Research Article

Prevalence of Gastro - Intestinal Infection in Captive Wild Animals at Arignar Anna Zoological Park, Tamil Nadu, India

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Abstract: A total of 262 fecal samples from 84 individuals, representing various species, were collected and examined at Aringar Anna Zoological Park. Among these, 13 herbivores (16.66%), 13 carnivores (37.94%), 3 omnivores (27.96%), 9 primates (25.92%), and 32 birds (17.18%) were found to be infected with parasites. In reptiles, 12 individuals (47.22%) tested positive for parasitic infections, while 2 rodents (24.99%) were also found to be infected. The present study highlights that helminth infections were more prevalent than protozoan infections in reptiles. Additionally, a higher incidence of helminthic parasites in zoo reptiles compared to other animals and birds has been reported. Overcrowding in the serpentarium likely increases physiological stress, predisposing reptiles to parasitic infections.

Keywords: *Strongyloides, Toxocara*, captive wild animals, prevalence, helminthic parasites.

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INTRODUCTION

The health status of wild animals in zoological parks plays a vital role in achieving the primary goal of wildlife conservation. However, accurately diagnosing the causes of illness in zoo animals and effectively treating them presents a significant challenge. The lack of comprehensive data on diseases and parasites affecting wild animals in captivity hinders efforts to maintain their overall health [1, 2].

Zoo animals are susceptible to a range of infectious and non-infectious diseases. In their natural habitats, wild animals typically possess natural resistance mechanisms or coexist within balanced ecosystems alongside their parasites [3]. The initiation, development, and spread of parasitic diseases are intricately influenced by the interaction between parasites, their hosts, and the surrounding microenvironment [4-7]. However, the transition from natural habitats to captivity, along with changes in living conditions, can disrupt the ecological balance and increase the animals' vulnerability to diseases, particularly parasitic infections [5, 8]. In captivity, the health of zoo animals depends on factors such as diet, management practices, and environmental conditions.

Endoparasites can have both direct and indirect effects on the health of wild animals, potentially causing a range of health issues. While wildlife may have adapted to the presence of parasites, they often struggle with the negative impacts of parasitism [9]. Parasites can influence host survival and reproduction both directly, through the induction of pathological effects, and indirectly, by impairing the host's immune system and overall physical condition [10]. Despite the significant impact of parasitic infections, our understanding of these infections in wild animals remains limited due to a lack of systematic investigations [11].

In the absence of robust surveillance and monitoring systems, sporadic reports and reviews [12] have been the primary source of information on parasitism in zoo animals. Most of these studies focus on animals in regional zoological gardens or parks. It is worth noting that geohelminths are more frequently responsible for widespread parasitic infections in zoo animals than biohelminths. Confined living spaces in zoological parks provide optimal conditions for geohelminth development, which can lead to rapid reinfection [7]. These infections pose significant management challenges and can result in mortality among captive wild animals [13]. Common parasitic diseases in captive wild animals include gastrointestinal parasites and haemoprotozoans. Many of these parasitic diseases are zoonotic, such as Trichinellosis, Hydatidosis, Giardiosis, Ancylostomosis, Toxocarosis, Fasciolosis, and Toxoplasmosis.

Historically, sporadic studies on parasitic infections in wild animals [14, 15] have been conducted, but these were not comprehensive enough to provide a full understanding of parasitism in captive animals and birds across various regions, particularly at Arignar Anna Zoological Park (AAZP) in Vandalur. AAZP houses a diverse range of wild herbivores (e.g., Cervidae, Bovidae, Elephantidae, Equidae, and Hippopotamidae), omnivores (e.g., Ursidae and primates), carnivores (e.g., Felidae, Hyaenidae, and Canidae), indigenous and exotic birds, and various reptilian species, including snakes, pythons, and crocodiles. Most studies on parasitic infections have focused on single parasite species, despite the fact that most hosts are co-infected with multiple parasites [16]. Recent studies have begun to recognize the number and specific identity of co-infecting parasites as critical factors in determining the impact of parasitic infections on host health [17-19].

With an increasing awareness of the significance of parasitic infections in wild animals, this study aims to conduct a comprehensive qualitative and quantitative coproparasitological analysis of gastrointestinal parasitism in zoo mammals, birds, and reptiles at AAZP. The objective is to determine and identify the prevalence of gastrointestinal parasitic infections among these zoo animals using traditional coprological techniques.

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MATERIALS AND METHODS

Collection of Fecal Samples

Fresh fecal samples were collected from the enclosures of wild animals using clean, dry, and sterile containers. The samples were transported immediately to the laboratory for subsequent qualitative and quantitative examination.

Assessment of Gastrointestinal Parasitism

I. Qualitative Fecal Examination

Floatation Method:

This method was primarily used for examining nematode eggs. A small fecal sample (3 grams) was mixed thoroughly with 15 mL of water to create an emulsion. The mixture was then strained through a nylon tea strainer to remove coarse fecal material. The filtrate was centrifuged at 2,000 rpm for 5 minutes. The supernatant was carefully decanted, and the tube was refilled with water. Additional centrifugation cycles (2–3 times) were performed until the supernatant became clear. The sediment was then mixed with 10 mL of saturated salt solution and centrifuged once more. A drop of the resulting fluid from the top layer was placed on a clean, dry glass slide, and a cover slip was applied. The slide was examined under low power (10X) on a microscope.

Sedimentation Method:

This method was primarily used for examining trematode and cestode eggs. A small quantity of feces (3 grams) was mixed thoroughly with 15 mL of water to create an emulsion. The mixture was strained through a nylon tea strainer to remove coarse material. The filtrate was transferred to a centrifuge tube and centrifuged at 2,000 rpm for 5 minutes. After decanting the supernatant, the tube was refilled with water and subjected to 2–3 additional centrifugation cycles until the supernatant became clear. A drop of the sediment was placed onto a clean, dry glass slide, and a cover slip was applied. The slide was then examined under low power (10X) on a microscope.

II) Quantitative fecal examination

McMaster egg counting technique:

For the McMaster egg counting technique, 3 grams of fecal sample were homogenized in a mortar and pestle with 42 mL of saturated salt solution. The resulting mixture was filtered through a sieve with an appropriate mesh size into a container. Both chambers of the McMaster egg counting chamber were filled with the suspension, and the contents were examined under low power (10X) on a microscope. The number of eggs or oocysts in the etched area was counted, and the calculation for Eggs Per Gram (EPG) was performed using the following formula:.

No. of eggs/ oocysts per gram of faeces=(X/ 0.15) x 45/ 3

Where, X = Number of eggs/ oocysts in counting chamber;

0.15 = Volume of sample in 1 sq. cm;

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45 = Total volume of final suspension;

The EPG was evaluated by multiplying the number of eggs counted in one chamber by 100.

Prevalence of Infection:

The prevalence (%) of gastrointestinal parasites in captive wild animals was calculated using the following formula:

Prevalence (%)= Number of animals positive for gastrointestinal parasites/

Total number of animals examined ×100

RESULTS AND DISCUSSION

Parasitic infections continue to be one of the most common health problems in captive wild animals, often leading to reduced vitality, poor reproductive performance, and in severe cases, mortality. The intensity and prevalence of gastrointestinal parasites in zoological collections vary according to climatic conditions, management practices, host species, and environmental hygiene. Therefore, assessing the burden of gastrointestinal parasites in different groups of captive animals is crucial for implementing appropriate control measures and ensuring both animal welfare and public health.

Prevalence of Gastrointestinal Parasitism in Zoo Animals, Birds, and Reptiles (Comparison with Other Indian Zoos)

The prevalence of gastrointestinal parasites was assessed during the summer season (May–July 2018). Out of the 262 fecal samples screened (160 from animals, 57 from birds, and 45 from reptiles), 78 samples tested positive for one or more parasitic infections. This corresponded to an overall prevalence of 27.63% in animals, 17.18% in birds, and 47.22% in reptiles.These prevalence rates were notably lower than those reported in earlier studies [3,8,20]. For instance, overall prevalence rates of 68.05%, 68.36%, 72.5%, and 46.20% were reported in wild mammals at Thrissur Zoo (Kerala), Almuñécar Zoological Garden (Spain), and Nandan Van Zoo (Raipur, Chhattisgarh), respectively [3,18,20]. However, the present findings are comparable to the 31.10% prevalence observed in animals at Mysore Zoo and 33.22% at Mahendra Chaudhary Zoological Park (MCZP), Chhatbir, Punjab.

The relatively lower prevalence at Arignar Anna Zoological Park (AAZP) may be attributed to improved management practices, including routine health screening and preventive care for captive animals and birds. Notably, parasite prevalence was lowest in birds (17.18%), moderate in mammals (27.63%), and highest in reptiles (47.22%). This trend is consistent with earlier studies [21], which also reported higher helminthic infections in reptiles compared to birds and mammals. Overcrowding within the serpentarium may act as a stressor, predisposing reptiles to higher susceptibility to endoparasitic infections.

Captivity- based prevalence

To further explore the influence of captivity on parasite prevalence, animals were categorized based on their housing system. Herd-living mammals, particularly herbivores, exhibited a higher prevalence of gastrointestinal parasites (28.30%) compared to individually housed species, such as large felids (9.02%). Reptiles again showed the highest prevalence overall (47.22%). Stress from overcrowding and competition for resources, such as feed and water, likely compromises immunity, increasing susceptibility to infections [21,22]. If untreated, these infections can result in clinical complications, including diarrhea, anemia, and pulmonary damage (Table 1).

Table 1. Clinical signs of different Endoparasites.

Endoparasite	Clinical signs	Animals affected
Toxocara spp.	Coughing, diarrhea, vomiting, intestinal rupture	Dogs and cats
Ancylostomatidae	Developmental impairment, diarrhea, anaemia, and hypoproteinaemia	Dogs
Trichusvulpis	Severe colitis, with lesions like thickening, ulceration, and necrosis of the intestinal mucosa, severe anaemia, dehydration, and even death.	Fox and dogs
Diplopylidium/ Joyeuxiella spp.	Intestinal function disorders	Wild and domestic carnivores.
Sarcocystis spp	Lesions	Herbivores, omnivores or birds
Leishmania infantum	Low weight, dermatitis, skin lesions, alopecia, splenomegaly, enlargement of lymph nodes, and onychogryphosis	Fox and dogs
Babesia spp.& Hepatozoon spp.	Enlarged spleen and liver	Fox
Toxoplasma gondii and Trichinella spp.	Clinical toxoplasmosis	Fox
Baylisascarisprocyonis	Intestinal obstruction	Raccoons
Toxoplasma gondii	Abortive agent in small ruminants and the cause of neurological disorders	Felids
Troglostrongylusbrevior	Damage to large areas of the lungs	Wildcats
Angiostrongyluschabaud	The lungs may be swollen and heavy with a cobblestone appearance. alveolar collapse or emphysemas, and parenchymal haemorrhages	Wildcats

Feeding behavior-based prevalence

Wild animals were categorized into three groups based on their feeding habits: herbivores, omnivores, and carnivores. Among herbivores, the overall prevalence of gastrointestinal parasitic infections was 16.66%, which aligns with previous reports of 18.17% and 15.6% [3]. The moderate temperature range and higher humidity within the park may have favored the survival of parasitic eggs and free-living stages. Additionally, grasslands likely serve as a significant source of gastrointestinal parasites for herbivores.In contrast, carnivores and omnivores exhibited higher prevalence rates of 37.94% and 27.96%, respectively. This elevated prevalence may be associated with smaller enclosure sizes and the conditions experienced by many carnivores, particularly wild felids, and omnivores, such as ursids. Overcrowding, infighting, and increased stress in these confined conditions likely contribute to their higher susceptibility to parasitic infections.

Among birds, an overall prevalence of 17.18% was observed, which is significantly lower than the coproprevalence rates of 44.93% and 57.73% reported in birds from Kankaria Zoo, Ahmedabad, and four zoos in Gujarat (Ahmedabad, Baroda, Junagadh, and Rajkot), respectively [23]. This lower prevalence at Arignar Anna Zoological Park may reflect the implementation of effective sanitary and biosecurity measures that interrupt the parasite life cycle among captive birds.

Reptiles showed the highest prevalence of parasitic infections at 47.22%, largely due to the high occurrence of geohelminths. In a comparable study, Parsani et al. [23] reported an even higher prevalence of 80.69% in reptiles at Baroda Zoo, underscoring the susceptibility of reptiles to gastrointestinal parasitism under captive conditions.

Group-wise copro-prevalence of endoparasites of animals

Helminthic infections were predominant among zoo animals across all categories—herbivores (16.66%), omnivores (27.96%), and carnivores (37.94%)—compared to protozoan parasites. This higher prevalence is likely associated with the direct life cycles of many helminths, which facilitate transmission within the zoological park environment [7].Among herbivores, the most commonly detected gastrointestinal parasite eggs included Toxocara sp., Strongyle sp., Trichuris sp., Strongyloides sp., Dictyocaulus sp., Trichostrongylus sp., Moniezia sp., and coccidian oocysts. Multiple infections were observed in 57.14% of infected individuals.In carnivores, frequently detected parasites included Toxocaracati, Toxascaris leonina, and Isospora sp. oocysts in large felids, Trichuris sp. in small felids, and Toxocaracanis in canids. Multiple infections occurred in 52.94% of the affected carnivores.Omnivores showed gastrointestinal parasites such as Ascarid sp. in bears, Trichuris sp. and Strongyloides sp. in primates, and Isospora sp. oocysts in wild boars, with multiple infections recorded in 30% of individuals.

Copro-prevalence of endoparasites of birds

Birds exhibited a relatively lower prevalence of helminth infections, with an overall rate of 17.18%. This lower prevalence may be attributed to several factors, including the presence of barriers limiting contact between free-ranging and captive birds, appropriately sized enclosures, reduced stress due to environmental enrichment, and a balanced, nutritious diet. The most commonly observed helminths included Ascaridia sp., Heterakis sp., Strongyle sp., and

Capillaria sp., whose direct life cycles likely contribute to their occurrence [23].

Protozoan infections in birds were primarily coccidian, caused by Eimeria sp. Notably, the prevalence of multiple infections among birds was relatively high at 81.81%. This may be related to the use of a deep litter system for rearing captive birds, a factor previously reported to influence parasite prevalence [16].

Copro-prevalence of endoparasites of reptiles

Reptiles exhibited the highest prevalence of parasitic infections among the studied groups, with 47.22% of individuals affected. This elevated prevalence may be attributed to overcrowding in the serpentarium and the use of wet bedding sand, which can favor parasite survival and transmission. The most frequently observed helminths included Oxyuris sp., Ophidascaris sp., Strongyle sp., and Kalicephalus sp., whose direct life cycles likely contribute to their persistence. These findings are consistent with previous reports by Thiruthalinathan et al. [24] and Taiwo et al. [25]. Multiple infections were recorded in 42.85% of the reptiles examined.

Severity of GI parasitic infection in Zoo animals, birds, and reptiles

The severity of gastrointestinal parasitic infections in captive wild animals varied across species and was assessed based on Eggs Per Gram (EPG) values. Among carnivores, infections ranged from mild to severe, with EPG values between 100 and 800. Royal Bengal tigers exhibited moderate to severe infections, while other carnivores showed mild to moderate infections. In herbivores, infection severity generally ranged from mild to moderate, with EPG values below 500. Exceptions included spotted deer and barking deer, which presented with severe multiple infections involving various parasitic species. For omnivores and primates, EPG values ranged from 100 to 300, indicating predominantly mild infections, consistent with the observations reported by Thawait et al. [3]. Reptiles demonstrated the highest variability in infection severity, with EPG values ranging from 100 to 1800. Moderate to severe infections were observed in star tortoises and pond terrapins, while the remaining reptiles and snakes exhibited mild to moderate infections. Among birds, the severity of infection was generally mild, with EPG values ranging from 100 to 300. Indian peafowl, however, displayed severe infections with multiple parasites, whereas other birds exhibited mild to moderate infections (Fig. 1).

The present study revealed that gastrointestinal parasitic infections are prevalent among captive wild animals, birds, and reptiles at Arignar Anna Zoological Park during the summer months (May–July 2018) (Table 2). Out of262 fecal samples examined (160 from mammals, 57 from birds, and 45 from reptiles), 78 samples tested positive for one or more parasitic infections, corresponding to overall prevalence rates of 27.63% in mammals, 17.18% in birds, and 47.22% in reptiles. Within mammals, herd-living species exhibited a

Table: 2. The Following Animals and under study in Arignar Anna Zoological Park (abbreviated AAZP), Southern part of Chennai, Tamilnadu.

S.No	Animal species	Parasite eggs detected	Severity of Infection	Egg per gram (EPG)
		HERBIVORES		
1	Barking deer *(Munticaus muntjak)*	*Strongyloides*sp.	+	200
		Trichostrongylus sp.	+	300
2	Indian gaur (*Bos gaurus*)	*Strongyloides* sp.	+	300
		Toxocara sp.	+	300
		Moneziabenedeni	+	300
3	Spotted deer (*Axis axis*)	*Dictyocaulus*sp	+++	600
		*Strongyloides*sp	+	400
		*Trichuris*sp	+	200
		Eimeria sp	+	200
4	Indian Elephant (*Elephas maximus)*	*Strongyle* sp	+	400
		Strongyloides sp.	+	100
		CARNIVORES		
5	Royal Bengal tiger *(Panthera tigris)*	*Toxoascaris leonina*.	++	800
		*Isospora*sp	+	100
6	Wild cat (*Felis silvestris*)	*Isospora*sp	+	200
		*Toxocara*sp.	+	100
7	Lion (*Panthera leo persica*)	*Isospora*sp	+	200
		Toxascaris leonina	+	200
8	Leopard (*Panthera pardus*)	*Toxocara* sp.	+	100
9	Palm Civet Cat	*Trichuris* sp.	+	200
		*Spirometra*sp	+	100
10	Small Indian Civet Cat	*Trichuris* sp.	+	200
11	Indian wolf *(Canis lupus)*	*Toxocaracanis*	+	200
12	Wild Dog (*Cuon alpinus)*	*Toxocaracanis*	+	200
13	Jackal (*Canisaureus*)	*Toxocaracanis*	+	300
14	Porcupine *(Hystrix indica)*	*Trichuris*sp	+	300

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		OMNIVORES		
15	Sloth bear (*Melursusursinus*)	*Ascarid*sp	++	300
16	Wild boar (*Sus scrofa*)	*Isospora*sp	+	100
		Strongyloides sp.	+	100
		PRIMATES		
17	Hanumanlangur	*Strongyloides*sp.	++	300
		Trichuris sp.	+	100
18	Savannah baboon *(Papio anubis)*	*Trichuris* sp.	+	100
19	Nilgirilangur (*Trochypthecusjohni*)	*Capillaria* sp.	+	200
20	Rhesus macaque (*Macaca mulatta*)	*Trichuris* sp.	+	300
21	LTM (*Macaca silenus)*	*Ascarid*sp	+	300
		Trichuris sp.	+	300
		REPTILES		
22	Star tortoise (*Geochelone elegans*)	*Strongyle* sp.	+++	1600
		*Oxyurid*sp	+	200
23	Indian rock python (*Python molurua*)	*Strongyle* sp.	++	800
		*Ophidascaris*sp	+	100
24	Reticulated python (*python reticulatus*)	*Strongyle* sp.	++	800
		*Ophidascaris*sp	+	100
25	Indian Pond Terrapin (*Mealnochelystrijuga*)	*Strongyle* sp.	+ to +++	200- 1600
		Oxyurid sp	+	200
26	Red eared Slider (*Trachemysscripta elegans*)	*Strongyle* sp.	+	300
		*Oxyurid*sp	+	200
27	Indian Cobra (*Naja naja*)	*Strongyloides*sp.	+	200
		*Ophidascaris*sp	+	200
		*Kalicephalus*sp	+	600
28	Green vine snake (*Ahaetulla nasuta*)	*Strongyloides* sp.	+	200
		BIRDS		
		Strongyle sp.	+ to ++	100 -900

29	Indian Peafowl (*Pavo cristatus*)	*Capillaria* sp.	+	200
		*Heterakis*sp	+	200
		*Eimeria*sp	_	_
30	Alexandrine Parakeet (*Psittaculaeupatria*)	*Heterakis*sp	+	100
31	Blossom headed parakeet *(Psittacularoseata)*	*Capillaria* sp.	+	100
32	Jawa sparrow *(Lonchuraoryzivora)*	*Capillaria* sp.	+	300
		*Ascaridia*sp	+	100
33	Red breasted parakeet(*Psittaculaalexandri*)	*Strongyle* sp.	+	200
		*Capillaria*sp.	+	300
34	Sulphur crested cockatoo (*Cacatua galterita*)	*Strongyle* sp.	+	300
		Capillaria sp.	+	300
35	Painted stork (*Mycteria leucocephala*)	*Echinostoma* sp	+	200

higher prevalence (28.30%) compared to individually housed animals (9.02%). Among the different feeding groups, the prevalence of parasitic infections was 16.66% in herbivores, 37.94% in carnivores, and 27.96% in omnivores, with the elevated rates in carnivores and omnivores likely associated with confinement in smaller enclosures, resulting in overcrowding, infighting, and increased stress.

Prevalence of gastrointestinal parasitic infection

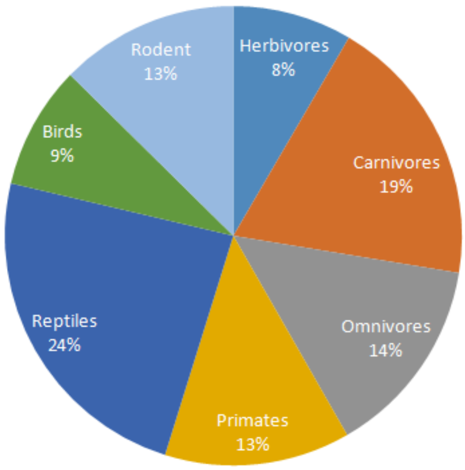

Fig: 1.The different proportions of parasites in fecal sample collected from AAZP, Vandalur.

Birds exhibited a relatively low prevalence (17.18%), reflecting the effectiveness of sanitary and biosecurity measures in interrupting the parasite life cycle. Reptiles showed the highest prevalence (47.22%), which may be attributed to overcrowding in the serpentarium and a higher abundance of geo-helminths. Collectively, these findings underscore the influence of species, housing conditions, and management practices on the prevalence and severity of gastrointestinal parasitic infections in captive wildlife.

CONCLUSION

This comprehensive study on the parasitic status of captive wild animals and birds at Arignar Anna Zoological Park, Vandalur, provides valuable baseline data on the prevalence of gastrointestinal parasitic infections. The findings are essential for informing effective management strategies and guiding future targeted investigations. The study highlights the susceptibility of zoo animals and birds to nematode and coccidian infections, emphasizing the need for strengthened parasite control programs. Anthelmintic treatments should be administered judiciously, preferably using alternate drug classes based on fecal screening results, to minimize the risk of anthelmintic resistance. Additionally, blanket treatment of herd- or group-housed animals and birds is recommended biannually, at the end of the monsoon and winter seasons, when the risk of infection is highest. Effective mitigation of parasitic infections requires collaborative efforts among veterinarians, zookeepers, and researchers. Such coordinated strategies are crucial for safeguarding animal health, enhancing welfare, and supporting the success of conservation programs within zoological parks.

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