): 243-251.
Department of Pharmaceutical Chemistry, University of California, San Francisco, CA 94143, USA.

7074 **Verlinde, C.L.M.J., Noble, M.E.M., Kalk, K.H., Groendijk, H., Wierenga, R.K. and Hol, W.G.J., 1991**. Anion binding at the active site of trypanosomal triosephosphate isomerase: monohydrogen phosphate does not mimic sulphate. [*T. brucei*.] *European Journal of Biochemistry*, **198** (1): 53-57.
Hol: BIOSON Research Institute, University of Groningen, Nijenborgh 16, NL-9747 AG Groningen, Netherlands.

7075 **Walsh, C., Bradley, M. and Nadeau, K., 1991**. Molecular studies on trypanothione reductase, a target for antiparasitic drugs. (Review.) *Trends in Biochemical Sciences*, **16** (8): 305-309.
Department of Biological Chemistry and Molecular Pharmacology, Harvard University School of Medicine, Boston, MA 02115, USA.

7076 **Wang, C.C., 1991**. The ornithine decarboxylase of *Trypanosoma brucei*: a stable protein *in vivo*. *In*: Wang, C.C. (ed.), *Molecular and immunological aspects of parasitism* (Washington, USA; American Association for the Advancement of Science), pp. 87-94.
Department of Pharmaceutical Chemistry, University of California, San Francisco, CA 94143, USA.

7077 **Weiden, M., Osheim, Y.N., Beyer, A.L. and Ploeg, L.H.T. van der, 1991**. Chromosome structure: DNA nucleotide sequence elements of a subset of the minichromosomes of the protozoan *Trypanosoma brucei*. *Molecular and Cellular Biology*, **11** (8): 3823-3834.
Ploeg: Department of Genetics and Development,

College of Physicians and Surgeons, Columbia University, New York, NY 10032, USA.

7078 **Wierenga, R.K., Noble, M.E.M., Postma, J.P.M., Groendijk, H., Kalk, K.H., Hol, W.G.J. and Opperdoes, F.R., 1991**. The crystal structure of the `open' and the `closed' conformation of the flexible loop of trypanosomal triosephosphate isomerase. *Proteins*, **10** (1): 33-49.

Wierenga: European Molecular Biology Laboratory, Meyerhof-strasse 1, D-6900 Heidelberg, Germany.

7079 **Williams, N., Choi, S.Y.-W., Ruyechan, W.T. and Frank, P.H., 1991**. The mitochondrial ATP synthase of *Trypanosoma brucei*: develop-mental regulation through the life cycle. *Archives of Biochemistry and Biophysics*, **288** (2): 509-515.

Williams: Department of Biochemistry, Uniformed Services University of the Health Sciences, 4301 Jones Bridge Road, Bethesda, MD 20814, USA.

7080 **Wirtz, E., Sylvester, D. and Hill, G.C., 1991**. Characterization of a novel developmentally regulated gene from *Trypanosoma brucei* encoding a potential phosphoprotein. *Molecular and Biochemical Parasitology*, **47** (1): 119-128.

Molecular Parasitology Training Program, Division of Biomedical Sciences, Meharry Medical College, 1005 D.B. Todd Boulevard, Nashville, TN 37208, USA.

7081 **Zomerdijk, J.C.B.M., Kieft, R., Duyndam, M., Shiels, P.G. and Borst, P., 1991**. Antigenic variation in *Trypanosoma brucei*: a telomeric expression site for variant-specific surface glycoprotein genes with novel features. *Nucleic Acids Research*, **19** (7): 1359-1368.

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