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Gastrointestinal parasites of birds in zoological gardens in south-west Nigeria

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Abstract. Infections with gastrointestinal parasites are a major health issue in captive birds. However, prevalence data of gastrointestinal parasites of birds in zoological gardens in Nigeria are scarce. This study was carried out to establish the gastrointestinal parasite profile of birds kept in zoological gardens in the University of Ibadan, Obafemi Awolowo University, University of Ilorin, University of Lagos and Federal University of Agriculture Abeokuta, all in south-west Nigeria. A total of 178 fecal samples from 83 birds (14 species in eight orders) were examined using three techniques; Feacal sedimentation using ethyl acetate, McMaster Egg Counting Technique and Petri Dish- Filter Paper Slant culture technique (modified Harada- Mori Technique). A total of 39(21.9%) of the 178 samples were infected. The highest prevalence (100%) of infection was recorded in Unilag zoo and a total of five species of parasites including two protozoans (coccidian and *Balantidium* spp.); and three nematodes *Capillaria* spp., *Ascaris* spp. and *Strongyloides* spp.) were recorded with *Capillaria* spp. (14.1%) as the most prevalent gastrointestinal parasite. Mixed infections were found in 18(10.1%) samples. *Strongyloides* larvae were observed in 6(3.4%) samples. All Anseriformes were infected but the Struthioniformes had the highest infection rate. The geometric mean intensity of eggs ranged from 101.98 ± 10.36 to 63.00 ± 16.67 epg and oocyst counts ranged from 332.47 ± 16.67 to 297.89 ± 20.41 opg. *Balantidium* cyst count was 324.04 ± 25.00. Count of oocyst of coccidian species was significantly higher in all the zoos. The feacal culture yielded *Strongyloides* species. Regular deworming and hygienic measures are necessary to prevent gastrointestinal infections in captive birds. So also, improved funding and management are necessary to ensure sustainability of Nigerian zoological gardens.

INTRODUCTION

Zoological gardens exhibit wild animals for aesthetic, educational and conservation purposes. However, parasitic diseases constitute one of the major problems causing mortality in these animals while in captivity (Rao & Acharjyo, 1984; Varadharajan & Kandasamy, 2000). The effects range from sub-clinical to death.

In 2003, Nigeria was said to be the seasonal, breeding or year round home of 906 species of birds (FEPA, 2003), three of the twelve species that are indigenous to Nigeria are threatened. These are the Anambra waxbill (*Estrilda poplioparei*a), Ibadan malimbe (*Malimbus ibadanensis*) and Jos plateau indigo bird (*Vidua maryae*) (Aminu-Kano, 2001). Some of these birds are kept in Nigerian zoos. Parasites usually cause little or no distress to healthy individuals in the wild; however parasitic infections are among the most common sanitary problems affecting captive birds, especially in high-density populations (Barnes, 1986). Despite the fact that there is a large body of literature on avian medicine including parasitic diseases (Altman *et al.*, 1997; Rupley, 1997; Olsen & Orosz, 2000), little has been documented about the epidemiology of gastrointestinal parasites in zoo birds. Some published studies included case reports (Kwon *et al.*, 2005; Luppi *et al.*, 2007; Ferrell *et al.*, 2009) or surveys on a single parasitic

agent (Rohela *et al.*, 2005; Schoener, 2010; Wang *et al.*, 2011), while others examined intestinal parasites in a limited range of zoo species (Sotirakis *et al.*, 2001; Hollamby *et al.*, 2003; Fallacara *et al.*, 2004; Yusufu *et al.*, 2004; Pheng *et al.*, 2005; Ibrahim *et al.*, 2006; Perez-Cordon *et al.*, 2008; Khan *et al.*, 2010; Mshelia *et al.*, 2010). Only a few coprological surveys were carried out in a wide range of avian species displayed in zoo settings (Patel *et al.*, 2000; Parsani *et al.*, 2003; Perez-Cordon *et al.*, 2009; Ajibade *et al.*, 2010; Akinboye *et al.*, 2010; Gurler *et al.*, 2010; Opara *et al.*, 2010; Papini *et al.*, 2012).

There is no doubt that a regular program of surveillance and measures of gastrointestinal parasites with correct diagnosis, effective treatment and proper prophylaxis would assist in maintaining good health of zoo birds. By trying to establish a profile of gastro-intestinal parasites in the zoo birds, valuable information will be obtained for the development of public health and preventive medicine. This study was therefore carried out to identify and determine the prevalence and intensity of gastro-intestinal parasites of kept birds in five zoological gardens in South West Nigeria.

MATERIALS AND METHODS

Study Area

The study was conducted from March to May 2012 in five zoological gardens in South-West Nigeria; University of Ibadan (U.I), Obafemi Awolowo University (OAU), University of Ilorin (Unilorin), University of Lagos (Unilag) and Federal University of Agriculture Abeokuta (FUNAAB) Zoological Gardens. There are a variety of animal species in these zoos, including non human primates, carnivores, herbivores, birds, and reptiles. The bird collections are composed of several species housed separately in cages or aviary depending on their size. Some birds are housed in uncemented enclosures while some in cemented enclosures. In the Unilorin zoo, most of the species are free ranging during the day and housed at night. Cages are cleaned daily in all of the zoos.

The climate in south–west Nigeria is characterized by both wet and dry seasons and relatively high humidity. The mean annual rainfall is about 1200mm (Olaniran, 2002).

Study Animals

A total of 178 fecal samples from 14 bird species in 8 orders were examined in the five zoological gardens (Table 1).

Sample Collection

Freshly passed feacal samples of birds were collected early in the morning before routine cleaning of all cages in each zoo. All samples were picked from the ground by utilizing a new sterile polystyrene spatula for each bird species to avoid cross contamination. In cases of small and medium sized zoo birds, multiple faecal droppings were pooled from all birds of the same species to collect an adequate amount of faeces for parasitological examination. Feacal samples of ostriches were collected from each bird. Samples were collected in plastic vials, which were clearly marked with the time, date of collection and species or subspecies of the bird. All samples were transported to the laboratory, and examined within 48 hrs. Collected samples were examined macroscopically for consistency, presence of blood, mucus, and tapeworm proglottids.

Parasitological Techniques

All the samples were examined for parasite eggs and larvae using standard methods. Qualitative egg identification was done by fecal sedimentation technique using ethyl acetate, McMaster Egg Counting Technique (MAFF, 1977) for egg, oocyst and cyst count and larva culture was done using the Petri Dish- Filter Paper Slant culture technique (modified Harada- Mori Technique) as described by Garcia (2001). Some quantity of each faecal sample was cultured for 10 days (Soulsby, 1982), to harvest and identify helminth larvae. Identification of helminth ova, oocyst and infective larvae was done by using the keys by Soulsby (1982) and Sloss *et al.* (1994).

Table 1. Bird species kept in the five zoological gardens under study in south-west Nigeria

Name of Zoo	Bird no	Sample no	Order	Scientific Name	Common Name
U.I ZOO	7	14	Anseriformes	*Anas platyrhynchos*	Mallard duck
	5	10		*Dendrocygna viduata*	White faced whistling duck
	4	8		*Anser rossi*	Ross's goose
	2	4	Pscittaciformes	*Psittacus erithacus*	Africa grey parrot
	2	4		*Poicephalus senegalus*	Senegal parrot
	2	4		*Psittacula krameri*	Parakeet
	3	6	Accipitriformes	*Kaupifalco monogrammicus*	Lizard buzzard
	2	4	Columbiformes	*Columba guinea*	Pigeon
	3	6	Galliformes	*Pavo cristatus*	Peacock
	1	2	Gruiformes	*Porphyrio porphyrio*	Purple swamphen
	3	6		*Balearica pavonina*	Crown crane bird
	3	6	Ciconiiformes	*Ciconia episcopus*	White stork
	4	8	Struthioniformes	*Struthio camelus*	Ostrich
OAU ZOO	5	10	Anseriformes	*Anser albifrons*	Water birds
	1	4		*Anser rossi*	Ross's goose
	1	4	Pscittaciformes	*Poicephalus senega*lus	Parrot
	2	6	Galliformes	*Pavo cristatus*	Peafowl
	2	6	Gruiformes	*Balearica pavonina*	Crown crane birds
	1	4	Accipitriformes	*Kaupifalco monogrammicus*	Lizard buzzard
	2	4	Struthioniformes	*Struthio camelus*	Ostrich
UNILORIN ZOO	6	12	Anseriformes	*Anser rossi*	Ross's goose
	7	14		*Dendrocygna viduata*	White face whistling duck
	6	12		*Anas platyrhynchos*	Mallard Duck
	3	6	Gruiformes	*Balearica pavonina*	Black crown crane
	3	6	Struthioniformes	*Struthio camelus*	Ostrich
UNAAB ZOO	2	6	Struthioniformes	*Struthio camelus*	Ostrich
UNILAG ZOO	1	2	Pscittaciformes	*Poicephalus senegalus*	Parrot

Statistical Analysis

Overall percentage prevalence of the number of infected samples and the parasites encountered in all the zoological gardens and in each zoological garden were determined. Prevalence values were calculated as number of positive samples/number of examined samples × 100. Geometric Mean Intensity (GMI) of faecal egg/oocyst count of each gastrointestinal parasite in each zoological garden was determined. Faecal egg counts of each parasite species encountered at each zoological garden were compared using analysis of variance (ANOVA). The significant level was set at $P < 0.05$.

RESULTS

The present study was undertaken from March to May 2012 to determine the prevalence of gastrointestinal parasites of birds in zoological gardens. The overall prevalence of gastrointestinal parasites was 21.9%. The highest prevalence (100%) of infection was recorded in Unilag zoo followed by Unaab zoo (75%). A total of five species of parasites including two protozoans (coccidian and *Balantidium* spp.); and three nematodes (*Capillaria* spp., *Ascaris* spp. and *Strongyloides* spp.) were recorded. *Capillaria* spp. was the most prevalent followed by *Ascaris* spp. and coccidian,

Table 2. Prevalence of gastrointestinal parasites in birds in five zoological gardens in south-west Nigeria

Study site	No of sample examined	No of sample infected (%)	Coccidia species (%)	*Balantidium* species (%)	*Capillaria* species (%)	*Ascaris* species (%)	*Strongyloides* species (%)	Mixed infection (%)
U.I ZOO	84	5(6.0)	2(2.4)	0	5(5.9)	2(2.4)	0	4(4.8)
OAU ZOO	38	9(23.7)	4(10.5)	2(5.3)	3(7.8)	2(5.3)	2(5.3)	4(10.5)
UNILORIN ZOO	50	20(40)	3(6)	0	12(24)	6(12)	4(8)	5(10)
UNAAB ZOO	4	3(75)	3(75)	0	3(75)	2(50)	0	3(75)
UNILAG ZOO	2	2(100)	2(100)	0	2(100)	2(100)	0	2(100)
Total	178	39(21.9)	14(7.9)	2(1.11)	25(14.1)	14(7.9)	6(3.4)	18(10.1)

Table 3. Prevalence and diversity of parasites in birds in five zoological gardens in south-west Nigeria

Bird Species	Total sample	Infected sample (%)	Coccidian (%)	*Capillaria* spp (%)	*Balantidium* spp (%)	*Ascaris* spp (%)	*Strongyloides* spp (%)
Accipitriformes							
Kaupifalco monogrammicus	10	0	0	0	0	0	0
Anseriformes							
Anas platyrhynchos	26	7(26.9)	5(19.2)	4(15.4)	0	3(11.5)	0
Anser rossi	24	7(29.1)	2(8.3)	3(12.5)	2(8.3)	0	2(8.3)
Anser albifrons	10	3(30.0)	2(20.0)	0	0	2(20.0)	0
Dendrocygna viduata	24	6(25.0)	0	5(20.8)	0	3(12.5)	0
Ciconiiformes							
Ciconia episcopus	6	0	0	0	0	0	0
Columbiformes							
Columba guinea	4	0	0	0	0	0	0
Galliformes							
Pavo cristatus	12	2(16.7)	0	2(16.7)	0	0	0
Gruiformes							
Porphyrio porphyrio	2	0	0	0	0	0	0
Balearica pavonina	18	0	0	0	0	0	0
Pscittaciformes							
Poicephalus senegalius	10	2(20.0)	2(20.0)	2(20.0)	0	2(20.0)	0
Psittacus erithacus	4	0	0	0	0	0	0
Psittacus krameri	4	0	0	0	0	0	0
Struthioniformes							
Struthio camelus	24	12(50)	3(12.5)	9(37.5)	0	4(16.7)	4(16.7)
Total	178	39(21.9)	14(7.9)	25(14.1)	2(1.1)	14(7.9)	6(3.4)

Strongyloides spp. and *Balantidium* spp. (Table 2). The mixed gastrointestinal infection (10.1%) was often composed of the five parasites identified. The mixed infections were either with two or three parasites.

The prevalence of gastrointestinal parasites was higher in struthioniform as compared to birds in other Orders. Struthioniform birds (Table 3) were found to be infected with four gastrointestinal parasites that is, coccidian, *Capillaria* spp., *Ascaris* spp. and *Strongyloides* spp. The anseriform birds had all the five gastrointestinal parasites.

Generally coccidian spp. and *Balantidium* spp. had the highest intensity. Coccidian species was found in all the zoos and the highest intensity occurred in Unilorin and Unaab zoos (332.47±16.67opg), while *Balantidium* spp. was found in OAU zoo

Table 4. Intensity of parasites encountered in birds in five zoological gardens in south-west Nigeria

Study Areas	Number of samples examined	Parasite oocyst/egg encountered	Number of infected samples (%)	Geometric mean intensity (epg/opg) ± S.E	Parasite larvae recovered (%)
UI ZOO	84	Coccidian spp	2 (2.4)	324.04 ± 25.00	–
		Capillaria spp	5 (6.0)	75.79 ± 12.24	–
		Ascaris spp	2 (2.4)	70.71 ± 25.00	–
		Total	9 (10.7)	103.07 ± 37.26	
OAU ZOO	38	Coccidian spp	4 (10.5)	297.89 ± 20.41	–
		Capillaria spp	3 (7.9)	63.00 ± 16.67	–
		Ascaris spp	2 (5.3)	100.00 ± 0.00	–
		Strongyloide spp	2 (5.3)	70.71 ± 25.00	*Strongyloides* spp (100)
		Balatidium spp	2 (5.3)	324.04 ± 25.00	–
		Total	13 (34.2)	142.87 ± 34.15	
ILORIN ZOO	50	Coccidian spp	3 (6.0)	332.47 ± 16.67	–
		Capillaria spp	12 (24)	101.98 ± 10.36	–
		Ascaris spp	6 (12)	84.92 ± 25.82	–
		Strongyloide spp	4 (8)	78.25 ± 23.94	*Strongyloides* spp (75%)
		Total spp	25 (50)	107.80 ± 17.56	
UNAAB ZOO	4	Coccidian spp	3 (75)	332 47 ± 16.67	–
		Capillaria spp	3 (75)	100.00 ± 0.00	–
		Ascaris spp	2 (50)	100.00 ± 0.00	–
		Total	8 (200)	156.91 ± 43.04	
UNILAG ZOO	2	Cocciadia spp	2 (100)	324.04 ± 25.00	–
		Capillaria spp	2 (100)	70.71 ± 25.00	–
		Ascaris spp	2 (100)	70.71 ± 25.00	–
		Total	6 (300)	117.45 ± 53 87	

alone with an intensity of 324.04± 25.00 cysts per gram. *Capillaria* spp. which was most prevalent had low intensity and the lowest occurred in OAU zoo (63.00 ± 16.67 epg). Intensity of the parasites encountered from one zoo to the other was statistically significant (P > 0.05). *Strongyloides* spp. larvae were the only larvae recovered using Harada Mori technique (Table 4).

DISCUSSION

An overall 39 (21.9%) of 178 bird fecal samples were infected with gastro-intestinal parasites and contamination rate of U.I, OAU, Unilorin, Funaab and Unilag Zoos were 6%, 23.7%, 40%, 75% and 100%, respectively. Papini *et al.* (2012) found an overall prevalence of 35.6%, 42.2% in zoo and 27% in pet birds. Previous studies show that 11.1–51.9% of zoo birds in Turkey (Gurler *et al.*, 2010), 48.1-71.4% of zoo birds in India (Patel *et al.*, 2000; Parsani *et al.*, 2001), and 51.6% of zoo birds in Spain (Perez-Cordon *et al.*, 2009) were infected with gastrointestinal parasites. In Nigeria, Ajibade *et al.* (2010) recorded no infection of birds in OAU and U.I Zoos, while the work of Opara *et al.* (2010) and Akinboye *et al.* (2010) showed prevalence rates of 76.6% and 61.5% in Nekede and U.I Zoos, respectively.

The prevalence of gastrointestinal parasites in zoo birds can be explained by husbandry dependent factors such as housing and feeding, inconsistency in treatment program, or the existence of favourable climatic conditions (Magona & Musisi, 1999). At all the zoos except Unilorin, the birds were housed in either cemented or uncemented cages with daily cleaning or raking. But in Unilorin zoo the birds were free ranging

during the day and housed at night. Most of the birds were fed with grains. Ostriches were fed with grass and vegetable collected from or around the zoo grounds while the accipitriform birds were fed with fish. Furthermore, all the parasites found in this study were transmitted faecal-orally through contaminated soil, food, and water. As a result, these may play a key role as sources of parasite infection to birds under captivity conditions.

In the five zoos, gastrointestinal helminthes were more prevalent than protozoans and this comprised mainly of nematodes. This finding agrees with the reports of Rossanigo & Gruner (1995) that nematodes were responsible for most of the helminth diseases of veterinary importance, because they don't need intermediate hosts.

Generally, the most common infection was of *Capillaria* spp. which was followed by *Ascaris* spp. and coccidian species, while the lowest was *Balantidium* spp. which occurred in two samples of same bird species. More than 10% of the examined faecal samples of birds had mixed infections. There was mixed infection of *Capillaria* and Coccidian spp., *Capillaria* and *Ascaris* spp., *Capilaria* and *Strongyloides* spp. and *Ascaris* and coccidian spp.

The most frequently encountered gastrointestinal parasite, *Capillaria* spp. are small roundworms that infect the small intestine and infection is usually asymptomatic, but birds with heavy parasite burden may show clinical signs of anorexia, diarrhoea, emaciation, reduced water intake, ruffled feathers, and weakness (Yabsley, 2009). None of the infected birds with *Capillaria* spp. in this study showed clinical signs.

Ascaris spp. are the largest nematodes of birds and generally inhabit the small intestine. They are usually not pathogenic in slight infection. However, they can produce overt clinical disease and even death if their number is sufficiently high enough to cause anaemia, severe inflammatory response, and starvation (Fagerholm & Overstreet, 2009; Fedynich & Thomas, 2009). None of the infected birds with *Ascaris* spp. showed clinical signs in this study.

Intestinal coccidiosis occurring in birds includes species of the genera *Eimeria*, *Isospora*, *Tyzzeria*, and *Wenyonella* (Friend & Franson, 1999). They can be distinguished by the characteristic morphology of their sporulated oocysts that differ mainly in number of sporocysts and sporozoites (Yabsley, 2009). In this study, unsporulated oocysts were found in faecal samples from five mallard ducks, two water birds, and two geese belonging to the orders Anseriformes, two parrots of the order Pscittaciformes and three ostriches of the order Struthioniformes. Previous studies have shown that *Eimeria* and *Isospora* infections can occur in Psittaciformes, Struthioniformes and Anseriformes (Friend & Franson, 1999; Patel *et al.*, 2000; Ibrahim *et al.*, 2006; Yabsley, 2009). Neither *Tyzzeria* nor *Wenyonella* is known to occur in avian species belonging to these orders (Friend & Franson, 1999). Therefore, the genera *Eimeria* and *Isopora* were thought to be the most likely cause of coccidian infection in this survey. Clinical signs of intestinal coccidiosis include watery, mucoid, or bloody diarrhoea, decreased egg production, emaciation, lack of appetite, lethargy, lack of coordination, ruffled feathers, and weight loss (Yabsley, 2009). None of the infected birds with intestinal coccidiosis showed clinical signs in this study.

Generally egg counts were low compared to oocyst count. Eggs and oocyst counts were high in Unaab zoo than in other zoos. The intensity of coccidian species is higher than other parasite species even though its prevalence in the birds is moderate. All parasites found in this study were reported by Mbaya *et al.* (2006) and Ibrahim *et al.* (2006) in earlier studies, except *Strongyloides* spp. larvae.

The presence of high parasite prevalence in OAU and Unilorin zoos, despite the use of parasiticide, demonstrated that the anthelminthic program in these zoological gardens needs to be re-evaluated by means of therapeutical trials to assess drug efficacy and possible nematodicide resistance of these parasites.

There is a need to carry out fecal examination and treatment programs for specific diagnosis of parasites and prevention in all zoos. The resulting data on parasite burdens in this study is an important component of a site-specific health assessment plan for wildlife populations. These data are necessary for understanding the impact of human activities and management efforts on wildlife and to develop responsible long-term conservation strategies. Improved funding and management are necessary to ensure sustainability of Nigerian zoological gardens.

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