Veterinary Research Communications, 15 (1991) 25–36

SERO-PREVALENCES OF SELECTED CATTLE DISEASES IN THE KAFUE FLATS OF ZAMBIA

M. GHIROTTI[1,2], G. SEMPRONI[3], D. DE MENEGHI[2], F.N. MUNGABA[4], D. NANNINI[3], G. CALZETTA[3] AND G. PAGANICO[3]
[1]WHO Collaborating Centre for Research and Training in Veterinary Public Health, Laboratorio di Parassitologia, Istituto Superiore di Sanitá, viale Regina Elena 299, 00161 Rome, Italy
[2]Corridor Disease Control Project, PO Box 50, Mazabuka, Zambia
[3]Istituto Zooprofilattico Sperimentale dell'Abruzzo e del Molise 'G. Caporale', via Campo Boario, 64100 Teramo, Italy
[4]Department of Veterinary and Tsetse Control Services, PO Box 50060, Lusaka, Zambia

ABSTRACT

Ghirotti, M., Semproni, G., De Meneghi, D., Mungaba, F.N., Nannini, D., Calzetta, G. and Paganico, G., 1991. Sero-prevalences of selected cattle diseases in the Kafue flats of Zambia. *Veterinary Research Communications*, **15** (1), 25–36

Sera from five traditionally managed herds grazing in the Kafue flats were tested for antibodies to bovine viral diarrhoea-mucosal disease (BVD-MD), parainfluenza 3 (PI3), infectious bovine rhinotracheitis-infectious pustular vulvovaginitis (IBR-IPV), bovine adenovirus 3 (BAV3) and Bluetongue (BT). The sero-prevalences of the first four diseases were respectively 76.2, 94.4, 42.1 and 87.4%. Five samples (2.3%) gave doubtful reactions for BT. Prevalences of 28.5% for brucellosis, 14% for Rift Valley fever (RFV), 0.9% for Q fever and 11.2% for chlamydiosis were also recorded. Significantly higher values for BVD-MD ($p < 0.005$), IBR-IPV ($p < 0.01$) and brucellosis ($p < 0.05$) were found in animals over 1 year of age. No differences were recorded between herds or between male and female animals.

The high concentration of wild and domestic ruminants grazing together in the flood plains during the dry season may be a major determinant of the high values observed. Traditional farmers, slaughterhouse workers and other people involved in livestock production are particularly at risk of contracting brucellosis and RVF because of the high prevalences in cattle and local habits favourable to their transmission.

Keywords: *Brucella*, cattle, epidemiology, public health, Rift Valley fever, serology, viruses, Zambia

INTRODUCTION

Cattle play an essential rôle in the agropastoral systems in Zambia. The national herd numbers over 2.5 million cattle while the human population is eight million (FAO-WHO-OIE, 1988). About 80% of Zambia's cattle are in the traditional sector and the development potential of this sector is considerable. However, the offtake from traditionally managed herds is less than 10%, considerably lower than that from commercial farms (Perry *et al.*, 1984).

In neighbouring countries, several viral diseases have been reported as causing loss of production in local herds, including bovine viral diarrhoea-mucosal disease (BVD-MD), parainfluenza 3 (PI3) and infectious bovine rhinotracheitis-infectious

pustular vulvovaginitis (IBR-IPV) (Provost *et al.*, 1967a,b; Taylor and Rampton, 1968; Jetteur *et al.*, 1988; Eyanga *et al.*, 1989). Furthermore, cattle can act as hosts for viruses which are pathogens for other domestic species, such as Bluetongue (BT) (Erasmus, 1975). No information on such diseases in livestock is available from Zambia.

Over 70% of the Zambian population is involved in agricultural activities, including animal husbandry (FAO, 1988). Several zoonoses can be transmitted to personnel working in cattle production. Brucellosis, Rift Valley fever (RFV), Q fever and to a lesser extent bovine chlamydiosis, are of economic importance because they can also affect herd productivity through abortions, stillbirths and reduction in fertility and milk production. RVF may be responsible for severe signs often resulting in death. Human cases have generally followed outbreaks in livestock (Meegan, 1979). In Zambia, epidemics of this infection in cattle were reported in Central and Southern Provinces during 1974, 1978 and 1985 and seem to have been associated with human deaths (Hussein *et al.*, 1987; Morita, 1988). Serological studies on RVF in cattle gave conflicting results. While Hussein and colleagues (1987) reported over 50% of sera collected in Southern Province to be positive for RVF, Morita (1988) did not find any reactors in animals sampled from Mazabuka, although 11.4% of the tested resident human population had antibodies against the virus.

Bovine brucellosis is particularly frequent in cattle in the Western Province of Zambia, which show about 30% positivity (d'Cruz, 1976). All the cattle there are under traditional management. Prevalences are also high in Southern and Central Provinces, where most of the national herd is found. On the southern bank of the Kafue river, d'Cruz (1976) recorded 14% reactors in Namwala (all these cattle being from the traditional sector), 4.4% in Mazabuka, 6.5% in Monze and 16.7% in Choma. In the last three districts a large proportion of livestock are bred in commercial farms. On the northern bank of the river, i.e. in Central Province, prevalences were 19.7% in Mumbwa (d'Cruz, 1976) and 10% in the Mukulaikwa area (Moorhouse and Snacken, 1983).

Data on Q fever and bovine chlamydiosis in livestock are not available from Zambia. However, these diseases have been reported in both people and cattle from neighbouring countries (Schutte *et al.*, 1976; Gear *et al.*, 1986).

One of the three major traditionally managed cattle populations of Zambia is to be found around the Kafue river plains, in Central and Southern Provinces. It is estimated to be about 700 000 head of cattle, approximately a quarter of the total national herd. These cattle and the Kafue river, a tributary of the Zambesi, are integral parts of a particular traditional farming system in which transhumance allows optimal utilization of the natural resources. A serological investigation into the prevalence of the major viral diseases and zoonotic infections was carried out in some of the traditionally managed herds grazing in the Kafue flats to obtain preliminary information on this particular cattle population and to provide recommendations for field staff involved in disease control.

MATERIALS AND METHODS

The location

The Kafue flats are located at 15° 10' to 16° 1'S and 26° 2' to 28° 9'E, south-west of the capital city, Lusaka (Figure 1). The elevation varies between 950 and 1050 metres above sea level, gradually declining towards the river. A few scattered hills are present in the plains.

The vegetation is divided into three different belts. Moving away from the river they are (a) the floodplain zone itself with grass species adapted to periodical inundations, scarce thorny shrubs (*Acacia albida*) and palms (*Borassus aethiopium*); (b) the termitaria grassland, progressively covered with *Euphorbia candelabra*; and (c) the woodland savanna where most human settlements occur and *Acacia, Albizzia, Combretum* and *Termitalia* are found.

As in the rest of Zambia, the climate is characterized by three seasons: hot-dry from August to October, warm-wet from November to April and cool-dry from May to July. The peak of the rains occurs in December, the average annual precipitation being 800 mm. Rainfall patterns influence life in the flats since most of the plains are subject to periodical inundation from the river. After the peak floods in May, the subsiding waters leave valuable and abundant grassland. The lowest water levels are recorded in November.

Integration of maize (formerly sorghum) and cattle production, the river levels and the farmers' seasonal activities and movements characterize the farming system in the Kafue flats. In November, as soon as the early rains come, oxen are used to plough maize fields. Until June, when the maize is ready, the cattle graze in the proximity of the village since there is abundant pasture and water. Once the crop is harvested and the grass becomes dry, they feed on maize by-products. When these sources are exhausted and water becomes scarce, often at the end of July, neighbouring herds link up and graze on the flats, where grass is abundant, sharing the pasture with wild ungulates. The cattle are driven back to their places of origin shortly before the return of the rains.

Local cattle are of the Sanga type, Ila-Tonga breed. Herd size ranges between 20 and 100 head. Because of the importance of milk in the household diet, about one-third of the animals are breeding cows. Traditional farmers retain a similar proportion of working oxen since they provide draught power for farming activities.

The lush plains sustain large numbers of different wild mammals. These are mainly concentrated in the three national parks situated along the Kafue river (Kafue, Lochinvar and Blue Lagoon). For example, it has been estimated that in Lochinvar alone there are about 42 000 Kafue Lechwe (*Kobus leche kafuensis*), the semi-aquatic antelope symbolic of these flood plains.

The herds

The 214 sampled cattle belonged to five traditionally managed herds strategically located on the south-eastern bank of the Kafue river (Figure 1). They were recorded as male or female calves (under one year of age), adult females, bulls or oxen, as shown in Table I. The calves in herd 5 were not sampled as they were very emaciated

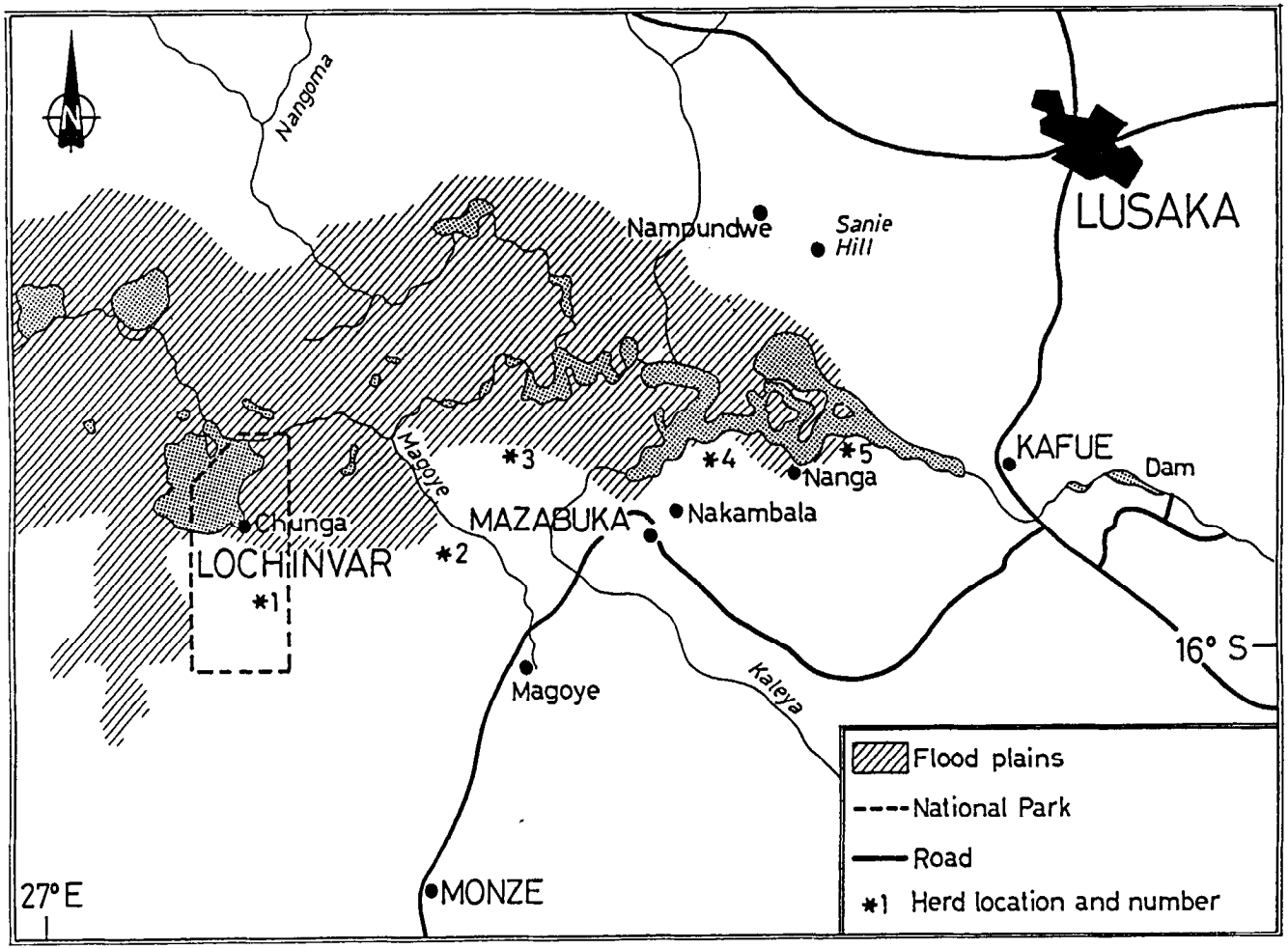


Figure 1. The Kafue flats in Zambia and the locations of the sampled herds

TABLE I
Composition of the sampled herds

Herd	Site	Calves		Adults			Total
		Female	Male	Female	Oxen	Bulls	
1	Lochinvar	6	5	15	13	3	42
2	Magoye North	1	1	15	16	0	33
3	Magoye West	0	2	15	4	1	22
4	Nanga North	6	10	52	20	5	93
5	Nanga East	–	–	16	5	3	24
	Total	13	18	113	58	12	214

– Not sampled

due to the prolonged dry season. All the sampled calves were over three months of age. The blood samples were collected using vacutainers in November and early December 1987, just before the onset of the rains. None of the cattle were vaccinated against the diseases tested for.

All the herds were on the fringe of a *Theileria parva* infected area and they were therefore treated for ticks at weekly intervals during the rainy season.

Serological tests

Sera were separated within 24 h of the blood being taken and stored at −30°C until tested. They were inactivated by heating at 56°C for 30 min before testing.

Sera were tested against BVD-MD by a microserum neutralization technique. 100 $TCID_{50}$ of a pretitred strain of BVD-MD, obtained from the National Animal Disease Laboratory, Ames, Iowa, USA, were added to serial doubling dilutions of the sera. After incubation at 37°C for 1 h, bovine testicular cells were added to each well to a concentration of 300,000 cells per ml. The plates were then incubated at 37°C for 48 h in the presence of 4.5% CO_2 and for a further 5 h in the absence of CO_2. Neutralization or viral growth were assessed by microscopic examination.

Haemagglutination-inhibition for PI3 and serum neutralization tests for IBR-IPV and bovine adenovirus 3 (BAV3) were carried out in microtitration plates according to standard techniques (MAFF/ADAS, 1984). The strains of PI3, IBR-IBV and BAV3 used were respectively SF4, R-63 and Weybridge. These three strains were all obtained from the Central Veterinary Laboratory, Weybridge, UK.

The presence of BT antibodies was detected by an agar gel immunodiffusion test using the Onderstepoort BT strain. 4% noble agar was prepared in distilled water, then diluted with one volume of an alkaline buffer solution (pH 8.65). The plates were examined after 72 h.

Standard techniques (Morgan, 1978) were used to detect *Brucella abortus* antibodies. Results were expressed as 0, 25, 50, 75 and 100% of positivity in the case of the Rose Bengal test (RBT), IU/ml for the serum agglutination test (SAT) and EEC U/ml for the complement fixation test (CFT). Titres greater than, or equal to, 25% for RBT, 13 IU/ml for SAT and 22 EEC U/ml for CFT were considered as positive for brucellosis. Since none of the sampled animals was vaccinated against brucellosis, SAT was considered as the reference test and the results of this test were adopted for determining the sensitivity and specificity of the other two tests, i.e. RBT and CFT, in the diagnosis of bovine brucellosis under local conditions.

To detect RVF antibodies, a haemagglutination-inhibition test was performed according to the method of Clarke and Casals (1958) using an RFV-inactivated antigen (Onderstepoort). Goose erythrocytes in phosphate buffer at a final pH of 6.0 were added to an antigen–serum mixture and incubated at 37°C. Titres greater than or equal to 1:20 were considered positive.

The microcomplement fixation test utilized for Q fever and chlamydiosis was as described by Baldelli and colleagues (1975). For chlamydiosis the antigen was strain A22 of *Chlamydia ovis*, kindly provided by the Moredun Institute, Edinburgh, while for Q fever it was a commercial product (Boehring-Werke). Threshold values for positivity were 1:16 for the former infection and 1:8 for the latter.

Statistical analysis

Analysis of the data was carried out using the χ^2 test, or by Fisher's exact test when one of the expected values was less than 5, and a Mantel–Haenszel stratified analysis was carried out with the statistical package Epi Info (CDC-WHO, 1989).

TABLE II
Sero-prevalences, in percentages, of various infections in five herds in the Kafue flats of Zambia

Herd	Sample size	Sero-prevalences[a]								
		BVD-MD	PI3	IBR-IPV	ADV3	BT	Bruc	RVF	QF	Chlm
1	42	74	93	33	98	0	19	14	0	17
2	33	70	88	52	94	3	39	18	0	6
3	22	91	86	36	82	0	18	23	0	5
4	93	75	99	39	89	4	30	9	2	9
5	24	79	96	63	58	0	33	21	0	25
Age										
Calves	31	55 **	94	19 **	84	0	10 *	10	3	19
Adults	183	80	95	46	88	2	32	15	1	10
Crude averages	214	76.2	94.4	42.1	87.4	2.3	28.5	14.0	0.9	11.2

* $p<0.05$; ** $p<0.01$

[a] BVD-MD (bovine viral diarrhoea-mucosal disease); PI3 (parainfluenza 3); IBR-IPV (infectious bovine rhinotracheitis-infectious pustular vulvovaginitis); ADV3 (bovine adenovirus 3); BT (Bluetongue); Bruc (brucellosis, serum agglutination test); RVF (Rift Valley fever); QF (Q-fever); Chlm (Chlamydiosis)

RESULTS

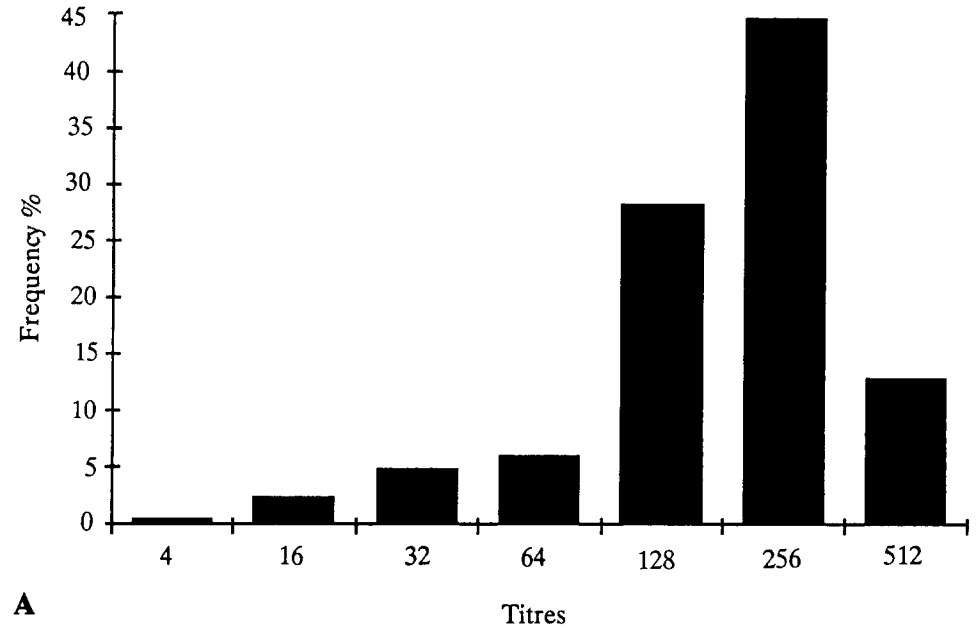
Table II summarizes the results of the tests. No significant differences in sero-prevalence were found among herds or between male and female animals. On the other hand, adults gave significantly higher values for BVD-MD ($p<0.005$), IBR-IPV ($p<0.01$) and *B. abortus* ($p<0.05$), which were not associated with sex. In this table, the data for brucellosis refer to the results of the SAT. The overall prevalences were 37.4% using RBT and 22% using CFT. When the validity of RBT and CFT in the diagnosis of brucellosis was compared to that of SAT, the sensitivity was 83.6% and the specificity 81% in the former test. In the latter test the sensitivity was 65.6% and the specificity was 95.4%.

Antibody responses to BVD-MD, *B. abortus*, RVF and IBR-IPV were statistically related ($p<0.01$). Five sera gave doubtful reactions for BT and positive results for the Q fever test were found in only one herd. Some of the antibody titres were high, as shown in Figure 2. Calves positive for RVF showed titres equal to or greater than 1:40.

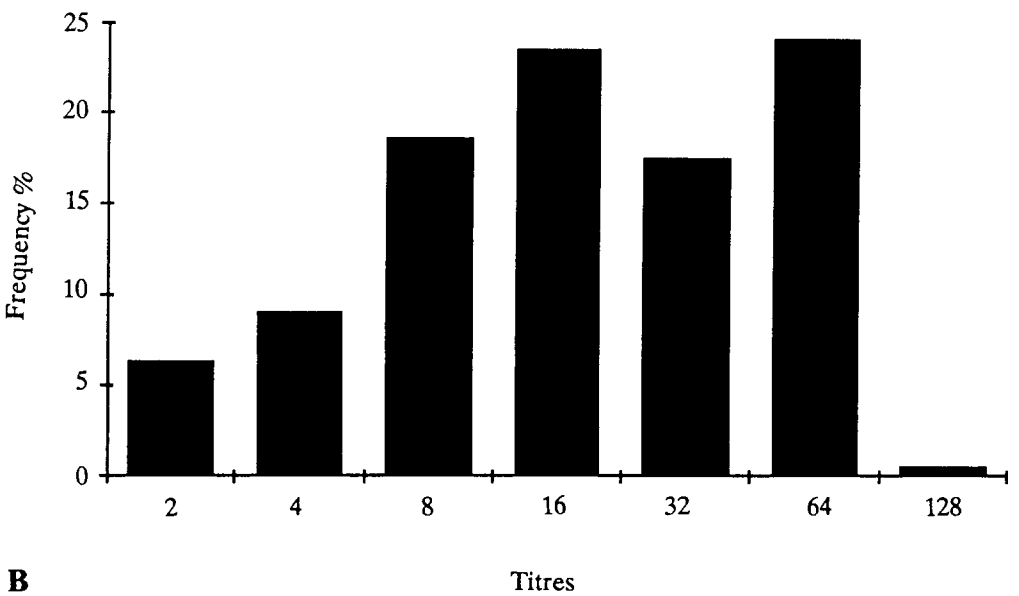
DISCUSSION

The high proportions of cattle positive for BVD-MD, PI3, IBR-IPV, BAV3 and *B. abortus* in the Kafue flats farming system are atypical of traditionally managed herds and need to be confirmed by larger surveys. These preliminary results could be used to calculate the required sample sizes. Taylor and Robinson (1968) found sero-prevalences of BVD-MD in native Kenyan cattle varying from 0% in Nyanza and Western Provinces to a maximum rate of 50% in Eastern Province. In the same survey, the highest percentage of positives in Uganda was 21.5. A lower occurrence of BVD-MD has been observed in Zaire (0–2%), where 44% of the sampled animals also presented antibodies to BAV3 and 27% to PI3 (Jetteur *et al.*, 1988; Eyanga *et al.*, 1989). In both studies, BVD-MD prevalences rose sharply to 41% in ranches and to 77% in regions where the average herd size was above 500 head. In Central Africa, where large herds are also found, the prevalences recorded among local zebus were 75% for BVD-MD and 96.7% for PI3 (Provost *et al.*, 1967a,b). These are similar to the values normally observed on European or North American intensive farms, associated with high concentrations of animals (Bruner and Gillespie, 1973). Over 50 cattle per square km are found in the flood plains of the Kafue river at the peak of the dry season, when forage is only available there. Communal grazing at such high concentrations may explain the consistently high prevalences recorded in this study. Moreover, brucellosis can easily spread between and within herds since the peak of calvings occurs at that time, from August to October, and the animals are night-kraaled together. The abundant wild ruminants, which share the same pasture, could also contribute to infection transmission (Provost *et al.*, 1967a,b; Hamblin and Hedger, 1979). PI3 and IBR-IPV antibodies have been found in wild mammals in Zambia (Krauss *et al.*, 1984).

The last reported outbreak of RVF in Zambia was in 1985, as also indicated by the high prevalence of positive cattle found at that time (Hussein *et al.*, 1987). Two years later, according to the results of this study, the virus seems to be still circulating among the traditional herds in Southern Province. This suggestion is supported by the

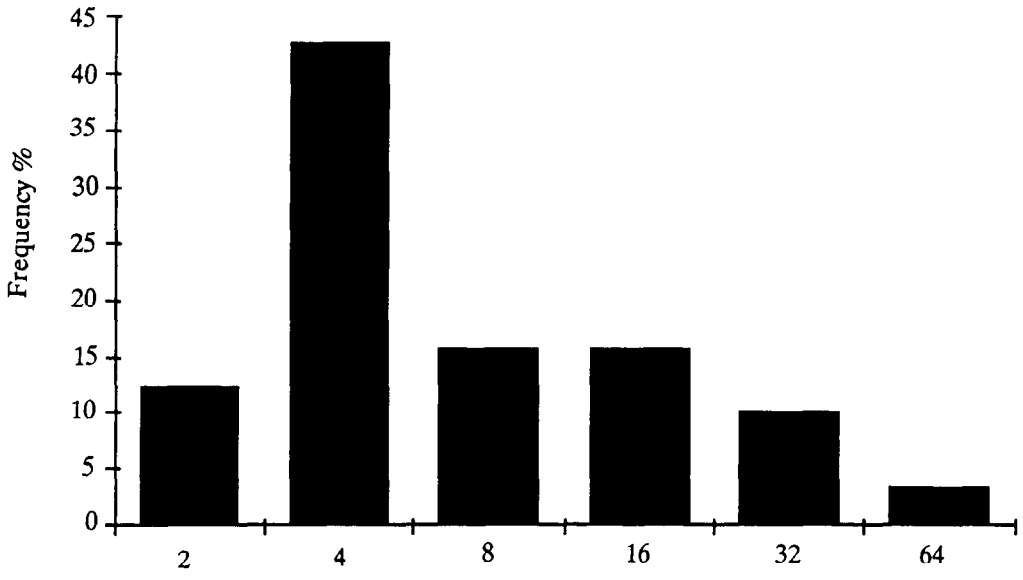


A

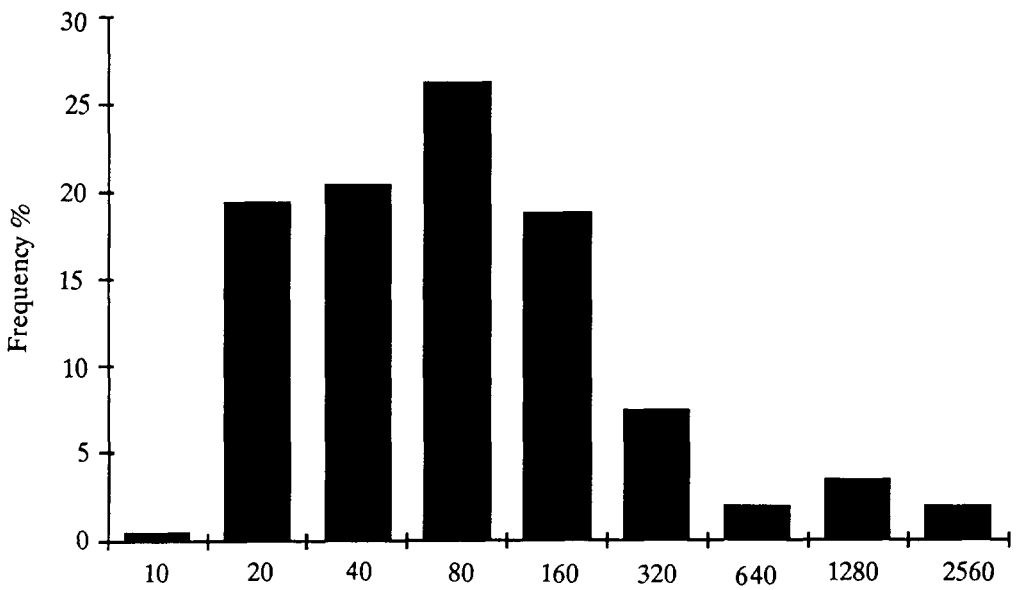


B

Figure 2. Frequency distribution of (A) BVD/MD, (B) BAV3, (C) PI3 and (D) IBR/IPV titres in sera from cattle on the Kafue flats in Zambia



C



D

Figure 2 *continued*

titres recorded in calves. Transmission is likely to occur through the mosquitoes which are abundant in the flood plains of the Kafue river. The prevalence we observed in cattle was similar to that recorded by Morita (1988) in the previous year among Mazabuka residents, one of the districts included in our investigation. However, Morita failed to detect reactors among the cattle he tested, possibly because of the antigen he used.

Q fever can be transmitted to domestic animals either by inhalation or by infected ticks, and different species of wild lagomorphs can act as hosts for the agent (Acha and Szyfres, 1988). The epidemiology of the disease in tropical livestock has not been fully investigated. However, in contrast to the situation in temperate areas, studies carried out so far in Africa emphasize tick-borne transmission rather than lateral spread among domestic animals (Schutte *et al.*, 1976; Chartier and Chartier, 1988). The abundant wild ruminants of the Kafue flats present antibodies for *C. burneti* and *Chlamydia psittaci* (Krauss *et al.*, 1984). Local herds are intensively treated to control ticks. This may be one of the factors resulting in the low proportion of cattle which presented antibodies against *C. burneti*.

The likely impact of these diseases on the livestock in the Kafue is difficult to assess on the basis of the present data only. Although the antibodies detected will have been the result of natural infection, their presence in single unpaired samples is not necessarily a sign of past or intercurrent viral disease. However, observed titres were high. Longitudinal investigations could quantify the impact of the different infections on the reproductive performance in these herds, aiming to define control measures. In such studies the different levels of validity of the tests used, probably associated with the health and nutritional status of the herd, should be borne in mind. BVD-MD virus is an immunosuppressive agent, and it may therefore be responsible for the outbreaks of cutaneous streptothricosis (or Senkobo as it is known in Zambia), a common disease in local herds (Stober, 1982). The unusual severe cases of babesiosis in calves recently observed in some commercial farms in the Central and Southern Provinces might also be associated with such immunosuppressive activity.

Regarding BT, the doubtful serological results do not allow any conclusion to be drawn. The agar gel immunodiffusion test is quite sensitive (Bruner and Gillespie, 1973); however, being a group test, it may give cross-reactions with other members of the BT complex (Sellers, 1981). Sheep are rarely bred in the Kafue and BT is often symptomless in cattle (Erasmus, 1975). Antibodies against the virus have been recorded in Zambian wild ruminants (Krauss *et al.*, 1984). Further investigations to confirm the presence of BT or related viruses in cattle are therefore recommended.

This study suggests a great resistance to disease in the local breed. Not only are a high proportion of Tonga cattle subclinical carriers of various infections, some of public health interest, but they are also affected by different tick-borne and helminthic diseases (Ghirotti *et al.*, 1988; De Meneghi and Ghirotti, 1990). Because of the low input system, this resistance is probably the best control measure that traditional farmers have at the moment against livestock diseases.

The high infection rates of RVF and brucellosis recorded in these cattle imply that traditional farmers are at particular risk from these zoonoses in view of their continuous and close contact with animals. Consumers are also at risk from brucellosis because of the local habit of drinking unpasteurized sour milk, a very common component of the daily diet in rural Zambia. Other professional categories exposed to these zoonoses are slaughterhouse employees, butchers and veterinarians.

All health care workers in the Southern and Central Provinces of Zambia need to be fully aware of the epidemiology and the clinical symptoms of these zoonoses in man. Monitoring the disease patterns in livestock and wildlife could provide baseline information for the surveillance and prevention of zoonoses. Educational programmes dealing with such occupational hazards and promoting hygienic practices should be developed within primary health care activities in rural areas.

ACKNOWLEDGEMENTS

This study was part of the field activities carried out within the Animal Health Program in the Republic of Zambia, financed by the Italian Government and implemented by the Istituto Superiore di Sanitá, Rome, jointly with the Zambian Department of Veterinary and Tsetse Control Services. The authors would like to thank Dr H.G.B. Chizyuka, Director, for permission to publish the results.

The assistance given by local farmers and by the veterinary field staff of Southern Province, of whom among many we wish to mention S. Mwaka, J.M. Zimba (Mazabuka and Monze SLOs) and W. Hamoonga (Project LO), was much appreciated.

Helpful comments on the script were provided by Drs R.B. Griffiths and J.M. Meegan. Ms S.Z. Babsa assisted in the early data compilation and typing of the text.

REFERENCES

Acha, P.N. and Szyfres, B., 1987. *Zoonoses and Communicable Diseases Common to Man and Animals*, (Pan African Health Organization, Washington DC)

Baldelli, R., Battelli, G., Caporale, V. and Semproni, G., 1975. Sulla tecnica di fissazione del complemento col micrometodo nella diagnosi di Leishmaniosi viscerale. *Nuovi Annali d'Igiene e Microbiologia*, **26**, 179–184

Bruner, D.W. and Gillespie, J.H., 1973. *Hagan's Infectious Diseases of Domestic Animals*, (Cornell University Press, Ithaca)

Chartier, C. and Chartier, F., 1988. Enquete seroepidemiologique sur les avortements infectieux des petits ruminants en Mauritanie. *Revue d'Elevage et de Medicine Veterinaire des Pays Tropicaux*, **41**, 23–24

Clarke, D.H. and Casals, J., 1958. Technique for haemagglutination and haemagglutination-inhibition with arthropod-borne viruses. *American Journal of Tropical Medicine and Hygiene*, 7, 561–573

CDC-WHO, 1989. Epi Info, version 5.0 (WHO, Geneva)

d'Cruz, S., 1976. Problems of reproduction in cattle of Zambia. *Proceedings of the 2nd International Conference of Institutions of Tropical Veterinary Medicine, West Berlin, 4–7 October 1976*, 387–395

De Meneghi, D. and Ghirotti, M., 1990. *Fasciola gigantica* quale causa di condanna nei mattatoi della Provincia Meridionale dello Zambia. *Proceedings of the 16th Congress of SOIPA, Cagliari, 7–11 May 1990* (unpublished)

Erasmus, B.J., 1975. The epizootiology of Bluetongue: the African situation. *Australian Veterinary Journal*, **51**, 196–198

Eyanga, E., Jetteur, P, Thiery, E., Wellemans, G. Dubuisson, J., Van Opdenbosch, E., Makumbu, S. and Pastoreu, P.P., 1989. Recherche des anticorps deriges contre les BHV-1, BHV-2, BHV-4, le virus BVD-MD, les adenovirus A et B, le rotavirus et le coronavirus bovins chez des bovins de l'Ouest du Zaire: resultats complementaires. *Revue d'Elevage et de Medicine Veterinaire des Pays Tropicaux*, **42**, 155–161

FAO, 1988. *FAO Production Year Book*, vol. 42

FAO-WHO-OIE, 1988. *Animal Health Yearbook*, vol. 42

Gear, J.H., Miller, G.B., Woolf, M. and Patz, I.M., 1986. Psittacosis in the RSA. *South Africa Medical Journal*, **69**, 689–693

Ghirotti, M., Moorhouse, P.D.S., Mungaba, F. and Samui, K., 1988. Control of malignant theileriosis in Southern province of Zambia. I. A review of its epidemiology. *La Medicina Tropicale nella Cooperazione allo Sviluppo*, **4**, 153–157

Hamblin, C. and Hedger, R.S., 1979. The prevalence of antibodies to bovine viral diarrhoea/mucosal disease virus in African wildlife. *Comparative Immunology and Microbiology of Infectious Diseases*, **2**, 295–303

Hussein, N.A., Chizyuka, R.Z., Ksiazek, T.G., Scott, R.M. and Boulos, B.A.M., 1987. Epizootic of Rift Valley fever in Zambia, 1985. *The Veterinary Record*, **119**, 111

Jetteur, P., Eyanga, E. and Makumba, S., 1988. Enquête sérologique concernant les virus bovipestique, IBR-IPV, RSB, PI3, et BVD-MD sur des bovins du Shaba et de l'Ouest du Zaire. *Revue d'Elevage et de Medicine Veterinaire des Pays Tropicaux*, **41**, 1212–124

Krauss, H., Roettcher, D., Weiss, R., Danner, K. and Hubschle, O.J.B., 1984. Wildtiere als Infectionpotential für Nutztiere: Untersuchungen an Wild in Sambia. *Giessener Beitrage zur Entwicklungsforschung, Reihe I*, **10**, 133–149

MAFF/ADAS, 1984. *Manual of Veterinary Investigation Laboratory Techniques*, vol. 1, (Her Majesty's Stationery Office, London)

Meegan, J.M., 1979. The Rift Valley fever epizootic in Egypt 1977–1978. 1. Description of the epizootic and virological studies. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, **73**, 618–623

Moorhouse, P.D.S. and Snacken, M., 1983. *Report of a baseline study of selected diseases of cattle carried out at Mukulaikwa CDA from January–May 1983*, (unpublished report, CVRI, Balmoral, Zambia)

Morgan, W.J., 1978. *Brucellosis Diagnosis Standard Laboratory Techniques*, (Central Veterinary Laboratory, Weybridge, UK).

Morita, C., 1988. Prevalence of Rift Valley fever in Lusaka and Mazabuka – Zambia. *Journal of Veterinary Medicine, series B*, **35**, 157–160

Perry, B.D., Mwanaumo, B., Schels, H.F., Eicher, E. and Zaman, M.R., 1984. A study of health and productivity of traditionally managed cattle in Zambia. *Preventive Veterinary Medicine*, **2**, 633–653

Provost, A., Bogel, K., Borredon, C. and Maurice, Y., 1967a. La maladie des muqueuses en Afrique centrale. Observations cliniques et epizootiologiques. *Revue d'Elevage et de Medicine Veterinaire des Pays Tropicaux*, **20**, 27–49

Provost, A., Borredon, C., Queval, R. and Maurice, Y., 1967b. Enquête sur l'infection des bovides par le virus parainfluenza 3 en Afrique centrale. *Revue d'Elevage et de Medicine Veterinaire des Pays Tropicaux*, **20**, 51–59

Schutte, A.P., Kurz, J., Barnard, B.J. and Roux, D.J., 1976. Q fever in cattle and sheep in Southern Africa. A preliminary report. *Onderstepoort Journal of Veterinary Research*, **43**, 129–132

Sellers, R.F., 1981. Bluetongue and related diseases. In Gibbs, E.P.J. (ed.), *Virus Diseases of Food Animals*, (Academic Press, London), pp. 567–584

Stober, M., 1982. Streptotrichose der Haut (Dermatophilose) bei Mastbullen mit boviner Virus-Diarrhoe. *Tierärztliche Umschau*, **37**, 629–630

Taylor, W.P. and Rampton, C.S., 1968. A survey of cattle sera from Kenya and Uganda for antibodies to bovine viral diarrhoea virus. *The Veterinary Record*, **83**, 121–124

(Accepted: 30 August 1990)