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Coprological study of gastrointestinal parasites of captive animals at Rangpur Recreational Garden and Zoo in Bangladesh

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Zoological gardens display wild animals for aesthetic, recreational, educational and conservation purposes (Varadharajan & Pythal 1999). One of their goals is to preserve rare and endangered species and in many parts of the world, parks and zoological gardens play an important role in species conservation (Parsani et al. 2001). In their natural habitat, wild animals have large areas available to them. Their exposure to parasitic infections is, therefore, fairly low and they have consequently a low genetic resistance against parasitic infections. When groups of these wild animals are kept in confined spaces in zoological gardens, the problem of parasitic infections can aggravate and pose a serious threat to the animals, occasionally causing sudden local fatalities (Muoria et al. 2005).

The occurrence of parasites in animals housed in zoos varies according to the type of husbandry, parasite prophylaxis and type of parasitic treatment. Usually, captive animals in the zoo do not show alarming signs of parasitism if deworming is carried out regularly (Parsani et al. 2001). Zoological gardens however are often located near city centers, where space is limited and many captive animal species are housed in close proximity to each other. Because of these space limitations, animals in these facilities succumb more frequently to parasitic infections, which can pose a serious health threat (Hoberg et al. 2008). In addition in captivity animals are often under considerable stress, which further diminishes their resistance to parasitic infections.

In Bangladesh, a few zoological gardens, safari parks and eco parks have been established which act as an important source of recreation for people of all ages. Until this date only few detailed and comprehensive studies have been conducted on the prevalence of the gastrointestinal parasites in animals housed in these facilities. Therefore, this study attempts to determine the occurrence and prevalence of gastrointestinal parasites in zoo animals at Rangpur Recreational Garden and Zoo in Bangladesh.

Study period, site and animals: This study was conducted during April and September 2011 at Rangpur Recreational Garden and Zoo which is located at Rangpur, in northern Bangladesh. It is the smaller one of two government zoos and was established in 1991, comprises an area of 20.7 acres and houses a total number of over 200 animals including mammals,

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Table 1. List of sampled animals with their scientific name and feed given at Rangpur Recreational Garden and Zoo in Bangladesh.

Common name	Scientific name	No. of animals (male-female)	No of samples collected	Feed
Indian Lion	*Panthera leo persica*	4(3-1)	4	Beef
Royal Bengal Tiger	*Panthera tigris*	2(1-1)	2	Beef
Hyena	*Crocuta crocuta*	1(1-0)	1	Beef
Python	*Morelia spilota variegata*	2(1-1)	2	Chicken
Indian Bear	*Melursus ursinus*	2(0-2)	2	Mixed boiled feed (Rice, milk, egg, banana, seasonal vegetables etc.)
Rhesus Monkey	*Macaca mulatta*	6(5-1)	6	Fruits, bread, seasonal vegetables, Cereal grains.
Olive Baboon	*Papiocyno cephalus anubis*	2(1-1)	2	Fruits, bread, seasonal vegetables, Cereal grains.
Spotted Deer	*Axis axis*	36	23	Grass, cereal grains
Sambar Deer	*Cervus unicolor*	1(1-0)	1	Grass, cereal grains
Water Buck	*Kobus ellipsiprymnus*	1(1-0)	1	Grass, cereal grains
Hippopotamus	*Hippopotamus amphibius*	1(1-0)	1	Grass, cereal grains

reptiles and birds. The study included the carnivores, nonhuman primates and herbivores housed at the zoo. A total of 45 samples were collected. The samples were collected once from each animal listed in Table 1.

Sampling and parasitological examination: With the assistance of the animal caretakers individual fresh fecal samples were collected. Because of the small number of animals, it was possible to associate each sample with a known individual. In the case of the tigers and lions, the individual animal was kept separately overnight and with the help of animal caretaker the sample was collected the next morning. For spotted deer, individual samples were collected immediately after defecation when the deer were supplied with feed. Attention was paid when a deer defecated, then its sex was identified and the fresh fecal sample was collected from the floor. Sample collection from hippopotamus, sambar, water buck and hyena was easy due to presence of only one animal in each cage. In python, the samples were collected separately from the animals bedding. It was easy because there were only two pythons in a large cage that were far from each other. In the case of the nonhuman primates (Rhesus Macaque and Olive Baboon) the individual sample was collected by keeping the animal separate the previous day with the help of caretaker.

The fecal sample was placed in a polythene bag containing 10% formalin and the sample was marked according to species and sex, and finally examined in the laboratory. The ova, cysts, oocyst and larvae of different parasites were identified according to the morphology and quantitative estimation was done by employing Stoll's ova counting technique (Soulsby 1982).

Results: A total of 45 fecal samples of different animals were examined for the presence of gastrointestinal parasites. The overall prevalence of parasitic infection was 60% (27/45) with 35.6% (16/45) of helminth infections and 24% (11/45) of protozoic infections. Results indicated that helminths infections were more common than protozoic infections in carnivores and herbivores, whereas in primates protozoic infection was more common than helminth infection (Table 2).

At least one intestinal parasite was identified in the fecal sample of each animal except in the bears, pythons, the water buck and olive baboons. Mixed infection was observed in three species, including Rhesus Monkey (*Trichuris* sp. + *Balantidium coli*), deer (*Strongyloides* sp. + *Coccidia*) and lion (*Toxascaris leonina* + *Spirometra* sp.) (Table 4). 72.7% (8/11) of the carnivores were found positive for gastrointestinal parasites of which 9.1% (1/11) were protozoa, whereas 63.6% (7/11) were helminths (Table 2). Parasites identified in carnivores comprised *Toxascaris leonina, Spirometra* sp., *Toxocara cati* and *Balantidium coli.* Lions were found infected with *Toxascaris leonina* (100%, 4/4) and *Spirometra* sp. (25%, 1/4). Tigers were found infected with *Toxocara cati* (100%, 2/2) (Table 3).

Of the herbivores 50% (13/26) of the animals were positive for gastrointestinal parasites of which 19.2% (5/26) were protozoa and 30.8% (8/26) were helminths (Table 2). Parasites identified in herbivores were *Fasciola* sp., *Moniezia benedeni*, *Strongyloides* sp., *Dictyocaulus* sp., stomach worm, *Coccidia* and *Balantidium coli.*

In the primates, 75% (6/8) of the animals were positive for gastrointestinal parasites of which 62.5% (5/8) were protozoa and 12.5% (1/8) were helminths (Table 2). The species identified were *Balantidium coli and Trichuris* sp. and were found in Rhesus Macaque.

Table 2. Overall prevalence of gastrointestinal parasites in captive animals at Rangpur Recreational Garden and Zoo.

Types of animal	No. of sample examined	No. of positive sample			Prevalence (%)		
		Protozoa	Helminth	Total	Protozoa	Helminth	Total
Carnivores	11	1	7	8	9.1	63.6	72.7
Herbivores	26	5	8	13	19.2	30.8	50.0
Primates	8	5	1	6	62.5	12.5	75.0
Total	45	11	16	27	24.4	35.5	60.0

Table 3. Prevalence of different gastrointestinal parasites in captive animals at Rangpur Recreational Garden and Zoo.

Name of the animal	Name of the parasite	No. of positive case (No of sample)	Prevalence (%)
Indian Lion	*Toxascaris leonina*	4(4)	100
	Spirometra sp.	1(4)	25
Royal Bengal Tiger	*Toxocara cati*	2(2)	100
Hyena	*Balantidium coli*	1(1)	100
Spotted Deer	*Fasciola* sp.	3(23)	13
	Moniezia benedeni	1(23)	4.4
	Strongyloides sp.	2 (23)	8.7
	Dictyocaulus sp.	1(23)	4.4
	Coccidia	3(23)	13
	Stomach worm	1(23)	4.4
Sambar Deer	*Balantidium coli*	1(1)	100
Rhesus Monkey	*Balantidium coli*	5(6)	83.3
	Trichuris sp.	1(6)	16.7
Hippopotamus	*Balantidium coli*	1(1)	100

Table 4. Mixed infection recorded at Rangpur Recreational Garden and Zoo.

Name of the animal	Name of the parasites	No. of cases (N = 45)
Lion	*Toxascaris leonina* + *Spirometra* sp.	1
Deer	*Strongyloides* sp. + *Coccidia*	1
Rhesus Monkey	*Trichuris* sp. + *Balantidium coli*	1

In this study, the sex related prevalence could only been assessed in deer as only in this species a suitable sample size was available. Here the prevalence of gastrointestinal parasites was higher in females (50%) than in males (33.3%) (Table 5).

As not enough samples of each species were available mean egg per gram of feces (EPG), ova per gram of feces (OPG), cyst per gram of feces (CPG) and larvae per gram of feces (LPG) were not calculated. So the results presented in Table 6 simply show the lowest and the highest numbers found in any sample. The highest infection rate was found for *Balantidium coli* with 1400 CPG in Rhesus monkey, followed by a rate of 700 CPG in hippopotamus, and a rate of 300 CPG in hyena and sambar deer.

Discussion: It has to be pointed out that the number of animals in the study was very low and the results, though they are interesting, are statistically irrelevant and rather anecdotical. 60% of the animals at Rangpur Recreational Garden and Zoo were found positive for gastrointestinal parasites. Other authors reported similar (Parsani et al. 2001), higher (Opara et al. 2010, Corden et al. 2008) or lower prevalences (Chakraborty & Islam 1996; Lim et al. 2008), but prevalence always ranged between 40.4 and 76.6%.

In all animals, except primates, the prevalence of helminth infections was higher than the prevalence of protozoic infections, an observation also confirmed in other studies (Varadharajan & Kandasamy 2000; Parsani et al. 2001). The high prevalence of helminths encountered in the survey can be explained by the favorable climatic conditions, which support prolonged survival of infectious nematode larvae. The finding of mixed infections might be due to presence of animals of all age groups in the same cages, the feeding management and improper disposal of feces.

In the present study 72.7% of the carnivores were found positive for gastrointestinal parasites. Lower (50%) and higher (97.3% and 89.3%) infection rates were found by other authors (Muller-Graf 1995; Lim et al. 2008). The main parasite found in carnivores were tapeworm *Spirometra* sp. It has been stated a long time ago that tapeworms were common among zoo animals (Chauhan et al. 1973). *Spirometra* sp. however, though the most common parasite in wild lions (Barutzki et al. 1985; Ghoshal et al. 1988), has not been reported in zoo lions until 1995 (Muller-Graf 1995). Occurrence of *Spirometra* depends on feeding management and availability of intermediate hosts in the corresponding areas. Two intermediate hosts are required to complete the life cycle of *Spirometra* sp. The first intermediate

Table 5. Sex related prevalence of different parasites in captive deer at Rangpur Recreational Garden and Zoo

Sex	No. of sample examined	Eggs/larvae/ oocyst of parasite	No. of positive cases	Prevalence (%)
Male	9	*Fasciola* sp.	1	11.1
		Moniezia benedeni	1	11.1
		Strongyloides sp.	1	11.1
		Coccidia	1	11.1
		Subtotal*	**3***	**33.3**
Female	14	*Fasciola* sp.	2	14.3
		Strongyloides sp.	1	7.1
		Dictyocaulus sp.	1	7.1
		Stomach worm	1	7.1
		Coccidia sp.	2	14.3
		Subtotal	**7**	**50.0**
Total	**23**		**10**	**43.5**

*= Total no. of animals affected is less than the summation of individual infection because same animal was infected by more than one type of parasites.

Heat destroys most of the ova or cyst of gastrointestinal parasites and might be the reason for absence of gastrointestinal parasites in bear in our study.

In this study 43.5% of the spotted deer were positive for gastrointestinal parasites, which is lower than the prevalence recorded by Kanungo et al. 2010 (75%). 13% of the spotted deer were found positive for *Fasciola* sp. This is lower than the rate of *Fasciola* sp. in deer recorded by Kanungo et al. (2010) at Dhaka Zoo (20%) and at Dulahazara Safari Park (19.1%). This difference might be due to location of animal cages, availability of intermediate hosts near the cages and the source of feeds. The occurrence of *Fasciola* sp. infection in Dhaka and Dulahazara was suspected to be connected with mud snails that live on the edges of the drains and act as intermediate hosts. Most of the deer cages at Dhaka zoo are located near the lake of the zoo. Moreover, the grass and leaves supplied to the deer are collected outside of the zoo and might be contaminated with

Table 6. Intensity of ova/cyst/oocyst/larvae of different parasites in captive animals at Rangpur Recreational Garden and Zoo.

Name of the animal	No. of sample examined	Ova/cyst/larvae of parasite	No. of positive cases (Male, Female)	Intensity of infection EPG/OPG/CPG/LPG Ranges
Indian Lion	4	*Toxascaris leonine*	4(3,1)	200–400
		Spirometra sp.	1(0,1)	300
Royal Bengal Tiger	2	*Toxocara cati*	2(1,1)	300–400
Hyena	1	*Balantidium coli*	1(1,0)	300
Spotted Deer	23	*Fasciola* sp.	3(1,2)	200–300
		Moniezia benedeni	1(1,0)	200
		Strongyloides sp.	2(1,1)	100–200
		Dictyocaulus sp.	1(0,1)	200
		Coccidia	3(1,2)	300–400
		Stomach worm	1(0,1)	300
Rhesus Monkey	6	*Balantidium coli*	5(4,1)	300–1400
		Trichuris sp.	1(0,1)	100
Sambar Deer	1	*Balantidium coli*	1(1,0)	300
Hippopotamus	1	*Balantidium coli*	1(1,0)	700

hosts are crustaceans and snakes; birds, mammals etc. are the second intermediate host (Soulsby 1982). So, the presence of *Spirometra* sp. in the lion of Rangpur Recreational Garden and Zoo might be due to ingestion of contaminated beef.

In this study, no gastrointestinal parasite was recorded in bear. This might be due to the feeding management, deworming and sample size. Bears are provided with a mixture of properly boiled ingredients. metacercaria of trematodes (Kanungo et al. 2010). But at Rangpur Zoo the chance of contamination is low as the deer enclosures are located far from the lake of the zoo and the grass supplied to the deer is cultivated at the zoo.

In sambar only *Balantidium coli* was recorded, which was different from other studies (Singh et al. 2009), which found a large number of gastrointestinal parasites including strongyles, *Strongyloides* sp., *Coccidia, Fasciola*

sp., Amphistomes and *Trichuris* sp. This difference might be due to the number of samples examined and the housing and feeding management of the zoo. Only one sambar is kept at Rangpur Recreational Garden and it has been reared in captivity and the chance for contamination from another individual and the environment was low. Singh's findings (2009) are made in a group of sambar in a free range area at Mechendra Choudhry Park, where the animals take to water readily and swim with the body submerged, which might expose them to infectiuos stages of parasites leading to higher parasitic prevalence in the species. Moreover, the moderate temperature range and the higher humidity at the park lead to the formation of a permanent mud area favorable to the survival of eggs and free-living stages of parasites (Singh et al. 2009).

Among the primates 75% animals were positive for gastrointestinal parasite infection. This result is much lower than the prevalence of 88.7% reported by Mutani et al. (2003), but higher than prevalences recorded by Lim et al. (2008) (54.5%) and Stuart et al. (1990) (48%). In accordance with other studies (Gomez et al. 1996; Leveck et al. 2007; Lim et al. 2008) we found a higher prevalence of protozoa (62.5%) than of helminths (12.5%) in this animal group. The occurrence of these parasites can be explained by the simplicity of their life cycle, the low infective dose, the short prepatent period and ability to survive in the environment. *Balantidium coli,* which was commonly found in our study, has a wide host range and possesses a simple direct life cycle and its occurrence in primates has been previously confirmed by Lim et al. (2008) and Gomez et al. (2000). *Trichuris* sp., which was found in the primates in this study, has been found by many authors (Lim et al. 2008; Singh et al. 2009) and is assumed to be the most common helminth in primates (Corden et al. 2008).

The present study did not find gastrointestinal parasites in Olive Baboon. Other studies however found baboons usually infected with various helminths (Nasher 1988; Murray et al. 2000; Mutani et al. 2003). The fact that we did not find any parasites might be the result of the number of samples, the animals' immune status and health condition, the deworming regime, hygienic management and low density of the animals in the enclosure.

In our study, sex related prevalence was only assessed in deer, as only here a suitable sample size was available. Here the prevalence of gastrointestinal parasites was higher in females (50%) than in males (33.3%). Although, the cause of the higher parasitic infection rate in females is not known, it can be hypothesized that pregnancy, lack of feed supplements during gestation and lactation, hormonal influences and stress factors during gestation, parturition and lactation may lead to an increased susceptibility for parasites. Llyod (1983) reported higher level of prolactin and progesterone hormones make an individual more susceptible to any infection.

Conclusion: This is the first documentation of gastrointestinal parasites of captive animals at Rangpur Recreational Garden and Zoo. The high prevalence of these parasites emphasizes the importance of controlling these parasites in order to safeguard the health of the housed animals and of humans working with these animals. More studies of parasitic infections are essential to understand the epidemiology of parasitism and also to better prevent parasitic infections.

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