



## PARASITOSIS IN WILD FELIDS OF INDIA: AN OVERVIEW

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**Abstract:** Being a tropical country, India provides an ideal environment for the development of parasites as well as for vector populations resulting in a high degree of parasitism in animals and humans. But only a few detailed studies and sporadic case reports are available on the prevalence of parasites in captive wild animals, and the knowledge of parasites and parasitic diseases in wild animals is still in its infancy. The family felidae comprises the subfamily felinae and pantherinae, and within those are all large and small cats. Most of the available reports on parasites in felids describe helminthic infections, which caused morbidities and occasional mortalities in the infected animals. The parasites most frequently found include the nematodes *Toxocara*, *Toxascaris*, *Baylisascaris*, *Strongyloides*, *Gnathostoma*, *Dirofilaria* and *Galonchus*, the trematode *Paragonimus* and the cestodes *Echinococcus* and *Taenia*. Almost all the studies identified the parasitic stages by classical parasitological techniques and only a few new studies confirmed the species using molecular techniques. Amongst the protozoan parasitic infections reported in felids: babesiosis, trypanosomiasis and coccidiosis are most commonly found. Most of the parasite species found in felids are transmissible to humans (zoonosis) and therefore have public health significance. Routine monitoring of the presence of parasites in captive wild felids is imperative for the formulation and implementation of measures to prevent and control parasitic infections and the transmission of these parasites to humans. This review summarizes the available reports and highlights deficient areas, which require further systematic investigation.

**Keywords:** Felids, parasitosis, wildlife, zoonosis.

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**Author Details:** AMAN DEV MOUDGIL has carried out detailed study on prevalence and management of parasitic infections in captive wild animals and has recently concluded PhD with the same objective in the field of veterinary parasitology. LACHHMAN DAS SINGLA possesses more than 21 years of teaching, research and extension experience in the field of veterinary parasitology, especially in wildlife parasitology. PALLAVI carries experience in research on the diseases of zoonotic and public health significance.

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## INTRODUCTION

There are around 250 species of wild carnivores distributed throughout the globe, out of which eight families comprising 60 species are found in India (Acharjyo 2002). The latin word “carnivores” means ‘meat-eater’ and the order Carnivora includes animals which predominantly eat meat as well as animals that occasionally eat meat and are in fact omnivores, such as bears and civets. Carnivores are kept in zoological gardens or wildlife parks for the purpose of education, exhibition and gene conservation (Khatun et al. 2014). The health of these animals requires special attention as conditions in captivity facilitate development of viral, bacterial and parasitic infections. These are of major concern as they pose a serious threat to the animals and persons who come in contact with the animals, like zoo keepers and veterinarians. In their natural habitat felids range over large areas, have low parasitic exposure and consequently low genetic resistance against parasitic infections (Raja et al. 2014). In captivity, for example in zoological gardens, the problem of parasitic infections in these animals can aggravate and pose a serious threat (Muoria et al. 2005). Parasitic infections are not only responsible for the morbidities of animals but heavier infections may actually be fatal (Chhabra & Pathak 2013). There is a woeful paucity of detailed studies of parasitic diseases of wild animals in India and mostly only case reports are available. This review compiles all available

case reports and other studies of the parasitic diseases of wild felids in India.

## METHODS

A majority of the infections found in wild felids in captivity are helminthic infections. Therefore, we have analysed the incidences of parasitic infections by species. All the literature included in the analyses is listed and organized as per parasite species in the tables below.

### NEMATODE INFECTIONS

#### *Toxocara* infections

*Toxocara*, which were not identified to species level, have been found both during regular faecal examination and during necropsies in different parts of India. Health problems caused by various species of *Toxocara* were found predominantly in younger animals (Kumar & Rao 2003). Parasite eggs and adult parasites were recovered from Leopard Cats, Bengal Tigers, Asiatic Lions, Leopards and Snow Leopards. Necropsy, coprology and molecular identification reports of the parasites in wild felids are listed in Table 1.

#### *Toxascaris leonina* infections

*Toxascaris leonina* is an intestinal parasite commonly found in domestic cats, dogs and foxes, but related wild species also frequently get infected with the parasite

**Table 1. Reports of *Toxocara* species in wild felids**

Species of the animal	Procedure of recovery	Locality (References)
Jungle Cat <i>Felis chaus</i>	Necropsy	Baranga Zoo, Odisha (Patnaik & Acharjyo 1970), Assam State Zoo, Guwahati (Nashiruddullah & Chakraborty 2001)
	Coprology	Thiruvananthapuram Zoo (Vardharajan & Pythal 1999), Thrissur Zoo (Varadharajan et al. 2001), in wild, Kerala (Mahali et al. 2010), Nandankanan Zoo, Odhisha (Mahali et al. 2010)
Golden Cat <i>Catopuma temminckii</i>	Coprology	Baranga Zoo (Patnaik & Acharjyo 1970)
Leopard Cat <i>Prionailurus bengalensis</i>	Necropsy	in wild, Kerala (Easwaran et al. 2003)
Royal Bengal Tiger <i>Panthera tigris tigris</i>	Coprology	Baranga Zoo (Patnaik & Acharjyo 1970), Thiruvananthapuram Zoo (Varadharajan & Pythal 1999), Rajkot Zoo (Parsani et al. 2001), MC Zoological Park, Chhatbir, Punjab (Singh et al. 2006), Nandankaran Zoo (Mahaliet al. 2010)
	Necropsy	Assam State Zoo (Nashiruddullah & Chakraborty 2001)
Asiatic Lion <i>Panthera leo persica</i>	Coprology	Zoological Park, Coimbatore (Varadharajan & Kandasamy 2000), Thrissur Zoo (Varadharajan et al. 2001), Rajkot Zoo (Parsani et al. 2001), captive at Ramgiri Estate, Wayanad (Ravindran et al. 2006), MC Zoological Park (Singh et al. 2006), Nandankanan Zoo (Mahali et al. 2010), Nandan Van Zoo, Chhatissgarh (Thawait et al. 2014)
	Coprology/ Molecular identification	Nehru Zoological Park, Hyderabad (Pawar et al. 2012)
Leopard <i>Panthera pardus</i>	Coprology	Rajkot Zoo (Parsani et al. 2001), M.C. Zoological Park (Singh et al. 2006), Nandankanan Zoo (Mahali et al. 2010), Nandan Van Zoo (Thawait et al. 2014)
	Necropsy	Assam State Zoo (Nashiruddullah & Chakraborty 2001)
Snow Leopard <i>Panthera uncia</i>	Coprology	Darjeeling Zoo (Maity et al. 1994)

and serve as definitive hosts for this species. Cases of various wild felids infected with *T. leonina*, including Jungle Cat *Felis chaus*, Royal Bengal Tigers *Panthera tigris tigris*, Asiatic Lions *Panthera leo persica* and Leopards *Panthera pardus* were documented from different parts of India. The parasite was found during coprology and at necropsy, but molecular confirmation of the parasite was carried out only once by Pawar et al. (2012) in Nehru Zoological Park, Hyderabad. The reports of this parasite from different zoological gardens of the country are listed in Table 2.

### **Ancylostoma (Hookworm) infections**

Hookworm species including *Ancylostoma* and *Uncinaria* species have been recorded from wild felids throughout the globe and are currently known to occur in more than 24 wild animal species. Ten species of hookworms belonging to three genera of the family Ancylostomatidae have been found in a variety of felids.

In the past, several new species of Ancylostomatidae were described from India: Maplestone (1939) described *Uncinaria felidis* from a Leopard Cat in Kolkata and Rao (1939) described *Arthrocephalus gambiensis* from Common Mongoose in Chennai. Dubey & Pande (1961) found that *A. caninum* could infect Jungle Cats by entering the lumen of the intestine from outside through the serosa. In 1985, Agarwal found *Ancylostoma paraduodenale* in the Asiatic Lion in India. The species was reported in felids for the very first time in 1951 by Biocca. This hookworm causes cutaneous larva migrans in humans, thus possesses significant zoonotic potential. The different reports of the hookworms are listed in Table 3.

### **Dirofilaria immitis infections**

This parasite is also known as heartworm of dogs and requires mosquitoes as vectors for its transmission. The definitive host of the parasite is the dog, but it has also

**Table 2. Reports of *Toxascaris leonina* in wild felids**

Species of the animal	Procedure of recovery	Locality (Reference)
Jungle Cat <i>Felis chaus</i>	Coprology	Nandankanan Zoo (Mahali et al. 2010)
Royal Bengal Tiger <i>Panthera tigris tigris</i>	Coprology	Lucknow and Delhi zoos (Chauhan et al. 1973), Lucknow and Kanpur zoos, Uttar Pradesh (Gaur et al. 1979; Arora & Das 1988), Maharajbagh Zoo, Nagpur (Dhoot et al. 2002), MC Zoological Park (Singh et al. 2006), Nandankanan (Mahali et al. 2010)
	Necropsy & vomitus	Assam State Zoo (Nashiruddullah & Chakraborty 2001)
Asiatic Lion <i>Panthera leo persica</i>	Coprology	Lucknow Zoo (Chauhan et al. 1973), Lucknow and Kanpur zoos (Gaur et al. 1979), Bikaner Zoo (Tanwar et al. 1984), Thiruvananthapuram Zoo (Varadharajan & Pythal 1999), Thrissur Zoo (Varadharajan et al. 2001), Maharajbagh Zoo (Dhoot et al. 2002), MC Zoological Park (Singh et al. 2006), captive at Ramgiri Estate, Wayanad (Ravindran et al. 2006), Nandankanan Zoo (Mahali et al. 2010)
	Necropsy	Assam State Zoo (Nashiruddullah & Chakraborty 2001)
	Coprology/ Molecular identification	Nehru Zoological Park (Pawar et al. 2012)
Leopard <i>Panthera pardus</i>	Coprology	Lucknow and Delhi zoos (Chauhan et al. 1973), Thiruvananthapuram Zoo (Varadharajan & Pythal 1999), Maharajbagh Zoo (Dhoot et al. 2002), Bannerghata Biological Park, Bengaluru (Chandranark et al. 2005)

**Table 3. Reports of hookworms from wild felids of different parts of India**

Species of the animal	Procedure of recovery	Locality (Reference)
Jungle Cat	Coprology	Coimbatore Zoo (Varadharajan & Kandasamy 2000), Nandankanan Zoo (Mahali et al. 2010)
Leopard Cat	Necropsy	Baranga Zoo, Odhisha (Patnaik & Acharyjo 1970), Nandankanan Zoo (Rao & Acharyjo 1984)
	Coprology	Lucknow and Kanpur zoos (Gaur et al. 1979)
Royal Bengal Tiger	Coprology	Lucknow and Delhi zoos (Chauhan et al. 1973), Lucknow Zoo, Uttar Pradesh (Gaur et al. 1979), Thiruvananthapuram Zoo (Varadharajan & Pythal 1999), Rajkot Zoo (Parsani et al. 2001), Maharajbagh Zoo (Dhoot et al. 2002), MC Zoological Park (Singh et al. 2006), Nandankanan Zoo (Mahali et al. 2010)
	Necropsy	Vandalur Zoo, Tamil Nadu (Thilakan et al. 2007)
Asiatic Lion	Coprology	Rajkot Zoo (Parsani et al. 2001), Thrissur Zoo (Varadharajan et al. 2001), Maharajbagh Zoo (Dhoot et al. 2002), MC Zoological Park (Punjab) (Singh et al. 2006), Nandankanan Zoo (Mahali et al. 2010)
	Necropsy	Zoological Park, Gwalior (Agrawal & Chauhan 2001)
Leopard	Coprology	Nehru Zoo (Suresh et al. 2000), Thrissur Zoo (Varadharajan et al. 2001), MC Zoological Park (Singh et al. 2006), Nandankanan Zoo (Mahali et al. 2010), Kerala Zoo (Ravindran et al. 2011)

**Table 4. Reports of *D. immitis* infections in wild felids**

Species of the animal	Procedure of recovery	Locality (Reference)
Golden Cat	Necropsy	Nandankanan Zoo (Rao & Acharjyo 1984, 1991)
Royal Bengal Tiger	Necropsy	Nandankanan Zoo (Rao & Acharjyo 1993), Birsa Biological Park, Ranchi (Gupta et al. 1999; Haque & Ahmed 2002)
Asiatic Lion	Necropsy	Nandankanan Zoo (Rao & Acharjyo 1993), Birsa Biological Park (Gupta et al. 1999; Haque & Ahmed 2002), Assam State Zoo (Narshiruddullah & Chakraborty 2001)
Leopard	Necropsy	Nandankanan Zoo (Rao & Acharjyo 1993), Birsa Biological Park (Haque & Ahmed 2002)

**Table 5. Reports of various nematode parasitic infections in wild felids**

Species of the parasite	Species of the animal	Procedure of recovery	Locality (Reference)
<i>Filaroides osleri</i>	Leopard Cat	Necropsy	Nandankanan Zoo (Rao et al. 1971; Rao & Acharjyo 1984)
	Leopard	Necropsy	Bannerghatta Biological Park (Chandranaiik et al. 2005)
<i>Galonchus perniciosus</i>	Jungle Cat	Necropsy	Maharajbagh (Dakshinkar et al. 2001)
	Lion	Coprology	Baranga Zoo (Patnaik & Acharjyo 1970)
	Leopard	Necropsy	Baranga Zoo (Patnaik & Acharjyo 1970), Thiruvananthapuram (Pythal et al. 1993)
<i>Gnathostoma spinigerum</i>	Royal Bengal Tiger	Necropsy	Assam State Zoo (Nashiruddullah & Chakraborty 2001), Vandaloor Zoo (Thilakan et al. 2007), Pench Tiger Reserve (Shrivastava et al. 2011)
<i>Strongyloides</i> sp.	Royal Bengal Tiger	Coprology	Thiruvananthapuram Zoo (Varadharajan & Pythal 1999)
	Leopard	Coprology	Thrissur Zoo (Varadharajan et al. 2001)
<i>Bronchostrongylus subcrenatus</i>	Royal Bengal Tiger	Necropsy	Assam State Zoo (Nashiruddullah & Chakraborty 2001)
<i>Spirocerca lupi</i>	Royal Bengal Tiger	Coprology	Maharajbagh Zoo, Nagpur (Dhoot et al. 2002)
<i>Capillaria aerophila</i>	Royal Bengal Tiger	Necropsy	Assam State Zoo (Nashiruddullah & Chakraborty 2001)
<i>Physaloptera</i> sp.	Royal Bengal Tiger	Coprology	Nandankanan Zoo (Mahali et al. 2010)
<i>Ollulanus tricuspis</i>	Royal Bengal Tiger	Necropsy	Sundarbans forest (wild), West Bengal (Mandal & Chaudhury 1985)
<i>Trichuris</i> sp.	Royal Bengal Tiger	Necropsy	Jim Corbett National Park (Arora & Das 1988)

been found in wild felids including the Golden Cat, Royal Bengal Tigers, Asiatic Lions and Leopards. Reports of *D. immitis* infections in wild felids are listed in Table 4.

#### Other nematode infections

A number of other nematode parasites were less frequently recorded from wild felids. Baylis & Dubney (1922) reported *Galonchus perniciosus*, a new species of hookworm from a leopard and this species was also found in the intestines of a lion cub (Patnaik et al. 1971). Eggs of spirurids and *Capillaria* species were found on faecal examination at Coimbatore and Thrissur (Varadharajan et al. 2001). The only acanthocephalan from felids, an *Oncicola* species, was recorded in Assam (Patnaik & Acharjyo 1970). A list of parasites found sporadically and their hosts and the places of recovery is given in Table 5.

#### TREMATODE INFECTIONS

##### *Paragonimus* infections

The most commonly encountered trematode infection in free-living and captive wild felids is paragonimiasis. *Paragonimus* was generally found embedded in cysts in the lung parenchyma and rarely caused the death of the infected animal. Histopathology showed bronchial hyperplasia due to mononuclear cell infiltration under the epithelial lining (Parihar & Shrivastava 1988). At Nandankanan Zoo, a necropsied Golden Cat and Royal Bengal Tiger were found to be infected with *Paragonimus westermani* (Rao & Acharjyo 1984, 1991). Cysts containing one or more reddish oval shaped flukes were macroscopically observed in one or both lungs in combination with patches of atelectasis and emphysema (Rao & Acharjyo 1991). *P. westermani* was also found during necropsies of tigers from different parts of the country including Corbett National Park in Uttar Pradesh (Arora & Das 1988), Kanha National Park in Madhya Pradesh (Parihar & Shrivastava 1988),

Vandalur Zoological Park in Tamil Nadu (Latha et al. 2000) and Assam State Zoo in Guwahati (Nashiruddullah & Chakraborty 2001). The species was also reported from a Clouded Leopard by Hiregoudar & Pethkar (1970) and was found in a Leopard during post mortem and coprological examination in Thiruvananthapuram Zoo (Pythal et al. 1993; Varadhrayan & Pythal 1999).

Sano et al. (1994) recovered *Paragonimus* eggs from four tigers and one Jungle Cat at Kanha National Park. These eggs differed from the eggs of *P. westermani* and raised the question of the existence of a new species of *Paragonimus* in India.

In 1970, the trematode *Euparyphium malayanum* was found at the necropsy of a Jungle Cat in Baranga Zoo in Odisha (Patnaik & Acharjyo). Coprological evidence of *Euparyphium* species was also found recently in Nandankanan Zoo (Mahali et al. 2010). *Nanophyetes salmincola* was identified in faecal examinations of lions and leopards at Maharajbagh Zoo in Odisha (Dhoot et al. 2002) and *Schistosoma* species eggs were found during faecal examination of lions at Nandankanan Zoo in Odisha (Mahali et al. 2010). Clinical cases of schistosomiasis were reported from lions of Maharashtra (Shrikhande et al. 2002).

#### CESTODE INFECTIONS

The most common cestode infection encountered in wild felids was echinococcosis. Both adult and metacestode stages were recovered from captive and rescued free-ranging wild felids. The adult stages cause catarrhal enteritis in wild animals and the parasite deserves particular attention due to its significant zoonotic potential (Acharjyo 2004). Easwaran et al. (2003) found *Echinococcus granulosus* and *Taenia* species during necropsies in Leopard Cats at Thekkady in Kerala. Pande et al. (1970) recorded *Spirometra* species from the lions of the zoological garden of Lucknow. *Taenia pisiformis* and *Spirometra erinaceae* were the two cestode species reported in Bengal Tigers at Baranga Zoo (Patnaik & Acharjyo 1970) and *Taenia taeniformis* was reported from the tigers of Corbett National Park (Gaur et al. 1980). Sharma et al. (1983) found *Taenia jaipurensis* in lions in India. *Diphyllobothrium* species infection was recorded during the post mortem of a male leopard at Thiruvananthapuram Zoo (Varadhrayan & Pythal 1999). *Diphyllobothrium latum* was the most common species of cestode reported at faecal examination of leopards and was found at several places, for example, in Thrissur (Varadharajan et al. 2001) and Maharajbagh zoo in Nagpur (Dhoot et al. 2002). Fecal examination of a Leopard cub from Baranga

Zoo identified another cestode, *Mesocestoides lineatus* (Patnaik & Acharjyo 1970). *Spirometra erinaceae* was reported at a necropsy from a Jungle Cat in Baranga Zoo (Patnaik & Acharjyo 1970) and unidentified *Spirometra* species were reported from tigers at Vandalur (Latha et al. 2000) and leopards at Rajkot Zoo (Parsani et al. 2001) and Maharajbagh Zoo (Gawande et al. 2007). Recently, *Taenia taeniaeformis* and *Spirometra mansonoides* were recovered during the necropsy of a leopard found in a forest near Shimoga in Karnataka (Ananda et al. 2011) and *Hymenolepis* and *Diphyllobothrium* species were identified from faecal samples at Thrissur Zoo (Varadharajan et al. 2001). Recently, *Joyeuxiella pascalei* was reported at a necropsy from a Jungle Cat at Puducherry (Das et al. 2011). Cases of hydatidosis were found in lions and jaguars at necropsy at Nagpur zoo (Ganorkar et al. 1997) and Chennai Zoological Park (Sathasivam et al. 2009), respectively.

#### PROTOZOAN INFECTION IN WILD FELIDS

The most common protozoan infections reported in wild felids are trypanosomiasis, babesiosis and coccidiosis. Large cats, mainly tigers, are frequently infected with *T. evansi* (Acharjyo 2000) and the reported signs include anorexia, pyrexia, panting, occasional convulsions and sudden death (Chaudhury et al. 1986; Devasena & Shobhamani 2006). The various protozoan infections reported are listed in Table 6.

#### ECTOPARASITIC INFECTION IN WILD FELIDS

Fleas, ticks and mites are the ectoparasites reported in wild felids in India. Ticks, mainly *Haemaphysalis* spp., were reported by Geevarghese et al. (1997) and the main tick species reported were *H. cuspidata* on leopards, *H. silvafelis* on Jungle Cats and *H. kinneari* on tigers. *Amblyomma hebraeum* and another unidentified *Amblyomma* species were reported on tigers in Assam Zoo in two separate studies by Geevarghese et al. (1997) and Nashiruddullah & Chakraborty (2001). *Sarcoptes scabiei* infection was reported in lions of Bikaner Zoo (Gaurav & Singh 1999) and infestation of Leopard Cats with *Ctenocephalides felis felis* was reported by Islam (2010).

#### TREATMENT OF PARASITIC INFECTIONS

The therapeutic management of parasitic infections in captive wild felids mainly consists of drug application targeting the specific parasite. Ivermectin was used to treat a mixed infection of *Toxocara*, *Ancylostoma* and tapeworm in Sundarban tigers brought to Alipur Zoo (Sur et al. 2001). Ivermectin was also used to treat

Table 6. Reports of protozoan parasitic infection of wild felids

Species of the parasite	Species of the animal	Diagnosis based on	Locality (Reference)
<i>Trypanosoma evansi</i>	Jungle Cat	Blood smear examination	Maharajbagh Zoo (Dakshinkar et al. 2002), Nandankanan Zoo (Sahoo et al. 2009)
	Tigers and cubs	Blood smear examination	National Circus at Kakinada, Andhra Pradesh (Rao et al. 1995)
	Tigers	Blood smear examination	Nandankanan Zoo (Parija & Bhattacharya 2001)
<i>Babesia</i> species	Tigress	Blood smear examination	Ranchi Zoo (Sinha et al. 2000)
	Tigers	Blood smear examination	MC Zoological Park (Misra et al. 2008)
	Leopards	Blood smear examination	Nagpur Zoo (Upadhye & Dhoot 2000)
	Lions	Blood smear examination	Lucknow Zoo (Haque 2007)
<i>Isospora felis</i>	Tigers and lions	Coprology	Lucknow Zoo (Chauhan et al. 1973), Mysore Zoo (Muraleedharan & Iswariah 1984), MC Zoological Park (Singh et al. 2006), Nandankanan Zoo (Mahali et al. 2010)
<i>Isospora</i> species	Leopards	Coprology	Lucknow Zoo (Agrawal et al. 1981), Nandankanan Zoo (Mahali et al. 2010), Kerala Zoo (Ravindran et al. 2011)
<i>Isospora viverrina</i>	Fishing Cat	Coprology	Mathura (Agrawal & Chauhan 1993)

toxocarasis in lions, which proved resistant to piperazine at MC Zoological Park (Singla et al. 2003).

Singh et al. (2006) used piperazine adipate and pyrantel pamoate to control *Toxocara cati*, *Toxascaris leonina* and hookworm infections in tiger cubs, adult tigers, lion cubs and treated panthers and leopards infected with hookworms with ivermectin. Amongst these drugs piperazine adipate was the most effective in controlling ascarids and 30 days after treatment the animals were parasite free. However in lions treated with pyrantel pamoate, *T. leonina* was recorded again 30 days after the treatment demonstrating its inefficacy to control the parasitic infection. Similarly, Dehuri et al. (2013) found ivermectin ineffective in the control of ascarids and hookworms in lions and reported reoccurrence of the parasites only a few days after treatment.

Triquin (quinapyramine sulphate and quinapyramine chloride) was used successfully to treat trypanosomiasis in wild felids (Gupta et al. 2009; Sahoo et al. 2009). Despite a thorough literature search we found that no successful treatment of babesiosis in wild felids was reported. And though ticks are commonly found on wild felids, their distribution, prevalence or treatment has not yet been studied comprehensively in India.

## CONCLUSIONS

Parasitic disease studies of wild felids are not only important with respect to the animal's health but also important for their zoonotic potential. At present there is an information gap. A detailed epidemiological study

targeting parasites of the felids should be carried out to obtain a clear picture of parasitism in India. Regular faecal examinations should be supported and supplemented with post mortem findings. Identification of the parasites and diagnosis of parasitic diseases needs to be improved using molecular techniques and the pathophysiology of several helminthic species. Administration of effective drugs with wide safety margins targeting a specific parasitic species and better management practices such as routine cleaning and disinfection, correct disposal of waste and clean food presentation should be adopted wisely, as all play important roles in reducing parasite infections in captive wild animals.

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