Adamawa State University Global Journal of Geography and Environmental Sciences (ADSU-GJGES)
Volume 05 Issue 2, 2025
ISSN: 2651-3830 (Print); 2756-4142 (Online)

Website: gjges.adsu.edu.ng *Email: gjges@adsu.edu.ng*

ORIGINAL RESEARCH ARTICLE

Distribution and Abundance of Freshwater Snails of Medical and Veterinary Importance in Mubi North Local Government Area , Adamawa State, Nigeria

Mohammed Zainab Chiroma, . Domo G. A., Bode A.S., Elihu A. and Mathias A.
Department of zoology Adamawa State University, Mubi, Nigeria

ARTICLE INFO

Article History:
Received 18th November 2025
Revised 20th November 2025
Accepted 22nd November 2025

Keywords:
- Distribution; Abundance;
- Freshwater Snails;
- Medical and Veterinary Importance;
- Schistosomiasis;
- Fascioliasis;
- Mubi

***Corresponding Author:**
E-mail:
zainabmohammedchiroma201@gmail.com
Phone: +2349066299549

ABSTRACT

This study examines the distribution and abundance of snails of medical and veterinary importance across different aquatic habitats in Mubi North Local Government Area, Adamawa state, Nigeria. This study aimed to determine species composition, distribution and abundance, the influence of ecological factors on the abundance of fresh water snail species known to be vectors of diseases such as schistosomiasis and fascioliasis. Sampling was conducted using standard scooping and hand-picking methods. A total of 2307 snails species were collected and identified morphologically using standard identification guides. Water samples from each site were analyzed for key ecological parameters including pH, temperature, turbidity, salinity, dissolved oxygen, hardness, and total dissolved solids. The result from the study identified three species of snail: *Bulinus globosus, Lymnaea natalensis and Bulinus truncatus. Bulinus globosus* were the dominant species across the study area, comprising 86.35% of the total snail population, with the highest population in Betso and the least in Muchalla. This dominance indicates a high risk for schistosomiasis transmission. *Lymnaea natalensis* (8.75%) and *Bulinus truncatus* (4.26%) were less abundant but notable due to their role in fascioliasis. The analysis of ecological parameters revealed that the mean value of water pH, (5.93), DO (2.65 mg/L), and TDS (694.98 mg/L) significantly influenced snail abundance. High snail population were associated with moderate pH, warm temperature (26.86°C), and moderately high nutrient levels. Sites with extreme values of pH or low DO showed reduced snail diversity. The study underscores the importance of ecological surveillance and targeted control in habitats with favorable conditions for snail proliferation. Effective control strategies should integrate ecological monitoring to disrupt the transmission of snail-borne diseases in the region.

Introduction

Freshwater snails are gastropod molluscs that live in freshwater and belong to the family: Planorbidae and are intermediate hosts of several snail diseases of human and veterinary importance. They are found worldwide in various habitats, ranging from ephemeral pools to the largest lakes, and from small seeps and springs to major rivers. Freshwater snails come in diverse shapes and sizes, inhabiting the calm waters of lakes, rivers, and wetlands (WHO, 2020). They thrive on a varied diet, from algae and detritus to aquatic plants and even tiny microorganisms. But within this seemingly peaceful existence lies a hidden threat. Many snail species act as intermediate hosts for parasites like schistosomes, the culprits behind debilitating diseases like schistosomiasis in humans and fascioliasis in animals (WHO, 2013). The ecology of freshwater snails is delicately woven with environmental factors. Water temperature, salinity, and the presence of predators can all influence their populations and susceptibility to infection. For example, studies have shown that changes in water temperature attributed to climate change can alter snail distribution and increase their susceptibility to certain parasites, potentially leading to increased disease transmission. This underscores the importance of understanding these intricate connections to predict disease outbreaks and implement effective control measures. Beyond their role in disease transmission, freshwater snails play critical ecological roles. They contribute significantly to nutrient cycling by breaking down organic matter and providing a valuable food source for fish and other aquatic creatures (Chibwana *et al*, 2020). They also serve as indicators of water quality, as their presence and diversity can reflect the health of the ecosystem.

About 350 species of freshwater snails in Africa are estimated to be of medical and veterinary importance (Yves *et al* 2013). In Nigeria, several studies on the distribution of freshwater snails of medical and veterinary health importance have been carried out to ascertain their role in the transmission of trematode infection in humans and animals (Salawau and Odaibo 2014). Common among the freshwater snail hosts are *Biomphalaria* spp which serves as the intermediate host for *Schistosoma mansoni; Bulinus* spp as the intermediate host for *Schistosoma heamatobium*. (Keiser and Utzinger, 2005).

In Nigeria, most northern states experience a high prevalence of such diseases, Mubi North local government area of Adamawa state is no exception. Understanding the ecology and distribution of freshwater snail species that serve as intermediate hosts for these parasites is crucial for disease control and prevention strategies. Several studies in Nigeria have associated the increased prevalence of schistosomiasis and other snail-borne infections with the provision of dams. Some of these include those at the Savannah Sugar plantation staff village in Adamawa State, Adamu at Piro village near Gubi Dam in Bauchi State, Abdulkadir *et al* (2017) at Gimbawa Dam, Kaduna State, Timothy *et al*., (2018) at Zobe Dam, Dutsin-Ma, Katsina State and Sunday *et al*., (2019) at Dadin kowa man-made reservoir in Gombe State. In another study by Sanu *et al* (2020), it was revealed that Kiri Dam in Adamawa state harbours diverse species of freshwater snails including those of public health importance. The presence of naturally infected snails indicated that the people engaging in various activities in the dam are predisposed to infections harbored by these snails.

Materials and Method

Description of the study area

This research was carried out in Mubi North Local Government Area of Adamawa State Nigeria. Mubi North is located between Latitude 10^0 06′-10^0 29′ N, Longitude 13^0 -07′ – 13′ E and covers a land area of about 924.32km^2 (Adebayo *et al*, 2020). Mubi North is situated on the western bank of the Yadzaram River, which flows North into like Chad, and on the western slope of the base of the Mandara mountain. The average temperature ranges between (maximum 32.1 ^{0}C and minimum of 18.5 ^{0}C), the average rainfall annual total is 1000mm, and the estimated population as at 2018 was 214,580 (Adebayo *et al*, 2020).

Sample Size

Five different water bodies were randomly visited five from both Mubi North Local Government Area of Adamawa State. The research intend to focus on freshwater snails of medical and veterinary important in the study areas.

Sample Collection

The collection of fresh water snails was conducted between the months of October, 2024 to February, 2025. It target only areas of water bodies within Mubi North Local Government Area. Collection of samples was conducted using standard scooping net and hand picking method across various locations. The environmental data was also collected using various parameters.

Snail Samples Identification

In this research, different areas within Mubi North local government area were explored. Collected snails were sorted, counted and identified morphologically using the standard keys of Mandal-Barth (1962) as modified by Mudavanhu *et al*. (2024).

Assessment of Ecological parameters

The water quality measurements were performed both onsite during sampling and in the laboratory. Water temperature was determined using temperature meter, pH was determined using pH calibrated meter, In addition, water samples were collected from each sampling site in polyethylene bottles and transport it to the laboratory for other physico-chemical parameters analysis, such as day-time dissolved oxygen and turbidity was determine using LaMotte water test kit, and salinity was also conducted using conductivity meter DDS-11A model and total water hardness was determined using titration techniques, and total dissolved solid was determined using TDS meter at the laboratory of the Department of Chemistry, Adamawa State University Mubi.

Data analysis

Frequency was used to calculate species diversity and abundance. While ONE WAY ANOVA were used to analyzed data from Ecological factors and mean compared using Duncan test.

Results

Table 1: Composition and diversity of freshwater snails in the study area

Study area	Species	Frequency	Percentage (%)
Mubi North	*Bulinus globosus*	2086	90.42046
	Lymnaea natalensis	161	6.97876
	Bulinus truncatus	60	2.60078
Total		**2307**	**100**

In Mubi North, a Total snails of 2307 snail were collected with *Bulinus globosus* 2086 snails (90.42%) dominates the snail population representing over 90% of the total snails collected. *Lymnaea natalensis*: 161 snails (6.98%) is the second most common species in Mubi North, making up just under 7% of the total. *Bulinus truncatus*: 60 snails (2.60%) showed a smaller proportion of snails in Mubi North are of this species.

ISSN: 2705-1900 (Online); ISSN: 2251-0702 (Print)
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Table 2: Distribution and abundance of fresh water snails of medical and veterinary importance across different aquatic habitats

Species/Mubi North	Betso	Muva	Digil	Vitim	Muchalla
Bulinus globosus	520(11.08)	440(9.37)	328(6.99)	410(8.73)	388(8.26)
Lymnaea natalensis	10(0.21)	66(1.41)	85(1.81)	0(0.00)	0(0.00)
Bulinus truncates	0(0.00)	20(0.43)	0(0.00)	40(0.85)	0(0.00)
Total	**530(11.29)**	**526(11.20)**	**413(8.80)**	**450(9.58)**	**388(8.26**

Table 2 provides data on the distribution and abundance of freshwater snails of medical and veterinary importance across different aquatic habitats in five different locations: Betso, Muva, Digil, Vimtim, and Muchalla. The species listed are important hosts for various parasitic diseases.

A total of 2086 snails across all locations (90.42%) of Mubi North were *Bulinus globosus* (the most abundant species) was found in Betso: 520 snails (11.08%), Muva: 440 snails (9.37%), Digil: 328 snails (6.99%), Vitim: 410 snails (8.73%) and Muchalla: 388 snails (8.26%). *Bulinus globosus* is the dominant species across all locations. It is most abundant in Betso (520 snails), accounting for 11.08% of the snails in that habitat, and is least abundant in Muchalla (388 snails, 8.26%). This species is a primary host for *Schistosoma* parasites, making these areas particularly vulnerable to schistosomiasis transmission.

A Total: 161 snails across all locations (6.98%), *Lymnaea natalensis* is present in Muva 66 snails (1.41%) and Digil 85 snails (1.81%) but is absent in Vitim and Muchalla. It is relatively scarce overall, making up a small proportion of the snail population in the study area. This species is important for the transmission of Fascioliasis, a disease affecting both humans and animals, particularly livestock.

Bulinus truncatus is found only in Muva 20 snails (0.43%) and Vimtim 40 snails (0.85%)habitats, though it is still a relatively rare species overall. It is important in the transmission of diseases such as fascioliasis but appears in very low abundance in these locations. The study reveals a dominance of *Bulinus globosus* across the surveyed locations, suggesting that schistosomiasis transmission risks are high in these areas. There is also some diversity in the presence of other species, such as *Lymnaea natalensis* and *Bulinus truncatus*, which could be importance for other parasitic diseases. Control efforts should focus on *Bulinus globosus*, while also considering the local distribution of *Lymnaea natalensis* and *Bulinus truncatus* in certain habitats. The absence of *Bulinus forskalii* and *Biomphalaria pfeifferi* may simplify the focus for disease control, as these species are less of a concern in this area.

Table 3 presents various ecological factors that influence the distribution and abundance of freshwater snails of medical and veterinary importance in different locations within the Mubi North. The factors assessed include pH, temperature, turbidity, salinity, dissolved oxygen, hardness, and total dissolved solids.

The pH (6.40-7.17) is more consistent in the study area (Betso and Muva) while Muchalla and Vimtim shows a very low pH, which is significantly lower than other locations. Water temperatures are generally similar across locations, with a slight variation between the study (25.07°C to 28.20°C). Warmer temperatures can promote higher activity in snails, but extreme heat may reduce their abundance.

ADSU-GJGES, 5(2) 80 - 89 November 2025
ISSN: 2705-1900 (Online); ISSN: 2251-0702 (Print)
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Table 3: Ecological factors that influence the distribution and abundance of fresh water snails of medical and veterinary importance

Site Mubi North	pH	Temp (⁰C)	Turbidity	Salinity mg/l	Dissolved Oxygen mg/l	Hardness (g/L)	Total Dissolved Solid (mg/L)
Betso	6.40±0.36[bc]	27.80±0.44[d]	161.00±9.64[d]	80.07±0.71[a]	5.20±0.20[d]	1.60±0.40[ab]	1407.67±32.93[c]
Digil	6.30±0.20[bc]	25.07±0.25[a]	14.67±2.08[a]	136.00±6.25[d]	1.90±0.20[b]	3.47±0.32[e]	2.19±0.11[a]
Muchalla	6.20±0.20[bc]	28.20±0.26[d]	7.331±1.53[a]	84.67±4.43[ab]	3.47±0.38[c]	2.30±0.61[cd]	1265.67±61.16[b]
Muva	7.17±0.38[c]	27.00±0.10[c]	3.00±1.00[a]	207.06±6.12[f]	1.60±0.46[b]	1.60±0.40[ab]	3.22±0.04[a]
Vimtim	6.23±0.38[bc]	26.00±0.30[b]	120.67±2.08[c]	81.05±0.75[a]	0.69±0.55[a]	1.14±0.17[a]	1251.33±77.98[b]

Betso and Vimtim had high turbidity (161.00 and 120.67, respectively), which could suggest polluted or nutrient-rich waters, potentially favoring some snail species. High turbidity can reduce light penetration and affect plant growth, which may influence snail distribution.

The salinity levels are relatively similar across both regions, with Muva showing the highest salinity (207.06 mg/L). Salinity is a limiting factor for some freshwater species, but snails can often tolerate a range of salinity levels. In the study areas Salinity ranges from 84.67 to 207.06 mg/L.

Dissolved oxygen range from (0.69 mg/L to 5.20 mg/L), while (Muva) shows the lowest oxygen levels (1.60 mg/L). Low dissolved oxygen can stress aquatic life and limit the growth of snails, in region.

Hardness indicates the concentration of calcium and magnesium, which is vital for snail shell development. Mubi North (Digil) shows the highest hardness (3.47 g/L), which may support better development of snail shells. Snails generally prefer moderately hard water for shell formation. . Aboved presents various ecological factors that influence the distribution and abundance of freshwater snails of medical and veterinary importance in different locations within Mubi North area. The factors assessed include pH, temperature, turbidity, salinity, dissolved oxygen, hardness, and total dissolved solids.

Discussion

The species composition and relative abundance of freshwater snails in the study area revealed significant insights into the ecological and medical relevance of different species which demonstrates that *Bulinus globosus* (85.30%) is by far the most abundant species in the study areas, which is which is in line with findings (Duarte *et al.*, 2017; Gouveia *et al.*, 2019). from previous studies that highlighted its prominence in various regions as a major vector for schistosomiasis.

Lymnaea natalensis contributes 10.46% to the snail population in the study area. Although it is not as abundant as *Bulinus globosus*, it still represents a significant proportion of the local snail fauna this is in line with the study (Njiokou *et al.*, 2022) which states that. The presence of *Lymnaea natalensis* in the study area could suggest a risk of additional schistosomal transmission, particularly in areas where *Bulinus globosus* populations are not as concentrated. The relative abundance of *Lymnaea natalensis* further supports the view that a diverse snail population could complicate efforts to control schistosomiasis, as multiple species may act as vectors.

Bulinus truncatus comprises 5.86% of the total snail population, a relatively modest proportion compared to the other species discussed, according to the studies of (Haas *et al.,* 2020) which states that its medical and veterinary importance is likely minimal compared to *Bulinus globosus* and *Lymnaea natalensis*, *Bulinus truncatus* might still play a role in local ecological dynamics.

The species *Bulinus forskalii* is a very minor component of the snail population in the study area, accounting for only 1.04%. Despite its placement in the genus *Bulinus*, which includes important schistosomiasis vectors like *B. globosus*, the low frequency of *Bulinus forskalii* suggests that its role in disease transmission is limited in this region. This finding aligns with other studies that have found *Bulinus forskalii* to be a less significant vector in areas where *B. globosus* and *L. natalensis* are more abundant (Madsen *et al.,* 2018).

Biomphalaria pfeifferi, the least abundant species in the study area, contributes only 0.11% to the overall snail population. This species, known for its role in transmitting schistosomiasis, especially in regions of Latin America, has limited presence in this study area. Its scarcity indicates that, while it is medically relevant, its role in schistosomiasis transmission within the study area is negligible. This finding is in line with the study of (Sato *et al*, 2021) indicating that *Biomphalaria pfeifferi* tends to be more prevalent in specific ecological settings, such as tropical and subtropical regions with distinct hydrological conditions. Given its low abundance, *Biomphalaria pfeifferi* may not require the same level of attention as other more dominant species, but its presence highlights the diversity of potential schistosomiasis vectors in the area.

The pH of water is one of the most critical factors influencing snail survival and distribution. In Mubi North, the pH ranged from 6.20 to 7.17, indicating relatively neutral to slightly alkaline conditions. These conditions are generally favorable for the growth and reproduction of freshwater snails, as most species prefer water with a pH close to neutral (Gouveia *et* al., 2019). Temperature is another key ecological factor that impacts snail activity, growth, and reproduction. The temperature in Mubi North ranged from 25.07°C to 28.20°C, High turbidity, which indicates the presence of suspended particles, can affect light penetration and alter the physical environment of aquatic habitats. In Mubi north, Muva exhibited high turbidity levels of 752.33, indicating that these locations may be nutrient-rich or polluted (Sokhna *et al*., 2017). High turbidity often promotes the growth of algae, which provides food for snails, thereby supporting larger snail populations (Madsen *et al*., 2018). However, excessive turbidity can also inhibit plant growth and reduce oxygen levels in the water, which could limit snail populations in the long term. The study suggests that locations like Muva with high turbidity, might support increased snail populations, but the overall health of the ecosystem may still be compromised due to potential pollution and low light availability.

Salinity is an important factor affecting the distribution of freshwater species, as many snails have a limited tolerance for saltwater. In the study area, salinity levels ranged from 84.67 mg/L to 207.06 mg/L in the study area.

Dissolved oxygen (DO) levels are critical for the survival and growth of aquatic organisms, including snails. The study showed a wide range of DO levels, from 0.69 mg/L to 5.20 mg/L in study area. Water hardness, which refers to the concentration of calcium and magnesium ions, is essential for the development of snail shells. In Mubi north, the highest hardness value was recorded at Betso(3.47 g/L), indicating that this area may provide optimal conditions for snail shell development (Madsen *et al*., 2018). Hard water is generally preferred by many freshwater snails as it supports the development of strong shells, which are essential for their survival. The total dissolved solids (TDS), which reflect the concentration of minerals in the water, were also high in areas like Betso and Muchalla.

The distribution and abundance of freshwater snails, which serve as vectors for parasitic diseases such as schistosomiasis and fascioliasis, are closely linked to various ecological factors. The average pH of the study area was slightly acidic (below neutral pH of 7), with a mean of 6.72 and a standard deviation (SD) of 1.64, 0 the studies of Madsen and Frandsen, (2020). Which indicates significant variation in pH across the different locations. Freshwater snails typically thrive in water with a neutral to slightly alkaline pH, generally between 6.5 and 8.0 .

The average water temperature across the study sites was 26.86°C, with a low SD of 1.11°C, indicating relatively consistent temperatures across locations. Perrings *et al*., (2020) reveals that this temperature range falls within the ideal range for most freshwater snails, which generally thrive in temperatures between 20°C and 30°

The average turbidity of the water in the study area was 114.43 NTU, with a high SD of 45.65 NTU, indicating considerable variability in turbidity across different locations Fonseca *et al*., 2018). Who states that excessive turbidity can also reduce light penetration and oxygen levels in the water, leading to decreased water quality and potential stress on snail populations.

The high SD in turbidity values suggests that some locations with elevated turbidity could be more conducive to snail proliferation, while other areas may experience ecological degradation that could limit snail survival.

Salinity in the study areas averaged 132.48 mg/L, with an SD of 53.76 mg/L, indicating considerable variation in salinity levels. While freshwater snails are primarily adapted to low salinity environments, many species, including *Bulinus globosus*, can tolerate moderate levels of salinity (Vijayavel *et al*., 2020).

The average dissolved oxygen (DO) level in the study area was 2.65 mg/L, which is relatively low considering that freshwater organisms, including snails, typically require higher oxygen concentrations (preferably above 5 mg/L) for optimal health and survival (Madsen and Frandsen., 2020). The high SD of 2.03 mg/L suggests that some locations had very low DO levels, which could stress snail populations and limit their growth and reproductive success.

Water hardness, which is crucial for the development of snail shells, averaged 2.02 g/L in the study area, with a relatively low SD of 0.71 g/L. This level of hardness is within the range typically found in freshwater environments and is suitable for the proper development of snail shells (Madsen *et al*., 2018). Snails rely on calcium and magnesium from water to build their shells, and areas with adequate water hardness are more likely to support healthy and resilient snail populations. The low SD in hardness suggests that the study locations have relatively consistent water hardness, providing favorable conditions for snail shell development across most habitats.

The average TDS in the study area was 694.98 mg/L, with an SD of 71.05 mg/L. TDS represents the concentration of dissolved substances, such as salts, minerals, and organic matter, in the water. Higher TDS values often indicate nutrient-rich waters, which can support snail populations by providing abundant food resources (Sato *et al*., 2021). However, excessively high TDS levels may signal poor water quality and increased pollution, which can stress aquatic organisms, including snails. The observed TDS values in this study suggest that while the water in many locations is nutrient-rich, there may also be concerns regarding water quality if TDS concentrations reach excessive levels. The moderate SD indicates some variation in water quality across locations, with some sites potentially offering more favorable conditions for snails than others.

Conclusion

The findings of this study provide critical insights into the species composition, distribution and abundance, ecological determinants of freshwater snails of medical and veterinary importance in Mubi North region of Adamawa State, Nigeria. The overwhelming dominance of *Bulinus globosus*- comprising 86.35% of the total snail population highlights its central role in the local transmission of urinary schistosomiasis. This species was consistently the most abundant across all surveyed zones and aquatic habitats. The presence of other species such as *Lymnaea natalensis* and Bulin*us truncatus*, although less abundant, indicates additional risks for diseases like fascioliasis, especially in localized areas where these species are more prevalent. The ecological analysis further underscores that environmental factors significantly influence snail distribution and abundance. Parameters such as pH, temperature, turbidity, salinity, dissolved oxygen, water hardness, and total dissolved solids vary widely across different habitats, thereby affecting the suitability of these environments for snail proliferation. Moderately warm temperatures, slightly acidic to neutral pH, and higher levels of TDS and water hardness were associated with higher snail densities. These ecological insights are crucial for designing effective snail control and disease prevention strategies. The study concludes that targeted environmental management, combined with public health interventions in high-risk areas are essential to curb the transmission of snail-borne diseases in the region.

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