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PREVALENCE OF SNAIL VECTORS OF SCHISTOSOMIASIS ALONG ANTAU RIVER, KEFFI, NASARAWA STATE

***BABANGIDA, S. M.; **RUKAIYA, H. A.; ***ABUBAKAR, B. S.; & ****MUHAMMAD, I. A.**

*Department of Biological Science.Kano State College of Education&Prelim. Studies.
**Department of Science Laboratory Technology, Nasarawa State University, Keffi.
***Department of Zoology, Nasarawa State University, Keffi. ****Department of Public Health, Institute of Global Health and Infectious Disease, Nasarawa State University Keffi

Corresponding Author:
sakinababangida@gmail.com

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Abstract

Schistosomiasis, or bilharzia, is a parasitic disease that affects over 230 million people worldwide, with 700 million at risk, primarily in tropical and subtropical regions, including Nigeria. The disease is transmitted through freshwater snails that host Schistosoma parasites. This study aims to understand the prevalence of snail vectors responsible for transmitting schistosomiasis along Antau River, Keffi, Nasarawas State. A snail sampling survey conducted at three locations - Saura Bridge, Antau Bridge, and Mannu Bridge - along Antau River yielded a total of 216 snails. The distribution showed Saura Bridge with the highest population (96

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snails, 44.4%), followed by Antau Bridge (81 snails, 37.5%) and Mannu Bridge (39 snails, 18.1%). Five snail species were identified, with Melanoides spp dominating (173 snails, 80.1%), followed by Anisus spp (28 snails, 13.0%), *Planorbarius spp* (11 snails, 5.1%), *Biomphalaria spp* (3 snails, 1.4%), and *Physa spp* (1 snail, 0.5%). *Biomphalaria spp*, a known schistosomiasis vector, had a high cercarial shedding rate (66.7%) near Antau Bridge, signaling a potential risk for disease transmission. Physico-chemical analysis revealed favorable snail habitat conditions, with a mean water temperature of 28.0°C, pH of 7.0, and dissolved oxygen ranging from 6.58 mg/L to 6.75 mg/L. The study concludes that while the overall risk of schistosomiasis transmission may be low due to the small population of *Biomphalaria spp*, targeted vector control measures are necessary, particularly around Antau Bridge, to prevent further transmission of schistosomiasis. Key recommendations include regular monitoring of snail populations, public health education, and targeted molluscicide to control the Biomphalaria spp population. The findings provide data for the development of control strategies aimed at reducing the burden of schistosomiasis in the region.

INTRODUCTION

Schistosomiasis, commonly referred to as bilharzia, is a parasitic disease caused by blood flukes of the genus Schistosoma (Vos *et al*., 2010; Colley *et al*., 2014). This disease is a pressing health issue worldwide, particularly in tropical and subtropical regions. The World Health Organization (WHO) estimates that over 230 million people are infected globally, with an additional 700 million at risk of infection (WHO, 2020). The impact of schistosomiasis extends beyond individual health, contributing to socio-economic burdens in affected communities. Schistosomiasis can lead to chronic health issues, including anemia, malnutrition, and growth stunting in children, as well as long-term complications such as liver damage and bladder cancer (Colley *et al*., 2014). The transmission of schistosomiasis is linked to freshwater snails, which serve as intermediate hosts for Schistosoma parasites

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(Akinwumi *et al*., 2020). These snail vectors are typically found in slow-moving freshwater bodies, including rivers, lakes, ponds, and irrigation channels, making these environments ideal habitats for their proliferation (Akinwumi *et al*., 2020). In Nigeria, schistosomiasis is widespread, with variations in prevalence across different regions due to environmental and socio-economic factors (Oladipo *et al*., 2020). Antau, located in Keffi, Nasarawa State, is situated in a region characterized by abundant freshwater bodies, including streams that can serve as habitats for snail vectors. The presence of these water sources, coupled with local agricultural practices that often rely on irrigation from these bodies, increases the likelihood of human exposure to Schistosoma cercariae. Additionally, the community's sanitation practices, including open defecation near water bodies, further contribute to the contamination of these freshwater sources with Schistosoma eggs, intensifying the risk of schistosomiasis transmission (Oladipo *et al*., 2020).

Understanding the prevalence of snail vectors is essential for developing effective control measures (Gryseels *et al*., 2006). However, limited studies have assessed the presence and distribution of these vectors in Nigeria, particularly in Keffi, Nasarawa State. Recent surveys in Nigeria have highlighted that areas with higher densities of Biomphalaria and Bulinus species correspond to increased rates of schistosomiasis among community members (Nwosu *et al*., 2020). This study aims to investigate the prevalence of snail vectors responsible for schistosomiasis transmission along Antau River, Keffi, Nasarawa State.

The research seeks to determine the prevalence of snail vectors of schistosomiasis along Antau River, Keffi, Nasarawa State. Specifically, the research objectives are to assess the prevalence of snails in riverine areas along Antau River, identify the diverse species of snails present in the study area, and analyze the physiochemical parameters of the water bodies in the study area, providing valuable insights into the ecological conditions conducive to snail vector proliferation and schistosomiasis transmission.

METHODOLOGY

Study Area

This study was conducted at Antau River, Keffi, Nasarawa State, Nigeria. Keffi, the administrative headquarters of Keffi Local Government Area, is

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approximately 58 kilometers from Abuja, the Federal Capital Territory, and 128 kilometers from Lafia, the state capital. Geographically, Keffi lies at 8°50′47″N latitude and 7°52′24″E longitude, at an altitude of 850 meters above sea level. The 2006 national census recorded Keffi's population as 92,664. Antau River, a vital water resource, supports various human activities, including bricklaying, washing, irrigation, and domestic chores, particularly in Angwan Dadin Kowa and around Federal Government College Keffi.

Sample Collection and Physicochemical Analysis

Sampling was conducted at three locations along Antau River, selected based on varying levels of human activity and environmental conditions: Gadan Mannu (Site A) with high human interaction, Antau Bridge near Federal Government College Keffi (Site B) with mechanical activities, and behind Keffi Township Stadium, Saura Road (Site C) with agricultural activities. Semiweekly water sampling occurred from July to September 2023, with three sampling points chosen at each site. Water samples were collected between 7:00 AM and 10:00 AM using clean, labeled 2-liter plastic bottles submerged 10-20 cm deep. Immediately after collection, samples were stored in cool, dark conditions and transported to the laboratory for analysis to preserve physicochemical properties and enable comparative analysis across sites with differing anthropogenic influences.

Determination of Physicochemical Parameters

Water temperature, a crucial factor in aquatic ecosystems, was measured using a mercury thermometer (0°C-100°C) following APHA (2012) guidelines. At each sampling point, the thermometer was submerged for 2-5 minutes to stabilize the reading. Measurements were taken in situ to ensure accurate representation of environmental conditions, minimizing external influences that could alter results during transport or analysis. This method captured temperature's impact on chemical reactions, nutrient availability, and aquatic organisms' metabolic rates.

pH Determination

The pH of water samples was measured using a calibrated Hanna 420 pH meter. Readings were taken in situ, immersing the electrode for 3-5 minutes, to accurately assess the water's suitability for aquatic life.

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Dissolved Oxygen (DO)

Dissolved oxygen (DO) levels were measured monthly using a JPB-607A portable DO analyzer, submerged for 3-5 minutes at each station, to assess water quality and capacity to support aquatic life, with low DO levels indicating potential organic pollution or poor water quality.

Turbidity

Turbidity, measuring water cloudiness/haziness, was assessed using a calibrated portable turbidity meter (SGZ-200BS). A 50 mL water sample was analyzed after settling, providing precise measurements. High turbidity can harm aquatic life by reducing light penetration, impacting photosynthesis, and affecting fish and invertebrates' survival.

Alkalinity

Alkalinity, the water's ability to neutralize acids, was measured using the HI 83200 Bench Photometer with Hi937755.0 reagent.

Electrical Conductivity (EC)

Electrical conductivity (EC) was measured using a calibrated Hanna 420 conductivity meter, submerged for 3-5 minutes, to assess water quality. EC indicates dissolved ions (salts, minerals, metals), with high values suggesting increased salinity or pollution.

Snail Collection Procedure

A snail collection study was conducted at three sampling locations along Antau River from June to August 2022 to assess mollusk diversity and abundance. Sampling occurred biweekly, using two methods: scooping with a long-handled net (three scoops per sample) and manual picking with forceps and gloved hands. Each 10-minute collection session targeted areas near vegetation. Collected snails were cleaned, counted, and stored in labeled bottles for transport to the laboratory. Species identification relied on morphological features, utilizing Brian Eversham's Identification Key (v2.2, 2013) and Flemming Frandsen's Practical Guide to African Freshwater Snails (1980), at three specific locations along the river.

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Direct Dissection and Microscopic Examination Method for Cercarial Isolation

After the morphological identification of the collected snail specimens, each snail was dissected through a method involving gentle crushing between two glass slides or by using forceps. This approach is designed to release the snail's digestive glands and tissue contents, which are the primary sites harboring cercariae. By employing this method, the cercariae are liberated into the surrounding fluid for direct observation. The released tissues and fluids are transferred into a petri dish containing clean water and subsequently examined under a microscope. The identification of *Schistosoma* cercariae relies on their distinct morphological features, notably the presence of a bifurcated tail, which is characteristic of this genus (Frandsen, 1980).

RESULTS

Prevalence of Snails along Antau River, Keffi, Nasarawa State

The 216 snails collected along Antau River is presented in Fig. 1, covering three primary sampling locations: Saura Bridge, Antau Bridge, and Mannu Bridge. The highest number of snails, **96 (44.4%),** were collected from Saura Bridge, followed by **81 (37.5%)** from Antau Bridge, and **39 (18.1%)** from Mannu Bridge. The Saura Bridge location, situated on the outskirts of Keffi and characterized by minimal environmental disturbance, exhibited a higher snail density and diversity compared to the other study sites.

Different Species of Snails in the Study Area

Five different species of snails were identified in the study, with ***Melanoides spp*** dominating the collection. As detailed in Table 1, a total of **173 (80.1%)** of the snails collected were Melanoides spp, while ***Anisus spp*** constituted **28 (13.0%)**, and ***Planorbarius spp*** accounted for **11 (5.1%)**. The least abundant species were ***Biomphalaria spp***, which is a known vector for schistosomes, and ***Physa spp***, with only 3 (1.4%) and 1 (0.5%) individuals collected, respectively.

Physico-Chemical Parameters of the Water Bodies

Physico-chemical characteristics of the water bodies were analyzed to understand the environmental conditions governing snail distribution, as summarized in Table 2. The water temperature ranged from **27.6°C to 28.4°C**,

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with a mean of **28.0°C.** The pH values ranged from **6.8 to 7.2**, indicating slightly neutral to mildly acidic water. Conductivity was measured between **0.08 to 0.12 µS/cm**, and the transparency of the water ranged from **18.9 cm to 24.7 cm.** The **chemical analysis** revealed the presence of nutrients such as phosphate, nitrate, and sulphate, with phosphate levels ranging between **0.13 to 0.15 mg/L**, nitrate between **1.08 to 1.32 mg/L**, and sulphate between **1.67 to 2.04 mg/L**. The **dissolved oxygen** levels ranged from **6.58 mg/L to 6.75 mg/L,** which is conducive to supporting aquatic life, including snails.

Isolation and Identification of Cercariae of Schistosomes from Snails Collected

The identification of cercariae of schistosomes, which are the larval forms of the parasite responsible for **schistosomiasis**, was conducted on snails collected from the three study sites. Cercarial shedding was investigated in 173 *Melanoides spp*, 3 Biomphalaria spp, and 1 *Physa spp*, with results presented in Table 3. Of these, only ***Biomphalaria spp*** were found to be shedding cercariae, with **2 out of 3 individuals** testing positive, giving a cercarial shedding rate of **66.7%.**

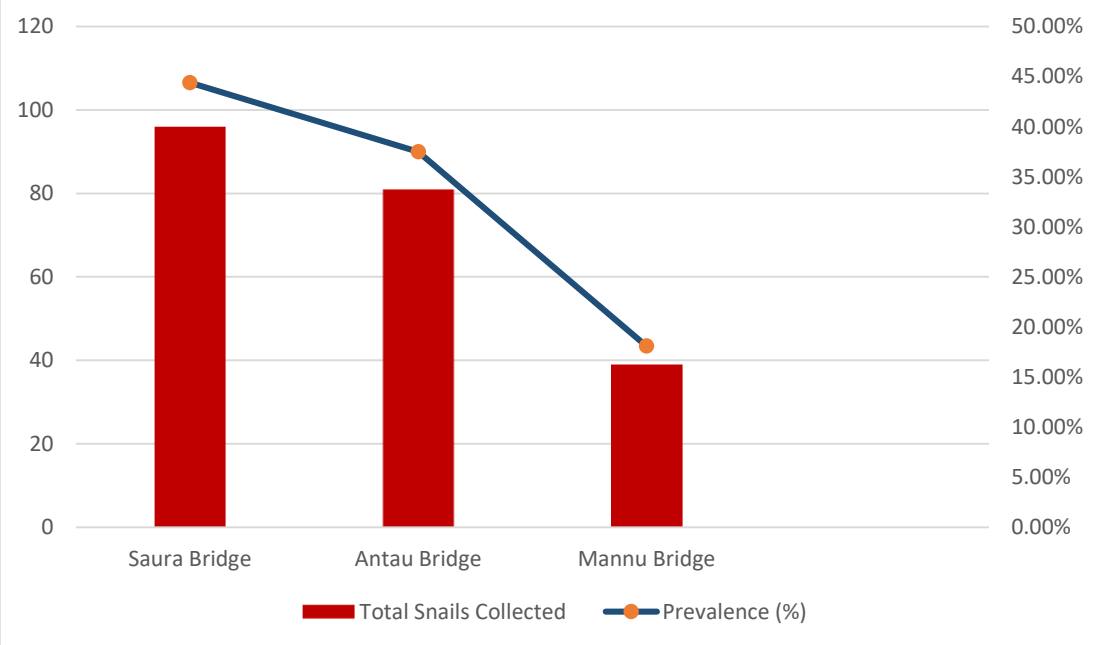


Fig. 1: Snail Prevalence Patterns in Antau River, Keffi, Nasarawa State

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Table 1: Different Species of Snails in the Study Area

Snail Species	Saura Bridge	Antau Bridge	Mannu Bridge	Total Collected	Prevalence (%)
Melanoides spp	86 (89.6%)	72 (88.9%)	15 (38.5%)	173	80.10%
Anisus spp	9 (9.4%)	10 (12.3%)	9 (23.1%)	28	13.00%
Planorbarius spp	0	1 (1.2%)	10 (25.6%)	11	5.10%
Biomphalaria spp (Schistosome Vector)	0	3 (3.7%)	0	3	1.40%
Physa spp	1 (1.0%)	0	0	1	0.50%

Table 2: Levels of Physico-Chemical Parameters Determined in the Water Bodies of the Study Area

Physical Parameters	Mean	Range
Water Temperature (°C)	28	27.6–28.4
pH	7	6.8–7.2
Conductivity (µS/cm)	0.1	0.08–0.12
Transparency (cm)	21.8	18.9–24.7
Chemical Parameters	Mean	Range
Phosphate (mg/L)	0.14	**0.13 – 0.15**
Nitrate (mg/L)	1.2	**1.08 – 1.32**
Sulphate (mg/L)	1.85	**1.67 – 2.04**
Dissolved Oxygen (mg/L)	6.68	6.58–6.75

Table 3: Isolation and Identification of Cercariae of Schistosomes from Snails Collected

Snail Species	Saura Bridge	Antau Bridge	Mannu Bridge	Total Collected	Cercarial Shedding Positive (%)
Melanoides spp	86	72	15	173	0%
Biomphalaria spp	0	3	0	3	2 (66.7%)

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Physa spp	1	0	0	1	0%

DISCUSSION, CONCLUSION, AND RECOMMENDATIONS

Discussion

A total of 216 snails were collected from three major riverine locations along Antau River, Keffi, Nasarawa State. Saura Bridge had the highest count, with 96 snails (44.4%), followed by Antau Bridge with 81 snails (37.5%), and Mannu Bridge with 39 snails (18.1%). Variation in populations across these sites is attributed to environmental factors such as water quality, vegetation cover, and human activity. Areas with slow-moving water and abundant vegetation, like Saura Bridge, provide better conditions for snail breeding. These findings align with studies in Kano State, Nigeria, which noted higher snail populations in favorable environmental conditions (Eze *et al*., 2020). The lower count at Mannu Bridge suggests less favorable conditions, possibly due to human disturbance or changes in water flow. Similar low populations were reported in Southwest Nigeria in areas with rapid water movement and greater human activity (Adewumi *et al*., 2016). Among the snail species, Melanoides spp. was the most dominant, accounting for 80.1% of the total collected. *Anisus spp*. made up 13.0%, *Planorbarius spp*. at 5.1%, and Biomphalaria spp. and Physa spp. contributed 1.4% and 0.5%, respectively. The dominance of Melanoides spp. is consistent with findings from Keffi and other parts of Nigeria (Eze *et al*., 2020; Banyigyi *et al*., 2022). Melanoides spp. thrives in neutral to slightly acidic pH levels and stable temperatures. In contrast, Biomphalaria spp. was found in low numbers, especially at Antau Bridge, where only three were collected. This low prevalence contrasts with higher populations reported in Benue State, Nigeria (Bassey *et al*., 2018). Variations in water chemistry may explain the differences, as Biomphalaria spp. prefers neutral to slightly alkaline pH levels, while the average pH in the study area was 6.4. The physico-chemical parameters of the water bodies showed mean temperature at 28.0°C, pH at 7.0, conductivity at 0.10 µS/cm, and transparency at 21.8 cm. The chemical analysis indicated phosphate levels of 0.14 mg/L, nitrate levels of 1.20 mg/L, and sulphate levels of 1.85 mg/L, indicating nutrient-rich water that supports algae growth, which benefits snails. These conditions resemble those in a study at the Kpong Head Pond in Ghana (Yirenya-Tawiah *et al*., 2011). The presence of nutrients supports aquatic vegetation, which provides food and shelter for snails (Adewumi *et al*.,

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2016). Notably, dissolved oxygen levels (mean: 6.68 mg/L) were higher than in some regions of Southwest Nigeria, where lower levels (around 4.0 mg/L) were linked to reduced snail populations (Eze *et al*., 2020). Higher oxygen levels may have contributed to increased snail abundance. Cercarial shedding was observed only in Biomphalaria spp., with a 66.7% shedding rate (2 out of 3 snails). This is notable as Biomphalaria spp. is the primary vector for schistosomiasis. The high shedding rate suggests a potential risk for transmission, particularly near Antau Bridge. This finding aligns with studies in Benue State and Kano State, which also reported high cercarial shedding rates (Bassey *et al*., 2018). However, the overall low population of Biomphalaria spp. suggests that the risk may be localized and dependent on specific environmental conditions. The absence of cercarial shedding in Melanoides spp. and Physa spp. is consistent with findings across Nigeria, confirming that these species are not vectors for schistosomiasis (Olalekan *et al*., 2021).

Conclusion

The study revealed a high prevalence of snails, particularly at Saura Bridge, where 44.4% of the total snails were collected. The distribution of snails varied across three riverine locations, with Mannu Bridge having the lowest snail count, linked to environmental conditions such as water quality and vegetation cover. Five snail species were identified, with Melanoides spp being the most dominant at 80.1% prevalence, while Biomphalaria spp, a known vector of schistosomiasis, was present in smaller numbers (1.4%). Physico-chemical parameters, including temperature (28.0°C), pH (7.0), dissolved oxygen (6.68 mg/L), phosphate (0.14 mg/L), nitrate (1.20 mg/L), and sulphate (1.85 mg/L), supported snail habitation. Additionally, Biomphalaria spp showed cercarial shedding with a 66.7% shedding rate, indicating potential schistosomiasis transmission near Antau Bridge, whereas other species like *Melanoides spp* and *Physa spp* did not shed cercariae, consistent with their non-vector status.

Recommendations

To manage snail prevalence and prevent schistosomiasis transmission along Antau River, recommendations include; regular monitoring and surveillance of snail populations, especially in high-prevalence areas like Saura Bridge (44.4%);

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habitat modification, such as clearing vegetation and altering water flow; and targeted mollusciciding programs, especially in Antau Bridge where Biomphalaria spp (1.4%) was found. Public health education is necessary for individuals engaging in high-risk activities near Antau Bridge. Authorities should implement water quality improvement initiatives, reducing nutrient pollution from agricultural runoff, and enforce environmental regulations regarding waste disposal and agricultural management. Regular health screening and treatment for schistosomiasis should be conducted in nearby communities, with anti-schistosomal treatment provided to positive cases. An Integrated Vector Management (IVM) strategy combining environmental management, chemical control, and biological control should be adopted to manage snail populations and prevent transmission, focusing on areas with favorable physico-chemical parameters (temperature: 28.0°C, pH: 7.0, dissolved oxygen: 6.68 mg/L, phosphate: 0.14 mg/L, nitrate: 1.20 mg/L, sulphate: 1.85 mg/L).

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