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Helminth Infections of Captive Animals and Management Practices at the University of Ilorin Zoo, North-Central, Nigeria

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Abstract

This study investigated the helminth parasites of animals and management practices at the University of Ilorin Zoological garden. Faecal samples were collected and analysed according to standard parasitological techniques while information on management practices was obtained using a structured questionnaire. The overall prevalence of helminths was 20.7%. Three parasites namely, *Ascaris* spp., *Trichostrongylus* spp. and *Enterobius* spp. were identified. Of the 92 animal faecal samples examined, common jackal (21.1%), crested porcupine (42.1%), Lioness (15.8%), and mongoose (21.1%) were positive ($p < 0.05$). Only mammals were positive for intestinal helminth while Aves were not infected ($p > 0.05$). Animals fed three times a week had higher helminth infection (57.9%) when compared with animals fed daily (42.1%). Cages cleaned daily had more helminth parasite contamination (78.9%) compared to those cleaned weekly (21.1%, $p < 0.05$). Also, animals dewormed on monthly basis harboured fewer intestinal helminths (5.3%), compared to those dewormed every three months (78.9%, $p > 0.05$). Surprisingly, animals in enclosures with cemented floors had the highest helminth infection (78.9%) compared to those living in enclosures with uncemented floor ($p < 0.05$). The overall prevalence of helminths is low in this study; therefore, zoo workers should take more cognizance of the routes of parasite transmission, since the faecal-oral route is the primary means through which animals acquired infection. There is a need for improved management practices to curb the spread of helminth infection. This will invariably ensure the sustainability of zoological gardens.

Keywords: Prevalence; helminths; zoo; management practices

Introduction

The increasing loss of global biodiversity is a widely recognized problem that has resulted in a significant number of wildlife species currently listed as endangered or critically endangered. This has necessitated the need for botanical gardens, parks and zoological gardens which play a vital role in the conservation of endangered species [1]

Zoological gardens are *ex-situ* conservation areas where wild animals are kept outside their natural environment within safe enclosures and exhibited for education, recreation and research. Several zoological gardens are located across Nigeria with diverse wildlife species. They serve as great tourist attraction sites and a good source of revenue generation for states in the country where they are located [2].

Zoo animals are known to harbour different gastrointestinal parasites which affect their fitness, survival, and reproductive performance. The infected host may suffer gastroenteritis, haemorrhage, extra-intestinal infection, spontaneous abortion and sometimes death [3]. Even though parasites cause captive animal deaths, some of these parasites are zoonotic and pose risk to human health. Gastrointestinal parasites are not only the sole cause of parasitic infection in captive animals, haemoparasites and ectoparasites are also perceived to be important threats to animal health [4].

The vulnerability of zoo animals to parasitic infection is inevitable since many species live in cohesive groups characterized by frequent social interactions which facilitate parasite transmission [5]. Also, zoo workers play a vital role in the transmission of parasites among animals, through their shoes, clothes, hands and work tools. Other factors which inform the health status of zoo animals include feeding, housing conditions, husbandry practices and environmental factors such as temperature and humidity [6].

Studies on the prevalence of gastrointestinal parasites in captive animals in several zoological gardens in Nigeria have documented varying prevalence rates. In South-Western and South-Eastern parts of Nigeria, prevalence rates as high as 65% and 76% have been reported [7, 8]. Some of the prominent parasite species of captive animals include *Entamoeba* spp. and *Balantidium* spp. (Protozoa); *Toxocara* spp., *Ascaris* spp., *Strongyloides* spp., *Trichuris* spp., *Enterobius* spp., *Trichostrongylus* spp. and *Strongyloides* spp. (Nematoda); *Capillaria* spp. and *Dipyllobothrium* spp. (Cestoda) [9-11]. Despite many documented reports on parasitic infections among zoo animals, very few studies have juxtaposed the infection status of captive animals with adopted management practices; therefore, this study was conducted to bridge this knowledge gap. Also, it is expected that the findings from this study will guide and inform better zoo management practices.

Materials and methods

Study area

The University of Ilorin Zoological garden is situated just by the entrance of the University. It was first established as a biological garden at the mini-campus of the University in 1975 and upgraded to a zoological garden in 1985 to complement the

University's Biological Sciences Departments in teaching and research. Unique features which draw visitors to the zoo are the 150 meters long and 45 meters high suspended canopy walkway and the presence of a stream that flows through the zoo. It is home to numerous animal groups like primates, carnivores, hoofed mammals, birds and reptiles.

The zoo is in the North-Central geopolitical zone of Nigeria and geographically located between Latitude 80°48'17" N and Longitude 40°63'82" E. The area has warm weather with daily mean temperature ranging from 24.2°C (in cold seasons) to 33.7°C (in hot seasons), with an annual rainfall of 1,317- 1,323 mm which spans between 5-6 months.

Study design

The study was a cross-sectional study involving 17 animal species that cuts across 2 animal groups namely, Aves and mammals. Ethical clearance was sought from the University of Ilorin ethical review committee. Also, consent was sought from the director of zoo management board after detailed briefing of the study protocols. Information such as age, sex, feeding duration, history of deworming, nature of animal cage, animal's behaviour and general management practices were obtained using a structured questionnaire. Faecal samples of each animal were collected with the assistance of zookeepers.

Collection and Processing of Stool Samples

Fresh faecal samples were collected from animals into pre-labelled clean sterile sample bottles with the assistance of the zookeepers before routine cleaning of cages, in the early morning hours. The samples were transported to the parasitology laboratory and examined for parasite eggs using simple floatation and concentration techniques after the methods of Ajibade *et al.* [12] with slight modifications.

Briefly, a simple test tube floatation technique was conducted by adding 10ml of saline solution to 3g of faeces in a plastic container and mixed thoroughly with a spatula until a homogenous solution was obtained. The mixture was filtered through a tea strainer into a 15ml centrifuge and centrifuged at 1500rpm for 5 minutes. The supernatant was decanted, and the sediment was re-suspended in 12ml zinc sulphate and centrifuged at 2500rpm for 1 minute. The tube was placed in a rack in a vertical position and slowly topped with zinc sulphate using a pipette so that an inverted meniscus was formed.

Thereafter, a coverslip was placed carefully on top of the tube in such a way that its underside rested on the meniscus and allowed to stand for 15 minutes, after which it was carefully lifted together with the drop of fluid adhering to it, placed on a clean slide, and then examined using a binocular microscope at x10 magnification.

For the sedimentation technique, 4g of faeces was mixed with 10ml of 10% formol-saline solution and filtered into a centrifuge tube using a fine mesh. The filtrate was centrifuged at 1500rpm for 10 minutes after which the supernatant was decanted, and the sediment re-washed with 10ml of formol-saline solution until the supernatant was clear. At the last wash, the supernatant was decanted and 10ml of 10% formalin was added to the sediment and allowed to stand for 5 minutes. Thereafter, 3ml of ethyl acetate was added to the mixture, shaken vigorously, and centrifuged at 1500rpm for 5 minutes. A layer of ethyl acetate, a plug of debris and a layer of formalin were

decanted leaving the sediment. A drop of sediment was placed on a slide covered with a coverslip and observed under the microscope at x10 magnification. All parasites detected were identified using photomicrographs.

Statistical Analysis

All data were analysed using Statistical Package for Social Sciences (SPSS) version 20.0. The proportion of positive samples was determined using descriptive statistics while Chi-square (χ^2) was used to determine if there was a significant relationship between prevalence and age, sex, animal class and management practices. The level of significance was set at $p < 0.05$.

Results

A total of ninety-two (92) samples were screened for various intestinal helminths. All the animals were above 2 years in age. The population and type of animals sampled are shown in Figure 1.

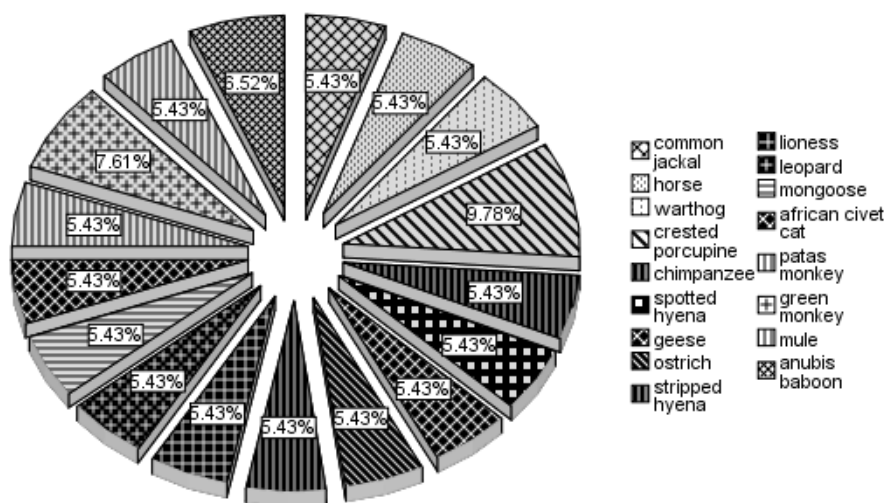


Figure 1: Percentage distribution of the animals sampled

The prevalence of intestinal helminth with specific parasites identified is shown in Table 1. The overall prevalence of helminths in the animal population sampled was 20.7%. Eighty per cent (80%) of the population of common jackals sampled were positive with *Ascaris* spp. while most of the crested porcupines (88.9%) were infected with *Trichostrongylus* spp. The mongooses sampled harboured three parasite species, although all were a single infection. A hundred per cent prevalence rate was observed in Lioness while other animals

sampled were negative for intestinal helminth infection.

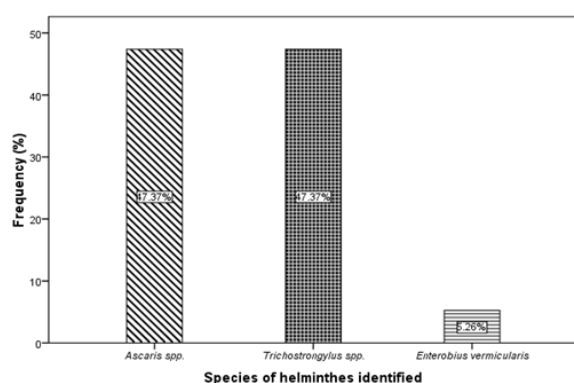
In all the sampled animals, three helminth parasite species namely *Ascaris* spp. (47.37%), *Trichostrongylus* spp., (47.37%) and *Enterobius vermicularis* (5.2%) were identified (Figure 2).

In table 2, out of the 63 faecal samples obtained from males, 13(20.6%) were infected with intestinal helminths. However, only 6(20.7%) faecal samples

Table 1: Prevalence of intestinal helminths and the parasites identified in the sampled animals

Animal name	Infection StatusN(%)		Total	Parasite Identified	χ^2	p-value
	Positive samples	Negative samples				
Common jackal	4(80.0)	1(20.0)	5(100.0)	<i>Ascaris</i> spp.	8.62	0.003
Horse	0	5(100.0)	5(100.0)	-		
Warthog	0	5(100.0)	5(100.0)	-		
Crested porcupine	8(88.9)	1(11.1)	9(100.0)	<i>Trichostrongylus</i> spp.		
Chimpanzee	0	5(100.0)	5(100.0)	-		
Spotted hyena	0	5(100.0)	5(100.0)	-		
Geese	0	5(100.0)	5(100.0)	-		
Ostrich	0	5(100.0)	5(100.0)	-		
Striped hyena	0	5(100.0)	5(100.0)	-		
Lioness	3(60.0)	2(40.0)	5(100.0)	<i>Ascaris</i> spp.		
Leopard	0	5(100.0)	5(100.0)	-		
Mongoose	4(80.0)	1(20.0)	5(100.0)	<i>Ascaris</i> spp. <i>Trichostrongylus</i> spp. <i>Enterobius</i> spp.		
African civet cat	0	5(100.0)	5(100.0)	-		
Patas monkey	0	5(100.0)	5(100.0)	-		
Green monkey	0	7(100.0)	7(100.0)	-		
Mule	0	5(100.0)	5(100.0)	-		
Anubis baboon	0	6(100.0)	6(100.0)	-		
Total	19(20.7)	73(79.3)	92(100.0)			

retrieved from female animals had intestinal helminths. The association was not statistically

**Figure 2: Percentage frequency of the identified helminths**

The specific prevalence of the intestinal helminths with respect to the class of animals sampled for this study showed that only mammals had helminth infections (20.7%), but none of the Aves sampled had helminths (Table 2).

The effect of management practices on the prevalence of intestinal helminths among zoo animals was assessed (Table 3). Animals that were fed three times a week recorded high helminth infection (57.9%) when compared with animals fed daily (42.1%, $p=0.045$). Cages cleaned daily had more helminth parasite contamination when compared to those cleaned every week (21.1%,

Table 2: Prevalence of intestinal helminths with respect to the gender of the animals

Gender	Prevalence			χ^2	p-value
	No. Ex.	Neg. (%)	Pos. (%)		
				0	0.995
Female	29	23 (79.3)	6 (20.7)		
Male	63	50 (79.4)	13 (20.6)		
Total	92	73 (79.3)	19 (20.7)		

Table 3: Prevalence of intestinal helminths with respect to animal class sampled

Animal class	Specific prevalence			χ^2	p-value
	No. Ex.	Neg. (%)	Pos. (%)		
Aves	10	10 (10.9)	0	2.920	0.087
Mammals	82	63 (68.5)	19 (20.7)		
Total	92	73 (79.3)	19 (20.7)		

$p < 0.05$). Animals that were dewormed on monthly basis harboured fewer intestinal helminths (5.3%), while those that were dewormed every three months had a high prevalence (78.9%) but was not statistically significant ($p > 0.05$). A high prevalence of helminths was observed in animals living in close association (78.9%), but animals living in solitary confinement had fewer parasites, (21.1%, $p > 0.05$). Animals living in small cage confinement were all infected (100%, $p < 0.05$). Surprisingly, a high number of animals living in enclosures with cemented floors had helminth infection (78.9%, $p < 0.05$) but no infection was recorded in animals living in uncemented enclosures.

Discussion

This study evaluated the prevalence of helminth infections in captive animals at the University of Ilorin zoological garden. A total of ninety-two (92) faecal samples were examined and only nineteen (20.7%) were infected with various helminths, specifically nematodes. The prevalence of infection reported in this study was lower than the results obtained by Ajibade *et al.* [8], who carried out a similar study at Obafemi Awolowo University and University of Ibadan zoological gardens with prevalence rates of 62.5% and 65% respectively.

In this study, four animals (jackal, crested porcupine, Lioness, and mongoose) were infected with three helminths namely *Ascaris* spp., *Trichostrongylus*

spp. and *Enterobius* spp. This finding differs from several studies conducted at various zoological gardens both in Nigeria and other countries, where helminths such as *Ancylostoma duodenale*, *Toxocara leonine*, *Trichuris trichiura*, *Eimeria* spp. and *Strongyloides* spp. were identified [8, 13].

Crested porcupine, Lioness and jackal had a high infection rate with *Trichostrongylus* spp. and *Ascaris* spp. Reports by authors have shown *Ascaris lumbricoides* to be the most prominent parasite which infects crested porcupines. However, an earlier study conducted at the University of Ilorin zoo by Kolapo and Jegede revealed a zero prevalence of infection in crested porcupines [10].

The present study indicated that the mongooses examined had a single infection with *Ascaris* spp., *Enterobius* spp. and *Trichostrongylus* spp. with a prevalence rate of 80%. However, studies from other countries have documented mixed infection in the animal [13, 14]. No helminth infection was recorded in horse, warthog, chimpanzee, spotted hyena, geese, ostrich, striped hyena, leopard, African civet cat, patas monkey and mule (Table 1). This observation is in contrast with results from other authors [7, 15], who identified *Ancylostoma* spp. and *Fasciolopsis buski* in horses examined at the Zoological gardens in Malaysia and Nakede respectively.

The finding of this present study on chimpanzees

Table 4: Effect of management practices on the prevalence of intestinal helminths in zoo animals

Mgt. practice	Prevalence			χ^2	p-value
	No. Ex.	Neg. (%)	Pos. (%)		
Feeding duration				4.00	0.045
<i>daily</i>	57	49 (67.1)	8 (42.1)		
<i>3times/week</i>	35	24 (32.9)	11 (57.9)		
Cage cleaning				11.36	0.001
<i>daily</i>	87	72 (98.6)	15 (78.9)		
<i>weekly</i>	5	1 (1.4)	4 (21.1)		
Last deworming				1.28	0.258
<i>monthly</i>	12	11 (15.1)	1 (5.3)		
<i>Every 3months</i>	80	62 (84.9)	18 (94.7)		
Animal behaviour				0.40	0.529
<i>solitary</i>	15	11 (15.1)	4 (21.1)		
<i>affiliate</i>	77	62 (84.9)	15 (78.9)		
Type of cage				21.01	<0.001
<i>small cage</i>	49	30 (41.1)	19 (100)		
<i>big cage</i>	28	28 (38.4)	0		
Cage floor				7.49	<0.01
<i>Cemented</i>	47	32 (43.8)	15 (78.9)		
<i>Uncemented</i>	45	41 (56.2)	4 (21.1)		

correlates with reports from the University of Ibadan Zoological garden and Skopje, Macedonia [6, 12]. However, *Strongyloides* spp was identified in Chimpanzees at the Zoological garden in Nakede, Nigeria [7]. Goose and Ostrich are birds of zoological importance. This study found no infection in any of the two birds. Similar results were reported by researchers both within Nigeria and outside the country [6, 12]. However, it is contrary to the report of Otegbade and Morenikeji which showed the presence of *Strongyloides* spp. and *Ascaris* spp. in geese and ostrich respectively in five Zoological gardens in Nigeria including this study area [11].

The specific prevalence of the intestinal helminths with respect to the class of animals sampled for this study showed that only mammals were infected. This finding contradicts several studies where helminth infections were reported in both mammals and Aves [11, 16]. Prevalence of helminth parasite with respect to sex of animals showed that females (20.7%) were more infected than males (20.6%). However, the association was not statistically significant ($p>0.05$), moreover, females sampled were fewer compared to

males. This indicates that the gender of animals does not predispose them to helminth infections in this present study.

Management practices adopted in the zoo were also assessed. A higher prevalence of intestinal helminths was observed in animals whose cages were cleaned daily and also in animals on cemented cage floors ($p<0.05$). These findings are unexpected; however, it is plausible that parasites were transmitted to infected animals through cleaning tools and contaminated food items. A higher prevalence of helminth infection observed in animals living together is not surprising as crowding facilitates parasite transmission due to frequent interaction; a phenomenon earlier suggested by Stoner [5].

Chemoprophylaxis is considered a key aspect of husbandry practices. This study revealed that a substantial proportion of animals dewormed every three months harboured more intestinal helminths compared to those dewormed monthly. An adjustment in the treatment schedule may appear to be a good proposition; however, since the overall

prevalence of infection is low, it might be inappropriate and also, caution must not be thrown to the wind as a major mechanism driving the development of anthelmintic resistance is, but not limited to the frequency of treatment. A 6-month duration chemoprophylaxis schedule adopted by 38 European Zoos for control of sensitive endoparasites in ungulates revealed that 97% of the Zoos still recorded a high prevalence of parasitic infection in animals, although anthelmintic resistance and route of administration were suggested as possible causes of treatment failure [17].

Conclusion

The low prevalence observed in this study indicates that management practices are not 100% adequate. Also, faecal-oral route and contamination are the primary means through which animals acquired infection, hence, food materials provided for the animals should be prepared properly. Flesh for carnivores should be thoroughly examined for worms while vegetables should be properly washed before they are made available to animals. Since helminth infections are diseases of public health importance due to transmission between animals and humans (zoonoses), there is the need to be more vigilant and prevent consequences that may arise from human infection. Further studies are needed in this study area to evaluate possible zoonoses. These might contribute to a better understanding of the epidemiology and association of the diseases in man and captive animals.

Authors' contribution

OOA and KRA designed the work, AAD and LAT supervised sample collection and analysis, SO and AK analysed and interpreted the data, OOA, AAD and AK drafted the manuscript, and OOA revised the final manuscript.

Conflict of interest

None

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