Incidence of parasitic diseases among wild mammals and their control in Indian zoos

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Wild mammals are an important group of zoo inmates and they like the domestic animals, suffer from viral, bacterial, fungal, metabolic, parasitic and other diseases. The parasites and the diseases they cause play an important role in the health and mortality of zoo animals. In nature, practically no animal is free from parasites. When the parasitised animal is brought from wild to captivity, the new zoo conditions are generally unfavourable to the animal but favourable to the parasite. In such a situation, the parasites exert their harmful role on the host. It is impossible to exterminate the parasites completely from zoo animals because of confinement and changed environmental conditions. Hence, attempts should always be made to keep the parasitic load in the host animal below danger level.

Sporadic reports on the incidence of parasitic diseases among wild mammals of Indian zoos have appeared in scientific literature from time to time in different publications, which are not easily available for the zoo veterinarians. In this communication, an attempt is made to discuss in brief the incidence of some of the common parasitic diseases encountered among wild mammals in Indian zoos.

Protozoan Diseases

Trypanosomiasis

Trypanosomiasis, caused by *Trypanosoma evansi* is mechanically transmitted by biting flies such as *Tabanus, Stomoxys* and *Lyperosia*. The details of *T. evansi* infection reported from Indian zoos are given in Table 1.

The first report of this infection in the form of an outbreak killing seven adult large cats was recorded at Calcutta Zoo during a period of 39 days in 1967. In another outbreak, Mysore zoo lost eight Tigers within the age group of 12 to 26 months during a period of 16 days in 1978. The rest of other deaths/ infections were sporadic in nature.

Besides, these two outbreaks of trypanosomiasis among six circus Tigers stationed at Vijayawada (Reddy *et al.*, 1975) and among nine circus Tigers stationed at Kakinada (Rao *et al.*, 1995) and their successful treatment have been reported.

These reports indicate that large cats specially Tigers are more susceptible to *T. evansi* infection than other species of wild mammals.

Bebesiosis

Babesiosis caused by *Babesia* spp. is transmitted by blood sucking ticks. This infection was reported from Delhi Zoo in an 11 year old WhiteTiger (Khurana, 1969); a male American Bison and a Lion (Arora, 1994); from Nandankanan Zoo, in an adult Mithun (Tripathy *et al.*, 1983) and from Lucknow Zoo, in a Lion (Arora, 1994).

Theileriosis

Theileriosis caused by *Theileria* spp. is also transmitted by ticks. This haemoprotozoan infection has been described in three Gayals of Calcutta Zoo (Sen Gupta, 1974a); a Gaur calf of Hyderabad Zoo (Ali Khan, 1981) and a Blackbuck of Nandankanan Zoo (Acharjyo, 1985). Concurrent infection of *Babesia* and *Theileria* was recorded in a male American Bison of Delhi Zoo (Arora, 1994).

Sarcocystosis

Sarcocystosis caused by *Sarcocystis* spp, a coccidian parasite has a prey-predator live-host life cycle in which the predator is the definite host. *Sarcocystis* infection in oesophageal musculature of a Goral of Lucknow Zoo (Agarwal *et al.*, 1982); in the heart muscle of a Sambar, a Nilgai, a Four-horned Antelope and a Mithun of Nandankanan Zoo (Acharjyo and Rao, 1988) and in cardiac muscle of a Lion of Bikaner Zoo (Bhatavdekar and Purohit, 1963) have been described. *Sarcocystis* spores were detected in the heart blood of three Gayals that died at Calcutta Zoo (Sen Gupta, 1974a). Chakraborty *et al.* (1994) reported the prevalence of this infection in Spotted Deer, Barking Deer, Sambar, Mouse-Deer, Nilgai, Serow and Mithun of Guwahati Zoo. Sarcocystosis in a Sambar deer of Thrissur Zoo has been described (Gangadharan *et al.*, 1992).

Coccidiosis

Coccidiosis mainly caused by *Eimeria* and *isospora* species affects a number of species of young captive wild mammals. Studies on the coccidian parasites based on the laboratory examination of faecal samples collected from several species of wild mammals with or without showing any clinical signs were carried out at Calcutta Zoo (Chaudhuri and Das, 1992); Lucknow Zoo (Panda *et al.* 1970) and Nandankanan Zoo (Patnaik and Acharjyo, 1971). These studies indicate that several species of wild mammals are hosts to several species of coccidian parasites.

Death associated with coccidiosis in a Common Laungur of Chillong Zoo (Rathore and Khera, 1981) and in a goitered Gazelle of Delhi Zoo (Parihar *et al.*, 1978) have been reported. Sen Gupta (1974a) stated that almost all Lion and Tiger cubs had coccidial infection at Calcutta Zoo. Three eastern Grey Kangaroos of Chennai Zoo suffered from coccidiosis, one died within 24 hours of showing clinical signs but the rest recovered after treatment (Thiruthalanathan *et al.*, 1998).

Balantidiosis

Balantidiosis caused by *Balantidium coli*, a ciliate protozoa has been reported in some Indian Zoos.

This infection has been reported in Monkeys (Ali Khan and Rao, 1981), a pair of White Rhino (Reddy *et al.*, 1984) and an Orangutan (Rao *et al.*, 1992) of Hyderabad Zoo. Faecal samples of 53 Bonnet Macaques and two Baboons of Calcutta Zoo were positive for this infection (Panda and Pal, 1996,1994b). Stool samples of Macaques and Langurs of Delhi Zoo, on microscopical examination, were found positive for *B. coil* infection (Adkoli *et al.*, 1974). *B. coli* infection was noticed in the intestine on histopathological examination in a Rhinoceros of Guwahati Zoo (Chakraborty *et al.* 1994).

Amoebiasis

Amoebiasis caused by *Entamoeba* sp. has been rarely reported in zoo animals of our country. Amoebiasis in seven species of primates of Hyderabad Zoo (Ali Khan *et al*, 1983) and in a female Orangutan (Kumar and Rao, 1988) of the same zoo has been reported. A case of amoebic dysentry in a Lioness of Mumbai Zoo was reported (Rao *et al.*, 1954). According to Panda and Pal (1994a, 1996) the faecal samples of three Chimpanzees and Bonnet Macaques of Calcutta Zoo, were found positive for *Entamoeba coli.*

Helminthic Diseases

Helminthic diseases are very common among zoo mammals. There are a number of reports on helminths and their diseases from Indian zoos. Some of the common and important disease conditions have been discussed hereunder.

Trematodes

Hepatic fascioliasis

Twelve of 24 Spotted Deer necropsied at Nandankanan Zoo during 1967-71 had heavy infestation of *Fasciola gigantica* in livers. Histopathological examination of livers of 34 more Spotted Deer of the same zoo revealed fascioliasis in 10 animals. Similarly, the livers of 10 Blackbucks, out of 31 animals examined, has fascioliasis (Acharjyo, 1985). *Fasciola gigantica* has been recovered from the liver of 18 Spotted Deer, one Serow, one Mithun and one Water Buffalo of Guwahati Zoo (Chakraborty *et al.*, 1994). Dutta *et al.* (1972) reported the occurrence of fascioliasis on faecal examination in Serow, White Fallow Deer, Bison, Rhino and Elephant of Guwahati Zoo and successful treatment.

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Table 1. List of Trypanosoma evansi *infection reported in Indian zoos.*

Location	Month and year of occurrence	Species affected (Numbers affected)	Status after treatment	Reference
Thrissur Zoo (Kerala)	December, 1964	Tiger (1)	Cured	Nair *et al.*, 1965
Madras Zoo (old one) (Tamil Nadu)	August, 1965	Tiger (1)	Cured	Gopalakrishnan, 1982.
Calcutta Zoo (West Bengal)	November-December, 1967	Tiger (4), Jaguar (2), Leopard (1)	All died	Sinha *et al.*, 1971
	August, 1971	Tiger (5)	2 died and 3 cured	
	December, 1974	Clouded Leopard (1), Wolf (3)	Died All died	Sen Gupta, 1974a; 1974b
Delhi Zoo	1969 - 1970	Hyena (1)	--	Arora, 1994
Darjeeling Zoo (West Bengal)	October-November, 1971	Siberian Tiger (8) Leopard (1)	2 died and 6 cured Cured	Das Gupta and Ghosh, 1979
Mysore Zoo (Karnataka)	August-September, 1978	Tiger (8)	All died	Jaya Kumar, 1978
	-	Wolf (1)	Died	Ziauddin *et al.*, 1992 a; 1992b
	-	Tiger (1)	Died	
Hyderabad Zoo (Andhra Pradesh)	-	Tiger, Puma, Lion, Leopard and Jackal	Cured	Ali Khan, 1986
	December, 1982	Jackal (1)	Cured	Ali Khan *et al.*, 1985
	September, 1984	Tiger (1)	Died	Choudary *et al.*, 1986
Bhilai Zoo (Madhya Pradesh)	Oct., 1987 - March, 1988	Chital (many)	Heavy mortality	Arora, 1994
Deer park, Nagpur (Maharashtra)	-	Sambar (2)	Died	Pathak *et al.*, 1988
Nandankanan Zoo (Orissa)	October, 1990	Wild Dog (1)	Cured	Ray *et al.*, 1991
	1999	Tiger (5)	3 died and 2 cured	B.K. Das, Pers. Comm.
Madhav National Park	February, 1993	Tiger (1)	Cured	Saxena, 1993
Lucknow Zoo (Uttar Pradesh)	Dec, 1996 - Jan., 1997	Tiger (1)	Cured	Singh *et al.*, 1997.

Fasciola jacksoni infection has been reported, in Elephants of Guwahati Zoo (Chakraborty and Choudhury, 1992; Islam, 1996).

Hepatic amphistomiasis

The gross and histopathological studies of liver of 18 Sambars of Nandankanan Zoo revealed that five animals had hepatic amphistomiasis caused by *Paramphistomum explanatum* (Acharjyo, 1985). None of the other wild ruminants of the said zoo had this infection.

Paramphistomiasis

Though no clinical case reports on this disease condition is reported the following flukes have been recorded from Indian zoo mammals.

Nandankanan Zoo (Orissa)	Sambar	*Fischoederius elongatus* *Homologaster poloiae* *Paramphistomum explanatum*
	Spotted Deer	*Cotylophoron cotylophoron* *Paramphistomum cervi* *Gastrothylax crumenifer* *Fischoederius elongatus*
	Barking Deer	*Homologaster poloniae* *Fischoederius elongatus*
	Nilgai	*Paramphistomum gracile* *Fischoederius cobboldi*
	Blackbuck	*Paramphistomum gotoi* *Carmyerius gregarius*
	Indian Wild Boar	*Fasciolopsis buski* *Opisthorchis novorca* (Patnaik, 1964a, Patnaik & Acharjyo, 1970; Padhi *et al.*, 1987)
Jaipur Zoo	Sambar	*Gastrothylax crumenifer* (Agrawal and Ahluwalia, 1980)
Hyderabad Zoo	American Bison	*Gastrothylax crumenifer* (Choudary *et al.*, 1987) *Gigantocotyle explanatum*
Kanpur Zoo (Gaur *et al.*, 1979)	Indian Wild Boar	*Fasciolopsis buski*

Paragonimiasis

During routine necropsy, *Paragonimus westermanii* specimens have been recovered from the cysts in the lungs of two Tigers, four Mongooses and a Golden Cat of Nandankanan Zoo (Rao and Acharjyo, 1991). This condition has been reported in a Clouded Leopard of Vadodara Zoo (Hiregoudar and Pethkar, 1970) and in a Bear Cat of Chhatbir Zoo (Singh and Gupta, 1988).

Cestodosis

Hydatidosis

Hydatidosis caused by *Echinococcus granulosus*, a tape worm in wild mammals has been reported from Indian zoos from time to time. Occurrence of hydatid cysts in the liver of Lions of Nagpur Zoo (Ganorkar *et al.*, 1997) and old Madras Zoo (Ramanujachari and Alwar, 1954) has been recorded. Hydatid cysts in the lungs of one and in the liver and spleen of another Indian Giant Squirrel of Hyderabad and Delhi Zoos respectively, were detected on post-mortem examination (Reddy and Ali Khan, 1970; Varma *et al.*, 1995). Choudary *et al.* (1987) recovered hydatid cysts from lungs and liver of an American Bison of Hyderabad Zoo. *E. granulosus*, associated with catarrhal enteritis in a Wolf of Nandankanan Zoo has been recorded (Rao *et al.*, 1973). The incidence of pulmonary hydatidosis in Giant Flying Squirrel, Spotted Deer, Four-horned Antelope and Indian Pangolin of the same zoo has been described (Rao *et al.*, 1972; Acharjyo, 1985). Chakraborty *et al.* (1994) recorded hydatid cysts in Rhinoceros, Spotted Deer, Giraffe and Ladhakhi Goat of Guwahati Zoo.

Coenurus gaigeri infection

Coenurus gaigeri has been recovered from thigh muscles of a Sambar (Varma *et al.*, 1994) of Delhi Zoo and a Goral (Singh *et al.*, 1999) of Mini Zoo, Gopalpur (Himachal Pradesh).

Cysticercus tenuicollis infection

Cysticercus tenuicollis cysts have been recovered from peritoneum/ peritoneal cavity of a Spotted Deer of Nagpur Deer Park (Kolte *et al.*, 1998) and Lucknow Zoo (Agrawal and Ahluwala, 1989). The cyst has also been recorded in peritoneal cavity of a Gibbon (Ramanujachari and Alwar, 1954) and in the liver of unspecified Deer (Alwar and Lalitha, 1961) of old Madras Zoo. *C. tenuicollis* in the brain of a male Beisa Oryx of Delhi Zoo has been described (Arora, 1994). *Cysticercus* cysts have been recovered from Spotted Deer, Barking Deer , Sambar, Blackbuck and Nilgai of Guwahati Zoo (Chakraborty *et al.*, 1994).

Other tapeworm infestations

Taenia taeniaeformis from Clouded Leopard; *Spirometra erinaeceae* from Jungle Cat, Clouded Leopard, Tiger and African Lion; *T. pisiformis* from Tiger, *Dipylidium caninum* from Indian Fox and *Mesocestoides lineatus* from Indian Fox and Leopard cub (Patnaik and Acharjyo, 1970) and *Moniezia expansa* from Barking Deer (Acharjyo, 1985) of Nandankanan Zoo have been recorded.

Chakraborty *et al.* (1994) reported the occurrence of *Moniezia* spp. from Serow and Ladhakhi Goat and *Anoplocephala* spp. from Indian rhinoceros of Guwahati Zoo.

Nematodosis

Toxocariasis

Toxocariasis is very common among carnivores specially the felids, in almost all indian zoos causing ill health in all age groups and mortality in young ones. Five 1.5 month old Himalayan Wolf-pups of Darjeeling Zoo died due to toxocariasis, caused by *Toxocara canis* (Chakraborty and Maity, 1995). Successful treatment of clinical cases of toxocariasis caused by *T. cati* has been described in five Snow Leopards of the same zoo (Maity et al., 1994). An Asiatic Lion of Bikaner Zoo has suffered from parasitic gastritis caused by *T. leonina* and *T. cati* and has been successfully treated (Tanwar *et al.*, 1984). A survey of faecal samples of wild mammals of Kanpur Zoo carried out by Gaur *et al.* (1979) indicated the presence of *T. leonina* in Lion (African and Indian) and Tiger. Patnaik and Acharjyo (1970) recorded *T. cati* from Jungle Cat, Golden Cat and Tiger, *T. leonina* from Fishing Cat and *Ascaris felis* from Indian Lion of Nandankanan Zoo.

Hookworm infection

All the carnivores, specially large cats of almost all the zoos of the country, suffer from various species of hookworms. At times, heavy infection becomes fatal for the animals particularly the young ones. The hookworms identified and reported from Indian zoos are *Ancylostoma caninum, A brasiliense, Unicinaria stenocephala, U. longespicula* and *Galonchus perniciosus.*

Nodular disease of the intestine caused by *G. perniciosus* has been frequently encountered on post mortem examination of Lion, Tiger and Leopard of Nandankanan Zoo.

Lungworm infection

Filaroides osleri causing parasitic nodules and pneumonia in the lungs of a Leopard Cat of Nandankanan Zoo has been discussed (Rao *et al.*, 1971). On histopathological examination Sharma *et al.* (1996) diagnosed verminous pneumonia due to the presence of larvae and eggs of *Muellerius capillaris* in the alveoli of lung parenchyma of a Barking Deer belonging to Mini Zoo, Gopalpur (Himachal Pradesh). Deaths of Musk Deer at Musk Deer breeding centre, Chamoli district (Uttar Pradesh) have been attributed to verminous pneumonia caused by *M. capillaris* (Singh *et al.*, 1992)

Heart worm infection

Dirofilaria immitis in the right ventricle of Lion, Tiger, Leopard, Golden Cat, Jackal, Indian Fox, Wild Dog and Wolf of Nandankanan Zoo has been described on necropsy (Rao and Acharjyo, 1993).

Stephanurus spp. infection

Stephanurus dentatus infection in the livers of four out of 13 Indian wild pigs of Nandankanan Zoo has been reported (Rao *et al.*, 1973).

Parasitic arteritis

Onchocerca spp. causing arteritis has been described in a Four-horned Antelope of Nandankanan Zoo (Acharjyo, 1985) and in three Spotted Deer, one Sambar, Nilgai, Blackbuck and Mithun of Guwahati Zoo (Chakraborty and Choudhury, 1993) on histopathological examination.

Oesophagostomiasis

Infection of *Oesophagostomum apiostomum* in a Gibbon (Patnaik, 1964b), *O. aculeatum* in a Golden Langur and *O. dentatum* in Wild Boar of Nandankanan Zoo (Patnaik and Acharjyo, 1970) and *Oesophagostomum* sp. in five Wild Boars of Kanpur Zoo (Gaur *et al.*, 1979) has been reported. Histopathological studies of *Oesophagostomum* spp. infection of intestine in a Gibbon of Guwahati Zoo has been described (Goswami *et al.*, 1994).

Murshidiasis

Murshidia spp. infection in zoo Elephants is very common and they respond very well to treatment given. This infection is invariably found in all the zoos of the country. *Murshidia murshidia* was responsible for murshidiasis in three Elephants of Calcutta Zoo (Roy and Mazumdar, 1988) and *M. falcifera* was the cause of this infection among Elephants of Nandankanan Zoo (Patnaik and Acharjyo , 1970).

Trichuriasis

Patnaik and Acharjyo (1970) reported the occurrence of *Trichuris discolor* in Sambar and *T. trichura* In a Golden Langur of Nandankanan Zoo and *T. cervicapra* in a Blackbuck of the same zoo (Patnaik, 1964a). Incidence of *Trichuris* sp. infection in Mouse Deer; Blackbuck, Serow, Mithun and Giraffe of Guwahati Zoo (Chakraborty, 1992) and in Baboons of Kanpur Zoo (Gaur *et al.*, 1979) has been reported.

Gongylonema sp. infection

Gongylonema sp. infection in Spotted Deer, Sambar, Mouse Deer, Nilgai, Serow and G iraffe of Guwahati Zoo has been described by Chakraborty (1994).

Hemonchosis

Haemonchus contortus infection in Spotted Deer and Blackbuck of Nandankanan Zoo (Acharjyo, 1985) and in Blackbuck of Kanpur Zoo (Gaur *et al.*, 1979) has been described.

Ectoparasitic Diseases

Ectoparasitic diseases include infestation of tick, louse, mite, leech, flea, fly and mosquito. They are often noticed in various species of zoo mammals. But, very few of these ectoparasites have been identified and studied. The occurrence of ectoparasites in wild mammals as reported from Indian zoos are given in Table 2.

Control measures

Several factors such as climatic conditions, design and dimension of animal enclosures, management practices,enclosure soil contamination, resistance/ susceptibility of host, age, nutrition and concurrent diseases in the host play a significant role on the incidence and severity of parasitic disease in zoo mammals. Besides, understanding the life cycle and epidemiology of the parasite and the habits and behaviour of host mammal will help in planning control measures for parasitic diseases in Indian zoos. The following control measures are usually adopted in Indian zoos.

Direct

(a) All new arrivals in the zoo can be a potential source of parasites to the healthy inhabitants. So, newly received animals should be kept in quarantine for atleast 30 days and screened for ecto, endo and haemoprotozoan parasites followed by suitable treatment of positive cases.

(b) Periodic faecal sample examination for three consecutive days and treatment of positive cases with appropriate broad spectrum anthelmintics should be carried out. Mass treatment of animals living in groups is always preferred.

(c) A deworming schedule is usually adopted for different species of wild mammals in most of the Indian zoos.

(d) All sick animals specially large cats with pyrexia should be screened for blood protozoan parasites.

(e) Usually anthelmintic drugs are changed from time to time to avoid drug resistance of the parasite.

(f) Commercially available ectoparasiticides can be used as spray for control of ectoparasites.

Indirect

(g) Attempts should be made to identify the source of infection and breaking the life cycle of the parasite outside the body of the host.
(h) General sanitation and hygiene of animal enclosures and surrounding areas, zoo veterinary hospital quarantine, isolation ward, post-mortem room and all places constantly used by visitors must be ensured.
(i) Excreta and food refuses of animals and all sorts of garbage, solid and liquid wastes generated inside the zoo premises can act as reservoir and breeding ground for disease causing parasites and their vectors. So provision for daily cleaning, quick disposal of wastes and disinfection of the enclosures and surrounding areas must be made.
(j) Retreating housing facilities must have crack free floor and wall for thorough cleaning. Houses must be well ventilated and lighted.
(k) There should be good drainage system to prevent waterlogging, dampness and unhygienic condition.
(l) Periodical drive to prevent the spread of mosquitoes, flies, fleas, ticks, snails, stray dogs, cats etc. inside the zoo premises should be carried out.
(m) Over crowding of enclosures must be avoided.
(n) Young animals are more prone to parasitic infection therefore, special care is essential.
(o) Supply of good quality, hygienic and nutritious diet in adequate quanity must be ensured. Grass from waterlogged areas must not be fed to the herbivores.
(p) Clean water from protected water supply is a must.
(q) Periodic lime treatment of animal houses (floor and walls) and water moats has to be carried out.
(r) Soil of animal enclosures are invariably infected due to confinement, movements of keepers etc. So the soil /sand should be replaced atleast twice in an year (before the onset of rains and after rains) with fresh soil / sand.
(s) In case of outbreak of any parasitic disease, the ground should be treated with lime or burnt under controlled conditions to avoid accidents.
(t) Proper disposal of carcasses after necropsy must be ensured.

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Table 2. Ectoparasites in wild mammals reported from Indian zoos.

Name of the Zoo	Species of ectoparasite	Animal host reported	Reference
Tick			
Nandankanan Zoo (Orissa)	*Amblyomma javanense*	Indian Pangolin, Ratel, Hyena cub	Sanyal *et al.*, 1987)
	A. testudinarium	Indian Wild Boar, Gaur, Indian Rhinoceros	
	Boophilus microplus	Ratel	
	Dermacentor auratus	Indian Wild Boar	
	Haemaphysalis bispinosa	Barking Deer, Tiger cub	
	H. indica	Ratel	
	H. turturis	Indina Wild Boar	
	H. intermedia	Tiger, Barking Deer	
	Hyalomma marginatum issaci	Indian Hare	
Delhi Zoo	*Rhipicephalus sanguineus*	Lasser panda and jaguar	Chakravarty & Malhotra, 1975
Chennai Zoo, (Tamil Nadu)	*R. sanguineus*	Wolf	Chakravarthy *et al.*, 1990
Thrissur Zoo (Kerala)	*Aponomma gervaisi*	Indian pangolin	Pillai & George, 1997
Dubare Elephant Camp (Kar)	*Rhinocephalus haemaphysaloides*	Indian elephant	Jagannath *et al.*, 1979
Guwahati Zoo (Assam)	*Boophilus microplus*	Mithun	Chakraborty *et al.*, 1994
Louse			
Hyderabad Zoo (Andhra)	*Haematomyzus elephantis*	Indian elephants (3)	Raghavan *et al.*, 1968
Dubare elephant camp (Kar)	*H. elephantis*	Indian elephant	Jagannath *et al.*,1979
Mite			
Bikaner Zoo (Rajasthan)	*Sarcoptes scabiei*	African lions (3)	Gaurava & Singh, 1999
Leech			
Nandankanan Zoo (Orissa)	*Limnatis granulosa*	Sloth Bear cub, young Indian Elephant (nostrils)	Acharjyo *et al.*, 1974

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