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

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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%) Toxocara canis sp. 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, Strongyloids, 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; Thwait 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-ovoscopic 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 (17.64%) *Ancylostoma* sp., 2 (5.71%) oocyst of *Eimeria* sp., 2 (5.71%) *Spirometra* sp. (Fig. 4) in tigers; 13 (38.23%) *Toxocara* sp., 6 (17.14%) *Ancylostoma* sp., 2 (5.71%) *Toxascaris leonina* (Fig. 5) and 2 (14.28%) *Toxocara* sp. in jungle cats; 2 (50%) *Ancylostoma* 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).
Gastrointestinal parasitism in captive canine and feline carnivorans

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

**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*                                  |
| Dhole (*Cuon alpinus*) | 4                               | 1 (25%)               | *Ancylostoma* sp                                  |
| Hyaena (*Hyaena hyaena*) | 2                               | 2 (50%)               | *Toxocara canis*                                  |
|                   |                                 | 1 (50%)               | *Ancylostoma* sp                                  |

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

Fig. 5: *Isospora* oocyst in fecal smear of jungle cat
Ascaris felis, Parascaris felif 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 parahumidenedale 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 mansonioides 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 Uncinia 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 India (Ilic et al., 2016). Species of Spirometra (S. mansoni, S. houghtoni and S. erinaceieurupaeli) 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 Dipyridium 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 striped hyenas 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 carnivores 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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REFERENCES

Ananda K.J., Vinay, S., Malatesh, D.S. and Dhanalakshmi, S. 2016. Incidence of endoparasitic infection in wild animals maintained at Shivamogga, Karnataka. Presented at 25th National Congress of Veterinary Parasitology, 17-19 February, 2016, TNVASU, Chennai, pp. 212-213.

Ananda, K.J. 2015. Studies on prevalence of endo-parasitic infection in wild carnivores maintained under captive state. J. Parasit. Dis., 1-4.

Ananda, K.J., Anjan Kumar, K.R., Krishnmurthy, C.M., Adeppa, J., Manjunath, S.S. and Chandrashekar, S. 2014. Hook worm infection (Ancylostoma spp.) in a Bengal tiger (Panthera tigris tigris) - a case report presented during 24th National
Congress of Veterinary Parasitology, 5-7 February, 2014 at CVAS, Mannuthy, Thrissur, Kerala, S.3.34, pp. 116.

Ananda, K.J., Chandrashekar, S., Naravi, Y., Ramesha, K. and Devaraj, M. 2012. Prevalence of gastrointestinal parasites of wild animals maintained under captive state. Presented during the 22nd National Congress of Veterinary Parasitology, College of Veterinary Science and Animal Husbandry, Mathura, DUVASU, 15-17 March, 2012, 2(21), pp. 28.

Ananda, K.J., Rani, B.K., Ramesha, K., Swethashree, M.J., Ranjitha, V.H., Nagaraj, K.H. and Prasad, R.V. 2011. Tapeworm infection in a leopard: A case report. In: Compendium of 21st National Congress of Veterinary Parasitology, Mumbai, 5-7 January, 2011, pp. 125.

Anon. 2012-2013. Annual report of Sri Chamarajendra Zoological Gardens, Mysore. Veterinary Section, pp. 28-46.

Berentsen, A.R., Becker, M.S., Stockdale-Walden, H., Matandiko, W., Mc Robb, R. and Dunbar, M.R. 2012. Survey of gastrointestinal parasite infection in African lion (Panthera leo), African wild dog (Lycaon pictus) and spotted hyena (Crocuta crocuta) in the Luangwa Valley, Zambia. African Wild Zool., 47(2): 363-368.

Bowmann, D.D. 2009 Georgi’s Parasitology for Veterinarians, 9th edn. Saunders Elsevier, St Louis.

Chhabra, M.B. and Pathak, K.M.L. 2013. Parasites and Parasitic diseases of wildlife in India. 2. Carnivores and birds. Indian J. Anim. Sci., 83: 567-578.

Cordon, G.P., Prados, A.H., Romero, D., Moreno, S.M., Pontes, A., Osuna, A. and Rosales, M.J. 2008. Intestinal parasitism in the animals of the zoological garden “Pena Escrita” (Almunecar, Spain). Vet. Parasitol., 156: 302-309.

Ilić, T., Becskei, Z., Petrović, T., Polaček, V., Ristić, B., Miloč, S., Stepavonić, P., Radišavljević, K. and Dimitrijević, S. 2016. Endoparasitism of red foxes (Vulpes vulpes) and golden jackals (Canis aureus) in Serbia. Acta Parasitolog., 61(2): 389-396.

Javaregowda, A.K. 2016. Studies on prevalence of endoparasitic infection in wild carnivores maintained under captive state. J. Parasit Dis., 40(4): 1155-1158.

Khatun, M.M., Begum, N., Mamun, M.M.A.A., Mondal M.M.H. and Shakif-ul-Azam, M. 2014. Coprological study of gastrointestinal parasites of captive animals of Rangpur recreational garden and zoo in Bangladesh. J. Threat. Taxa., 6(8): 6142-6147.

Kvapil, P., Kastelic, M., Dove, A., Bártova, E., Cízek, P., Limn N. and Strus, S. 2017. An eight-year survey of the intestinal parasites of carnivores, hoofed mammals, primates, raffles and reptiles in the Ljubljana zoo in Slovenia. Folia Parasitologica., 64: 013.

Mahali, A.K., Panda, D.N., Panda, M.R. Mohanty B.N. and Sahoo B. 2010. Incidence and seasonal variation of gastrointestinal parasitic infections in captive carnivores in Nandankanan Zoological Park, Orissa. J. Vet. Parasitol., 24: 111-115.

Meshgi, B., Eslami, A., Bahonar, A.R., Kharrzian-Moghadam, M. and Gerami-Sadeghian, A. 2009. Prevalence of parasitic infections in the red fox (Vulpes vulpes) and golden Jackal (Canis aureus) in Iran. Iranian J. Vet. Res., 10(4): 387-391.

Moudgil, A.D., Singla L.D. and Pallavi 2015. Parasiotis in wild felids of India: an overview. J. Threatened Taxa., 7(10): 7641-7648.

Murkari, N.L., Vassilev, G.D., Tagwireyi, W.M. and Tavengwa, M. 2013. Occurrence, prevalence and intensity of internal parasite infections of African lions (Panthera leo) in enclosures at a recreation park in Zimbabwe. J. Zoo. Wildl Med., 44(3): 686-693.

Panayotova-Pencheva, M.S. 2013. Parasites in Captive Animals: A Review of Studies in Some European Zoos. Zool. Garten N.F., 82: 60-71.

Pawar, R.M., Lakshmkant, U., Hasan, S., Poornachandar, A. and Shivaji, S. 2012. Detection and molecular characterization of ascarid nematode infection (Toxascaris leonina and Toxocara cati) in captive Asiatic Lions (Panthera leo persica). Acta Parasitologica., 57: 67-73.

Peng, Z., Liu, S., Hou, Z. and Xing, M. 2016. Ascarid infestation in captive Siberian tigers in China. Vet. Parasitol., 226(15): 74-77.

Raja, M.M.R.U., Dey, A.R., Begum, N., Kundu, U.K. and Ashad, F.A. 2014. Coprological prevalence of gastrointestinal parasites in carnivores and small mammals at Dhaka zoo, Bangladesh. J. Threatened Taxa., 6(3): 5574-5579.

Ravindran, R., Kumar, K.G.A. and Gafoor, V.M.A. 2011. Parasitic infections in wild animals of Kerala. Zoos’ Print J., 26: 34.

Renukaraprasad, C., Shilpa and Sudharani. 2011. Parasitic infections in wild animals. In Compendium of XIV National Training Programme, Centre of Advanced Faculty Training in Veterinary Parasitology, Veterinary College (KVAFSU), Hebbal, and Bangalore-560 024, pp. 30-33.

Sarvi, S., Daryani, A., Sharif, M., Rahimi, M.T., Kohansal, M.H., Mirshafiee, S., Siyadatpanah, A., Hosseini, S. and Gholami, S. 2018. Zoonotic intestinal parasites of carnivores: A systematic review in Iran, Vet. World, 11(1): 58-65.

Shrikhande, G.B., Satpute, A.K., Zanzad, S.S. and Maske, D.K. 2008. Helminth parasites in captive wild animals of Rajiv Gandhi Zoological Park. Vet. World, 1(7): 207.

Thawairt, V.K., Maiti, S.K. and Dixit, A.K. 2014. Prevalence of gastrointestinal parasites in captive wild animals of Nandanvan zoo, Raipur, Chhattisgarh. Vet. World, 7: 448-451.