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TSETSE AND TRYPANOSOMIASIS INFORMATION QUARTERLY

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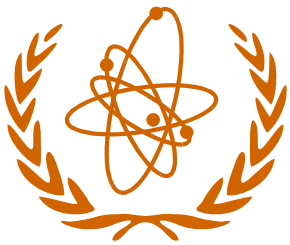

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section b — abstracts

1. GENERAL (INCLUDING LAND USE)

10138 **Artzrouni, M. and Gouteux, J.-P., 1997.** *A model of sleeping sickness: open vector populations and rates of extinction*. Pau, France; Laboratoire de Mathématiques Appliquées (UPRES A 5033), Université de Pau et des Pays de l'Adour/CNRS (*Analyse Non Linéaire et Modélisation* 97/15). 25 pp.

Artzrouni: Département de Mathématiques Appliquées, Université de Pau, 64000 Pau, France.

A compartmental model of sleeping sickness is described that takes into account a density-dependence of the vector population which is subjected to a regulating migratory mechanism. The analysis of the model focuses on the stability of the origin, which is assessed through the growth rate ev_5 of the infected populations. This growth rate is negative if and only if the basic reproduction number R_0 is less than 1. (In such a case we call ev_5 the extinction rate.) However, ev_5 and R_0 do not change in a consistent fashion. An example shows that a lowered R_0 (which may seem a desirable result) can actually slow down the extinction of the epidemic. We thus argue that ev_5 may be a better criterion for extinction that R_0 since it takes into account in a consistent fashion the time to extinction. This is an important factor in the study of control strategies which must be used over a period of time. The results are illustrated with numerical examples, and the consequences for control strategies are briefly discussed.

10139 **Echessah, P.N., Swallow, B.M., Kamara, D.W. and Curry, J.J., 1997.** Willingness to contribute labor and money to tsetse control: application of contingent valuation in Busia District, Kenya. *World Development (Oxford),* **25** (2): 239-253.

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

A household survey was conducted in six villages of Busia District, Kenya, to assess people's willingness to contribute labour and money to control tsetse flies. A Heckman's two-step model was estimated to identify factors affecting the probability that a respondent was willing to contribute labour or money and the factors affecting the amounts of labour or money he or she was willing to contribute. Everything else being equal, households willing to contribute the most money were those whose heads were female and well educated, while those willing to contribute the most labour were headed by men, had high cash income and had participated in an educational event.

10140 **Holmes, P.H., 1997.** New approaches to the integrated control of trypanosomosis. *Veterinary Parasitology*, **71** (2-3): 121-135.
University of Glasgow Veterinary School, Bearsden Road, Glasgow G61 1QH, UK.
Trypanosomosis is one of the most devastating diseases of animals and man in sub-Saharan Africa. Over the past century numerous methods of control have been developed yet the disease has proved very difficult to eradicate. Current methods to control the parasite, in the absence of a vaccine, have to rely on the use of trypanocidal drugs and trypanotolerant breeds of livestock. Vector control previously depended on ground and aerial spraying of insecticide but now depends on the use of traps, targets and bait technology. The application of insecticides to cattle is currently of particular interest. Unfortunately all of the current methods of control have disadvantages and none has proved to be sustainable. There is growing interest in integrated control which can be at three levels: integration with rural development, integration with other disease control measures and integration of various tsetse and trypanosomosis control measures. It is anticipated that distinct benefits can be achieved by an integrated approach which will improve the effectiveness of control and enhance the prospects of sustainability.

10141 **Lindberg, R. (ed.), 1996.** *Veterinary medicine – impacts on human health and nutrition in Africa* (Proceedings of a conference held at ILRI, Addis Ababa, Ethiopia, 27-31 August 1995). Uppsala, Sweden; Sveriges Lantbruksuniversitet (Swedish University of Agricultural Sciences). 163 pp.
Among the 20 contributions presented is a paper on the Sustainable use and development of national animal and feed resources in the production of human food in Africa (J. Rendel, pp. 81-86) which includes a discussion of trypano-tolerant cattle, and two abstracts on African trypanosomiasis – a major constraint to livestock production and a threat to human health (L. Logan-Henfrey, p. 51) and Contagious livestock diseases in Ethiopia: implications and control measures (B. Kebede, p. 53).

10142 **Pépin, J., 1997.** Zaire (Congo): resurgence of trypanosomiasis (`patients within borders'). *Lancet*, **349** (Suppl. 3): 10-11.
Centre for International Health, University of Sherbrooke, Sherbrooke, PQ J1H 5N4, Canada.
Attention is drawn to the plight of `patients within

borders'. Despite $500 million being disbursed by the international health community in 1994-96 to support 1.5 million refugees on Zairean territory, very little was allocated to the 45 million Zaireans exposed to sleeping sickness, dysentery, tuberculosis and other infectious calamities because their health system had largely collapsed as a result of anarchy, corruption and incompetence. Despite a new administration taking control in March 1997, at least a two-year delay can be expected before it establishes sufficient credibility for donors to resume funding.

10143 **Reid, R.S., Wilson, C.J., Kruska, R.L. and Woudyalew Mulatu, 1997.** Impacts of tsetse control and land-use on vegetative structure and tree species composition in south-western Ethiopia. *Journal of Applied Ecology*, **34** (3): 731-747.

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

The objective of this study was to assess the impacts of tsetse control, through expansion of agricultural land-use, on vegetative structure and tree species composition in the Ghibe Valley, south-western Ethiopia. This was done by first describing land cover/land-use patterns in areas with and without tsetse flies, and then quantifying land-use impacts on vegetation. Land-use/land cover was assessed and quantified by classifying a recent LANDSAT Thematic Mapper (TM) image of the valley and analysing the abundance of cover types in a geographical information system (GIS). Vegetative structure and tree species composition were measured in field plots in two types of cultivated fields (oxen- and tractor-ploughed), and in upland wooded grasslands and riparian woodlands. Land cover in the Ghibe Valley was dominated by wooded grasslands (60%) and cultivation (26%), with smaller patches of dense upland woodland (9%) and sparse woodland strips along river courses (3%). Most farms were cultivated by smallholders using oxen (25% of the total cultivated area) with limited areas ploughed by largeholders using tractors (0.5%). The cover of woody plants was highest in riparian woodlands (53%), moderate in oxen-ploughed fields (6%) and wooded grasslands (9%), and lowest in tractor-ploughed fields (1%). Species diversity (Shannon index $-H\hat{}$) was greatest in riparian woodlands (1.6) and smallholder fields (1.4), moderate in grasslands (1.0) and low on largeholder farms (0.7). These results highlight the importance of rare but biologically rich riparian areas, which should be a focus for conservation. If

tsetse control, through the expansion of cultivation, causes degradation of these woodlands, the potential for impact is high. However, there appear to be few changes in the vegetation in the process of conversion of wooded grasslands into smallholder fields, which is the likely result of successful tsetse control. A hypothetical model of vegetative change in the Ghibe Valley is described in the light of the vegetative potential of the area and recent changes in the frequency of hunting and burning in the valley.

10144 **Yapi-Gnaore, C.V., Oya, B.A. and Zana, O., 1996.** Revue de la situation des races d'animaux domestiques de Côte d'Ivoire. [Review of the status of breeds of domestic animals in Côte d'Ivoire.] *Animal Genetic Resources Information*, no. 19: 99-118.
Institut des Savanes (IDESSA), 01 B.P. 633, Bouaké 01, Côte d'Ivoire.
The major cattle, sheep and goat breeds in Côte d'Ivoire are described. Important cattle breeds are the Baoulé, the N'Dama and the Lagune, the last two of which are trypanotolerant. While the Baoulé breed still numbers about half a million and the N'Dama about 100,000, the population of the small-bodied Lagune is less than 1000. Crosses of the Baoulé with the zebu and of the N'Dama with the German Simmental and the French Abondance are also found. The major sheep breed is the Djallonké (West African Dwarf), of which there are about 1,200,000 animals under forest and savanna conditions. A selection programme for this breed was started in 1980. The only goat breed in Côte d'Ivoire is the West African Dwarf, which numbers about 1 million. Production of pigs and poultry is based mainly on indigenous types.

2. tsetse biology

(a) REARING OF TSETSE FLIES

(b) TAXONOMY, ANATOMY, PHYSIOLOGY, BIOCHEMISTRY

10145 **Aksoy, S., Chen, X. and Hypsa, V., 1997.** Phylogeny and potential transmission routes of midgut-associated endosymbionts of tsetse (Diptera: Glossinidae). *Insect Molecular Biology*, **6** (2): 183-190.
Aksoy: Department of Epidemiology and Public Health, Yale University School of Medicine, New Haven, CT 06510, USA.
Many tsetse species harbour two morphologically different intracellular endosymbiotic microorganisms (Proteobacteria) associated with gut tissue: primary (P) and secondary (S) endosymbionts. The P-

endosymbionts (*Wigglesworthia glossinidia*) are sequestered in specialised epithelial cells, bacteriocytes, which form a structure (bacteriome) in the anterior portion of the gut. The S-endosymbiont, which is a smaller (1-2 μm) gram-negative rod and is harboured in midgut epithelial cells, is a member of the family Enterobacteriaceae. Some tsetse species harbour a third bacterium in their reproductive tissue, which belongs to the *Wolbachia pipientis* assemblage of microorganisms. Here, it is shown that S-endosymbionts from five tsetse species (*Glossina morsitans morsitans*, *G. austeni*, *G. brevipalpis*, *G. fuscipes* and *G. palpalis palpalis*), representing all three subgenera, form a cluster of closely related microorganisms, based on their almost identical 16S rRNA gene sequences. This high similarity provides strong evidence of recent independent acquisitions of S-endosymbionts by individual tsetse species, unlike *Wigglesworthia* which displays concordant evolution with host insect species, suggesting an evolutionarily ancient association. A PCR-based assay and restriction fragment length polymorphism analysis was developed to localise the S-endosymbionts and *Wigglesworthia* in ovary, egg, milk gland and spermatheca tissues in order to investigate the potential routes for the vertical transmission of these symbionts to the intrauterine larvae. Only S-endosymbionts were found to infect milk gland tissue, suggesting that milk gland secretions represent a route of transmission for these symbionts into the developing larva. The ovary tissue was found to harbour only *Wolbachia*, confirming its transovarial transmission, whereas the mode of transmission of *Wigglesworthia* remains unknown.

10146 **Gooding, R.H., 1997.** Genetic analysis of hybrid sterility in crosses of the tsetse flies *Glossina palpalis palpalis* and *Glossina palpalis gambiensis* (Diptera: Glossinidae). *Canadian Journal of Zoology*, **75** (7): 1109-1117.
Department of Biological Sciences, University of Alberta, Edmonton, AB T6G 2E9, Canada.
Reciprocal crosses of *G. p. gambiensis* and *G. p. palpalis* were carried out using flies that had four marker genes on the X chromosome, two in linkage group II and one in linkage group III. The results of the reciprocal crosses conformed to Haldane's rule: F_1 males were sterile and most F_1 females were fertile. F_1 females mated to *G. p. gambiensis* were more likely to be fertilised than females that were mated to *G. p. palpalis*. In three of the four experiments, the fertility of backcross females was not significantly different from that of F_1

females, and there was little evidence that specific chromosomal combinations influenced the fertility of backcross females. Intrachromosomal recombination was lower in hybrid females than in *G. p. palpalis*. The major genetic factor associated with sterility among backcross males was the presence of sex chromosomes from the two subspecies; a minor factor was the number of heterozygous autosomes, but interactions between sex chromosomes and autosomes from different taxa did not contribute to hybrid male sterility. Evidence is presented that a major factor causing hybrid male sterility lies between the loci *tan* (an eye colour) and *Est-t* (testicular esterase) on the X chromosome. The use of differences between the fertility of males produced by backcrossing F_1 females to the two parental subspecies as indicators that other X chromosome loci have a role in hybrid sterility is discussed.

10147 **Sang, R.C., Jura, W.G.Z.O., Otieno, L.H., Tukei, P.M. and Mwangi, R.W., 1997.** Effects of tsetse DNA virus infection on the survival of a host fly, *Glossina morsitans centralis* (Diptera: Glossinidae). *Journal of Invertebrate Pathology*, **69** (3): 253-260.

Sang: Virus Research Centre, Kenya Medical Research Institute, P.O. Box 54628, Nairobi, Kenya.

Freshly deposited third instar *G. m. centralis* larvae were infected with the tsetse DNA virus by microinjection. At emergence comparative observations were made on longevity and feeding behaviour of infected and control flies. Gut tissues from the control and virus-infected flies were fixed and processed for light and electron microscopy. The longevity of infected flies was significantly reduced compared to that of the controls ($P < 0.05$). The main mortality factors in the virus-infected flies with severe lesions in the salivary glands were starvation due to failure to feed and clotting of blood in and/or rupture of the crop. Rupture of the midgut also caused some mortalities. Infected flies probed significantly more times during feeding to repletion ($P < 0.05$) and took significantly longer to feed compared to the control flies ($P < 0.05$). Infected flies which fed took significantly less blood compared to the controls ($P < 0.05$). Histological studies revealed pathological changes in the epithelial cells of the anterior midgut, secretory midgut and posterior midgut. There was severe disintegration of the membranous organelles, especially the mitochondria and rough endoplasmic reticulum, leading to extensive vacuolation in such epithelial

cells. No viral particles were observed in the secretory and posterior midgut. Virions were observed in the anterior midgut lumen and occasional particles were seen invading the epithelial cells in this area of the midgut, especially in heavily infected flies.

10148 **Sutton, B.D. and Carlson, D.A., 1997.** Cuticular hydrocarbons of *Glossina*, III: subgenera *Glossina* and *Nemorhina*. *Journal of Chemical Ecology*, **23** (5): 1291-1320. Carlson: USDA-ARS, Center for Medical, Agricultural and Veterinary Entomology, Gainesville, FL 32604, USA.

The cuticular methyl-branched alkanes of tsetse flies of the subgenera *Glossina* (*sensu stricto*, formerly *morsitans*) (*G. morsitans centralis*, *G. m. submorsitans*, *G. longipalpis*, *G. swynnertoni*) and *Nemorhina* (formerly *palpalis*) (*G. caliginea*, *G. fuscipes martinii*, *G. pallicera pallicera*, *G. p. newsteadi*) were identified and quantified by capillary gas-liquid chromatography (GC) and gas chromatography-mass spectrometry. Males of *G. (Nemorhina)* are differentiated from *G. (Glossina)* by dominant 27-, 28- and/or 29-carbon backbone trimethyl-alkanes with the methyl positions at 3,7,11-, 4,8,12- and 3,7,11-, respectively. All females contain major quantities of long-chain internally branched di- and/or trimethylalkanes that were previously implicated as mediators of sexual behaviour in males. Taxa within these two subgroups that are closely related and/or conspecific, based upon conventional morphological and ecological criteria, exhibit similar GC patterns and similar internally branched di- and trimethylalkane isomers in females. Examination of these potentially stimulatory methylalkanes may provide reasons for the reproductive isolation of closely related species from each other.

(c) DISTRIBUTION, ECOLOGY, BEHAVIOUR, POPULATION STUDIES

[See also **20**: no. 10156.]

10149 **Brightwell, R. and Dransfield, R., 1997.** Odour attractants for tsetse: *Glossina austeni*, *G. brevipalpis* and *G. swynnertoni*. *Medical and Veterinary Entomology*, **11** (3): 297-299. Brightwell: SNV Netherlands Development Organization, P.O. Box 30776, Nairobi, Kenya.

The effects of acetone, cow urine and octenol on catches of *G. austeni*, *G. brevipalpis* and *G. pallidipes* were studied at Bodhai in Garissa District, south-eastern Kenya, using modified NG2F traps in a 4 ∃ 4 randomised latin square with two replicates run over 4 days in eight sites. The effect of octenol on catches of *G. swynnertoni* and *G. pallidipes* during a survey of tsetse

distribution at Barkitabu in Narok District, south-western Kenya, was also studied. Acetone roughly doubled the catch of male and female *G. pallidipes* at Bodhai ($P < 0.001$), and the addition of cow urine gave a further 60-100% increase ($P < 0.001$). Octenol gave a slight (20%) non-significant increase for males, with no evidence of increase for females. For male *G. austeni*, acetone and cow urine together gave a significant ($P < 0.05$) increase in catch over the unbaited trap, whether with or without octenol; results for females were less clear, but acetone with cow urine still gave a higher catch than unbaited traps. For *G. brevipalpis*, octenol produced a clear increase in catches of both males ($P = 0.055$) and females ($P < 0.001$). A suggestion of a small increase was seen with cow urine but none with acetone. At Barkitabu, the addition of octenol to traps baited with acetone and cow urine increased catches of *G. swynnertoni* males by 80% ($P = 0.058$) and females by 40%. There therefore appear to be good prospects of developing combinations of traps and odours for effective monitoring of *G. austeni*, *G. brevipalpis* and *G. swynnertoni*.

10150 **Brightwell, R., Dransfield, R.D., Stevenson, P. and Williams, B., 1997.** Changes over twelve years in populations of *Glossina pallidipes* and *Glossina longipennis* (Diptera: Glossinidae) subject to varying trapping pressure at Nguruman, south-west Kenya. *Bulletin of Entomological Research*, **87** (4): 349-370.

Brightwell: SNV Netherlands Development Organization, P.O. Box 30776, Nairobi, Kenya.

Long-term changes in the size of populations of the tsetse flies *G. pallidipes* and *G. longipennis* were monitored over a 12 year period at Nguruman in south-western Kenya. Tsetse populations were subject to droughts of varying intensity and, from 1987, to trapping, initially by a research organisation, and later by a community-based development project. Populations were mainly sampled using odour-baited biconical traps, with data from other monitoring traps corrected accordingly. Mark-release-recapture studies were carried out to relate trap catches to absolute population size, and to quantify movement between subpopulations. Trypanosomiasis incidence rates in a herd of local cattle were also monitored for much of this period. Trap catches were shown to be well correlated with estimates of absolute population size, with no evidence of any seasonal change in trap efficiency. The intensity of trapping and level of seasonal immigration

appeared to be the main determinants of population trends, with effective control being achieved when traps were well maintained. Movement between the two lowland subpopulations was shown to be greater for females, and to be inversely related to temperature. An analytical model was used to investigate the responses of a partially isolated population to trapping pressure. Predictions of a deterministic simulation model demonstrated that the observed changes are consistent with an adult trapping mortality of 4-8% per day, and immigration of 100,000 *G. pallidipes* females per month in the long rains (April and May), 5000 per month in the short rains (November), and about 500 per month during the dry seasons. Trypanosomiasis incidence in local cattle was greatly reduced during the period of community-based tsetse control. When tsetse were sampled exactly where the cattle were grazing, disease incidence was shown to be linearly related to *G. pallidipes* catches. Arguments for trap resistance and residual populations were examined, and found to be inconsistent with the data. The future for tsetse control by the Nguruman community is considered.

10151 **Gouteux, J.-P., Jarry, M. and Wagner, C., 1997.** Etude de la structure spatio-temporelle d'un peuplement de *Glossina palpalis*, *G. pallicera* et *G. nigrofusca* (Diptera: Glossinidae) à l'aide de l'analyse triadique en secteur pré-forestier de Côte d'Ivoire. [A study of the spatial and temporal patterns of a tsetse guild consisting of *G. palpalis*, *G. pallicera* and *G. nigrofusca* in the preforested area of Côte d'Ivoire using triadic analysis.] *Journal of African Zoology*, **111** (2): 121-136. Gouteux: ORSTOM, Laboratoire de Mathématiques Appliquées, UPRES A CNRS 5033, IPRA-UPPA, Avenue de l'Université, F-64000 Pau, France.

The spatio-temporal pattern of a tsetse fly guild (*G. palpalis*, *G. pallicera* and *G. nigrofusca*) was studied by analysing catch data from biconical traps. The temporal dynamics of the two dominant species, *G. palpalis* and *G. pallicera* (67.6% and 30.1% of trapped flies), are in opposite phases, and there also appears to be a similar spatial relationship for these two species. A triadic analysis helped to clarify which aspects of this relationship result from a permanent pattern related to the habitat and which are linked to seasonal fluctuations. The analysis revealed the existence of *G. nigrofusca*, a marginal species which represents 2.3% of trapped flies. Zones with a high density of tsetse flies showed a varied ecological pattern (forest-

plantation mosaic, enclosed savannas, talwegs with water holes). The two dominant species alternate in these areas, probably depending on human presence. *G. palpalis* is mainly associated with large settlements or villages, while *G. pallicera* is more often present when settlements are small or nonexistent. Other more complex interspecific interactions may also be involved. *G. nigrofusca* avoids inhabited areas. This multi-species approach emphasises the importance of *G. pallicera* whose epidemiological role requires further elucidation.

10152 **Odulaja, A. and Abu-Zinid, I.M., 1997.** The relative efficiencies of Latin square and randomized complete block designs for insect trapping experiments: an investigation using field data on tsetse flies. *Ecological Entomology*, **22** (2): 184-188.
Odulaja: ICIPE, P.O. Box 30772, Nairobi, Kenya.
The Latin square design (LSD) is usually preferred over the randomised complete block design (RCBD) in insect trapping experiments because of its ability to cater for variations due to both sites and days in addition to treatments. The efficiency of LSD relative to RCBD was quantified for tsetse trapping experiments using a data set comprising 2200 trap-days. LSD was found to be more efficient than RCBD when blocks Θ days, but less efficient when blocks Θ sites, especially when experiments involve only three or four treatments. The importance of sites relative to days as sources of variation in tsetse trapping experiments was quantified. Effects due to site differences were shown to be more important than day to day variability. By relating LSD relative efficiency to the relative importance of sites, it was found that LSD efficiency depended on the relative magnitude of effects of sites and days.

10153 **Odulaja, A. and Mohamed-Ahmed, M.M., 1997.** Estimation of the efficiency of the biconical trap for *Glossina fuscipes fuscipes* along the Lake Victoria shore. *Entomologia experimentalis et applicata*, **82** (1): 19-24.
Odulaja: ICIPE, P.O. Box 30772, Nairobi, Kenya.
Prior to estimating the efficiency of the unbaited biconical trap for *G. f. fuscipes*, the flying height of the insects was estimated using 1 m^2 electrified nets placed at 0 and 4 m above the ground level. The degree of avoidance of these nets by the flies was determined by comparing catches in traps surrounded and those not surrounded by incomplete rings of nets. On the basis of the catches in traps surrounded by nets, the

expected catches on both sides of the nets were computed and compared with the observed catches, to further estimate this degree of avoidance. About 48% of males and 35% of females were captured above 1 m. An average of 61% of males and 40% of females appeared to avoid the nets. Between 18% and 40% fewer tsetse were caught in traps surrounded by an incomplete ring of nets of respectively 1 m and 2 m radius than in traps not surrounded. After corrections for net avoidance and flying height, it appeared important to determine the optimum radius for the incomplete ring of nets for a reliable efficiency estimate.

10154 **Robinson, T., Rogers, D. and Williams, B., 1997.** Univariate analysis of tsetse habitat in the common fly belt of Southern Africa using climate and remotely sensed vegetation data. *Medical and Veterinary Entomology*, **11** (3): 223-234.

Robinson: Department of Zoology, University of Oxford, South Parks Road, Oxford OX1 3PS, UK.

Tsetse are vectors of trypanosomes that cause diseases both in humans and livestock. Traditional tsetse surveys, using sampling methods such as Epsilon traps and black screen fly rounds, are often logistically difficult, costly and time-consuming. The distribution of tsetse, as revealed by such survey methods, is strongly influenced by environmental conditions, such as climate and vegetation cover, which may be readily mapped using satellite data. These data may be used to make predictions of the probable distribution of tsetse in unsurveyed areas by determining the environmental characteristics of areas of tsetse presence and absence in surveyed areas. The same methods may also be used to characterise differences between tsetse species and subspecies. In this paper we analyse the distribution of *Glossina morsitans centralis*, *G. m. morsitans* and *G. pallidipes* in southern Africa with respect to single environmental variables. For *G. m. centralis* the best predictions were made using the average NDVI (75% correct predictions; range > 0.37) and the average of the maximum temperature (70% correct predictions; 27.0-29.2□C). For *G. m. morsitans* the best prediction was given by the maximum of the minimum temperature (84% correct predictions; range > 18.8□C), and for *G. pallidipes*, also by the maximum of the minimum temperature (86% correct predictions; range > 19.6□C). The following paper (see **20**: no. 10155) compares a range of multivariate techniques for making predictions about the distribution of these species in the same region.

10155 **Robinson, T., Rogers, D. and Williams, B., 1997.** Mapping tsetse habitat suitability in the common fly belt of Southern Africa using multivariate analysis of climate and remotely sensed vegetation data. *Medical and Veterinary Entomology*, **11** (3): 235-245.
Robinson: Department of Zoology, University of Oxford, South Parks Road, Oxford OX1 3PS, UK.
The distributions of *Glossina morsitans centralis*, *G. m. morsitans* and *G. pallidipes* are described in part of southern Africa, using a range of multivariate techniques applied to climate and remotely sensed vegetation data. Linear discriminant analysis is limited in its predictive power by the assumption of common co-variances in the classes within multivariate environment space. Maximum likelihood classification is one of a variety of alternative methods that do not have this constraint, and produce a better prediction, particularly when *a priori* probabilities of presence and absence are taken into account. The best predictions are obtained when the habitat is subdivided, prior to classification, on the basis of a bimodality detected on the third component axis of a principal component analysis. The results of the predictions were good, particularly for *G. m. centralis* and *G. m. morsitans*, which gave overall correct predictions of 92.8% and 85.1%, with a Kappa index of agreement between the prediction and the training data of 0.7305 and 0.641 respectively. For *G. pallidipes*, 91.7% of predictions were correct but the value of Kappa was only 0.549. Very clear differences are demonstrated between the habitats of the two subspecies *G. m. centralis* and *G. m. morsitans*.

3. TSETSE CONTROL (INCLUDING ENVIRONMENTAL SIDE-EFFECTS)

[See also **20**: nos. 10138, 10139, 10143, 10147, 10150, 10206.]

10156 **Torr, S.J., Hall, D.R., Phelps, R.J. and Vale, G.A., 1997.** Methods for dispensing odour attractants for tsetse flies (Diptera: Glossinidae). *Bulletin of Entomological Research*, **87** (3): 299-311.
Torr: NRI, Central Avenue, Chatham Maritime, Kent ME4 4TB, UK.
Methods for dispensing tsetse attractants using sealed polyethylene sachets and bottles were studied in the laboratory and in the field in Zimbabwe. 1-Octen-3-ol (octenol), 4-methylphenol and 3-*n*-propylphenol were dispensed singly or as blends from sachets 25-200 cm^2 in surface area and with a wall thickness of 0.06-0.32 mm; butanone was dispensed from polyethylene bottles.

The release rates of attractants, assessed gravimetrically or by gas chromatograhic analysis of volatiles released, were independent of the amount present. The rates were related directly to surface area, inversely related to wall thickness and increased exponentially with temperature. With blends of the attractants, the release rates of the two phenols were directly proportional to the concentration present, but that of octenol showed an exponential dependence. A similar exponential effect was seen with blends of the attractants and an involatile diluent. For mixtures of chemicals, the ratio of the released components was not affected significantly by temperature, sachet size or wall thickness. Release rates from polyethylene sachets and bottles in the field varied 100-fold according to temperature differences related to the time of day, season and degree of insolation. Day-degree models to predict the losses of attractants from a polyethylene sachet in shade or in full sunlight were highly correlated (r^2 = 0.84 and 0.81, respectively) with observed losses. The practical implications of these findings are discussed.

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

[See also **20**: nos. 10138, 10151, 10173, 10180, 10188, 10206, 10210, 10222.]

10157 **Laveissière, C., Sané, B., Diallo, P.B., Truc, P. and Méda, A.H., 1997.** Le risque épidémiologique dans un foyer de maladie du sommeil en Côte d'Ivoire. [Epidemiological risk in an endemic area of sleeping sickness in Côte d'Ivoire.] *Tropical Medicine and International Health*, **2** (8): 729-732.

Laveissière: OCCGE/IPR, B.P. 1500, Bouaké 01, Côte d'Ivoire.

An epidemiological risk indicator based on purely entomological factors can be used to identify regions which are at higher risk of trypanosomiasis transmission within the endemic forest zones of Côte d'Ivoire and can serve to point out biotopes to be treated to make antivector campaigns more effective. In the forests of Côte d'Ivoire, so-called socially open environments, which are populated by a great number of ethnic groups who are highly mobile and whose camps are spread over a large area, are particularly vulnerable to epidemics of the disease. Transmission always occurs near water: at rivers, water holes, wells in plantations. By contrast, socially closed societies

consisting of a single ethnic group settled in a village are at much lower risk. It seems that human behaviour plays as much a role in transmission dynamics as environmental changes which may be more or less favourable to the vector.

10158 **Leak, S.G.A. and Rowlands, G.J., 1997.** The dynamics of trypanosome infections in natural populations of tsetse (Diptera: Glossinidae) studied using wing-fray and ovarian ageing techniques. *Bulletin of Entomological Research*, **87** (3): 273-282.

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

Trypanosome infections in approximately 110,000 tsetse of 12 species or subspecies (*Glossina pallidipes*, *G. morsitans morsitans*, *G. m. submorsitans*, *G. fuscipes fuscipes*, *G. f. quanzensis*, *G. palpalis palpalis*, *G. p. gambiensis*, *G. tachinoides*, *G. austeni*, *G. nashi*, *G. brevipalpis* and *G. tabaniformis*) at sites in Zaire, Côte d'Ivoire, Ethiopia, Kenya, Zambia and Gabon were studied over various periods between 1983 and 1994. Infection rates ranged from 0.2% in *G. f. quanzensis* at a site in Zaire, to 18% in *G. tabaniformis* at a site in Gabon. Statistical models were fitted to data for nine species or sub-species of tsetse (*G. pallidipes*, *G. m. morsitans*, *G. m. submorsitans*, *G. f. fuscipes*, *G. f. quanzensis*, *G. p. palpalis*, *G. p. gambiensis*, *G. tachinoides* and *G. tabaniformis*) recorded across eight sites. The prevalence of mature trypanosome infections increased with age, as determined by wing-fray category, for both *Trypanosoma vivax*- and *T. congolense*-type infections, although for *G. palpalis*, *G. tabaniformis* and *G. tachinoides* the rate of *T. vivax*-type infections decreased in older age categories. Infection rates for *T. brucei* were very low and statistical analysis was not possible for this species. Overall prevalences of *T. vivax*-type infections were significantly higher in female than in male flies in four tsetse species: *G. pallidipes*, *G. palpalis*, *G. tabaniformis* and *G. tachinoides*. At sites where ovarian ages were also determined, close correlations between wing-fray category and ovarian age were found.

10159 **Nigam, Y., Maudlin, I., Welburn, S. and Ratcliffe, N.A., 1997.** Detection of phenoloxidase activity in the hemolymph of tsetse flies, refractory and susceptible to infection with *Trypanosoma brucei rhodesiense*. *Journal of Invertebrate Pathology*, **69** (3): 279-281.

Nigam: Biomedical and Physiological Research Group, University of Wales, Singleton Park, Swansea SA2 8PP, UK.

Many defence reactions exhibited by insects are mediated by the enzyme phenoloxidase (PO) which

normally exists in the haemolymph as an inactive form, prophenoloxidase (proPO). ProPo is activated to PO by various microbial factors, triggering an enzyme cascade which culminates in immobilisation of the pathogen, making it more susceptible to other host defences. An investigation to detect PO in the haemolymph of tsetse flies revealed the presence of an elicitable enzyme system. Levels of spontaneous proPO activation in the haemolymph of refractory *Glossina palpalis palpalis* were always higher than those obtained for susceptible *G. morsitans morsitans* ($P < 0.001$ at 2 and 4 h). Moreover, while live procyclics of *T. b. rhodesiense* activated the proPO of both flies, PO activity was significantly higher in *G. p. palpalis* than in *G. m. morsitans* ($P = 0.0005$ at 4 h). Since female *G. m. morsitans* show lower levels of mature salivary gland infections with *T. b. rhodesiense* than males, the sexes were compared for haemolymph proPO activation. Spontaneous PO activity was slightly higher in female flies than in males (significant only at 4 h, $P = 0.014$). However, when stimulated by *T. b. rhodesiense* procyclics, PO activity was found to be much higher in females than in males ($P = 0.0015$ at 4 h), supporting the possibility of a correlation between proPO and the ability of tsetse to mature their infections.

10160 **Reifenberg, J.M., Cuisance, D., Frezil, J.L., Cuny, G. and Duvallet, G., 1997.** Comparison of the susceptibility of different *Glossina* species to simple and mixed infections with *Trypanosoma (Nannomonas) congolense* savannah and riverine forest types. *Medical and Veterinary Entomology*, **11** (3): 246-252.

Reifenberg: c/o Prof. G. Duvallet, CIRAD-EMVT Division Enseignement-Formation, B.P. 5035, 34032 Montpellier Cedex 1, France.

Teneral *Glossina morsitans morsitans*, *G. m. submorsitans*, *G. palpalis gambiensis* and *G. tachinoides* were allowed to feed on rabbits infected with *T. congolense* savanna type or on mice infected with *T. congolense* riverine-forest type. The four tsetse species and subspecies were also infected simultaneously *in vitro* on the blood of mice infected with the two clones of *T. congolense* via a silicone membrane. The infected tsetse were maintained on rabbits, and from day 25 after the infective feed the surviving tsetse were dissected in order to determine the infection rates. Results showed higher mature infection rates in *morsitans*-group tsetse flies than in *palpalis*-group tsetse flies when infected with the savanna type of *T. congolense*. In contrast, infection rates with the riverine-forest type of *T. congolense* were

lower, and fewer flies showed a full development cycle. The intrinsic vectorial capacity of *G. m. submorsitans* for the two *T. congolense* types was the highest, whereas the intrinsic vectorial capacity of *G. p. gambiensis* for the savanna type and *G. m. morsitans* for the riverine-forest type were the lowest. Among all tsetse which were infected simultaneously with the two types of *T. congolense*, the polymerase chain reaction detected only five flies which had both trypanosome taxa in the midgut and the proboscis. All the other infections were attributable to the savanna type. The differences in the gut of different *Glossina* species and subspecies allowing these two sub-groups of *T. congolense* to survive better and undergo the complete developmental cycle more readily in some species than in others are discussed.

10161 **Welburn, S.C. and Maudlin, I., 1997.** Control of *Trypanosoma brucei brucei* infections in tsetse, *Glossina morsitans*. *Medical and Veterinary Entomology*, **11** (3): 286-289. Welburn: Division of Molecular Genetics, University of Glasgow, Anderson College, 56 Dumbarton Road, Glasgow G11 6NU, UK.

Numbers of immature *T. b. brucei* within a tsetse midgut remain remarkably constant after establishment throughout the course of an infection, irrespective of whether the infection eventually matures. These results suggest a system of self-regulation of the parasite population in the insect gut based on a form of programmed cell death which would carry advantages for both the parasite and the vector.

5. human trypanosomiasis

(a) SURVEILLANCE

10162 **Buyse, D., Ende, J. van den, Vervoort, T. and Enden, E. van den, 1996.** [Sleeping sickness developed after a stay in Zaire.] (In Dutch.) *Acta Clinica Belgica*, **51** (6): 409-411. Ende: Instituut voor Tropische Geneeskunde, Kronenburgstraat 43/3, B-2000 Antwerp, Belgium.

A 32-year-old Italian man developed fever and general malaise 3 weeks after arrival in Zaire. Malaria was diagnosed by a thick blood film, but consequent treatment with quinine was unsuccessful. After repatriation, the diagnosis of early stage sleeping sickness due to *Trypanosoma brucei gambiense* was established. Treatment with eflornithine (Ornidyl) resulted in complete recovery.

10163 **Coordination Internationale de Lutte contre la Trypanosomiase, 1997.** Mise en place d'un système de surveillance épidémiologique de la trypanosomiase humaine africaine: méthodologie. [Putting in place a system of epidemiological surveillance of human African trypano-somiasis: methodology.] *Bulletin de Liaison et de Documentation de l'OCEAC*, **30** (1): 25-31.
At a meeting at Yaoundé in November 1996 the six OCEAC countries (Cameroon, Central African Republic, Chad, Congo, Equatorial Guinea, Gabon) decided to put in place a system of epidemiological surveillance of human African trypanosomiasis with standardised procedures for collecting and analysing data, with the general objective of providing information on the epidemiological status of the disease in endemic and at-risk areas as a guide to when and where to carry out control measures. Specific objectives are: to identify all villages situated in endemic or at-risk areas, to delimit foci, to find out the extent of surveillance and the disease intensity in each area, to establish epidemiological profiles of each focus, to analyse the dynamics of the foci in time and space and to analyse the impact of control activities. Two types of information will be gathered: quantitative (records of confirmed cases) and qualitative (population screening using MicroCATT to discover serological suspects). The data obtained will be analysed and interpreted by GIS, making it possible to present and compare data in different ways. Four categories of village will be identified: affected, suspect, unaffected and of unknown status. Instructions are appended for collecting blood samples on filter papers and for preparing and carrying out the MicroCATT test.

(b) PATHOLOGY AND IMMUNOLOGY

10164 **Ayed, Z., Brindel, I., Bouteille, B., Meirvenne, N. van, Doua, F., Houinato, D., Dumas, M. and Jauberteau, M.-O., 1997.** Detection and characterization of autoantibodies directed against neurofilament proteins in human African trypanosomiasis. *American Journal of Tropical Medicine and Hygiene*, **57** (1): 1-6.
Ayed: Laboratory of Immunology, Faculty of Medicine, 2 rue du Docteur Marcland, 08725 Limoges Cedex, France.
In serum and in cerebrospinal fluid (CSF) from patients with human African trypanosomiasis (HAT) with central nervous system (CNS) involvement, we detected autoantibodies directed to some proteins from these tissues. The characterisation of antigenic proteins by

Western blotting showed that the antibodies recognised the 200 kD and 160 kD proteins of neurofilament (NF). Serum anti-NF antibodies were more frequent in HAT patients than in control subjects (86% versus 24%; $P < 10^{-9}$) and they belonged predominantly to the IgM class (anti-NF IgM = 86% versus anti-NF IgG = 4%; $P < 10^{-9}$) in the patients with stage II (CNS involvement) HAT. The CSF antibodies to NF were IgM in 88% (22 of 25) of the cases and IgG in 32% (8 of 25) of the cases. Epitopes shared by NF and trypanosomes were detected by indirect immunofluorescence and this was confirmed by the disappearance of anti-NF reactivity after adsorption with trypanosome antigens (*Trypanosoma brucei brucei* or *T. b. gambiense*). Anti-NF antibodies were undetectable in the CSF from stage I HAT patients.

10165 **Chimelli, L. and Scaravilli, F., 1997.** Trypanosomiasis. *Brain Pathology*, 7 (1): 599-611.

Chimelli: Departamento de Patologia, Faculdade de Medicina Ribeirao Preto, 14049-900 Ribeirao Preto, SP, Brazil.

A review is given of the epidemiology, clinical presentation and pathological features of both African sleeping sickness and American Chagas' disease, based on human and experimental studies of both the central and peripheral nervous system. Although neurological involvement is common in both, African trypanosomiasis causes meningoencephalitis, in which somnolence is a prominent feature, while in American trypanosomiasis it is mainly the autonomic nervous system which is involved, leading to cardiomegaly and digestive megaviscera.

(c) TREATMENT

10166 **Harrison, S.M., Harris, R.W. and Bales, J.D., 1997.** Attempt to correlate urine arsenic excretion with clinical course during melarsoprol therapy of patients with Rhodesian trypanosomiasis. *American Journal of Tropical Medicine and Hygiene*, **56** (6): 632-636.

Harrison: P.O. Box 9224, Jackson, WY 83002, USA.

This study enrolled 28 CNS-involved patients with *Trypanosoma brucei rhodesiense* infection at the Kenya Trypanosomiasis Research Institute (Alupe, Kenya) to examine treatment efficacy and toxicity of melarsoprol in relation to renal excretion/dose relationships. This study complied with WHO treatment recommendations, initially treating with suramin followed by three courses of melarsoprol. Traced study patients had a relapse rate of 4.1%. The toxicity and crude death

rate was 7.1%. Total urine arsenic output was measured between 24 and 48 h after the last dose for each course. The range of means of total urine arsenic output between the three treatment courses was 356-511 μg. There was no correlation comparing melarsoprol dose, estimated creatine clearance, or urine arsenic output. Urinary pharmacokinetic parameters are not predictive of toxicity or therapeutic efficacy.

10167 **Khonde, N., Pépin, J. and Mpia, B., 1997.** A seven days course of eflornithine for relapsing *Trypanosoma brucei gambiense* sleeping sickness. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, **91** (2): 212-213.
Pépin: Centre Universitaire de Santé de l'Estrie, 3001 12ème Avenue Nord, Sherbrooke, Quebec, J1H 5N4, Canada.
Forty-seven patients with a relapse following a first treatment of *T. b. gambiense* trypanosomiasis were treated with a 7 day course of i.v. eflornithine (100 mg/kg every 6 h) and followed for 2 years. Four patients died after treatment, two of them possibly due to trypanosomiasis. One patient was completely lost to follow-up, 36 were followed for at least one year, and 25 have completed the 2 years' follow-up. Only one patient, a 5-year-old child, subsequently relapsed. Considering this child and two of the fatalities as treatment failures, the rate of failure was 6.5%. A 7 day course of i.v. eflornithine is an adequate treatment for cases of Gambian trypanosomiasis relapsing after treatment with another drug.

6. animal trypanosomiasis
(a) SURVEY AND DISTRIBUTION
[See also **20**: no. 10181.]

10168 **Alemu, T., Luckins, A.G., Phipps, L.P., Reid, S.W.J. and Holmes, P.H., 1997.** The use of enzyme linked immunosorbent assays to investigate the prevalence of *Trypanosoma equiperdum* in Ethiopian horses. *Veterinary Parasitology*, **71** (4): 239-250.
Alemu: National Tsetse and Trypanosomiasis Investigation and Control Centre, P.O. Box 8596, Addis Ababa, Ethiopia.
A field study involving 309 horses was undertaken in the provinces of Arsi and Bale in the Ethiopian highlands to investigate the prevalence of *T. equiperdum* infections using enzyme linked immunosorbent assays (ELISAs) for the detection of both trypanosomal antigen and antibody. Adult horses of both sexes were examined for clinical signs of *T. equiperdum* infection and serum samples were collected for the assays. One hundred and

one horses showed the presence of trypanosomal antibodies in their serum and 70 animals showed typical clinical signs of dourine. Nineteen horses showed the presence of trypanosomal antigen. Eight horses were positive for both *T. equiperdum* antibody and antigen. Blood and genital washes from seven antigenaemic horses were inoculated into mice and rabbits in an attempt to isolate trypanosomes but none became infected. Statistical analysis of the results of the antibody assays indicated that there were significant differences in the distribution of serologically positive horses in the different clinical groupings, with seroprevalence increasing with the severity of the observed clinical signs ($P < 0.001$). There was also a positive correlation between the presence of circulating trypanosomal antigen and clinical evidence of infection. Although it was not possible to obtain direct parasitological evidence of infection, the results of the serological assays, together with the clinical signs of disease observed in many of the horses, provide strong circumstantial evidence that *T. equiperdum* occurs in Arsi and Bale provinces of Ethiopia. Furthermore, in view of the large number of horses in Ethiopia and the unrestricted movement of animals throughout the country it is likely that dourine may be more widespread in Ethiopia than is currently realised. The assays used show potential for diagnosis of dourine, but to be widely applied in field situations for the diagnosis and control of dourine in Africa they require further validation of their specificity and sensitivity.

10169 **Almeida, P.J.L.P. de, Ndao, M., Meirvenne, N. van and Geerts, S., 1997.** Diagnostic evaluation of PCR in goats experimentally infected with *Trypanosoma vivax*. *Acta Tropica*, **66** (1): 45-50.

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

Six goats were experimentally infected with a stock of *T. vivax*. Parasitaemia was monitored weekly by buffy coat and wet blood film examination during a period of 15 weeks and another 3 weeks following drug treatment. Dried blood samples were tested by the polymerase chain reaction (PCR), using an extraction method with Chelex 100 (BioRad). PCR proved consistently more sensitive than the parasitological techniques.

10170 **Doko, A., Verhulst, A., Pandey, V.S., Büscher, P. and Lejon, V., 1996.** Détection d'antigènes circulants au cours d'une infection expérimentale à *Trypanosoma brucei brucei*

chez des bovins Borgou, Lagunaire et zébus Bororo blancs. [Detection of blood antigens in Borgou, Lagune and White Bororo zebu cattle experimentally infected with *T. b. brucei*.] *Revue d'Elevage et de Médecine vétérinaire des Pays tropicaux,* **49** (3): 207-211.
Pandey: Institute of Tropical Medicine, Nationalestraat 155, B-2000 Antwerp, Belgium.
Borgou (*n* = 10), Lagune (*n* = 10) and White Bororo zebu (*n* = 10) cattle were experimentally infected in Benin with a clone of *T. b. brucei* for evaluation of blood antigens using ELISA tests. None of the three non-inoculated control animals for each breed developed any infection. Borgou and Lagune cattle developed a benign disease followed by spontaneous recovery, whereas White Bororo zebus developed a typical chronic disease, fatal within several months. Overall ELISA sensitivity to *T. brucei* antigens was 20.46%, clearly lower than that of the buffy coat method of detecting parasites (40.24%). The sensitivity of ELISA tests differed greatly according to the type of animals and the dynamics of infection. It was highest in Borgou cattle (44.44%), which had high parasitaemias of short duration, and lowest in White Bororo zebus (4.09%), which had low and intermittent parasitaemias. To increase the sensitivity of the ELISA by decreasing the cut-off point of optical density (threshold of positivity) from 0.050 to 0.025 would highly compromise the test specificity. The false negatives at the beginning of the infection and false positives after spontaneous cure further compromise the validity of ELISA tests for diagnosis of active *T. brucei* infections.

10171 **Greiner, M., Bhat, T.S., Patzelt, R.J., Kakaire, D., Schares, G., Dietz, E., Böhning, D., Zessin, K.-H. and Mehlitz, D., 1997.** Impact of biological factors on the interpretation of bovine trypanosomosis serology. *Preventive Veterinary Medicine*, **30** (1): 61-73.
Greiner: Department of Tropical Veterinary Medicine and Epidemiology, Institute for Parasitology and Tropical Veterinary Medicine, Königsweg 67, D-14163 Berlin, Germany.
A total of 457 cattle from dairy farms in Mukono County, Uganda, were investigated for *Trypanosoma* antibodies by ELISA. The objective of the study was to identify explanatory covariate factors for seropositivity among nine farm-specific and four animal-specific variables. We used logistic regression models for parasitological and serological outcome variables and then compared the adjusted odds ratios for explanatory factors between the models. Age is positively correlated with seropositivity but not with the detection of the parasite. Therefore, age group-specific cut-off values were established using mixture-distribution analysis. This procedure, as well as a mixture-distribution-derived cut-off value for the total sample, resulted in a greater relative efficiency of the ELISA as compared to conventional interpretation (cut-off value defined using non-exposed negative controls). The relevance of age and other biological factors for the serological status is briefly discussed.

10172 **Jibike, G.I., Anene, B.M., Onyekweodiri, E.O., Chime, B.A. and Anika, S.M., 1995.** Rainy season prevalence of bovine trypano-somiasis in South-Eastern Nigeria. *Journal of the Pasteur Institute (Romania)*, **3**: 93-102.
Jibike: Department of Veterinary Physiology and Pharmacology, University of Maiduguri, Maiduguri, Nigeria.
A cross-sectional survey was carried out in five states in south-eastern Nigeria to measure the prevalence of bovine trypanosomiasis during the rainy season (July-October). The overall prevalence was 8.75% (88 of 1006 cattle were infected). The infection rate was highest in the rain forest zone (15.53%), followed by derived savanna (7.51%) and montane vegetation (1.5%). Of 57 herds screened, 25 were infected. Infection rates were higher in females and adults than in males and young animals. The infection rate was 30.86% amongst the exotic Friesian cattle compared with 10.10% in N'Dama, 9.33% in Muturu and 6.13% in Zebu. *Trypanosoma vivax*

accounted for over 57% of infections, followed by *T. congolense* (30%) and *T. brucei* (6%). It is concluded that the risk of bovine trypanosomiasis still exists in the areas covered by the survey. The nomadic nature and number of infected herds may contribute to the spread of the disease in these areas in the future.

10173 **Kalu, A.U., 1997.** *Epidemiology of ruminant trypanosomiasis in sleeping sickness endemic areas of Nigeria*. Ph.D. thesis, University of Nigeria, Nsukka. 186 pp.

Department of Veterinary Public Health and Preventive Medicine, University of Maiduguri, P.M.B. 1069, Maiduguri, Borno State, Nigeria.

The epidemiology of ruminant trypanosomiasis was investigated in three sleeping sickness endemic foci of Nigeria. A total of 2912 samples were collected of which 1975 were from trypanosusceptible cattle, 616 from Yankassa sheep and 321 from West African Dwarf and Red Sokoto goats or their cross-breeds. Also, 268 trypanotolerant cattle under different management systems were investigated at the most southern focus (Lower Benue river area). At the Lower Benue primordial sleeping sickness area, 1248 ruminants consisting of 705 Zebu cattle and 304 sheep under semi-nomadic management and 239 peri-domestic goats showed a prevalence of infection, over a twelve-month period, of 24.3%. Interspecies infection rates of 38.2%, 21.7% and 14.2% among sheep, cattle and goats respectively were significantly different ($P < 0.05$). Significant differences in prevalence were recorded between seasons of the year ($P < 0.01$) and among different age groups ($P < 0.01$) but not the localities ($P > 0.05$) and gender ($P > 0.05$) of the animals sampled. Low rainfall and relative humidity favoured high apparent density of *Glossina tachinoides*, the only tsetse fly species encountered in the area. Among trypanotolerant bovine herds, prevalence averaged 8.9%, was lowest in N'Dama (5.9%) and totally absent in yearling calves. Prevalence differed according to management practices, breed and age of animals and season of the year: significantly higher infection rates were diagnosed among herds on extensive management ($P < 0.01$), the Muturu breed ($P < 0.01$), cattle aged 6-9 years ($P < 0.05$) and during the rainy season ($P < 0.01$). The mean trypanosome infection rate among semi-nomadic ruminants on the Jos Plateau was 21.0% and was significantly higher ($P < 0.05$) in cattle. Low parasitaemia was common and accounted for 57.1% of the positive cases and 13.0% of the population at risk.

However, the vectors (*G. tachinoides* and *G. palpalis palpalis*) were encountered only during the rains. The presence of *G. morsitans submorsitans* in association with riverine tsetse species resulted in significantly higher ($P < 0.01$) infection in Jema's Local Government Area, Kaduna State, vis-à-vis other endemic foci: 36.4% of cattle, 9.8% of sheep and 7.3% of goats were trypanosome-positive. In all three locations monitored, *Trypanosoma vivax* was responsible for infections in 44.9% of parasite-positive cases and in 10.2% of the ruminants sampled. Corresponding figures for *T. congolense* were 17.6% and 4.0%, respectively. *T. brucei* ssp. was responsible for 4.7% of positive cases and was not encountered in caprine hosts. Stocks of *T. vivax* (21), *T. congolense* (15), *T. brucei* (12) and their mouse-passaged derivatives tested for susceptibility to trypanocides in small ruminants and rodent models showed that one *T. vivax*, four *T. congolense* and three *T. brucei* stocks were consistently resistant to Berenil (diminazene aceturate) at 7.0 mg/kg body weight and higher doses. Samorin (isometamidium chloride) also failed to effect parasitological cure of infections caused by two stocks each of *T. congolense* and *T. brucei* ssp. at 0.5 mg/kg. Two *Trypanozoon* stocks resistant to both Berenil and Samorin were also positive by the blood incubation infectivity test (BIIT), suggesting potential human infectivity.

10174 **Kalu, A.U. and Lawani, F.A., 1996.** Observations on the epidemiology of ruminant trypanosomosis in Kano State, Nigeria. *Revue d'Elevage et de Médecine vétérinaire des Pays tropicaux*, **49** (3): 213-217.

Kalu: Department of Veterinary Public Health and Preventive Medicine, University of Maiduguri, P.M.B. 1069, Maiduguri, Borno State, Nigeria.

The epidemiology of ruminant trypanosomosis was investigated during a two-year period in Kano State, Nigeria. Prevalence was 5.3 □ 1.3% (mean □ confidence interval), 1.2 □ 1.6% and 0.7 □ 1.3% in cattle, sheep and goats, respectively. Prevalence of bovine trypanosomosis was higher during the second year (6.1%) than in the first (4.8%). Infections doubled during the rains (7.6%) in comparison with an average of 3.8% during the dry season. The northern guinea vegetational zone recorded a high infection rate (Tudun-Wada local government area (LGA), 16.7%). It was the only area in which tsetse flies (*Glossina tachinoides*) were encountered. Nevertheless, haematophagous flies were common in the sudan savanna; tabanids were ubiquitous. *Trypanosoma vivax* infected 3.0%

of bovine herds and was responsible for 57.6% of all diagnosable cases. It is suggested that vector control in Tudun-Wada LGA and chemo-prophylaxis may break the transmission cycle of ruminant trypanosomosis in the area.

10175 **Olaho-Mukani, W., Munyua, W.K., Njogu, A.R., Mutugi, M.W., Omuse, J.K. and Sayer, P.D., 1992.** Application of an antigen-enzyme linked immunosorbent assay for the diagnosis of trypano-somosis in camels in Kenya. *In*: Allen, W.R. *et al*. (eds), 1992 (see **20**: no. 10181), pp. 33-36.

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

An antigen-ELISA (Ag-ELISA) employing the monoclonal antibody TEA 1/23.4.6 was used for the diagnosis of *Trypanosoma evansi* infections in 455 camels (10 herds) from Kenya. Parasitological examinations showed 109 camels to be infected, while serological examinations detected 161 positive samples (35%). Ag-ELISA detected 101 (93%) of the parasite-positive samples. Ag-ELISA also detected trypanosomal antigens in 93% of serum samples stored at −20□C for over 10 years. It was also shown that trypanosomal antigens disappeared from circulation within 30 days when the camels were successfully treated with quinapyramine prosalt.

10176 **Otte, M.J. and Gumm, I.D., 1997.** Intra-cluster correlation coefficients of 20 infections calculated from the results of cluster-sample surveys. *Preventive Veterinary Medicine*, **31** (1-2): 147-150.

Otte: University of Reading, VEERU, P.O. Box 236, Reading RG6 6AT, UK.

In developing countries, information on the prevalence of infections in the livestock population is generally obtained by means of cross-sectional surveys. Owing to the limited availability of sampling frames and high travel costs, it is usually impossible and impractical to select a simple random sample of animals from the population. The only solution for most surveys is to take a cluster sample, with herds or villages being randomly selected from a list and a defined number of animals then being randomly selected within each herd or village. The standard error (SE) of a cluster sample is usually larger than that for a random sample. This increase in the SE is known as the design effect (D) and is related to the average size of the cluster and the intra-cluster correlation coefficient (ρ) of the disease in question. The ρ values were calculated for a range of infections derived from surveys in traditional livestock production systems in Colombia,

Uruguay, Uganda, Zambia and Turkey. Fourteen of 33 values were between 0.05 and 0.10 and most (24/33) were below 0.20. High values (up to 0.39) were found for highly infectious infections, while moderately contagious infections had values between 0.08 and 0.12. ρ values for vector-borne diseases were very variable depending on the distribution, abundance and efficiency of the vector. Trypanosomiasis had ρ values of 0.12 and 0.15 in surveys in Uganda. Assuming a ρ value of 0.20, the *D* of a cluster sample survey with a sample of 10 animals is 2.8. Thus, assuming a prevalence of 50%, sampling 27 clusters of 10 animals should provide a prevalence estimate with a 95% confidence interval of plus or minus 10% for a wide range of infections.

10177 **Pathak, K.M.L., Yadvendra Singh, Meirvenne, N. van and Kapoor, M., 1997.** Evaluation of various diagnostic techniques for *Trypano-soma evansi* infections in naturally infected camels. *Veterinary Parasitology*, **69** (1-2): 49-54. Pathak: Department of Veterinary Parasitology, College of Veterinary and Animal Science, Bikaner 334 001, Rajasthan, India.

One hundred and eight camels (*Camelus dromedarius*) from *T. evansi* endemic areas of the Thar Desert of Rajasthan State, India, were evaluated by various diagnostic tests including parasitological tests (wet blood film – WBF, stained thick blood film), chemical test (mercuric chloride), biological test (mouse subinoculation – MSI), and immunodiagnostic tests based on antibody detection (double immunodiffusion test – DID, card agglutination test – CATT), antigen detection (double antibody sandwich enzyme linked immunosorbent assay – Ag-ELISA). Of the tested camels 49 were found infected using the WBF of which nine gave false negative results with the mercuric chloride test. The efficacy of MSI was 87.03%, while the mercuric chloride test was 60.18% efficient. The diagnostic efficacy of CATT (72.22%) was found to be much better than DID (28.70%). Ag-ELISA was 86.11% efficient in detecting trypanosomal antigens. A good correlation was found between the positive results obtained by wet blood film, CATT and Ag-ELISA. It was inferred that CATT can be used to study the seroprevalence of *T. evansi* with great ease. However, trypanosome antigen detection may give a more accurate idea of the prevalence of *T. evansi* in an endemic area.

10178 **Rae, P.F. and Luckins, A.G., 1992.** Problems in the diagnosis of cameline trypanosomosis. *In*: Allen, W.R. *et al*. (eds), 1992 (see **20**: no. 10181), pp. 29-31.

CTVM, Easter Bush, Roslin, Midlothian EH25 9RG, UK.
Some of the problems of diagnosing *Trypanosoma evansi* infections in camels, such as the difficulty of detecting chronic infections, are discussed and possible solutions suggested, including the use of species-specific monoclonal antibody technology.

10179 **Reifenberg, J.-M., Solano, P., Duvallet, G., Cuisance, D., Simpore, J. and Cuny, G., 1997.** Molecular characterization of trypanosome isolates from naturally infected domestic animals in Burkina Faso. *Veterinary Parasitology*, **71** (4): 251-262.
Reifenberg: CIRAD-EMVT, B.P. 5035, 34032 Montpellier Cedex 1, France.
A total of 33 trypanosome cryostabilates isolated from domestic animals (cattle and dogs) were analysed using the polymerase chain reaction (PCR). The PCR was undertaken on diluted and treated buffy coat solutions according to an easy protocol of purification, using primers specific to *Trypanosoma (Nannomonas) congolense* of savanna, riverine-forest, Kilifi and Tsavo types, *T. (N.) simiae*, *T. (Trypanozoon) brucei* and *T. (Duttonella) vivax*. The results showed a lack of PCR sensitivity when target solutions were simply diluted, probably a reflection of the inaccuracy of the dilution procedure at very low trypanosome numbers. Nine mixed infections were found in purified samples whereas only three were detected in diluted crude solutions. *T. congolense* savanna type was present in all stabilates. Double infections involving this type with the riverine-forest type, *T. vivax* or *T. brucei* were found. One stabilate was found to be infected with three trypanosome types, namely *T. congolense* savanna and riverine-forest genotypes and *T. vivax*. No infection attributable to *T. congolense* Kilifi and Tsavo types or *T. simiae* was detected in these stabilates. This work confirmed the abundance of mixed infections in the field, which could not have been detected by the classical parasitological methods. Amongst the *T. congolense* infections, the savanna genotype was found to be predominant over the riverine-forest type; this could be a consequence of differences in genotype virulence in cattle. The detection of *T. congolense* riverine-forest type in vertebrate hosts living in wet areas could be confirmation of the suspected affinity of relationships between this taxon and the riverine forest tsetse fly species.

10180 **Truc, P., Formenty, P., Duvallet, G., Komoin-Oka, C., Diallo, P.B. and Lauginie, F., 1997.** Identification of trypanosomes isolated by KIVI from wild mammals in Côte d'Ivoire:

diagnostic, taxonomic and epidemiological considerations. *Acta Tropica*, **67** (3): 187-196.
Truc: Laboratoire de Génétique des Parasites et Vecteurs, OCCGE/ IPR, B.P. 1500, Bouaké 01, Côte d'Ivoire.
In Côte d'Ivoire, a comparative study was carried out on 122 wild animals by parasitological and serological examination and by *in vitro* isolation of trypanosomes from fresh blood (KIVI). Thirteen isolated stocks were studied by isoenzymes and compared with *Trypanosoma congolense* and *T. brucei* Bouaflé group reference stocks. Of the 122 animals, only 22 were positive on blood smears while 88 were KIVI positive and 92 were CATT/*T. b. gambiense* positive. For six stocks identified by isoenzymes as *T. congolense*, the agreement between ELISA and CATT was good (75%). As compared with CATT, antigen detection ELISA was not satisfactory for *T. brucei* (20%). Out of 18 stocks, 16 represented a separate zymodeme (seven *T. congolense* and nine *T. brucei*) and a high genetic heterogeneity was observed. For *T. congolense*, savanna, Kilifi and forest groups were represented by one zymodeme each. The four remaining zymodemes, while put into this *T. congolense* group, were strongly independent of each other. Morphology indicated that these new zymodemes corresponded to *T. congolense*. On the other hand, five new zymodemes fitted into *T. brucei* classification.

(b) PATHOLOGY AND IMMUNOLOGY

10181 **Allen, W.R., Higgins, A.J., Mayhew, I.G., Snow, D.H. and Wade, J.F. (eds), 1992.** *Proceedings of the First International Camel Conference, Dubai, 2-6 February 1992*. Newmarket, UK; R & W Publications (Newmarket) Ltd.
These proceedings include several papers concerning trypanosomiasis in camels (see **20**: nos. 10175, 10178, 10184, 10190) and abstracts on Camel trypanosomosis in the Sudan (H.S. Abdalla, p. 401), Evaluation of monoclonal and polyclonal antibody based antigen detection immunoassays for diagnosis of *Trypanosoma evansi* infections in camels (O. Diall, V.M. Nantulya, A.G. Luckins, E.B. Songa and B. Diarra, p. 404), Serum biochemical, enzymes and haematological changes in one humped camels infected with surra (Zia-ur-Rahman, p. 405) and Influence of some diseases on liver and kidney functions in camels (A.M.A.F. Sameie, p. 413).

10182 **Doko, A., Verhulst, A., Pandey, V.S. and Stuyft, P. van der, 1997.** Artificially induced *Trypanosoma brucei brucei* infection in Lagune and Borgou cattle in Benin.

Veterinary Parasitology, **69** (1-2): 151-157.
Pandey: Prince Leopold Institute of Tropical Medicine, Nationale-straat 155, B-2000 Antwerp, Belgium.
Lagune (n = 10) and Borgou (n = 10) cattle of Benin were inoculated subcutaneously with *T. b. brucei* AnTat 1.1E. Clinical signs, PCV, parasitaemia, specific trypanolytic antibodies and haemolytic complement were monitored to evaluate the between- and within-breed variations. All the animals showed only transitory symptoms with clinical recovery within 20 days p.i. Infected animals showed a moderate drop in PCV after 5-10 days of infection. The drop in PCV at day 20 was 2.9 □ 2.7% for Borgou and 1.2 □ 1.8% for Lagune. Except for two animals of Borgou breed, all animals developed detectable parasitaemia. Two peaks of parasitaemia, the first on day 5-6 and the second on day 9-10 p.i., were observed. Parasitaemia persisted for 25 days in two Borgou and one Lagune cattle. There were large individual variations in PCV and parasitaemia. AnTat 1.1 specific trypanolytic antibodies were detected from day 6-7 in all animals, except one Borgou, and they persisted until the end of observation on day 30. A drop in serum haemolytic complement occurred corresponding to the first parasitaemic waves. After day 15, complement level was restored rapidly, largely exceeding the initial values of day 0. The results indicate that all the artificially infected individuals belonging to the Borgou breed as well as to the better known Lagune breed are tolerant to *T. b. brucei* infection.

10183 **Katunguka-Rwakishaya, E., Murray, M. and Holmes, P.H., 1997.** The influence of supplementation with cotton seed cake on the resistance of Ugandan goats to primary and secondary challenges with *Trypanosoma congolense* and on their response to treatment. *Veterinary Parasitology*, **70** (1-3): 67-76.
Katunguka-Rwakishaya: Department of Veterinary Medicine, Makerere University, P.O. Box 7062, Kampala, Uganda.
The present study investigated the influence of supplementation with cotton seed cake on the resistance of the Small East African breed of goats to primary and secondary challenges with *T. congolense* and on their response to chemo-therapy with diminazene aceturate. The supplemented group received 300 g of cotton seed cake per day in addition to about 500 g of fresh napier grass which was available to the unsupplemented group. It was observed that the supplemented infected (SI)

group tended to sustain higher intensities of parasitaemia than the unsupplemented infected (USI) group, particularly during the primary challenge, and both groups showed longer prepatent periods to secondary challenge than to primary challenge. Infection caused a significant reduction in the rate of live body weight gain in the USI group compared with the unsupplemented control (USC) group, whilst the SI group grew at the same rate as the supplemented control (SC) group. This effect was observed during both primary and secondary challenges. Following primary challenge, both infected groups developed similar degrees of anaemia, but the PCV levels in the SI group improved towards the end of the first challenge and were also significantly higher than those of the USI group during the second challenge. After treatments at 56 and 126 days p.i., the greatest response was observed in PCV values. The response of the SI group was superior to that of the USI group and by 4 weeks after treatment the PCV values of the SI and SC groups were similar while those of the USI group were significantly lower than those of the USC group. It is concluded that supplementation with cotton seed cake plays an important role in the rate of live weight gain and in the rate of recovery from anaemia produced by trypanosome infection in goats.

10184 **Luckins, A.G., 1992.** Protozoal diseases in camels. *In*: Allen, W.R. *et al*. (eds), 1992 (see **20**: no. 10181), pp. 23-27.

CTVM, Easter Bush, Roslin, Midlothian EH25 9RG, UK.

The aetiology, clinical signs, pathology, diagnosis, treatment and control of *Trypanosoma evansi* infection in camels is discussed. Piroplasmid and coccidial infections are also mentioned.

10185 **Mutayoba, B.M., O'Shaughnessy, P.J., Jeffcoate, I.A., Eckersall, P.D., Cestnik, V. and Holmes, P.H., 1997.** Effect of experimental infection with *Trypanosoma congolense* and scrotal insulation on Leydig cell steroidogenesis in the ram. *Theriogenology*, **48** (3): 411-422.

Jeffcoate: Department of Veterinary Physiology, University of Glasgow Veterinary School, Glasgow G61 1QH, UK.

Testicular steroid content and Leydig cell steroidogenesis *in vitro* were investigated in rams on days 28 and 58 after *T. congolense* infection and were compared with those of rams in which testicular temperature had been raised artificially by insulation of the scrotum for 58 days. Testicular testosterone content increased

significantly on day 28 p.i. but was lower than that of controls on day 58, while it increased in scrotal-insulated rams compared with that of controls by day 58. Testicular progesterone was undetectable in the control and trypanosome-infected groups throughout the experiment, but it increased in the insulated rams by day 58. Basal (unstimulated) Leydig cell testosterone production in the infected rams was similar to that of control rams on day 28 but was significantly lower on day 58. Stimulation of Leydig cell testosterone production with hCG or 22R-hydroxycholesterol (22ROHC) was significantly reduced in infected rams at both 28 and 58 days p.i. as well as in scrotal-insulated rams on day 58. It is concluded that the increase in testicular testosterone content in the infected and scrotal-insulated rams on days 28 and 58, respectively, was induced by elevation of testicular temperature by trypanosome infection, perhaps through an effect on testicular blood flow. Reduced testosterone production by Leydig cells from infected and scrotal-insulated rams in response to hCG and 22ROHC suggests that trypanosome-induced pyrexia might be involved in reducing Leydig cell steroidogenesis and subsequent plasma testosterone levels, possibly by affecting enzymes involved in steroid biosynthesis.

10186 **Osaer, S., Goossens, B., Sauveroche, B. and Dempfle, L., 1997.** Evaluation of the semen quality and reproductive performance of trypanotolerant Djallonké rams following an artificial infection with *Trypanosoma congolense*. *Small Ruminant Research*, **24** (3): 213-222.

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

Following an experimental infection with *T. congolense*, the semen quality and reproductive performance of 17 mature Djallonké rams was studied during a period of 26 weeks. The rams were randomly divided into three groups, namely one control group (G1) and two infected groups (G2 and G3). During the 5 weeks pre-infection the normal semen parameters were assessed. Following infection, moderate clinical symptoms associated with trypanosomosis were seen among the infected rams. Thirteen weeks p.i. diminazene aceturate was administered to group 3. Both the treated group and the control group had significantly better weights than the infected group in the period following the trypanocidal treatment. The impact of trypanosomosis on the reproductive performance of the rams was seen in reduced libido with a higher rate of refusals and on semen quality with some temporary

effects on mass motility, percentage live sperm cells and minor sperm cell abnormalities. However, these temporary changes in semen parameters were not significant when analysed as impact of infection. From the present study it was concluded that reproductive performance was not significantly impaired following artificial *T. congolense* infection. In addition, the Djallonké rams also showed an important clinical tolerance. However, significant differences between rams indicated a large variation in clinical response and reproductive performance following trypanosome infection.

10187 **Ouma, J.O., Olaho-Mukani, W., Wishitemi, B.E.L. and Guya, S.O., 1997.** Changes in classical pathway complement activity in dromedary camels experimentally infected with *Trypanosoma evansi*. *Veterinary Immunology and Immunopathology*, **57** (1-2): 135-140.

Ouma: Division of Biochemistry and Immunology, KETRI, P.O. Box 362, Kikuyu, Kenya.

The complement system is known to have important effector functions in immune responses. However, its role in camel trypanosomosis has not been determined. The present study was undertaken to evaluate haemolytic complement activity in *T. evansi*-infected and uninfected camels. Five dromedary camels were experimentally infected with *T. evansi* and classical pathway haemolytic complement activity was assayed. Parasitaemia and PCV were also monitored. Following infection, classical pathway haemolytic complement showed a slight initial increase (7%) in all the camels. The amounts later dropped as the infection progressed and correlated negatively with parasitaemia. Haemolytic complement recovered following elimination of trypanosomes by treatment with melarsomine. Treatment of uninfected camels had no effect on complement. This study has demonstrated that complement concentration increases in the initial phase of infection followed by a drop as the infection progresses towards chronicity. In addition, the study has shown that activation of the classical complement pathway occurs in camels infected with *T. evansi*. Complement could therefore be involved in the *in vivo* control of parasitaemia in dromedary camels infected with *T. evansi*. Decreased complement levels in this species could lead to immunosuppression, widely reported in animal trypanosomosis.

(c) TRYPANOTOLERANCE

[See **20**: no. 10182.]

(d) TREATMENT

[See also **20**: no. 10173.]

10188 **Diack, A., Moloo, S.K. and Peregrine, A.S., 1997.** Effect of diminazene aceturate on the infectivity and transmissibility of drug-resistant *Trypanosoma congolense* in *Glossina morsitans centralis*. *Veterinary Parasitology*, **70** (1-3): 13-23.

Peregrine: Department of Pathobiology, Ontario Veterinary College, University of Guelph, Guelph, ON N1G 2W1, Canada.

To determine the duration after treatment of cattle with diminazene aceturate that the drug influences the tsetse infectivity and transmissibility of a drug-resistant *T. congolense*, six Boran cattle were infected with *T. congolense* IL 3338 via the bites of *G. m. centralis*. At the first peak of parasitaemia, different groups of 120 teneral *G. m. centralis* were fed on one occasion on each animal, 1 h before treatment with diminazene aceturate at a dose of 3.5 mg/kg body weight. Thereafter, on days 1, 2, 3, 7, 14 and 21 after treatment, six different groups of 120 teneral *G. m. centralis* were similarly fed on each animal. After 28 days maintenance on uninfected goats, all the flies were probed onto slides at 37□C to identify those extruding metacyclic trypanosomes. Flies with mature infections from each group were then fed on one occasion on individual mice to determine the transmissibility index. After dissection of flies on day 30 after their feed on the cattle, the mean mature (□ SE) infection rates in the seven groups of flies were 32.1 □ 2.2, 1.0 □ 0.7, 0.4 □ 0.4, 0.5 □ 0.3, 20.0 □ 1.7, 33.3 □ 2.2 and 23.4 □ 2.0% for flies fed on days 0, 1, 2, 3, 7, 14 and 21 after treatment with diminazene, respectively. The transmissibility rates for the seven groups ranged from 94 to 100%. Thus, when cattle were infected with a diminazene-resistant *T. congolense*, treatment with diminazene aceturate caused a substantial reduction in the ability of the trypanosomes to establish mature infections in tsetse for at least the first 7 days after treatment. In contrast, no significant effect on the transmissibility of the parasites to mice was observed at different intervals after treatment.

10189 **Eisler, M.C., Stevenson, P., Munga, L. and Smyth, J.B.A., 1997.** Concentrations of isometamidium chloride (Samorin$^{\varepsilon}$) in sera of Zebu cattle which showed evidence of hepatotoxicity following frequent trypanocidal treatments. *Journal of Veterinary Pharmacology and Therapeutics*, **20**

(3): 173-180.
Eisler: University of Glasgow Veterinary School, Bearsden Road, Glasgow G61 1QH, UK.
The concentrations of isometamidium circulating in poorly nourished Zebu cattle which showed morbidity, mortality and biochemical and histopathological evidence of hepatotoxicity following frequent treatments with isometamidium chloride and diminazene aceturate were investigated using the isometamidium-ELISA. As few as two isometamidium treatments one month apart were associated with significant weight loss, and cattle treated with diminazene aceturate after three or four isometamidium treatments suffered a 50% mortality. Although there were no obvious, marked elevations in isometamidium concentration which might have allowed the use of the ELISA as a predictor of a potential toxicity problem, concentrations did increase significantly with the number of monthly treatments administered, suggesting drug accumulation, and the increases were significantly higher in cattle to which diminazene had also been administered. In cattle treated with both trypanocides, weight loss and serum glutamate dehydrogenase levels were correlated with isometamidium concentrations. These observations, together with the histopathological findings, support the hypothesis that the morbidity and mortality observed were related to the repeated treatment with isometamidium in conjunction with diminazene aceturate, and that the pathogenesis involved a component of hepatic damage. It is therefore recommended that cattle, particularly those under nutritional stress, are not subjected to repeated treatments with isometamidium at intervals as short as one month, and particularly not with concurrent administration of diminazene.

10190 **Gool, F. van, Zelleke, D. and Musa, M., 1992.**
Cymelarsan: a new treatment for *Trypanosoma evansi* infections in camels. *In*: Allen, W.R. *et al*. (eds), 1992 (see **20**: no. 10181), pp. 37-41.
Rhone Merieux, Lyon, France.
Field trials to investigate the efficacy and safety of Cymelarsan in the treatment of *T. evansi* infections in camels were conducted in Niger and Ethiopia using experimentally infected animals and in Kenya and Sudan using naturally infected animals. In all the trials, Cymelarsan was effective against *T. evansi* at doses of 1.25, 0.625, 0.6, 0.5 and 0.25 mg/kg body weight, with complete elimination of parasites within the 90 day

trial period.

10191 **Kalu, A.U., 1995.** Studies on the chemotherapeutic control of animal trypanosomiasis in Nigeria. *Journal of the Pasteur Institute (Romania)*, **3**: 82-92.
Department of Veterinary Public Health and Preventive Medicine, University of Maiduguri, P.M.B. 1069, Maiduguri, Borno State, Nigeria.
Stocks of *Trypanosoma vivax* and *T. congolense* isolated from bovine herds in central and northern Nigeria were tested for sensitivity to therapeutic (and higher) doses of diminazene aceturate (Berenil) and isometamidium chloride (Samorin) using sheep, goats and rodents. In ruminants, one *T. vivax* and four *T. congolense* stocks were consistently resistant to diminazene at 7.0 mg/kg and to isometamidium at 0.5 mg/kg. However, isometamidium at 1.0 mg/kg effected parasitological cure of infections with *T. vivax* and three stocks of *T. congolense*. Total multiple resistance to the sanative pair was exhibited by *T. congolense* stock Kaf 2/CT 128 and all eight of its mouse-passaged strains at 10.5 mg/kg for diminazene and 1.0 mg/kg for isometamidium. In laboratory models, resistance increased the minimum clearing dose by two to six times and cure was not achieved at doses less than 35.0 mg/kg diminazene and 5.0 mg/kg isometamidium. The results are discussed in relation to the chemotherapeutic control of animal trypanosomiasis in the field in Nigeria.

7. experimental trypanosomiasis

(a) DIAGNOSTICS

10192 **Singla, L.D., Juyal, P.D. and Kapur, J., 1996.** Dot-enzyme linked immunosorbent assay for detection of *Trypanosoma evansi* antibodies in rabbits. *Journal of Veterinary Parasitology*, **10** (1): 87-89.
Department of Veterinary Parasitology and Immunology, Punjab Agricultural University, Ludhiana 141 004, India.

(b) PATHOLOGY AND IMMUNOLOGY

[See also **20**: nos. 10214, 10234, 10245, 10248, 10251.]

10193 **Akingbemi, B.T., Aire, T.A. and Oke, B.O., 1997.** The influence of protein malnutrition on the antifertility action of gossypol in the *Trypanosoma brucei*-infected rat: some ultrastructural observations from the testis. *Reproductive Toxicology*, **11** (4): 533-538.
Akingbemi: Department of Preclinical Veterinary Studies, University of Zimbabwe, P.O. Box MP 167, Harare, Zimbabwe.

10194 **Kaushik, R.S., Uzonna, J. and Tabel, H., 1997.** Effect of

different cytokines on the growth of *Trypanosoma congolense* cultured under axenic conditions. *Veterinary Parasitology*, **70** (1-3): 25-31.

Kaushik: Department of Veterinary Microbiology, Western College of Veterinary Medicine, University of Saskatchewan, Saskatoon, SK S7N 5B4, Canada.

10195 **Kemp, S.J., Iraqi, F., Darvasi, A., Soller, M. and Teale, A.J., 1997.** Localization of genes controlling resistance to trypanosomiasis in mice. *Nature Genetics*, **16** (2): 194-196.

Kemp: School of Biological Sciences, Donnan Laboratories, University of Liverpool, Liverpool L69 7ZD, UK.

10196 **Muranjan, M., Wang, Q., Li, Y.-L., Hamilton, E., Otieno-Omondi, F.P., Wang, J., Praagh, A. van, Grootenhuis, J.G. and Black, S.J., 1997.** The trypanocidal Cape buffalo serum protein is xanthine oxidase. [*T. b. brucei*; *Syncerus caffer*.] *Infection and Immunity*, **65** (9): 3806-3814.

Black: Paige Laboratory, Department of Veterinary and Animal Science, University of Massachusetts, Amherst, MA 01003, USA.

10197 **Saeki, N., Komatsu, T., Sakamoto, I., Funato, T. and Nakanishi, K., 1996.** The role of an FBS component in the trypanocidal reaction mediated by guinea pig serum. [*T. b. gambiense*.] *Japanese Journal of Parasitology*, **45** (6): 474-480.

Komatsu: Department of Immunology and Medical Zoology, Hyogo College of Medicine, 1-1 Mukogawa-cho, Nishinomiya, Hyogo 663, Japan.

10198 **Swarnkar, C.P., Raisinghani, P.M., Kimar, D. and Singh, L., 1996.** Haematological changes in rats immunized with killed *Trypanosoma evansi*. *Indian Veterinary Journal*, **73** (3): 261-264.

Department of Parasitology, College of Veterinary and Animal Science, Bikaner 334 001, Rajasthan, India.

(c) CHEMOTHERAPEUTICS

[See also **20**: nos. 10228, 10248.]

10199 **Freiburghaus, F., Jonker, S.A., Nkunya, M.H.H., Mwasumbi, L.B. and Brun, R., 1997.** *In vitro* trypanocidal activity of some rare Tanzanian medicinal plants. *Acta Tropica*, **66** (2): 79-83.

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

Extracts prepared from 15 rare Tanzanian medicinal plants were tested for their *in vitro* activity against

Trypanosoma brucei rhodesiense. Of 37 extracts investigated, the chloroform extract of *Asteranthe asterias* and the ethanol extract of *Annickia kummeriae* were found to have strong activity with IC_{50} values below 1 μg/ml, and ten extracts revealed promising activities with IC_{50} values between 1 and 5 μg/ml. [See also **20**: no. 10200: the two papers appear identical apart from differences of editorial style – Ed.]

10200 **Freiburghaus, F., Jonker, S.A., Nkunya, M.H.H., Mwasumbi, L.B. and Brun, R., 1997.** *In vitro* trypanocidal activity of some rare Tanzanian medicinal plants. *Acta Tropica*, **67** (3): 181-185.

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

10201 **Jennings, F.W., Gichuki, C.W., Kennedy, P.G.E., Rodgers, J., Hunter, C.A., Murray, M. and Burke, J.M., 1997.** The role of the polyamine inhibitor eflornithine in the neuropathogenesis of experimental murine African trypanosomiasis. [*T. b. gambiense*, *T. b. rhodesiense*.] *Neuropathology and Applied Neurobiology*, **23** (3): 225-234.

Kennedy: Glasgow University Department of Neurology, Institute of Neurological Sciences, Southern General Hospital, Glasgow G51 4TF, UK.

10202 **Kuromi, H. and Seino, S., 1997.** Suramin inhibits glucose-induced Ca^{2+} response in single rat pancreatic cells. *Japanese Journal of Pharma-cology*, **73** (2): 179-182.

Division of Molecular Medicine, Centre for Biomedical Science, Chiba University School of Medicine, 1-8-1 Inohana, Chuo-ku, Chiba 260, Japan.

10203 **Peregrine, A.S., Gray, M.A. and Moloo, S.K., 1997.** Cross-resistance associated with development of resistance to isometamidium in a clone of *Trypanosoma congolense*. *Antimicrobial Agents and Chemotherapy*, **41** (7): 1604-1606.

Peregrine: Department of Pathobiology, Ontario Veterinary College, University of Guelph, Guelph, ON N1G 2W1, Canada.

Resistance to isometamidium was increased 94-fold in a clone of *T. congolense* (IL 1180) by repeated subcurative treatment of infected mice for 11 months. This was associated with 3.4-, 33- and 4.2-fold increases in resistance to diminazene, homidium and quinapyramine, respectively. Both *T. congolense* IL 1180 and the resistant derivative were able to undergo cyclical development in *Glossina morsitans centralis* tsetse flies, producing hypopharyngeal infection rates of 40.0 and 39.8%, respectively.

10204 **Scott, A.G., Tait, A. and Turner, C.M.R., 1997.** *Trypanosoma brucei*: lack of cross-resistance to melarsoprol *in vitro* by cymelarsan-resistant parasites. *Experimental Parasitology*, **86** (3): 181-190.

Turner: Division of Infection and Immunity, IBLS, University of Glasgow, Joseph Black Building, Glasgow G12 8QQ, UK.

10205 **Zhang, K.-H., Shen, J., Zhou, Y.-Z. and Wang, Y.-F., 1995.** *In vitro* test of the mutagenicity of a new antitrypanosomal drug. [T-46.] *Chinese Journal of Veterinary Science and Technology*, **25** (1): 25-26.

Zhang: Institute of Parasitic Diseases of Domestic Animals, CAAS, Shanghai 200232, China.

8. trypanosome research

(a) CULTIVATION OF TRYPANOSOMES

(b) TAXONOMY, CHARACTERISATION OF ISOLATES

[See also **20**: nos. 10179, 10180, 10236.]

10206 **Enyaru, J.C.K., Matovu, E., Odiit, M., Okedi, L.A., Rwendeire, A.J.J. and Stevens, J.R., 1997.** Genetic diversity in *Trypanosoma (Trypanozoon) brucei* isolates from mainland and Lake Victoria island populations in south-eastern Uganda: epidemiological and control implications. *Annals of Tropical Medicine and Parasitology*, **91** (1): 107-113.

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

A total of 230 *Trypanozoon* stocks (135 from humans, 47 from cattle, 17 from pigs, 2 from dogs and 29 from *Glossina fuscipes fuscipes*), isolated between 1988 and 1993 in Tororo, Mukono including the Buvuma Islands, and in three districts of Busoga (Iganga, Kamuli and Jinja), were separated into 73 zymodemes based on variations in the electrophoresis patterns of eight of the nine enzymes examined. Taxonomic relationships were evaluated with a dendrogram. Previous isoenzyme electrophoresis of trypanosomes isolated in the period 1976-1981 revealed that six different zymodemes were circulating in Busoga. Thus, the present level of genetic diversity in trypanosome populations circulating in south-eastern Uganda appears far greater than that previously recorded. The most diverse collection of trypanosome isolates was that from tsetse, the 29 isolates being classified into 23 different zymodemes, of which 19 were previously unrecorded and 18 were only represented by a single isolate. The dendrogram showed five groupings of epidemiological significance, two of which corresponded broadly to humans, two to domestic animals and one to tsetse. It is concluded that tsetse control (carried

out in mainland south-eastern Uganda from the late 1980s) has been effective in reducing levels of trypanosomiasis and in eliminating certain zymodemes, which are now confined to the Buvuma Islands. However, it does not appear to have brought about an overall reduction in diversity, when compared with the results of previous studies. The lack of control in the Buvuma Islands appears to have allowed the continued existence of a reservoir of parasite diversity on a par with that seen on the mainland prior to control. This, together with the uncontrolled tsetse population of the islands, remains a potential source of sleeping sickness re-invasion in south-eastern Uganda.

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