Tabasshum *et al. Animal Diseases* (2022) 2:4
https://doi.org/10.1186/s44149-022-00037-9

Animal Diseases

SHORT COMMUNICATION

Occurrence of gastrointestinal (GI) parasites in captive Olive Baboon and Common Langur in Bangladesh

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Abstract

Non-human primates (NHPs) serve as necessary reservoir hosts of parasites that create diseases to human. A close interaction between human and NHP can make a pathway for transmission of zoonotic diseases. To prevent zoonotic infection of zoo keepers, park visitors as well as keeping the captive NHPs in healthy state, it is necessary to carry out regular parasitological examination and treatment. A total of 72 fecal samples of Olive Baboon ($n = 39$) and Common Langur ($n = 33$) irrespective of their age and sex were collected from two zoological gardens of Bangladesh. Eggs and oocysts of seven gastrointestinal (GI) parasites were observed and identified in samples of both host species. The prevalence of GI parasites recorded was 100%. In case of Olive Baboon, the protozoan prevalence was higher (53.83%) than that of helminths, but opposite scenario was seen in case of Common Langur. Besides, higher intensity of coccidian oocysts in both hosts was recorded in the study.

Keywords: *Papio anubis*, *Semnopithecus entellus*, Captive, Gastrointestinal parasite

Main text

Non-human primates (NHPs) represent one of the most interesting as well as important groups among zoo animals for their valuable role in public recreation (Agoramoorthy and Hsu 2005). NHPs in captivity often live in small to large groups characterized by frequent social interactions, which facilitate parasite transmission between individuals making them vulnerable to gastrointestinal (GI) parasitic infections (Stoner 1996). Severe GI parasitic infections can lead to serious damages such as, tissue damage, blood loss, congenital malformations and eventually death (Verweij et al. 2003). Many studies reported the occurrence of GI parasites in wild and captive NHPs worldwide (Karere et al. 2002; Tachibana et al. 2009; Li et al. 2015). Olive Baboon (*Papio anubis*) is frequently studied in different countries (Bezjian et al. 2008); on the contrary, studies on endoparasitic infections of Common Langur (*Semnopithecus entellus*) are still on the baseline. To date, very few data is available about the prevalence of GI parasites in captive NHPs in zoos of Bangladesh (Raja et al. 2014; Khatun et al. 2014; Tabasshum et al. 2018; Karim et al. 2020).

The present study was performed to investigate the occurrence of GI parasites in captive Olive Baboon and Common Langur present in two zoological gardens of Bangladesh. Moreover, systematic studies on GI parasitic infections among captive NHPs present in the zoos of Bangladesh are demanded for the proper appliance of anthelmintic drug administration as well as the safety management of the animal keepers and visitors.

The current study showed that all fecal samples were positive with at least one protozoan or helminth parasite. We identified eggs and oocysts of seven GI parasites consisting of one protozoan (*Coccidia* spp.) and six

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helminths of which, two cestodes (*Hymenolepis* spp. and *Spirometra* spp.) and four nematodes (*Ascaris* spp., *Toxocara* spp., *Trichuris* spp. and hookworms) in both host species (Fig. 1). No trematodes were detected in the observed samples as there are no intermediate hosts present in captivity.

The highest prevalence of *Coccidia* spp. and *Spirometra* spp. (both 53.85%) were recorded in Olive Baboon (Table 1) followed by *Ascaris* spp. (46.15%), *Hymenolepis* spp. (38.46%) and hookworms (30.77%). Prevalence of *Trichuris* spp. (15.38%) and *Toxocara* spp. (23.08%) were comparatively less among the Olive Baboons. 95% Bayesian Confidence Interval (BCI) showed a different range of parasite prevalence. Again, overall protozoan intensity was much higher than that of helminths recorded in Olive Baboons. The highest intensity was found for *Coccidia* spp. (96.29) and the lowest was for hookworms (1.00) (Table 1).

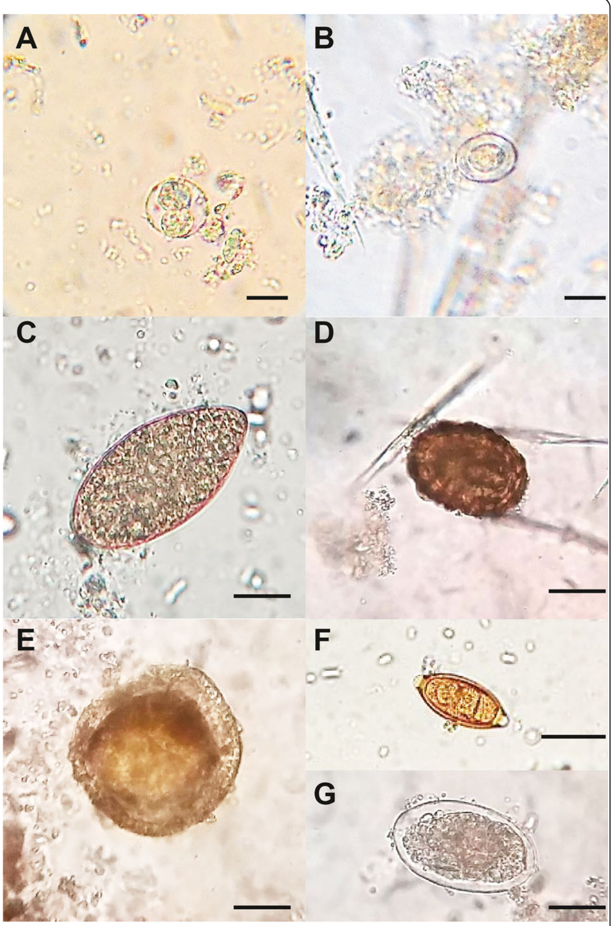

Fig. 1 Identified eggs and oocysts of seven GI parasites under compound microscope: (**A**) *Coccidia* spp., (**B**) *Hymenolepis* spp., (**C**) *Spirometra* spp., (**D**) *Ascaris* spp., (**E**) *Toxocara* spp., (**F**) *Trichuris* spp. and (**G**) hookworm in both Olive Baboon (*Papio anubis*) and Common Langur (*Semnopithecus entellus*). Bars means 50 nm. GI, gastrointestinal

Table 1 Prevalence and intensity of different GI parasites in captive Olive Baboon ($n = 39$)

Name of parasites	No. of positive samples	Prevalence (%)	95% CI	EPG/ CPG/ OPG	Intensity
Coccidia spp.	21	53.85	37.38–69.57	2022	96.29
Hymenolepis spp.	15	38.46	23.81–55.35	44	2.93
Spirometra spp.	21	53.85	37.38–69.57	325	15.48
Ascaris spp.	18	46.15	30.43–62.62	44	2.44
Toxocara spp.	9	23.08	11.71–39.72	12	1.33
Trichuris spp.	6	15.38	6.41–31.21	7	1.17
Hookworms	12	30.77	17.55–47.73	12	1.00

Notes: *GI* gastrointestinal, *EPG* eggs per gram, *CPG* cysts per gram, *OPG* oocysts per gram

We found dominance of helminths prevalence over protozoan parasites in Common Langur. 100% prevalence was recorded for *Spirometra* spp., *Ascaris* spp., *Toxocara* spp. and hookworms and the lowest prevalence was recorded for *Trichuris* spp. (9.09%) (Table 2). But the maximum intensity of protozoan parasites (here, *Coccidia* spp., intensity 31.95) was identified in Common Langur, which is also a similar case for Olive Baboons. The least intensity in Common Langur was calculated for *Toxocara* spp. (0.18) (Table 2).

The present study reported seven similar GI parasites recorded in both host species with overall 100% prevalence. Literature records showed various prevalence among NHPs in different countries. For example, Li et al. (2015) reported 26.51% prevalence of GI parasites in 24 zoos of China; Bichi et al. (2016) found 26.09% prevalence in Kano State Zoological Garden, Nigeria; Aviruppola et al. (2016) detected 61.1% prevalence in Dehiwala National Zoological Gardens, Sri Lanka. On the contrary, the prevalence of GI parasites in present study was much higher than those recorded previously. The host species, Olive Baboon and Common Langur were housed in adjacent cages and provided the same food, which makes a great

Table 2 Prevalence and intensity of different GI parasites in captive Common Langur ($n = 33$)

Name of parasites	No. of positive samples	Prevalence (%)	95% CI	EPG/ CPG/ OPG	Intensity
Coccidia spp.	21	63.64	45.14–79.04	671	31.95
Hymenolepis spp.	15	45.45	28.53–63.40	45	3
Spirometra spp.	33	100	87.02–100	561	17
Ascaris spp.	33	100	87.02–100	19	0.58
Toxocara spp.	33	100	87.02–100	6	0.18
Trichuris spp.	3	9.09	2.38–25.47	4	1.33
Hookworms	33	100	87.02–100	15	0.45

Notes: *GI* gastrointestinal, *EPG* eggs per gram, *CPG* cysts per gram, *OPG* oocysts per gram possibility to contaminate each other. Additionally, it came to our knowledge during the survey that anthelmintic drug administration among the zoos is irregularly maintained.

We found oocysts of only one protozoan parasite *Coccidia* spp. with high prevalence and intensity in both hosts. The high rate might occur due to their simple life cycle, lack of intermediate host and favorable climatic condition (Kheysin 2013). Among nematodes, *Ascaris* spp. was the most prevalent parasite with 46.15% and 100% in Olive Baboon and Common Langur respectively (Tables 1 and 2). Previous studies of Ocaido et al. (2003), Hope et al. (2004) and Larbi et al. (2020) reported *Ascaris* spp. in Olive Baboon; and Parmar et al. (2012) in Common Langur. Among these studies, Hope et al. (2004) found 78.6% prevalence of this parasite which is higher than other parasites.

Spirometra spp. and *Toxocara* spp. are generally found in carnivores (Ghoke 2012; Javaregowda 2016). Liza et al. (2020a, 2020b) found these two parasites in captive Asiatic black bear, Bengal tiger and African lion in different zoological gardens of Bangladesh. We also detected these helminths in the present study (Tables 1 and 2). One of the reasons behind their presence in non-human primates can be the strong resistance and longevity of infective eggs in the environment that ensure their transmission to another host. Again both the zoos, selected as study areas, have one or two carnivore cages nearby NHP cages. The walls and floors of those cages are built with cement which aid in clutching parasite eggs and may promote infections.

Previous studies showed the presence of *Trichuris* sp., *Ascaris* sp., and *Hymenolepis* sp. (including unidentified protozoa, nematode and hookworm) in Olive Baboon; and *Trichuris* sp., *Ascaris* sp., *Spirometra* sp. and unknown hookworms in Common Langur similar to current study (Table 3). Among these parasites, *Trichuris* sp. was the most reported nematode in both hosts (Table 3). The study of Raja et al. (2014) in Dhaka zoo of Bangladesh found *Trichostrongylus* sp. and *Balantidium coli* in Olive Baboon; and *Balantidium coli* and *Capillaria* sp. in Common Langur, which we did not observe in the current study. We collected samples randomly from both Dhaka and Rajshahi zoo, two different zoos with different geographic conditions unlike Raja et al. (2014). This may result the variation in parasites from the previous study. Khatun et al. (2014) also conducted a similar study in Rangpur zoo of Bangladesh, but did not report any parasites in Olive Baboon.

Different studies found diverse parasites in Olive Baboon and Common Langur that have not been observed during our study. For example, *Oesophagostamum* sp. was reported in the studies of Murray et al. (2000), Ocaido et al. (2003), Legesse and Erko (2004), Bezjian et al. (2008) and Ryan et al. (2012) in Olive Baboon; while the studies of Gunasekera et al. (2012) and Parmar

Table 3 Prevalence of GI parasites recorded in Olive Baboon and Common Langur in the previous studies

Host name	References	*Trichiuris* sp.	*Ascaris* sp.	*Hymenolepis* sp.	*Spirometra* sp.	Protozoa (unk.)	Nematode (unk.)	Hookworm (unk.)
Olive Baboon	Murray et al. (2000)	66					63	44
	Hahn et al. (2003)	73						
	Ocaido et al. (2003)		21					35.7
	Hope et al. (2004)	16.4	78.6	7.1				
	Legesse and Erko (2004)	27.1						
	Weyher et al. (2006)	+					+	
	Bezjian et al. (2008)	46						22
	Ryan et al. (2012)					47		
	Li et al. (2015)	13.6						
	Bichi et al. (2016)	50						
	Larbi et al. (2020)	+	22.32					38.4
Common Langur	Gunasekera et al. (2012)							+
	Parmar et al. (2012)	20	20		13.3			
	Sreedevi et al. (2017)	+						

The table represents the GI (gastrointestinal) parasites found in Olive Baboon and Common Langur reported by several previous studies. The parasites found in the present study in consistency with the previous studies are mentioned in the table only. The '+' sign indicates the infected samples by the respective parasites, where the prevalence data was unavailable.

Table 4 Information (sex and age) of the host species from two zoological gardens

Species name	Study area	Sex		Age (in years)	
		Male	Female	5 to 10	More than 10
Olive Baboon (*Papio anubis*) *n* = 39	Bangladesh National Zoo, Dhaka	9	3	3	9
	Shaheed A.H.M. Central Park and Zoo, Rajshahi	27	–	–	27
Common Langur (*Semnopithecus entellus*) *n* = 33	Bangladesh National Zoo, Dhaka	3	3	–	6
	Shaheed A.H.M. Central Park and Zoo, Rajshahi	27	–	27	–

et al. (2012) found *Enatamoeba* sp. in Common Langur. This may be different from our study due to different geographic location, climatic condition and varied susceptibility of hosts to the parasites.

These parasites can affect health of the primates in captivity, increasing their stress level and consequently can claim their lives. The presence of zoonotic parasites, like- *Trichuris* spp., *Ancylostoma* spp. in the host species can affect the health of handlers and visitors to the zoos if not controlled (Adejinmi and Ayinmode 2008; Monteiro et al. 2007). The present result with high prevalence of protozoan and helminth parasite necessitates initiating an optimization of the treatment protocol in both zoological gardens.

Methods

This study was conducted at two zoological gardens of Bangladesh (Bangladesh National Zoo, Dhaka and Shaheed A.H.M. Central Park and Zoo, Rajshahi) from July 2017 to February 2018. The fecal samples were collected from two species of captive non-human primates (Olive Baboon and Common Langur) from both zoos with permission of the authority. A total of 72 fresh fecal samples of Olive Baboon ($n = 39$) and Common Langur ($n = 33$) were collected from the cage floor with the help of caretakers following simple random sampling (Yates et al. 2008) (details in Table 4).

All individuals of the host species seemed healthy during sample collection and were housed in small to large cages with available water supply. Generally, the cages of NHPs were cuboid in shape in both zoos; average height was about 4 m. The roof of the cages was covered by iron sheets, and the floor was made of concrete. Wire net was used around the cage for safety. The procedures of sample processing, identification, counting and calculation of eggs/ cysts/ oocysts of GI parasites are given as follows:

After collection, the samples were placed in plastic jars containing 10% formalin, and sealed tightly to avoid contamination. Later, samples were stored in the refrigerator at 4 °C for not more than seven days in Parasitology laboratory of Department of Zoology, University of Dhaka.

The sample screening was performed following Formol-Ether Concentration Technique (Cheesbrough 1987). Observation of eggs/ cysts/ oocysts and larva has been performed with the help of compound microscope using 10X and 40X objective lenses.

Identification of parasite's eggs/ cysts/ oocysts was confirmed on the basis of morphological descriptions, life cycles and pictures published by Chatterjee (1980), Cheng (1997), Soulsby (1982) and Schmidt and Roberts (1996). We found hookworm eggs in all samples but they were difficult to identify to genus or species level.

After identification, the eggs/ cysts/ oocysts per gram (hereafter, EPG/ CPG/ OPG) was determined by Stoll's counting method (Stoll 1923). Prevalence and intensity of the identified GI parasites in NHPs were calculated according to Margolis et al. (1982) and Bush et al. (1997). Additionally, 95% Bayesian Confidence Interval (BCI) was calculated in R (version 3.6.1).

Abbreviations

NHP: Non-human primate; **GI**: Gastrointestinal; **EPG**: Eggs per gram; **CPG**: Cysts per gram; **OPG**: Oocysts per gram; **n**: Number of samples examined; **BCI**: Bayesian confidence interval

Acknowledgements

We express our gratitude to the Ministry of Science and Technology of Bangladesh government for providing necessary funding. We are thankful to the curators and veterinary doctors of Bangladesh National Zoo, Dhaka and Shaheed A.H.M. Central Park and Zoo, Rajshahi for allowing us to collect the samples. We also thank the laboratory attendant, Mizan Dakua for helping in sample processing.

Authors' contributions

Author AB designed the study. Author TT, FTL, MMA and MFR collected and analyzed samples in the laboratory, managed literature searches and performed statistical analysis. Author TT wrote the protocol and first draft of the manuscript. Author MM managed the analysis of the study and edited the last manuscripts. All authors read and approved the final manuscript.

Funding

Ministry of Science and Technology, Government of the People's Republic of Bangladesh.

Availability of data and materials

Not applicable.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests
The authors declare no competing or financial interests.

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Received: 2 December 2021 Accepted: 4 February 2022
Published online: 08 March 2022

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