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A SURVEY OF GASTROINTESTINAL PARASITES OF CAPTIVE ANIMALS AT THE UNIVERSITY OF ILORIN ZOOLOGICAL GARDEN

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Summary

Parasites affect the well-being and productivity of wild animals in captivity, increasing their stress level and resulting in failure to thrive. A survey was done to investigate the gastrointestinal parasites of animals at the University of Ilorin zoological garden. All animals present were screened for gastrointestinal parasites via faecal analysis using standard coprological techniques. An overall prevalence rate of 62.9% was recorded (carnivores 68%, herbivores 72.2%, primates 38.9% and reptiles 77.8%). *Trichuris spp* was the only parasite isolated in primates, while *oxyurid* nematoda was the only parasite isolated in reptiles. *Strongyle* type eggs were the most prevalent in the herbivores with a prevalence of 66.7% while *Ancylostoma spp* was the most prevalent nematode parasite in carnivores at 32.0%. Coccidia oocysts were the only gastrointestinal protozoa recorded in this study and were found in carnivores (40%) and herbivores (27.8%). Four avian species were involved in this study (Emu, Ostrich, White peafowls and White pelican) and only the peafowls had gastrointestinal parasites. Parasites isolated were *Syngamus trachea, Capillaria spp, Ascaridiagalli* and Coccidia oocysts. The outcome of this study indicates the presence of parasites of zoonotic importance (*Trichuris spp, Toxocara spp* and *Ancylostoma spp*) among screened animals. The outcome of this survey calls for the optimisation of husbandry, management, surveillance and therapeutic practices in the zoo in order to prevent a possible failure to thrive of the animals and breakdown of public health.

***Key words**: Captive animals, gastrointestinal parasites, Prevalence, Public health*

Introduction

Wild animals are held in captivity in places like the zoological gardens majorly for recreational, educational and entertainment purposes [5]. The zoological garden also serves as a means of conserving some of the endangered wild animal species [23]. The zoo apart from boosting the image of its host institution or community also serves as a source of revenue making venture.

Infectious diseases have been incriminated as a major source of decline in terms of population in wild animals [7] and animals in captivity harbour a huge number of parasitic diseases which could lead to severe morbidity and mortality [28]. A number of factors contribute to the severity of parasitic infections of confined animals found in the zoo; husbandry practices especially housing and feeding are of major consideration [17].

The interplay of activities in the zoological garden enhances the transmission of parasitic diseases from one animal to the other and also from animals to human (animal handlers and zoo visitors) [11] and vice versa; such infections are termed zoonotic, and can lead to serious health challenge in humans. A regular program to monitor gastrointestinal parasite and control measures based on correct timely diagnosis, proper prophylaxis and effective treatment would assist in preventing and reversing ill health in zoo animals thus improving their ability to thrive and also safeguard the public health.

University of Ilorin zoological garden has been in existence for the past thirty years and showcases animals of various species. Its environment has plants and trees of botanical importance and a children's playground which ensures the influx of visitors, young and old alike. A set up which favours the transmission of zoonotic infections if adequate control measures are not in place or are not enforced. Several authors have documented gastrointestinal helminth parasites of wild animals in captivity both within and outside the country [4, 6, 31,2] but there has been no comprehensive report on animals at the University of Ilorin zoological garden. The outcome of this study will assist in the commissioning of a robust health plan for all animals in the zoo; prevent and control possible public health hazard to all humans visiting the zoo.

Materials and Methods

Study area

The University of Ilorin zoological garden is located in Ilorin, the Kwara state capital just by the entrance of the institution. It was established in 1985 to complement the University's biological sciences departments in teaching and research, which also presently serves Zoo/Wildlife Veterinary clinical training and research. University of Ilorin Zoo, Ilorin, Nigeria (LAT 08° 28' 54" N, LONG 08° 38' 17" E) is in the North Central Geopolitical Zone of Nigeria with a Tropical savanna climate. The area has a warm weather with daily mean temperature ranging from 24.2°C (in cold seasons) - 33.7°C (in hot seasons), with an annual rainfall of 1,317- 1,323 mm which span between 5-6 months [22]

Animals and husbandry system

The University of Ilorin zoological garden is home to numerous animals like the primates, carnivores, hoofed mammals, birds and reptiles. Due to its large expanse, it serves the dual purpose of a botanical garden and a zoological garden. It also has a playground which is walled by a mesh

with different play items for children. Animals are housed separately in different cages and houses designed specifically to simulate each of their natural habitat as much as possible. The primates are housed in cemented floor cages and an outlet which leads to an outer enclosure (play area with grass) where they play and interact with the visitors. They are fed fruits and vegetables and also cooked household foods. Carnivores are housed in cemented cages also and the bigger ones like the lions and hyenas also have (an outer enclosure) where they relax and exercise after meal. They are fed with slaughtered carcass from the abattoir thrice weekly. Herbivores also have similar cemented and open outlet for exercise and are fed concentrates, grains and grass. Larger outer enclosures are allowed for the giraffe and giant eland. Some equids (Mules, donkeys and horse) and camels are allowed to roam free range in the zoo and feed on grasses in the vast land made available to the zoo but also come in the mornings for their concentrate and grain rations.

Sample collection and examination

Faecal samples were collected between February and August, 2015. Samples were collected fresh per rectum for most of the herbivores and reptiles or topmost of the freshly voided faeces for the carnivores and primates. All samples were transported to the parasitology laboratory at the department of Veterinary Parasitology and Entomology University of Ilorin. Samples were examined physically for consistency and presence of nematode larva or tapeworm proglottids. Faecal analysis was done using simple concentration techniques; flotation and sedimentation tests [32]. Recovered ova identification was based on morphologic and micrometric measurements as provided by [9].

Result

This study screened all animals (present at the time of survey) resident at the University of Ilorin zoological garden for gastrointestinal parasites. A total of seventy (70) zoo animals were involved in this study, twenty five (25) of which were carnivores, eighteen (18) hoofed mammals, eighteen (18) primates, and nine (9) reptiles while samples from the birds were pooled according to their species. Out of the seventy (70) animals examined, forty four (44) were positive for at least one intestinal parasite giving 62.9% prevalence. (Table 1). Intestinal helminths were the major parasitic infection indicated from the results. Protozoa parasite was recorded in carnivores and herbivores only, Coccidia oocysts being the only intestinal protozoa parasite recorded (Table 2). *Trichuris spp* was the only parasite recorded in the primates with a prevalence of 38.9%. In herbivores, there was an overall prevalence of 72.2% with specific prevalence of 5.6% *Ascaris spp*, 66.7% *Strongyle* type eggs, 11.1% *Strongyloides spp* 11.1% *Capillaria spp*, 5.6% *Trichonema spp* and 27.8% *coccidia spp*. All infected herbivores recorded *Strongyle* type parasite. For carnivores, an overall 68.0% prevalence was recorded with Coccidia oocysts having the highest prevalence of 40%, *Toxocara spp*12%, *Ascaris spp* 16%, *Ancylostoma spp* 32%, *Strongyle* type eggs 24%, *Strongyloides* 16% and *Capillaria* spp 16%. Only oxyurid nematode eggs were recovered in the reptiles with a prevalence of 77.8%. Mixed infection was recorded in 34.5% of all infected animals (Table 3). Four avian species were screened for gastrointestinal parasites and only the white peafowls were positive with *Syngamus trachea, Capillaria spp, Ascarida galli* and *Coccidia* oocysts.

Table 1: Overall prevalence (%) of intestinal parasitic infections in each category

S/N	Type of animal	Sample Size	No infected (%)
1	Primates	18	7 (38.9)
2	Herbivores	18	13 (72.2)
3	Carnivores	25	17 (68.0)
4	Reptiles	9	7 (77.8)
	Total	70	44 (62.9)

Table 2: Prevalence of parasitic helminth infection in each animal category

Parasites	Carnivores (%)	Herbivores (%)	Pimates (%)	Repitiles (%)	Aves (%)
Trichuris spp	-	-	38.9		
Toxocara spp	12	-	-	-	-
Ascaris spp	16	5.6	-	-	-
Ancylostoma spp	32	-	-	-	-
Strongyle type egg	24	66.7	-	-	-
Strongyloides spp	16	11.1	-	-	-
Capillaria spp	16	11.1	-	-	
Trichonema spp	-	5.6	-	-	-
Oxyurid nematode	-	-	-	77.8	-
Syngamus trachea	-	-	-	-	
Ascaridia galli					
Coccidia oocysts	40	27.8	-	-	

Table 3: Parasites found in each animal at the University of Ilorin Zoological garden

S/N	ANIMALS	NUMBER EXAMINED	NUMBER INFECTED	GASTROINTESTINAL PARASITE FOUND	TOTAL PARASITE FOUND
1	Green Monkey	6	-	-	0
2	Baboon	6	4	*Trichuris spp*	1
3	Patas Monkey	4	2	*Trichuris spp*	1
4	Chimpanzee	2	1	*Trichuris spp*	1
5	Lion	3	3	*Toxocara spp*	1
6	Stripped Hyena	2	2	*Ascaris spp, Ancylostoma spp*	2
7	Spotted Hyena	4	4	*Ancylostoma spp, coccidia oocyst*	2
8	Jackal	2	0	-	0
9	Crested Porcupine	5	0	-	0
10	Badger	2	2	*Toxocara spp, Strongyle type eggs, Coccidia oocyst*	3
11	Mongoose	4	4	*Strongyle type eggs, Strongyloides spp, Capillariaspp, Coccidia oocysts*	4
12	Genet cat	2	2	*Ancylostoma spp*	1
13	Civet cat	1	0	-	0
14	Mare	1	0	-	0
15	Stallion	1	1	*Strongyle type eggs, Strongyloides spp*	2
16	Foal	1	1	*Strongyle type eggs*	1
17	Mule	1	1	*Trichonema spp, Coccidia spp*	2
18	Donkey	2	0	-	0
19	Giraffe	1	1	*Strongyle type eggs, Ascarids*	2
20	Sitatunga	3	3	*Strongyle type eggs, Coccidia oocysts*	2
21	Duiker	1	0	-	0
22	Gazelle	2	2	*Strongyle type eggs, Capillaria*	2
23	Goat	1	0	-	0
24	Eland	1	1	*Strongyle type eggs*	1
25	Camel	2	2	*Strongyle type eggs*	1
26	Ram	1	1	*Strongyle type eggs Strongyloides spp, Coccidia oocysts*	3
27	African rock python	5	4	*Oxyurid type eggs*	1
28	Royal python	1	0	-	0
29	Tortoise	3	3	*Oxyurid type eggs*	1

% of animals with at least more than one infection = 34.5

Table 4: Prevalence of gastrointestinal parasite in primates

Parasite found				
	Green monkey (n=6)	Baboon (n=6)	Patas monkey (n=4)	Chimpanzee (n=2)
Trichuris spp	0(0)	4(66.7)	2(50)	1(50)

Table 5: Prevalence of gastrointestinal parasites in carnivores

Parasite found									
	Lion (n=3)	Stripped hyena (n=2)	Spotted hyena (n=4)	Jackal (n=2)	Crested porcupine (n=5)	Honey Badger (n=2)	Mongoose (n=4)	Genet cat (n=2)	Civet cat (n=1)
Toxocara spp	3(100)	0	0	0	0	0	0	0	0
Ascaris spp	0	2(100)	0	0	0	2(100)	0	0	0
Ancylostoma spp	0	2(100)	4(100)	0	0	0	0	2(100)	0
Strongyle type eggs	0	0	0	0	0	2(100)	4(100)	0	0
Strongyloides spp	0	0	0	0	0	0	4(100)	0	0
Capillaria spp	0	0	0	0	0	0	4(100)	0	0
Coccidia oocyst	0	0	4(100)	0	0	2(100)	4(100)	0	0

Table 6: Prevalence of gastrointestinal parasites in herbivores

Parasites found													
	Mare (n=1)	Stallion (n=1)	Foal (n=1)	Mule (n=1)	Donkey (n=2)	Giraffe (n=1)	Sitatunga (n=3)	Duiker (n=1)	Gazelle (n=2)	Eland (n=1)	Camel (n=2)	Ram (n=1)	Goat (n=1)
Strongyle type eggs	0	1(100)	1(100)	0	0	1(100)	3(100)	0	2(100)	1(100)	2(100)	1(100)	0
Strongyloides spp	0	1(100)	0	0	0	0	0	0	0	0	0	1(100)	0
Trichonema spp	0	0	0	1(100)	0	0	0	0	0	0	0	0	0
Ascarids	0	0	0	0	0	1(100)	0	0	0	0	0	0	0
Capillaria spp	0	0	0	0	0	0	0	0	2(100	0	0	0	0
Coccidia oocysts	0	0	0	1 (00)	0	0	3(100)	0	0	0	0	1(100)	0

Table 7: Prevalence of gastrointestinal parasites in Reptiles

Parasite found			
	African rock python (n=5)	Royal python (n=1)	African Spurred Tortoise (n=3)
Oxyurid nematoda	4(80)	0	3 (100)`

Table 8: Prevalence of gastrointestinal parasites in Aves

Parasite found				
	Emu (n=4)	Ostrich (n=2)	White peafowls (n=4)	White pelican (n=1)
Capillaria spp	0	0	+	0
Syngamus trachea	0	0	+	0
Ascaridia galli	0	0	+	0
Coccidia oocysts	0	0	+	0

Discussion

The result of this study revealed the presence of parasites which can affect the well being of animals in captivity thus increasing their stress level and if left unattended to can claim their lives. Equally important is the presence of parasites termed zoonotic like the *Trichuris spp, Toxocara canis and Ancylostoma spp* which if adequate control measures are not in place can affect the health of handlers and visitors to the zoo. An overall gastrointestinal parasite infection rate of 62.9% was recorded for all animals excluding the avian species; an outcome which necessitates an optimisation of the treatment protocol in the zoo. Isolated parasites are not novel and have been reported in similar works while the prevalence rate in this study is in tandem with results from similar studies in Nigerian zoos [6, 27]. Nematode parasites of the gastrointestinal tract have been incriminated as the most important helminth of Veterinary importance [30] causing serious disease condition in animals; the outcome of this study is a reflection of this, coccidia oocysts being the only gastrointestinal protozoa parasite isolated.

Trichuris spp was the only parasite recovered from the primates and its prevalence (38.9%) when compared to other studies of zoo primates in Nigeria [4,15,12,27] is on the low side. This low prevalence can be attributed to the housing system for primates adopted in the University of Ilorin Zoological garden which put them in groups of the same species thus limiting contact and exchange of infectious materials. Furthermore, the management of the primate's cages incorporates an acceptable level of hygiene thus reducing the possibility of oral transmission of parasites. *Trichuris* infection in zoo primates have been documented by several authors in other parts of the country and beyond [4, 12, 19, 16] and this makes it a prevailing zoonosis in our environment. While the prevalence is comparatively low, its presence at all calls for prompt

action in terms of control and prevention so as to curtail a possible outbreak of infection among the primates and transfer of the zoonotic infection to handlers and visitors to the zoo.

All the herbivores except the stallion were negative for intestinal parasite when samples were taken during the dry season. Findings revealed that the herbivores were treated with Ivermectin 0.5% pour-on solution for tick infestation by the Veterinary clinical team of the institution. This could have been absorbed and acted against parasite in the gastrointestinal tract. Samples taken few months later however revealed 72.2% gastrointestinal parasite prevalence and a high parasitic load amongst the herbivores. The high prevalence could be attributed to husbandry and management practices for most of the animals in this group, and climatic and environmental conditions which favour parasite life cycle and maturity [26] as most of the herbivores are on free-range or semi-intensive management system. Gastrointestinal strongyles had the highest prevalence among this group of zoo animals in the study, a result which collaborates previous studies on similar group of animals [24,29,33] This result highlights the essence of continued monitoring and therapy in these animals vis a vis improvement of management practices.

Toxocara spp, *Ancylostoma spp*, *Ascaris spp* and coccidia oocysts were the major intestinal parasites affecting the carnivores in this study, the highest nematode infection being *Ancylostoma spp*. This result is similar to that of [35] in India where the nematodes *Toxocara spp* and *Ancylostoma spp* had the highest prevalence in zoo carnivores. In Japan, [1] recorded more infection with *Toxocara spp* in their study contrary to the outcome of this study; this could be due to the fact that different species of carnivores were involved in the two studies. Furthermore, the prevailing environmental condition of the two study areas differs and this might affect the maturity of the nematode parasites. Also contrary to studies conducted by [3], *Strongyloides spp* was found only in Mongoose and not in other carnivores. This result could be as a result of the fact that more species of carnivores were involved in this study as compared to those of [3].

African rock python and the tortoise were the reptiles which harbored parasites of any kind in this study, and Oxyurid nematodes were the only parasites isolated from them. This parasite has been documented to have developed a commensal relationship with their host [8, 13, 25] hence may have no negative effects on its host. Zoo and pet reptiles can harbor parasites which are of zoonotic importance and are often victims of death due to endo and ectoparasites which might go undiagnosed. It is therefore important to have reptiles screened before been introduced to the home or the zoological garden and prompt treatment given to positive ones to prevent the spread of infection to humans and to save the lives of the reptiles.

The pea fowls were the only avian species in which gastrointestinal parasites were isolated of the four avian species (Emu, Ostrich, white peafowls and white pelican) examined. This is due to the improved housing system adopted in the zoological garden which houses birds of different species separately with adequate space and biosecurity, thus limiting transfer of infections amongst birds. While birds infected with *Capillaria spp, Ascaridia galli, Coccidia oocysts* are usually asymptomatic is low infection, heavy parasite burden leads to clinical signs like anorexia, ruffled feathers,

emaciation weakness and reduced water intake [38]. Infection with *Syngamus trachea* has a high morbidity rate especially in birds with high stocking densities and poor sanitary conditions [18]. Furthermore, mortality rates can reach 80% [36] especially in juvenile immunologically naive birds. Syngamosis in wild birds affects population directly by reduction in host fecundity and indirectly by increasing the predation rates of infected birds thus affecting population structure and size in a significant way [21]. Treatment with anthelminthics increases survival and reproductive success in birds [14, 20] and it has been established that birds treated with anthelmintics reared twice as much chicks compared to those left untreated [37]. Increase in the availability of the larva stage of *Syngamus trachea* in infected birds occur around April to June [18] hence adequate monitoring and deworming plan should be made around this period for effective control whilst continued regular check would be advantageous.

Emerging human infection of zoonotic importance have an estimated 71% wildlife origin [10] hence the need for constant monitoring of captive wild life in close contact with humans as found in a zoo setting. Infection of any form could lead to death in these zoo animals which not only questions the integrity of the host intuition in terms of health care but also has economic implications because acquiring zoo animals comes with a price and a huge one at that. The outcome of this study indicates that despite the husbandry practices, management and quarantine measures present at the zoo, a high level of gastrointestinal parasites infection still persists among the animals. A result which indicates that standards in terms of husbandry and management should be raised, quarantine measures should remain strict and regular gastrointestinal parasites surveillance and prophylactic measures continued in order to forestall health crises both in the animals and visitors to the zoo. Following this study a bi-annual deworming program in the months of February and August each year have been adopted by the Veterinary team of the Institution in an attempt to increase the prophylactic standards against these parasites.

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References

1. Abe, N., Yasukawa, A.(1996). Prevalence of Toxocara spp. Eggs in sandpits of parks in Osaka city, Japan, with notes on the prevention of egg contamination by fence construction. *Journal of Veterinary Medical Science*, Vol 59, 79–80.
2. Adedokun O.A., Adedokun R.A.M., Emikpe B.O., Ohore O.G., Oluwayelu D.O., Ajayi O.L. (2002). Concurrent fatal helminthosis and Balantidosis in red monkey (Erythrocebuspatas) in Ibadan, *Nigeria. Nigerian Veterinary Journal*. 23(2):56-59.
3. Adeniyi I.C., Morenikeji O.A. and Emkpe B.O. (2015). The prevalence of gastro-intestinal parasites of carnivores in University Zoological gardens in South West Nigeria. *Journal of Veterinary Medicine and Animal Health*. Vol 7(4): 135-139
4. Adetunji V.E. (2014). Prevalence of gastro-intestinal parasites in primates and their keepers from two zoological gardens in Ibadan, Nigeria. *Sokoto Journal of Veterinary Science*. Vol 12(2):25-30
5. Agoramoorthy G., Hsu M.J. (2005) Use of nonhuman primates in entertainment in Southeast Asia.

Journal of Applied Animal Welfare Science.Vol 8: 141-149.
6. Ajibade W.A., Adeyemo O.K., Agbede S.A. (2010). Coprological survey and Inventory of animals at Obafemi Awolowo University and University of Ibadan zoological gardens. *World Journal of Zoology*. Vol 5(4):266-271
7. Bengis R.G., Leighton F.A., Fischer J.R., Artois M.&Morner T., (2004).The Role of emerging and re-emerging zoonoses. Scientific and Technical Review.*World Organisation for Animal Health*, Vol 23 (2): 497-511
8. Bouamer S., Serge M. (1862): Description of Tachygonetriacombesi n. sp. and redescriptions of four species of TachygonetriaWedl, (Nematoda: Pharyngodonidae), with a new diagnosis of the genus. *Systemic Parasitology*. (2002), 53 (2): 121-139.
9. Bowman D.D., Lynn R.C. (1999) *Georgis' parasitology for veterinarians*, 6th edn. W.B. Saunders Company, Sydney, pp 55–68
10. Brown C (2004). Emerging zoonoses and pathogens of public health significance-an overview. *Revue Scientifiqueet Technique de l Office International des Epizooties*. Vol 23:435–442.
11. Daszak P., Cunningham A.A.and Hyatt A.D. (2000). Emerging Infectious Diseases of Wildlife-Threats to Biodiversity and Human. *Health Science*, 287(5452): 443-449
12. Dawet A., Yakubu D.P.andButu H.M. (2013).Survey of gastrointestinal parasites of non-human primates in Jos zoological Garden. *Journal of Primatology*, Vol 2(1):1-3
13. Dovč A., VerglesRataj A., Golja J., Vlahović K., Pavlak M., Zorman-Rojs O., Račnik J.(2002) Treatment of endoparasitosis in tortoises on big farm in Slovenia "Veterinarskidani ", 74-75.
14. Draycott, R.A.H., Woodburn, M.I.A., Ling, D.E., Sage, R.B., (2006). The effect of an indirect anthelmintic treatment on parasites and breeding success offree-living pheasants (Phasianuscolchicus). *Journal of Helminthology*. Vol 80, 409–415.
15. Egbetade A., Akinkuotu O., JayeolaO., NiniolaA., EmmanuelN., OlugbogiE.andOnadekoS. (2014). Gastrointestinal helminths of resident wildlife at the Federal University of Agriculture Zoological Park, Abeokuta. *Sokoto Journal of Veterinary Sciences,* Volume 12(Number 3).
16. Emikpe B.O., Ayoade G.O., Ohore O.G., Olaniyan O.O.andAkusu M.O. (2002).Fatal trichuriosis in a captive baboon (Papioanubis) in Ibadan Nigeria: A case report. *Tropical Veterinarian*, Vol 20(1): 36-39
17. Geraghty, V., Mooney, J., Pike, K., (1982). A study of parasitic infections in mammals and birds at the Dublin Zoological Garden. *Veterinary Research. Communication*. 5, 343–348.
18. Gethings, O.J., Sage, R.B., Leather, S.R., 2015. Spatio-temporal factors influencingthe occurrence of *Syngamus trachea* within release pens in the South West ofEngland. *Veterinary Parasitology*, Vol 207, 64–71.
19. Gillespie T.R. (2006).Non-invasive Assessment of Gastrointestinal Parasite Infections in Free-Ranging Primates.*International Journal of Primatology*. Vol 27(4):1129-1143.
20. Hudson, P.J., (1986). The effect of a parasitic nematode on the breeding productionof Red Grouse. *Journal of Animal Ecology*. Vol 55, 85–92.
21. Hudson, P.J., Newborn, D., Dobson, A.P., (1992). Regulation and stability of afree-living host-parasite system-*Trichostrongylus tenuis* in red grouse: I.Monitoring and parasite reduction experiments. *Journal of Animal Ecology*. Vol 61, 477–486.
22. Jegede H.O., Odeniran P.O., Ambali S.F. (2015) Evaluating the effectiveness of varying concentrations of permethrin on ticks of genus Aponoma on Royal pythons (Python regius). *Tanzania Veterinary Journal*. Vol 30 (2): 13-18
23. Kohn B. (1994), Zoo animal welfare. *Rev Science and Technology*. Vol 13: 233-245
24. Lim, Y. A. L., NguiR., ShukriJ., RohelaM., and Mat NaimH. R. (2008). Intestinal parasites in various animals at a zoo inMalaysia. *Veterinary Parasitology*. Vol 157: 154–159.

25. Mader D.R. (1996): Reptile medicine and surgery. Philadelphia: W.B. Saunders
26. Magona, J.W. &Musisi, G. (1999). Prevalence and infections levels of gastrointestinal nematodes in Ugandan goats in different agro climatic zones. *Bulletin of AnimalHealth and Production in Africa Vol***47**: 49-56.
27. Opara M.N., Osuji C.T., Opara J.A. (2010). Gastrointestinal parasitism in captive animals at the Zoological Garden Nekede, Owerri, Southeast Nigeria. *Rep. Opin.* 2(5):21-28.
28. Otegbade A.C., Morenikeji O.A. (2014). Gastrointestinal parasites of birds in zoological gardens in south-west Nigeria. *Tropical Biomedicine,* 31(1): 54–62.
29. Ranga Rao, G. S., SharmaR. L., and Hemaprasanth. (1994). Parasitic infections of Indian yak Bos (poephagus) grunniens—an overview. *Veterinary Parasitology.* Vol 53: 75–82.Rossanigo, C.E. and GrunerL. (1995). Moisture and temperature requirements in faeces for the development of free living stages of gastrointestinal nematodes of sheep and cattle and deer. *Journal of Helminthology.* Vol 67:357-362.
30. Singh P., Gupta M.P., Singla L.D., Sharma S., Sandhu B.S., Sharma D.R. (2006b). Parasitic infections in wild herbivores in the Mahendra Choudhury Zoological Park, ChhatBir, Punjab. *Zoo's Print Journal* 21(11):2459-2461.
31. Soulsby E.J.L. (1982) Helminthes, arthropods and protozoa of domesticated animals, 7th edn. Bailliere Tindall, London, pp 156–168
32. Tessaro, S. V. (1989). Review of the disease, parasites and miscellaneous pathological conditions of North America bison. *Canada Veterinary Journal* 30: 416–422.
33. Urquhart G., Armour,J., Duncan, J.L., Dunn, F.W.(2000)*Veterinary Parasitology*. Longman Scientific Technical, U.K, pp: 4-96.
34. Varadharajan A., Kandasamy A. (2000) A survey of gastrointestinal parasites of wild animals in captivity in V.O.C. Park and minizoo, Coimbatore. *Zoo's Print Journal* Vol 15(5):257–258
35. Wójcik, A.R., Wasilewski, I., Grygon-Franckiewicz, B., Zbikowska, E., (1999).Economic losses in pheasant breeding evoked with endoparasites. *Wiad.Parazytol.* 45, 363—368 (In Polish).
36. Woodburn M., Sage R.B., Carroll J.P., (2002). The efficacy of a technique to controlparasitic worm burden in pheasants (Phasianuscolchicus) in the wild. Z.JAGDWISS. 48, 364–372.
37. Yabsley M.J. (2009). Capillarid Nematodes. In: *Parasitic Diseases of Wild Birds*, Atkinson, C.T., Thomas, N.J. & Hunter, D.B. (Editors). Johnwiley& Sons, Oxford, UK: pp. 463-497.