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Short Communication

Gastrointestinal Helminths in Large Felines from a Zoo in Malaysia

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ABSTRACT

In nature, wild animals live in an enormous space and usually have very low genetic resistance against parasitic infection mainly due to low exposure towards the parasites themselves. However, when herds of these wild animals are kept in captivity, or in zoological gardens, parasitic infections might be worse and pose a serious threat to endangered species. The present study was conducted to observe the occurrence of gastrointestinal parasites in large felines in a Malaysian zoo. Ten faecal samples were collected from pumas (*Puma concolor,* n = 5), African lions (*Panthera leo,* n = 3), a spotted leopard (*Panthera pardus,* n = 1), and a black panther (*Panthera onca,* n = 1). All faecal samples were examined for parasite eggs, larvae, and oocysts by simple faecal floatation and formalin – ether sedimentation technique. All large felines in the zoo were infected with gastrointestinal parasites. A total of six species of gastrointestinal parasites were recovered including four nematodes (*Toxocara cati*, *Ancylostoma* spp., *Toxascaris leonina*, and *Oxyuris* sp.), a cestode (*Spirometra* sp.), and a protozoan (*Isospora* sp.). Half (n=5/10) of the large felines had mixed infections with *Toxocara cati* and *Ancylostoma* spp.

Zoos have been protecting endangered species by playing a major role in promoting the animals' biodiversity in enclosures for the past few decades (Parsani *et al*., 2001). Unfortunately, despite the proper care and routine management offered, the zoo animals are under constant stress mainly due to captivity. Stress can be one of the predisposing factors for these captive animals to be infected with gastrointestinal parasites (Duszynski and Upton, 2001). In general, it is nearly impossible for zoo management to recreate the abiotic environmental conditions that mimic their native habitat such as temperature and humidity extremes, as well as photoperiod and space requirements. Other than that, the biotic conditions such as co-evolved vertebrates and invertebrates, and seasonal dietary needs are nearly impossible to be duplicated in captivity. A zoological garden is where the animals are frequently exposed to humans at a distance. Even so, such proximity to a massive number of people is unnatural and can cause various levels of stress (Duszynski and Upton, 2001). Infection by gastrointestinal parasites may affect the host's survivability both directly and indirectly by reducing the host's immunity and affecting the physical condition with pathological effects such as blood loss, tissue damage, and spontaneous abortion (Thawait *et al*., 2014). Animals kept in confined areas for a long time will be susceptible to parasitic infections. Transmission could happen as a result of moving from one enclosure to another without appropriate anthelmintic treatment. The source of infection could be from other zoo animals, or could even be zoo staff who carry the parasites on their attire, hands, or working tools (Atanaskova *et al*., 2011). In general, most infections are undetectable unless the infection is significant and shows clinical signs (Maesano *et al*., 2014). Thus, the factors contributing to the intensity of the infection include the hygiene of the enclosures and food, type of breeding, and prophylaxis and treatment (Lim *et al*., 2008). Captive animals have the potential to be vectors of zoonoses (Duszynski and Upton, 2001) and some of the parasitic diseases affecting the zoo animals are zoonotic and pose a potential risk to humans, especially the zoo workers and veterinarians (Varadhrajan and Kandasamy, 2000; Kashid *et al*., 2003).

As a result of all these factors, we believe that it is very critical to practice prevention protocols, provide regular control and monitoring of parasite infections, and initiate

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proper anthelmintic therapy whenever needed. Only one research project has been conducted earlier, investigating the epidemiology of parasites in animals from zoological gardens in Malaysia. This indicates a lack of information on the biology and epidemiology aspects of parasitism in zoo animals in Malaysia. Therefore, this study was conducted to evaluate the presence of gastrointestinal parasites in large felines in a Malaysian zoo.

Materials and methods

The study was conducted at the zoo which covers 110 acres of land and is occupied by a total of 5,317 animals from 476 species of mammals, amphibians, fishes, birds, and reptiles. This study involved 10 large felines which consist of five pumas (*Puma concolor*), three African lions (*Panthera leo*), a spotted leopard (*Panthera pardus*), and a black panther (*Panthera onca*). All animals were adults aged more than one year old, and individual data is recorded in Table I. All animals did not show any clinical signs associated with parasitic infections such as diarrhoea and had good body condition scores.

The animals were mainly housed in two different locations inside the zoo. The pumas were housed in the Mammalian Kingdom section which was located further north compared to the other species in this study which were housed in the Carnivores section and located in the centre of the zoo. Every day after the animals were released into the exhibition area, the night holding facilities were cleaned with a high-pressure water pipe. In the exhibition area the faeces was removed once every two days. The large felines in the zoo were fed once daily in the evening when the animals return to their holding facilities after visiting hours. Their diet consists of mainly poultry meat and beef, and there are livestock reared for feeding purposes to the carnivorous animals in the zoo. Other than that, the pumas are sometimes fed with white rats once every week.

A total of 10 faecal samples (one faeces per animal) were collected according to individual animals listed in Table I. Some of the animals are kept together in one cage, therefore before sample collection, with help from the zoo management team, the animals (pumas and African lions) were kept separately for this purpose. Sample collections were conducted in the morning, after the animals were released into the exhibition area and before the cages were cleaned. All samples were subjected to simple floatation technique by using salt solution (Sodium Nitrate, specific gravity= 1.30) and formalin–ether sedimentation technique.

Results and discussion

In general, the fecal consistency was well-formed faeces for all fecal samples without any sign of diarrhea. All animals in the present study were infected with nematodes (n= 10), while cestode infection (10 %; n=1/10) and protozoan infection (10 %; n=1/10) were also observed. Half (n=5/10) of the large felines had mixed infections with *Toxocara* spp. and *Ancylostoma* spp. All five pumas were infected with *Toxocara cati* (n = 5/5, 100%) (95% CI: 46.29-98.13) (Supplementary Fig. 1) and one of the pumas suffered from mixed infection with *Ancylostoma spp.* (n = 1/4, 20%), *Oxyuris spp.* (n = 1/4, 20%), and Isospora-like oocyst (n = 1/4, 20%) (CI: 1.32-78.05). All three African lions had mixed infections with *Toxascaris leonina* (n = 3/3, 100%) and *Ancylostoma spp.* (n = 3/3, 100%) (CI: 30.99-96.82) (Supplementary Fig. 2). The spotted leopard was infected with *Toxocara cati* (n = 1/1, 100%) while the black panther was suffering from mixed infection with *Toxocara cati* (n = 1/1, 100%) and a *Spirometra* spp. (n = 1/1, 100%) (CI: 54.62-89.22).

This is the first documentation of gastrointestinal parasite infection involving large captive felines maintained in a zoo. A previous survey on intestinal parasites of various animals in a Malaysian zoo was described by Lim *et al*. (2008). The carnivores examined in the present study were infected with at least one gastrointestinal parasite and all identified species have been previously described in captive carnivores. Among these gastrointestinal parasites, two of the identified species (*Toxocara cati* and *Ancylostoma* spp.) possess zoonotic potential and can be a source of transmission between animals and humans. In general, *Toxocara* sp. is known to cause visceral larval migrans and ocular larval migrans (Magnaval, 2001) while *Ancylostoma* spp. causes cutaneous larval migrans in humans (Bowman, 2010). In comparison with the previous work done in the same zoo in 2008 (Lim *et al*., 2008), the pumas' parasite infection changed from single infection with *Toxocara cati* to mixed infection with *Ancylostoma* spp., *Oxyuris* spp., and *Isospora* sp. eggs. For African lions, the gastrointestinal parasite infection changed from single infection with *Toxocara cati* to having mixed infection with *Toxascaris leonina* and *Ancylostoma* spp. Other than that, the black panther had no gastrointestinal parasites detected previously, but currently suffers from mixed infection with *Toxocara cati* and *Spirometra* sp. There are various factors that could contribute to the differences between the 2008 research and this present work. Firstly, the method used for processing and examining the samples were different. In the previous work, direct wet mount was used where small amounts of faeces and only normal saline were used as a medium to examine the presence of gastrointestinal eggs or oocysts. In the present work, simple floatation technique was used as eggs will float in a salt solution which could increase the chances of finding parasite eggs. However, for trematode egg identification the formalin

Table I. Individual record of the large felines in the zoo involved in the study.

Species	Name	Sex	Age	Origin	Deworming record
Puma concolor	Anuia	Female	16 years	Transferred from other zoo in 2014	April 2013
Puma concolor	Atilia	Female	5 years	Parent raised in the present zoo	*
Puma concolor	Amelia	Female	5 years	Parent raised in the present zoo	*
Puma concolor	Agong	Male	11 years	Parent raised in the present zoo	April 2013
Puma concolor	Akila	Female	11 years	Parent raised in the present zoo	*
Panthera leo	Manjakani	Male	13 years	Transferred from other zoo in 2007	July 2012; April 2013; June 2015
Panthera leo	Samba	Male	4 years	Parent raised in the present zoo	June 2015
Panthera leo	Simba	Male	4 years	Parent raised in the present zoo	June 2015
Panthera pardus	Panjang	Male	Unknown	Transferred from other zoo in 2012	*
Panthera onca	Apow	Male	Unknown	Captured in the wild in 2010	*

*No deworming regime stated in the health record.

ether sedimentation techniques were similar for both studies. The most common determinants for differences in prevalence are management practices, animal food source, and other factors (Javaregowda, 2016; Rokib ur Raja *et al*., 2014). The large felines in the present work harboured gastrointestinal parasites most likely as a result of high environmental contamination as they are kept intensively which increases the chances of parasite infective stages to be abundant in a confined area. Despite proper attention to feeding and maintenance of hygiene, animals that are kept in captivity or in confined areas are prone to different parasitic infections (Lim *et al*., 2008). In the zoo, the holding cages are cleaned daily while faeces in the exhibition area will be removed once every two days. However, this is not always the case as faeces could be present in the exhibition area for longer than two days. This situation might contribute to the occurrence of gastrointestinal parasite infection that may persist in the environment and lead to constant infection of the animals. Parasitic diseases often represent a major concern in zoo animals for the high environmental contamination and constitutes one of the major problems causing mortality in these animals (Fagiolini *et al*., 2010). Mortality in these animals might result from changes in the integrity of the host enterocytes (Sheppard, 1974) caused by the gastrointestinal parasites. This causes interference with both intestinal digestion and absorption (Stein and Marquard, 1973) which leads to changes in the architecture of the intestinal villi (Fernando and McCraw, 1973). Subsequently, this leads to increased flow of tissue fluid and blood into the intestinal lumen (Bailey, 1994) thus resulting in the clinical sign of diarrhoea, leaving the host susceptible to secondary bacterial invasion (Li *et al*., 1996).

Conclusion

The results of this study showed that even with regular faecal examination performed in the zoo, there is still a presence of detectable levels of parasitic infection in these large felines. Other than that, the majority of parasite species detected in this study are known to be zoonotic and transmission to humans is a significant risk. Proper parasite control of the environment as well as food and water sources is important together with providing better quality food with vitamins and minerals as supplements and identifying procedures to diminish the risk of infection (Borghare *et al*., 2009).

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Supplementary material

There is supplementary material associated with this article. Access the material online at: https://dx.doi.org/10.17582/journal.pjz/20190917030922

Statement of conflict of interest

Authors have declared no conflict of interest.

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