Sci Parasitol 11(4):171-178, December 2010
ISSN 1582-1366

ORIGINAL RESEARCH ARTICLE

Prevalence of endoparasites in cattle within urban and peri-urban areas of Lake Victoria Basin, Kenya with special reference to zoonotic potential

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Abstract. The growing human population and the tendency to keep livestock in urban settlements in developing countries in particular has caused concern due to the unplanned nature of such developments and the constraints they cause. A study was carried in six sites within Kisumu urban and peri-urban areas, focused on the cattle endoparasites. Feces were sampled from three different age groups for determination of the prevalence and infection levels of various helminths and protozoans, with focus on those with zoonotic potential. Associations and correlations between different variables were determined using computer software. The prevalence of various parasite types was 51% strongyles, 2% *Strongyloides papillosus*, 2% *Toxocara vitulorum*, 2% *Trichuris* spp. Others were *Fasciola* 64.2%; *Paramphistomum* 31.3%, *Moniezia* spp (16%) and *Entamoeba* 83%; *Eimeria* spp. 30%; *Giardia* spp. 14% and *Balantidium coli* 6.6%. The correlations in prevalence and intensity between age, breed, different parasite types and area of origin are discussed. Strongyles were the most common nematodes especially among the under-one-year olds. Trematodes were significantly more frequent and intense in young stock and adults compared to the calves. Majority of cattle had 2 to 3 parasite types while very few had none, single or multiple infections involving 4 parasite types. The zoonotic potential for these parasites is discussed in relation to the possible human infections.

Keywords: Cattle; Endo-Parasites; Zoonosis; Urban; Peri-urban; Lake Victoria Basin.

Received 30/09/2010. Accepted 29/11/2010.

Introduction

Urban and peri-urban livestock keeping is a socio-economic and livelihood enhancing strategy in urban centers around the Lake Victoria (Ishagi, et al., 2002; Mireri et al., 2007). In Kisumu municipality, livestock keeping is common in the open spaces which include road sides, dump sites with solid waste and unconstructed lands (Kagira and Kanyari, 2008). The farmers in the municipality are faced with many production constraints, chief among them being livestock diseases. A preliminary questionnaire survey showed that diarrhea and helminthiasis were perceived by urban and peri-urban farmers in Kisumu to be highly prevalent in the cattle (Kagira and Kanyari, 2008). The two conditions could be related since the gastrointestinal nematodes are known to cause gastroenteritis leading to diarrhea. In the municipality, flooding from local rivers, which occurs during the two rainy seasons, often leads to creation of wetlands such as swamps and these can support life cycle stages and vectors of different livestock parasites.

Parasitic diseases constitute a major threat to livestock production in sub-Saharan Africa owing to the direct and indirect losses (Kagira and Kanyari, 2001). It has been estimated that in Kenya, returns could be increased by as much as 470% by controlling haemonchosis (Mukhebi et al., 1985), while fasciolosis leads to losses estimated at £7 million annually, through a combination of poor productivity, death of stock, condemnation of infected livers and reduction in carcass quality (Harrison et al., 1996; Kithuka et al., 2002). However, these are conservative estimates since there are only a few studies on the epidemiology and economic impact of these trematodes in Kenya and other sub-Saharan African countries. The occurrence of risk factors for zoonoses due to livestock keeping in the African towns has been highlighted in recent studies (Kang'ethe et al., 2007; Omudu and Amuta, 2007). In Kisumu, a recent questionnaire survey showed the presence of risk factors such as grazing of cattle in areas with poor sanitation and disposal of manure in areas inhabited by people (Kagira and Kanyari, 2008). The possibility of maintenance and transmission of zoonotic parasites between humans and livestock in the municipality could be real.

The current study aimed at determining the prevalence of endoparasites among cattle that adversely affect the livestock productivity and with zoonotic potential.

Materials and methods

Study area

Kisumu, the third largest city in Kenya, is a commercial and industrial centre for the Lake Victoria Basin. Currently the population is estimated at 500,000 with a growth rate of 2.8% per annum. About 60% of the resident population of the municipality is involved in some form of urban agriculture and livestock keeping, since 80% of Kisumu's municipal land area is rural in nature (Mireri et al., 2007).

Selection of study sites and farms

The study sites and farms were purposively selected in collaboration with the government extension and administration officers on the basis of a higher concentration of livestock keeping. These sites are shown in figure 1 and included: Nyamasaria, Nyalenda, Obunga, Manyatta, Mamboleo and Kolando, located in Chiga, Nyalenda, Kanyakwar, Manyatta and Korando sub-locations respectively. Nyalenda, Obunga and Manyatta sites were within the urban areas while Nyamasaria, Mamboleo and Kolando were in the peri-urban area of Kisumu municipality. Nyalenda and Obunga were highly populated and are mainly regarded as slums (UNDP, 1996). In each study site, the farmers were randomly selected from a list prepared from the previous vaccination campaigns by the veterinary office in Kisumu.

Sampling and analysis

The animals included in the study were only those not de-wormed within three months previously. From each farmer, a maximum number of three animals were sampled to allow for an almost equal distribution of sampled subjects. The sampled cattle were stratified by sex and age so that those up to one year were classified as calves, over one year up to three were categorized as young stock and those older than three years categorized as adults.

Fecal samples were collected per-rectum using plastic gloves, put into fecal pots, labeled and kept cool before transportation to the laboratory.

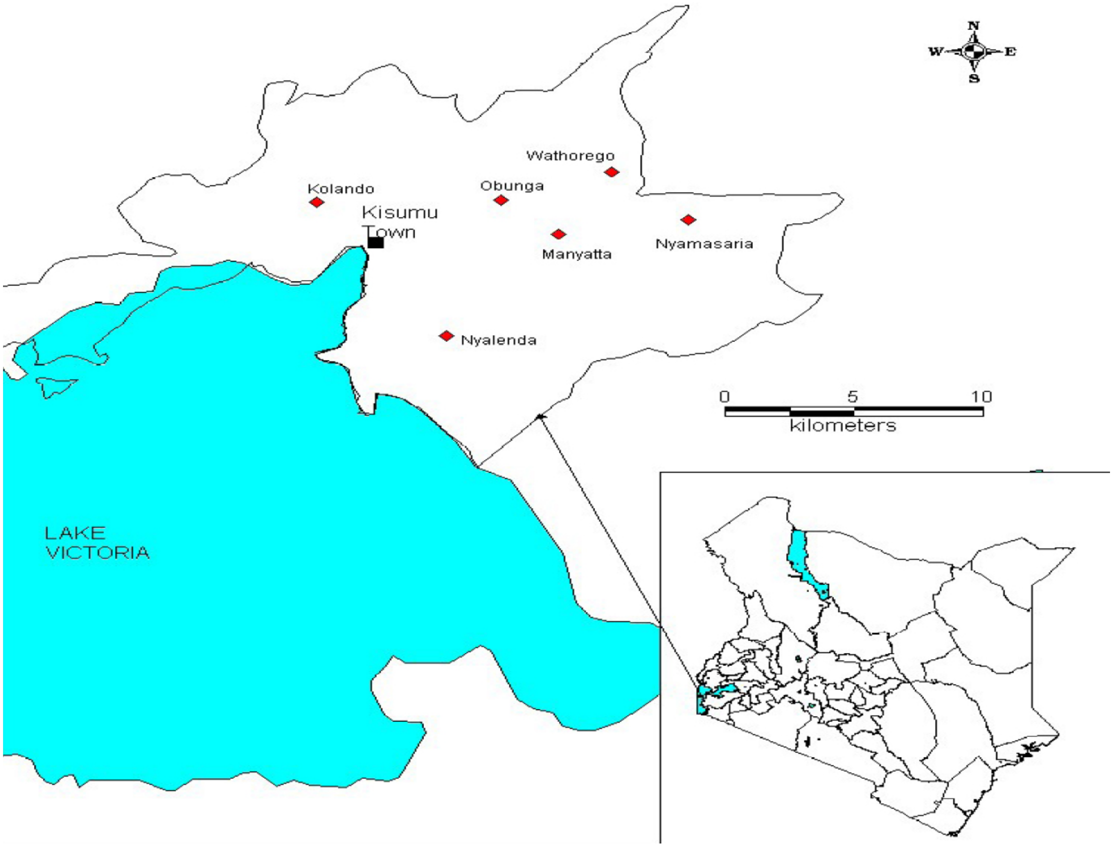

Figure 1. Location of the study sites randomly selected within Kisumu Municipality and the Peri-urban area

Feces were quantitatively analyzed to determine the nematode eggs per gram (EPG) and the coccidian oocysts (OPG) using a modified McMaster technique (MAFF, 1986). Fecal smears were also made on glass slides and examined for the presence of moving trophozoites and cysts of protozoan parasites. Fecal samples were also examined for the trematode eggs using the sedimentation technique (MAFF, 1986). Morphological and color differences were used to distinguish between *Fasciola* and *Paramphistomum* eggs.

Data analysis

Data was entered into Ms Excel®, 2003 (Microsoft Corporation, USA) and analysis was conducted using Ms Statview® (SAS Institute Inc, 1995-1998, Cary, NC, USA). Descriptive statistics were calculated and presented as tables and graphs. The prevalence (p) of cattle harboring each parasite was calculated as $p=d/n$, where d is the number of cattle diagnosed as having a given parasite at that point in time and n=number of cattle at risk (examined) at that point in time. The association between independent factors (age, sex, body condition and area of origin) and continuous dependent variables (EPG, OPG and trematode intensity) was calculated using one way analysis of variance (ANOVA). The intensity of infection was measured as EPG/OPG and, for trematodes, +1=1 egg per field; +2(2-5), +3(6-10), and +4(>10/field). These observations were made at microscope objective 10x. The association between the independent factors and the prevalence of the various parasites was evaluated using Chi-square statistic (χ^2). The correlation between the occurrence and intensity of the parasites was undertaken using the Pearson partial correlation (rho, r). In all the analysis, confidence level was held at 95%, and $p<0.05$ was set for significance.

Results

Characteristics of sampled animals

A total of 364 cattle were sampled and were mainly kept for generation of income (97%) and domestic consumption (59%). Ninety eight percent (98%) of the cattle were indigenous, while the 2% were Friesian and Aryshire breeds. All the livestock, apart from exotic breeds, were grazed in the open spaces, along the roads and solid waste dump sites in the municipality. The few exotic breeds were kept in zero-grazing units.

Helminths

In order of importance, the nematode parasites observed in cattle as seen from table 1 were strongyles (51%), *Strongyloides papillosus* (2%), *Toxocara vitulorum* (2%) and *Trichuris* spp. (2%). Of the animals infected with strongyles, 36% had light infection while only 15% had EPG of more than 500 (figure 2).

Table 1. The prevalence and intensity of parasites in cattle feces in Kisumu municipality

Parasite Type	N	Positive (%)	EPG/OPG Intensity		
			Mean	SE	Range
Strongyles	349	51	296	37.3	0-8300
S. papillosus	349	2	19	12.4	0-3600
T. vitulorum	349	2	2	0.6	0-100
Trichuris spp.	349	2	4	1.8	0-400
Any nematode	349	51	306	37.5	0-8300
Monieza spp.	349	16	114	20.4	0-2600
Fasciola spp.	344	64	-	-	0 - +4
Paramphistomum spp.	344	33	-	-	0 - +4
Eimeria spp.	349	30	124	17.5	0-3000
Entamoeba spp.	364	83	-	-	-
B. coli	364	7	-	-	-
Giardia spp.	364	14	-	-	-

The trematodes observed were *Fasciola* and *Paramphistomum* spp., with a prevalence of 64.2% and 31.3%, respectively. The prevalence of cattle excreting any species of trematodes was 75%. The percentage of animals with +1, +2, +3 and +4 intensities of *Fasciola* infection were 33%, 14%, 16%, and 1% respectively. For *Paramphistomum*, the proportion of animals with +1, +2, +3 and +4 intensities were 15%, 8%, 8% and 1% respectively. The only cestode observed in the cattle was *Moniezia* species with a prevalence of 16% of which 9% had light infections (figure 2). The gastrointestinal protozoan parasites observed in the study included *Entamoeba* spp., *Eimeria* spp., *Giardia* spp., and *Balantidium coli* with a prevalence of 83%, 30%, 14% and 6.6%. Majority of cattle had light infection with coccidian parasites (figure 2).

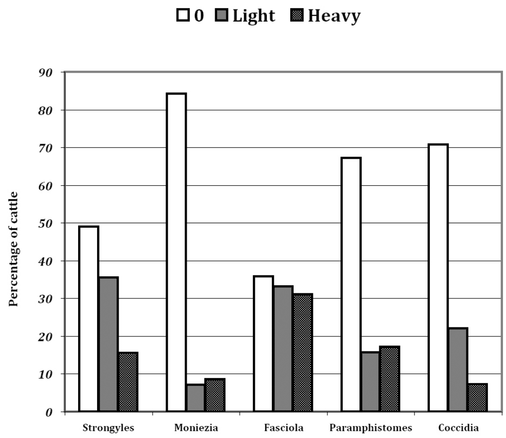

Figure 2. Intensity of shedding various parasite eggs/oocysts in cattle

Number of parasites and correlations

The animals were grouped according to the type of parasites they were shedding (nematodes, cestodes, trematodes, and protozoa). Most cattle were excreting two or three parasites types at the time of sampling (figure 3). Very few animals excreted 4 parasite types.

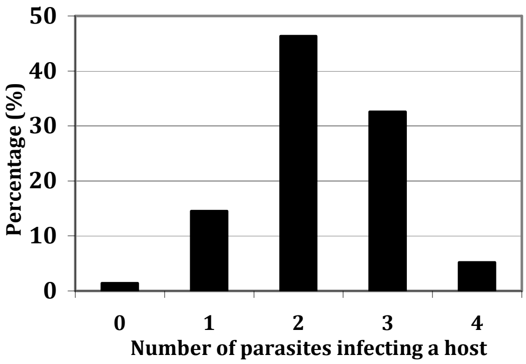

Figure 3. Percentage of cattle shedding a given number of endoparasites in feces

There were significant associations between strongyle EPG and prevalence of paramphistomes (r=0.104, p=0.05); prevalence of strongyle and prevalence of coccidia (r=0.108, p=0.05). Other significant associations were between prevalence of *Moniezia* and prevalence of paramphistomes (r=0.112, p=0.04), coccidia (r=0.131, p=0.02), and *Giardia*, (r=-0.095, p=0.08). The prevalence of *Fasciola* was significantly associated with prevalence of paramphistomes (r=0.147, p=0.008) and *Giardia* spp. (r=-0.111, p=0.044). For coccidia, significant associations observed were between coccidia OPG and prevalence of *Giardia* spp. (r=-0.114, p=0.039), coccidia intensity and *Giardia* spp. (r=-0.108, p=0.05), coccidia prevalence and *Giardia* (r=-0.144, p=0.0093). The prevalence of *B. coli* was significantly associated with that of *Giardia* (r=0.140, p=0.01).

Association between host/environmental factors and occurrence of the parasites

Gastrointestinal nematodes: The under-one-year-olds (calves) had significantly higher prevalence (χ^2=8.84, p=0.0002), mean EPG (F=5.4, p=0.0047) and level of intensity (χ^2=11.2, p<0.0001) than young stock and adults. There was no significant (p>0.05) difference between the prevalence, mean EPG and level of intensity of strongyles between adults and young stock. Age was not significantly associated with measured parameters in case of *Trichuris* spp. and *Strongyloides* spp. However, calves had significantly (χ^2=5.7, P=0.004) higher prevalence of *T. vitulorum* than either adults or young stock. Male cattle had significantly higher strongyle intensity (χ^2=13.6, p=0.0002), prevalence (χ^2=8, p=0.005) and mean EPG (F=3.7, p=0.04) than female ones. Indigenous cattle had higher prevalence (χ^2=4.1, p=0.04) and mean EPG (F=3.2, P=0.076) than exotic ones. Cattle with good body condition had lower prevalence (χ=5.8, p=0.02), mean EPG (χ=4.7, p=0.01) and level of intensity (χ=12.7, p=0.0004) of strongyles. Area of origin was significantly associated with strongyle intensity levels (F=2.97, p=0.01), but not with strongyles prevalence (F=0.57, p=0.72) and mean EPG (F=1.86, p=0.1).

Cestodes: The highest mean EPG and prevalence of *Moniezia* spp. were recorded in calves and adults, respectively. However, comparisons across groups for these variables were not significant (p>0.05). The local breeds of cattle had higher prevalence and mean EPG of *Moniezia* than the exotic breeds, although the differences were not significant (p>0.05). Male animals had a higher prevalence (χ^2=0.308, p=0.58) and mean EPG (F=0.79, p=0.38) than females. Animals with poor body condition had higher prevalence (χ=2.3, p=0.13) and mean EPG (F=6.3, p=0.01) of *Moniezia* spp. than those with good body conditions. Cattle from Wathirigo had highest mean EPG and prevalence of *Moniezia* spp. than all the other areas, and statistically, the area of origin was significantly (p<0.0001) associated with both the mean EPG and prevalence of *Moniezia* spp.

Trematodes: In descending order, the prevalence and intensity of *Fasciola* spp and paramphistomes was highest in adults, young stock and calves. Age was significantly associated with prevalence (χ=10.4, p=0.005) and intensity (χ=6.5, p=0.04) of *Fasciola* eggs. Calves had significantly (p<0.05) lower prevalence of *Fasciola* than young stock and adults while for intensity, only among adults and calves were levels significantly different (p=0.01). Age was significantly (χ=23.9, p<0.0001) associated with paramphistomes prevalence, each age group of cattle being significantly (p<0.05) different from each other. Similarly, age was significantly (χ=14.3, p=0.0008) associated with intensity of paramphistomes, with adults being significantly higher than calves (p=0.0004) and young stock (p=0.02). The intensities in latter two groups (calves and young stock were not significantly different (p=0.15). Local breed of cattle had higher burdens of the both *Fasciola* and *Paramphistomum*. Breed was not significantly (p<0.05) associated with the measured variables of *Fasciola*. However, significantly higher prevalence (χ=14.2, p=0.0002) and intensity (χ=6.1, p=0.01) of paramphistomes were observed in the indigenous cattle than exotic ones. Female animals had higher prevalence, mean EPG and intensities of the trematodes than male animals, but the differences were not significant (p>0.05). Body condition was significantly associated with prevalence of *Fasciola* (χ=3.4, p=0.04) and any trematode (χ=7.3, p=0.007), but was not associated (p>0.05) with the other measured variables. *Fasciola* intensity was significantly (F=8.5, p<0.0001) associated with area of origin being highest in Nyalenda and lowest Nyamasaria. In descending order, prevalence of paramphistomes was highest in Wathirigo (52.8%), Nyamasaria (47.4%), Manyatta (39.1%), Nyalenda (35.7%), Kolando (5.4%) and Obunga (9.1%). Area of origin was significantly associated with prevalence (F=8.8, p<0.0001) and intensity (F=3.5, p=0.004) of paramphistomes.

Protozoa: The mean EPG of coccidia was significantly (p=0.03) higher in calves than young stock. Age of cattle was not significantly associated with prevalence (χ=3.1, P=0.2). Exotic animals and those with poor body condition had higher coccidia burdens than animals which were indigenous or in good body condition respectively. Age, breed, sex and body condition of cattle was not significantly (p>0.05) associated with prevalence of *Entamoeba* spp., *B. coli* and *Giardia* spp. Area of origin was significantly associated with prevalence of *Entamoeba* (F=4.3, p=0.0008) and *Giardia* (F=7.45, p<0.0001) but not (p>0.05) prevalence of *B. coli.*

Discussion

This is the first report on the parasite infestations among cattle kept in the urban/peri-urban environment of the Lakeside town of Kisumu. In this study Strongyles were reflected as the most important nematodes among the sampled cattle, a feature which has been reported in other studies in other parts of Kenya (Gatongi et al., 1987; Waruiru et al., 2000). The strongyles are known to depress growth rates in cattle when burdens are sufficiently high. It is clear that a substantial number of cattle had moderate to high nematode loads.

The trematodes observed in the livestock were *Fasciola* and *Paramphistomum* spp but not *Schistosoma* spp. Majority of the animals had light to heavy infections. Fasciolosis and paramphistomosis are two important parasitic diseases in farmed livestock all over the world where they cause huge losses to production (Wamae et al., 1998; Mage et al., 2002). Indeed, high prevalence of these two parasitic diseases has been observed in livestock from Kenya and Tanzania (Waruiru et al., 2000; Keyyu et al., 2005). The environment around Kisumu has plenty of water marshes which favor the presence of the water snails, the intermediate hosts for these trematodes. Human fasciolosis has been reported from different parts of the world (Torresi et al., 1996; O'Neill et al., 1998; Hughes et al., 2003). Infections are thought to be acquired from ingestion of infective metacercariae encysted on water growing plants such as watercress (Hughes et al., 2003). In Kisumu, there is a variety of water growing edible greens and the possibility of human infections requires investigation especially considering that, sanitation in many parts of this Lakeside urban center is poor and drinking water at times subject to contamination by feces of animal origin including bovines. Though Schistosome eggs were not encountered, medical records show bilharziasis as prevalent and hence cattle could be the reservoirs of these zoonotic trematodes.

The only cestode observed in the cattle was *Moniezia*. The occurrence of this parasite elsewhere in tropics and Kenya in particular has been described. However, the economic and pathogenic significance of the parasite is not well understood.

High prevalence of coccidiosis has been reported in Kenyan livestock possibly due to the favorable climate in terms of moisture and warmth (Kanyari, 1993; Waruiru et al., 2000). Although, the parasites were not further characterized to the species, some *Eimeria* species such as *E. bovis* and *E. zuernii* are known to be most pathogenic, being associated with acute and chronic disease.

Other protozoan parasites observed in the study included *Entamoeba* spp., *Balantidium coli* and *Giardia* spp. The prevalence of *Entamoeba* was high (77-87%). For *B. coli* trophozoites prevalence was between 2 and 6%. All the three parasites have both pathogenic and zoonotic importance. It would be important to further characterize *Entamoeba* spp. since *E. histolytica* is known to be pathogenic to human. In recent years, the zoonotic importance of *B. coli* and *Giardia* spp. has been noted (Thompson, 2000; 2004). These parasites are potential pathogens especially to immunocompromised humans particularly those suffering from HIV/AIDS. In Kisumu, the prevalence of HIV/AIDS is relatively high and it would therefore be important to determine the prevalence of these parasites in humans and their origin.

For a rational and sustainable helminth control program, comprehensive knowledge on the epidemiology of parasites, and how they relate with a given climate and management is a pre-requisite. It would be important to determine the relationship between the occurrence of the parasite and environmental factors.

Acknowledgement

The authors are very grateful to VicRes for financially supporting the project and to both the University of Nairobi and Kenya Agricultural Research Institute for providing the laboratory facilities. The technical and logistical support given by the Laboratory staff at the University of Nairobi and the field staff at the Kisumu Veterinary office is highly appreciated.

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