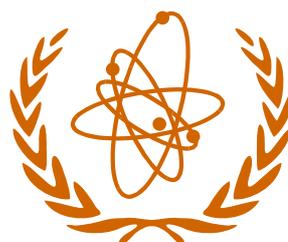


TSETSE AND TRYPANOSOMIASIS INFORMATION QUARTERLY

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section b – abstracts

1. general (including land use)

9662 **Dobson, A. and Carper, R., 1992.** Global warming and potential changes in host-parasite and disease-vector relationships. *In*: Peters, R.L. and Lovejoy, T.E. (eds), *Global warming and biological diversity* (New Haven, USA; Yale University Press), pp. 201-217.

Dobson: Department of Ecology and Evolutionary Biology, Princeton University, Princeton, NJ, USA.

The authors address both general questions about the response of parasite-host systems to long-term climatic changes (parasite life history strategies, effect of temperature on parasite transmission rates, predictive models for parasites of domestic livestock, structure of parasite-host communities) and the effect of climatic change on the distribution of trypanosomiasis in Africa. When published data for 91 sites throughout tropical Africa are examined in terms of identified optimal environmental conditions for *Glossina morsitans*, 94% of the sites within the present known distribution fall within the predicted bioclimatic limits. When possible distribution is predicted given a mean 2°C increase in temperature for sub-Saharan Africa, the analysis suggests that *G. morsitans* may become less common in West Africa and across the main sub-Saharan zone of central Africa but may spread farther south in East Africa.

9663 **Itty, P., 1993.** Economics of trypanosomiasis control: research implications. *In*: Kategile, J.A. and Mubi, S. (eds), *Future of livestock industries in east and southern Africa: Proceedings of the Workshop held at Kadoma Ranch Hotel, Zimbabwe, 20-23 July 1992* (Addis Ababa, Ethiopia; ILCA), pp. 127-134.

Department of Agricultural Economics, Swiss Federal Institute of Technology, ETH Zentrum SOL, 8092 Zurich, Switzerland.

Past research on the economics of tsetse and trypanosomiasis control in rural cattle production systems in tsetse-infested areas of Africa is reviewed. A comparison is made of trypanosomiasis control methods using trypanotolerant cattle and/or chemotherapy in Ethiopia, The Gambia, Kenya, Côte d'Ivoire, Zaire and Togo. Control methods were distinguished according to the level of investment: high initial capital investment (aerial and ground spraying, SIT and importation of trypanotolerant livestock), and high recurrent cost methods (traps and screens, deltamethrin treatment of cattle, trypanocidal drugs and indigenous trypanotolerant cattle). The latter methods were found to be less risky and more flexible as costs and

benefits flow in parallel and operations can be implemented by the local population.

9664 **Itty, P., 1996.** Profitability, efficiency and comparative advantage of African cattle meat and milk production: the case of trypanotolerant village cattle production. *Agricultural Economics*, **14** (1): 33-44.

Department of Agricultural Economics, Swiss Federal Institute of Technology, ETH Zentrum SOL, 8092 Zurich, Switzerland.

The use of African trypanotolerant breeds of cattle is one approach to controlling trypanosomiasis that is being given increasing attention. This paper examines under what circumstances trypanotolerant village cattle enterprises can be economically viable in regions of origin and areas of introduction. On-going production is analysed in four countries (Gambia, Côte d'Ivoire, Togo, Zaire) using cost-benefit analyses. Comparative advantage and subsidies received are also estimated. Results indicate that resources for trypanotolerant cattle production are efficiently allocated as the sector has a comparative advantage and contributes effectively to the national welfare. Financial returns to producers are attractive and by comparing social and private prices important constraints are identified to improve profitability.

2. tsetse biology

(a) REARING OF TSETSE FLIES

[See **19**: no. 9668.]

(b) TAXONOMY, ANATOMY, PHYSIOLOGY, BIOCHEMISTRY

[See also **19**: no. 9671.]

9665 **Buschbeck, E.K. and Strausfeld, N.J., 1996.** Visual motion-detection circuits in flies: small-field retinotopic elements responding to motion are evolutionarily conserved across taxa. *Journal of Neuroscience*, **16** (15): 4563-4578.

Buschbeck: Arizona Research Laboratories, Division of Neurobiology, 611 Gould-Simpson Building, University of Arizona, Tucson, AZ 85721, USA.

The Hassenstein-Reichardt autocorrelation model for motion computation was derived originally from studies of optomotor turning reactions of beetles and further refined from studies of houseflies. Its application for explaining a variety of optokinetic behaviours in other insects assumes that neural correlates to the model are principally similar across taxa. This account examines whether this assumption is warranted. The results demonstrate that an evolutionarily

conserved subset of neurons corresponds to small retinotopic neurons implicated in motion-detecting circuits that link the retina to motion-sensitive neuropils of the lobula plate. The occurrence of these neurons in basal groups suggests that they must have evolved at least 240 million years before the present time. Functional contiguity among the neurons is suggested by their having layer relationships that are independent of taxon-specific variations such as medulla stratification, the shape of terminals or dendrites, the presence of other taxon-specific neurons, or the absence of orientation-specific motion-sensitive levels in the lobula plate. [Includes studies on *Glossina morsitans*.]

9666 **Grimaldi, D.A., 1992.** Vicariance biogeography, geographic extinctions, and the North American Oligocene tsetse flies. *In*: Novacek, M.J. and Wheeler, Q.D. (eds), *Extinction and phylogeny* (New York, USA; Columbia University Press), pp. 178-204.

Department of Entomology, American Museum of Natural History, New York, NY 10024, USA.

Fossil taxa occurring in areas remote from the closest living relatives can be the most robust test of vicariant biogeographic hypotheses, but only if the fossil taxon is not plesiomorphic to or the sister group of the living relative. Cladistic criteria and conditions are proposed for analysing the historical geographical significance of a fossil where its relationships are known. Several fossil arthropod examples are discussed where geographic extinctions have apparently been of major influence in biogeography, including the famous case of the tsetse flies (Glossinidae) from the Oligocene shales of Florissant, Colorado, USA. Eight of the nine known specimens of fossil tsetse flies were compared in detail for the first time. Two species, not four, exist, with the following synonyms proposed: *Glossina oligocenus* (= *G. veterna*), *G. osborni* (= *G. armatipes*). Species characters are based on size and proportions in wing venation. The two Oligo-cene *Glossina* species are closely related, but plesiomorphic to the monophyletic group of living, Afrotropical *Glossina*, as based on two newly described characters of the legs, and possibly the absence of the characteristic tertiary-branched arista found in living *Glossina*. Thus the primitive North American fossil tsetse flies have little relevance to the biogeography of living Afrotropical species, other than establishing their minimum age as Upper Oligocene.

9667 **Isaacson, L.C. and Nicolson, S.W., 1996.** Electrical transients in the cell-volume response to cyclic AMP of the tsetse fly Malpighian tubule. *Journal of Experimental Biology*, **199** (7): 1597-1604.

Nicolson: Department of Zoology, University of Cape Town, Rondebosch 7700, South Africa.

Using cyclic AMP to stimulate perfused tsetse fly (*Glossina morsitans morsitans*) Malpighian tubules bathed in SO_4^{2-} Ringer frequently causes an immediate but transient peak in transtubular potential (V), before stabilisation of V at an increased value. These transients were investigated by monitoring the associated changes in cable properties and current-voltage (I/V) relationships. Tubules were perfused and bathed in either Cl^- Ringer or SO_4^{2-} Ringer (containing $8 \text{ mmol l}^{-1} \text{ Cl}^-$). Tubules bathed in Cl^- Ringer showed a transient swelling of the cells on exposure to cyclic AMP. Cable analysis confirmed the visually observed narrowing of the tubular lumen and revealed transient increases in core resistance (R_c) and transtubular resistance (R_t). As the cells returned to their initial volume, the lumen became distended, and R_c and R_t fell below their initial levels. These changes were accompanied by an increase, and a subsequent decrease, in the slope of the I/V plot. None of the above changes was apparent in SO_4^{2-} Ringer, other than a fall in R_c and in the slope of the I/V plot. The results suggest that, in the Cl^- Ringer, cyclic AMP induces swelling of the tubular cells by promoting increased basolateral solute (and water) entry and that the subsequent rapid return to normal cell volume, with a concomitant progressive increase in the rate of tubular secretion, reflects the operation of a specific cell-volume regulatory mechanism of transepithelial transport. The cyclic-AMP-induced peak that occurs in V in SO_4^{2-} Ringer appears to be primarily due to a transient overshoot in the fall in series resistance (i.e. an increase in basolateral Na^+ conductance), accompanied by a proportionately lesser increase in shunt resistance.

9668 **Jordan, A.M., 1993.** Tsetse-flies (Glossinidae). In: Lane, R.P. and Crosskey, R.W. (eds), *Medical insects and arachnids* (London, UK; Chapman and Hall), pp. 333-388. Holly House, Plud Street, Wedmore, Somerset, BS28 4BE, UK.

This book chapter on tsetse flies has sections on recognition and elements of structure, classification and identification (including identification keys and a

table of distribution of species and subspecies), biology (life history, mating, biting behaviour and hosts, dispersal and movement), medical importance, control, and collecting, preserving and rearing material.

9669 **La Rocque, S. de, Geoffroy, B. and Cuisance, D., 1996.** Nouvelle approche pour l'estimation de l'âge des glossines par analyse d'image de l'aile. [A new approach to estimating the age of tsetse flies by analysing an image of the wing.] *Revue d'Elevage et de Médecine vétérinaire des Pays tropicaux*, **49** (1): 46-48.

La Rocque: CIRAD-EMVT, Campus International de Baillarguet, B.P. 5035, 34032 Montpellier Cedex 1, France.

A first study has been carried out to determine the age of *Glossina tachinoides* by analysing the various levels of grey in the wing. Among the laboratory female tsetse flies studied, five groups stood out as significantly different. Provided these results are confirmed with wild tsetse flies, this method could constitute a new approach to studying this important factor in the epidemiology of animal trypanosomosis.

9670 **Saini, R.K., Hassanali, A., Andoke, J., Ahuya, P. and Ouma, W.P., 1996.** Identification of major components of larviposition pheromone from larvae of tsetse flies *Glossina morsitans morsitans* Westwood and *Glossina morsitans centralis* Machado. *Journal of Chemical Ecology*, **22** (7): 1211-1220.

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

The presence of pheromones produced by larvae of *G. m. morsitans* and *G. m. centralis*, which attract gravid females and result in aggregation of pupae, is confirmed. Behavioural experiments indicated that females preferred to larviposit over moist sand conditioned by previously allowing larvae to pupariate in it. Similar results were obtained with filter papers contaminated with the pre-pupariation excretions of larvae and with volatiles collected from larvae prior to pupariation. *n*-Pentadecane and *n*-dodecane were identified as the dominant electrophysiologically active components of the larviposition pheromones of *G. m. morsitans* and *G. m. centralis*, respectively, by GC-EAD and GC-MS analysis of the trapped larval volatiles. Both identified compounds were shown to significantly attract gravid females to larviposition sites in laboratory behavioural assays.

(c) DISTRIBUTION, ECOLOGY, BEHAVIOUR, POPULATION

STUDIES

[See also **19**: nos. 9662, 9668, 9670, 9679, 9681, 9693.]
9671 **Adlington, D., Randolph, S.E. and Rogers, D.J., 1996.** Flying to feed or flying to mate: gender differences in the flight activity of tsetse (*Glossina palpalis*). *Physiological Entomology*, **21** (2): 85-92.

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

To test the prediction that female and male tsetse should differ in their behaviour and the partitioning of their energy budgets to maximise their respective reproductive outputs, we investigated experimentally the relationship between blood intake, fat content and flight activity in virgin and mated female flies, following the same procedure as in a previous study on males (see *TTIQ*, **19** (1): no. 9274). Those flies whose fat content was raised to higher levels by being fed more frequently performed more flight activity, but all females showed very little activity until day 4 after their last blood meal, thereby using only a small fraction of their fat reserves. This contrasted markedly with the large amount of flight performed by males on day 3, resulting in the depletion of their fat reserves. The difference is interpreted with respect to females flying only to find food approximately once every 3 days (and larviposition sites approximately once every 9 days), compared with males flying to find as many mates as possible during the earlier part of the feeding cycle when their energy reserves are high and feeding is a low priority.

9672 **Katunguka-Rwakishaya, E. and Kabagambe, E.K., 1996.** Tsetse survey in Mukono District, south-east Uganda: population structure, distribution and blood meal status. *Tropical Animal Health and Production*, **28** (2): 151-157.

Katunguka-Rwakishaya: Department of Veterinary Medicine, Faculty of Veterinary Medicine, Makerere University, P.O. Box 7062, Kampala, Uganda.

The population structure, feeding state and distribution of *Glossina fuscipes fuscipes* in Ssugu parish, Mukono District, south-east Uganda, were investigated between August and December 1993. Tsetse caught with pyramidal traps were counted, sexed and age graded by wing fray (males) or status of ovaries and uterus (females). In the dry season (August and December), most tsetse were caught in valley habitats, but the distribution was almost uniform within the parish in the wet season, the apparent density rising to 2.04 in October following the rains in September. On average

17.8% of dissected tsetse contained a fresh blood meal, the prevalence being highest in the warm humid months (September and October). More males had a fresh blood meal than females ($P < 0.05$). There was a preponderance of young tsetse of less than 60 days in the population, and significantly more teneral males than teneral females ($P < 0.05$). In all months the percentage of females was higher than that of males and ranged between 51.1% in September and 64.6% in December. These results suggest that greatest man-tsetse-animal contact and risk of contracting trypanosomiasis is in September and October, and that tsetse control, by applying insecticides on animals and targets, should be undertaken at this time.

9673 **Ogana, W., 1996.** Modelling the vertical distribution of insects. *Ecological Modelling*, **89** (1-3): 225-230.

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

The Weibull distribution has been used to model the vertical distribution of insects under a number of activities: natural flight without any artificial stimulus, resting behaviour, and responses to trapping involving colour attractants and odour baits. Initial approximations of the Weibull parameters are obtained using the least squares method, with more accurate values computed using the maximum likelihood estimates. Coefficients of determination are obtained after linearisation of the Weibull equation and results show that these coefficients are generally high, indicating suitability of the model for fitting the observed data. The model yields an analytical formula for determining the mean heights at which the activities tend to occur. The model is tested on data from three sources:

Coleoptera in natural flight over Tallulah, Louisiana, USA; *Glossina palpalis palpalis* at rest during the dry season in northern Nigeria; and catches of *Glossina* spp. in Rwanda, by traps placed at varying heights above the ground and baited with acetone and cow urine. Results show that different species of insects tend to fly, rest or be trapped at heights which are characteristic of the species.

9674 **Rogers, D.J. and Williams, B.G., 1994.** Tsetse distribution in Africa: seeing the wood *and* the trees. In: Edwards, P.J., May, R.M. and Webb, N.R. (eds), *Large-scale ecology and conservation biology: the 35th Symposium of the British Ecological Society with the Society for Conservation Biology, University of Southampton, 1993* (Oxford, UK; Blackwell Scientific Publications), pp. 247-271.

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

After outlining the differences between the biological and statistical approaches to understanding the distribution and abundance of organisms, the authors give two examples of dimension-reducing statistical techniques whereby large amounts of environmental data can be processed and sifted to extract useful correlates of the distributional ranges of animal species. These techniques are illustrated using the tsetse fly, *Glossina morsitans*, as an example. The first technique is that of linear discriminant analysis which predicts the past and present distribution of *G. morsitans* in Zimbabwe, Kenya and Tanzania with an accuracy of > 80%. Conclusions from the statistical analysis coincide with previous biological interpretations of the distribution of this species in Africa. The message to emerge from the analysis is that global circulation models (GCMs) will need to achieve a greater degree of accuracy than at present if they are to be useful in making predictions about changing vector distributions with global climate change. The second technique is temporal Fourier analysis of a series of normalised difference vegetation indices (NDVIs) of Africa derived from the advanced very high resolution radiometers (AVHRR) of Earth-orbiting meteorological satellites of the National Oceanic and Atmospheric Administration (NOAA) series. The analysis captures the important characteristics (i.e. the average, amplitude and phase) of the major annual and biannual cycles of vegetation growth. Examples are given of features (the Gezira irrigation project in Sudan) and processes (the timing of the peak vegetation growth along the Nile from Uganda to the Mediterranean) which are revealed clearly by Fourier analysis. A strong association is demonstrated between the amplitude of the first term of the Fourier expansion (= the amplitude of the annual cycle of vegetation growth) and savanna woodland areas of Africa, and a similar close association is shown between the same features of the analysis and the areas infested with the tsetse *G. morsitans*. Both discriminant analysis and Fourier analysis achieve dimension-reduction without the obfuscation of the underlying biological processes that is often associated with statistical processing of biological data (e.g. as with principal components analysis). Finer resolution of biologically important features may be possible in both space and time using

satellite sensor information at a finer spatial resolution.

9675 **Torr, S.J. and Mangwiro, T.N.C., 1996.** Upwind flight of tsetse (*Glossina* spp.) in response to natural and synthetic host odour in the field. *Physiological Entomology*, **21** (2): 143-150.

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

In Zimbabwe, studies were made of the flight responses of tsetse to synthetic and natural ox odour using arrangements of electric nets. Tsetse flying away from a target showed a significant upwind bias when a blend of carbon dioxide (2 l/min), acetone (500 mg/h), octenol (0.4 mg/h), 4-methylphenol (0.8 mg/h) and 3-*n*-propylphenol (0.1 mg/h) was dispensed 15 m upwind, with *c.* 35% flying upwind. Without carbon dioxide this percentage was significantly reduced to 15% which was not significantly different from that with no odour (8%). This pattern was not altered by reducing the doses of acetone, octenol and phenols by 10-100 times, to levels comparable to those produced by an ox. With natural ox odour or a synthetic equivalent of ox odour dispensed from a ventilated pit 8 m upwind of the target, *c.* 28% flew upwind. This was reduced significantly to 15% if carbon dioxide was removed. In studies using a 17 m line of nets arranged orthogonally across the prevailing wind line, *c.* 50% of the catch was caught on the downwind side in the absence of odour. This increased significantly to *c.* 60% when acetone, octenol and phenols were dispensed 15 m upwind, with or without carbon dioxide. With a shorter line (9 m) or an incomplete one (16.5 m long with 5 \times 1.5 m wide gaps along its length) there was no change in the proportion caught downwind. For all three lines, dispensing odour upwind increased the catch 2-5 times on both the up- and downwind sides of the nets. It is concluded that a stronger upwind response to host odour is elicited when carbon dioxide is present. It is suggested that in nature upwind flight is very imprecisely orientated, with tsetse making flights up and down an odour plume 'searching' for a host.

3. tsetse control (including environmental side-effects)

[See also **19**: nos. 9663, 9668, 9702.]

9676 **Allsopp, R., 1994.** Community-based IPM of tsetse flies. In: *Proceedings of the IPM Implementation Workshop for East/Central/Southern Africa, Harare, Zimbabwe, 1993* (Chatham, UK;

Natural Resources Institute), pp. 25-30.

Tsetse Control Division, Department of Animal Health and Production, P.O. Box 14, Maun, Botswana.

The primary objective of integrated pest management (IPM) is to reduce the reliance upon pesticides or, where they are essential, to reduce the volumes used. This has long been an objective of tsetse control and, together with the increasing logistical difficulties of large-scale ground spraying, has stimulated control authorities to seek alternative methods. Although IPM is concerned mainly with crop protection, it involves the same coordinated approach as that increasingly recommended for livestock protection, such as the UN special action programme for trypanosomiasis and related development. The challenge is to find sustainable ways of treating tsetse and trypanosomiasis as problems of farming systems. Recent developments in tsetse control and some projects involving community participation and implementation are briefly outlined.

9677 **Ejobi, F., Kanja, L.W., Kyule, M.N., Müller, P., Krüger, J. and Latigo, A.A.R., 1996.** Organochlorine pesticide residues in mothers' milk in Uganda. *Bulletin of Environmental Contamination and Toxicology*, **56** (6): 873-880.

Ejobi: Centre for Environmental Research, Institute for Bio-geography, University of Saarland, P.O. Box 151150, D-66041 Saarbrücken, Germany.

Despite their persistence in the environment, organochlorine pesticides are still used in Uganda against cotton pests and mosquitoes (c. 80 tonnes per year of DDT), against banana weevils and termites (c. 392 tonnes per year of dieldrin) and for ground spraying and selective treatment of tree trunks for tsetse control (30 tonnes per year of dieldrin). A total of 143 human milk samples were collected between October 1992 and January 1993, 60 from Kampala city and 83 from the rural areas of Iganga District. DDT residues were detected in all 143 samples and dieldrin was detected in 83.2%, with smaller percentages (1.4-9.1%) positive for lindane, α -HCH and β -HCH. The overall average estimated daily intake of sum DDT was 14.74 $\mu\text{g}/\text{kg}$ body weight, below the maximum acceptable daily intake (ADI), although 19.6% of individual samples exceeded the maximum ADI. The overall average estimated daily intake of dieldrin was 0.32 $\mu\text{g}/\text{kg}$, exceeding by 3.2 times the maximum ADI recommended by FAO/WHO, 75.5% of individual samples being above the maximum ADI. Although dieldrin was extensively used for tsetse control in Iganga District from the early

1970s to 1981, no statistically significant difference was found in its mean levels between Iganga and Kampala, suggesting that its use for tsetse control in this area did not contribute significantly to environmental contamination.

9678 **Mitchell, M., 1996.** Acaricide resistance – back to basics. *Tropical Animal Health and Production*, **28** (2, Suppl.): 53S-58S.

Cooper Zimbabwe PVT Ltd, P.O. Box 2699, Harare, Zimbabwe.

A brief discussion of acaricide resistance is presented. The point is made that, where products are also used to control tsetse, it may be more important to have live cattle with the risk of resistance (which may take years to develop) than severe losses through trypanosomiasis.

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

[See also **19**: nos. 9672, 9675, 9694.]

9679 **Baylis, M., 1996.** Effect of defensive behaviour by cattle on the feeding success and nutritional state of the tsetse fly, *Glossina pallidipes* (Diptera: Glossinidae). *Bulletin of Entomological Research*, **86** (4): 329-336.

Department of Arbovirology, Institute for Animal Health, Ash Road, Pirbright, Surrey GU24 0NF, UK.

Two experiments were conducted at Galana Ranch, Kenya, which examined, under natural conditions, the relationships between the number of tsetse flies (*G. pallidipes*) attracted to cattle, the rate at which the cattle made defensive movements, and the feeding success of the tsetse. The most frequent defensive movements were skin ripples and tail swishes, while leg kicks were of intermediate frequency, and head and ear movements were infrequent. In one experiment, the rate of skin ripples, but no other type of defensive movement, was significantly correlated with the number of tsetse attracted to the cattle. The proportion of tsetse that engorged was significantly ($P < 0.004$) correlated with the rate of leg kicks, more weakly with the rate of head movements ($P < 0.07$), and uncorrelated with the rates of other types of defensive movement. In the second experiment, the rates of skin ripples, tail swishes and leg kicks were significantly correlated with the number of tsetse attracted to the cattle. The proportion of tsetse that engorged was again significantly correlated to the rate of leg kicks ($P < 0.03$), more weakly to the rate of head movements

($P < 0.04$), and unrelated to the rates of other types of defensive movement. In neither experiment was there a significant relationship between the number of tsetse attracted to the cattle and the proportion that engorged, suggesting that any density-dependent feeding success was too weak to be detected. In experiment 1, the relative fat content of the male *G. pallidipes* that fed decreased as the rate of leg kicks increased, suggesting that when hosts are more active the sub-sample of tsetse that feed, out of those that approach, is both smaller and hungrier. There was no detectable effect of host defensive behaviour on the bloodmeal size of male *G. pallidipes*.

9680 **Dagnogo, M., Traoré, G. and Koné, M., 1996.** Evaluation de l'attractivité de *Glossina palpalis palpalis* vis-à-vis de l'homme et du porc dans la région de Daloa en Côte d'Ivoire. [Evaluation of the attractiveness of humans and pigs to *G. p. palpalis* in the Daloa region of Côte d'Ivoire.] *Revue d'Elevage et de Médecine vétérinaire des Pays tropicaux*, **49** (1): 50-54.

Dagnogo: CEMV, 01 B.P. 2597, Bouaké 01, Côte d'Ivoire. Trapping experiments on *G. p. palpalis* were performed in the village of Noumousséria II (Daloa forest area, Côte d'Ivoire) using a mosquito netting enclosure baited with a human or a pig. The results show that: (i) catches using the pig as bait were 2.4 times greater than those using the man; (ii) the percentage of females captured with the pig was higher (76.16%) than that of males, while no significant difference between the two sexes appeared with the human as bait; (iii) seasonal variations in catches were more marked with the pig than with the man. Qualitative analyses revealed that tsetse samples obtained with the pig were similar to those obtained with biconical traps. Despite the low number of dye-marked individuals recaptured, it seems that tsetse flies were attracted back more to the pig (12 tsetse flies) than to the man (none).

9681 **Madubunyi, L.C., Hassanali, A., Ouma, W., Nyarango, D. and Kabii, J., 1996.** Chemoecological role of mammalian urine in host location by tsetse, *Glossina* spp. (Diptera: Glossinidae). *Journal of Chemical Ecology*, **22** (6): 1187-1199.

Madubunyi: Department of Veterinary Parasitology and Entomology, Faculty of Veterinary Medicine, University of Nigeria, Nsukka, Nigeria.

Trap catch size was used to investigate whether *Glossina pallidipes* and *G. longipennis* could distinguish between the urine of the African buffalo, cattle and waterbuck at

Nguruman in southwest Kenya. NG2G traps baited with aged urine of these bovids caught significantly more of each tsetse than did the controls. The mean catch of either tsetse species in traps baited with aged urine of buffalo and cattle (tsetse hosts) and waterbuck (a nonhost) did not differ significantly. Aged urine from both tsetse hosts (buffalo and cattle) and the nonhost (waterbuck) was found to contain 4-cresol and 3-*n*-propylphenol in about the same ratio. However, the aged urine from other tsetse hosts (bushpig and warthog) lacked 3-*n*-propylphenol. Cattle urine had to be aged outside the soil to produce statistically significant increases in the trap catch of *G. pallidipes*. Furthermore, patches of soil on which fresh urine of cattle was deposited, and in which it was aged, failed to effect a significant increase in the trap catch of either *G. austeni*, *G. brevipalpis* or *G. pallidipes* at Gazi, southeast Kenya. The likelihood of tsetse either differentiating its hosts from nonhosts or locating favoured hosts by the urine scent appears remote under natural conditions. It is more likely that the chemical signals critical for host location by the tsetse emanate from skin glands rather than volatilise from the urine of mammals.

5. human trypanosomiasis

(a) SURVEILLANCE

9682 **Bailey, W., 1995.** The use of QBC in the diagnosis of African trypano-somiasis. *Diagnostics in Africa*, **1995** (Sept.): v-vi.

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

A short account is given of the use of the quantitative buffy coat (QBC) technique for the diagnosis of trypanosomiasis caused by *Trypanosoma brucei rhodesiense* and *T. b. gambiense*. The technique is described in detail and its sensitivity in recent studies is reviewed. It is concluded that QBC is a useful technique to be employed in areas of endemic trypanosomiasis in Africa, especially in district hospitals and rural health centres where passive screening of patients occurs.

9683 **Lejon, V., Büscher, P., Magnus, E. and Meirvenne, N. van, 1996.** Rationalization of stage determination in sleeping sickness. (Meeting abstract no. 74.) *Scandinavian Journal of Immunology*, **43** (6): 711.

Lejon: Laboratory of Serology, Institute of Tropical Medicine, Nationalestraat 155, 2000 Antwerp, Belgium. Criteria to diagnose second stage *Trypanosoma brucei*

gambiense trypanosomiasis are related to the presence of trypanosomes, increased protein and white blood cell levels in the CSF but these determinations are imprecise and the prescribed cut-off values arbitrary. An investigation aimed at improving diagnosis and follow-up of second stage trypanosomiasis determined albumin, total protein and total and trypanosome-specific IgG and IgM levels in serum and CSF samples of 105 patients. No close relationship between the currently used CSF criteria was observed. Blood-brain barrier impairment correlated with a high CSF protein content (> 700 mg/l). In many CSF samples, a high level of trypanosome-specific IgM and IgG was present. The presence of trypanosome-specific IgM might be a useful fourth parameter for stage determination.

(b) PATHOLOGY AND IMMUNOLOGY

[See also 19: no. 9697.]

9684 **Brandenberger, G., Buguet, A., Spiegel, K., Stanghellini, A., Muanga, G., Bogui, P. and Dumas, M., 1996.** Disruption of endocrine rhythms in sleeping sickness with preserved relationship between hormone pulsatility and the REM-NREM sleep cycles. *Journal of Biological Rhythms*, **11** (3): 258-267.

Brandenberger: Laboratoire de Physiologie et de Psychologie Environnementales, 21 rue Becquerel, 67087 Strasbourg Cedex, France.

In human African trypanosomiasis (sleeping sickness), sleep and wake episodes are sporadically distributed throughout the day and night. To determine whether these sleep disturbances affect the 24 h hormone profiles and the normal relationships between hormone pulsatility and sleep stages, polygraphic sleep recordings and concomitant hormone profiles were obtained in six African patients with sleeping sickness and in five healthy African subjects selected from Abidjan, Côte d'Ivoire. Polysomnographic recordings were continuous, and blood was taken every 10 min throughout the 24 h period. Plasma was analysed for cortisol, prolactin and plasma renin activity (PRA). The 24 h rhythm of cortisol, considered to be an endogenous circadian rhythm, was attenuated in all of the patients except one. However, as in normal subjects, slow wave sleep (SWS) remained associated with the declining phases of the cortisol secretory episodes. Prolactin and PRA profiles, which are strongly influenced by the sleep-wake cycle, did not manifest the nocturnal increase normally associated with the sleep period; instead, they reflected a sporadic distribution of the sleep and wake episodes

throughout the 24 h period. In patients with sleeping sickness as in normal subjects, rapid eye movement (REM) sleep began during the descending phases of prolactin pulses. In both groups, PRA reflected the sleep stage distribution with non REM (NREM) sleep occurring during the ascending phases and REM sleep during the descending phases of the PRA oscillations. However, in sleeping sickness patients, the marked sleep fragmentation often did not allow sufficient time for PRA to increase significantly, as is normally the case in subjects with regular NREM-REM sleep cycles. These results demonstrate that, together with the disruption of the sleep-wake cycle, there are profound differences in the temporal organisation of the 24 h hormone profiles in humans with African trypanosomiasis. However, the relationship between hormonal pulses and specific sleep stages persists, indicating the existence of a robust link between hormonal release and the internal sleep structure.

9685 **Pearson, T.W., 1993.** The immunology of African trypanosomiasis. *In*: Lachmann, P.J., Peters, K., Rosen, F.S. and Walport, M.J. (eds), *Clinical aspects of immunology*, 5th edition (Cambridge, USA; Blackwell Scientific Publications), pp. 1599-1612. Department of Biochemistry and Microbiology, University of Victoria, P.O. Box 3055, Victoria, B.C. V8W 3P6, Canada.

This review covers antigenic variation and the immune system, the life cycle of African trypanosomes, the disease in humans, cattle and mice, and the immunology of trypanosomiasis (trypanocidal activity of sera, immune responses during infection, genetics of resistance, trypanosome differentiation, trypanosome virulence, the role of the surface coats, immunodiagnosis).

9686 **Sternberg, J.M., 1996.** Elevated serum nitrate in *Trypanosoma brucei* 'rhodesiense' infections: evidence for inducible nitric oxide synthesis in trypanosomiasis. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, **90** (4): 395.

Department of Zoology, University of Aberdeen, Tillydrone Avenue, Aberdeen AB9 2TN, UK.

Investigations of the immunobiology of trypanosomiasis in the mouse model have demonstrated a high level of nitric oxide (NO) synthesis associated with activated macrophages, contributing to immunosuppression in the spleen and lymph nodes and to anaemia. Inhibition of NO synthesis *in vivo* in the mouse has been shown to lead

to improved control of *T. brucei* parasitaemia. To consider the situation in human trypanosomiasis, an initial retrospective examination of human serum nitrate levels in 26 *T. b. rhodesiense* patients and 25 control sera was carried out using sera obtained from the WHO Central Serum Bank for Sleeping Sickness, Antwerp. Nitrate is the final oxidation product of NO and thus a direct measure of total NO synthesis. The mean nitrate concentration in infection sera was significantly raised compared to controls, providing strong evidence for the activation of NO synthesis in human trypanosomiasis. Further studies on a larger group of patients is now necessary to determine the role of NO in the pathogenesis of the disease.

9687 **Tapie, P., Buguet, A., Tabaraud, F., Bogui, P., Doua, F. and Bert, J., 1996.** Electroencephalographic and polygraphic features of 24-hour recordings in sleeping sickness and healthy African subjects. *Journal of Clinical Neurophysiology*, **13** (4): 339-344.

Tapie: Institut de Neurologie Tropicale, Faculté de Médecine, 2 rue du Docteur Marcland, 87025 Limoges Cedex, France.

Electroencephalographic (EEG) and polygraphic features were analysed in six healthy control subjects and eight patients suffering from sleeping sickness meningoencephalitis in order to determine possible functional relationships. One patient was disqualified because of intermittent metabolic disease. Twenty-four hour polygraphic recordings (EEG, electrooculography, electromyography, nasal and buccal air flow, chest respiratory movements) were performed continuously both on paper and on cassette tapes. Tapes were played back on paper (paper speed: 15 mm/s). Traces were analysed for normal and pathological features, and transient activation phases and paroxysmal hypnopompic hypersynchrony events were counted. During wakefulness, slow theta and delta waves occurred in four patients, but alpha reactivity was present. During sleep, normal features were seen. However, transient activation phases were decreased in the patients. During slow-wave sleep, four patients presented predominantly monophasic frontal delta bursts along with paroxysmal hypnopompic hypersynchrony events. In conclusion, in sleeping sickness patients, although dampened, the waking process remains responsive and slows down only during the late stage of meningoencephalitis.

9688 **Vickerman, K., Myler, P.J. and Stuart, K.D., 1993.** African

trypanosomiasis. In: Warren, K.S. (ed), *Immunology and molecular biology of parasitic infections*, 3rd edition (Oxford, UK; Blackwell Scientific Publications), pp. 170-212.

Vickerman: Department of Zoology, University of Glasgow, Glasgow G12 8QQ, UK.

This extensive review of African trypanosomiasis covers the trypanosome as antigenic stimulus, innate immunity in mammalian host and vector, specific immunity, serodiagnosis, immunopathology and trypanotolerance.

(c) TREATMENT

9689 **Ancelle, T., Delahais, E., Mbulamberi, D. and Moren, A., 1993.** An outbreak of arsenic reactive encephalopathy among patients treated for African trypanosomiasis, Adjumani, Uganda, 1992. (Meeting abstract no. 1323.) *Program and Abstracts of the 33rd Interscience Conference on Antimicrobial Agents and Chemotherapy* (New Orleans, Louisiana, USA, 17-20 October 1993): 361.

Ancelle: Epicentre, 8 rue Saint-Sabin, 75011 Paris, France.

In August 1992 the incidence of arsenic reactive encephalopathy at the sleeping sickness centre of Adjumani, Uganda, suddenly increased to 12% of 111 patients treated by melarsoprol, with a mortality rate of 73.1%. A retrospective case-control study was conducted in order to determine the cause of the outbreak and to propose preventive measures. Forty-one cases which occurred between April and October 1992 were compared with 83 controls selected among patients who received melarsoprol during the same period. Among the risk factors studied, two appear to increase the risk of arsenic reactive encephalopathy: the prescription of thiabendazole to treat strongyloidiasis during the melarsoprol cure and the bad general clinical condition of patients. However, these factors explain only 31% of the epidemic cases which followed a period of massive increase in hospital activity.

Recommendations were to avoid administration of diffusible anti-helminthic treatment during the cure, to improve the general condition of patients before beginning the cure, and to regulate the admission flow of patients in the hospitalisation ward.

9690 **Foulkes, J.R., 1996.** Metronidazole and suramin combination in the treatment of arsenical refractory rhodesian sleeping sickness - a case study. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, **90** (4): 422.

Mukinge Hospital, P.O. Box 120092, Kasempa, Zambia.

The case is described of a 37-year-old resident of

Kasempa, Zambia, who was treated on five occasions between November 1992 and January 1995 at Mukinge Hospital for late-stage *Trypanosoma brucei rhodesiense* trypano-somiasis. On the first occasion he was given only 198 mg melarsoprol because the drug was in short supply. In July 1993 he received the full dose of 1350 mg melarsoprol over 4 weeks. When he relapsed again in May 1994 he was given a high dose course of metronidazole. After relapsing again in September 1994 he was given a higher dose of metronidazole, followed by a short course of melarsoprol. Finally in January 1995 he was apparently cured (follow-up of 12 months) by a combination of suramin (1 g i.v. on day 1 and then weekly to a total of 5 g) and metronidazole (1.5 g orally every 6 h for 1 week, starting on day 1, then 1 week of rest, then another week of treatment at the same dose). Further study of this alternative therapy is recommended.

6. animal trypanosomiasis

(a) SURVEY AND DISTRIBUTION

[See also 19: no. 9698.]

9691 **Delafosse, A., Bengaly, Z. and Duvallet, G., 1996.** Utilisation du test ELISA de détection des antigènes circulants de trypanosomes dans le cadre d'un suivi épidémiologique dans la zone de Sidéradougou, Burkina Faso. [Use of a trypanosome antigen detection ELISA during an epidemiological survey in the Sideradougou area, Burkina Faso.] *Revue d'Elevage et de Médecine vétérinaire des Pays tropicaux*, **49** (1): 32-37.

Delafosse: CIRDES, 01 B.P. 454, Bobo-Dioulasso 01, Burkina Faso.

Plasmas taken during a parasitological survey on bovine trypanosomosis were retested *a posteriori* with an antigen detection ELISA test. The objective was to evaluate the relevance of this test for epidemiological monitoring. The results were compared to those obtained using the usual parasitological technique (buffy coat examination). Of the 297 zebu cattle studied, 216 came from four villages in the pastoral zone of Sideradougou. A large eradication programme had led to the disappearance of tsetse in the area. Blood samples were taken during the rainy season (September 1986), at the beginning (January 1987) and at the end (May 1987) of the dry season. The

parasitological diagnosis was carried out in the field and plasmas were stored at -20°C . The serological test was performed in August 1993. The incidence rates of bovine trypanosomiasis obtained with the antigen detection ELISA were low in the centre of the zone, decreasing proportionally to the distance between the blood sampling area and the boundary of the infested area. The results of the parasitological diagnosis were similar except for a village located on the edge of the treated zone. The use of the antigen detection ELISA confirmed the low incidence of trypanosomiasis in the centre of the Sideradougou area following the eradication campaign. It also enabled refinement of the parasitological results, showing trypanosome persistence in peripheral zones more exposed to reinfestations.

9692 **Egbe-Nwiyi, T.N. and Chaudhry, S.U.R., 1994.**
 Trypanosomiasis: prevalence and pathology of camel of arid zone of north eastern Nigeria.
Pakistan Veterinary Journal, **14** (1): 24-27.

Department of Veterinary Pathology, University of Maiduguri, P.M.B. 1069, Borno State, Nigeria.
 Blood samples from 200 camels slaughtered at Maiduguri abattoir were examined for trypanosomes. Overall, 2.5% of the camels were found to be infected with *Trypanosoma evansi*. Season had no influence on prevalence. Infected animals showed various pathological symptoms including anaemia, leukopenia, lymphopenia, eosinopenia, hyperproteinaemia and monocytosis, and their spleens and livers were grossly enlarged.

9693 **Kalu, A.U., 1996.** Current status of tsetse fly and animal trypanosomiasis on the Jos Plateau, Nigeria.
Preventive Veterinary Medicine, **27** (3-4): 107-113.

Department of Veterinary Public Health and Preventive Medicine, University of Maiduguri, P.M.B. 1069, Maiduguri, Borno State, Nigeria.
 Blood samples were collected from 1035 systematically selected zebu (white Fulani) cattle resident in two local government areas (LGAs) of the Jos Plateau, and analysed for infections with trypanosomes. Their grazing grounds were also sampled for tsetse flies using unbaited blue Challier (biconical) traps. Mean prevalence of trypanosome infection was 6.4% (95% confidence interval (CI) \pm 0.02) and 9.1% (CI \pm 0.02) in Barkin-Ladi and Bassa LGAs, respectively. A higher

infection rate was recorded during the rains (9.3%; CI \square 0.02) than in the dry season months (1.5%; CI \square 0.02). In both localities prevalence in cows (8.9%; CI \square 0.04) consistently doubled that in bulls (4.0%; CI \square 0.01). Also, infection rates increased with age until the 7th year. *Trypanosoma vivax* was both the predominant species and the only one diagnosed among yearlings. Only riverine tsetse species were trapped, all during the rains (nine hungry *Glossina tachinoides* in Bassa, of which only one was infected, and five hungry, uninfected *G. palpalis* in Barkin-Ladi).

9694 **Katunguka-Rwakishaya, E., 1996.** The prevalence of trypanosomosis in small ruminants and pigs in a sleeping sickness endemic area of Buikwe County, Mukono District, Uganda. *Revue d'Elevage et de Médecine vétérinaire des Pays tropicaux*, **49** (1): 56-58.

Department of Veterinary Medicine, Faculty of Veterinary Medicine, Makerere University, P.O. Box 7062, Kampala, Uganda.

A survey of trypanosomosis in goats, sheep and pigs was carried out in Buikwe County, Mukono District of south-eastern Uganda, between April and August 1994.

Infection rates of 8.8% in 204 goats, 26.7% in 60 sheep and 32.4% in 68 pigs of all ages and both sexes were recorded. *Trypanosoma brucei* was found in goats and pigs, *T. congolense* in sheep and pigs and *T. vivax* in goats and sheep. Infection rates were similar in both sexes of the animal species and it was observed that *T. vivax* caused high levels of parasitaemia while *T. brucei* infections were associated with very low levels of parasitaemia. *T. brucei* infections accounted for 66.7% and 30% of all infections in goats and pigs, respectively. It is postulated that some of these *T. brucei* parasites could be *T. b. rhodesiense*, the causative agent of sleeping sickness in this area.

(b) PATHOLOGY AND IMMUNOLOGY

[See also **19**: nos. 9685, 9688, 9692.]

9695 **Dam, J.T.P. van, Heide, D. van der, Hel, W. van der, Ingh, T.S.G.A.M. van den, Versteegen, M.W.A., Wensing, T. and Zwart, D., 1996.**

The effect of *Trypanosoma vivax* infection on energy and nitrogen metabolism and serum metabolites and hormones in West African Dwarf goats on different food intake levels. *Animal Science*, **63** (1): 111-121.

Dam: Department of Animal Husbandry, Wageningen Agricultural University, P.O. Box 338, 6700 AH Wageningen, Netherlands.

Effects of *T. vivax* infection on nitrogen and energy

metabolism and serum hormones and metabolites were measured using 24 castrated West African Dwarf bucks. In order to discriminate between the effect of infection and the effect of food intake level on energy and nitrogen balance, food quantity restriction was applied for isonutritional comparison; a number of the animals were not infected and served as controls. Daily dry-matter (DM) intake was measured, and energy and nitrogen balance for a 7-day period in weeks 2, 4 and 6 p.i. Weekly blood sampling for analysis of hormones and metabolites was carried out. Infected animals had a lower DM intake, compared with control animals, viz. 38.6 (s.e. 3.2) and 16.1 (s.e. 2.0) g/kg $M^{0.75}$ per day, respectively ($P < 0.001$). Intake of gross energy and nitrogen followed the same pattern. Metabolisability was not changed by infection and averaged 0.44. Heat production was increased by infection with an average of 33 kJ/kg $M^{0.75}$ per day. Energy and nitrogen retention were negative for all groups; infection reduced energy retention and, during weeks 2 and 4 p.i., also nitrogen retention. The required metabolisable energy (ME) intake for maintenance was increased in infected animals (406 and 335 kJ/kg $M^{0.75}$ per day for infected and control goats respectively), based on linear regression of energy retention on ME intake. The efficiency with which energy mobilisation from body stores was substituted by dietary ME was estimated at 0.809 for both infected and control animals. The relationship between nitrogen retention and energy retention was not changed by infection. Therefore no indications were found for an increased catabolism of protein due to infection. Serum thyroxine and triiodothyronine were reduced by infection; serum metabolites and insulin levels reflected the negative energy balance in infected animals.

9696 **Egbe-Nwiyi, T.N. and Antia, R.E., 1996.** Relapses in experimental canine trypanosomiasis with special reference to the effect of splenectomy. *Israel Journal of Veterinary Medicine*, **51** (1): 37-41.

Egbe-Nwiyi: Department of Veterinary Pathology, University of Maiduguri, P.M.B. 1069, Maiduguri, Borno State, Nigeria.

Experimental canine trypanosomiasis was studied in 20 adult male and female local mongrel dogs weighing 10-15 kg. Ten of the dogs were splenectomised. Five splenectomised and five intact dogs were infected i.v. with *Trypanosoma brucei brucei* strain 8/18. The remaining

dogs served as uninfected controls. All the infected dogs developed teeming parasitaemia within 4-7 days p.i. Splenectomy enhanced fever, parasitaemia and relapses, and shortened the prepatent period of infection. Treatment of the infected animals with diminazene aceturate (Berenil) at 7.0 mg/kg body weight i.m. on day 21 p.i. cleared the parasites from the blood. Splenectomy neither enhanced nor inhibited the recovery rate of the animals.

9697 **Igbokwe, I.O., 1994.** Mechanisms of cellular injury in African trypanosomiasis. *Veterinary Bulletin*, **64** (7): 611-620.

Department of Veterinary Pathology, Faculty of Veterinary Medicine, University of Maiduguri, P.M.B. 1069, Maiduguri, Nigeria.

The factors involved or suspected of being involved in causing cellular injury in African trypanosomiasis, and the mechanisms associated with the injury, are discussed. Factors include trypanosome toxins and metabolites (proteases, neuraminidases, phospholipases and free fatty acids, pyruvate, aromatic by-products), trypanosome autolysates, immunochemical reactions, oxidative stress and peroxidation, fever, microangiopathy, and nutritional and hormonal imbalances. The relative importance of the various mechanisms of cellular injury is as yet unknown.

9698 **Luckins, A.G., 1994.** Equine trypanosomiasis. *Equine Veterinary Education*, **6** (5): 259-262.

CTVM, Easter Bush, Roslin, Midlothian EH25 9RG, UK. This article discusses the distribution, disease occurrence, incidence, aetiology, mode of infection, incubation period, age, breed and gender susceptibility, clinical signs, pathology, diagnostic aids, laboratory specimens, prognosis, treatment, control and prophylaxis of this disease.

9699 **Okech, G., Dolan, R.B., Stevenson, P., Alushula, H., Watson, E.D., Luckins, A.G. and Omuse, J.K., 1996.** The effect of

trypanosomiasis on pregnancy in trypanotolerant Orma Boran cattle. *Theriogenology*, **46** (3): 441-447.

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

A study was undertaken to investigate the influence of trypanosomiasis on the outcome of pregnancy in trypanotolerant Orma Boran (*Bos indicus*) cattle exposed to natural tsetse challenge in an area of Kenya infested predominantly with *Glossina pallidipes*. Of 73 pregnant Orma heifers, 58 (79.5%) produced live calves at term, 13 (17.8%) aborted and 2 (2.7%) died of trypanosomiasis. Of the 71 surviving animals, 22 (31%) were infected

with *Trypanosoma vivax*, 21 (29.6%) *T. congolense*, and 26 (36.6%) had mixed infections with *T. vivax* and *T. congolense*. These results suggest that in areas of high trypanosomiasis risk reproductive function is affected even in trypanotolerant cattle, and that both *T. vivax* and *T. congolense* can be responsible for the abortions observed in the field. It is suggested that maintenance of pregnancy in the face of trypanosome challenge was dependent on individual variation among the Orma cattle, but as challenge increased beyond the limits of effectiveness of trypanotolerance, disruption of pregnancy occurred.

9700 **Okech, G., Watson, E.D., Luckins, A.G. and Makawiti, D.W., 1996.**

The effect of experimental infection of Boran cattle in early and mid-pregnancy with *Trypanosoma vivax*. *British Veterinary Journal*, **152** (4): 441-451.

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

Six susceptible Galana and five trypanotolerant Orma Boran (*Bos indicus*) cattle were infected experimentally with *T. vivax* KETRI 2501 by cyclical trans-mission using *Glossina morsitans morsitans* during early and mid-pregnancy. Four pregnant animals, two of each Boran type, were used as controls and remained uninfected throughout the study period. Three out of the six infected susceptible Galana Borans aborted, whilst one had a stillborn calf. None of the trypanotolerant Orma Boran cattle aborted and all carried their pregnancies to term. All control animals produced live calves at term. The mechanisms leading to disruption of reproductive function in susceptible Boran cattle were not clear but could involve a number of factors, including anaemia, weight loss and post-infection decline of plasma progesterone levels. It is concluded that infection with *T. vivax* disrupts maintenance of pregnancy in susceptible Galana Borans but does not affect maintenance of pregnancy in the Orma Boran, demonstrating their tolerance to infection with *T. vivax*.

9701 **Rabo, J.S. and Oyejide, A., 1996.** Humoral immune response of West African Dwarf sheep to infection with *Trypanosoma congolense* (Gboko strain). *Small Ruminant Research*, **21** (2): 161-164.

Rabo: Department of Veterinary Pathology, University of Maiduguri, P.M.B. 1069, Borno State, Nigeria.

Eight West African Dwarf (WAD) sheep were inoculated i.v. with 1×10^6 *T. congolense* (Gboko strain) organisms in order to determine their immune response to the trypanosomes. Most infected sheep showed detectable antibodies in week 2 p.i. and there was progressive

increase in antibody levels. Whereas some sheep showed high antibody titres, others showed a very weak response. The difference in antibody titres between responders was not statistically significant. One animal failed to seroconvert and died 14 days p.i. The findings underline the importance of humoral immune response in fighting infection from trypanosomes and also show the *T. congolense* (Gboko strain) can break through the humoral defence mechanism of WAD sheep to produce moderate to severe disease which can lead to death.

9702 **Rowlands, G.J., d'Ieteren, G.D.M., Coulibaly, L., Hecker, P.A., Leak, S.G.A. and Nagda, S.M., 1996.** Assessment of the effect of tsetse control on livestock productivity – a case study in northern Côte d'Ivoire. *Preventive Veterinary Medicine*, **28** (1): 17-32.

Rowlands: ILRI, P.O. Box 30709, Nairobi, Kenya.
In order to assess the effect of tsetse control on livestock productivity, 21 herds of cattle of N'Dama, Baoulé and zebu cross breeds in the region of Boundiali, northern Côte d'Ivoire, were monitored monthly for trypanosome prevalence, PCV, body weight and reproductive performance between January 1987 and December 1989. Mean calf growth rate over the wet season of 1987, prior to tsetse control, was 243 ± 48 (standard deviation among herds) g per day; mean cow body weight in 1987 was 223 ± 15 kg; mean cow PCV, $29.8 \pm 2.5\%$; mean conception rate by 6 months postcalving, $28 \pm 22\%$; median monthly trypanosome prevalence was 21.4% (range 3.9-32.0%) in animals under 24 months of age and 12.6% (range 0.0-44.7%) in cows. A tsetse control campaign using alpha-cypermethrin-impregnated traps was introduced in December 1987 to control trypanosomiasis. Regression analyses were used to relate changes in mean PCV, calf growth rate, and cow body weight and conception rate between 1987 and 1988/89 (the period of tsetse control) to corresponding reductions in trypanosome prevalence. An average 13.6 percentage unit reduction in mean trypanosome prevalence in calves between 1987 and 1988/89 was associated with an increase of 12.2 ± 3.6 (standard error, SE) kg in calf liveweight gain over the 7-month wet season. In cows, a corresponding 8.7 percentage unit reduction in trypanosome prevalence was associated with a 4.9 ± 2.3 (SE) kg increase in body weight and a 1.3 ± 0.3 percentage unit increase in PCV. An 18.4 ± 8.0 (approximate SE) percentage unit increase in the number of cows conceiving within 6 months of calving

resulted from a mean decrease of 6.8 percentage units in trypanosome prevalence from 1987 to 1988. The difficulties in obtaining estimates of effects of health interventions on livestock productivity that are both precise and unconfounded with other effects over time are discussed.

9703 **Vercammen, F., Deken, R. de and Kageruka, P., 1996.** Een geval van trypanosomosis bij de hond. [A case of trypanosomiasis in a dog.] *Vlaams Diergeneeskundig Tijdschrift*, **65** (3): 148-150.

Instituut voor Tropische Geneeskunde, Departement Diergeneeskunde, Nationalestraat 155, B-2000 Antwerp, Belgium.

This case report describes the etiology, diagnosis and treatment of a dog that developed *Trypanosoma brucei brucei* infection during a stay in Sierra Leone. After a relapse occurred due to ineffective treatment with isometamidium, the dog was cured completely with suramin.

(c) TRYPANOTOLERANCE

[See also **19**: nos. 9663, 9700.]

9704 **Rowlands, G.J. and Teale, A.J. (eds), 1994.** *Towards increased use of trypanotolerance: current research and future directions.* Proceedings of a Workshop organised jointly by ILRAD and ILCA, held at ILRAD, Nairobi, Kenya, 26-29 April 1993. Nairobi; ILRAD/ILCA. 189 pp.

For several years ILCA and ILRAD [now combined as ILRI] have been involved in research on various aspects of trypanotolerance and the productivity of trypanotolerant livestock. This Workshop was convened to review progress to date and to consider future research and extension needs. The 24 papers given at the Workshop are arranged in sections on the significance of trypanotolerance as a control option (1 paper), the biology of trypanotolerance (13 papers), the adoption, utilisation and impact of trypanotolerance (5 papers), and conservation, preservation, enhancement and propagation (5 papers). Abstracts of all papers are given in section 6c of this issue of *TTIQ*, arranged, for convenience, in the order in which they are presented in the Proceedings.

Research needs and plans were discussed in three round-table sessions: recommendations arising from these sessions are included in the Proceedings.

9705 **d'Ieteren, G.D.M., 1994.** Trypanotolerant livestock, a sustainable option for increasing livestock production in tsetse-affected areas. *In*: Rowlands, G.J. and Teale,

A.J. (eds), 1994 (see **19**: no. 9704), pp. 3-11.
ILRI, P.O. Box 30709, Nairobi, Kenya.
From 1977 to 1985 the trypanotolerant cattle population (including crossbreeds) increased at an average annual rate of 3.2% from 7.8 million to 9.9 million, due mainly to an annual increase in N'Dama of 4.5%. Although there have been significant increases in some countries (e.g. Côte d'Ivoire and Ghana) during the period, there have been decreases in others (e.g. Benin, Nigeria, Senegal). Data for different agro-ecological zones would be more meaningful but unfortunately are not available. There are now N'Dama herds in nearly all western and central African countries; the reasons why N'Dama have not spread further to the east of Zaire are not clear and not documented. It is possible that they would have no comparative advantage to indigenous breeds in low input production systems, often close to a subsistence economy. There appears to be no shortage of supply of N'Dama breeding stock. Substantial progress has been made in assembling data on various breeds and their crosses under different levels of trypanosomiasis risk in different ecological and management situations which should help to facilitate decision making on breed choices. Strategic research on mechanisms of trypanotolerance, carried out so far mainly on N'Dama and Baoulé cattle, needs to include other breeds of cattle and small ruminants where the mechanism may be different. Future research also needs to address the development of new diagnostic tools, socioeconomic aspects and the environmental impact of the proposed technologies.

9706 **Leak, S.G.A., d'Ieteren, G.D.M. and Rowlands, G.J., 1994.**

Factors affecting estimation of tsetse challenge and the expression of trypanotolerance. *In*: Rowlands, G.J. and Teale, A.J. (eds), 1994 (see **19**: no. 9704), pp. 15-22.

Leak: ILRI, P.O. Box 30709, Nairobi, Kenya.
Trypanotolerance is a relative rather than an absolute trait, and trypanotolerant breeds of cattle and small ruminants can be severely affected in high challenge situations or when under stress. Tsetse challenge has been defined as the product of the relative density of tsetse, their trypanosome infection rate and the proportion of feeds which they have taken from domestic livestock. Many questions remain regarding the causes of the differences observed in trypanosome prevalence between trypanotolerant and susceptible breeds.

Entomological aspects are discussed here. One unanswered question is whether trypanotolerance is a result of these cattle not being fed upon by infected tsetse to the same extent that susceptible breeds are fed upon. Some factors which could influence feeding preferences of tsetse are: physical (skin thickness, skin rippling), visual (coat colour, size), olfactory (breath, urine, skin secretions) and behaviour (tail flicking, head swings). Another question is whether, if fed upon to the same extent, trypanotolerant cattle require a higher infective dose of trypanosomes in order for an infection to become established. Studies carried out so far are briefly reviewed. Results have been generally inconclusive and further investigations are required. The main differences between trypanotolerant and susceptible breeds are, however, likely to be found in the way in which they deal with the trypanosomes transferred by tsetse bite.

9707 **d'Ieteren, G.D.M. and Trail, J.C.M., 1994.** Field research on measurement and use of trypanotolerance criteria to enhance trypanotolerant livestock productivity. 1. ILCA's achievements and future plans. *In*: Rowlands, G.J. and Teale, A.J. (eds), 1994 (see **19**: no. 9704), pp. 23-28.

d'Ieteren: ILRI, P.O. Box 30709, Nairobi, Kenya.

The major constraints to putting trypanotolerance to better practical use have been due to difficulties in the definition and measurement of its indicators. The approach and the steps taken from the early 1980s to the most recent ongoing or planned experiments carried out by ILCA [now ILRI] and its partners in the African Trypanotolerant Livestock Network are reviewed.

Trypanotolerance has been recognised as being driven by three fundamental processes: the ability to control the development of the parasites, the ability to control the development of anaemia and the ability to acquire a better degree of tolerance. These have been researched in some detail over recent years, particularly in N'Dama and Baoulé cattle. Evaluation of anaemia control by PCV measurement is relatively easy. The degree of parasitaemia is not so easily quantified because of the difficulty of demonstrating parasites at low levels of parasitaemia, although the antigen-ELISA technique is showing promise. To date few data are available on aspects of acquiring better resistance. The work reported provides evidence that trypanotolerance is not only a breed characteristic of the N'Dama but is also a heritable trait within the breed.

The genetic variation identified within the N'Dama breed opens new opportunities for improved productivity through selection for trypano-tolerance. Preliminary but promising heritability estimates of anaemia control capability and their genetic correlations with animal performance are encouraging further studies on the genetics of trypanotolerance, including the development of genetic maps which will facilitate the search for disease resistance markers or genes.

9708 **Trail, J.C.M., Wissocq, N. and d'Ieteren, G.D.M., 1994.** Field research on measurement and use of trypanotolerance criteria to enhance trypanotolerant livestock productivity. 2. Recent results quantifying trypanotolerance indicators. *In*: Rowlands, G.J. and Teale, A.J. (eds), 1994 (see 19: no. 9704), pp. 29-32. Trail: ILRI, P.O. Box 30709, Nairobi, Kenya. Analysis of long-term data collected over a four-year period at Mushie Ranch, Zaire, has clarified the pattern of trypanosome infection over the life of individual N'Dama cattle in this region of Central Africa, and allowed quantification of various trypanotolerance indicators. It has been found that N'Dama cattle appear to be able to acquire, over time, some control of the development of parasitaemia following a *Trypanosoma vivax* infection but not, apparently, following a *T. congolense* infection. Simultaneous quantification of four indicators (species of trypanosome detected, length of time parasitaemic, parasitaemia score, and anaemic condition as estimated by PCV) in post-weaners showed that each had an approximately equal effect on the final performance trait of daily liveweight gain, stressing the necessity for information on all these criteria in assessing an animal's trypanotolerance phenotype. For practical breeding and production schemes it will be necessary to weight these post-weaner indicators. In addition, pre-weaner calves (i.e. up to 10 months of age), grazing with their dams, appeared to have some protection from, or be more resistant to, both *T. vivax* and *T. congolense* infections when compared with their dams and with their own immediate post-weaning situations. The reason for this is not known but it is unlikely that colostrum had any significant effect.

9709 **Planchenault, D. and Traoré, M., 1994.** Genetic improvement of growth parameters in N'Dama cattle in Mali. *In*: Rowlands, G.J. and Teale, A.J. (eds), 1994 (see 19: no. 9704), pp. 33-42.

Planchenault: CIRAD-EMVT, Campus International de

Baillarguet, B.P. 5035, 34032 Montpellier Cedex 1, France.

A programme for genetic improvement of N'Dama cattle in Mali was initiated in 1975. The Madina Diassa Centre's objective is to supply genetically superior animals for the internal market and then for exportation. The Centre's choice of selective breeding strategy, the implementation constraints and the results obtained are described. The ranch herd was formed between 1975 and 1981 from genetically unselected animals purchased in the target zone and maintained under moderate to high tsetse challenge using a system which simulated local village breeding conditions as closely as possible so as to facilitate subsequent translocation of the animals produced. The chosen criteria for selection have remained closely in line with the breeding objectives set down in 1981: to increase growth potential of N'Damas which have to retain product-ivity and reproductive capacity in a tsetse-infested environment. No criterion directly related to trypanosomiasis has been considered. It is still not possible to assess the genetic parameters affecting the selection criteria used, but evaluation of growth parameters in animals raised in an environment of high tsetse challenge has demonstrated families with good productivity levels, which must be related to good environmental adaptation, and others that did not perform so well. These variations should help us to approach trypanotolerance more objectively.

9710 **Duvallet, G. and Touré, S.M., 1994.** Characterization and mechanisms of trypanotolerance in Baoulé cattle. *In*: Rowlands, G.J. and Teale, A.J. (eds), 1994 (see **19**: no. 9704), pp. 43-50.

Duvallet: CIRDES, 01 B.P. 454, Bobo-Dioulasso 01, Burkina Faso.

Recent research at CIRDES on the Baoulé breed is described under three sections: (a) expression of its resistance in comparison with zebu cattle submitted to natural and/or artificial challenge; (b) analysis of some mechanisms; and (c) its genetic characterisation. When Baoulé cattle are introduced into an area of high tsetse challenge, they show a lower susceptibility (around 34% mortality) than zebu (100% mortality), and some resist completely without showing any clinical symptoms and without being apparent carriers of the parasites. Baoulé were superior to zebu in controlling parasitaemia and anaemia, and previous exposure to natural challenge had a significant positive effect.

Experiments on artificial challenge with either wild or laboratory-bred infected tsetse showed similar superior PCV and parasitaemia control in Baoulé compared to zebu but without the marked differences between individual Baoulé seen in natural challenge conditions that could lead to selection of animals with higher resistance. Needle challenge appears to result in taurines and zebu becoming equally infected, with similar prepatent periods. Work on non-immunological mechanisms of trypano-tolerance suggested that Baoulé may be less attractive to tsetse than zebu, while the possible role of trypanolytic serum factors appears inconclusive. Immuno-logical mechanisms studied (skin reaction, immune response) showed no clear difference between resistant and susceptible animals. Genetic characterisation of more than 20 different populations of resistant and susceptible taurine and zebu cattle have shown animals to be homozygous for haemoglobin A and albumin F in areas of high tsetse challenge, with significant variability in frequency of albumin gene F in different populations of Baoulé.

9711 **Williams, D.J.L., Taylor, K., Wilkie, B., Gichuki, B. and Authié, E., 1994.** Antibody responses to the surface-exposed epitopes of the trypanosome variable surface glycoprotein in N'Dama and Boran cattle. *In*: Rowlands, G.J. and Teale, A.J. (eds), 1994 (see **19**: no. 9704), pp. 51-53.

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

To test the hypothesis that the lower parasitaemia seen in trypanotolerant cattle is the result of a more effective antibody response against the VSG, VSG-specific antibody responses in 11 N'Dama and 11 Boran cattle were measured during an experimental *Trypanosoma congolense* infection. Cattle aged 1-3 years were cyclically infected with *T. congolense* ILNat 3.1.

Parasitaemia was estimated by the dark ground/phase contrast technique, PCV was measured using a haematocrit centrifuge and reader, and serum samples were collected from each animal weekly. Complement lysis assay (CLA) and fluorescence activated cell sorter (FACS) analysis were carried out. All cattle became parasitaemic 10-12 days p.i. The overall mean parasitaemia was higher, and the PCV lower, in Borans than in N'Damas. Serum antibodies were detected in the CLA 14 days p.i. in one Boran and 21 days p.i. in the remaining 10 Borans and 11 N'Damas; these persisted until the end of the experiment on day 42 p.i. There was no significant difference in the percentage lysis

between the breeds. IgM, IgG₁ and IgG₂ antibodies were all detected but there was no difference between the breeds in the level or isotype of antibodies specific for surface-exposed epitopes of the VSG. However, these results were obtained in cattle undergoing a primary infection: some data suggest that anti-VSG antibodies are involved in the superior resistance of trypanotolerant cattle to homologous rechallenge infection.

9712 Authié, E., Boulangé, A., Muteti, D., Taylor, K. and Williams, D.J.L., 1994. Antibody responses to invariant antigens of *Trypanosoma congolense*. In: Rowlands, G.J. and Teale, A.J. (eds), 1994 (see 19: no. 9704), pp. 55-60.

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

Two major invariant antigens of *T. congolense*, with molecular masses of 69 and 33 kDa, have been identified. The 69 kDa antigen belongs to the heat shock proteins 70 (hsp70) family, homologous to the mammalian immuno-globulin binding protein (BiP), and thus, when present in the plasma of infected cattle, might bind to host proteins, e.g. immunoglobulins, cell receptors and cytokines, and might play a role in the immunological dysfunction associated with trypanosome infection. The 33 kDa antigen is a protein identical to a cysteine protease (CP), is abundant in the parasite's lysosomes and thus must be released in the bloodstream following lysis of the trypanosomes during infection, possibly contributing to determining immunosuppression and hypocomplement-aemia. The 69 kDa antigen was recognised by all infected N'Dama and Boran cattle. However, essentially IgG₁ was elicited in rechallenged N'Dama cattle, whereas IgM was elicited in Boran cattle. Similar differences were observed during primary infections. The 33 kDa antigen appeared to be recognised by N'Dama but not by Boran during primary infections. However, specific IgM was elicited in both breeds but all formed immune complexes with circulating protease, making it undetectable in conventional assays. In N'Dama, but not Boran, high titres of free IgG₁ were detected from 20-30 days p.i. When several breeds of cattle were examined, a positive correlation was seen between the mean level of anti-protease IgG antibodies in a given breed and the known level of trypanotolerance. Repeated infection of susceptible individuals, however, increases the IgG response. It is possible that, in addition to these differences, taurine and zebu cattle may recognise different epitopes on both 33 and 69 kDa antigens.

9713 **Naessens, J., 1994.** CD5⁺ B lymphocytes in cattle infected with African trypanosomiasis. *In*: Rowlands, G.J. and Teale, A.J. (eds), 1994 (see **19**: no. 9704), pp. 61-63.

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

During trypanosomiasis there is a general activation of the humoral component of the immune system which can be summarised as follows: an increase in cellularity of the spleen and an increase in the proliferation status of spleen cells; an increase in the number of B cells but not T cells in the periphery; an increase in the levels of Igs, especially of the IgM class; appearance of antibody activities to non-trypanosome antigens (heterophylic Abs, non-specific Abs); and presence of auto-antibodies and immune complexes. A polyclonal activation of B cells could explain the massive increase in B cells, Ig and the occurrence of antibodies to apparently unrelated antigens, but no general consensus has been reached over which parasite antigen is the cause. However, a subset of B cells, called the B-1 subpopulation and characterised by the expression of Ly-1 or CD5, has been described. When we monitored the number of CD5⁺ B cells during *Trypanosoma congolense* infections in Boran and N'Dama cattle, we observed a sharp increase in their percentage of the total B cells around week 3, about one week after the first parasites were detected in the blood. Their percentage rose steadily until they constituted 60-80% of the blood B cells, accounting for most of the total B cell increase. The tissue distribution of CD5⁺ B cells remained the same as before infection. No significant difference was seen between Boran and N'Dama cattle. A similar rise in CD5⁺ B cells has been seen in *T. vivax* infection. It may be this increase which leads to secretion of large amounts of IgM, and to polyspecific and auto-antibodies, and may explain the occurrence of non-trypanosome specificities. It is not yet certain that bovine CD5⁺ B cells are identical to B-1 cells. It is possible that ruminants have only B cells that belong to the B-1 class, in which all B cells express CD5.

9714 **Andrianarivo, A.G., Muiya, P., Opollo, M. and Logan-Henfrey, L.L., 1994.** Comparative bone marrow responses during *Trypanosoma congolense* infection in N'Dama and Boran cattle. *In*: Rowlands, G.J. and Teale, A.J. (eds), 1994 (see **19**: no. 9704), pp. 65-67.

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

A study was undertaken in three N'Dama and three Boran

cattle to determine whether the N'Dama's better ability to control anaemia resides in a superior bone marrow response. The cattle were cyclically infected with *T. congolense* IL1180 and sternal bone marrow samples were collected weekly and assayed in *in vitro* culture for haemopoietic progenitors. PCV, haemoglobin levels, erythrocyte count, and total and differential leucocyte counts were determined twice a week. The cattle were first detected parasitaemic 11-14 days p.i. After the first wave of parasitaemia 14-17 days p.i., parasitaemia became progressively lower in N'Damas but remained high in Boran. Decrease in PCV was similar in both breeds until 25 days p.i. and thereafter dropped much faster in Boran. An increase in mean corpuscular volume from 46 days p.i. in Boran and 63 days p.i. in N'Dama was indicative of the responsive nature of the anaemia. The total nucleated cells (TNC) counts dropped below the preinfection baseline in the bone marrow by 7 days p.i. to 89% for N'Dama and 66% for Boran. The evolution of the TNC thereafter (fluctuating in both breeds, below the baseline for Boran throughout the infection, sometimes above for N'Dama) was consistent with the grossly observed cellularity of the bone marrow samples at the time of collection. Study of CFU-E, BFU-E and CFU-GM responses throughout the infection indicated that the N'Dama cattle were more efficient than the Borans in increasing progenitors from both the erythroid and the myeloid lineages. This might partially account for their better ability to control anaemia and parasitaemia.

9715 **Kemp, S.J. and Teale, A., 1994.** Markers for mapping trypanotolerance genes. *In*: Rowlands, G.J. and Teale, A.J. (eds), 1994 (see **19**: no. 9704), pp. 69-70. Kemp: ILRI, P.O. Box 30709, Nairobi, Kenya.

A 'genome analysis' approach is being adopted in an attempt to identify the genetic basis for trypanotolerance in the N'Dama. A cross between N'Dama and trypanosusceptible Boran has been established using embryo-transfer to generate large full-sibling families. The F1 generation is almost complete and 14 F2 calves were born by April 1993. These will be challenged with *Trypanosoma congolense* and genotyped with a large array of genetic markers. Correlations will then be sought between marker inheritance and trypanotolerance status. These markers fall into three main categories: (i) randomly amplified DNA polymorphisms (RAPDs); (ii) randomly identified

polymorphic dinucleotide repeat sequences (microsatellites); and (iii) polymorphisms in specific genes. The use of these markers is briefly described. 9716 **Dolan, R.B., Alushula, H., Munga, L., Mutugi, M., Mwendia, C., Okech, G., Sayer, P.D., Stevenson, P.G.W., Baker, R.L. and Magadi, M., 1994.** The Orma Boran – ten years of field observations. *In*: Rowlands, G.J. and Teale, A.J. (eds), 1994 (see 19: no. 9704), pp. 71-79.

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

Since 1913 trypanotolerance has been reported in various *Bos indicus* breeds in Sudan, Zaire, Uganda and Kenya but little effort has been made to investigate the nature or extent of differential susceptibility to trypanosomiasis amongst *B. indicus* breeds. The degree of trypanotolerance in African cattle is a reflection of the severity of tsetse challenge to which they have been exposed and the length of time over which that exposure has taken place. It seems likely that tsetse challenge has been less intense in East Africa and there is also evidence that *B. indicus* cattle arrived in Africa many centuries after *B. taurus* cattle. The Orma Boran originated in Ethiopia and was introduced into Kenya between 1400 and 1500, eventually being restricted to the tsetse-infested lands of the Tana River District. The Galana Boran, which also originated in Ethiopia, was introduced into the Kenyan Highlands at the beginning of this century. Three aspects of field studies on Orma and Galana Borans on the Galana Ranch are presented: (i) a summary of various yearly trials; (ii) results of a two-year trial analysing aspects of acquired and innate resistance; and (iii) some preliminary results from a statistical analysis on Orma and Galana cows and their calves born on Galana Ranch. Results showed a clear superiority of Orma Boran over Galana Boran in the face of tsetse and trypanosomiasis challenge. There are two facets to this superiority. Firstly, Orma Boran, when exposed to natural field challenge, are detected parasitaemic less often. This superiority is more apparent under *Trypanosoma vivax* than *T. congolense* challenge, and the magnitude of the difference in infection rates between the breeds decreases with increasing tsetse challenge. Secondly, once parasitaemic, Orma Boran have a superior ability to control parasitaemia and anaemia. Mortality rates were lower in untreated cattle and time to death was extended. When infections were treated only when PCV fell to 15%, fewer Orma required treatment. The decreased susceptibility to infection under natural

challenge appears to be related to both acquired and innate factors. The Orma cattle appear better able to improve their control of anaemia over time, particularly in relation to *T. vivax* infections. The economic benefits which might accrue from the exploitation of these differences remain to be determined.

9717 **Mwangi, E.K., Stevenson, P., Gettinby, G. and Murray, M., 1994.**

Variation in susceptibility to tsetse-borne trypanosomiasis among *Bos indicus* cattle breeds in East Africa. *In*: Rowlands, G.J. and Teale, A.J. (eds), 1994 (see **19**: no. 9704), pp. 81-86.

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

Epidemiological studies at KETRI over a period of ten years have identified the Orma Boran as a trypanotolerant breed. The present study was aimed at investigating the variation in susceptibility among three *Bos indicus* cattle breeds, the Maasai zebu, Orma Boran and Galana Boran, in different tsetse-infested parts of Kenya. The experiments were done in two phases, the first in a group ranch at the Nguruman escarpment (1989-1990), the second at a commercial beef ranch, the Galana Ranch, near the Kenya coast (1991-1992). Nineteen to 25 animals of each breed were used in each study. Parasitaemia and PCV were monitored weekly, body weight was recorded fortnightly, and parasitaemic animals with PCV of 17% or less were treated with diminazene aceturate. At both Nguruman and the Galana Ranch, the Maasai zebu and Orma Boran were less susceptible to trypanosomiasis than the Galana Boran, as reflected by the significantly lower disease incidence, less severe degree of anaemia and higher growth rates. Self-cure was seen in all breeds but the number of cases was significantly higher in the Maasai zebu than in the other breeds. The resistance observed in the Maasai zebu and Orma Boran was not confined to particular strains of trypanosomes since similar results were obtained at separate locations.

9718 **Rowlands, G.J., d'Ieteren, G.D.M., Authié, E., Leak, S.G.A.,**

Woudyalew Mulatu and Nagda, S.M., 1994. Variations in susceptibility to the effects of trypanosomiasis in East African zebu cattle. *In*: Rowlands, G.J. and Teale, A.J. (eds), 1994 (see **19**: no. 9704), pp. 87-94.

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

Since 1986, approximately 840 East African zebu cattle raised under trypanosomiasis risk in the Ghibe Valley of southwest Ethiopia have been studied to investigate the effects of trypanosomiasis on health and

productivity. Diminazene aceturate has been used to treat animals infected with *Trypanosoma congolense* and, in spite of high levels of drug resistance, appears to have helped to limit trypanosome growth and allowed the cattle to maintain reasonable levels of productivity. Trypanosome infection in the calf significantly affected growth rate between 13 and 24 months of age but this effect was transient. The proportion of time a cow was detected parasitaemic during the first 5 months of lactation also had a significant effect on calving interval. The most significant effects of trypanosomiasis appeared to be on calf mortality and on foetal mortality, with a high average rate of abortion, estimated at 8.4% of all calvings, associated with low mean PCV during the last 3 months of pregnancy. The associations between PCV, corrected for frequency of parasitaemia and treatment, and growth rate and calving interval agree with findings in N'Dama cattle. Although all animals eventually required treatment, there was evidence of genetic variation in susceptibility to the effects of trypanosomiasis. When offspring were compared with their dams, significant regression coefficients for PCV and for frequency of detected parasitaemias were obtained. Although the data suggested a negligible maternal influence, interpretation in the light of the number of recurrent infections suggested some evidence of heritability.

9719 **Traoré, M., Planchenault, D., Kone, O., Berti, F. and Berthe, A.S., 1994.** Promotion of N'Dama stockbreeding and extension activities in village herds in the Yanfolila area of Mali. *In*: Rowlands, G.J. and Teale, A.J. (eds), 1994 (see 19: no. 9704), pp. 97-101.

Traoré: Service de l'Élevage et de la Santé Animale, Direction Nationale de l'Élevage, B.P. 265, Avenue de la Liberté, Bamako, Mali.

The Yanfolila area of southwest Mali is a region of plateaux with a Sudanian-Guinean climate. Savanna woodland and light forest give way to savanna grassland along the Baoulé River and its principal tributaries where vegetation provides shelter for insects including *Glossina morsitans submorsitans*, *G. tachinoides* and *G. palpalis gambiensis*. Crop farming is the main activity. N'Dama cattle, probably long established in the area, usually vary between 40 and 100 animals per village, herds usually being jointly owned. In the crop growing season, animals have restricted grazing time; in the dry season they are allowed to wander freely. Bulls are often used for draught as well as breeding.

Trypanosomiasis is prevalent throughout the year but greatest between the end of the rains and the end of the cool dry season (November to January). The development of a programme to improve N'Dama productivity started with the establishment of a breeding ranch at Madina Diassa (see **19**: no. 9709). Here the methodology for the translocation of some of the ranch cattle into four target villages is described. This began with a campaign of information and public awareness. Altogether 200 head of cattle have been distributed and are being regularly monitored for performance and health. The villagers participate actively, with young trainees learning about veterinary care or performance monitoring. Extension of the programme to villages has permitted transfer of experience acquired at the Madina Diassa ranch, particularly pertaining to pastoral management, and the formation and structuring of village associations as grantors of livestock loan contracts. A pastoral management committee was formed in each village to implement a management model based on controlled burning and rotation of land: this has resulted in better management and quality of pastures and in improved animal nutrition. The creation of pastoral associations has helped to promote literacy and village development.

9720 **Itty, P. and Swallow, B.M., 1994.** The economics of trypanotolerant cattle production in regions of origin and areas of introduction. *In*: Rowlands, G.J. and Teale, A.J. (eds), 1994 (see **19**: no. 9704), pp. 103-114.

Itty: Department of Agricultural Economics, Swiss Federal Institute of Technology, ETH Zentrum SOL, 8092 Zurich, Switzerland.

Some of the economic analyses that have been conducted through the African Trypanotolerant Livestock Network are summarised. The following question is addressed: under what circumstances can trypanotolerant cattle enterprises be economically viable in regions of origin and areas of introduction? Ongoing village cattle enterprises in four countries are analysed using benefit-cost analysis at both social and private level. Sites studied were: Gunjur and Keneba in The Gambia and Boundiali in northern Côte d'Ivoire (regions of origin), and Avetonou in southern Togo and Idiofa in western Zaire (areas of introduction). At the Gambian sites farmers continue to keep N'Dama cattle as part of an integrated crop/livestock production system despite

the fact that trypanosomiasis has become insignificant compared to other disease and feed resource constraints. At Boundiali, Côte d'Ivoire, livestock keepers raise a variety of trypanotolerant and trypanosusceptible breeds of cattle in an intensifying farming system with moderately high levels of trypanosome prevalence. At Avetonou, Togo, a bilateral development agency introduced cattle to farmers that previously had no experience with cattle through interest-free animal loans, input subsidies and extensive extension support. At Idiofa, Zaire, N'Dama cattle were introduced into an area of moderate trypanosome prevalence by a local non-governmental organisation that provided fewer subsidies and extension. N'Dama appear to be well suited to their new environment in both areas of introduction. However, benefits in these areas were limited to meat in the short to medium term, whereas in the regions of origin benefits were derived from meat, milk, animal traction and other crop-livestock interactions. Despite these differences the cattle enterprises generated attractive social-level returns (18-46%) and good to fair private-level returns (10-26%) to capital invested in initial herd purchase and production at all sites. The greatest constraints to successful adoption at the two areas of introduction appeared to be management, labour and capital, and here external agencies and extension services can play an important role.

9721 **Swallow, B.M. and Jabbar, M.A., 1994.** Cattle breed preferences and breeding practices in southern Nigeria. *In*: Rowlands, G.J. and Teale, A.J. (eds), 1994 (see 19: no. 9704), pp. 115-121.

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

This paper summarises the results of three surveys undertaken among farmers in the derived savanna of southern Nigeria, an area of low to moderately high trypanosomiasis risk where farmers are familiar with a variety of trypano-tolerant and trypanosusceptible breeds and crosses. The first survey (1986-1987) was designed to provide information on the sedentarisation of Fulani agro-pastoralists (settlement patterns, adoption of crop cultivation, herd composition). The second (1989) questioned peri-urban agro-pastoralists about feed resources, calving frequency and their attitude towards the N'Dama. The third survey (1990) questioned peri-urban agro-pastoralists on general household characteristics, farming activities and

labour, cattle breeds and breeding, calf rearing, feed resources and feeding practices. The results indicated that farmers' breed portfolios are the outcomes of dynamic processes that vary both across farmers within a particular micro-environment and across micro-environments within an agro-ecological zone. The sedentarisation study results indicated that the percentage of zebu animals in the herds of recently settled Fulani agro-pastoralists is negatively correlated with the length of time they have been settled. The 1989 survey results indicated that farmers consider a variety of characteristics of different breeds, and that their breed preferences are based on a composite of those characteristics, with experience modifying preferences over time. The results of the 1990 survey indicated that farmers within a particular area are likely to have different breed preferences and to modify the breed structure of their herd to reflect their preferences.

Trypanosomiasis is one of the factors, sometimes the most important, influencing choice. The objectives of a planned new phase of research on breeding practices and breed preferences are described.

9722 **Agyemang, K., Little, D.A. and Dwinger, R.H., 1994.** Salvaging the image of the N'Dama breed: productivity evidence from village production systems in The Gambia. *In*: Rowlands, G.J. and Teale, A.J. (eds), 1994 (see **19**: no. 9704), pp. 123-133.

Agyemang: ILRI, P.M.B. 2248, Kaduna, Nigeria.

Trypanotolerant cattle represent only a small proportion of the total cattle population of Africa. It has been postulated that this is due in part to the widely held belief that they are not productive because of their relatively small size. A study assessing the productivity levels of different breeds has found that, in areas of zero to low tsetse risk, the productivity of N'Dama and West African Shorthorn cattle was only marginally lower than that of zebu. Under medium to higher tsetse challenge a similar comparison could not be undertaken because only trypanotolerant livestock were present. This paper summarises data on N'Dama productivity in traditional production systems in The Gambia with low to high tsetse challenge and describes the responses to nutritional interventions. When milk extracted from N'Dama for human consumption was taken into consideration, the overall productivity of the N'Dama was found to be superior to that of zebu breeds maintained under similar traditional but tsetse-free

systems. Nutritional supplementation to reduce the constraints of seasonal feed shortages could result in a major increase in productivity. These results clearly show that the N'Dama breed has great potential for exploitation in the agricultural development of tsetse-infested areas, and its 'unproductive' stigma should be shed forthwith.

9723 **Reid, R.S., Curry, J.J., Swallow, B.M., Mukhebi, A.W., Perry, B.D. and Ellis, J.E., 1994.** Ecological, social and economic impacts of trypanotolerance: collaborative research in Central and West Africa. *In*: Rowlands, G.J. and Teale, A.J. (eds), 1994 (see **19**: no. 9704), pp. 135-144.

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

Despite over a century of recognition of the possible impacts of removing the constraint of trypanosomiasis, research has yet to be conducted that quantifies the ecological or socio-economic impacts of trypanosomiasis control. This leaves African governments, donor agencies and international organisations such as FAO, ILCA and ILRAD without the information to effectively plan disease control research and delivery, or base sound natural resource and land-use policies. To partially fill this gap, ILRAD, ILCA and Winrock International are launching a project with regional and national partners to evaluate the impacts of trypanosomiasis control at the continental, national and local levels. Trypanotolerant livestock will feature predominantly in the analyses for West and Central Africa. This study will be linked to current research that seeks to determine how expanded adoption of trypanotolerant livestock influences livestock and agricultural production and economic output from the agricultural sector. To supplement existing data, future research will aim (i) to determine how trypanosomiasis and economic, environmental, demographic and socio-cultural factors influence farmers' choice concerning selection of breeds, especially trypanotolerant breeds, other trypanosomiasis controls, livestock production and crop enterprises, labour organisation and allocation, and migration, and (ii) to quantify the impacts of land-use change associated with trypanosomiasis control on ecological properties and human welfare at the different levels (local, national and continental). This paper presents the conceptual framework and research methods that will be used in the project and discusses the hypotheses to be tested and the expected outputs of the research.

9724 **Rege, J.E.O. and Baker, R.L., 1994.** Characterization, conservation and utilization of indigenous African animal genetic resources – ILCA's proposed program. *In*: Rowlands, G.J. and Teale, A.J. (eds), 1994 (see **19**: no. 9704), pp. 147-153.

Rege: ILRI, P.O. Box 5689, Addis Ababa, Ethiopia. Accelerating demands of a growing human population, changing circumstances in traditional communities and pressures of economic development are affecting the security and survival of indigenous African animal genetic resources even before they are characterised for effective utilisation. This paper describes a proposed programme of research to be undertaken by ILCA [now ILRI] in partnership with national agricultural research systems through existing collaborative work networks. The objectives of the programme are: (i) to characterise indigenous African livestock breeds; (ii) to formulate action plans that might arrest or reverse declines in threatened or endangered populations; (iii) to develop strategies for conservation and sustainable utilisation of indigenous genetic resources, including utilisation of economically important unique attributes; (iv) to adapt techniques in collection, evaluation and storage of gametes and embryos for *ex situ* preservation of endangered breeds; and (v) to develop a computerised database on African animal genetic resources in line with recommendations by FAO/UNEP and OAU. Breed populations to be characterised in the initial phases are: cattle: Sheko, Abigar, Horro, Fogera Boran (Ethiopia), Ankole (Burundi, Uganda), Kenana, Butana (Sudan), Mashona (Zimbabwe), Nkone or Nguni (Zimbabwe, Swaziland), Muturu (Nigeria), Kuri (Nigeria, Chad), Kapsiki, Namchi (Cameroon), Ghana Shorthorn (Ghana), Somba, Lagune (Benin); sheep: Menz, Horro (Ethiopia), Red Maasai (Kenya, Tanzania), Sabi (Zimbabwe), Djallonké (Togo, Senegal); goats: West African Dwarf (Nigeria). The work programme, expected output and potential impact are presented.

9725 **Teale, A.J., Gwakisa, P., Maillard, J.C. and Kemp, S.J., 1994.** Progress in molecular and genetic characterization of cattle populations, with emphasis on African breeds. *In*: Rowlands, G.J. and Teale, A.J. (eds), 1994 (see **19**: no. 9704), p. 155.

Teale: ILRI, P.O. Box 30709, Nairobi, Kenya. There has been considerable interest for some time in developing means to identify specific breeds of cattle on the basis of molecular polymorphisms. Our focus has been on searching for polymorphisms which differentiate

breeds such as the N'Dama and Baoulé (*Bos taurus*) from non-trypanotolerant zebu (*B. indicus*) types. We have examined variation in the products of MHC loci, biochemical variants of a variety of gene products and both mitochondrial and nuclear DNA polymorphisms. These approaches have revealed informative polymorphisms, especially in the MHC, in the products of a small number of selected non-MHC loci, in nuclear satellite DNA and in a Y chromosome sequence. This level of molecular and genetic characterisation provides good differentiation of the major subspecies of cattle. It is anticipated that it will soon be possible to examine a sufficiently large number of loci to obtain increasingly specific population genetic profiles providing definition beyond the subspecies level.

9726 **Clifford, D.J., 1994.** Multiplication of improved trypanotolerant livestock. *In*: Rowlands, G.J. and Teale, A.J. (eds), 1994 (see **19**: no. 9704), pp. 157-163.

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

The International Trypanotolerance Centre (ITC) was established in 1982 for the purpose of increasing the production and improving the quality of trypanotolerant livestock. In the first five years, emphasis was placed on establishing on-station breeding herds of N'Dama cattle bought from Gambian village herds. Data collected on the health and productivity of village N'Dama cattle in different tsetse risk areas of The Gambia and Senegal showed them to be more productive than originally believed, with milk extracted for human consumption being an important productivity component. Constraints identified included high tsetse challenge and poor nutrition. Extensive data were also collected on tsetse numbers, distribution and infection rates, patterns of cattle movement, and tsetse-cattle contact. Work at ITC currently emphasises germplasm enhancement and breeding programmes. This includes identification and selection of superior stock from within the existing ITC herds. Data are being collected to facilitate the development of feeding strategies to enhance overall productivity and disease resistance within traditional and improved farming systems. Entomological studies continue to devise methods of estimating tsetse challenge. The emphasis of health and productivity studies is currently changing to include small ruminants. As part of the policy of identifying superior male animals for use in breeding,

experiments have been conducted on the effect of trypanosomiasis on semen quality in N'Dama bulls and Djallonké rams. Future plans are outlined.

9727 **Wilson, R.T. and Hammond, K., 1994.** Programme for Conservation of Domestic Animal Diversity: a Food and Agriculture Organization contribution to conserving animal genetic resources. *In*: Rowlands, G.J. and Teale, A.J. (eds), 1994 (see **19**: no. 9704), pp. 165-173.

Wilson: Bartridge House, Umberleigh, North Devon EX37 9AS, UK.

Domestic animal diversity is a heritage of 10,000 years of evolution and is needed to (i) meet human demands for more varied and more affordable food and provide support for arable agriculture in the form of fibre, power and fertiliser, and (ii) achieve sustainability throughout the range of local ecosystems. Since 1980, FAO has been involved in several initiatives related to breed characterisation and genetic diversity. In 1992, following international directives, FAO started to implement a global action plan. Preliminary analyses of data already collected have shown that estimates of domestic livestock population sizes are available only for about 35% of recorded breeds and more than 10% of all breeds are considered to be at some level of risk. Although risk levels in Africa appear to be comparatively low, this may be an artefact of the data, many breeds probably being unrecorded so far. The Programme for Conservation of Domestic Animal Diversity is being set up to direct FAO efforts in the conservation of animal genetic resources. Its mission is to establish and maintain global activities for the conservation of diversity in each domestic livestock species used for food and agriculture. The Programme's initial tasks and specific objectives are outlined. Its operational components comprise: the characterisation of diversity, the generation of a global information system, approaches to both *in situ* and *ex situ* conservation, planning, and programme management. With regard to trypanotolerance, a Regional Project for the Promotion of Trypano-tolerant Livestock, funded by UNDP and executed by FAO, has been set up to 'ensure the economic production of livestock in the tsetse-infested areas of West and Central Africa as a means of improving the overall standard of living of the human population residing there'. The immediate objectives are to: increase government capacities in development of livestock policy and planning instruments; increase

the use of trypanotolerant livestock; and increase the productivity of livestock and the people who work with them through research support, training and the free flow of information. Activities being undertaken to achieve these objectives are described. They include the identification of sites for the selection and multiplication of trypanotolerant livestock and the design of selection programmes, open nucleus breeding schemes, characterisation of endangered breeds and establishment of gene banks, data collection and standardisation of methodology, establishment of a trypanotolerant livestock reference library and dissemination of information.

9728 **Kennedy, D., 1994.** Breeding biotechnologies. *In*: Rowlands, G.J. and Teale, A.J. (eds), 1994 (see **19**: no. 9704), pp. 175-179.

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

Embryo transfer is the collection of seven-day-old embryos from the uterus of a donor cow (which has been superovulated using follicle stimulating hormone and artificially inseminated) and their transfer individually to the uteri of recipient cows which act as surrogate mothers. At the seven-day stage the embryo is very resistant and can be frozen and stored in liquid nitrogen indefinitely with a 90% survival rate on thawing. ILRAD [now ILRI] first used this technique in 1983 to support research on trypanotolerance. Embryos from N'Dama donors in The Gambia were frozen and imported into Kenya where they were implanted into Boran recipients in a project to locate the genes responsible for trypanotolerance in the N'Dama by crossing the two breeds. The technique is also being used to produce haemopoietic chimaeras where N'Dama and Boran twins are implanted into a recipient cow: because of the placentation in the cow, the blood of the twins mixes *in utero*, so the Boran can be born with N'Dama blood components and vice-versa. Since embryo transfer avoids stress to the animal and reduces costs of transportation, the technique could be used to disseminate and propagate trypanotolerant livestock in Africa. Some related developing technologies (*in vitro* production of embryos, transgenics, cloning, embryo sexing and semen sexing) are briefly described.

(d) TREATMENT

[See also **19**: nos: 9663, 9664, 9698, 9703.]

9729 **Olaho-Mukani, W., Nyang'ao, J.M.N. and Ouma, J., 1995.**

Elimination of drug-resistant *Trypanosoma evansi* infection in a group of camels by sequential treatment with melarsomine. *Journal of Camel Practice and Research*, **2** (2): 83-85.

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

In 1992, a herd of 61 camels in the Machakos district, about 10 km south-east of Nairobi, Kenya, with a history of endemic *T. evansi* infection were subjected to weekly blood and serum examination and treatment with melarsomine at 0.25 mg/kg body weight for a period of 5 months after they had been unsuccessfully treated with Naganol and quinapyramine sulphate. After this treatment, all infected camels became parasite-negative by the buffy-coat technique or mouse inoculation and the number of camels that tested positive for trypanosomal antigen dropped from 98% in the previous year to below 20%. These camels remained parasite-negative 3 years after treatment.

7. experimental trypanosomiasis

(a) DIAGNOSTICS

(b) PATHOLOGY AND IMMUNOLOGY

[See also **19**: no. 9685.]

9730 **Akingbemi, B.T., Aire, T.A. and Oke, B.O., 1996.** Infection with *Trypanosoma brucei* potentiates the antifertility effect of gossypol, especially in the protein-malnourished male rat. *International Journal of Andrology*, **19** (3): 179-189.

Akingbemi: Department of Preclinical Veterinary Studies, University of Zimbabwe, P.O. Box MP 167, Harare, Zimbabwe.

9731 **Bakhiet, M., Jansson, L., Büscher, P., Holmdahl, R., Kristensson, K. and Olsson, T., 1996.** Role of interleukin-4 in natural control of parasitemia and survival during *Trypanosoma brucei brucei* infection in highly susceptible and relatively resistant mouse strains. (Meeting abstract no. 36.) *Scandinavian Journal of Immunology*, **43** (6): 702.

Bakhiet: Section for Neurology, Huddinge Hospital, 14186 Huddinge, Sweden.

9732 **Bakhiet, M., Olsson, T., Ljungdahl, A., Höjeberg, B., Meide, P. van der and Kristensson, K., 1996.** Induction of interferon- γ , transforming growth factor- β , and interleukin-4 in mouse strains with different susceptibilities to *Trypanosoma brucei brucei*. *Journal of Interferon and Cytokine Research*, **16** (6): 427-433.

Bakhiet: Department of Medicine, Molecular Medicine Unit, Karolinska Hospital, S-17176 Stockholm, Sweden.

9733 **Carcereri de Prati, A., Menegazzi, M., Mariotto, S., Cavalieri, E., Kristensson, K. and Suzuki, H., 1996.** Nitric oxide production during trypanosome infection in rats. (Meeting abstract no. 96.) *Journal of Leukocyte Biology*, **1996** (Suppl.): 29.

Carcereri de Prati: Istituto di Chimica Biologica, Università di Verona, 37134 Verona, Italy.

9734 **Ekanem, J.T., Odutuga, A.A. and Akanji, M.A., 1996.** African trypanosomiasis: plasma lipid changes suggest extracellular cholesterol esterification by *Trypanosoma brucei*. [Rats.] *Bioscience Research Communications*, **8** (1): 23-27.

Ekanem: Department of Biochemistry, University of Ilorin, Ilorin, Nigeria.

9735 **Olsson, T., 1995.** Interactions between *Trypanosoma brucei* and CD8⁺ cells. [Mice.] *Bulletin of the Scandinavian Society for Parasitology*, **5** (3): 18.

Molecular Medicine Unit, Department of Medicine, Karolinska Hospital, S-17176 Stockholm, Sweden.

9736 **Tomlinson, S. and Raper, J., 1996.** The lysis of *Trypanosoma brucei brucei* by human serum. (Review.) *Nature Biotechnology*, **14** (6): 717-721.

Tomlinson: Department of Pathology, New York University Medical Center, New York, NY 10016, USA.

The natural immunity of humans to the cattle pathogen *T. b. brucei*, but not to the morphologically indistinguishable human pathogens *T. b. gambiense* and *T. b. rhodesiense*, is due to the selective killing of the parasite by normal human serum. Research into this phenomenon is reviewed. The factor in human serum that mediates lysis of *T. b. brucei* has long been attributed to a minor subclass of high density lipoprotein (HDL). Evidence indicates that the trypanolytic activity of isolated human HDL is due to peroxidase activity of an associated haptoglobin-related protein-haemoglobin complex. However, recent data suggest that the trypanolytic activity of normal human serum is due to a second, less well-defined factor of high molecular weight.

(c) CHEMOTHERAPEUTICS

[See also **19**: nos. 9730, 9748.]

- 9737 **Akingbemi, B.T., Aire, T.A., Oke, B.O., Onwuka, S.K. and Ogwuegbu, S.O., 1996.** Gossypol toxicosis in the rat associated with protein malnutrition and experimental infection with *Trypanosoma brucei*. *Journal of Comparative Pathology*, **115** (1): 13-22.
Akingbemi: Department of Preclinical Veterinary Studies, University of Zimbabwe, P.O. Box MP 167, Harare, Zimbabwe.
- 9738 **Callahan, H.L., Kelley, C., Pereira, T. and Grogl, M., 1996.** Microtubule inhibitors: structure-activity analyses suggest rational models to identify potentially active compounds. [Incl. *T. brucei*; trifluralin.] *Antimicrobial Agents and Chemotherapy*, **40** (4): 947-952.
Callahan: U.S. Army Medical Research Unit - Brazil, American Consulate - Rio de Janeiro, APO AA 34030-3501, USA.
- 9739 **Fang, Y., Ye, W.-X., Nie, H.-Y. and Wang, Y.-L., 1995.** Effect of immunosuppression on the efficacy of suramin and diminazene treatment of mice infected with *Trypanosoma evansi*. (In Chinese with English summary.) *Chinese Journal of Veterinary Science*, **15** (2): 145-148.
Military Medical Institute, Nanjing Military Area, Nanjing 210002, China.
- 9740 **Jagdish, S., Ranade, V.V. and Sharma, L.K., 1989.** Acute toxicity studies with Tevansi (quinapyramine sulphate-quinapyramine chloride combination) in albino rats. [*T. evansi*.] *Journal of Veterinary Physiology and Allied Sciences*, **8** (2): 27-29.
Department of Pharmacology, Bombay Veterinary College, Parel, Bombay 400 012, India.
- 9741 **Mutugi, M.W., Boid, R. and Luckins, A.G., 1996.** Growth rates of suramin-sensitive and resistant *Trypanosoma evansi*. *Tropical Animal Health and Production*, **28** (2): 147-150.
Mutugi: 12 Sholtery Road, Greystone Park, Harare, Zimbabwe.
- 9742 **Nok, A.J., Williams, S. and Onyenekwe, P.C., 1996.** *Allium sativum*-induced death of African trypanosomes. [*T. b. brucei*, *T. congolense*, *T. vivax*; mice.] *Parasitology Research*, **82** (7): 634-637.
Nok: Biochemie Institut, Christian Albrecht Universität, Olshausen-strasse 40, D-24098 Kiel, Germany.
8. trypanosome research
(a) CULTIVATION OF TRYPANOSOMES
[See **19**: no. 9764.]
- (b) TAXONOMY, CHARACTERISATION OF ISOLATES

9743 **Kanmogne, G.D., Stevens, J.R., Asonganyi, T. and Gibson, W.C., 1996.** Genetic heterogeneity in the *Trypanosoma brucei gambiense* genome analysed by random amplification of polymorphic DNA. *Parasitology Research*, **82** (6): 535-541.
 Kanmogne: Department of Pathology and Microbiology, University of Bristol, Langford, Bristol BS18 7DU, UK.

9744 **Stevens, J.R. and Tibayrenc, M., 1996.** *Trypanosoma brucei s.l.*: evolution, linkage and the clonality debate. *Parasitology*, **112** (5): 481-488.
 Stevens: School of Biological Sciences, University of Bristol, Woodland Road, Bristol BS8 1UG, UK.
 The Index of Association (I^A) was proposed by Maynard Smith *et al.* (1993) as a general method for characterising the population structures of micro-organisms as clonal, epidemic, cryptic species or panmictic. With reference to the current debate surrounding the mode of reproduction in parasitic protozoa, this study explores (i) the suitability and limitations of the I^A for characterising populations of *T. brucei s.l.*, and (ii) the idea that the significance of genetic differences between populations may be better understood if the evolution, spread and temporal stability of certain parasite genotypes are also considered. Four populations of *T. brucei* from Côte d'Ivoire, Uganda and Zambia were analysed using the I^A and a complementary test for linkage disequilibrium^A (test *f* of Tibayrenc *et al.* 1990). The two populations from Uganda were characterised as epidemic, while the others appeared more or less clonal; the merits of the two methods are compared. The implications of the various population classifications are discussed with reference to genotype longevity in each region; the evolutionary and biomedical consequences of the genetic non-homogeneity of *T. brucei* are reviewed.

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

[See also **19**: no. 9738.]

9745 **Adolph, K.W. (ed.), 1994.** *Methods in molecular genetics, vol. 3. Molecular microbiology techniques, Part A.* San Diego, CA, USA and London, UK; Academic Press. 398 pp.

This book includes chapters on: Gene regulation in Trypanosomatidae [*T. brucei*] (V.B. Carruthers, P.K. Patnaik and V. Bellofatto, pp. 49-60); Molecular and biochemical methods for analysis of kinetoplastid RNA editing [*T. brucei*] (V.W. Pollard, R. Sabatini and S.L. Hajduk, pp. 61-87).

- 9746 **Alexandre, S., Paindavoine, P., Hanocq-Quertier, J., Paturiaux-Hanocq, F., Tebabi, P. and Pays, E., 1996.** Families of adenylate cyclase genes in *Trypanosoma brucei*. *Molecular and Biochemical Parasitology*, **77** (2): 173-182.
Pays: Department of Molecular Biology, Free University of Brussels, 67 rue des Chevaux, B-1640 Rhode St. Genèse, Belgium.
- 9747 **Andersson, M., Löw, P. and Bakhiet, M., 1996.** Lovastatin inhibits interferon- γ -induced *Trypanosoma brucei brucei* proliferation: evidence for mevalonate pathway involvement. *Journal of Interferon and Cytokine Research*, **16** (6): 435-439.
Bakhiet: Department of Medicine, Molecular Medicine Unit, Karolinska Hospital, S-17176 Stockholm, Sweden.
- 9748 **Baillet, S., Buisine, E., Horvath, D., Maes, L., Bonnet, B. and Sergheraert, C., 1996.** 2-Amino diphenylsulfides as inhibitors of trypanothione reductase: modification of the side chain. [*T. brucei*; mice.] *Bioorganic and Medicinal Chemistry*, **4** (6): 891-899.
Baillet: Institut Pasteur de Lille, URA 1309 CNRS, Faculté de Pharmacie, 1 rue Calmette, 59019 Lille Cedex, France.
- 9749 **Bangs, J.D., Brouch, E.M., Ransom, D.M. and Roggy, J.L., 1996.** A soluble secretory reporter system in *Trypanosoma brucei*: studies on endoplasmic reticulum targeting. *Journal of Biological Chemistry*, **271** (31): 18387-18393.
Bangs: Department of Medical Microbiology and Immunology, University of Wisconsin-Madison Medical School, 1300 University Avenue, Madison, WI 53706, USA.
- 9750 **Bastin, P., Bagherzadeh, A., Matthews, K.R. and Gull, K., 1996.** A novel epitope tag system to study protein targeting and organelle biogenesis in *Trypanosoma brucei*. *Molecular and Biochemical Parasitology*, **77** (2): 235-239.
Gull: School of Biological Sciences, University of Manchester, 2.205 Stopford Building, Oxford Road, Manchester M13 9PT, UK.
- 9751 **Berger, B.J., Dai, W.W., Wang, H., Stark, R.E. and Cerami, A., 1996.** Aromatic amino acid transamination and methionine recycling in trypanosomatids. [Incl. *T. b. brucei*.] *Proceedings of the National Academy of Sciences of the United States of America*, **93** (9): 4126-4130.
Berger: Picower Institute for Medical Research, 350 Community Drive, Manhasset, NY 11030, USA.
- 9752 **Brooks, H.B. and Phillips, M.A., 1996.** Circular dichroism assay for decarboxylation of optically pure amino

- acids: application to ornithine decarboxylase. [*T. brucei*.] *Analytical Biochemistry*, **238** (2): 191-194.
Department of Pharmacology, University of Texas Southwestern Medical Center, 5323 Harry Hines Boulevard, Dallas, TX 75235-9041, USA.
- 9753 **Bütikofer, P., Boschung, M., Brodbeck, U. and Menon, A.K., 1996.** Phosphatidylinositol hydrolysis by *Trypanosoma brucei* glycosyl phosphatidylinositol phospholipase C. *Journal of Biological Chemistry*, **271** (26): 15533-15541.
Bütikofer: Institute of Biochemistry and Molecular Biology, University of Bern, Bülhstrasse 28, CH-3012 Bern, Switzerland.
- 9754 **Chi, T.B., Choi, S.Y.-K. and Williams, N., 1996.** The ATP synthase of *Trypanosoma brucei* is developmentally regulated by an inhibitor peptide. *Archives of Biochemistry and Biophysics*, **333** (1): 291-297.
Williams: Department of Microbiology, State University of New York, 235 Biomedical Research Building, Buffalo, NY 14214, USA.
- 9755 **Clayton, C. and Hotz, H.-R., 1996.** Post-transcriptional control of PARP gene expression. [*T. brucei*.] (Review.) *Molecular and Biochemical Parasitology*, **77** (1): 1-6.
Clayton: Zentrum für Molekulare Biologie, Universität Heidelberg, Im Neuenheimer Feld 282, 69120 Heidelberg, Germany.
- 9756 **Cruz-Reyes, J. and Sollner-Webb, B., 1996.** Trypanosome U-deletional RNA editing involves guide RNA-directed endonuclease cleavage, terminal U exonuclease, and RNA ligase activities. [*T. brucei*.] *Proceedings of the National Academy of Sciences of the United States of America*, **93** (17): 8901-8906.
Cruz-Reyes: Department of Biological Chemistry, Johns Hopkins University School of Medicine, 725 North Wolfe Street, Baltimore, MD 21205, USA.
- 9757 **Das, A., Peterson, G.C., Kanner, S.B., Frevert, U. and Parsons, M., 1996.** A major tyrosine-phosphorylated protein of *Trypanosoma brucei* is a nucleolar RNA-binding protein. *Journal of Biological Chemistry*, **271** (26): 15675-15681.
Parsons: Seattle Biomedical Research Institute, 4 Nickerson Street, Seattle, WA 98109, USA.
- 9758 **Dungan, J.M., Watkins, K.P. and Agabian, N., 1996.** Evidence for the presence of a small U5-like RNA in active *trans-spliceosomes* of *Trypanosoma brucei*. *EMBO Journal*, **15** (15): 4016-4029.

Agabian: Intercampus Program in Molecular Parasitology, Uni-versity of California, San Francisco, CA 94143-0422, USA.

9759 **Eisen, H. and Strand, A., 1993.** Use of DNA sequence homology and pseudogenes for the construction of active VSG genes in *Trypanosoma equiperdum*. In: Davies, K.E. and Warren, S.T. (eds), *Genome analysis, vol. 7. Genome rearrangement and stability* (Plainview, NY, USA; Cold Spring Harbor Laboratory Press), pp. 153-160.

Eisen: Fred Hutchinson Cancer Research Center, Seattle, WA 98104, USA.

9760 **Gerold, P., Striepen, B., Reitter, B., Geyer, H., Geyer, R., Reinwald, E., Risse, H.-J. and Schwarz, R.T., 1996.** Glycosyl-phosphatidyl-inositols of *Trypanosoma congolense*: two common precursors but a new protein-anchor. *Journal of Molecular Biology*, **261** (2): 181-194.

Schwarz: Zentrum für Hygiene und Medizinische Mikrobiologie, Philipps-Universität Marburg, Robert-Koch-Strasse 17, D-35037 Marburg, Germany.

9761 **Graham, V.S. and Barry, J.D., 1996.** Is point mutagenesis a mechanism for antigenic variation in *Trypanosoma brucei*? *Molecular and Biochemical Parasitology*, **79** (1): 35-45.

Barry: Wellcome Unit of Molecular Parasitology, University of Glasgow, Anderson College, 56 Dumbarton Road, Glasgow G11 6NU, UK.

9762 **Güther, M.L.S., Treumann, A. and Ferguson, M.A.J., 1996.** Molecular species analysis and quantification of the glycosylphosphatidylinositol intermediate glycolipid C from *Trypanosoma brucei*. *Molecular and Biochemical Parasitology*, **77** (2): 137-145.

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

9763 **Hua, S.-B., To, W.-Y., Nguyen, T.T., Wong, M.-L. and Wang, C.C., 1996.** Purification and characterization of proteasomes from *Trypanosoma brucei*. *Molecular and Biochemical Parasitology*, **78** (1-2): 33-46.

Hua: Department of Pharmaceutical Chemistry, University of California, San Francisco, CA 94143-0446, USA.

9764 **Hyde, J.E. (ed.), 1993.** *Methods in molecular biology, vol. 21. Protocols in molecular parasitology*. Totowa, NJ, USA; Humana Press. 470 pp.

This book includes chapters on: Culturing and biological cloning of *Trypanosoma brucei* (M. Carrington, pp. 1-13); Preparation of DNA and RNA from *Trypanosoma brucei* (M. Carrington, pp. 101-111); Isolation of

parasite genes using synthetic oligonucleotides [incl. *T. brucei*] (J.E. Hyde and S.P. Holloway, pp. 303-318); Transfection of *Leishmania* and *Trypanosoma brucei* by electroporation (S.M. Beverley and C.E. Clayton, pp. 333-348); Isoenzyme electrophoresis for parasite characterization [incl. *T. brucei*] (S. Ben Abderrazak, F. Guerrini, F. Mathieu-Daudé, P. Truc, K. Neubauer, K. Lewicka, C. Barnabé and M. Tibayrenc).

9765 **Koslowsky, D.J., Kutas, S.M. and Stuart, K., 1996.** Distinct differences in the requirements for ribonucleoprotein complex formation on differentially regulated pre-edited mRNAs in *Trypanosoma brucei*. *Molecular and Biochemical Parasitology*, **80** (1): 1-14.

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

9766 **Leeuwen, F. van, Wijsman, E.R., Kuyl-Yeheskiely, E., Marel, G.A. van der, Boom, J.H. van and Borst, P., 1996.** The telomeric GGGTTA repeats of *Trypanosoma brucei* contain the hypermodified base J in both strands. *Nucleic Acids Research*, **24** (13): 2476-2482.

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

9767 **Li, F., Hua, S.-B., Wang, C.C. and Gottesdiener, K.M., 1996.** Procyclic *Trypanosoma brucei* cell lines deficient in ornithine decarboxylase activity. *Molecular and Biochemical Parasitology*, **78** (1-2): 227-236.

Gottesdiener: Merck Research Laboratories, P.O. Box 2000, RY 33-644, Rahway, NJ 07065, USA.

9768 **Lips, S., Geuskens, M., Paturiaux-Hanocq, F., Hanocq-Quertier, J. and Pays, E., 1996.** The *esag 8* gene of *Trypanosoma brucei* encodes a nuclear protein. *Molecular and Biochemical Parasitology*, **79** (1): 113-117.

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

9769 **Lueder, D.V. and Phillips, M.A., 1996.** Characterization of *Trypanosoma brucei* γ -glutamylcysteine synthetase, an essential enzyme in the biosynthesis of trypanothione (diglutathionylspermidine). *Journal of Biological Chemistry*, **271** (29): 17485-17490.

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