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Prevalence of Cercariae Infection Among Freshwater Snails Around Irrigation Schemes, in the Benue River Valley, Adamawa State, Nigeria

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ABSTRACT

Schistosomiasis and fascioliasis are similar in their life cycles in which freshwater snails that act as intermediate host. The aim of the study was to assess the rate of cercaria shedding in snails collected around irrigation schemes in the Benue River Valley of Yola South, Adamawa State, Nigeria. Freshwater snails sampled were kept in the aquaria for 2-3 days to acclimatize and fed with aquatic vegetation. Each snail was placed in a beaker and exposed to morning sunlight. The beakers were observed for the presence of cercariae using hand lens and microscope in the Department of Zoology, Modibbo Adama University, Yola. The distribution of freshwater snail's species, showed that a total of 1,620 snails were sampled with Njoboliyo having the highest number of snails with 373, followed by Lake Geriyo with 287, Dasin Hausa with 266, Rugange with 255, Dasin Bwattiye with 235, while Boronji had the least with 204 freshwater snails. Overall-in the wet season: - *Bulinus globosus* being the most abundant snail, with a total of 287 (28.47%) snails, and the least *B. truncatus* with 228 (22.62%). The distribution of cercaria in the wet season; the highest was in *B. globosus* with 23 (32.39%), the least was in *B. truncatus* with 14 (19.72%). A total of 612 freshwater snails were collected in the dry season. *B. globosus* was most abundant snail with 173 (28.27%) snails, the least being *B. reticulatus* 144 (23.53%). The cercaria shedding showed that the highest was in *B. reticulatus* with 38 (33.63%), the least was in *B. truncatus* with 22 (19.47%). All species shade cercaria in all the communities

Keyword: Cercariae, Freshwater Snails, Irrigation Schemes, *Bulinus globosus, Bulinus truncatus*

INTRODUCTION

Molluscs are extremely important organisms of many ecological communities (Sharma *et al*., 2014), these snails are of economic and medical importance (Wosu, 2003). Various genera of these planorbid snails have been associated with specific parasite types. For example, *Bulinus* sp. is responsible for hosting the *Schistosoma haematobium* parasite and *Biomphalaria,* and *Oncomelania* sp. responsible for hosting *S. mansoni* and *S. japonicum,* respectively (Ayanda, 2009). Members of these families of snails are necessary intermediate hosts of blood-dwelling trematode parasites, which cause serious public health problems to man and animals in the tropical and subtropical regions of the world (Ayanda, 2009).

Helminth parasites transmitted by snails cause different degree of diseases which are refer to as snail borne diseases. Transmission of these parasites is usually from eating raw or undercooked snails or other vectors. Infection is also frequent from ingestion of contaminated water or vegetables that may contain small snail and slugs, or have been

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contaminated by them or having direct contact with fresh water infected with the free swimming cercariae. Of all the helminth parasites, only nematode and trematode are transmitted by snails (Taofiq *et al.,* 2017).

The prevalence of human schistosomiasis is varied greatly in African countries depending on the level of environmental sanitation and the suitability of the area for the snail intermediate hosts, as well as the type of snail in the area. Similarly, the prevalence of schistosomes cercaria in snail intermediate hosts is varied in different locations within the same country and also from country to country in Africa. Several epidemiological studies are available on the types and prevalence of human infecting schistosomes among snail intermediate hosts in Africa (Siama *et al.,* 2023). The aim of the study was to assess the prevalence and intensity of cercariae in the snail intermediate host around irrigation schemes of the Benue River valley in Adamawa State

MATERIALS AND METHODS

Study Area

Adamawa State is located in the North Eastern part of Nigeria. It lies between latitude 7° 11' N of the equator and longitude 11° 14' E of Greenwich meridian. It has an altitude of 185.9 and covers a land area of about 38.741km. It shares boundary with Taraba State in the South and West, Gombe State in its North West and Borno State to the North. Adamawa State has an international boundary with Cameroon Republic along its Eastern border. The River Benue which is the major river in the State it rises from the highlands of Cameroon and flows South ward to join the River Niger at Lokoja. Two seasonal periods are experienced in the State: the wet and the dry seasons. The months of May to October constitute the wet season. During this period no place receives less than 60 mm of rain. The months of November to April constitute the dry season. It experiences Harmattan between the months of November to February. March and April are the hottest months (42.78^{o}C), while November and December are the coldest months (11.11^{o}C), (Adebayo and Tukur, 1999).

The study covered the community around Lake Geriyo and along the banks of the River Benue, Yola area starting from Boronji Community (behind the Adamawa State Water Board Treatment Plant) close to the Jimeta-Girei bridge at the boundary of Yola North LGA and Girei LGA, it will follow the communities of Rugange Bwatiye through Njoboliyo in Yola South LGA and Dason Bwatiye upto Dasin Hausa in Fufore LGA. These areas are characterized by farming and fishing activities all year round.

Malacological Survey

Snail Habitat Data

Sampling of freshwater snails was done for twelve (12) months, in sites where there are major human water contact within settlements along the scheme of the Benue River, Yola area. During the period of sampling, snails were captured once every month covering both the dry and wet season. The two seasonal periods showed changes in the ecosystems around the River/Lake based on the quantity and quality of water (Alhassan *et al.,* 2017).

Malacological surveys

Snails were sampled from identified sites on the basis of availability of water and observation of human or animal water contact activities. Collection was done once every month for a period of 12 months (September, 2022 to August, 2023).

The survey covered a different range of site types including irrigation canals which draw water directly from the River Benue, and the smaller dirt-lined canals that deliver water to

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rice paddies; the paddy-fields, the river (shallows of the main body of the River Benue), and spillways (floodplain of tributaries feeding into the river). All the water contact sites where people used for irrigation, watering of cattle and other activities were surveyed. Sampling was carried out by 2 trained field collectors using standard snail scoops or occasionally, by hand collection where necessary. The same collectors scooped for snails throughout so as to achieve some level of standardized sampling effort. Sampling time was fixed at 30 minutes per location and was performed between 08:30 am and 10:30 am. Sampling area per location was approximately $5m^2$, whereas lengths of 10 metres along streams and Lake Shoreline was used also. At each collection time, snails from each site was appropriately labelled and transported in separate perforated plastic containers. The collected snail specimens were transferred to the Department of Zoology laboratory as described by Opisa *et al.* (2011). Snails were identified according to shell morphology and structure using standard identification keys (Brown, 1994; Panda *et al.,* 2014).

Parasitological investigation for cercariae

The snails were kept in an aquarium for 2-3 days to acclimatize and fed with algea and sliced spinach leaves. Using forceps, each snail was placed individually into a 400 ml beaker containing some water and leaves from the aquaria. The beaker was then covered with rubber net and tightened at the tip to prevent the snails from coming out of the beakers. The beakers were put inside the aquaria (10-15 beakers per aquarium). The water and leaves in each beaker were observed for the presence of cercariae using hand lens and microscope. Where there is shedding of *Schistosoma* spp. cercariae, snail was recorded as positive for patent infection (hereafter, referred to as 'shedding'). The cercariae was individually collected by micro-pipette in 3–5 µl of water (Frandsen and Christensen, 1984)

RESULTS

Overall, *Bulinus globosus* being the most abundant snail collected in the wet season with a total of 287 (28.47%) snails, followed by *B. reticulatus* 256 (25.40%), *L. natalensis* 237 (23.51%) and the least being *B. truncatus* with 228 (22.62%). The distribution of cercariae in relation to species in the six study stations during the wet season showed that the highest cercariae shedding was in *Bulinus globosus* with 23 (32.39%), followed by *L. natalensis* 23 (32.39%), *B. reticulatus* 19 (26.76%). The least was in *B. truncatus* with 14 (19.72%). With respect *L. natalensis* Lake Geriyo recorded the highest with 4 (26.67%), followed by Njoboliyo and Dasin Hausa with 3 (20.00%) each and Boronji and Rugange had 2 (13.33%) each. While, Dasin Bwatiye had the least with 1 (6.67%). *B. globosus* Njoboliyo had the highest with 7 (30.43%), followed by Rugange and Dasin Hausa with 4 (17.39%) each, Boronji and Dasin Bwatiye with 3 (13.04%), Lake Geriyo had the least with 2 (8.70%). As for *B. reticulatus*; Njoboliyo, Rugange and Dasin Bwatiye had the highest with 4 (21.05%) each, followed by Lake Geriyo and Dasin Hausa with 3 (15.79%) each. While, Boronji had the least with 1 (5.26%). *B. truncatus* Dasin Hausa had the highest with 4 (28.57%), followed by Njoboliyo and Rugange with 3 (21.43%) each, Lake Geriyo had 2 (14.29%), the least was recorded in Boronji and Dasin Bwatiye with 1 (7.14%) each (Table 1).

A general total of 612 freshwater snails intermediate host for schistosomiasis were collected at the six study stations in the dry season. *Bulinus globosus* being the most abundant snail collected in the dry season with a total of 173 (28.27%) snails, followed

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by *L. natalensis* 149 (24.35%), *B. truncatus* 146 (23.68%) and the least being *B. reticulatus* with 144 (23.53%). The distribution of cercaria in relation to species in the six study stations during the dry season showed that the highest cercaria shedding was in *B. reticulatus* with 38 (33.63%), followed by *B. globosus* 27 (23.89%), *L. natalensis* 26 (23.01%) the least was in *B. truncatus* with 22 (19.47%). With respect *L. natalensis,* Njoboliyo recorded the highest with 6 (23.08%), followed by Boronji with 5 (19.23%), Lake Geriyo, Rugange and Dasin Hausa had 4 (15.38%) each. While, Dasin Bwatiye had the least with 3 (11.54%). *B. globosus*; Njoboliyo had the highest with 6 (22.22%), followed by Dasin Bwatiye and Dasin Hausa with 5 (18.52%) each, Lake Geriyo and Boronji both had 4 (14.81%) each, Rugange had the least with 3 (11.11%). *B. reticulatus;* Njoboliyo had the highest with 12 (31.85%), followed by Dasin Hausa with 7 (18.42%), Dasin Bwatiye had 6 (15.79%), Boronji 5 (13.16%), Lake Geriyo and Rugange had the least with 4 (10.53%) each. For *B. truncatus* Njoboliyo had the highest with 5 (22.73%), followed by Lake Geriyo, Rugange and Dasin Bwatiye with 4 (18.18%) each, Dasin Hausa had 3 (13.64%), the least was recorded in Boronji with 2 (9.09%) (Table 2).

Table 1: Snail and Cercariae Distribution in the wet season at the study sites.

Study Sites		*L. natalensis*	*B. globosus*	*B. reticulatus*	*B. truncatus*	Total
Lake Geriyo	Snail	42 (17.72)	47 (16.38)	49 (19.14)	45 (19.74)	183 (18.15)
	Cercariae	4 (26.67)	2 (8.70)	3 (15.79)	2 (14.29)	11 (15.49)
Boronji	Snail	27 (11.39)	35 (12.20)	37 (14.45)	33 (14.47)	132 (13.10)
	Cercariae	2 (13.33)	3 (13.04)	1 (5.26)	1 (7.14)	7 (9.86)
Rugange	Snail	35 (14.77)	47 (16.18)	35 (13.67)	36 (15.79)	153 (15.18)
	Cercaria	2 (13.33)	4 (17.39)	4 (21.05)	3 (21.43)	13 (18.31)
Njoboliyo	Snail	62 (26.16)	63 (21.95)	58 (22.66)	46 (20.18)	229 (22.72)
	Cercariae	3 (20.00)	7 (30.43)	4 (21.05)	3 (21.43)	17 (23.94)
Dasin Bwatiye	Snail	35 (14.77)	50 (17.42)	27 (10.55)	24 (10.53)	136 (13.49)
	Cercariae	1 (6.67)	3 (13.04)	4 (21.05)	1 (7.14)	9 (12.68)
Dasin Hausa	Snail	36 (15.19)	45 (15.68)	50 (19.53)	44 (19.30)	175 (17.36)
	Cercariae	3 (20.00)	4 (17.39)	3 (15.79)	4 (28.57)	14 (19.72)

Table 2: Snail and Cercariae Distribution in the dry season at the study sites

Study Sites		*L. natalensis*	*B. globosus*	*B. reticulatus*	*B. truncatus*	Total
Lake Geriyo	Snail	31 (20.81)	29 (16.76)	14 (9.72)	30 (20.55)	104 (16.99)
	Cercariae	4 (15.38)	4 (14.81)	4 (10.53)	4 (18.18)	16 (14.16)
Boronji	Snail	17 (11.41)	16 (9.25)	16 (11.11)	23 (15.75)	72 (11.76)
	Cercariae	5 (19.23)	4 (14.81)	5 (13.16)	2 (9.09)	16 (14.16)
Rugange	Snail	23 (15.44)	29 (16.76)	28 (19.44)	22 (15.07)	102 (16.67)
	Cercariae	4 (15.38)	3 (11.11)	4 (10.53)	4 (18.18)	15 (13.27)
Njoboliyo	Snail	26 (17.45)	52 (30.06)	32 (22.22)	34 (23.29)	144 (23.53)
	Cercariae	6 (23.08)	6 (22.22)	12 (31.58)	5 (22.73)	29 (25.66)
Dasin Bwatiye	Snail	26 (17.45)	26 (15.03)	24 (16.67)	23 (15.75)	99 (16.18)
	Cercariae	3 (11.54)	5 (18.52)	6 (15.79)	4 (18.18)	18 (15.93)
Dasin Hausa	Snail	26 (17.45)	21 (1214)	30 (20.83)	14 (9.59)	91 (14.87)
	Cercariae	4 (15.38)	5 (18.52)	7 (18.42)	3 (13.64)	19 (16.81)

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DISCUSSION

The present study showed that cercariae were found in all types of aquatic habitats. This is similar with the findings of Mereta *et al.* (2019), who reported that all types of aquatic habitats in their study area yielded one or more types of cercariae. Masceline *et al.* (2020), showed that among the *B. globosus* collected and tested for patent infection, 30/1542 (1.9%) were shedding schistosome cercariae. The morphology of the cercarial infection in the present study were different from the reports of Mereta *et al.* (2019), who recorded a total of eight morphologically distinguishable types of cercariae in their study. The infection rate in the present study was less than the report of Mereta *et al.* (2019), who stated that out of the 3,045 snails examined, 109 (3.6%) released one or more cercaria species. Mengistu *et al.,* (2011), reported 58% infection in their study area. Muriel *et al.* (2019), reported that the prevalence's of *Schistosoma* spp. within snails across the entire study were as follows: *Bi. pfeifferi*: 3.45% (79/2290); *B. truncatus*: 0.8% (342/42,500); and *B. forskalii*: 0.2% (24/11,989). No *R. natalensis* ($n = 2530$) were infected. Ejehu *et al.* (2017) recorded that snail infestation was found from the 385 snails collected during their survey and none was found to shed cercariae.

The low prevalence of infection in this study could be due to low parasite pressure, making contact between miracidia and snails a rare occurrence as supported by Frandsen and Christensen, (1984). Additional factors may be the difference in snail species observed at different study areas. Adejumoke *et al.* (2016) reported that trematode larvae were found only in *Bulinus* species. Out of the 400 bulinid snails (*B. globosus* and *B. truncatus*) examined over the period of this study, only 2 (0.5%) snail specimens were found infected with trematode larvae. The infected snails were specimens of *B. globosus.* Taofiq *et al.* (2017) reported that out of the total number of snails collected and examined, 230 (28.26%) were found to carry one or more cercariae or larva of helminth species. Of the infected snails, 53 (14.28%) were *A. fulica*, 98 (42.79%) were *B. globosus* and 79 (36.91%) were *L. natalensis*. Sanu *et al.* (2020), reported that among the snail species were encountered at the Kiri Dam of Shelleng LGA *Bulinus globosus, Bulinus truncatus, and Biomphalaria pfeiffeiri* shedded cercariae typical of schistosomes. Tamirat *et al.* (2020), reported that a total of 273,643 snails from *Biomphalaria* and *Bulinus* genera were examined for the presence of *S. mansoni* and *S. haematobium* cercaria in the 51 eligible studies, respectively. Out of these snails, 8,682 of them were infected by either *S. mansoni* or *S. haematobium*. The prevalence of schistosome cercariae in the individual study ranged from 0.05% to 58.03% with substantial heterogeneity across studies within and across countries. The pooled prevalence of schistosome cercariae among freshwater snails was 5.5%. The highest pooled prevalence of schistosome cercaria was observed among freshwater snails from Nigeria (19.0%), followed by Ethiopia (15.9%), Mali (5.2%), and Tanzania (4.9%).

The *Cercaria shedding* in the present study differ from what Tamirat *et al.* (2020) recorded in their findings; they reported that the overall pooled prevalence of schistosome cercaria was nearly 6.0% among freshwater snails in Africa. These differences might be associated with prevalence and intensity of schistosome infection in the communities, the level of environmental sanitation, suitability of the climate for the snails, level of existing snail control strategies, level of human exposure to open surface water, methods of schistosome detection, and seasons of snail collection and examination. Tamirat *et al.*

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(2020) reported that the difference in the level of environmental sanitation and the suitability of the area for the intermediate host, as well as the types of snail species in the area, may contribute for the difference in infection of snails across communities.

Akinwale *et al.* (2009); Ezeh *et al.* (2019) reported that prevalence of schistosomiasis could reach as high as 94% in Nigeria. Several species of freshwater snails that potentially serve as intermediate hosts for *S. mansoni* and *S. haematobium* have been recently reviewed by Abe *et al*. (2018). Tamirat *et al.* (2020) stated that *Biomphalaria* and *Bulinus* snails are the common and widely distributed intermediate hosts for schistosomes in Africa. These authors recorded twelve snail species belonging to either *Biomphalaria* or *Bulinus* genus.

The present study has characterized abundance and distribution of *B. truncatus* that are compatible hosts for *Schistosoma* spp., these data provide a proxy of animal and human schistosomiasis transmission risk. The findings of a high abundance of *B. truncatus* and high numbers shedding cercariae in the dry season have clear implications for monitoring of transmission for *Schistosoma* spp., and could for example, contribute to an evidence-based snail control programme to tackle interruption of transmission in the region (Muriel *et al.,* 2019). There is correlation between the overall abundance and the total number of infected snails in the present study. Muriel *et al.* (2019) reported a significant correlation between the abundance and number of infected snails for both *B. truncatus* and *Bi. Pfeifferi.* This may be due to a sampling effect as infection rates were much lower and consistent with published findings (Garba *et al.,* 2010), including for the Niger River Valley (Labbo *et al.,* 2007). In the present study, some of the snail species observed were infected. This finding was similar to that reported by Warren (1979) and Brown and Wright (1980) who opined that snails are implicated for one type of trematode disease or the other.

CONCLUSION

From the finding of the present study, it showed that less half of the freshwater snails are infected with cercariae. Among the infected freshwater snail in relation to location; Njoboliyo recorded the highest infection rate of cercariae while Dasin Hausa had the least cercariae infection.

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