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Original article

Distribution and diversity indices of principal vectors (*Bulinus Spp*) of Schistosomiasis at Farms in Doko Community, Lavun, Niger State

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ABSTRACT

Distribution and diversity indices of principal vectors (*Bulinus spp*) of Schistosomiasis at farms in Doko community, Lavun, Niger State was investigated in the year 2023. Schistosomiasis is human infectious disease which results from penetration of the cercariae of *Schistosoma* spp. through the skin. Farmers Survey as a first step measure was conducted at the locality, farm type, abundance was observed from their farms, there was limited faring activity within the sampling period. Aestivating snail samples were collected from soil samples by excavating the soil at a shallow depth of 3cm (30 x 30cm), at three randomly selected points, in each sampling site, more so, hand picking of available surface snails was done simultaneously at three randomly selected points, in each sampling site. Through the survey, it was established that, snail abundance was more at rice field farm, vegetable farms and others respectively, with ability of aestivating during early dry season. Results revealed significant variation in conductivity and water hardness, with rice farm water recording significantly higher conductivity and hardness (290 ± 22.46 µS/cm and 58.33 ± 1.29 mg/ml) respectively. Evenness diversity indices revealed that snail in vegetable farms had the rearrests species distribution followed by others and Rice farm had the highest with the following evenness index value of 0.9259, 0.9165 and 0.8231 respectively. More so, Eigen value also revealed 82.95 and 17.05 % influence of environmental factors on the distribution of the snails in the selected farms. Conclusively the study revealed a strong association of availability of potential snail vector of schistosomiasis at various farms studied, which could serve as a serious public health treat to the control of Schistosomiasis in the locality.

Keywords: Farming practices, snail diversity, Aestivation, Mechnick diversity

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INTRODUCTION

Schistosomiasis is human infection, results with penetration of the *cercariae* of *Schistosoma spp* through the skin (4). Schistosomiasis is one of several Neglected Tropical Diseases (NTDs) considered major public health problems that affect tropical and sub-tropical countries such as Nigeria, Ghana, and Cameroon. The disease is endemic in several communities in Nigeria, such as Gwako in the Federal Capital Territory (FCT), Abuja. The disease causes economic and health inconveniences for patients and communities where it is endemic, and Nigeria is the most schistosomiasis-endemic African nation (3). The country has an overall prevalence of 9.5% with about 24 million persons at risk of schistosomiasis (7). The Federal Capital Territory where Gwako is located has a reported prevalence of urinary schistosomiasis of 31.30% (9). In general, urinary schistosomiasis is a persistent health problem among children in schistosomiasis endemic communities. Poverty is a major driver facilitating the spread of schistosomiasis in Nigeria. Additionally, the lack of access to safe water and adequate sanitation and toilet facilities exacerbates the situation (2) In endemic communities like Gwako, a large proportion of the population use unsafe streams, ponds and other seasonal stagnant water bodies for domestic and agricultural purposes (5) The indiscriminate disposal of human faeces into water sources through open defecation also aids the spread of disease agents and vectors.

Iraq is one of many countries that suffer from a health problem of Schistosomiasis. Some studies suggest that the cases of Schistosomiasis are increased through the last two decades especially in primary school children. Using of the irrigation water as a waste place, washing and swimming may cause of Schistosomiasis. Presenting of *B. truncatus* snails is a limited factor of Schistosomiasis (17). Schistosomiasis, transmitted by water snails, is the most widespread of all vector-borne diseases, affecting almost 240 million people worldwide. It is a parasitic disease caused by trematodes belonging to genus *Schistosoma*. It is an important public health problem second only to malaria in terms of morbidity and mortality (17).Two forms of human schistosomiasis endemic in Kenya are Intestinal schistosomiasis caused by *Schistosoma mansoni* and transmitted mainly by *Biomphalaria pfeifferi* snails and urinary schistosomiasis caused by *Schistosoma haematobium* which is transmitted by *Bulinus* species, 3 In Kenya, 6 million people are infected and an estimated 15 million are at risk (1).This disease poses serious socio-economic and health effects since it is endemic in developing countries

MATERIALS AND METHODS

Study Area

The study was carried out in Doko community, situated in lavun, Niger State, Nigeria. Its geographical coordinates are 8° 57’ 0’ north 5° 58’ 0’’ east. Doko community has a typical tropical climate with mean annual temperature of 30.20C, relative humidity of 61% and rainfall of 1334mm. The climate in the area has two distinct seasons: rainy season (April - October) and a dry season (November - March), completely devoid of rains. Its vegetation is typically grass-dominated savannah with scattered short trees (9). Basically, three types of wetland ecosystems were selected for the study, which include rice field farm, vegetable

farms and others. Farming is a major pre-occupation of the inhabitants of Doko community and environs, with the area particularly famous for rice production; being a staple food of the people.

Collection and Preservation of Snail collected from Rice farms, Vegetable farms and other farm types

Snail samples were collected from topmost/substratal soil samples by excavating the soil at a shallow depth of 3cm (30 x 30cm), at three randomly selected points, in each sampling site. 2kg of soil was transferred into plastic bowl (30cm in diameter and 40cm deep) and flooded with 2.0 liters of borehole water in the Postgraduate (PG) Laboratory of the Department of Biology Department, Ibrahim Badamasi Babangida University Lapai, Niger State. Each farm was represented with three replicate bowls covered with net to prevent snails from escaping. The soil sample was collected in the early hours of 9 – 11am, more so, hand picking of available surface snails was done, according to modified method of (15).

Identification of Snail

The collected snails were identified to species level according to their shape, size, markings, colour, spire angle, sculpture and aperture using hand lens, relevant literatures and identification chart as described by (6), (13).

Data Analysis

Water samples were collected from selected farms and subjected physicochemical analysis to determine the influence of some physicochemical parameter on the ecology, distribution and diversity of the snail species in the sampling area. The physico-chemical parameters studied include temperature, hydrogen ion concentration (pH), Hardness, electrical conductivity, dissolved oxygen (DO) and Biological Oxygen Demand (BOD). These were done according to details in American Public Health Association (APHA).

Shannon's and Simpson's index are non-parametric measure of alpha diversity. Evenness is measured so as to know how evenly species are distributed in a locality, as well as Eigenvalue which measure the influence of environmental factors on the distribution of organisms in an eco-setting.

Data from nail abundance were subjected to Analysis of Variance (ANOVA) to verify if there was a significant difference in snail abundance among the study sites. The Shannon – Weiner index (H'), Simpson index of diversity (1-D) and Eigenvalue as implemented in PAST (Hammer, 2011), were used to compare the snail diversity distribution within the selected farm types. Relationship between snail abundance and the physico-chemical parameters of the environment was determined using the canonical correspondence analysis (CCA), using PAST (Salihu *et al.,* 2020; Hammer *et al*., 2001; Gururaja and Ramachandra, 2012).

RESULTS

Table 1 revealed mean physicochemical analysis of flooded water of the selected farm sites, the results revealed significant variation in conductivity and water hardness, with rice field water recording significantly higher conductivity and hardness (290 ± 22.46 µS/cm and 58.33 ± 1.29 mg/ml), whereas, other farms recorded the least of the same parameters respectively.

Table 1: Mean physicochemical analysis of flooded water of the selected farm sites

Farm categories	Temperature (0°C)	pH	Conductivity (µS/cm)	Hardness (mg/ml)	DO (mg/ml)	BOD (mg/ml)
rice field	30.17±2.45[a]	6.63±0.43[a]	290±22.46[c]	58.33±1.29[b]	6.76±1.22[a]	4.13±0.13[a]
veg farm	31.11±1.26[a]	6.23±0.23[a]	279±26.04[b]	46.15±2.67[ab]	6.83±0.98[a]	4.02±0.55[a]
others	32.51±1.89[a]	6.89±0.26[a]	265±18.65[a]	42.28±1.98[a]	7.21±2.04[a]	3.88±0.29[a]

*Mean value with similar subscript alphabets on the same column are not significantly different at P=0.05
DO = Dissolved Oxygen; BOD = Biological Oxygen Demand

Species composition and relative abundance of snail species in selected farm lands in Doko community is presented in table 2. The results revealed that *Bulinus globosus* had the highest relative abundance (28.39%) and *Limicolaria sp* had the least (2.82%) recovered from rice farm and other categories of farm respectively.

Table 2: Species composition and relative abundance of snail species in selected farmlands in Doko community

Snail Spacies	Number of individuals species	Relative abundance (%)
Rice Farm		
Bulinus Pfeifferi	64	11.28
Bulinus globosus	161	28.39
Bulinus unicolor	21	3.70
Vegetable Farm		
Achatina achatina	55	9.70
Achatina fulica	108	19.04
Archachatina marginata	18	3.17
Others farms		
Achatina achatina	46	8.11
Achatina fulica	78	13.76
Limicolaria sp	16	2.82
		100

Mean spatial and temporal abundance of snails collected from selected farms in Doko community are presented in table 3. The results revealed significant (P = 0.05) higher abundance of snails in rice farm (82.21) and the least other categories of farm (46.67), on the other hand the abundance was decreasing as the months move forward with January recording the significant higher abundance and March recorded the least.

Table 3: Mean spatial and temporal abundance of snails collected from selected farms in Doko community

PERIOD / MONTHS	RICE FARM	VEGITABLE FARM	OTHERS
JANUARY	$51.33\pm11.23^{a*}c^{**}$	$31.33\pm5.62^{b}b$	$23.67\pm3.13^{a}a$
FEBRUARY	$20.22\pm2.76^{b}c$	$16.33\pm3.89^{a}b$	$15\pm1.00^{b}b$
MARCH	$10.66\pm1.92^{c}b$	$12.66\pm1.07^{c}c$	$8\pm0.28^{c}a$
MEAN AGGREGATE	82.21	60.32	46.67

*Mean value with similar superscript alphabets on the same column are not significantly different at P=0.05
**Mean value with similar subscript alphabets on the same row are not significantly different at P=0.05

Spatial diversity indices of snails recorded from various categories of farms in Doko community is presented in table 4. Three categories of farms were selected viz: rice farm, vegetable farm and others. The three categories of the farms recorded the same number of species richness: Taxa (S) = 3.000 for the three categories of farms) respectively. Though, Simpson Diversity indices that measure the dominance level of a community, had revealed that vegetable farm is more diverse with Simpson index value of 0.6129 followed by others with index value of 0.6101 and category rice farm had the least of 0.5328. Shannon Winner Diversity index recorded similar pattern as explained above, with an index value of 1.022, 1.011 and 0.9039 for vegetable farm, others and rice farm respectively. More so, Evenness diversity index revealed that vegetable recorded the rearrests snails collected with evenness index value of 0.9259 and rice farm was the opposite.

Table 4: Spatial diversity indices of snails recorded from various categories of farms in Doko community

Diversity Indices	RICE FIED	VEGETABLE FARM	OTHERS
Taxa_S	3	3	3
Individuals	81	59	46
Dominance_D	0.4672	0.3871	0.3899
Simpson_1-D	0.5328	0.6129	0.6101
Shannon_H	0.9039	1.022	1.011
Evenness_e^H/S	0.8231	0.9259	0.9165

Influence of environmental factors on the distribution of snails on different selected farms in Doko community was presented on table 5. The result revealed that 82.95% of the environmental factors are responsible for the distribution of snails in axis 1 while 17.05% of the factors are responsible for the distribution in axis 2 (figure 1).

Table 5: Measure the influence of environmental factors on the distribution of snails on different selected farms in Doko community

Axis	Eigenvalue	%
1	0.012393	82.95
2	0.002547	17.05

Conical Correspondent Analysis (CCA) showing the relationship between the environmental variables and monthly snails collected is presented in Figure 1. The figure shows that physicochemical parameters influence snails distribution monthly, though only conductivity influences snail distribution in March

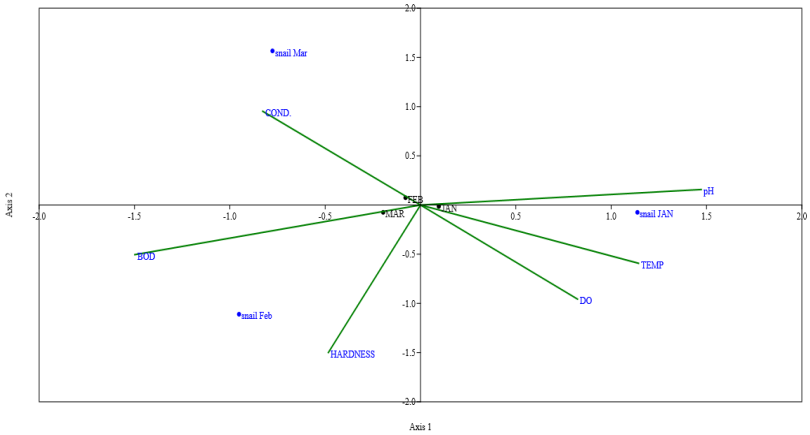

Figure 1: Conical Correspondent Analysis (CCA) showing the relationship between the environmental variables and monthly snails collected

DISCUSSION

The result of this study is an indication of the presence and abundance of snail species in the study area. The number of snail individual's species obtained in this study was lower than that recorded in other studies. For example, 681 individuals were recorded in Ngel-Nyaki forest reserve, Mambilla Plateau, Taraba State, Nigeria, (14), 872 individuals, 9 families, 15 genera and 25 species in Cebu, Philippines. The difference might be due to the month of June observed to have the highest number of snails might probably be the month with the most favorable condition of moisture, temperature and humidity as well as rainfall which favours their availability and abundance. Though, there was no significant difference ($P>0.05$) in their distribution between the sampling months. However, the species of land snails observed in this study are in line with those found in Northern Nigeria (8) and Southern Nigeria (12). Which could be due to factors like leaf litter and decaying dead wood / grasses that are also

involved (16). This was also in line with the findings of (6).

The low richness in abundance and diversity of snails in rice farm could be due to the influence of previous application of herbicide in the rice farm as well as period of collection, this agrees with the report of (15), who attributed the variations in the composition of species associated with rice agro-ecosystems in different places to be as a result of differences in climate and geographical characteristics of the locations where the studies were conducted, as well as, and the most important, the influences exerted by native natural areas surrounding different agronomic farming systems approach.

CONCLUSION

This present study highlights a significant risk of schistosomiasis due to the presence of potential snail vectors, particularly *Bulinus spp*., with the highest abundance in rice fields. Environmental factors such as water conductivity and hardness play a crucial role in snail distribution, with rice fields showing elevated levels that favour snail survival. Diversity indices reveal that vegetable farms exhibit higher species diversity and even distribution compared to rice fields, indicating varying environmental suitability across different farm types. The influence of environmental factors on snail distribution is substantial, explaining a significant proportion of variability.

Declaration

We hereby declared that this research work has not been publish elsewhere

Authors Contribution

AAM, SIM, DS and OIK conceptualized the study. AAM, SIM and DS designed the study. HOM, UAG, HUI, YI and UMD participated in fieldwork and data collection. AAM and SIM performed the data analysis; AAM and SIM interpreted the data. AAM prepared the first draft of the manuscript, reviewed by SIM and DS. All authors contributed to the development of the final manuscript and approved its submission.

REFERENCES

1. Bottieau, E., Clerinx, J., de-Vega, M.R., Van-den, E., Colebunders, R., Van-Esbroeck, M. (2006)."Imported Katayama fever: clinical and biological features at presentation and during treatment". *The Journal of Infection.* 52 (5): 339–45. doi:10.1016/j.jinf.2005.07.022 (https://doi.org/10.1016%2Fj.jinf.2005.07.022) . PMID 16169593 (https://pubmed.ncbi.nlm.nih.gov/16169593) .

2. Bishop, H.G. (2017). Menace of Schistosomiasis: Its true neglected nature in Nigeria. *MOJ Public Health* 6: 421-426.

3. Chitsulo L, Engels D, Montresor A. & Savioli L (2000). The global status of Schistosomiasis and its control. *Acta tropical journal,* 77: 41-51.

4. Colley, D.G., Bustinduy, A.L., Secor, W.E., & King, C.H. (2014). "Human Schistosomiasis" (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4672382). Lancet. 383 (9936): 2253–64. doi:10.1016/s0140-6736(13)61949-2 (https://doi.org/10.1016%2Fs0140-6736%2813%2961949-2) .

5. Ekpo, U.F, Laja-Deile, A., Oluwole, A.S., Sam-Wobo, S.O. & Mafiana, C.F. (2010). Urinary schistosomiasis among preschool children in a rural community near Abeokuta, Nigeria. *Parasite Vectors* 3: 58.

6. Elijah, M.I. (2023) A Survey of Snail Species Present In Biological Garden Of Federal Polytechnic Bali, Taraba State, Nigeria. A Paper presented at the 5th Annual National Conference, Federal polytechnic, Bali.

7. Global Network Neglected Tropical Diseases (2015) Government of Nigeria releases new data on the prevalence of schistosomiasis and intestinal worms. SABIN: Vaccine Institute, USA.

8. Gadzama, I.M.K. (2012). Distribution and taxonomy of molluscs (Molluscan) in some parts of Northern Nigeria. Ph.D. Thesis submitted to the Department of Biological Sciences, School of Post graduate Studies, Ahmadu bello university, Zaria, Nigeria, Pp. 118-124.

9. Ifeanyi, C.I.C., Matur, B.M., Ikeneche, N.F. (2009). Urinary Schistosomiasis and concomitant bacteriuria in the Federal Capital Territory Abuja Nigeria. New York *Science Journal* 2: 1-8.

10. Joseph, R.C., Adri, V. & Ben, O. (2008). Snail Farming in West Africa: A practical guide. Pp.1-78.

11. Olayemi, I.K., Ande,A.T.,Isah, B.& Idris, A.R. (2009).Epidemiology of malaria in relation to climatic variables in Minna, Nigeria. *African International Journal of Medical Sciences*, 2, 5-10.

12. Oke, C.O. & Omoregie, C.E (2012). Land Snail Species Richness in a Cocoa Agro-Forest In: Ile-Oluji, Ondo State, Nigeria. The Zoologist, 10:40-47.

13. Raut, S. K. & Barker, G. M. (2002). *Achatina fulica* Bowdich and other Achatinidae as pests in tropical agriculture. In: Barker, G. M. (ed.), Molluscs as Crop Pests, 55-114. New York: CAB International.

14. Ronald, W.I.A. & Walson, F. (2021). Species Richness and Diversity of Land Snails in Ngel-Nyaki Forest Reserve, Mambilla Plateau, Taraba State Nigeria. *International Journal of Scientific and Management Research*, 4(7), 88-102.

15. Salihu I.M., I.K. Olayemi, U.I. Hamza, I. Yahaya, U.G. Alhassan, A.M. Muhammad, D.A. Aliyu, Y. Garba, and M.D. Usman (2020). Abundance and Diversity Indices of Aestivating Insect in Rice-Field Soil Exposed to Different Agro-Chemical Practices in Minna Metropolis, Nigeria. *Lapai Journal Applied and Natural Science*, 5(1): 68-73.

16. Voichița, G., Ana, M.B. & Erika, S. (2021). Exploring land snails' response to habitat characteristics and their potential as bio-indicators of riparian forest quality. *Ecological Indicators*, 132:1-9.

17. WHO (2013) Schistosomiasis: Progress report 2001–2011, strategic plan 2012–2020 (https://www.who.int/iris/bitstream/10665/78074/1/9789241503174_eng.pdf). Geneva: World Health Organization.