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OCCURRENCE OF GASTROINTESTINAL HELMINTHS IN CAPTIVE RHESUS MACAQUES (*MACACA MULATTA*)

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Abstract: A total of 66 (sixty-six) fresh fecal samples were collected during July 2017 to October 2018 from rhesus macaques (*Macaca mulatta*) residing in Bangladesh National Zoo, Dhaka. Samples were analyzed applying formol-ether concentration technique. All the rhesus macaques, irrespective of age and sex, were found to be infested with one or more species of gastrointestinal (GI) helminth parasites. *Ascaris* spp. was noticed in all the fecal samples. Overall intensity of helminths was higher in male (38.53) that in female (31.04) comprising the maximum (58.08) in adult male ($p < 0.005$). The highest intensity was of *Ascaris* spp. (3.33 ± 1.39) and found in adult male hosts. Young female rhesus macaques displayed the maximum intensity of *Trichuris* spp. (3.56 ± 0.73).

Key words: Captive, rhesus macaques, helmench, prevalence, *intensity*

INTRODUCTION

Non-human primates (NHP) are the closest living biological relatives, offering critical perceptions into human evolution, biology and behavior and playing important roles in the livelihoods, cultures, and religions of many societies. They contribute to tropical biodiversity and run many functions of ecological importance. Among the NHPs, rhesus macaques (*Macaca mulatta*) are synanthropic, thriving in human altered environments that help them to be among the most widely distributed and successful primates in the world (Hasan *et al.* 2013). But unsustainable human activities are now the major force driving primate species to extinction (Estrada *et al.* 2017).

NHPs are particularly vulnerable to parasitic infestations because many species live in unified groups characterized by frequent social exchanges which simplify parasite transmission between individuals (Stoner 1996). Studies on the prevalence of gastrointestinal (GI) parasitic infestation in NHP in several zoological gardens exhibited that 13.63% at the State Zoo, India (Bichitra *et al.* 2012), 19.1% at Negara Zoo in Malaysia (Lim *et al.* 2008), 75% at Negede Zoo, Owerri, Nigeria (Opara *et al.* 2010) and 100% at the Zoological Garden in Jos, Nigeria (Dawet *et al.* 2013) were infested. Wongsawad (2009) found *Toxocara* sp.,

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Oesophagostomum sp., *Strongyloides* sp., *Trichuris* sp. and *Capillaria* sp. from *Macaca assamensis* in Thailand. Usually, when the parasitized animal is brought from wild to captivity, despite quarantine measures, the new condition of zoos is generally unfavorable for the animal but favorable to the parasites. The constant stress of captivity makes animals more susceptible to parasitic infection as the immune system of these captive animals becomes weak (Cordon *et al.* 2008). Moreover, gastrointestinal parasites of wild animals in captivity include zoonotic species affecting humans and raise public health concerns (Opara *et al.* 2010). Occurrence of parasites in animals kept in zoo might differ according to the type of husbandry practices and prophylactic measures. Generally, captive animals do not display alarming marks of parasitism if regular deworming practices are carried out in the zoo (Parasani *et al*. 2001).

The present study attempts to investigate the occurrence of endoparasitic helminths affecting rhesus macaques living in captive condition at Bangladesh National Zoo, Dhaka. We hope that information obtained from the study, will be convenient for the development of captive animal health policy.

MATERIAL AND METHODS

Study design: The present study was conducted among the 60 (male = 39, female = 27) captive rhesus macaques (*Macaca mulatta*) of Bangladesh National Zoo, Dhaka. The rhesus macaques were categorized into two age groups- young (≤5) and adult (≥10). A total of sixty-six fecal samples from sixty captive rhesus macaques were collected during monsoon; July 2017 to October 2018. We tried to exclude repeated samples. Previously sampled rhesus macaques were tagged and a few number of rhesus macaques were sampled twice (six in number).

Collection and preservation of samples: Faecal samples of rhesus macaque were collected from the cage in the early morning with the help of caretakers of the zoo. Each fecal sample was placed in a polythene bag containing 10% formalin. After collection the polythene bags mouth was knotted tightly with ribbon to avoid contamination, then it was kept in a plastic pot and each sample containing pot was sealed. The samples were marked according to age and sex. All possible aseptic measures like- hand gloves, wearing apron and shoes etc. were taken to avoid contamination.

Laboratory screening: Collected samples were analyzed by Formol-Ether Concentration Technique (Cheesbrough 1987) in the Parasitology Laboratory, Department of Zoology, University of Dhaka. Morphological identification of helminths and their different developmental stages were observed. The eggs of different helminths were observed with the help of compound (10X) microscope.

Eggs were identified with the support of Chatterjee (1967), Soulsby (1982) and Wallach and Boever (1983).

Data analysis: Data were entered into an excel spreadsheet and transferred into SPSS version 20. Intensity and prevalence of each gastrointestinal (GI) parasite species was determined and compared statistically using regression method.

RESULTS AND DISCUSSION

In the present study, all the rhesus macaques (*Macaca mulatta*), irrespective of age and sex, were found to be infested with one or more species of GI helminth parasites. But intensity of infection was high in adult males (Table 1). Exploring twenty-four zoological gardens in China, Li *et al.* (2015) found the prevalence of gastrointestinal parasitic infection ranged from 3.77% to 100%. Nath *et al.* (2012) recorded 13.63% parasitic infestation in captive NHP in Assam State Zoo whereas Aviruppola *et al.* (2016) detected 61.1% prevalence in Dehiwala National Zoological Gardens, Sri Lanka. Various factors can explain the higher prevalence found in the present study compared to the previous studies.

Table 1. Occurrence of GI helminths in captive rhesus macaques

Sex	Age	No. examined	No. positive	Prevalence (%)	EPG	Intensity	p-value
Male	Young	15	15	100	109	7.27	0.01
	Adult	24	24	100	1394	58.08	0.001
	Sub-total	39	39	100	1503	38.53	
Female	Young	9	9	100	77	8.56	0.03
	Adult	18	18	100	469	26.06	0.006
	Sub-total	27	27	100	546	20.22	
	Total	**66**	**66**	**100**	**2049**	**31.04**	

In the monsoon, the climatic conditions are usually favourable for the development and maturation of parasites. All the samples were collected during monsoon, in the present study. Significantly higher prevalence of parasitic infection during monsoon season is reported by Kumar *et al.* (2009). The species variety and different feeding behavior may be responsible. Different species harbor different kinds of parasites and this could be the reason behind varied prevalence and intensity. The present study found the high prevalence of *Ascaris* spp. (100%) and *Toxocara* spp. (60%) in young male. In adult male, the maximum prevalence was of *Ascaris* spp. (75%) and *Hymenolepis* spp. (62.05%) ($p < 0.05$) (Table 2). Generally, rhesus macaque (*Macaca mulatta*) lives in a social group or a community and they show various social behavior like -

grooming, playing, foraging etc. These social behaviors create closeness among them. These interactions among hosts increase the possibility of transmission of parasites. Socially mediated exposure appears to be important for direct transmission of nematode parasites MacIntosh *et al.* (2012). In the present study, midst the young female the high prevalence was recorded for *Ascaris* spp. in both the age groups. *Trichuris* spp. was found to be priority infestation in young females ($p < 0.05$) and *Toxocara* spp. in adult ($p < 0.05$) (Table 3). MacIntosh *et al.* (2012) found that young adult females were concurrently infected by more species than were adults. Mutani *et al.* (2003) found that the infection rate in male rhesus macaques (88.9%) was insignificantly dissimilar from females (88.6%). He also found that the prevalence in adults (88.2%) was not significantly different from the juveniles (88.9%).

Table 2. Prevalence and intensity of GI helminths among the male young (N=15) and adult (N = 24) rhesus macaques

Parasites	Category	Prevalence (%)		EPG	Intensity (± SD)
		n	%		
Hymenolepis spp.	Young	3	20	10	3.33 ± 1.39
	Adult	15	62.05	42	2.8 ±1.82
Taenia spp.	Young	6	40	6	1 ± 0.51
	Adult	3	12.5	6	2 ± 0.68
Ascaris spp.	Young	15	100	36	2.4 ± 1.06
	Adult	18	75	43	2.39 ± 1.67
Toxocara spp.	Young	9	60	18	2 ± 1.21
	Adult	9	37.5	16	1.78 ± 1.05
Trichuris spp.	Young	6	40	27	1.8 ± 0.77
	Adult	12	50	21	1.75 ± 1.08
Capillaria spp.	Young	6	40	6	1 ± 0.51
	Adult	9	37.5	12	1.33 ± 0.72
Hookworm	Young	6	40	6	1 ± 0.51
	Adult	6	25	6	1 ± 0.44

The high prevalence of *Ascaris* spp. may occurred due to warm temperature of the study area which is suitable for egg production. Though *Taenia* spp. and *Toxocara* spp. are generally seen in carnivores but these parasites were observed among the rhesus macaque in the present study. One of the reasons of their presence in NHP may be the strong resistance and longevity of infective eggs in the environment that ensure their transmission to another host. Furthermore, it was noticed during fecal sample collection, same mops were used for cleaning every cage's wall, which might be a reason behind the transmission of those eggs to NHP cages.

Table 3. Prevalence and intensity of GI helminths among the female young (N = 9) and adult (N = 18) rhesus macaques

Parasites	Category	Prevalence (%)		EPG	Intensity (± SD)
		n	%		
Hymenolepis spp.	Young	6	66.67	12	2 ± 1.32
	Adult	9	50	27	3 ± 2.20
Ascaris spp.	Young	9	100	21	2.33 ± 0.50
	Adult	18	100	30	1.67 ± 0.77
Toxocara spp.	Young	3	33.33	3	1 ± 0.50
	Adult	18	100	30	1.67 ± 0.77
Trichuris spp.	Young	9	100	32	3.56 ± 0.73
	Adult	6	33.33	6	1 ± 0.49
Capillaria spp.	Young	6	66.67	9	1.5 ± 0.87
	Adult	9	50	13	1.44 ± 0.83
Hookworm	Young		-	-	-
	Adult	3	16.67	3	1 ± 0.38

Species specific intensity of infection was quite inconsequential in the present study. In young male, *Hymenolepis* spp. (3.33 ± 1.39 in young; 2.8±1.82 in adult) showed the highest intensity followed by *Ascaris* spp. (2.4 ± 1.06 in young; 2.39 ± 1.67 in adult) (Table 2). MacIntosh *et al.* (2010) found a male bias in egg per gram (EPG) and prevalence of infection with directly transmitted species in Japanese macaques, except in the prevalence of *Oesophagostomum aculeatum* and no sex bias in the other parasites. Infection with *O. aculeatum* showed a female bias in prevalence among young adults. Variation in hosts immune response because of malnutrition and stress may be accountable for parasite intensity. Parasite-host interaction may be influenced by various geographical habitat, distribution and environmental condition. Favourable environment aids in spreading parasites quickly. In the present study, among the young female, *Trichuris* spp. showed the highest intensity (3.56 ± 0.73) followed by *Hymenolepis* spp. (3.33 ± 1.39). No hookworm infection was encountered among the young females though the thin skin of young provides better entry of hookworm (Table 3).

CONCLUSION

High levels of parasitism in captive animals can be attributed to cross-species transmission and stress due to imprisonment which aggravate parasitic infections to the point of demise. Although anthelmintic drugs are used in Dhaka zoo twice in a year but may be the doses are not enough to acquire defense against gastrointestinal parasites. As a result, the perimeter of parasite infestation is high. In zoos there are an increasing risk of parasite transmission from rhesus macaques to visitors or keepers as a result of direct or indirect

contact through contaminated food, water and hands. Effective control actions should be run by the zoo authorities to lessen the probability of environmental contamination.

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