World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
Journal homepage: https://wjarr.com/

(RESEARCH ARTICLE)

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A study on the gastrointestinal parasites (GIP) of wild animals found within the surrounding forests of Zuku and Rumfan Gwamna villages in Bassa Local Government Area, Plateau State, Nigeria

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World Journal of Advanced Research and Reviews, 2022, 14(02), 384–392

Publication history: Received on 09 April 2022; revised on 15 May 2022; accepted on 18 May 2022

Article DOI: https://doi.org/10.30574/wjarr.2022.14.2.0336

Abstract

Parasitic infections of wild animals can lead to the death of the affected animals tending towards extinction and act as a predisposing factor for the development of secondary infectious diseases. Infected animals serve as source of infection to other wildlife and zoonosis to human. This study was carried out to determine the gastrointestinal parasites of wild animals found within the forests of Zuku and Rumfan Gwamna villages in Bassa LGA. 238 fresh faecal samples were collected from wild animals found within the forests. The samples were each prepared using direct wet mount, sedimentation and floatation techniques, and staining method. From the number examined, 227 (95.38%) samples were positive for GIP infection. Nematodes were the most prevalence (64.84%) with Ascaris lumbricoides being the highest species (46.64%), while trematodes had the least prevalence (11.45%). Age and sex had no significant effect in the parasite's infection except *Trichostrongylus retotaeformis* which had significant difference ($p<0.05$). Among the animals infected, Giant rats was most prevalent (100%) followed by Squirrel had (94.14%), while the Adamawa turtle doves had the lowest infection (89.66 %). The result of this study shows higher prevalence of GIP infection, and presence of various genera in the study area. Hence, more study is necessary to identify the species of parasites in animals within the study area. Deworming of wild animals in the forests with broad spectrum anthelmintic is recommended to prevent zoonotic infections of people living in the communities.

Keywords: GIP; wild animals; Forests; Bassa

1. Introduction

Meat of wild animals widely referred to as bush meat has the advantage of having less saturated fat, which makes it healthier than other fatty meats, low calories when compared with beef and pork, high level of Eicosapentaenoic acid, an essential omega 3 fatty acid that has several health benefits and because they grow in natural environments, they are rich in vitamins and minerals. Thus, bush meat is a good source of organic meat [1]. Wild animals can predominately be affected by various gastro-intestinal parasites. Intestinal parasitic infections are major causative agents of wildlife health complications among different parts of the world [2]. Infections are widely distributed in tropical and subtropical areas, with the greatest numbers occurring in sub-Saharan Africa, the Americas, China and East Asia. Globally over 600 million people are estimated to be infected by *S. stercoralis* however, since also this parasite is transmitted in areas where sanitation is poor, its geographical distribution overlaps with the one of the other soil-transmitted helminthiases. *https://www.who.int/news-room/fact-sheets/detail/ soil-transmitted-helminth-infections*. Intestinal parasitic infections remains a major public health problem particularly in rural areas [3]. Gastrointestinal parasites of these wild games can

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be the source of infections to other non-infected animals and humans. Meat handlers are under the risk of being infected with parasites from infected wild animals. The high prevalence (46.3%) of intestinal parasitic infections were found among food handlers within the Bule Hora Town clientele, Ethiopia [4]. Wild deer were a source of infection for livestock and humans in the UK [5]. In a study conducted on carnivorous animals in three strategic Universities zoological gardens (University of Ibadan, Obafemi Awolowo University and Univeristy of Ilorin) in South West Nigeria, [6] observed a total prevalence of 49.1% of gastro-intestinal parasites in carnivores. *Isospora* spp., *Spirometra* sp., Taeniidae and *Sarcosystis* spp were most common gastrointestinal parasites observed from spotted hyaenas (*Crocuta crocuta*), lions (*Panthera leo*) and African wild dog (*Lycaon pictus*) from Luangwa Valley, Zambia [7].

In a study carried out on gastrointestinal parasitism of wild animals in captivity [8] reported an overall mean infection of 73.8% with different parasite species in the Zoological Garden of Haramaya University, Ethiopia. High prevalence 52.7% (116/220) of gastrointestinal parasites were recorded in wild animals in the State of Paraná, Brazil [9].

2. Material and methods

2.1. Study Sites

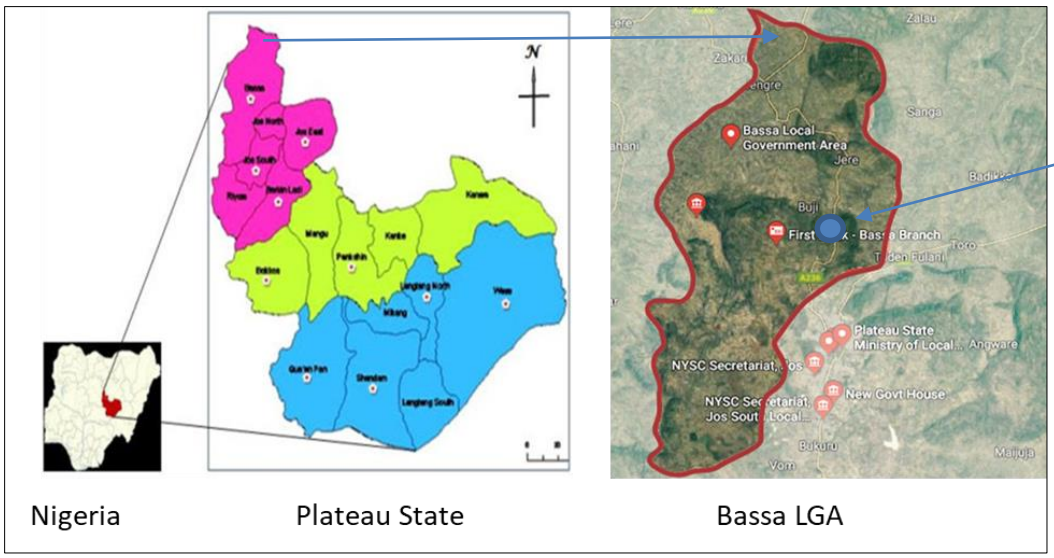
The study was carried out in the forest's areas of Zuku and Rumfan Gwamna in Buji District of Bassa LGA located between latitudes 9°55'59.99"N and longitudes 8°43'59.99"E (https://latitude.to/articles-by-country/ng/nigeria/183077/bassa-plateau-state) in Bassa LGA, Plateau State (Figure 1). Bassa is a Local Government Area in the north of Plateau State, Nigeria, bordering Kaduna and Bauchi States. Its headquarters are in the town of Bassa at 9°56′00″N 8°44′00″E

2.2. Study Animals

Three classes of animals (reptiles, birds and mammals) were studied and the species of animals encountered included; monitor lizards, turtle doves / other birds, house rats, giant rats, squirrel and monkeys.

2.3. Faecal Sample Collection and Laboratory Examination

This was carried out as describe by [2]. Two hundred and thirty-eight fresh fecal samples were collected from November, 2020 to February, 2021 from the two forests. Collection of faecal samples was carried out by the assistance of some forests Officers who were always available in the forests.



https://openi.nlm.nih.gov/detailedresult?img=PMC3162497_1746-6148-7-36-1&req=4 https://www.plateaustate.gov.ng/government/lgas/bassa

Figure 1 Map of Nigeria showing Plateau State and Bassa LGA ● **-** Study sites

The animals were trailed and fresh stool samples were collected using sterile spatulas into sample bottles. Each faecal sample taken was representative of an animals. The animals whose samples were collected, grouped into young (the small ones) and the adults (those that were mature) and males or females. Samples were placed into sterile bottles and stored in 70% ethanol and transported to the Laboratory, Department of Zoology, University of Jos for examination

within 12 hours. Direct wet mount (normal saline and Lugol's iodine) preparation, concentration techniques (formalin-ethyl and Simple Spontaneous Sedimentation Techniques), Saturated Salt Floatation Techniques and permanent staining techniques were carried for each faecal sample to ensure that the parasites were detected.

2.4. Statistical analysis

Data were entered into an Excel spreadsheet and transferred into SPSS version 23. Chi-square test was used to compare parasite prevalence between different animals' groups. *P* values below 0.05 were considered as significant.

3. Results

The overall infection of 95.38 % (227 out of 238) was recorded from the animals in the two forests (Table 1). Nematodes had the highest infection (64.71 %) with also the highest number of parasites species (11), followed by cestodes (16.81 %) with two parasites species, protozoans (13.87 %) with two parasites species, acanthocephalans (13.45 %) having one species while trematodes recorded the least infection (10.92 %) with also one parasites species.

Table 1 Gastrointestinal infection rate of wild animals in Zuku and Rumfan Gwamna forests, Bassa. (N=238)

Parasites group	Number infected (%)	No. of parasites species
Protozoans	33 (13.87)	2
Acanthocephalance	32 (13.45)	1
Cestodes	40 (16.81)	2
Trematodes	26 (10.92)	1
Nematodes	154 (64.71)	11

Table 2 Parasites species in the wild animals

Parasites		No. Tested	No. Infected (%)
Protozoans	*Eimeria tenella*	238	30 (12.61)
	*Entamoeba histolytic*a	238	3 (1.26)
Acanthocephalans	*Moniliformis moniliformis*	238	32(13.45)
Cestodes	*Taenia saginata*	238	27 (11.34)
	Hymenolepsis nana	238	13 (5.46)
Trematodes	*Dicrocoelium hospes*	238	26 (10.92)
Nematodes	*Ancylostoma sp*	238	6 (2.52)
	Ascaris lumbricoides	238	111 (46.64)
	Ascaridia galli	238	53 (22.27)
	Capillaria bursata	238	43 (18.07)
	Enterobius vermicularis	238	10 (4.20)
	Globocephalus diducta	238	12 (5.04)
	Matastrongylus elongatus	238	52 (21.85)
	Oesophagostonum columbianum	238	21 (8.82)
	Strongyloides papillosus	238	46 (19.33)
	Trichuris trichiura	238	52 (21.85)
	Trichostrongylus retortaeformis	238	27 (11.34)
	Total	238	227 (5.38)

Table 2 shows that, of the parasites species identified, *Ascaris lumbricoides* was more prevalent (46.64 %) followed by *Ascaridia galli* (22.27 %), *Trichuris trichiura* and *Metastrongylus elongatus* both had 21,85 % while *Ancylostoma* sp and *Entamoeba histolytica* recorded the least infection of 2.52 % and 1.26 % respectively. Gender base infection showed that 117 (96.69 %) out of 121 males examined were infected while of the 117 females examined, 110 (94.02 %) animals were infected (Table 3). The results showed that adult's animals had slightly higher infection (96.90 %) than young animals (93.58 %). Infection according to animals' groups indicates small mammals were more infected with higher parasites diversity than any other groups of which Giant rats recorded the highest prevalence (100 %), followed by squirrel (97.14 %), House rats (95.59 %) (Table 4). Reptiles (Monitor lizards) was the next groups after small mammals with 94.47 % infection. Monkeys and other birds both recorded 93.75 % infections while Turtle doves had 89.66 % prevalence. The distribution of parasites species in the different animals groups is shown in Table 5. *Eimeria* sp was recorded in birds' group only and *Globocephalus diducta* was only found in house rats with infection rate of 17.65 % (12/68). Similarly, *E. histolytica* was observed only in monitor lizards where three out of 19 were infected (15.79 %) while *Ancylostoma* sp was identified only in Giant rats 6/39 (15.38 %). *H. nana* and *E. vermicularis* were recovered in squirrel with prevalence of 37.14 % and 28.57 % respectively. *T. trichiura* was detected in all animals group except birds and monkeys.

Table 3 Gender and age prevalence of gastrointestinal parasites of wild animals in Zuku and Rumfan Gwamna forests, Bassa

Characteristics	Number examined	Number infected (%)
Gender		
Males	121	117(96.69)
Females	117	110(94.02)
Total	238	227 (95.39)
Age		
Young	109	102(93.58)
Aduts	129	125 (96.60)
Total	238	227 (95.38)

Table 4 Gastrointestinal parasites in animals groups

Class of animal	Animals	No. Examined	No. Infected (%)	Parasites diversity (%)
Reptilia	Monitor lizards	19	18 (94.74)	6(35.29)
Aves	Adamawa Turtle doves	29	26 (89.66)	3(17.65)
	Other birds	32	30 (93.75)	5 (29.41)
Mammalia	House rats	68	65 (95.59)	8 (47.06)
	Giant rats	39	39 (100)	8 (47.06)
	Squirrel	35	34 (97.14)	8 (47.06)
	Monkeys	16	15 (93.75)	5 (29.41)
Total	7	238	227 (95.38)	17 (100)

Table 5 Parasites species in the animals groups

Parasites species	Monitor lizards (19)	Adamawa Turtledoves (29)	Other birds (32)	House rats (68)	Giant rats (39)	Squirrels (35)	Monkeys (16)	Total (238)
Protozoans								
Eimeria tenella	0(0)	14(48.28)	16(50)	0(0)	0(0)	0(0)	0(0)	30(12.61)
*Entamoeba histolytic*a	3(15.79)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	3(1.26)
Acanthocephalans								
Moniliformis moniliformis	0(0)	0(0)	0(0)	21(30.88)	7(17.95)	4(11.43)	0(0)	32(13.45)
Cestodes								
Taenia saginata	0(0)	0(0)	0(0)	0(0)	17(43.59)	10(28.57)	0(0)	27(11.34)
Hymenolepsis nana	0(0)	0(0)	0(0)	0(0)	0(0)	13(37.14)	0(0)	13(5.46)
Trematodes								
Dicrocoelium hospes	0(0)	0(0)	0(0)	0(0)	19(48.72)	7(20)	0(0)	26(10.92)
Nematodes								
Ancylostoma sp	0(0)	0(0)	0(0)	0(0)	6(15.38)	0(0)	0(0)	6(2.52)
Ascaris lumbricoides	11(57.89)	0(0)	21(65.63)	34(50)	22(56.41)	15(42.86)	8(50)	111(46.64)
Ascaridia galli	0(0)	25(86.21)	28(87.5)	0(0)	0(0)	0(0)	0(0)	53(22.27)
Capillaria bursata	12(63.16)	15(51.72)	16(50)	0(0)	0(0)	0(0)	0(0)	43(18.07)
Enterobius vermicularis	0(0)	0(0)	0(0)	0(0)	0(0)	10(28.57)	0(0)	10(4.20)
Globocephalus diducta	0(0)	0(0)	0(0)	12(17.65)	0(0)	0(0)	0(0)	12(5.04)
Matastrongylus elongatus	0(0)	0(0)	0(0)	38(55.88)	4(10.26)	0(0)	10(62.5)	52(21.85)
Oesophagostonum columbianum	0(0)	0(0)	0(0)	15(22.06)	0(0)	0(0)	6(37.5)	21(8.82)
Strongyloides papillosus	8(42.11)	0(0)	0(0)	8(11.76)	0(0)	0(0)	5(31.25)	46(19.33)
Trichuris trichiura	9(47.37)	0(0)	0(0)	29(42.63)	12(30.77)	2(5.71)	0(0)	52(21.85)
Trichostrongylus retortaeformis	0(0)	0(0)	0(0)	0(0)	0(0)	23(65.71)	4(25)	27(11.34)

4. Discussion

The high prevalence of GIP of 95.38 % (227 out of 238) found from the animals in the two forests is consistence with [10] who reported a total prevalence of 92 % zoonotic Gastrointestinal Parasites in Baboons (*Papio anubis*) in the Shai Hill Reserve in Ghana. In their survey [11] revealed a high prevalence of GIP, where 86% (48/56) of faecal samples screened positive for parasitic infections. However, this results varies with [12] who reported a prevalence of 57.9 % (11 of 19) in ocelots. This results is also higher than the prevalence of 46.2 % GI parasites recorded in captive wild animals of Nandan Van Zoo [13]. However, [14] reported the prevalence of 35.11%, GIP infection in macaque at Kosumpee Forest Park. The high prevalence of parasites encountered in this study may probably be due to the existence of favorable climatic conditions, which support prolonged survival of parasites. Moderate temperature, moisture, and more humidity between the soil and the herbage are favorable to the survival of eggs and free-living stages of parasites [15]. The environmental factors which favours the reproduction rates of the parasites in the study areas might be a contributory cause for the high infection in an area. In the present study areas the animals moved about freely where they may came in contact with another infected on probably eaten food contaminated by egg, cycts and larvae of parasites. The source of these parasites is likely from ingesting infected prey, although exactly which prey is responsible for individual parasites is unknown [7]. The differences in the prevalence of these parasites was attributed to differences in transmission dynamics as well as the environmental, parasite, and host factors that contribute to development, survival, and dispersal of the infective stages of the parasite in the environment [10]. The low prevalence reported by other researchers could probably be due to small numbers of faecal samples observed in their studies.

The seventeen GIP species observed in faecal samples of the wild animals in this study is in agreement with [16] who reported a total of 23 species of parasites found in the seven monkey species at Tai where 20 GIP species (86.96 %) were detected in *Cercocebus atys* and *Cercopithecus petaurista* and 19 species of parasites (82.61 %) in *Cercopithecus campbelli* and *Cercopithecus diana* monkeys. A total of eight parasitic genera were detected in gastrointestinal tracts of these felids. The high prevalence of nematodes in this study agrees with [12] who found out that the most prevalent parasites in felids were nematodes (ascarids and strongyles) followed by trematodes (*Schistosoma* spp.) and intestinal protozoa (*Balantidium* and I*sospora* spp.). Helminth infection was more common than protozoal infection, with helminth eggs observed in 21 (46.7%) animals, while protozoans were observed in four (8.9%) of the total positive animals [17]. Interestingly, only one cestode and one trematode were detected in this study. *Isospora* spp., *Spirometra* sp., Taeniidae and *Sarcosystis* spp were most common gastrointestinal parasites observed from spotted hyaenas (*Crocuta crocuta*), lions (*Panthera leo*) and African wild dog (*Lycaon pictus*) from Luangwa Valley, Zambia[7]. Superfamily Trichostrongyloidea (6/16) and *Strongylus* sp. (4/16) were considered as the most prevalent helminth infections as well, *Blastocystis* sp. (6/14), *Entamoeba* cyst (3/14) and *Eimeria* sp. (3/14) were the prevalent protozoan parasites [9]. In their study on the ecology of GIP interactions in wild Gaur (Bos gaurus) at Satpura Tiger [15] reported that the overall prevalence rate of Strongyles was maximum 13 (14.44%) followed by that of *Eimeria* sp. 11 (12.22%), *Moniezia* sp. 10 (11.11%), *Amphistomes* 6 (6.66%), *Trichuris* sp. 5 (5.55%), and *Fasciola* sp. 3 (3.33%). The results of the parasites species in this study is at variance with [18], who reported *Spirometra* sp. as the most prevalent parasite (63.4%) and had the highest number of eggs per g of feces (median = 975) followed by Taeniidae (58%), *Ancylostoma* sp. (56%), and a coccidi (53%). It is also contrary to the report of [15] who revealed that the Strongyles were the most prevalent parasites in wild Guar (*Bos guarus*). High prevalence of *Haemochus* spp. and *Nematodirus* spp infestation were reported in domestic ungulates of Kashmir [19]. The prevalence of Trichuris in this study is similar to the findings of [14] who showed that *Strongyloides* spp. Had 15.27% (20 of 131) *Trichuris* spp. 22.90% (30 of 131), Hookworm 4.58% (6 of 131) and *Ascarid* spp. 1.53 (2 of 131). The most common gastrointestinal parasites found in African lion (*Panthera leo*), African wild dog (*Lycaon pictus*) and spotted hyaena (*Crocuta crocuta*) in the Luangwa Valley, Zambia were *Isospora* spp., *Spirometra* sp., Taeniidae and *Sarcosystis* spp [7]. The probability of trematode and cestode infections in captive animals is lower, as the life cycle of these helminths is indirect [17] since animals in zoos are kept in closed enclosures, giving very limited access to the intermediate hosts, their intermediate hosts are less likely accumulated in the enclosure. There was no Cestode and Trematode species recovered from the fecal samples of Wild Animals in Captivity at the Zoological Garden of Haramaya University, Ethiopia [8]. The gastro-intestinal helminth fauna drains the essential nutrients rendering the animals weak which effects the reproductive potential and survival rate of hosts [20]. The helminth parasites lower the body mass, reduce fecundity, and increase mortality among wild ungulates [21]. The presence of gastrointestinal helminth parasites in markhor and musk deer with known ill impacts may threaten the survival of these two threatened mountain ungulates [19].

The high infection in males compared with the females in this study could be due to raised level of testosterone which does leads to immunosuppression [22]. This concurs with [23] who stated that reduced immunity leads to increased intensity of infection. Males usually move around searching for females during mating and are expose to infection from

the environment and even from infected females. On the contrary, most females station themselves in one place looking after their young and move around their vicinity searching for food thereby reducing their risk of exposure to infections.

In the present study, the high infection in adult's animals than the young animals concurs with [10] who observed that adults had the highest prevalence of intestinal parasites (39%), while the juveniles (18%) had the least. There was no relationship between age and parasite abundance was observed, except for baboon where age was found to be associated with prevalence of two parasite taxa (*Strongyloides* sp. and *E. coli*). Juveniles had increased prevalence of *E. coli* (66.6% in adults; 73.3% in juveniles) and *Strongyloides* sp. (20% in adults; 53.3% in juveniles) [24]. The tendency of parasites transmission is associated with the host's age since exposure to parasites depends on age, behavior and immunity of the animals [25]. High prevalence of adults in this study may be attributed to the behavior of the animals. Some parasites lives longer life and continue to reproduce and colonize the host [26]. Therefore, adult's animals that are not periodically dewormed are likely to have high parasites load and species.

The high infection of mammals than other animals encountered in this study concurs with [9] who reported 59.1 % (91/154) infection mammals while in birds, the positivity rate was 37.9% (25/66). Strongyloidea superfamily eggs were observed in 37.3% (82/220) of the samples, *Eimeria* spp. in 10% (22/220), and *Trichuris* spp. in 4.5% (10/220). The most frequent mammal species were llamas (*Lama glama*), and dromedaries (*Camelus bactrianus*) with infection rate of 70.1 % (54/77) and 60.8 % (14/23), respectively. According to [11], civet, buffalo and Leopard recorded 100% prevalence.

5. Conclusion

Based on the prevalence of GIP in wild animals in the two forests, periodic deworming should be carried out by keeping food and/or water with antiparasitic medications at certain points for the animals to feed. This will help reduce the levels of infections which will also curtail the zoonotic rate of transmission to humans. Forests should be properly guarded and protected by the Government though the forestry officers to help preserve the animals species in the forests and also reduce the possibility of bringing in eggs, larvae and parasites which could be deposited and subsequently be a source of infection to the wild animals.

Compliance with ethical standards

Acknowledgments

We thank the forest Officers for assisting in the collection of stool samples at different sites within the forests.

Authors' contributions

AD and BD designed the study, all authors contributed significantly in collection of the literatures, drafting the manuscript and reading and approval of the manuscript

Disclosure of conflict of interest

The authors declare that there are no competing interests.

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