# A survey of gastrointestinal helminths in Baboons *(Papio Cynocephalus)* and warthogs (*Phacochoerus africanus)* at Saadani National Park, Bagamoyo, Tanzania

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## SUMMARY

A cross-sectional study was conducted in August and September 2013 to establish the status of gastrointestinal helminths affecting yellow baboons and warthogs at Saadani National Park (SANAPA). Baboon (n=48) and warthog (n=30) freshly defecated faeces were opportunistically collected from the ground and examined for helminth eggs using wet smear preparation and McMaster counting techniques. All 48 yellow baboon faecal samples had different species of helminths namely *Oesophagostomum* (100.0%), *Strongyloides* (72.9%), *Trichuris* (58.3%), *Physaloptera* (54.2%) and *Trichostrongylus* (52.1%). Twenty nine percent of some helminth eggs observed were not identified. Up to 75% of the baboon samples had more than one species of helminth eggs. The mean±SDev helminth egg counts in yellow baboon samples was 1213.5 ± 1038.8 eggs per gram (EPG) with *Oesophagostomum* spp. having the highest mean±SDev egg count (509.4 ± 665 EPG) compared to the rest. In warthogs, 19 out of 30 (63.3%) faecal samples had helminth eggs. The species identified were *Strongyloides* (63.3%), *Oesophagostomum* (16.7%) and *Trichostrongylus* (10.0%). The observed high worm burden in yellow baboons and warthogs of SANAPA show that wild animals are the resevoirs of gastrointestinal parasites and could serve as potential sources of infections to domestic animals and humans.

**Keywords:** gastrointestinal helminths, baboons, EPG, warthogs, Saadani

## INTRODUCTION

Yellow baboons *(Papio cynocephalus)* and warthogs (*Phacochoerus africanus)* are among the common wild animals found in the Tanzanian National parks and other reserved areas. These animals are both monogastrics and have more less similar digestive systems which may also have similar types of gastrointestinal parasites. Under normal circumstances, helminths are the most common parasites that are known to affect the gastrointestinal tract of many animals including wild animals (Soulsby, 1982; Aiello and Mays, 1998). These parasites are normally aquired through ingestion of contaminated food or through direct skin penetration. In domestic animals, helminth infestation could sometimes cause high morbidity and mortality rates and compromise the production and reproduction performance of affected animals. In domestic pigs for example, gastrointestinal parasites cause loss of appetite, poor growth rate, poor feed conversion efficiency and potentiation of other pathogens or even death (Stewart and Hoyt, 2006). A different picture is seen in wild animals which could be infested with heavy worm burden but they don’t show clinical signs although they could still shed the helminth eggs and contaminate their environment continuously. Nevertheless, parasites in wild animals may contribute to mortality in malnourished hosts, exacerbate the effects of food shortage or indirectly, affect host survival by increasing the susceptibility of the infected host to predation or by reducing the competitive fitness of the infected host (Scott, 1988; Gulland, 1992). Indeed, under zoo environment, heavy infestation with gastrointestinal helminths may equally cause clinical effects and sometimes deaths of affected wild animals. Similarly, wild animals may suffer from clinical disease associated with heavy worm infection when they are stressed as with the case of starvation, prolonged drought, concurrent infections, overcrowding and other stress causing factors. For example, in 2013 an episode of mass mortality of Lesser flamingo (*Phoeniconaias minor* Geoffroy) at Lake Natron, Tanzania established that all the 120 carcasses examined had their gastrointestinal track heavily packed with helminths of different species (Dr. Ernest E. Mjingo, personal communication, 2013). The patterns of infestation with gastrointestinal parasites in wild animals could, thus, provide an excellent proxy for population health.

Yellow baboons are good at free ranging and easily get in contact with other wild animals, domestic animals and humans under different environment. This is the case with yellow baboons found at Saadani National Park (SANAPA). Studies show that different gastrointestinal parasites particularly helminths are known to affect baboons. The gastrointestinal helminths that commonly infest baboons are in the group of nematodes in particluar *Oesophagostomum* sp., *Trichostrongylus* spp., *Trichuris* sp., *Strongyloides* spp., *Ternidens* spp., *Abbreviata* spp., *Molineus* spp. *Trichuris* spp., *Schistosoma* spp. and *Physaloptera* spp. (Legesse and Erko, 2004; Weyher *et al.*, 2006; Bezjian *et al.*, 2008; Howells *et al.*, 2011). Other groups of helminthes that could affect baboons are *Ascaris* spp. and hookworms. Protozoan parasites are also reported to be among the common parasites of baboon which include *Cryptosporidium* spp., *Giardia* spp., *Eimeria* spp., *Entamoeba* spp. and *Balantidium* (Muriuki *et al.*, 1997; Hope *et al*., 2004; Munene *et al*., 1998; Kooriyama *et al.*, 2012). Similarly, warthogs are known to habour a different species of gastrointestinal parasites of different kinds. Horak *et al.* (1983) and Wyk and Boomker (2011) reported infestation of warthogs with *Oesophagostomum, Ascaris, Trichostrongylus, Probstmayria, Murshidia, Echinococcus granulosus, Cooperia, Impalaia, Murshidia, Physocephalus* and *Monezia*.

Sadaani National Park is similar to a conservation area since within the park there are several residential villages. People in these villages keep domestic animals which interact with wild animals in different ways including sharing grazing areas, sources of water and the general environment. Free ranging yellow baboons and warthogs are always seen around the villages where they feed on garbage together with domestic animals. In this way different diseases that are in wild animals may crossover to domestic animals and humans and *vice versa*. Indeed, a study by Muriuki *et al.* (1998) in Kenya and Legesse and Erko (2004) in Ethiopia established that most of the parasites observed in non-human primates could infect human (zoonotic parasites) and others had a potential of infecting domestic animals. Similarly in warthogs, all the parasites identified in South African warthogs (*Phacochoerus aethiopicus*) and bushpigs (*Potamochoerus porcus*) were potentially infective to domestic animals and some were zoonotic (Conradie, 2008; Wyk and Boomker, 2011). None of such surveys have been conducted in Tanzanian National Parks like Saadani with high humans, domestic animals and wildlife interactions. The purpose of this study was to establish the baseline information on the status of gastrointestinal helminths in yellow baboons and warthogs that scavenge freely in human and domestic animal environments at SANAPA. The non-invasive faecal sampling used in this study enabled to examine changes in host–parasite ecology and transmission dynamics that can serve as a proxy for population and ecosystem health.

## MATERIALS AND METHODS

### Study area

The study was conducted in August and September 2013 at SANAPA. The park is located at the centre of the historic triangle of Bagamoyo, Pangani and Zanzibar. Saadani National Park covers an area of 1100 $km^2$ and is the only wildlife sanctuary in Tanzania bordering the Indian ocean. The climate is coastal, hot and humid. About 30 species of larger mammals are present as well as numerous reptiles and birds.

### Sample collection and handling

With the aid of tour guide at selected areas of SANAPA where baboons prefer, freshly voided faeces samples were opportunistically collected by using gloved hands, placed into plastic sample bottle and labelled accordingly. During collection of samples from baboons much care was taken to pick only distinct droppings so that each dropping would represent a single baboon. Where possible, groups of baboons were being followed for possibilities of getting as much fresh faecal materials as possible. A similar approach was also used for warthogs. The whole sampling exercise was done for two months (August and September, 2013). A total of 48 and 30 faecal samples of baboons and warthogs respectively were collected. The collected samples were stored under refrigeration at 4°C so as to prevent hatching of eggs before transport them to the laboratory within 5 days of sampling. Parasite analysis in the samples was done at Veterinary Parasitology laboratory, Sokoine University of Agriculture, Morogoro.

### Laboratory sample analysis

### Qualitative sample analysis

Qualitative analysis of helminth eggs was done as described by Hansen and Perry (1990). Briefly three grams of intestinal contents were mixed with floatation fluid (super saturated salt solution), shaken thoroughly and filtered into a test tube. The solution was filled into the test tube to the top and covered with glass cover slip and left to stand for 20 minutes. Thereafter the cover slip was carefully lifted off from the test tube and placed on the microscope slide. Presence of parasites (helminth eggs) was examined using a 10× eyepiece and a 4× objective (40× total magnification) on a light microscope. Helminth eggs were identified by using standard identification keys based on their morphological features (Soulsby, 1982).

### Quantitative faecal sample analysis

Quantitative analysis of helminth eggs in faecal samples was done only for yellow baboons and the method used was as described by Hansen and Perry (1990). Quantification of helminth eggs in intestinal content samples was done by use of McMaster counting technique. Briefly, 4 g of intestinal content sample was placed into a tube containing 56 ml of flotation fluid and stirred thoroughly. The intestinal content suspension was filtered through a tea strainer into a second tube. A filtered sample was taken using a Pasteur pipette and filled into a McMaster counting chamber and left to stand for five minutes. The sample was examined under a microscope at 10 x 10 magnification and all the eggs of different species were separately counted in the graved area of both chambers. The same was done for coccidia oocysts. Thereafter, the egg per gram (EPG) of intestinal content was calculated by adding the counts of both chambers and multiplied by 50. The guideline to interpretation of intestinal content egg in samples adopted that of sheep as described by Hansen and Perry (1990) with some modifications. Helminth count of <100 EPG was grouped as low levels of infection while >300 EPG was grouped as significant high levels.

## RESULTS

### Qualitative detection of helminth eggs in faecal samples

The results show that all the 48 yellow baboons sampled were infected with different species of helminths. The details of different helminth species identified and their prevalence are shown in Table 1. The yellow baboon faecal samples had five different species of helminth eggs namely *Oesophagostomum* spp., *Strongyloides* spp., *Trichuris* spp., *Physaloptera* spp. and *Trichostrongylus* spp.

A total of 14 (29.2%) helminth eggs were not identified. The common species of helminths was *Oesophagostum* which was identified in samples followed by *Strongyloides* (72.9%). Seventy five percent of the yellow baboon samples had more than one species of helminth eggs. In warthogs, 19 out of 30 (63.3%) faecal samples had helminth eggs with 26.7% having mixed infections. The common helminth eggs identified in warthogs were *Strongyloides* spp. (63.3%). Other species identified included *Oesophagostomum* and *Trichostrongylus*.

### Quantitative results of helminth eggs in yellow baboon faecal samples

The quantities (EPG) of helminth eggs are shown in Table 2. The average egg count was 1213.5 ± 1038.8 (mean±SDev) EGP. *Oesophagostomum* spp. had the highest mean egg count (509.4 ± 665) compared to the rest of the helminth species identified.

**Table 1.** Percentage of infection by different helminth species in yellow baboons and warthogs

| Helminth species | Number (%) of yellow baboon infected (n=48) | Number (%) of infected warthogs (n=30) |
|---|---|---|
| *Oesophagostomum* spp. | 48 (100.0) | 5 (16.7) |
| *Strongyloides* spp. | 35 (72.9) | 0 (0.0) |
| *Trichuris* spp. | 28 (58.3) | 0 (0.0) |
| *Physaloptera* spp. | 26 (54.2) | 19 (63.3) |
| *Trichostrongylus* spp. | 25 (52.1) | 3 (10.0) |
| Unidentified helminth eggs | 14 (29.2) | 0 (0.0) |

**Table 2.** The mean egg counts of different helminth species in yellow baboons

| Helminth species | Mean±SDev EPG/OPG | Range |
|---|---|---|
| *Oesophagostomum* spp. | 509.4 ± 665 | 50 - 3500 |
| *Strongyloides* spp. | 370.5 ± 273.6 | 50 - 1000 |
| *Trichuris* spp. | 278.8 ± 244 | 50 - 900 |
| *Physaloptera* spp. | 251.9 ± 279.4 | 50 - 1500 |
| *Trichostrongylus* spp. | 208.0 ± 204.5 | 50 - 900 |
| Unidentified helminth eggs | 121.4 ± 91.4 | 50 - 300 |

## DISCUSSION

This study was conducted to establish the status of gastrointestinal helminth infestation in yellow baboons and warthogs that scavenge freely in human and domestic animal environments at SANAPA. The results showed that there is high prevalence of gastrointestinal helminths in yellow baboons and warthogs at SANAPA. Findings of this study concur with the previously published work in Tanzania, Kenya, Uganda, Ethiopia and South Africa (Muriuki *et al.*, 1998; Legesse and Erko, 2004; Conradie, 2008; Kooriyama *et al.*, 2012; Bezjian *et al.*, 2008). Indeed, all the 48 yellow baboons sampled were infected with different species of helminths while 63.3% of warthogs were infected mostly by *Strongyloides* spp. All the helminths had a potential of infecting domestic animals and some species like *Strongyloides*, *Trichuris* and *Trichostrongylus* are known to infect also humans. The significance of these results is based on the fact that the yellow baboons and warthogs interact with humans and domestic animals at SANAPA therefore, presence of parasitic helminths poses a high risk of infections.

Five different species of helminth had infected yellow baboon of SANAPA that included *Oesophagostomum*, *Strongyloides*, *Trichuris*, *Physaloptera* and *Trichostrongylus*. The presence of wide spectrum of gastrointestinal helminths at high prevalence is an indication that favourable environmental conditions for infection, survival and perpetuation exist in wildlife areas in Tanzania. The results of the current study are in agreement with the previously reported species of gastrointestinal helminthes of non human primates of Gombe and Mahale Forest National Parks in Tanzania (Murray *et al.*, 2000; Kooriyama *et al.*, 2012). Similarly Hahn *et al.* (2003) reported six gastrointestinal helminth species in free-ranging Kenyan baboons (*Papio cynocephalus* and *P. anubis*). Nevertheless, a study by Gillespie *et al.* (2004) in guenon (*Cercopithecus* spp.) reported more helminth species which involved not only nematodes but also cestodes and trematodes than the observed in the current study. Several other studies have investigated the gastrointestinal parasites of non-human primates and revealed similar helminth faunas that just differ in number of species indentified in different countries (Ocaido *et al.*, 2003; Weyher *et al.*, 2006). The differences in the prevalence and species may be due to the differences in climatic conditions, the methods used in helminths analysis, types of parasites circulating in the locality, seasonality and climatic conditions. However, small sample size precluded comparisons of helminth species prevalence.

*Oesophagostum* spp. was the most common in yellow baboon and it is a common parasite on many non-human primate as previously reported by Ocaido *et al*. (2003); Bezjian *et al*. (2008); Kooriyama *et al*. (2012). *Oesophagostomum* spp. are acquired by oral ingestion or skin penetration by infective larvae which cause pathological lesions especially in the lower intestinal tract. Severity of the *Oesophagostomum* infections occur during the wet season (Pettifer, 1984); however, in this study sampling was done during August & September which was a period of dry season as previously observed by Bezjian *et al*. (2008). This parasite may resist desiccation due to the lush habitat of some areas of SANAPA and the presence of the Wami River. It is also known that during the dry season, *Oesophagostomum* larvae can avoid adverse weather conditions by arresting their development (Pettifer, 1984). In addition, the differences in prevalence of *Oesophagostomum* among the non-human primates in different reports may be due to differences in diet and gut physiology.

*Strongyloides* infection was the second most prevalent (72.9%) in yellow baboon. Other studies observed also high *Strongyloides* infection rates to the extent of being regarded as among the common gastrointestinal parasites in non human primates (Ocaido *et al.*, 2003; Gillespie *et al.*, 2004; Howells *et al.*, 2011; Kooriyama *et al.*, 2012). Normally, *Strongyloides* infection is acquired through skin penetration by infective larvae. Yellow baboon of SANAPA being terrestrial primates may be more predisposed to *Strongyloides* infection through larvae skin penetration from the contaminated environment. Similar primates like chimpanzees, vervet monkeys, and yellow baboons in Mahale Mountains National Park, Tanzania and Kibale National Park in Uganda showed higher prevalence than red colobus which are arboreal primates (Bezjian *et al.*, 2008; Kooriyama *et al.*, 2012).

High mean±SDev egg count (1213.5 ± 1038.8 EPG) was recorded in yellow baboons. This signifies that baboons shed massive number of helminth eggs on the ground where livestock and wild herbivores graze. This keeps on contaminating the environment and other animals and humans may get infected through contaminated water sources or ingestion of contaminated food. Similar observations of high faecal parasite outputs have been reported by Weyher *et al*. (2006). Though the impacts of gastrointestinal parasite infections was not determined during the current study, it is obvious that heavy worm burden in animals has significant health effects like emaciation that exacerbate the effects of food shortage, indirectly affect host survival by increasing the susceptibility to predation or by reducing the competitive fitness of the infected host and sometimes helminths causing direct mortality (Scott, 1988; Gulland, 1992).

In warthogs, three species of helminths were identified being dominated by *Strongyloides* spp. (63.3%). Elsewhere, studies established higher prevalence and more species diversity of warthog gastrointestinal helminths than those observed in the current study (Conradie, 2008; Wyk and Boomker, 2011). In the report by Wyk and Boomker (2011) *Oesophagostomum* was the common gastrointestinal helminth of warthog in South Africa. Generally, the gastrointestinal parasites of warthogs in Africa are quite many but the differences in climatic conditions determines the species of helminths likely to be available. Other species identified in the current study included *Oesophagostomum* and *Trichostrongylus*. *Strongylodes* are also common gastrointestinal helminths of warthogs and has been reported in many previous studies (Horak *et al.*, 1988; Boomker *et al.*, 1991). Because *Strongyloides* has a direct life cycle, as well as an indirect life cycle, warthog infected with this parasite provide a threat to both human and animal communities they encounter.

The mere presence of helminth eggs does not necessarily indicate clinical disease. However, they do provide an indication of helminth species prevailing in free range yellow baboon and warthogs in Tanzania, an important step toward future research direction and programmes in gastrointestinal parasite in wild monogastric population. The fact that the baboons and the warthogs in the study areas use the same water sources as humans and range freely over human habitats make them potential source for human zoonotic parasitic infections. They also serve as transport hosts or reservoirs of infection to domestic animals. The findings of this study will be a road map for detailed epidemiological study and the role of yellow baboon and warthogs as reservoirs where wildlife, livestock and human interaction is high as with the case of SANAPA.

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