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Copro-ovoscopical Assessment of Gastrointestinal Parasitism in Captive Canine and Feline Carnivorans

V. Manjunatha[1]*, M. Rout[2], N. Salian[3], L.M. Kshama[3], V Sreevatsava[4], K.S. Umashankar[3] and S.M. Byregowda[4]

[1]*Wild Animal Disease Diagnostic Laboratory, Institute of Animal Health and Veterinary Biologicals, Bannerghatta Biological Park, Bannerghatta, Bengaluru, Karnataka, INDIA*

[2]*ICAR-Directorate of Foot and Mouth Disease, IVRI Campus, Mukteswar, Nainital, Uttarakhand, INDIA*

[3]*Zoo Hospital, Bannerghatta Biological Park, Bannerghatta, Bengaluru, Karnataka, INDIA*

[4]*Institute of Animal Health and Veterinary Biologicals, Hebbal, Bengaluru, Karnataka, INDIA*

**Corresponding author: V Manjunatha; Email: manjuvet330@gmail.com*

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ABSTRACT

The health surveillance through a copro-ovoscopical study was conducted to assess the gastrointestinal parasitic infections in captive canine {jackal (*Canis aureus*), wolf (*Canis lupus*), dhole (*Cuon alpinus*) and hyaena (*Hyaena hyaena*)} and feline carnivorans {lion (*Panthera leo*), tiger (*Panthera tigris*), leopard (*Panthera pardus*) and jungle cat (*Felis chaus*)}, maintained at Bannerghatta Biological Park, Bengaluru, Karnataka. A total of 41 fecal samples from apparently normal/healthy captive lions, 35 from tigers, 34 from leopards, 14 from jungle cats, 4 from dholes, 4 from wolves, 4 from jackals and 2 from hyenas were collected over a period of 12 months during 2015-2016 and were screened using classical parasitological techniques including sedimentation and floatation technique followed by microscopic identification of eggs. It revealed the prevalence of ova of 3 (7.31%) *Strongyle* sp., 8 (19.51%) *Ancylostoma* sp., 21 (51.21%) *Toxocara* sp., 16 (39.02%) *Toxascaris leonina,* 4 (9.75%) mixed (*Ascaris* and *Ancylostoma* sp.) in lions; 19 (54.28%) *Toxocara* sp., 8 (22.85%) *Toxascaris leonina,* 6 (17.14%) *Ancylostoma* sp., 2 (5.71%) oocyst of *Eimeria* sp., 2 (5.71%) *Spirometra* sp. in tigers; 13 (38.23%) *Toxocara* sp., 6 (17.64%) *Ancylostoma* sp. in leopards; 7 (50%) *Isospora* sp. and 2 (14.28%) *Toxocara* sp. in jungle cats; 2 (50%) *Ancylostoma* sp. in jackals; 2 (50%) *Toxocara canis* and 1 (25%) *Ancylostoma* sp. in wolves; 2 (50%) *Toxocara canis* in dholes; while ova of only 1 (50%) *Ancylostoma* sp. could be observed in hyaena. This preliminary data may be useful for health management of the said species in captivity.

Keywords: Ancylostomatid ova, Canids, Coccidia oocyst, Felids, Strongyle, Toxascaris

'Carnivora' is a diverse scrotiferan order that includes numerous species of placental mammals formally referred to as 'carnivorans'. Out of 250 species of wild carnivores globally distributed, eight families comprising 60 species are found in India, which are displayed in enclosures of zoological gardens or biological parks for aesthetic, research and conservation purposes (Khatun *et al.,* 2014; Thawait *et al.,* 2014). Karnataka state is endured with considerable variety of wildlife species including carnivores such as tiger, lion, leopard, jackal, wolf, dhole, hyaena and jungle cat. Parasitic infections not only cause the morbidity of animals, its severe load may cause fatal consequences (Chhabra and Pathak, 2013) leading to a number of negative effects (Panayotova-Pencheva, 2013). The weakening of immune system due to stress of captivity makes these animals more prone to parasites and other pathogens (Cordon *et al.,* 2008). Under such state of captivity their health status varies with several factors such as management, feeding, environment and sanitation. Studies on parasitic diseases of wildlife species are sparse or in infancy in India with only few systematic studies having been undertaken and data are still on the base line. This study was hence attempted with an objective of documenting the diversity and prevalence of gastrointestinal parasites in captive canine {jackal (*Canis aureus*), wolf (*Canis lupus*), dhole (*Cuon alpinus*) and

hyaena (*Hyaena hyaena*)} and feline carnivorans {lion (*Panthera leo*), tiger (*Panthera tigris*), leopard (*Panthera pardus*) and jungle cat (*Felis chaus*)} maintained at Bannerghatta Biological Park (BBP), Bengaluru, Karnataka. Moreover, as these species are confined to fragmented protected landscapes, obtaining such baseline data on parasite infection may hopefully assist in health management and indirectly the conservation efforts.

MATERIALS AND METHODS

Freshly defecated fecal samples from the captive carnivores (lion, tiger, leopard, jungle cat, wolf, dhole, hyaena and jackal) were obtained opportunistically with the assistance of the animal care-takers over a period of 12 months during 2015 - 2016 at BBP, Bengaluru. Each animal's individual identification, age, gender were recorded. After complete parasite identification, the information was filled up in each animal's record sheet. A total of 41 fecal samples from apparently normal/healthy captive lions, 35 from tigers, 34 from leopards and 4 from jackals, 14 from jungle cats, 4 from dholes, 4 from wolves, 4 from jackals and 2 from hyaenas were collected, placed in properly labeled interlocked polythene bags, sealed properly and were brought to the Wild Animal Disease Diagnostic Laboratory for processing. In the laboratory, coprological analyses by qualitative methods e.g. direct smear examination, standard sedimentation, and floatation technique was followed as per standard protocols described by Bowmann (2009). Then, the parasitic eggs/ova/oocysts were identified based on their morphology (Bowmann, 2009) using a light microscope at 10X and 40X enlargements.

RESULTS AND DISCUSSION

The present copro-ovoscopical investigation in carnivoran species revealed the ovo-prevalence of 3 (7.31%) *Strongyle* sp., 8 (19.51%) *Ancylostoma* sp. (Fig. 1), 21 (51.21%) *Toxocara* sp., 16 (39.02%) *Toxascaris leonina,* 4 (9.75%) mixed infection (*Ascaris* and *Ancylostoma* sp.) in lions; 19 (54.28%) *Toxocara* sp. (Fig. 2), 8 (22.85%) *Toxascaris leonina* (Fig. 3)*,* 6 (17.14%) *Ancylostoma* sp., 2 (5.71%) oocyst of *Eimeria* sp., 2 (5.71%) *Spirometra* sp. (Fig. 4) in tigers; 13 (38.23%) *Toxocara* sp., 6 (17.64%) *Ancylostoma* sp. in leopard; 7 (50%) *Isospora* sp. (Figure 5) and 2 (14.28%) *Toxocara* sp. in jungle cats; 2 (50%) *Ancylostoma* sp. in jackal; 2 (50%) *Toxocara canis* and 1 (25%) *Ancylostoma* sp. in wolves; 2 (50%) *Toxocara canis* in dholes and only 1 (50%) *Ancylostoma* sp in hyena (Table 1).

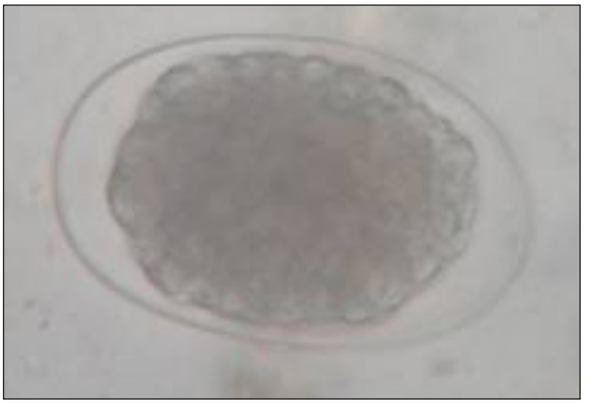

Fig. 1: Ancylostomatid egg in fecal smear of lion

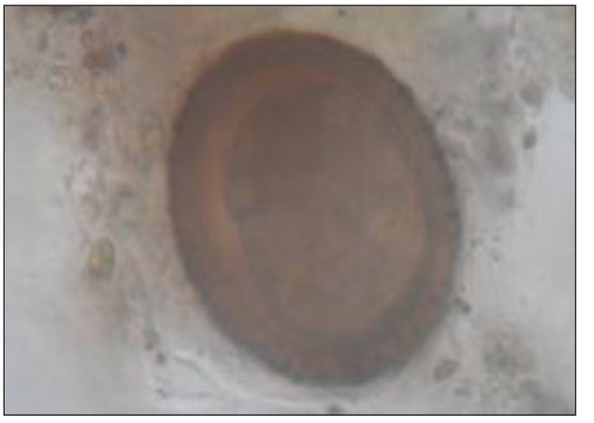

Fig. 2: *Toxocara* ova in fecal smear of tiger

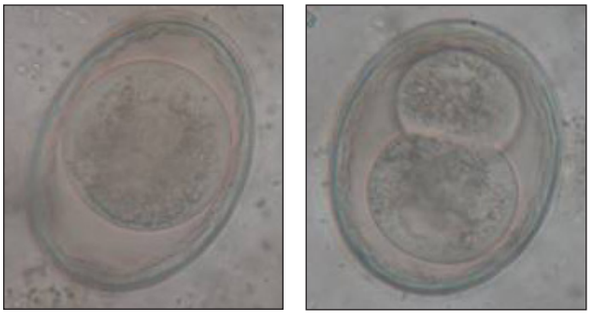

Fig. 3: *Toxascaris leonina* ova in fecal smear of tiger

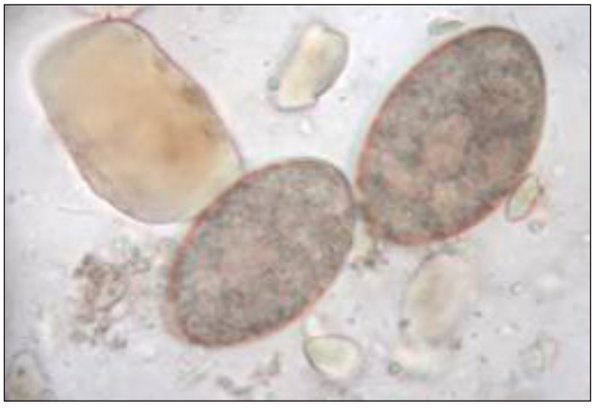

Fig. 4: *Spirometra* ova in fecal smear of tiger

Fig. 5: *Isospora* oocyst in fecal smear of jungle cat

Table 1: Prevalence of gastrointestinal parasites in captive canine and feline carnivorans at BBP, Bengaluru identified by coprological examination

Species	Total number of samples examined	Number and % positive	Eggs/oocysts of parasites identified
Lion (*Panthera leo*)	41	3 (7.31%)	*Strongyle* sp.
		8 (19.51%)	Ancylostomatid ova
		21 (51.21%)	*Toxocara* sp.
		16 (39.02%)	*Toxascaris leonina*
		4 (9.75%)	Mixed (*Ascaris* and Ancylostomatid ova)
Tiger (*Panthera tigris*)	35	19 (54.28%)	*Toxocara* sp.
		8 (22.85%)	*Toxascaris leonina*
		2 (5.71%)	Eimeria oocyst
		6 (17.14%)	Ancylostomatid ova
		2 (5.71%)	*Spirometra* sp.
Leopard (*Panthera pardus*)	34	13 (38.23%)	*Toxocara* sp.
		6 (17.64%)	Ancylostomatid ova
Jungle cat (*Felis chaus*)	14	7 (50%)	*Isospora* sp,
		2 (14.28%)	*Toxocara* sp.
Jackal (*Canis aureus*)	4	2 (50%)	Ancylostomatid ova
Wolf (*Canis lupus*)	4	2 (50%)	*Toxocara canis,*
		1 (25%)	*Ancylostoma* sp
Dhole (*Cuon alpinus*)	4	2 (50%)	*Toxocara canis*
Hyaena (*Hyaena hyaena*)	2	1 (50%)	*Ancylostoma* sp.

Cases of infection with *T. leonina* have been documented in Royal Bengal Tigers (*Panthera tigris tigris*), Asiatic lions (*Panthera leo persica*) and leopards (*Panthera pardus*) from different parts of India. The parasite has been reported during coprology and necropsy as well, while Pawar *et al.* (2012) confirmed the parasite using molecular technique at Nehru Zoological Park, Hyderabad. Mixed (*Ascaris* and Ancylostomatid ova) in 4 (9.75%) lion samples were also recorded in the present study. Such mixed infection has also been documented by earlier workers. Javaregowda (2016) found eggs of *Toxocara* sp. and mixed infections of *Strongyle* sp., *Toxocara* sp, and coccidian oocysts in lions. The lions of TLS (Tyavarekoppa Lion and Tiger Safari), Shivamogga reportedly harboured higher percentage

of *Toxocara* infection, either alone or mixed with strongyles and coccidial infections (Ananda *et al.,* 2012; Ananda, 2015; Ananda *et al.,* 2016). Earlier surveys on gastrointestinal parasites of leopards at BBP (1981-1982), Bengaluru and Mysore Zoo (1990) declared freedom from infection, while further coprological examinations of leopards showed high infections of *Toxascaris leonina* and *Ancylostoma* sp., either single or with combinations. Strongyle infection alone and its combination with ascarid were reported at BBP, Bengaluru. At the same BBP, three repeated screening from more than 100 lions during 2003-2004 could find 56.39% samples positive for *T. leonina* ova. Catarrhal enteritis in lion cubs at BBP due to *T. leonina* has been recorded by Renukaprasad *et al.* (2011). Interestingly, *T. leonina* was reported from wild felids and canids in most parts of the world. *Eimeria* species do not usually parasitize felids. However, earlier workers have reported coccidiosis in tiger, lion, leopard and hyaena (Javaregowda, 2016) and in white tiger. Ascaridoses have been reported to be the most frequent helminthoses in predatory animals and predominantly younger animals are victimized by *Toxocara* sp.

Survey in Mysore Zoo revealed that infection of *Toxocara*, *Toxascaris*, *Ancylostoma* and coccidia were commonly encountered in tigers. At BBP, Bengaluru, strongyles and coccidian were earlier recorded, while Renukapasad *et al.* (2011) noticed coccidian oocysts in fecal samples. Ananda (2015) and Ananda *et al.* (2014, 2016) observed ova of *Ancylostoma* sp., *Toxocara* sp., *Strongyle* sp. and *Spirometra* sp. as single or mixed infections as well as coccidian oocysts in tigers of TLS, Shivamogga. Shrikhande *et al.* (2008) reported ova of *Spirometra* sp. and *Toxascaris* sp. in tigers at Rajiv Gandhi Zoological Park, Maharashtra. Javaregowda (2016) documented mixed infections of *Strongyle* sp., *Toxocara* sp, *Spirometra* sp and oocysts of coccidia in tiger. *Toxocara* sp. from Royal Bengal Tiger were reported through coprology at Baranga Zoo, Delhi Zoo, Lucknow Zoo (Gaur *et al.,* 1979), Thiruvananthapuram Zoo, Rajkot Zoo, Maharajbagh Zoo, MC Zoologial Park, Punjab, Nandankanan Zoo (Mahali *et al.,* 2010) and through necropsy at Vandalur Zoo, Tamil Nadu and Assam State Zoo. Peng *et al.* (2016) recorded eggs of *T. leonina* in captive Siberian tigers in China, while Sarvi *et al.* (2018) reported *Toxocara* sp. and *T. leonina* in carnivores in Iran.

Ascaris felis, *Parascaris felis* and *T. leonina* were reported from lions. Wild Gir forest lions and Indian zoo lions had *Toxascaris* sp. and *Ancylostoma* sp. *T. leonina* and *Spirometra* sp. have been described in Australian circus lions. An Asiatic lion of Bikaner Zoo was reported to have suffered from parasitic gastritis due to *T. leonina*. An abnormal incidence of 100% ascarid infection was documented in lions at Mysore Zoo, of which 86.67% had *Toxascaris* and the remaining had combination of *Toxocara* and *Toxascaris* infections. *Ancylostoma paraduodenale* was reported in the Asiatic lion in India. Mukarati *et al.* (2013) reported eggs of *Ancylostoma* sp., *T. leonina* and *T. canis* in African lions in Zimbabwe. Hookworms of *Toxocara* species from Asiatic lion were reported through coprology at Zoological Park, Coimbatore, Rajkot Zoo, Thrissur Zoo, Maharajbagh Zoo, MC Zoological Park, Punjab, Ramgiri Estate, Wayanad, Kerala, Nandankanan Zoo (Mahali *et al.,* 2010), Nandanvan Zoo, Chhatissgarh (Thawait *et al.,* 2014) and through necropsy at Zoological Park, Gwalior.

The reports from TLS, Shivamogga indicated higher percentage of *Toxocara* and *Spirometra* infections in leopards (Ananda *et al.,* 2012; Ananda, 2015; Ananda *et al.,* 2016). Javaregowda (2016) found eggs of *Toxocara* sp. and *Spirometra* sp. in leopards. Unidentified *Spirometra* species were reported from leopards at Rajkot Zoo and Maharajbagh Zoo. *Spirometra mansonoides* were recovered during necropsy of a leopard in a forest near Shimoga in Karnataka (Ananda *et al.,* 2011). Panayotova-Pencheva (2013) reported *Ancylostoma* sp. and *Uncinaria* sp. in leopards. Reports of *Toxocara* species from leopard have been reported through coprology at Rajkot Zoo, Nehru Zoo, Thrissur Zoo, MC Zoological Park, Nandankanan Zoo (Mahali *et al.,* 2010), Kerala Zoo (Ravindran *et al.,* 2011), Nandanvan Zoo (Thawait *et al.,* 2014) and through necropsy at Assam State Zoo. *Toxocara* sp. was reported in snow leopard (*Panthera uncia*) at Darjeeling Zoo.

Four species of ascarids are reported in golden jackals with *Toxocara canis* and *Toxascaris leonina* being ubiquitous. Jackal of Mysore Zoo had moderate infection of *Ancylostoma* sp. with additional presence of *Toxocara* and *Strongyle* (Anon, 2012-2013). At TLS, Shivamogga, ova of *Toxocara* sp. were noticed in jackals (Ananda *et al.,* 2012), but in later screening, strongyle infections were found along with *Toxocara* sp. (Ananda, 2015).

Mixed infection of Eimerian oocysts and strongyle eggs was also reported later (Ananda *et al.,* 2016). Meshgi *et al.* (2009) reported *A. caninum*, *T. canis* in golden Jackal in Iran. Nematodes (*T. canis*, *Ancylostoma*, *Trichuris vulpis* and *Capillaria aerophila*) were reported in golden jackals in different regions of Serbia (Ilic *et al.,* 2016). Species of *Spirometra* (*S. mansoni*, *S. houghtoni* and *S. erinaceieuropaei*) were identified in golden jackals from Europe and Asia. Previously, *Spirometra erinaceae* was reported from small intestine of tiger, lion and clouded leopard. Raja *et al.* (2014) reported *T. leonina* and *Spirometra* sp. in Indian lion and *Spirometra* sp. in leopard fecal samples.

Berentsen *et al.* (2012) reported 33% spotted hyaenas (*Crocuta crocuta*) to be infected with *Isospora* sp., 22% with *Dipylidium* sp. and 22% with *Spirometra* sp. during the survey of gastrointestinal parasite infection in the Luangwa Valley, Zambia. A prevalence of 33.33% *Trichuris* ova in faecal samples of striped hyaena (*Hyaena hyaena*) of Mysore Zoo and *Toxocara* and strongyles of TLS, Shivamogga (Ananda *et al.,* 2012, 2016) were reported. Oocysts of *Isospora levinei* were reported in stripped hyaenas of India, while 20% prevalence of Coccidia was reported in striped hyaena at Mysore Zoo. Hook worm of *Ancylostoma* sp. was reported in hyaena and other wild carnivores in India.

Hookworm of *Ancylostoma* sp. was reported in jungle cat at Coimbatore Zoo and Nandankanan Zoo (Mahali *et al.,* 2010). Golden cat and jungle cat of Mysore Zoo were found to be infected with *Ancylostoma* sp. (Anon, 2012-2013). The recovery of *Toxocara* species and *Spirometra erinaceae* in jungle cat was reported during necropsy at Baranga Zoo, Odisha. *Toxocara cati* and *Toxocara mystax* were recorded from jungle cat. One case of *Oncicola* sp. (member of Acanthocephala) from jungle cat was reported at Nandankanan Zoo. It has been reported that *A. caninum* could infect jungle cats by entering the lumen of the intestine from outside through the serosa (Moudgil *et al.,* 2015). Eggs of a new species of *Paragonimus* were recovered from jungle cat at Kanha National Park.

Echinococcus granulosus worms associated with marked catarrhal enteritis were recovered from both small and large intestine of an Indian wolf during necropsy at Nandankanan Zoo. Shrikhande *et al.* (2008) reported eggs of *Paragonimus* sp. in fecal sample of wolf at Rajiv Gandhi Zoological Park, Maharashtra and predicted that the wolf might have been infected by eating infected crustacea. Death of Himalayan wolf pups at Darjeeling Zoo was reported due to *Toxocara canis*. *Belascaris marginata* was reported from intestine of wolf. Kvapil *et al.* (2017) observed eggs of *Capillaria* sp., *Trichuris* sp. in fecal samples of grey wolf (*Canis lupus*) from Ljubljana zoo in Slovenia.

Consequently, all the results obtained during the present study are consistent with available reports from different regions of India and other countries regarding the prevalence and diversity of parasites in captive carnivores. To our knowledge, this qualitative study provides a comprehensive coprological survey of gastrointestinal parasite infection in captive canine and feline carnivorans from BBP, Karnataka and provides baseline data for future studies. Although overall management of zoo including nutrition, sanitation, and deworming practices were followed, the study identifies that there is still scope for improvement in the management practices for prevention of such parasitic infections. Nevertheless, overcrowding of animals in enclosures, being precipitating factors for re-infections of parasites should be avoided.

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