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Short notes

Prevalence of endoparasites in captive snakes of Kerala, India

Sulekha Akhila[1], Vengotuparambil Suresh Sukanya[2], Anu Anto[2], Shyamala Karunakaran[3]

[1]Department of Microbiology, Pondicherry University, Pondicherry, India
[2]Department of Zoology, St. Xavier's College for Women, Aluva, Kerala, India
[3]Department of Parasitology, College of Veterinary and Animal Sciences, Mannuthy, Kerala, India

Corresponding Author: Anu Anto; e-mail: anujimy@gmail.com

ABSTRACT. The objective of the study was to evaluate the status of parasitic infections in captive snakes of Kerala. Faecal samples were collected from captive snakes of State Museums and Zoos of Thrissur and Thiruvananthapuram. Parasites were screened by direct smear, sedimentation, simple floatation and Shaether's sugar floatation method. Forty-nine snakes from 15 species were screened and 35 (71.4%) were found to be positive. While 80% of the snakes from Thrissur were found to be positive for parasitic infections, 70.6% of the samples from Thiruvananthapuram zoo were positive. *Strongyloides* sp. was the most prominent infection, accounting for 25.7% of all infections, followed by *Capillaria* sp. (22.8%) and Strongyles (20%). The preliminary investigation of captive Green Anaconda samples from Thiruvananthapuram zoo revealed mites, non-sporulated Coccidia of the genus *Eimeria* sp. and *Cryptosporidium* sp. It is understood that most of the infections of the captive snakes were acquired through the feeding and handling of the snakes, therefore periodical sampling is needed for both the snakes and their prey.

Key words: coprological, endoparasites, captive snakes, Kerala

Introduction

Snakes are increasingly kept as captive animals in zoos. However, these captured from the wild and kept in the stress of captivity can harbour diverse species of endoparasites, such as protozoans, nematodes, cestodes, pentastomids, acanthocephalans and trematodes, which can lead to serious diseases [1–3]. These infected snakes have compromised immune responses and are susceptible to further infections which can spread to other animal species and even to humans. Therefore, to ensure the health and well-being of these animals, accurate coprological examination for reptile parasites constitute an important part of the daily routine of veterinarians [2,4]. Diagnosis of parasitic infection is generally achieved by analysing the eggs, larvae, oocysts and cysts of the parasites present in faeces by floatation, sedimentation and through direct faecal smears [1–3,5]. Very few studies have been conducted on gastrointestinal parasite load of the captive snakes in the zoos of Kerala. A decade earlier, a preliminary study of six different captive snake species housed in three different herpetaria in Kerala state carried out by Radhakrishnan et al. [2] found that 88% of the snakes were infected. However, no further attempts have been made to study gastrointestinal parasites in these animals. This is therefore the second study from this part of the world, and its findings will allow a fuller understanding of the status of current gastrointestinal parasitic load in captive snakes in the zoos of Kerala, South India. It should also aid in making several important management decisions.

Materials and Methods

Faecal samples were collected during August 2016 and March 2017 from 49 snakes of 15 species and six families (Colubridae, Elapidae, Boidae, Veperidae, Pythonidae and Homalopsidae) housed at the State Museum and Zoo, Thrissur (10°31'N,

Table 1. List of examined snakes from Thrissur and Thiruvananthapuram State Museums and Zoos, India

Host	Thrissur (n=30)	Thiruvananthapuram (n=19)
Elapidae		
Indian Cobra (*Naja naja*)	11	3
Common Krait (*Bungarus caeruleus*)	2	
King Cobra (*Ophiophagus hannah*)	2	1
Colubridae		
Common Cat Snake (*Boiga trigonata*)	1	
Common Wolf Snake (*Lycodon aulicus*)	2	
Trinket Snake (*Coelognathus helena*)	2	
Rat Snake (*Ptyas mucosa*)	4	
Green Vine Snake (*Ahaetulla nasuta*)	1	
Pythonidae		
Indian Rock Python (*Python molurus*)	2	1
Reticulated Python (*Python reticulatus*)		3
Homalopsidae		
Mud Snake (*Enhydris dussumieri*)	2	
Asciatic Water Snake (*Xenochrophis piscato*)	1	
Viperidae		
Russels Viper (*Daboia russeli*)		3
Boidae		
Sand Boa (*Eryx conicus*)		1
Green Anaconda (*Eunectes murinus*)		7

n – number of examined snakes

76°12'E) and the Museum and Zoo, Thiruvananthapuram (8°30'N, 76°57'E) (Table 1). All the snakes were originally captured from various locations in the state of Kerala, India, and housed individually in enclosures. Approximately 3–4 g of non-desiccated snake faecal samples were collected from State Museums and Zoos of Thrissur (n=30) and Thiruvananthapuram (n=19). Faecal samples were collected in labelled containers and kept at 4°C until processing.

Direct smear, sedimentation, faecal floatation, and Shaether's sugar floatation with a specific gravity (SG) of 1.23 to 1.27 was used for faecal examination [4,6].

Eggs, oocysts and larvae of parasites were counted, photographed and identified in accordance with previously reported guidelines [7]. Formol ether concentration followed by Ziehl-Neelsen staining was used to detect *Cryptosporidium* oocysts. Observed eggs or oocysts were qualified as parasites and pseudoparasites.

Results

In total, 35 snakes (71.4%) were infected with parasites. Twenty-four snakes (80%) from Thrissur Zoo and 13 (68.4%) from Thiruvananthapuram Zoo were positive for parasitic infections. The most strongly represented infection in Thrissur samples was *Strongyloides* spp. (30%), followed by ascarids (23%) and *Capillaria* sp. (20%). The pseudoparasite *Rodentolepis* sp. was detected in one sample of *Python molurus* (Table 2).

In the Thiruvananthapuram Zoo samples, the most widespread infection was *Cryptosporidum*. The captive Anaconda samples were found to contain mites, non-sporulated Coccidia of the genus *Eimeria* sp. and *Cryptosporidium* sp. An adult worm of *Ophidascaris* sp. was recorded from an Indian Cobra. *Cryptosporidium* infection was only observed in the snakes of family Pythonidae and Boidae *viz.,* Indian Rock Python, Reticulated Python, Sand Boa and Green Anaconda (Table 3).

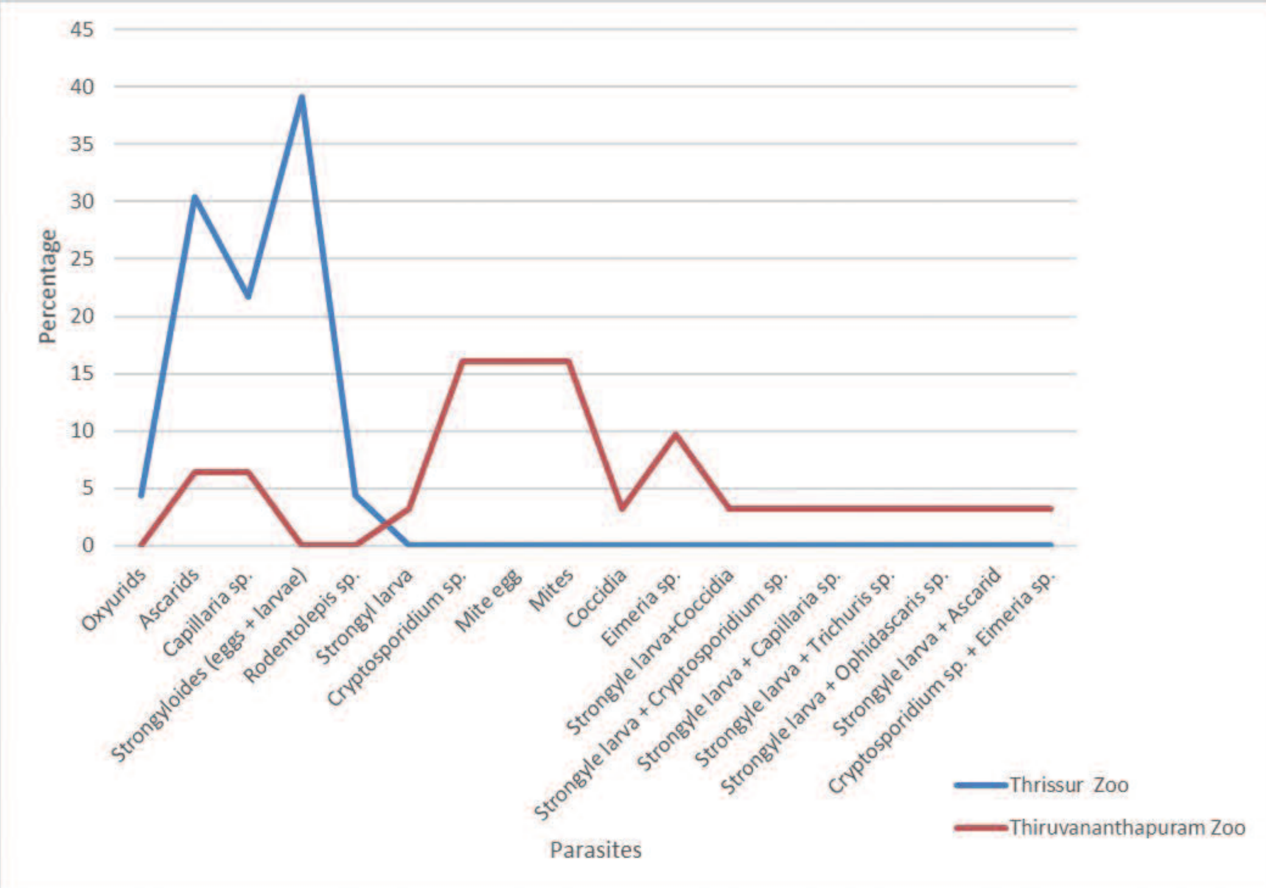

Fig. 1. Abundance (%) of parasites in the snake faecal samples of Thrissur and Thrivananthapuram Zoo

Table 2. Endoparasitic infection of the captive snakes from Thrissur State Museum and Zoo, India

Hosts	Oxyurids	Ascarids	*Capillaria* spp.	*Strongyloides* (eggs + larvae)	*Rodentolepis* sp.	No. examined/infected
Elapidae						
Indian Cobra	–	5	2	2	–	11/9
Common Krait	1	1	–	–	–	2/2
King Cobra	–	–	–	2	–	2/2
Colubridae						
Common Cat Snake	–	–	–	1	–	1/1
Common Wolf Snake	–	–	–	2	–	2/2
Trinket Snake	–	–	–	2	–	2/2
Rat Snake	–	–	4	–	–	4/4
Green Vine Snake	–	–	–	–	–	1/0
Pythonidae						
Indian Rock Python	–	1	–	–	1	2/2
Homalopsidae						
Mud Snake	–	–	–	–	–	2/0
Asiatic Water Snake	–	–	–	–	–	1/0

Discussion

Coprological examination revealed endoparasitic infection in 71.4% of 15 species of snakes from Thrissur Zoo and Thiruvananthapuram Zoo, Kerala State. A study of six species of snakes kept at three herpatauria in Kerala by Radhakrishan et al. [2] found the prevalence of infection to be 88%; however, positive measures undertaken by the zoo authorities have improved the situation in these zoos. Elsewhere, helminth infections have been identified in Indian Pythons in Sakkar Baug, India [8], an infection rate of 80.3% was identified in Brazil [9], and an ecto- and endoparasite infection rate of 75% among snakes in Thailand [10]. A study in Sao Paulo found 70.8% of samples from rattlesnakes to be positive for nematodes [11], whereas a coprological analysis of European reptile samples revealed a broad spectrum of parasites, with 93.2% of the samples found to be positive [4]. Parasites comprising two groups of protozoa, *viz., Choleoeimeria* sp. and Ciliata, as well as the nematodes *Kalicephalus* sp., Dioctowittidae and a pinworm (Oxyurida), were detected in 13.7% of snakes from City Zoological Garden in Wrocław, Poland. [12]. Our findings also agree with the results from other studies indicating several parasitic nematodes and protozoa such as *Strongyloides* sp., Oxyurids, *Capillaria* sp., *Cryptosporidium* sp., ascarids to be the most frequent parasites causing infection in reptiles, especially in snakes [2,13,14].

The eggs and larvae of *Strongyloides* spp. were identified in most of the Thrissur Zoo faecal samples. *Kalicephalus* sp. is the most important strongylid of snakes [8,10]. This genus was the most prevalent nematode genus, being detected in 25% of the snakes studied by Souza et al. [9]. Of the 133 snake species found in Costa Rica [15], 40 (30%) have so far been found to harbour nematodes [16]. Kalicephalids and Ophidascarids were isolated from five species of terrestrial snakes in Korea [17]. *Kalicephalus* sp. was first reported in Nepal from *Amphiesma stolatum* (Reptilia: Colubridae) near human settlements by Shyam and Mahendra [18]. Holt et al. [19] reported that the presence of *Strongyloides* sp. larva in snakes led to anorexia, dehydration and weight reduction. On microscopic

Table 3. Endoparasitic infection of the captive snakes from Thiruvananthapuram State Museum and Zoo, India

	Hosts						
	Viperidae	Elapidae		Pythonidae		Boidae	
Parasites	Russels Viper	Indian Cobra	King Cobra	Indian Rock Python	Reticulated Python	Sand Boa	Green Anaconda
Strongyle larva	–	–	1	–	–	–	–
Cryptosporidium sp.	–	–	–	1	1	1	2
Capillaria sp.	–	–	1	1	–	–	–
Ascarids	–	1	1	–	–	–	–
Mite eggs	–	–	–	–	–	–	5
Mites	–	–	–	–	–	–	5
Coccidia	1	–	–	–	–	–	–
Eimeria sp.	–	–	–	–	–	–	3
Strongyle larva+Coccidia	1	–	–	–	–	–	–
Strongyle larva+ *Cryptosporidium*	1	–	–	–	–	–	–
Strongyle larva+ *Capillaria* sp.	1	–	–	–	–	–	–
Strongyle larva+*Trichuris* sp.	1	–	–	–	–	–	–
Strongyle larva+ *Ophidascaris*	–	1	–	–	–	–	–
Strongyle larva+ Ascarids	–	1	–	–	–	–	–
Cryptosporidium+*Eimeria* sp.	–	–	–	–	–	–	1
No. examined/infected snakes	3/3	3/1	1/1	1/1	3/1	1/1	7/5

examination, Strongyle larvae appear as larvae within thin-walled eggs.

Infection by non-sporulated coccidians, *Eimeria* sp. and *Cryptosporidum* sp., was noted in the Thiruvananthapuram Zoo samples. Rosenthal [20] reports that transmission of coccidiosis occurred by ingestion of sporulated oocysts from contaminated faeces or soil. Although husbandry practices and crowding play a role in the occurrence of coccidiosis in snakes or any other reptilian group, the snakes sampled in Thiruvananthapuram Zoo were kept in individual enclosures, thus ruling out the spread of infection from other snakes. But transmission could occur via the faecal route, water and food [21]. Infection by *Cryptosporidium* sp. is characterised by hypertrophic gastritis progressive weight loss, mortality and the continuous shedding of oocysts in faeces [22,23].

Ascarids were found in the faecal samples of snakes belonging to Elapidae. Earlier studies in Kerala reported ascarid ova only in python faecal samples [2]. The ascarids are important nematode pathogens for snakes, and infection can be fatal [24]; *Ophidascaris* is a significant ascarid genus in snakes, with infection resulting in regurgitation, diarrhoea and pneumonia caused by the worms occluding the stomach [20].

Cestode parasitic infection was absent from the coprological samples from Thrissur Zoo and Thiruvananthapuram Zoo. Similar findings were observed in studies conducted by Rajesh et al. [25] on captive snakes in Tamil Nadu. It is observed that the aquatic snakes are more prone to cestode infection than rodent-fed snakes [25,26]. Generally, cestode parasites that affect snakes are hermaphroditic and non-host specific. Transmission occurs by ingestion of an intermediate host such as amphibians, rodents or other mammals; infection with the cestode *Ophiotaenia europaea* has been reported in colubrid snakes in Central Iraq (Al-Moussawi) through ingestion of amphibians [27]. Snakes showing high foraging activity have more chance than those in captivity of acquiring infection through intermediate hosts [28]; this may be the reason for the low rate of cestode infection observed in our captive snake samples.

Sedimentation proved to be a superior method of detecting Strongyle infection, whereas faecal floatation was found to be superior in the detection of coccidian oocysts and nematode eggs [4].

The *Capillaria* spp. collected from faecal samples of Python, Rat Snake, Indian Cobra and Viper were found to be one of the most widespread parasites. However, smaller numbers *Capillaria* sp. eggs were reported than in a previous study by Rajesh et al. [25].

Our findings revealed the presence of non-sporulated coccidia *Eimeria* sp., as well as mites and mite eggs, in faecal samples from anacondas housed at Thiruvananthapuram zoo. Over 120 species of the genus *Eimeria* have been reported in reptiles. However, relatively few species have been associated with disease [29]; unfortunately a major limitation of the present study was the inability to identify eggs at the species level.

The eggs of *Rodentolepis* sp. encountered in python faeces could come from the wide variety of prey animals on which they survive [30]. Most of the infections occurring in captive snakes could be attributed to a range of factors, such as the selection of prey species, stress due to conditions of captivity and transmission through the faecal route; the chances of transmission between snakes is unlikely as most of the snakes are kept in isolated glass houses. The most commonly observed parasites in the captive animals were those with a direct life cycle, such as *Cryptosporidium* sp., as they are easily spread from one animal to another; in contrast, those requiring intermediate hosts for their survival, such as cestodes, were not encountered in any samples from either zoo.

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