Prevalence of bovine trypanosomosis in Central Mozambique from 2002 to 2005

E.J.K. SPECHT*

Laboratório Regional de Veterinária, P.O. Box 42 , Chimoio, Mozambique

ABSTRACT

SPECHT, E.J.K. 2008. Distribution of bovine trypanosomosis in central Mozambique from 2002 to 2005. *Onderstepoort Journal of Veterinary Research*, 75:73–81

The study is the result of analyzing 16 895 blood smears of cattle collected at 180 sites in the provinces of Manica, Sofala, Zambézia and Tete in Mozambique. Of the blood smears 73.9 % were from Manica, 11.8 % from Tete, 8.5 % from Sofala and 5.8 % from Zambézia; 75.6 % of these were collected from smallholder cattle. Infections with trypanosomes were highest in smallholder cattle from Sofala Province with 36.8 % of the 872 blood smears examined positive for trypanosomes, and lowest in cattle of commercial farmers in Manica Province with only 6.2 % of 2 252 blood smears being positive. *Trypanosoma congolense* was the predominant species, followed by *Trypanosoma vivax* and *Trypanosoma brucei* sensu lato. *Trypanosoma brucei*, which also infects humans, was more frequent in the districts of Buzi, Mutarara and Morrumbala with 15.1 %, 10.5 % and 9.8 % of all examined cattle in 2005 being infected with it, respectively. The results show a significant increase in the infection rate with trypanosomes compared with results obtained in previous years by the Regional Veterinary Laboratory in Manica Province and by the Regional Tsetse and Trypanosomiasis Control Programme in Zambézia, Tete and Sofala provinces.

Keywords: Bovine, Mozambique, trypanosomosis

INTRODUCTION

Infections with trypanosomes represent one of the major constraints for cattle production in Mozambique because approximately two thirds of the country is infested by its vector, *Glossina* spp. (Pires 1952, Regional Tsetse and Trypanosomiasis Control Programme 2000). Infection results in anaemia, stunted growth, mass loss, reproductive disorders, poor milk production and if not treated, death. Smallholders—without the knowledge and often the financial means to buy therapeutic agents—are most severely stricken by disease or death of the few cattle they possess. The disease deprives them of meat, sometimes milk and draft power.

During the colonial period cattle husbandry was absent in large areas in central and northern Mozambique (Pires 1952). These areas are part of the "common fly belt", which extends over some 320 000 km² in Malawi, Mozambique, Zambia and Zimbabwe. Little information exists about tsetse fly eradication programmes during colonial times. Between 1962–1975 control operations against *Glossina morsitans* and *Glossina pallidipes* were carried out in Muabsa and Rio Save areas, using Dieldrin until 1969 and DDT thereafter (Lovemore 1986). In 1985 a 15-year programme for tsetse fly and trypanosomosis control was proposed for the "common fly belt" (Jordan 1985). This Regional Tsetse and Trypanosomiasis Control Programme (RTTCP) conducted a survey in 46 districts of the ten provinces between May 1995 and February 2000 to update the information about distribution of bovine

* E-mail: vetlabman@teledata.mz

Accepted for publication 19 November 2007—Editor

trypanosomosis in Mozambique. The Regional Veterinary Laboratory (LRV) in Chimoio carried out several surveys on trypanosomosis in smallholder cattle in the Manica district of Manica Province (Specht 1999a, 2001, 2003).

The lack of control implementation after independence, movement of people and cattle, climatic changes during the last 15 years with a drought at the beginning of the 1990s, and the abandoning of farm land after the heavy rains in 2000 undoubtedly had a marked influence on the distribution of the tsetse fly and trypanosomosis. Bovine trypanosomosis is also on the increase because of the distribution of cattle to smallholders in areas known to be tsetse fly habitats, often without training the farmers in cattle husbandry.

The purpose of this paper is to provide information pertaining to the distribution of bovine trypanosomosis in 23 districts of the provinces of Manica, Sofala, Zambézia and Tete that will assist the veterinary authority in the effort to fight the disease.

MATERIAL AND METHODS

Sampling sites and sample selection

During the last 4 years the LRV in Chimoio in Manica Province has assisted not only the veterinary services of this province, but also those of Sofala, Zambézia and Tete provinces which possess only small veterinary laboratories (Fig. 1). The veterinary services urgently needed an update on the disease situation in smallholder cattle, since the state had stopped subsidizing basic animal health care some years ago and the smallholders did not take care of their animals as expected. Nowadays most of the smallholders seek treatment only for the very sick animals and regular treatments with trypanocides are only done by a few more educated smallholders.

Samples were taken from cattle at dip tanks and treatment crushes indicated by the services to determine the prevalence of blood and intestinal parasites. Between October 2002 and December 2005,

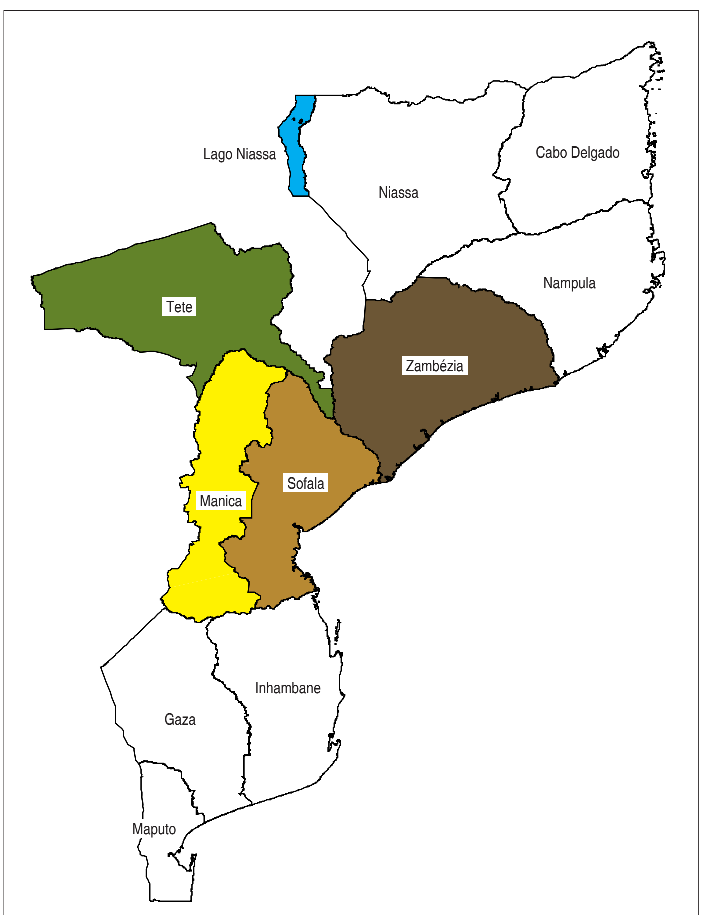

FIG. 1 Map of Mozambique showing the four provinces of the survey

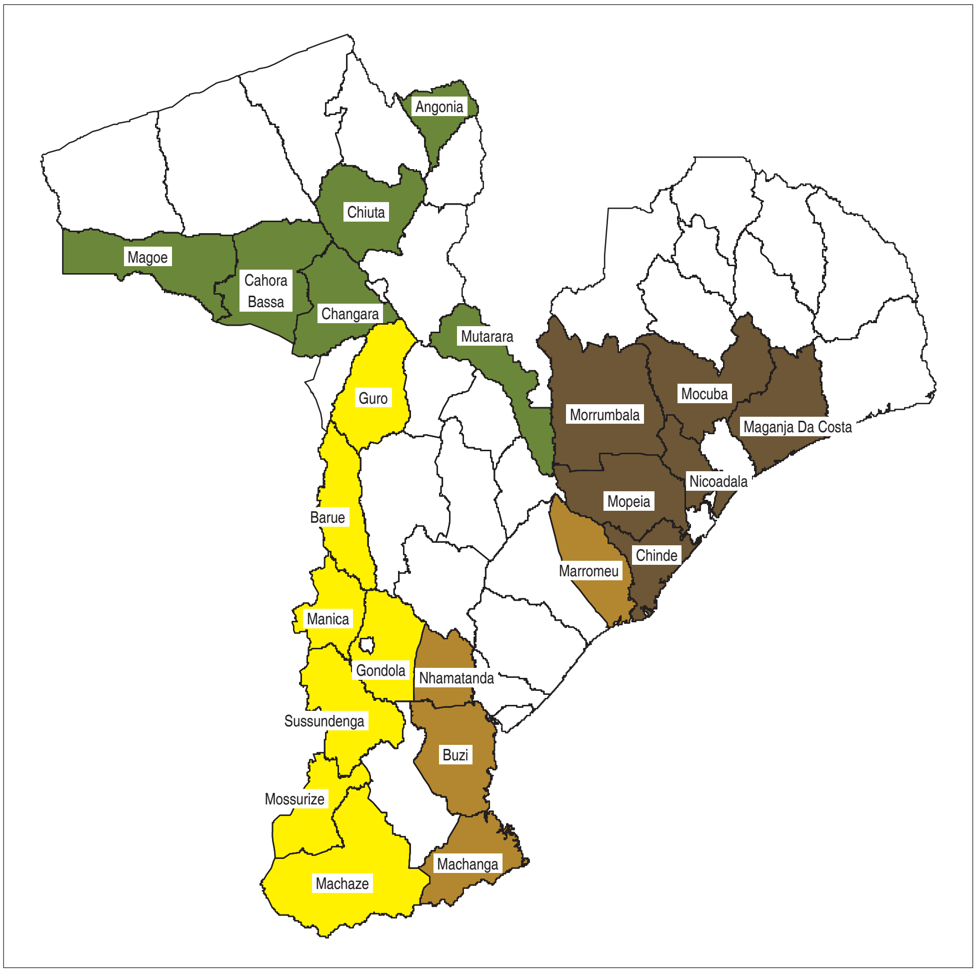

FIG. 2 Districts sampled in Manica, Sofala, Zambézia and Tete

mainly adult cattle were sampled at dip tanks and treatment crushes in 23 districts of the Manica, Sofala, Zambézia and Tete provinces (Fig. 2).

Samples were collected from cattle of smallholders and commercial farmers in the districts of Gondola, Manica and Sussundenga in Manica Province during 2003, 2004 and 2005 and four small commercial farms were sampled twice during this period. In Buzi district in Sofala Province sampling was done in 2002 and 2005 and in Changara district in Tete Province in 2002 and 2003.

The sample size depended on the total cattle population at a particular site (especially at small commercial farms, the total cattle population did not exceed 50–60 animals), the appearance of smallholder's cattle at the sampling site (at some sites only 25–50 animals appeared) and the limits in the capacity of the laboratory staff to perform the *in vivo* examination for trypanosomes at the site. Therefore, generally a maximum of 72 cattle per site could be sampled. The number of the smallholder cattle existing at a particular site chosen by the distrital veterinary officer was often not known before the start of the sampling. But varied mostly between 300 and 1 500 animals and 5–25 % of this cattle population was being sampled. During collection of samples from smallholder cattle, care was taken to sample cattle of most of the smallholders present at the sampling site. Generally the worst and the best farmers, which did not care to participate, may be underrepresented during the sampling.

At commercial farms 25–90 % of the cattle population were being sampled.

Parasitological diagnostic methods

Blood samples (two capillary tubes per animal) were taken from marginal ear veins into heparinised microhaematocrit tubes (Na-heparin haematocrit capillaries from Brand, Hirschmann or Herenz) and onto glass slides, as thin blood smears. The capillary tubes were sealed (Cristaseal, Gelman & Hawskley) and centrifuged immediately (Microhaematocrit centrifuge, Gelman & Hawskley) for 5 min at 9000 rpm.

After centrifugation the packed cell volume (PCV) was determined and the capillary tubes were rotated under the microscope in search of motile trypanosomes in the buffy-coat area using x 10 and x 20 objective lenses (Woo 1970). The thin smears were fixed with methanol, stained with Giemsa and observed under a 100x oil immersion lens. Fixation of the blood smears was generally done on site during sampling in Sofala, Zambézia and Tete provinces and in distant districts in Manica Province and at the Veterinary Laboratory in Chimoio for samples taken in the nearby Manica and Gondola districts. Staining with Giemsa was always done at the Veterinary Laboratory in Chimoio.

RESULTS

Between October 2002 and December 2005, 16895 mainly adult cattle were sampled at 180 sites in 23 districts of the four provinces Manica, Sofala, Zambézia and Tete. Of the blood smears 73.9% were from Manica, 11.8% from Tete, 8.5% from Sofala and 5.8% from Zambézia. Of the samples 75.6% were collected from smallholder cattle.

Infections with trypanosomes were highest in smallholder cattle from Sofala Province with 36.81% of the 872 blood smears examined being positive for trypanosomes and lowest in cattle of commercial farmers in Manica Province with only 6.21% of 2252 blood smears being positive.

In smallholder cattle *Trypanosoma congolense* was the predominant species at 41.53%, followed by *Trypanosoma vivax* at 31.84% and *Trypanosoma brucei* sensu lato at 18.16%. Mixed infections also occurred. Infections with *T. vivax* + *T. congolense* accounted for 2.98%, *T. vivax* + *T. brucei* for 2.32%, *T. congolense* + *T. brucei* for 2.98% and, with all three species, for 0.19% of the infections. Including mixed infections, 23.65% of the positive animals (or 5.9% of all animals examined) harboured *T. brucei* sensu lato.

In commercial cattle *T. vivax* was the predominant species at 42.25%, followed by *T. congolense* at 37.45% and *T. brucei* sensu lato at 15.68%. Mixed infections accounted for 4.61% of all infections. Including the mixed infections, 18.08% of the positive animals (or 2.38% of all animals examined) harboured *T. brucei* sensu lato.

In smallholder cattle *T. brucei* sensu lato was more frequent in the districts of Buzi and Mutarara with 15.12% and 10.50% of all the animals examined in 2005 being infected with it (Table 1). In the same year 9.83% of the cattle of small-scale commercial farmers in the Morrumbala district were positive for *T. brucei* sensu lato (Table 2).

In Manica Province more infections with *T. brucei* sensu lato were found in cattle of smallholders in the Manica district. In 2003 8.67% and in 2004 7.68% of all cattle examined were positive for it (Table 1). In other districts such as Sussundenga and Gondola in 2004 and Mossurize in 2005, 5–6% of all smallholder cattle examined had infections with *T. brucei* sensu lato (Table 1).

In smallholder cattle the mean PCV per year and district ranged between 27.70% for 291 cattle in Buzi district in 2005 to 32.80% for 282 cattle in Chiuta district in 2003 (Table 1). In commercial cattle the mean PCV was generally higher. The mean PCV for all samples was 33.64% for commercial cattle compared to 29.72% for smallholder cattle (t-test, $P > 99.999\%$). The mean PCV was lower than 30% only at a small, badly-managed farm in Gondola district. Most mean values of commercial herds ranged between 32 and 36% (Table 2).

When considering the details per province, district and production sector, the prevalence of trypanosomes in smallholder cattle can be summarized as follows: In Manica Province the highest prevalence of trypanosomes was in Manica district, with 30.30% being found positive in 2004, in Guro district with 37.25% being positive in 2005 and in Sussundenga district with 35.56% being positive in 2005. In Sofala Province the highest prevalence of trypanosomes was in Machanga district, with 40.11% being positive in 2003 and in Tete Province in the Changara district with 40.08% being positive in 2003, while in Zambézia Province 30% of the 40 smallholder cattle examined were positive (Table 1).

A detailed picture of the prevalence of trypanosomes at commercial farms and one state farm was as follows: In Manica Province the highest prevalence of trypanosomes was found in Sussundenga district, with 15.87% of the cattle being positive in 2004 and 18.23% being positive in 2005. In Sofala Province in Buzi and Marromeu districts 22.22% and 20.16%, respectively, of the cattle examined in 2003 were found positive. In Zambézia Province, most of the cattle were regularly treated with trypanocidal drugs; cattle in Nicoadala and Morrumbala districts showed the highest prevalence of trypano-

TABLE 1 Prevalence of trypanosomal infections in small-holder cattle in 15 districts in central Mozambique between October 2002 and December 2005

Year	**District**	**No. of cattle**	**Mean PCV %**	**± STDEV**	**Total no. of trypano-somes**	**% trypano-somes**	**% *T. vivax***	**% *T. congo-lense***	**% *T. brucei* sensu lato**	**% mixed infection with *T. brucei***	**% *T. vivax* + *T. con-golense***
SH-Manica											
2003	Gondola	431	29.43	5.08	63	14.62	3.71	6.73	1.86	2.09	0.20
2003	Guro	292	32.73	3.96	31	10.62	3.08	5.82	1.71	0.00	0.00
2003	Manica	1627	28.81	4.40	480	29.50	6.39	13.03	6.21	2.46	1.41
2003	Machaze	272	31.39	4.36	58	21.32	5.51	10.29	4.78	0.37	0.37
2003	Sussund.	292	30.63	4.66	63	21.58	6.51	7.88	4.79	1.71	0.68
2004	Gondola	778	30.83	4.50	173	22.24	6.03	10.53	4.75	0.77	0.13
2004	Guro	381	29.80	5.67	76	19.95	7.35	8.40	2.89	0.79	0.52
2004	Machaze	347	28.75	4.50	25	7.20	2.02	3.17	1.15	0.29	0.58
2004	Manica	1627	28.66	3.22	493	30.30	10.08	12.42	6.76	0.92	0.12
2004	Sussund.	540	29.93	4.22	95	17.59	6.67	7.41	3.52	0.00	0.00
2005	Báruè	335	31.54	4.93	42	12.54	6.27	5.67	0.60	0.00	0.00
2005	Gondola	709	27.93	4.61	98	13.82	4.51	5.78	2.82	0.28	0.42
2005	Guro	247	29.68	5.91	92	37.25	20.65	14.57	2.02	0.00	0.00
2005	Manica	1520	29.23	4.29	397	26.12	9.47	10.59	3.75	1.25	1.05
2005	Mossurize	270	28.57	4.46	56	20.74	7.78	7.04	5.93	0.00	0.00
2005	Sussund.	568	27.87	4.70	202	35.56	14.08	12.15	4.75	2.82	1.76
SH-Sofala											
2003	Machanga	359	29.54	4.73	144	40.11	9.19	21.45	5.57	3.06	0.84
2003	Buzi	222	30.34	5.72	78	35.14	12.61	17.12	3.60	1.35	0.45
2005	Buzi	291	27.70	3.69	99	34.02	8.59	8.93	9.62	5.50	1.37
SH-Zambézia											
2004	Maganja	40	35.10	3.81	12	30.00	12.50	15.00	2.50	0.00	0.00
SH-Tete											
2002	Changara	218	30.76	6.45	62	28.44	10.55	11.47	2.75	2.29	1.38
2003	Chiuta	282	32.80	5.32	48	17.02	6.03	5.32	3.55	1.06	1.06
2003	Changara	258	31.03	5.63	105	40.70	15.50	9.69	3.49	5.81	6.20
2004	Cahora Bassa	245	29.68	5.17	39	15.92	5.71	4.08	3.67	1.63	0.82
2004	Mágoè	278	30.21	5.33	62	22.30	3.96	16.91	1.08	0.36	0.00
2005	Mutarara	343	32.73	4.53	95	27.70	7.29	9.91	10.50	0.00	0.00
Total		**12 772**			**3 188**	**24.96**					

SH = Smallholder

TABLE 2 Prevalence of trypanosomal infections in cattle of commercial farmers in 13 districts in central Mozambique between 2003 and 2005

Year	District	No. of cattle	Mean PCV %	± STDEV	Total no. of trypano-somes	% trypano-somes	% *T. vivax*	% *T. congo-lense*	% *T. brucei* sensu lato	% mixed infection with *T. brucei*	% *T. vivax* + *T. con-golense*
CF-Manica											
2003	Gondola	42	30.57	3.67	4	9.52	2.38	7.14	0.00	0.00	0.00
2003	Manica	30	34.63	4.00	0	0.00	0.00	0.00	0.00	0.00	0.00
2003	Sussund.	96	33.18	4.46	1	1.04	0.00	1.04	0.00	0.00	0.00
2004	Gondola	50	29.54	4.17	3	6.00	4.00	2.00	0.00	0.00	0.00
2004	Manica	197	33.10	4.72	1	0.51	0.51	0.00	0.00	0.00	0.00
2004	Sussund.	208	33.89	7.09	33	15.87	5.77	6.73	3.37	0.00	0.00
2005	Gondola	987	35.31	6.81	24	2.43	0.71	1.22	0.41	0.00	0.10
2005	Manica	280	32.59	4.95	8	2.86	1.43	1.07	0.36	0.00	0.00
2005	Sussund.	362	32.00	5.69	66	18.23	9.12	6.63	1.93	0.00	0.55
CF-Sofala											
2003	Buzi	36	32.58	4.14	8	22.22	16.67	5.56	0.00	0.00	0.00
2003	Marromeu	124	33.99	5.29	25	20.16	7.26	8.87	4.03	0.00	0.00
2004	Nhamatanda	331	31.14	4.92	53	16.01	4.83	3.32	3.93	2.72	1.21
2005	Buzi	72	30.60	3.89	8	11.11	2.78	1.39	6.94	0.00	0.00
CF-Zambézia											
2003	Chinde	87	34.87	4.02	7	8.05	3.45	2.30	2.30	0.00	0.00
2004	Nicoadala	330	34.15	5.23	93	28.18	16.97	10.00	0.61	0.61	0.00
2004	Maganja	228	35.50	4.66	46	20.18	10.09	7.02	1.75	0.44	0.88
2004	Mocuba	52	37.87	4.85	9	17.31	11.54	3.85	1.92	0.00	0.00
2004	Mopeia	71	36.15	6.50	18	25.35	7.04	12.68	2.82	0.00	2.82
2005	Morrumbala	173	31.33	4.83	55	31.79	11.56	10.40	9.83	0.00	0.00
State Tete											
2005	Angônia (EZA)	367	33.38	4.00	80	21.80	6.27	10.90	4.09	0.27	0.27
Total		**4 123**			**542**	**13.15**					

CF = Commercial farmer

somes with 28.18 % and 31.79 % being positive, respectively. At the zootechnical research station (EZA) in Ulongwe, District of Angônia, situated at an altitude of 1 300 m, 21.80 % of all the Angoni cattle examined in 2005 were positive for trypanosomes (Table 2).

DISCUSSION

Most of Mozambique north of the Save River with the exception of some highlands in Niassa, Cabo Delgado and Tete is considered to be infested by tsetse flies (RTTCP 2000). Historical data indicate that around 1950 large tsetse-infested areas of central Mozambique such as the districts of Gorongosa, Cheringoma and Chemba had no cattle at all. Others such as Mossurize, Machaze, Mocuba and Mopeia that now have large populations of cattle, had less than 500 animals at that time (Pires 1952). Most of these areas had good agro-ecological conditions for the grazing, and 40 years earlier they had harboured large herds, which disappeared due to trypanosomosis. A good example is provided by the districts of Chemba and Sena, which had about 15 000 head of cattle around 1913 (Pires 1952). Trypanosomosis was, apart from tuberculosis, considered the main constraint for animal husbandry along the banks of the Révuè River in Manica and Sofala Province (Gradil 1969).

Despite the lack of updated data about the distribution of the tsetse fly in central Mozambique and the consequent risk of the animals becoming infected with trypanosomes, in the decade after 1990 cattle were distributed on a large scale to smallholders. The population resettled at the end of the civil war needed animals, especially for traction purposes. The distribution was generally done without training the new owners in basic animal health care. At that time the provincial and district veterinary officers and dip tank attendants looked after the health of the animals and treated sick ones at no, or only very low cost to the owners. This policy changed about 5 years ago and the state stopped subsidizing basic animal health care services. The result was a large increase in parasitic diseases, including trypanosomosis (Specht 2003).

The LRV relies unfortunately until now on parasitological methods for the detection of trypanosomes, combining the observation of thin blood smears with the microhaematocrit centrifugation technique (WOO method). Both methods fail to detect all infected animals (Luckins 1993) and are dependant on the volume of blood examined and the experience of the microscopist. The prevalence of trypanosomes would without doubt been higher if serological diagnostic tests would have been used.

Connor (1993) predicted that, with the return of peace and people to their land, both they and their livestock would be at serious risk of contracting trypanosomosis. This is well illustrated by comparing data collected by the RTTCP in Zambézia, Tete and Sofala provinces between 1995 and 2000 and those collected by the LRV between 2002 and 2005.

The RTTCP examined a total of 12 596 adult cattle at 274 sampling sites in 46 districts of the ten provinces of Mozambique between May 1995 and February 2000, using parasitological and serological methods (RTTCP 2000). In Zambézia Province the RTTCP took parasitological samples of 1 033 cattle at 16 sampling sites in four districts of which 4.5 % were found positive for trypanosomes. This is in sharp contrast to the results obtained by the LRV. Out of a total of 941 commercial cattle examined between 2003 and 2005 in Zambézia Province 24.2 % were found positive for trypanosomes.

The RTTCP found only 1.4 % of 6 568 head of cattle examined at 74 sites in nine districts in Tete Province positive for trypanosomes. The parasitological prevalence was highest in Zumbo with 10.1 %, followed by Changara district with 8.9 %. In the latter, the LRV found 40.7 % of the 258 animals examined in 2003 positive for trypanosomes. Out of a total of 1 624 smallholder cattle examined by the LRV between 2002 and 2005 at 28 sampling sites in five districts, 25.3 % were positive for trypanosomes.

In Sofala Province the RTTCP examined 415 cattle at ten sampling sites in three districts. Trypanosomal infections were detected in 4.1 % of the animals examined at six sampling sites, all located in the Buzi district. Sampling done by the LRV in Buzi district during 2003 and 2005 showed 35.1 % of 222 and 34.0 % of 291 smallholder cattle positive for trypanosomes.

In Manica Province between 1989 and 1997 the LRV examined 21 660 head of cattle of which 7.7 % were positive for trypanosomes (Specht 1999b). In 1993 morbidity and mortality increased in cattle in Manica district and trypanosomal infections were found in 35.9 % of 585 cattle examined between January and May (Specht 1999a). After rigorous treatments trypanosomal infections were reduced to 7.7 % in 519 cattle examined between March and August of 1994 (Specht 1999b).

The encroachment of people and their livestock into tsetse-infested wilderness areas is considered to be responsible for the changes in the propagation of trypanosomosis (Van den Bossche 2001). Clearing of vegetation and the introduction of agriculture and animal husbandry lead to a gradual decrease in the density of wildlife and cattle become the main source of food for tsetse flies. This leads consequently to an increase in trypanosomal infections in cattle. This pattern is probably partly responsible for the high infections rates in smallholder cattle.

The fact that smallholders are often not aware of the necessity for treatment or are not willing to pay for treatment or often simply do not have access to the drugs needed, also contributes to the steady increase in trypanosomal infections. Unpublished data of a survey carried out in Manica district at the beginning of 2006 indicate that the infection rate has doubled in comparison with that of 2005. Trypanosomal infections increased from 26.1 % in 1 520 cattle at 24 sites in 2005 to 54.5 % in 1 319 cattle at 21 sites in 2006. In the first months of 2006 large numbers of animals were in poor condition despite the abundance of food, and 17.7 % of 63 untreated animals examined the year before had died (Specht, unpublished data 2006).

Trypanosoma congolense was the predominant species during the RTTCP survey of 1995–2000 and also in smallholder cattle during the study carried out by the LRV in 2002–2005. Historically *T. congolense* was considered the epizootiologically more important species, but *T. vivax*, which was the predominant species on commercial farms in the LRV study, was found more frequently in domestic animals (Pires 1952).

In the present study *T. brucei* sensu lato accounts for 23.65 % of the infections (including mixed infections) in smallholder cattle and for 18.08 % of the infections in commercial cattle. This is alarming considering that *T. brucei* also infects humans, with game animals and livestock serving as the reservoir of infection (Kioy & Mattock 2005). In Uganda cattle are considered to be its principal reservoir (Fèvre *et al*. 2005). Fèvre, Picozzi, Waiswa, Coleman & Welburn (2005) observed that the movement of cattle into the Soroti district in Uganda in 1998 resulted in the spread of sleeping sickness to the area.

The PCV values in commercial cattle are generally higher than in smallholder cattle which are due to the regular dipping and treatments against blood and gastrointestinal parasites and to pasture management and feed supplementation during the dry season. The influence trypanosomal infection has on the PCV will be subject of a separate report. In particular, smallholder cattle often have a "cocktail" of infections, which makes it difficult to judge which one is more responsible for low PCVs. Further studies on trypanosomosis in which other PCV- influencing factors will be eliminated by treating the animals with babesicides and anthelminthics, will be carried out.

During their annual meeting held in Togo in 2000 the African Union heads of State adopted a decision to eradicate tsetse flies in Africa since they are a threat to human and animal health. They declared the year 2001 as "The Year of the Control of the Tsetse Fly" (Jihui 2001). In 2001 the Pan African Tsetse and Trypanosomosis Eradication Programme (PATTEC) was launched, but Mozambique has clearly not yet benefited from these decisions. Great efforts will be needed by government agencies, donors and also by PATTEC to deal with this situation which may, in addition, threaten neighbouring countries.

ACKNOWLEDGEMENTS

The author wishes to thank all her colleagues of the Regional Veterinary Laboratory in Chimoio who helped in the collection and processing of the samples often under very adverse conditions. Special thanks are due to Dr Mary Louise Penrith and Dr Wilna Vosloo for corrections of the paper, Dr Flemming Nielsen for help with the statistics and to Mr Lazaro Gumene for producing the maps.

REFERENCES

CONNOR, R.J. 1993. A review of animal trypanosomiasis in the common fly belt. *Regional Tsetse and Trypanosomiasis Control Programme Malawi, Mozambique, Zambia and Zimbabwe,* February 1993.

FÈVRE, E.M., PICOZZI, K., WAISWA, M., COLEMAN, P.G. & WELBURN, S.C. 2005. A burgeoning epidemic of sleeping sickness in Uganda. *The Lancet*, 366:745–747.

GRADIL, J.M. 1969. Subsídios para o estudo da terapêutica das tripanossomíases na bacia hidrográfica do Revué. 1.- Inquérito hematológico ao gado bovino leiteiro, da Sociedade Agrícola de Trás-os-Montes, com vista a determinar o rísco de tripanossomiase. *Anais dos Serviços de Veterinária de Moçambique*, 15:403–17.

JIHUI, Q. 2001. Launching the Pan African Tsetse and Trypanosomosis Eradication Campaign (PATTEC). *The 26th meeting of the International Scientific Council for Trypanosomiasis Research and Control, October 2001, Quagadougou, Burkina Faso.*

JORDAN, A.M. 1985. Tsetse eradication plans for southern Africa. *Parasitology Today*, 1–5:121–123.

KIOY, D. & MATTOCK, N. 2005. Control of sleeping sickness—time to integrate approaches. *The Lancet*, 366:695–696.

LOVEMORE, D.F. 1986. Tsetse control by chemical means in Malawi, Mozambique, Zambia and Zimbabwe. *Proceedings of the Commission of the European Communities International Symposium/Ispra*: 27–41.

LUCKINS, A.G. 1993. Diagnostic methods in trypanosomiasis of livestock, in *Improving the diagnosis and control of trypanosomiasis and other vector-borne diseases of African livestock using immunoassay methods, International Atomic Energy Agency, TECDOC,* 707:27–35.

PIRES, F.A. 1952. As tripanossomíases animais. *Anais dos serviços de Veterinária*, 5:63–79.

RTTCP 2000. An update of the distribution of bovine trypanosomosis in Mozambique.

SPECHT, E.J.K. 1999a. Tripanossomas em gado bovino no sector familiar no distrito de Manica. *O Agrário*, 15:12–15.

SPECHT, E.J.K. 1999b. Relação entre maneio sanitário e a prevalência de alguns parasitas nos bovinos da Provincia de Manica. *O Agrário* 16:11–15.

SPECHT, E.J.K. 2001. Breve comunicação sobre análises de esfregaços de sangue de bovinos do sector familiar da Provincia de Manica, in *II Seminário Nacional de Investigação e Extensão em Sistemas de Produção*.

SPECHT, E.J.K. 2003. Trypanosoma, Babesia e Anaplasma em gado bovino do sector familiar do distrito de Manica. *Proceedings da III Reunião Nacional de Investigação Agrária e Extensão em Maputo.*

VAN DEN BOSSCHE, P. 2001. Some general aspects of the distribution and epidemiology of bovine trypanosomosis in southern Africa. *International Journal for Parasitology*, 31: 592–598.

WOO, P.T.K. 1970. The haematocrit centrifuge technique for the diagnosis of African trypanosomiasis. *Acta Tropica,* (Basel) 27:384–386.