Rodents and Shrews as Vectors of Zoonotic Spirochetes and Trypanosomes in Tanzania

A.A.S. Katakweba[1], M.J. Kipanyula[2], L. Durnez[3], G.F. Mgode[1], G. Mhamphi[1], C. Luziga[2] and R.S. Machang'u[1]

[1]Pest Management Centre (PMC), Sokoine University of Agriculture (SUA), P.O. Box 3110, Chuo Kikuu Morogoro, Tanzania. [2]Department of Veterinary Anatomy, Sokoine University of Agriculture (SUA), P.O. Box 3016, Chuo Kikuu Morogoro, Tanzania. [3]Institute of Tropical Medicine, Department of Biomedical Sciences, Medical Entomology Unit Nationalestraat 155, B-2000 Antwerp, Belgium
Email: kipanyula@suanet.ac.tz

SUMMARY

Clinically healthy wild rodents and shrews (*Crocidura* spp.) were captured from different localities in Morogoro, Tanga, Dodoma, Singida, Mbeya, Kilimanjaro and Mtwara regions of Tanzania. Blood samples were collected from the captured animals and screened for infectious agents of public health importance, including; *Trypanosoma* spp., *Plasmodium* spp., *Borrelia* spp. and *Bacillus* spp. Out of 4,963 blood smears examined, 424 (8.5%) were from shrews and 4,539 (91.5%) were from rodents. *Trypanosoma* spp. were demonstrated in 198 (3.9%) and 7 (0.1%) blood smears of rodents and shrews, respectively. *Borrelia* spp. were demonstrated in 6 (0.2%) and 5 (1.2%) rodents and shrews, respectively. *Bacillus* spp. were found in 149 (3.6%) and 27 (6.4%) rodents and shrews respectively. *Mastomys natalensis, Rattus rattus* and *Crocidura* spp. were found to host all of the five haemoparasites detected. The public health significance of this study is notable from the fact that haemoparasites that were demonstrated in apparently healthy rodents are potential human pathogens.

Key words: Rodent, shrew, *Crocidura* spp., haemoparasite, spirochete

INTRODUCTION

Infestation with rodents is common in many parts of the world. In Tanzania, the roof rat, *Rattus rattus*, is the most abundant and widespread commensal rodent species, while *Mastomys natalensis, Mus musculus, Cricetomys gambianus* and *Arvicanthis niloticus* are the predominant field species in the country (Kilonzo, 1976). *Mastomys natalensis* and *A. niloticus* are peri-domestic species and are found in fallow and cultivated lands, up to 2000 m above sea level (Makundi *et al*., 1999). Other species including *Lemniscomys griselda, Acomys spinosissimus, Otomys* spp., *Grammomys dolichurus* and *Rhabdomys pumilio* are also common but less abundant in many parts of Tanzania (Makundi *et al*., 1991).

Wild rodents play an important role as reservoirs and hosts of many haemoparasitic pathogens of animal and public health importance. Rodents also cause extensive damage in agriculture, forestry and the environment. Certain rodent species, however, are carriers of specific zoonotic diseases, which are transmitted directly or indirectly to humans through their ectoparasite vectors. Such vectors include ticks, bugs, mites, fleas, lice or sand flies (Powelczyk *et al*., 2004; Korbawiak *et al*., 2005). Contamination of foods with urine, hairs or faeces is another possibility of direct disease transmission by

rodents and shrews (Begon *et al*., 2003; Faine *et al*., 1999; Buckle and Smith, 1994).

Aetiologic agents of rodent borne zoonoses include viruses, bacteria, rickettsia, protozoa and helminths (Maeda-Machang'u, 1992; Silayo, 1992; Machang'u *et al*., 2004). Most outbreaks of rodent-borne diseases in humans are commonly related to socio-economic deficiencies such as poor hygiene, poverty and overcrowding. However, the incidences of these diseases are grossly underestimated, thus the diagnosis of these diseases increases with a high index of clinical suspicion (Machang'u *et al*., 1997). In many settlements, there is relatively little awareness that rodents and shrews can transmit diseases. Consequently, little emphasis is directed towards the management of rodents and associated disease vectors (Buckle *et al*., 2013).

The aim of this study was to explore the prevalence of haemoparasites of public health importance in rodents and insectivores captured in and around houses and fields in selected urban and periurban areas of Tanzania.

MATERIALS AND METHODS

Rodents and shrews trapping

Rodents and shrews from different parts of Tanzania (Table 1) were trapped starting in 1997 in Singida areas using Sherman®, Havahart® traps and locally made wooden box traps. The bait used included green maize for *C. gambianus* and a mixture of maize bran and peanut butter (ratio 4:1) for the other rodent species and shrews. Trapping sites included: human residences, peridomestic areas, home gardens and fallow lands in the vicinity of human settlements. The traps were placed in lines approximately 10 m apart in the fallow lands. In residences, five Sherman®, two Havaharts® and three box traps were placed in strategic sites for four consecutive nights. The traps were inspected every morning to identify the captured animals.

Blood sample collection and smear preparation

Before sample collection, rodents and shrews were anaesthetized by inhalation using ether soaked in cotton wool, and 20 – 25 µl of blood were drawn from the supraorbital veins using glass capillaries. Thick blood smears were prepared by spreading three drops of blood from the capillary tubes onto microscope slides, over an area of about one centimetre in diameter. The dried, unfixed blood smears were immersed in distilled water to allow the lysis of the erythrocytes to occur. The slides were then immersed in 10 % Giemsa stain (1:10 dilutions) for 30 minutes and then washed under running water for 10 second, dried and examined under the light microscope (Olympus BH-2) at 1000x magnification with immersion oil.

RESULTS

Identification of captured animals

The predominant rodent species captured in residence areas was *R. rattus*, while in peri-domestic areas, swamps and fallow lands was *Mastomys* spp. *S*hrews were captured mainly in peri-domestic sites. Species captured and their corresponding locations were as indicated in Table 2.

Haemoparasite detection

Out of 4,963 blood smear samples screened, 447 samples (9.0%) were positive for haemoparasites. Following primary identification, the haemoparasites were described as *Trypanosoma* spp.,

Plasmodium, *Spirillum* spp., *Borrelia* spp., *Bacillus* spp. and coccal bacterial organisms (Table 3). The haemoparasite burden in the different species of rodents and in the shrews was as follows (percentages in brackets); *R. rattus* (35.4%), *Mastomys natalensis* (35.1%), *Mus* spp. (7.6%), *Arvicanthis* spp. (3.6%), *Cricetomys gambianus (*3.1%), *Grammomys* spp. (1.3%) and *Crocidura* spp. (11.5%).

Table 1. Localities where rodents and shrews were trapped for detection of haemoparasites

Region	District	Localities
Morogoro	Morogoro and Mvomero	Urban, periurban, Turiani and Dakawa
Dodoma	Dodoma rural	Mvumi and Ihanda
Singida	Singida rural	Mpambaa, Mwao and Mang'onyi
Mtwara	Masasi	Mbonde, Liputu, Masasi mbovu, Msikisi and Miwale
Tanga	Lushoto and Korogwe	Magamba, Gologolo, Mavumo and Mamba
Mbeya	Chunya	Chang'ombe
Kilimanjaro	Moshi	Mabogini (Lower Moshi)

Table 2. Rodents and shrews screened for haemoparasites from selected localities of Tanzania

Region	Total number of blood samples	Species examined											
		M. natalensis	*Crocidura* spp.	*R. rattus*	*R. norvegicus*	*M. musculus*	*C. gambianus*	*A. niloticus*	*Grammomys* spp.	*Tatera* spp.	*Dasymys* spp.	*Uranomys* spp.	*Nannomys* spp.
Kilimanjaro	28	28	-	-	-	-	-	-	-	-	-	-	
Mtwara	229	196	6	21	-	-	-	-	-	3	-	2	1
Mbeya	20	19	-	1	-	-	-	-	-	-	-	-	-
Singida	364	306	-	53	-	-	-	4	1	-	-	-	-
Tanga	355	326	-	8	-	-	-	6	15	-	-	-	-
Dodoma	251	9	-	43	-	-	-	199	-	-	-	-	-
Morogoro	3716	2011	418	634	32	375	157	1	23	44	6	-	15
Total	4963	2895	424	760	32	375	157	210	39	47	6	2	16

Table 3. Species of blood parasites detected in the blood smears of rodent and shrews from different localities of Tanzania

Species of rodents	Samples screened	*Trypanosoma* spp.	*Borrelia* spp.	*Bacillus* spp.	*Spirillum* spp.	*Cocci* spp.	*Plasmodium* spp.	Total (%) per spp
M.natalensis	2895	31	3	92	0	24	8	158 (5.5)
Crocidura spp	424	7	5	27	0	8	4	51 (12.1)
R. rattus	760	134	1	16	0	3	3	157(20.7)
R. norvegicus	32	2	0	3	0	0	0	5 (15.6)
M.musculus	375	10	0	22	0	1	1	34 (9.1)
C.gambianus	157	7	0	6	1	0	0	14 (8.9)
Tatera spp.	47	1	0	2	0	0	0	3 (6.4)
Nanomys spp.	16	0	0	0	0	1	0	1 (6.3)
A.niloticus	210	10	2	4	0	0	0	16 (7.6)
Dasymys spp.	6	0	0	1	0	0	0	1 (16.7)
Uranomys spp.	2	1	0	0	0	0	0	1 (50.0)
Grammomys spp.	39	2	0	3	0	0	1	6 (15.4)
TOTAL (%)	4963	205(4.1)	11 (0.2)	176(3.6)	1(0.0)	37(0.8)	17(0.3)	447(9.0)

The type of haemoparasite varied among the rodent species and shrews (Table 3). For example most of the *Trypanosoma* spp. were found in *R. rattus*. *Bacillus* spp. were more prevalent in *M. natalensis, M. musculus and Crocidura* spp. while *Borrelia* spp. were found in *M. natalensis, R. rattus, Crocidura* spp. and *A. niloticus*. *Mastomys natalensis, R. rattus* and *Crocidura* spp. were found to host most of the haemoparasites detected except *Spirillum* spp. that was only detected in *C. gambianus* (Table 3).

DISCUSSION

This study was carried out to determine the prevalence of haemoparasites in rodents from selected areas of Tanzania. Morogoro region presented a wider range of species, apparently because trapping was done over a longer period (more than one year). Some rodent species were more predominant in certain regions than others. A good example was *Arvicanthis* spp., which occured more in Dodoma region. Most of the *R. rattus* were trapped in houses, while *R. norvegicus* were trapped in sewage systems in Morogoro urban only. *Mastomys natalensis* were captured in fallow land and cultivated fields, while *Crocidura* spp. and *Dasymys* spp. were captured mostly in swampy areas. Most of *Tatera* spp. and *Arvicanthis* spp. were trapped in fallow lands. This variation of species by season and location has been also reported elsewhere (Juh *et al*., 2003; Makundi *et al*., 2005).

Wild and domestic rodents and shrews are known to carry various pathogens which can be transmitted to humans. This study has demonstrated the presence of trypanosomes in the blood smears of rodents and shrews, with *R. rattus* accounting for the majority of positive cases. Based on these findings, it was established that the burden of typanosomal infection differed among the rodent species trapped in different localities and at different times of the year. It was further observed that all the *R. rattus* trapped in the same house were infected with trypanosomes. This observation suggests that there could be vectors (e.g flea, lice), which transmit trypanosomes from one rodent to another. High temperatures (22 to 26°C) and humid conditions favour rapid multiplication of fleas, which are potential carriers of pathogens, thus increasing their

abundance on the host and the chances of infection (Juh *et al*., 2003; Korbawiak *et al*., 2005; Makundi *et al*., 2005; Powelczyk *et al*., 2004). It has been reported that *Trypanosma lewisi* is a common blood parasite of the small mammals; however, the pathogenic potential of this protozoa has not been established (Silayo, 1992). The presence of the trypanosomes in the blood of a large number of *R. rattus* raises a public health question whether this commensal rat could be a potential reservoir and vector of human or animal pathogenic trypanosomes such as *T. rhodesiense* or others (Silayo, 1992; Begon, 2003; Juh *et al*., 2003). The trypanosomes were, however, not further characterized to determine their species or pathogenic significance in infected animals.

Our study has also revealed a spirochaetemia in *M. natalensis*, *R. rattus*, *A. niloticus* and *Crocidura* spp., captured in Morogoro and Dodoma. The presence of the spirochetes supports previous reports on the potential role of the rodents as reservoirs of *Borrelia* spp. and *Leptospira* spp. (Norman, 1977; Machang'u *et al*., 2004). Spirochetes have been detected in a tick parasite (*Ixodes persulcatus)* and in its wild rodent hosts in Russia (Sato *et al*., 1995).

Furthermore, bacillary/cocobacillary were also encountered though at lower frequencies. No bacillary organisms were detected in the samples collected from Chunya and Moshi districts, however, this finding cannot be considered conclusive due to the small sample size of rodents studied. The presence of the bacillary organisms in rodent blood smears was not totally unexpected since rodents are known to be carriers of various bacteria in their blood, including the agent of plague *Yersinia pestis* (Kilonzo, 1997). In plague endemic areas the presence of coccobacillary organisms in the blood of commensal rodents can be a cause of concern.

The public health significance of this study is notable from the fact that haemoparasites that were demonstrated in apparently healthy rodents are potential human pathogens. Therefore, rat consumers could be at risk of infection with rodent borne-diseases. It is recommended that further studies be carried out to characterize the rodent haemoparasites and establish the potential role of the diverse species of rodents and shrews in disease transmission.

AKNOWLEDGEMENTS

We would like to thank Evi Paemelaere and Nele Willekens from the University of Antwep, Belgium for their technical support. This work was supported by the European Union project RATZOOMAN.

REFERENCES

Begon M. Disease: Health effects on humans, population effects on rodents. In rats, mice and people: Rodent biology and management. Grant RS, Lyn, AH, Charles JK and Dave, MS. (Eds.) Australian Centre for International Agricultural Research Canberra pp 13-19, 2003.

Buckle AP, Smith RH. Rodent Pest and their Control. 1st Ed., CAB, Int.Wallingford, Oxon: CAB International, 1994.

Daniel E, Beyene H, Tessema T. Relapsing fever in children: Demographic, social and clinical features. *Ethiop Med J* 30: 207-214, 1992.

Faine S, Adler B, Bolin C, Perolat P. *Leptospira* and Leptospirosis. 2nd Ed. MediSci, Melbourne, Australia, 1999.

Juha L, Jukka TL, Haingotiana R, Patricia, CW. *Trypanosome* parasites in the invading R. rattus and endemic rodents in Madagascar. Grant, R.S, Lyn, A.H, Charles, J.K and Dave, M.S. (Eds.) pp 37-39, 2003.

Kilonzo BS. A survey of rodents and their flea ectoparasites in North Eastern Tanzania. *East Afr Med J* 3: 117-126, 1976.

Kilonzo BS. Plague epidemiology and control in Eastern and Southern Africa during the

period of 1978 to 1997. *Central Afr J Med* 45 (3): 70 – 76, 1997.

Korbawiak G, Rychlik L, Norwakowsk W, Wita, I. Natural infestation of small mammals with blood parasites on the borderland of boreal and temperate forest zones. *Acta Theriolog* 50: 31 – 42, 2005.

Machang'u RS, Mgode G, Mpanduji D. Leptospirosis in animals and humans in selected areas of Tanzania. *Belg J Zool* 127: 97-104, 1997.

Machang'u R, Mgode G., Asenga J, Mhamphi G, Hartskeerl R, Goris, M, Cox C, Weetjens B, Verhagen R. Serological and molecular characterization of leptospira serovar Kenya from captive African giant pouched rats, Cricetomys gambianus : In Rats Mice and People. Rodent Biology and Management. R. Singleton, L. Hinds, C.J.Krebs and M.D. Spratt. (Eds) CSIRO Canberra, 2004

Maeda-Machang'u AD. The role of rodents in the ecology and epidemiology of viral and rickettsial diseases of livestock and humans. Proceedings of International Workshop on the economic Importance and Control of Rodent in Tanzania. Morogoro Tanzania July 6th to 8th 1992; 67-75, 1992.

Makundi RH, Oguge NO, Luwanyabe, OS. Rodend Pest Management in East Africa – Ecological Approach. In SingletonG, Hind L, Leirs H and Zheng Z (Eds). Ecologically Based Rodent Management. ACIAR Monograph No 59 Canbera Australia pp. 460 – 476, 1999.

Makundi RH, Mbise TJ, Kilonzo BS. Observations on the role of rodents in crop losses in Tanzania and control strategies. *Beitr Trop Landwirtsch Vet Med* 29: 465-474, 1991.

Makundi RH, Massawe AW, Mulungu LS. Rodent populations in three ecologically heterogenous locations in northeast, central and South – west Tanzania. *Belg J Zoolog* 135: 159 – 165, 2005.

Norman GG. The burden of rodent-borne diseases in Africa south of Sahara. *Belg J Zool* 127: 71-84, 1977.

Powelczyk A, Bejer A, Behnke JM, Gilbert FS, Sinski E. Factors affecting the component community structure of haemoparasites in common voles (Microtus arvalie) from the Mazury lake District region of Poland. *Parasitol Res J* 92(4): 270 – 284, 2004.

Sato YK, Miyamoto A, Iwaki T, Masuzawa Y, Yanagihara EI, Korenberg NB, Gorelova V, Volkov VI, Liberova RN. Prevalence of Lyme disease spirochetes in Ixodes persulcatus and wild rodents in far Eastern Russia. *Appl Environ Microbiol* 62: 3887-3889, 1995.

Silayo RS. Rodent and protozoan parasites of veterinary and medical importance. Proceedings of International Workshop on the economic Importance and Control of Rodents in Tanzania. Morogoro Tanzania July 6th to 8th 1992: 76-79, 1992.