**SHORT PAPER**

**Prevalence of gastrointestinal parasites in captive non-human primates of twenty-four zoological gardens in China**

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**Abstract**

Captive primates are susceptible to gastrointestinal (GIT) parasitic infections, which are often zoonotic and can contribute to morbidity and mortality. Fecal samples were examined by the means of direct smear, fecal flotation, fecal sedimentation, and fecal cultures. Of 26.51% (317/1196) of the captive primates were diagnosed gastrointestinal parasitic infections. *Trichuris* spp. were the most predominant in the primates, while *Entamoeba* spp. were the most prevalent in Old World monkeys (*P < 0.05*). These preliminary data will improve the management of captive primates and the safety of animal keepers and visitors.

**Introduction**

The exhibits of captive primates (i.e., non-human primates, NHPs) are an important highlight for visitors to zoological gardens. Captive primates, however, are susceptible to gastrointestinal (GIT) parasitic infections, which are often zoonotic [2, 8, 21]. Severe GIT helminth and protozoan infections can lead to blood loss, tissue damage, spontaneous abortion, congenital malformations, and death [24]. Numerous studies of GIT parasites in both wild and captive primates worldwide [11, 22] report that GIT helminth and protozoan parasites infect all major NHP groups, including captive animals, and cause high morbidity and mortality rates [9, 12, 24, 26]. Yet few studies have quantified prevalence data of GIT parasites in zoos [5, 15, 16, 20], and existing studies have limited their focus to specific primate species, specific parasite species, or specific zoos [18, 20]. To date, little is known about the prevalence of GIT parasitic infections in captive primates in Chinese zoos [10, 25, 27]. Systematical studies on GIT parasitic infection in captive NHPs housed in a larger range of representative Chinese zoological gardens are demanded for the management of primates and the safety of animal keepers and visitors.

**Materials and methods**

**Ethics statement**

All procedures were reviewed and approved by the Wildlife Management and Animal Welfare Committee of China. During fecal collection, animal welfare was taken into consideration.

**Fecal sample collection and examination**

From April 2010 to October 2012, 1196 fresh fecal samples were collected from twenty-four zoological gardens for three consecutive days in the morning. The sampled...
feces belonged to 57 primate species within nine families [3, 9]. The animals were housed either individually or in groups but species separately. Before fecal collection, the animals were all separated. Detailed information (i.e., sampling times, species, age, sex) was gathered using double labeling method, which means using a label paper inside and outside the plastic bags, during the sample collection. Fecal samples were transferred to plastic bags and stored at 4°C prior to laboratory analyses.

Fecal samples were examined for the presence of helminth eggs, larvae, and protozoan cysts by different methods: direct smear, fecal flotation, fecal sedimentation, and fecal cultures [7]. Direct smear staining with Lugol’s iodine solution (0.3% iodine) was firstly used to detect trophozoites of amoebae and flagellates in all fecal samples [17]. Eggs, larvae, and cysts were then scanned under microscope with 10 times and 40 times objectives with the methods of fecal flotation and fecal sedimentation technique on the basis of their morphology, shape, color, size, and other visible structures [19, 26]. Given the sampling collection method and the detection threshold, McMaster’s technique was only employed to assess the intensity of Trichuris spp. infection, with results were expressed as egg count per gram (EPG) [23]. Analysis of variance (ANOVA) test, Duncan’s multiple range test, and Student’s t-test were conducted using SAS software (SAS Institute, Cary, ND, USA). Statistical significance was set at $P < 0.05$.

Results

GIT parasitic infections in NHPs in zoological gardens

Of 1196 fecal samples, 317 (26.51%) were infected with at least one parasite taxon. Prevalence of GIT parasitic infections differed amongst the zoos from 3.77% to 100% (Fig. 1A). We detected five nematode species, one tapeworm species, and three protozoan species, of which the Trichuris spp. nematodes were the most abundant clade of parasites (16.30%; Table 1).

GIT parasitic infections in NHP species

We found that GIT parasites species vary greatly amongst primate clades (Fig. 1B). For example, H. nana was the most common parasite infection amongst the prosimians, while Trichuris spp. were most prevalent in Old World (OW) monkeys. OW monkeys also exhibited a higher prevalence of Entamoeba spp. infections than did other primate clades. Indeed, the prevalence rates of GIT parasitic infections differed greatly from species to species, with no parasites in the feces of 22 of the 57 primate species represented in our collection. We found that Colobus guereza harbored a significantly higher prevalence of GIT parasitic infections than other primate species ($P < 0.05$).

![Fig. 1](A) Number of feces sampled and the prevalence of gastrointestinal parasites in captive primates in twenty-four zoological gardens of China, 2010–2012. Key to zoo name abbreviations: BJ: Beijing, CD: Chengdu, GZ: Guangzhou, SHZ: Shanghai zoo, SHW: Shanghai wild zoo, CQ: Chongqing, LZ: Lanzhou, TY: Taiyuan, XA: Xi’an, JN: Jinan, ZH: Zhengzhou, QL: Quanzhou, ZY: Zunyi, NN: Nanning, KM: Kunming, KY: Kunming wild zoo, KD: Kunming institute of zoology, NJ: Nanjing, XJ: Xinjiang, WH: Wuhan, DL: Dalian, YA: Ya’an.

![Fig. 1](B) The prevalence of GIT parasites within four primate clades based on feces obtained from 57 species of primates held captive in twenty-four zoological gardens of China.
Table 1  Prevalence of gastrointestinal parasites in fifty-seven captive primates’ species from China, 2010–2012. Mean intensity = mean number of Trichuris spp. in eggs per gram of fecal samples

| Species                     | Family   | GIT parasite prevalence (%) | Mean intensity (Mean ± SD) |
|-----------------------------|----------|-------------------------------|---------------------------|
| Macaca assamensis           | Cercopithecidae | 1 (9.09%)                      | 1.009                     |
| M. sphenus                  |          |                               |                           |
| M. nigra                    |          |                               |                           |
| M. thibetana                |          |                               |                           |
| M. fascicularis             |          |                               |                           |
| M. arctoides                |          |                               |                           |
| M. mulatta                  |          |                               |                           |
| M. nemestrina               |          |                               |                           |
| P. anubis                   |          |                               |                           |
| P. cynocephalus             |          |                               |                           |
| P. papio                    |          |                               |                           |
| M. leucophaeus              |          |                               |                           |
| P. phayrei                  |          |                               |                           |
| M. francoisi                |          |                               |                           |
| R. bieti                    |          |                               |                           |
| R. brelichi                 |          |                               |                           |
| Cercopithecus neglectus     |          |                               |                           |
| C. nictitans                |          |                               |                           |
| C. aethiops                 |          |                               |                           |
| Colobus polykommos         |          |                               |                           |
| C. guereza                  |          |                               |                           |
| Erythrocebus patas          |          |                               |                           |
| Galago crassicaudatus       |          |                               |                           |
| Ateles paniscus             |          |                               |                           |
| Callithrix jacchus          |          |                               |                           |
| Cebus capucinus             |          |                               |                           |
| Cebus kaapori               |          |                               |                           |
| Cebus apella               |          |                               |                           |
| Calithrix jacchus           |          |                               |                           |
| Callithrix leucogenys       |          |                               |                           |
| Callithrix flavus           |          |                               |                           |

(continued)
Trichuris spp. infections in NHPs

The prevalence of *Trichuris* spp. infections differed greatly amongst the 24 species observed to harbor GIT infections (range = 1.94% to 100%; Table 1). *Trichuris* spp. prevalence was highest for *Colobus guereza* and *Rhinopithecus roxellanae*, with 100% and 80% of their fecal sampled infected, respectively. In addition, *R. roxellanae* exhibited a significantly higher average egg count of *Trichuris* spp. than many other species (*Erythrocebus patas, Papio hamadryas, C. guereza, Presbytis francoisi*, and *R. bieti; P < 0.05; Table 1).

Discussion

This study presents the first extensive survey of GIT parasitic infections in captive primates in China. The prevalence of parasites in primates housed in the zoos varies according to husbandry practices, disease prophylaxis, and anthelmintic treatment administered. Efficacious control measures have been taken by the zoos to reduce the environmental contamination, such as frequent dung removal. In addition, the primates are treated twice a year with anthelmintic drugs to prevent and control the parasite burdens. So, we found a low prevalence of GIT parasites in many of the sampled species. Nevertheless, Helminths, especially *Trichuris* spp., *S. fulleborni*, and *Oesophagostomum* spp., were the most prevalence parasites amongst the captive primate species. This supports the findings of previous studies [6, 13]. *Trichuris* spp. seems to be a globally distributed parasite in primates and should be considered in the management practices of captive primates.

Surprisingly, protozoan infections were rare and of low prevalence within our samples, which may be a consequence of host susceptibility or behavior [4]. For example, OW monkeys in the wild harbor high parasite infection rates as a result of their ground-dwelling habits [1, 14], although in zoos they were housed in clean cages. It is also possible that the prevalence of protozoan infection was underestimated in this study due to low detection rates by the methods used. Molecular techniques offer a robust means of corroborating prevalence of protozoan infections in captive primates, once technical difficulties can be overcome (e.g., eliminating the influence of preservatives, such as potassium dichromate [21, 28]).

Many parasites are known to be transmissible between non-human primates and humans [2, 8]. In zoos, there is an increased risk of parasite transmission from primates to visitors or keepers as a result of direct or indirect contact through contaminated...
food, water, and hands. The GIT parasites detected in this study are amongst those known to represent human public health concerns (Trichuris spp., Entamoeba spp., and G. duodenalis [21]). Hence, our results highlight that proper precautions should be taken by the zoological gardens with large number of animals to mitigate against parasite transmission. This includes adhering to basic hygiene standards, undertaking regular deworming of animals, and ensuring cages are cleaned and disinfected daily.

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References
1 Beaver P, Blanchard J, Seibold H: Invasive amebiasis in naturally infected New World and Old World monkeys with and without clinical disease. Am J Trop Med Hyg 1988; 39:343–52.
2 Brown C: Emerging zoonoses and pathogens of public health significance–an overview. Rev Sci Tech OIE 2004; 23:435–42.
3 Calle PP, Joslin JO: Chapter37- New world and Old world monkeys. Fowler’s Zoo Wild Anim Med 2015; 8:301–35.
4 Davies TJ, Pedersen AB: Phylogeny and geography predict pathogen community similarity in wild primates and humans. Proc R Soc B Biol 2008; 275:1695–701.
5 Gunasekera UC, Wickramasinghe S, Wijesinghe G, Rajapakse R: Gastrointestinal parasites of captive primates in the National Zoological Gardens of Sri Lanka. Taprobanica 2012; 4:37–41.
6 Gillespie TR, Greiner EC, Chapman CA: Gastrointestinal parasites of the colobus monkeys of Uganda. J Parasitol 2005; 91:569–73.
7 Gillespie TR: Noninvasive assessment of gastrointestinal parasite infections in free-ranging primates. Int J Primatol 2006; 27:1129–43.
8 Huffman M, Nahallage C, Hasge- wa H, Ekanayake S, De Silva L, Athauda I: Preliminary survey of the distribution of four potentially zoonotic parasite species among primates in Sri Lanka. J Natl Sci Found 2013; 41:319–26.
9 Johnson-Delaney CA: Parasites of captive nonhuman primates. Vet Clin North Am Exot Anim 2009; 12:563–81.
10 Jian FC, Zhang QT, Li SY, Li TY, Li DZ, Zhang LX, Ning CS: Epidemiological investigation and dispelling parasite test on herbivore and quadruped in Zhengzhou Zoo. Chin Agric Sci Bull 2008; 24:29–34.
11 Karere G, Munene E: Some gastrointestinal tract parasites in wild De Brazza’s monkeys (Cercopithecus neglectus) in Kenya. Vet Parasitol 2002; 110:153–7.
12 Lee JI, Kim NA, Ahn KH, Park CG: Investigation of helminths and protozoans infecting old world monkeys: captive vervet, cynomolgus, and rhesus monkeys. Korean J Vet Res 2010; 50:273–7.
13 Melli V, Poyser F: Trichuris burdens in zoo-housed Colobus guereza. Int J Parasitol 2007; 28:1449–56.
14 Munene E, Otsuya M, Mbaabu D, Mutahi W, Muriuki S, Muchemi G: Helminth and protozoan gastrointestinal tract parasites in captive and wild-trapped African non-human primates. Vet Parasitol 1998; 78:195–201.
15 Nath BG, Islam S, Chakraborty A: Prevalence of parasitic infection in captive non human primates of Assam State Zoo, India. Vet World 2012; 5:614–616.
16 Panayotova-Pencheva MS: Parasites in captive animals: a review of studies in some European zoos. Zool Garten 2013; 82:60–71.
17 Pourrut X, Diffo J, Somo R, Bilong Bilong C, Delaporte E, LeBreton M, Gonzalez JP: Prevalence of gastrointestinal parasites in primate bushmeat and pets in Cameroon. Vet Parasitol 2011; 175:187–91.
18 Rivera WL, Yason JAD, Adao DEV: Entamoeba histolytica and E. dispar infections in captive macaques (Macaca fascicularis) in the Philippines. Primates 2010; 51:69–74.
19 Sloss MW, Kemp RL, Zajac AM: Veterinary Clinical Parasitology. Ames, Iowa: Iowa State University Press, 1994.
20 Sanchez VVV, Patino AS, Segundo VJP, Sandoval JAC, Esquivel CVC, Sanchez TAC: Prevalence of gastrointestinal parasites among captive primates in Panama. J Anim Vet Adv 2009; 8:2644–9.
21 Thompson R: The zoonotic significance and molecular epidemiology of Giardia and giardiasis. Vet Parasitol 2004; 126:15–35.
22 Tachibana H, Yanagi T, Akatsuka A, Kobayashi S, Kanbara H, Tsutsui V: Isolation and characterization of a potentially virulent species Entamoeba muttalli from captive Japanese macaques. Parasitology 2009; 136:1169–77.
23 Vercruysse J, Holdsworth P, Letonja T, Barth D, Conder G, Hamamoto K, Okano K: International harmonisation of anthelmintic efficacy guidelines. Vet Parasitol 2001; 96:171–93.
24 Verweij JJ, Vermeer J, Brien EA, Blotkamp C, Laeijendecker D, van Lieshout L, Polderman AM: Entamoeba histolytica infections in cap-
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25 Wang XL, Li PY, Gu YF, Xu QM, Zhao CC, Liu W: Investigation into *Cryptosporidium* infection on primates and herbivores in a zoo in Anhui. *J Anhui Sci Tech Univ* 2010; 24:8–11.

26 Yang GY, Zhang ZH: Parasitic Diseases of Wildlife. Beijing: Science Press, 2013; 11-16.

27 Zhao JF, Qi M, Wang HL, Feng C, Zhang LX: Prevalence of intestinal parasites in captive Macaques (*Macaca mulatta*). *J Henan Agric Sci* 2011; 40:135–7.

28 Zhao GH, Cong MM, Bian QQ, Cheng WY, Wang RJ, Qi M, Zhang LX, Lin Q, Zhu XQ: Molecular characterization of *Cyclospora*-like organisms from Golden Snub-nosed Monkeys in Qinling mountain in Shaanxi province, northwestern China. *PLoS ONE* 2013; 8:e58216.
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