Conservation of wildlife is an essential component of environmental rejuvenation. India is blessed with great climatic diversity naturally favourable to a vast spectrum of animal species. The highly fragile ecosystem of the country still carries > 340 mammals, > 1200 birds, > 420 reptiles and > 140 amphibians (Jani and Patel 2001). Unfortunately, due to several man-made factors, majority of them have undergone enormous reduction in their numbers and some are endangered. Opinion on the importance of healthcare among aspects of wildlife conservation is now gathering momentum, and has found expression in an occasional book (Arora 1994). Although parasites and diseases caused by them are recognized as important health problems, wildlife parasitology in India is still in its infancy. In the absence of an adequate surveillance and monitoring system, there had been only sporadic reports and reviews (Chakraborty et al. 1994, Acharjyo 2000, Islam 2006) on the topic. Majority of these reports had information based on animals maintained in captivity in regional zoological gardens or parks. The flow of information has been continuous in recent years and has considerably advanced our knowledge. The objective of this review is to update the comprehensive information in order to gain a composite nation-wide perspective on this highly relevant subject of wildlife parasites. In view of the vastness of the subject, it is proposed to be dealt in two parts. The first of these is devoted to wild herbivores excluding the Indian elephant, mithun and yak, which have already been covered in an earlier review (Pathak and Chhabra 2012). Non-human primates and reptiles have also been included in this part. Parasites and parasitic diseases in different species of these wild animals are discussed as hereunder.

**Indian one-horned rhinoceros:** The one-horned rhinoceros (*Rhinoceros unicornis*) taxonomically belongs to the mammalian order *Perissodactyla*. Majority of the Indian rhinos are found in Assam at the Kaziranga National Park (KNP) where the latest census (IANS 2012) has put their numbers at 2290. The major threat to their conservation is poaching due to the supposed medicinal properties of the horn. The liver fluke *Fasciola gigantica* as cause of fatal fascioliasis in a captive rhino calf in Assom was documented (Bhattacharjee and Halder 1971). The symptoms and pathological changes were similar to those observed in fascioliasis in other animals. Another case of fasciolosis due
to F. gigantica has been reported from Pobitora wild life sanctuary (Arora and Chakraborty 2009). Other trematodes like amphistomes and schistosomes are also known to affect rhinos (Khan 1979). Chakraborty (1991) and Chakraborty et al. (1994) in Asom recorded Paramphistomum sp. and 2 other varieties of conical flukes in the small intestine, while Varadharajan and Pythal (1999) found both Fasciola and amphistomes on faecal examination of rhinos at a zoo in Kerala. Anoplocephalid tapeworms had also been recorded variously in captive rhinos (Chauhan et al. 1973, Arora 1986, Chakraborty 1991, Chakraborty et al. 1994). The last named found anoplocephalid infection at post mortem (p.m.) not only in small intestine but also in biliary system of the rhino. However, despite large number of parasites in the liver, much pathogenicity could not be observed by light microscopy. However, Scanning electron microscopic study showed tissue destruction in the biliary system. EDAX study showed significant variation in the concentration of elements in the affected biliary tissue (Chakraborty 1991). Anoplocephala magna was recovered from the small intestine and stomach of rhino on autopsy at a Zoological Park at Chhatbir in Punjab (Singh et al. 2006). In a survey of gastro-intestinal (g.i.) parasitic infections in free-ranging rhinos at KNP, Asom (Chakraborty and Islam 1993), 52 of 84 faecal samples (61.90%) were found positive. Paramphistomes (39 positive) were found predominant, followed by strongyle (17) and anoplocephalid (4) infections in captive wild herbivores (Chauhan et al. 1994), was negative for these worms in 12 necropsy findings, noted 4 species of nematode parasites in rhinos. Among arthropods, the tick Amblyomma testudinarium is known to parasitize Indian rhinos (Acharjyo 1990).

Out of 4 zebra (Fam. Equidae) examined at p.m., the lungworm Dictyocaulus arnfieldi in 2, Habronema in 1 and fly larvae Gastrophilus intestinalis (stomach bots) in 1, were recorded in Asom (Chakraborty et al. 1994). A study on strongylid helminths in Indian wild asses (Equus hemionus khur) in their natural habitat Little Rann of Kutch, based on faecal examination of 84 animals in 4 flocks (Sengupta and Dey 2009), revealed positivity for 1 or more species of helminths. The pathogenic Strongylus vulgaris was present in 19.65% of samples. The other entities observed were S. edentates, S. equinus, Gyalophalus sp., Oesophagodontus sp., Poteriostomum sp. Tridontophorus sp., Cyathostomum sp., Trichostrongylus sp. and Strongyloides sp.

Deer species (and allied herbivores)

The deer belong to the order Artiodactyla, of which family Cervidae contains the genera like Cervus, Axis and Muntiacus. Family Tragulidae has genus Tragus. Some other genera like Antilope, Gazella, Tetracercus, Bos and Boselaphus are placed in the family Bovidae. Apart from the deer species, Artiodactyla also includes some deer-like caprines such as Alpine ibex, Nilgiri tahr and Grey goral. These animals share most of the parasites and will therefore be dealt together for convenience.

Helminth parasites

Trematodes: Chauhan et al. (1973) reported the occurrence of amphistomes by faecal examination in spotted deer (Axis axis) and chinkara (Gazella gazella) at Lucknow zoo and in Sika deer (Cervus nippon) at Delhi zoo. At Lucknow zoo, p.m. examination of a spotted deer revealed ‘heavy’ infection with Gastrothylax sp. According to another report from Uttar Pradesh covering Jim Corbett National Park and Kanpur zoo (Gaur et al. 1979), infections with Fasciola gigantica were fairly high and it, along with amphistomes, appeared to be a well-established parasite of wild deer, notably of spotted deer and barasingha (Cervus duvaucelli) at the former location. Rao and Acharjyo (1984) also reported high incidence with F. gigantica at necropsy in spotted deer and black buck (Antilope cervicapra) and with Gigantocotyle explanatum in sambar (Cervus unicolor) at Nandankanan zoo, Odisha. Acharjyo (1985) described gross and histological pathology of hepatic amphistomiasis (Gexplanatum) in sambar. Other records of amphistomes include occurrence in the rumen of spotted deer of Nandankanan Bio-Park, Odisha (Padhi et al. 1987) of 3 species viz. Paramphistomum cervi, Gastrothylax crumenifer and Fischoederius elongatus. Paramphistomum lobatum in rumen-reticulum of a black buck at Bareilly, UP (Varma et al. 1990), P. epicleithum from rumen and Geplanatum from bile duct of sambar at Delhi zoo (Varma et al. 1993). A more comprehensive report based on p.m. observation (Chakraborty et al. 1994) recorded Fasciola in spotted deer (18/33), serow (Capricornis sumatrensis) and mithun (Bos frontalis), while 6 genera of amphistomes in various deer species and related bovids were identified. Of the amphistomes, genus Paramphistomum was the commonest, found in all species of deer but most in spotted deer (26/33), sambar (31/42) and barking deer (Muntiacus muntjak 21/41). The other amphistome genera were Gastrothylax in spotted deer and sambar, Fischoederius in
spotted deer, barking deer, sambar and hog deer (*Axis porcinus*), *CARMYERIUS* in black buck and mithun, *COTYLOPHORON* in spotted deer only and *GIGANTOCOTYLE* in sambar. *GASTROTHYLAX CRUMENIFER* and *G. GLANDIFORMES* were reported from barasingha (Shrivastava et al. 1998). Faecal positivity found for amphistomes in spotted deer, sambar and black buck at Thiruvananthapuram zoo, Kerala (Varadharajan and Pythai 1999) in spotted deer, sambar and hog deer at Thrissur zoo, Kerala (Varadharajan et al. 2001), in nilgai and spotted deer in Uttarakhhand (Banerjee et al. 2005) and in sambar at a zoological park in Punjab (Singh et al. 2006). At Thrissur zoo, additionally *FASCIOLA* was recorded in a Kashmiri goat (*CAPRA SIBIRICA*). Chakraborty (2001) opined that although *F. GIANTICA* infected all captive cervids in the zoo, only spotted deer were pathologically affected, which found confirmation in records of clinical cases at a deer park in West Bengal (Jana and Jana 2001 a, b) with nodular lesions and fatal outcome in 2 of 12 spotted deer, and a recent outbreak of fascioliasis in spotted deer with 11 fatalities (Sahoo et al. 2010) out of 30 inmates of a deer park in Cuttak, Odisha. Gross and histological pathology was also recorded, marked by haemorrhages, ascites and migratory tracts on liver, necrosis and cellular infiltrations in bile ducts. Interestingly, *DIACOCOELIUM* was recorded from spotted deer at Maharajbagh zoo, Nagpur, Maharashtra (Dhoot et al. 2002). Additional recent record also exists of *FASCIOLA* in sambar deer at Periyar Wildlife Sanctuary, Kerala (Ravindran et al. 2011). No record of schistosomes in any deer species could be traced from literature and this aspect merits further exploration.

**Cestodes:** Mainly limited findings of larval cestodes at p.m., such as hydatid cyst in lungs of spotted deer at Nandanankan zoo, Odisha (Rao and Acharjyo 1984), in spotted deer and Ladakhi goat (*CAPRA SIBIRICA*) by copro-culture in Asom (Chakraborty et al. 1994), *CYSTICERCUS* sp. In spotted deer, sambar, barking deer, black buck and nilgai (*BOS ELAPUS TRAGOCAMELUS*) in Asom (Chakraborty et al. 1994), and *CYSTICERCUS TENUICOLLIS* from mesenteric of black buck at Indian Veterinary Research Institute, Izatgarh, Uttar Pradesh (Varma et al. 1998) are available. Moniezia at p.m. was sighted in serow and Ladakhi goat (Chakraborty et al. 1994) and faecally as part of g.i. parasites in a sambar deer at Coimbatore Mini zoo (Varadharajan and Kandasamy 2000).

**Nematodes:** The prevalence of nematode parasites appeared more common than the trematodes and cestodes. Faecal eggs of bursate worms in several species of cervids, wild bovids and tragulids were reported from the zoos of Lucknow and Delhi (Chauhan et al. 1973). In addition, trichurid infection in nilgai, spotted deer and chinkara as well as *STRONGYLOIDES* sp. in black buck were reported. A later report on findings from Jim Corbett National Park and Kanpur zoo (Gaur et al. 1979) used larval cultures and identified the stomach worm *HAEMONCHUS CONTORTUS* as the predominant infection in wild deer, followed by other strongyles, *STRONGYLOIDES PAPILOOSUS, OESOPHAGOSTOMUM* sp. and a single case of *BUNOSTOMUM* sp. *HAEMONCHUS CONTORTUS* was found associated with fatal gastritis in an 8-month-old black buck at a deer park in Hisar (Sadan et al. 1980). At Bannerghatta National Park, Bangalore, strongyle species in chinkara and spotted deer, and ascarids were recorded in sambar, spotted deer and barking deer (Jayagopala Reddy et al. 1992). *HAEMONCHUS* sp. in spotted deer and *OESOPHAGOSTOMUM* sp. in nilgai were encountered at Maharajbagh zoo, Nagpur (Dhoot et al. 2002). Chakraborty (1992) recorded *TRICHURIS* sp. from mouse deer (*TRAGULUS MENINNA*), black buck and serow at p.m. in Asom State Zoo (ASZ). From the same location (ASZ), *GONGYLONEMA* infection was reported from captive wild herbivores like spotted deer, sambar, mouse deer, nilgai and serow (Chakraborty 1994). The parasites were recovered at necropsy from the mucosa of oesophagus, cheek and base of tongue. They were associated with fibrinous inflammation and destruction/disruption of epithelium. Apart from the records of *Trichuris* and *Gongylonema* as above, Chakraborty et al. (1994) reported from ASZ, Asom, p.m. findings of *HAEMONCHUS* in barking deer, black buck, serow and Ladakhi goat, *TRICHOSTRONGYLUS* in barking deer, *SETARIA* in barking deer and sambar, *OESOPHAGOSTOMUM* in mouse deer, *Cooperia* in nilgai, *Dioctophyma* in kidney of black buck and mithun, and *Onchocerca* in spotted deer, black buck, nilgai and Ladakhi goat. Six genera of strongyles viz. *OESOPHAGOSTOMUM, TRICHOSTRONGYLUS, OSTERTAGIA, MARSHALLAGIA, NEMATODIRUS* and *HAEMONCHUS* as well as *STRONGYLOIDES* sp. were recorded in the g.i. tract of Hanful (*Cervus elephas HANGLU*) at Dachigam National Park in Kashmir (Shahdar et al. 1995). In different sanctuaries of Tamil Nadu, Bhat and Manickam (1998) reported *STRONGYLOIDES, TRICHOSTRONGYLUS* and *COOPERIA* by copro-culture in spotted deer with observations on seasonal variations in worm burdens. Strongyles and spiruroids were found to be the predominant nematode infections by faecal examination in 5 deer species viz. spotted deer, sambar, hog deer, barking deer and black buck at the Thiruvananthapuram zoo in Kerala (Varadharajan and Pythai 1999). Additionally, spotted deer and sambar were found harbouring *STRONGYLOIDES* and ascarids, and hog deer had *CAPPILLARIA* sp. Similar observations were recorded at Coimbatore regarding spotted deer and Asomese goat faecally (Varadharajan and Kandasamy 2000) and in 5 common deer species and Kashmiri goat at Thrissur zoo, Kerala (Varadharajan et el. 2001). Strongyles, notably *TRICHOSTRONGYLUS* sp., were observed parasitizing blue bull, spotted deer and black buck at Rajkot Municipal Zoo in Gujarat (Parsani et al. 2001) while at Maharajbagh Zoo at Nagpur, Maharashtra (Dhoot et al. 2002), *HAEMONCHUS* in spotted deer and *OESOPHAGOSTOMUM* sp. in nilgai were notable findings. Another report on helminth parasites of axis deer at Nagpur (Hussain et al. 2002b) found 5 genera including *STRONGYLOIDES, TRICHURIS, NEMATODIRUS* and *HAEMONCHUS*. Prevalence of Muellierus
capillaris in free ranging spotted deer in 3 National Parks (Ramaswamy and Arora 1991) and later, verminous pneumonia associated with this lungworm in a barking deer was reported from Himachal Pradesh (Sharma et al. 1996). The lungworm Dicyocaulus morphologically similar to D. viviparusr was found in Kashmir stag or hangul (Nashiruddullah et al. 2005). The pathological changes and observations were similar to those observed in lungworm infections in sheep and goat (Nashiruddullah et al. 2007). Feecal samples of eighteen spotted deer stags (Mohan and Coumarane 2007) at the Department of Forest and Wildlife, Pudducherry revealed individual and mixed infections of Cooperia sp., Capillaria sp. and Trichostrongylus sp. Faecal infection in 4 species of deer, blue bull and Ladakhi goat at a zoological park in Punjab (Singh et al. 2006) revealed predominantly strongyles in all with Trichuris sp. as additional infection in ibex, blue bull and chinkara. Faecal examination of axis deer maintained in forested area of Vidharba region of Maharashtra (Meshram et al. 2008), revealed 178 (89%) of 200 faecal samples to be positive for parasitic eggs. Apart from routine Trichuris sp., strongyles and Strongyloides sp., Trichostrongylus sp., Oesophagostomum sp., Haemonchus and Bunostomum were identified. Parasitic infections in Periyar Wildlife Sanctuary in Kerala were mainly strongyle in gaur (Bos gaurus), Nilgiri tahr (Nilgiritragus hylocrius) and sambar with Trichuris sp. as additional in the last named (Ravindran et al. 2011).

Appearance of clinical signs suggestive of helminthisis was not a regular feature in the wild mammals despite faecal samples found positive. However, suppression of haematological values and their post-treatment increase in axis deer was observed (Hussain et al. 2002a). Oral administration of effective anthelmintics such as fenbendazole against g.i parasites in hangul (Shahardar et al. 1995) and in axis deer (Hussain and Sarode 2003) and oxyclozanide against Paramphistomum sp. in zoo herbivores at Nandankanan, Odisha (Anonymous 2010) can be judiciously employed. Proper disposal of dung/excreta, hygienic practices and general measures of endoparasite management should be scrupulously followed (Anonymous 2010). In a study of over 50 faecal samples of wild animals including Sambar and chital, Gupta et al. (2011) found out that the parasitic profile was dominated by coccidia infection (60.0%) followed by Strongyloides (50.0%) in Sambar, whereas, Amphistoma (30.0%) and Strongyloides (30.0%) showed equal prevalence followed by Trichuris (20.0%) and Fasciola (10.0%). In Chital, the prevalence of Strongylides (60.0%) was the highest followed by Trichuris (53.3%) and Fasciola (6.7%).

Protozoan parasites: Trypanosomiasis (caused by Trypanosoma evansi) appears common and often fatal in deer species. Episodes such as death of 2 sambar at deer park, Nagpur (Pathak et al. 1988) and outbreaks among spotted deer at Bhilai zoo (Arora 1994) and in spotted deer and sambar at a nature reserve in Rajasthan (Singh 1998), are on record. Of the 44 samples screened of wild captive herbivores (Shailaja et al. 2005) 11 were found positive for Trypanosoma evansi by conventional microscopic examination and 14 by PCR technique. Clinical trypanosomiasis concurrent with tuberculosis in black bucks at a deer park in Punjab and its successful treatment with quinapryamine therapy was reported (Gupta et al. 2009). Clinical theileriosis in a gaur calf (Khan 1981) and Concurrent Babesia and Theileria in a male American bison of Delhi zoo (Arora 1994) were reported. Theileria cervi was recorded in spotted deer (Harikrishnan et al. 2004), and in a black buck from a deer park in Punjab (Gupta et al. 2009). Sarcocystis was encountered in the heart muscle of 4-horned antelope (Tetracerus quadricornis) in Odisha (Rao and Acharjyo 1984), in sambar, nilgai and 4-horned antelope and mithun of Nandankanan zoo (Acharjyo and Rao 1988), in spotted deer, barking deer, Sambar, mouse deer, nilgai, serow and mithun of Guwahati zoo (Chakraborty et al. 1994) and in the cardiac muscle of a barasingha (Cervus duvauceli branderi) at Kanha National Park, MP (Shrivastava et al. 1999). The species recorded from chital (Axis axis) with dhole (Cuon alpinus) as definitive host, was identified as S. saxicounis (Jog et al. 2003 2005). Coccidian infection was commonly detected in mammals at Lucknow zoo (Chauhan et al. 1973) such as Eimeria cheetai from spotted deer and black buck, E.ramgai from mouse deer, E.chinikari from chinkara, E.parahi from hog deer, E.chausinghi from four-horned antelope and from nilgai, three species viz. E.yakimovi, E.nilgaii and E.tragocamelus. At Delhi zoo, the same authors (Chauhan et al. 1973) detected E.arloingi and E.crandaillis in Ladakhi goat. Coccidial/ Eimeria as part of g.i parasites were observed, without species identification, in chinkara, sambar and ibex (Jayagopala Reddy et al. 1992) from Bangalore, in spotted deer, barking deer, nilgai, serow and mithun at ASZ, Guwahati (Chakraborty et al. 1994), in spotted deer, sambar and black buck from Kerala (Varadharajan and Pythal 1999), in spotted deer at Coimbatore Mini Zoo (Varadharajan and Kandasamy 2000) at Rajkot Municipal Zoo in Gujarat (Parsani et al. 2001), in nilgai and spotted deer in Uttarakhand (Banerjee et al. 2005) and in sambar at a zoological park at Chhatbir in Punjab (Singh et al. 2006) and more recently in sambar deer of Periyar Wildlife Sanctuary in Kerala (Ravindran et al. 2011). Another protozoan Balantidium coli was found by faecal cysts in blue bull at Muncipal zoo, Rajkot (Parsani et al. 2001).

Arthropod parasites: The deer species are subject to attacks of haematophagous flies as evidenced by the incidence of trypanosomiasis in them. Myiasis of fly larvae in wounds is also likely but not reflected in reports. Hippoboscids flies of the genus Lipoptena have been reported as L.indicum from barking deer (Rao et al. 1964) and Lipoptena sp. from spotted deer and hog deer (Chhabra and
Chander 1969) in Uttar Pradesh. Occurrence of the sheep ked *Melophagus ovinus* in a wild hog deer was recorded from KNP, Asom (Islam and Lahkar 1996). The deer warble *Hypoderma diana* (Islam et al. 2003) was recorded from hog deer in 2 national parks in Asom. Fleas recorded include *Ancistropsylla* sp. from sambar and barking deer in the Nilgiris (Joseph and Mani 1980) and *Vermipsylla* sp. fleas from swamp deer at Nandankanan in Odisha (Anon 2010). According to Sridhar (2011) cervids are also infested by several biting and sucking lice as well as mange mites, although reports on these are scarce. In their checklist of Indian ticks, Geervghese et al. (1997) listed *Amblyomma testudinum* parasitizing sambar deer, *Haemaphysalis birmaniae* in barking deer and serow, *H. spinigera* and some other *Haemaphysalis* spp. common in a variety of wild mammals including deer. Also prevalent among *Artiodactyla* are *Rhipicephalus haemaphysalooides* and *Otobius megnini* (Geervghese et al. 1997). *Linguatula serrata* larvae in a sambar deer were found at Thekkady, Kerala (Easwaran et al. 2003). Order *Artiodactyla* also includes the giraffe (*Giraffa camelopardalis*) in Fam. *Hippopotamidae* and wild boar (*Sus scrofa*) under the Family Suidae. In their studies on parasites of captive wild herbivores in ASZ, Asom, Chakraborty (1992) found *Trichuris* sp. with gross and microscopic pathology, and later, Chakraborty et al. (1994) reported ascarids, *Gongylodema, Trichuris*, hydatid cyst and *B. coli* at p.m. examination of giraffes. Varadharajan and Pythal (1999) recorded strongyles and coccidia in hippopotamus at Thiruvananthapuram zoo and Varadharajan et al. (2001) encountered strongyles, *Fasciola*, spirurid and ascarids by faecal concentration technique in captive hippos at Thirissur, Kerala. Gaur et al. (1979) found 7 of 10 wild boars at Zoological Park, Kanpur (U.P.) faecally positive. *Oesophagostomum* sp. was found in 5, while 2 had *Ascaris suum* and *Fasciolopsis buski*. At Nandankanan zoo, Odisha, 6 of the captive wild boars at necropsy were found infected with *Stephanurus dentatus* in liver and kidneys while one had hydatid cyst in peritoneal cavity (Rao and Acharjyo 1984). Easwaran et al. (2003) recorded *Gastrodiscoides hominis* and *Gnathostoma hispidum* in the wild boar at Thekkady, Kerala. Nine different helminthic infections by faecal examination were found in free-ranging wild boars (67/91 found positive) in Uttarakhand (Banerjee et al. 2005). Predominated by *Macrocanthorhynchus*, others in descending order were *Metastrongylus*, *Trichuris*, strongyles, *Capillaria, Ascaris, Physocepalus, Fasciolopsis* and *Strongyloides*. Besides these, coccidia (26) appeared fairly common. Ascarioidia was also reported from captive wild boars at Zoological Park, Hyderabad (Rao and Hanza 2007) and at MC Zoological Park, Chhathbir, Punjab (Singh et al. 2009) while *Macrocanthorhynchus hirudinaceus* was found in a dead wild boar at a forest range in Tamil Nadu (Krithiga et al. 2010). In the latter report, granuloma formation and nodular lesions at the adhering site in small intestine were observed. Faecal examination of 8 wild boars in Periyar Wildlife Sanctuary in Kerala (Ravindran et al. 2011) revealed strongyle ova presumed to be *Stephanurus dentatus* since many worm specimens were also frequently observed in the internal organs of the same animals. Also observed were *Ascaris suum, Strongyloides* sp., spirurid, coccidian oocysts and cysts of *B. coli*.

Several tick species have been listed as infesting wild boar (Geervghese et al. 1997) viz. *Dermacentor auratus, Haemaphysalis* (5 species recorded from various parts of the country), *Hyalomma dromedarii* and *Nosomma monstrosum*. Easwaran et al. (2003) identified *Amblyomma* sp. from this host at Thekkady, Kerala. These authors also reported the pig louse *Haematopinus suis*.

**Marsupials**

There is a solitary report in recent Indian literature on clinical coccidiosis in Eastern Grey kangaroos (*Macropus giganteus*) at A. Anna Zoological Park near Chennai, Tamil Nadu (Thiruthalinathan et al. 1998). Three joeyeys born in captivity became dull, anorectic and weak, but one of them additionally developed signs of colic, enteritis and died within 24 h. Oocysts, passed in the faeces by all three, were tentatively identified as *Eimeria cunnamullensis*. Necropsy of the dead joeyey revealed enteritis, oedema and haemorrhages on the mucosa of caecum and colon. The other two joeyeys were treated with amprolium along with supportive therapy. Coccidiosis appeared to be a fairly common condition among a variety of wild mammals.

**Non-human (N.H.) primates**

Early-on, *Trichuris* sp. was documented as one of the most commonly encountered parasites in N.H. primates, by itself (Rao et al. 1972) or with *Strongyloides*, hookworm and *Ascaris* (Chauhan et al. 1973, Gaur et al. 1979). At Nandankanan Zoo, Odisha, Rao and Acharjyo (1984) found tapeworms in one slow loris, roundworms in another and parasitic nodules in a slender loris, but did not identify them. Histopathological studies of *Oesophagostomum* spp. Infection in intestine of a hollock gibbon (*Hyllobates hoolock*) of Guwahati zoo was described (Goswami et al. 1994). Later, Goswami and Chakraborty (1996) recorded pathology of 14 N.H. primates naturally infected with *Oesophagostomum aculeatum, Enterobius vermicularis, Trichuris trichiura, Dirofilaria sp.*, *Fasciola gigantica* and *Cysticercus* at p.m. examination. Enteritis was present in all. *Trichuris* sp. reported in the faecal samples of Nilgiri langur (*Semnopithecus johnii*) in Silent Valley National Park (Joseph et al. 1999, Xavier et al. 2000) finds easy dissemination in the hosts’ feeding habits and contamination through defecation from tree tops. Chakraborty and Goswami (2001) recorded 5 nematodes 2 cestodes and one trematode parasite in a necropsy study of 85 captive N.H. primates of ASZ, Asom. The parasites identified were *Trichuris trichurina*...
(9.41%), filarial parasite (7.05%), Enterobius vermicularis (4.70%), O.aculeatum (4.70%), Cysticercus sp. (4.70%) and an unidentified cestode (1.70%). The occurrence of Fasciola gigantica in the bile duct of a common langur was also observed. Coproscopic examination revealed the presence of other parasites viz. Ancylostoma sp., Ascaris sp., Strongyloides sp. Survey of g.i. parasites in Nilgiri langur by faecal exam (Rajendran et al. 2004) revealed high prevalence of nematode infection viz. strongyles (100%), Trichuris (25%), Strongyloides (18.75%) and spirurids (18.75%). Identical prevalence of helminthic infections in 35 species of macaques at Thrisur zoo in Kerala (Varadharajan et al. 2001) was recorded, with Hymenolepis and Metagonimus as additional findings in Bonnet macaque (Macaca radiata). Study of helminthic fauna of free-living primates in a wild life sanctuary in Kerala (Subramanian et al. 2006) found faecal positivity of strongyles, Strongyloides, trichurids and spirurids. Arora and Chakraborty (2009) included hydatid cysts and Fasciola gigantica infection in the liver of common langurs (Presbytis entellus), while Singh et al. (2009) recorded Trichuris sp. Hymenolepis diminuta and Strongyloides in two types of macaques and two types of langurs in MC Zoological Park at Chhatbir, Punjab. These workers found therapy with proprietary combination of pyrantel pamoate, praziquantel and fenbendazole as efficacious. Further, regular faecal examination, assessment of parasitic load and administration of desired anthelmintics were recommended for control.

Presence of Strongyloides spp., Trichuris spp., Entamoeba histolytica spp., Ascaris sp., Entamoeba coli and Spirometra spp was observed by Parmar et al. (2012) in a study of faecal samples of the non -human primates (including hanuman langur and rhesus macaque) of Gujarat state. Nath and colleagues in a study on 22 faecal samples of non-human primates in the same year, observed eggs of Oesophagostomum sp. and Trichuris sp. in 3 samples.

Among protozoa, the zoonotic Entamoeba histolytica infection was found in 29.3% of 116 rhesus monkeys (Macaca mulatta) at PGI, Chandigarh (Jindal et al. 1977). Toxoplasma antibodies in rhesus monkeys at the same centre were also reported (Chhabra et al. 1976). B. coli had been commonly found in the stool samples of 200 macaques and langurs (Acharjyo 2000). Entamoeba coli had also been recorded by faecal presence in chimpanzees and bonnet macaques (Acharjyo 2000). Clinical balantidiosis in an orangutan (Pongo pygmaeus) at a zoological park in Hyderabad was reported (Bhaskara Rao et al. 1992). Three protozoan infections viz. Entamoeba sp., Balantidium sp. and Giardia sp. were recorded from ASZ, Assam (Chakraborty and Goswami 2001). Among arthropods, sarcoptic mange in a large number of Hanuman langurs (Semnopithecus entellus) around Jodhpur, Rajasthan (Chhangani et al. 2001) and its treatment, is on record. Demodicosis associated with alopecia in a rhesus monkey (Macaca mulatta) has been reported from Pune (Nighot et al. 2011). Geervarghese et al. (1997) had listed some tick species of genus Haemaphysalis as parasitizing monkeys viz. H.bispinosa, H.obesa, H.cuspidata, H.kinneari, H.wellingtoni and H.turturis.

Reptiles

Patnaik and Acharjyo (1970) recorded at p.m. examination at Baranga Zoo in Odisha, Bothridium pythonis and Ophidascaris filaria from Indian python (Python molurus) while Polydelphis attenuata and Kalicaphalus willeyi were found in Russel’s Viper (Vipera russelli). The Indian rock python (Python molurus) is distributed all over India. Pythons are predominantly parasitized by the pathogenic ascarid Ophidascaris ajagaris (Sarode et al. 1991). Muraleedharan et al. (1990) found a python infected with O. filaria. If in large numbers, it can damage the intestinal wall and even cause occlusion of the g.i. tract (Dehingia and Choudhury 1991). Pythons in captivity may also harbour a cestode Bothridium pythonis (Abdul Rahman et al. 1980, Muralidharan et al. 1990). Islam and Kheria (2003) recorded B.pithonis in a free-living python at KNP, Assam. In Chennai Snake Park, Strongyloides and strongyles were detected (Jayantharaj et al. 2006) in a spectacled cobra (Naja naja). A gharial (Gavialis gangeticus) of Chambal River Reserve was found infected with Ascaris and had ulcerative nodular growth in its stomach at postmortem (Arora and Chakraborty 2009). In a rat snake (Ptyas mucosa) in Namakkal district of Tamil Nadu, one g.i. nematode, later identified as Kaliccephalus sp. (Fam. Strongylidae) was recovered at p.m. (Arunachalam et al. 2010). Tick infestation due to Aponomma sp. was also recorded. Common snakes of Western Ghats of Karnataka were screened faecally for g.i. parasites (Ananda et al. 2011a). The rock python showed strongyle, Strongyloides, Capillaria and ascarid eggs, king cobra had only the first three types and spectacled cobra had faecal positivity for only strongyle and ascarid eggs. In a case report (Ananda et al. 2011b), Ascaridia infection in an Indian rock python was described at autopsy. There were petechial haemorrhages, ulceration and necrotic foci on the mucosa throughout the small intestine. Great numbers of the nematodes were found in the large intestine of the python. The tapeworm Ophiotaenia burgeria was recorded in a spectacled cobra near Puducherry (Das et al. 2012 a). Of the arthropods on reptiles, only ticks find mention in Indian literature. Geervarghese et al.(1997) in their checklist of Indian ticks, listed Aponomma gervaisi occurring on python and Indian monitor lizard, A. lucasi on cobra in addition to the two earlier-names reptiles, A. laevi on python, cobra and rat-snake, while Amblyomma helvolum was recorded from monitor lizard only. However, Amblyomma sp. was found on a Red Sand Boa (Erhus johnii) near Puducherry (Das et al. 2012 b). At Alipur Zoo, Kolkata, a number of snakes like cobra and rat snake died just after hibernation (Sur et al. 2001) due to heavy infestation with ticks.
CONCLUSION

Parasites and morbidity/disease caused by them, constitute major hazards for the vulnerable wildlife which is stressed by captivity and/or shrinking natural habitat. An effective monitoring and surveillance system needs to be put in place to generate more data. For conservation and rehabilitation of wildlife in zoo/sanctuary, provision of adequate veterinary/health care is mandatory. Although wildlife science/healthcare has been introduced in the veterinary curriculum and some colleges now have an independent department for teaching and research of this emerging but important discipline, there is a continuing shortage of zoo veterinarians and trained ancillary manpower.

There is a Central Zoo Authority in New Delhi which provides financial support for projects as well as several NGO’s which are contributing to the conservation and welfare of wildlife as a common cause. The growth in information on parasites has been disproportionately favourable to helminths, whereas protozoa (particularly haemoproteozoa) and arthropods in general need greater exploration. A standard p.m. protocol should be scrupulously carried out and all organs/tissues should be thoroughly searched for parasites. Pathological changes, both gross and histological should be recorded and correlated. Serodiagnosis for blood protozoa and biotechnological tools should be standardized for use on wild herbivores and skin-scrapings for mange mites can be a routine procedure. Many of the g.i. parasites of wild ruminants are shared with the domestic stock. Therefore, domestic animals should not be let out for grazing in the forest ranges. The prevalence of schistosomes in wild ruminants is a grey area and should receive greater attention. Well-designed anthelmintic/acaricide trials should be promoted.

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May 2013] PARASITES OF WILDLIFE 471


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