

Species Richness Assessment of Aquatic Snails in Donga River, Taraba State, Nigeria

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ABSTRACT

River Donga is one of the fresh water rivers that is located in Taraba State. Its ecological status was assessed using aquatic snails and its physicochemical parameters. This study examined the species composition, distribution, and ecological implications of freshwater snails in the Donga River, Taraba State, alongside an analysis of key physicochemical water parameters. A field-based ecological survey was conducted using a stratified random sampling approach and a total sample of 223 snails were collected in January and February, 2025 from quadrats (1m²) placed along the riverbank and shallow water area. Standardized hand-picking and scooping methods were employed for the collection, with snails identified using the Brian Eversham identification key. Five snail species from four families were identified, with *Melanoides tuberculata* being the most abundant (53.7%), followed by *Bulinus globosus* (30.0%) and *Biomphalaria* spp. (16.3%). Species diversity indices indicated moderate richness of value 0.853 in January and 0.845 in the month of February and evenness with values 0.775 and 0.796 for the months of January and February respectively, with Shannon-Weiner Index values of 1.247 in January and 1.282 in February. Physicochemical analysis showed that all parameters were within WHO and SON guidelines, except dissolved oxygen, which was below the recommended range (3.68–4.31 mg/L). PH (6.90–7.10), temperature (26.50–26.90°C), turbidity (1.03–1.25 NTU), conductivity (11.50–15.2bn3 μS/m), and total dissolved solids (31.30–31.80 mg/L) were within acceptable limits. These findings suggest that while the water quality supports snail populations, low dissolved oxygen levels may pose a risk, highlighting the need for continued ecological monitoring.

Keywords: Aquatic snails, Ecological Assessment, Physiochemical, WHO and SON guidelines.

INTRODUCTION

Aquatic freshwater snails live across various water environments while playing essential roles in maintaining ecological stability in these habitats. Gastropods enhance water quality through their feeding activities which involves consumption of algae and organic materials and decomposed detritus (Preston *et al.*, 2022). Freshwater habitats depend on freshwater snails since they act as essential food resources for aquatic organisms such as fish, amphibians, birds and mammals (Gurarie *et al.*, 2018).

Freshwater snails maintain vital importance in ecosystems though they present significant health risks because they serve as host intermediaries for parasitic infections

which lead to the development of schistosomiasis, fascioliasis and paragonimiasis. The parasitic disease schistosomiasis continues to impact human health worldwide especially in tropical regions mainly because the freshwater bodies serve as perfect conditions for the vector-snail life cycle (Mutuku, *et al.*, 2020).

Human-caused transformations of natural freshwater settings through activities including agriculture and deforestation along with pollution and climate change affect both diversity and abundance of snail populations. Snails multiply more efficiently because agricultural activities produce eutrophic environments which promote the growth of their food resources (Adekiya *et al.*, 2020).

Freshwater snails are integral components of aquatic ecosystems, yet their ecological roles are often overlooked. In many freshwater bodies, including the Donga River, snails contribute to nutrient recycling, food web stability, and ecosystem health. However, they are also vectors of debilitating parasitic diseases, posing significant public health threats. Despite these dual roles, there is a lack of comprehensive studies on their population dynamics, diversity and distribution in the Donga River.

The increasing anthropogenic pressures on the Donga River, such as pollution, land-use changes, and climate variability, may be altering the composition and abundance of freshwater snail populations. The absence of up-to-date ecological assessments hinders effective management strategies to mitigate potential outbreaks of snail-borne diseases and ensure the conservation of biodiversity in the river.

The Donga River, a significant freshwater body in Taraba State, supports diverse aquatic life, including freshwater snails. However, comprehensive studies on the population dynamics and ecological significance of these gastropods in the river remain scarce. Understanding the distribution, diversity, and abundance of freshwater snails in the Donga River is essential for informing conservation strategies, controlling disease vectors, and maintaining ecosystem balance. This study helped to fill this knowledge gap by investigating the ecological characteristics of freshwater snails in Donga River, providing insights into their population structure and environmental determinants.

The focus of the work was to assess the abundance, diversity, and ecological distribution of freshwater snails in Donga River, Taraba State, Nigeria by determining the species composition and diversity of freshwater snails in the Donga River and also assessed the abundance and distribution of freshwater snails in relation to physicochemical water parameters.

MATERIALS AND METHODS

Study Area

The study was conducted in Donga River, Taraba State, Nigeria. The river which originates from the Adamawa Plateau in Cameroon, serves as a vital resource for agriculture, fishing, and domestic use. It lies between latitude 7°N and longitude 10°E and flows into the Benue River near Ibbi. The region has a tropical climate, characterized by a distinct wet and dry season, with an average temperature of 32°C. The river supports savanna vegetation with riparian forests, providing habitat for diverse aquatic life. During the rainy season (May to October), the river overflows, expanding its reach and replenishing surrounding farmlands, while in the dry season (November to April), the water levels decline, making the river more accessible for economic activities such as fishing, irrigation, and sand mining.

The Donga River plays a crucial role in the livelihoods of the surrounding communities, providing water for farming, transportation, and local trade. The river's seasonal fluctuations influence activities, with peak water levels occurring in September and gradually receding until the next rainy season. Many farmers depend on the river for dry-season rice and vegetable farming, while fishing remains a key occupation for locals. Additionally, the river serves as a site for domestic activities such as washing, bathing, and food processing, especially during the dry months. However, challenges such as deforestation, sand mining, and pollution threaten the sustainability of the river, necessitating better conservation efforts to maintain its ecological and economic importance.

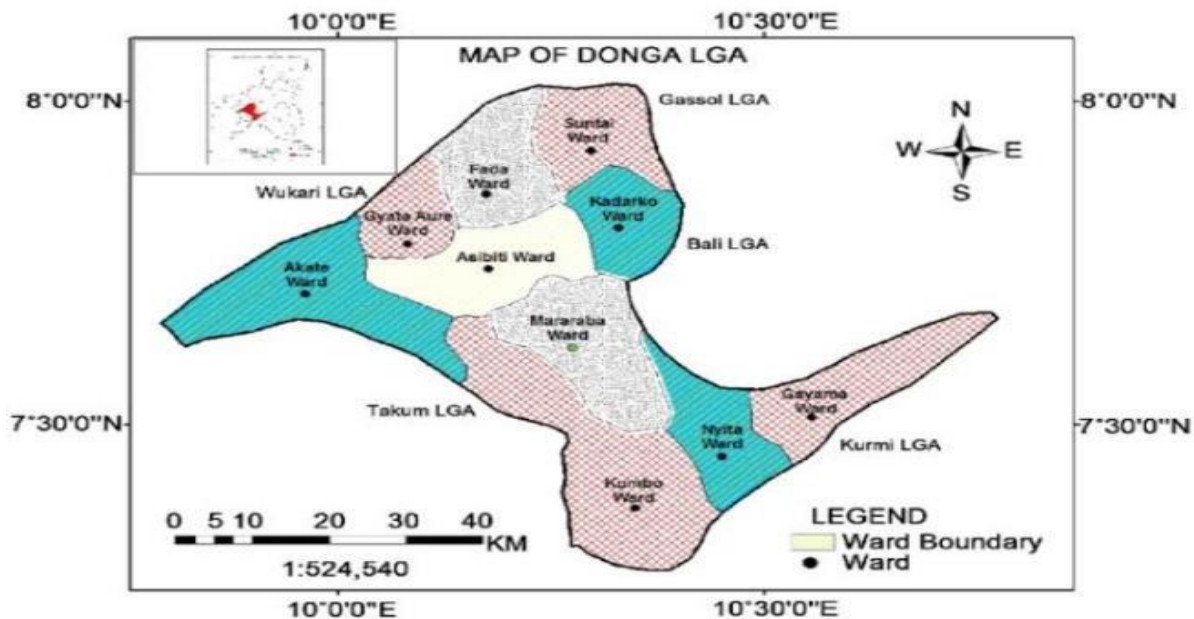


Fig 1: Map of Donga Local Government Area

Source: Ministry of Land and Survey, Taraba State (2019)

Sampling Procedure and Identification

Sampling was carried out in the month of January, 2025 and February 2025. Snail samples were collected using scooping and handpicking methods described by Okita *et al.* (2020). Samples were collected biweekly in the morning hours between 8.00am and 10.00am from January to February 2025 with a long-handled snail sieve net which is also known as a scoop net. The Scoop net consisted of a wide squared frame attached with fine-meshed net and a long handle. The Scoop net was laid down randomly at the water edge near the vegetation (where the snails may be possibly found) by holding its handle and digging into the ground, after which it was raised with the aim of capturing the snails around the water banks. The snails captured were then cleaned with water, counted (as number of snails per scoop) and later transferred into the pre-labeled specimen containers. This was repeated twice in the same site. The scoop net was also dragged through the water thereby collecting snails clinging to the aquatic plants. Where sieve net could not be used especially in muddy areas, a total of 10 minutes manual picking was done using a long forceps and gloved hands, to pick the visible

snails, which were transferred into the same container used for the scoop collection. The collected samples were later transported to Biology Laboratory, Federal University Wukari and kept in cool, out of direct sunlight before identification. The snail samples were identified using their morphological characteristics using Brian Eversham identification key (Version 2.2, 2013) (Eversham, 2013).

Physicochemical Analysis of the River

Different physicochemical parameters of the water body namely; conductivity, pH, temperature, turbidity, dissolved oxygen and total dissolved solids were analyzed according to the standard methods described by UNICEF/WHO, (2017).

Statistical Analysis

The results obtained from this research study were analyzed using simple statistical method such as percentage abundance, correlation and ANOVA. The analysis was performed using Statistical Package for Social Sciences (SPSS) version 24 statistical package. PAST software was used to calculate the diversity indices.

RESULTS

Species Abundance and Distribution

The study identified five freshwater snail species belonging to four families: Thiariidae, Planorbidae, Physidae, and Lymnaeidae. *Melanoides tuberculata* was the most abundant species, accounting for 53.7% of the total individuals, followed by *Bulinus globosus* (30.0%) and *Biomphalaria sp.* (16.3%) as shown in Table 1. The least abundant species were *Physa acuta* (5.4%) and *Radix natalensis* (4.4%) (Table 2). Seasonal variation was observed, with 109 individuals recorded in January and 114 in February, indicating relatively stable population dynamics based on the two months study.

Species Diversity, Richness, and Evenness

As shown in table 3, Diversity indices revealed moderate species richness and evenness within the snail population. The Shannon–Weiner Index (H') values for January (1.247) and February (1.282) indicated a comparable level of diversity across the months, with the combined value at 1.265. The Margalef Index (D) showed a slight decline from 0.853 in January to 0.845 in February, suggesting relatively low species richness. The Evenness Index (E) values of 0.775 in January and 0.796 in February demonstrated a balanced distribution of species, with no single species overwhelmingly dominating the community.

Physicochemical Characteristics of the Donga River

The water quality parameters remained within acceptable limits set by the WHO and SON guidelines, with the exception of dissolved oxygen levels. The pH values (6.90 ± 0.15 in January and 7.10 ± 0.15 in February) fell within the recommended range of 6.5–8.5, indicating a slightly acidic to neutral environment. Water temperature ($26.90 \pm 0.50^\circ\text{C}$ in January and $26.50 \pm 0.50^\circ\text{C}$ in February) remained stable and below the WHO limit of 29°C .

Turbidity levels (1.03 ± 0.10 NTU in January and 1.21 ± 0.10 NTU in February) were low, suggesting clear water conditions. Conductivity (11.50 ± 2.00 S/m in January and

15.23 ± 2.00 S/m in February) and Total Dissolved Solids (TDS) (31.30 ± 2.00 mg/L in January and 31.80 ± 2.00 mg/L in February) were significantly lower than WHO limits, indicating low dissolved mineral content. However, dissolved oxygen levels (3.68 ± 0.30 mg/L in January and 4.31 ± 0.30 mg/L in February) were below the recommended 6.5–8 mg/L, which could impact aquatic life by limiting oxygen availability.

Table 1: Species Abundance of Freshwater Snails Collected in Donga River

Family	Snail Species	January	February	Total (%)
Thiaridae	<i>Melanoides tuberculata</i>	54	55	109 (53.7)
Planorbidae	<i>Bulinus globosus</i>	30	31	61 (30.0)
Planorbidae	<i>Biomphalaria spp.</i>	16	17	33 (16.3)
Physidae	<i>Physa acuta</i>	5	6	11 (5.4)
Lymnaeidae	<i>Radix natalensis</i>	4	5	9 (4.4)
Total		109	114	223

Table 2: Percentage Abundance of Freshwater Snails Collected in Donga River

Family	Number of Species	Percentage of Species (%)	Number of Individuals	Percentage of Individuals (%)
Thiaridae	1	20	109	53.7
Planorbidae	2	40	94	46.3
Physidae	1	20	11	5.4
Lymnaeidae	1	20	9	4.4
Total	5	100	223	100

Table 3: Diversity, Richness and Evenness of Freshwater Snails Collected in Donga River

Family	January	February	Combined
Shannon–Weiner Index (H')	1.247	1.282	1.265
Margalef Index (D)	0.853	0.845	0.74
Evenness (E)	0.775	0.796	0.786

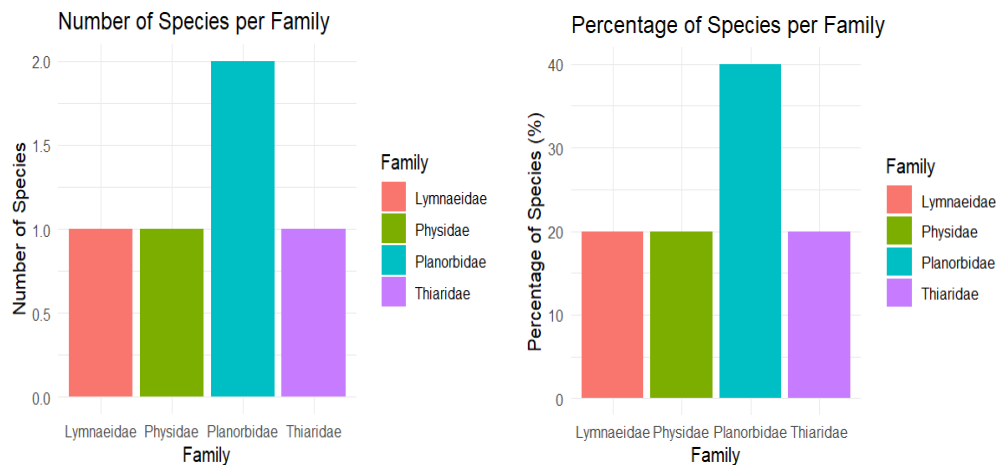


Figure 1: Number and percentage of species per family

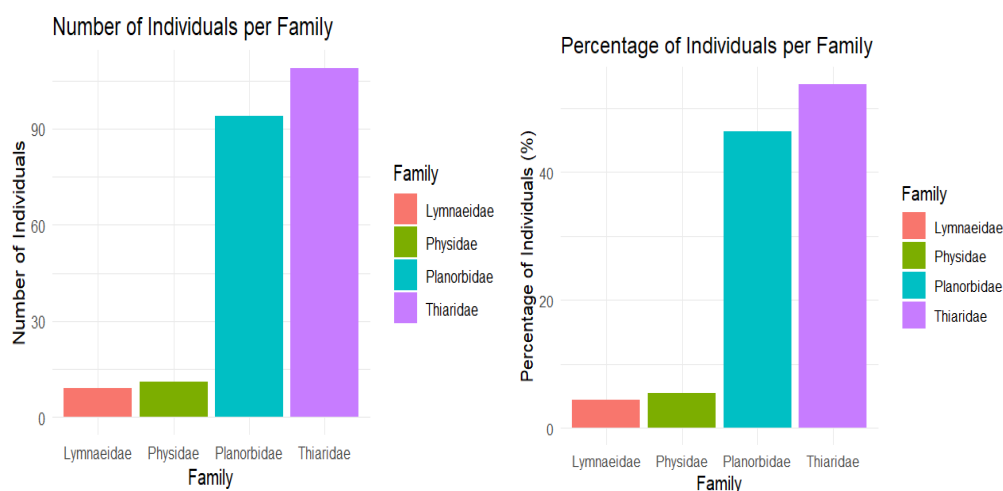


Figure 2: Number and percentage of individuals per family

Table 4: Physiochemical analysis of Donga River water sample

Parameter	January	February	WHO	SON
Colour	Colourless	Colourless	Colourless	Colourless
Ph	6.90 ± 0.15	7.10 ± 0.15	6.5-8.5	6.5-8.5
Temperature (°C)	26.90 ± 0.50	26.50 ± 0.50	29	Ambient
Turbidity (NTU)	1.03 ± 0.10	1.21 ± 0.10	5	5
Dissolved Oxygen (mg/L)	3.68 ± 0.30	4.31 ± 0.30	6.5-8	6.5-8
Conductivity (S/m)	11.50 ± 2.00	15.23 ± 2.00	1000	1500
Total Dissolved Solids (mg/L)	31.30 ± 2.00	31.80 ± 2.00	500	500

World Health Organization (WHO) Standard Guidelines (2011) and Standard Organization of Nigeria (SON) Standard Guidelines (2007)

Correlation between Physicochemical Parameters and Abundance of Snail Species

Table 5 presents the results on the correlation between physicochemical parameters and the abundance of various snail species. The results reveals that pH, temperature, and conductivity have the strongest positive correlations with the abundance of species such as *Melanooides tuberculata*, *Bulinus globosus*, and *Biomphalaria spp.* Specifically, pH shows a strong positive correlation with *M. tuberculata* (0.80), *B. globosus* (0.75), and *B. spp.* (0.65), indicating that these species thrive in environments with higher pH levels. Similarly, temperature correlates strongly with *M. tuberculata* (0.70) and *B. globosus* (0.65), suggesting that these species prefer warmer water conditions. Conductivity also shows a positive relationship with these species, particularly *M. tuberculata* (0.55) and *B. globosus* (0.60), indicating that they are more abundant in waters with higher conductivity.

Also, dissolved oxygen (DO) demonstrates negative correlations with the abundance of several species, including *M. tuberculata* (-0.60), *B. globosus* (-0.55), and *B. spp.* (-0.45), suggesting that these species are less abundant in areas with lower oxygen levels. Total dissolved solids (TDS) also show positive correlations with species such as *M. tuberculata* (0.40) and *B. globosus* (0.45), indicating a preference for waters with higher TDS levels.

In terms of species interactions, *M. tuberculata* and *B. globosus* exhibit strong positive correlations with each other, particularly with *B. spp.* (0.75 and 0.85, respectively). Additionally, *P. acuta* is positively correlated with *B. globosus* (0.60), *B. spp.* (0.70), and *R. natalensis* (0.85), while *R. natalensis* shows strong correlations with *P. acuta* (0.85), *B. globosus* (0.55), and *B. spp.* (0.60). These relationships suggest that these species share similar habitat preferences or environmental conditions, which may influence their abundance in the same areas.

Table 5: Correlation between Physicochemical Parameters and Abundance of Snail species

Parameter	pH	Temp (°C)	Turb (NTU)	DO (mg/L)	Cond (S/m)	TDS (mg/L)	<i>M. tuberculata</i>	<i>B. globosus</i>	<i>B. spp.</i>	<i>P. acuta</i>	<i>R. natalensis</i>
pH	1	0.6	0.3	-0.2	0.25	0.1	0.80*	0.75*	0.65*	0.4	0.2
Temp (°C)	0.6	1	0.5	-0.1	0.3	0.4	0.70*	0.65*	0.55*	0.35	0.15
Turb (NTU)	0.3	0.5	1	0.1	0.45	0.6	0.5	0.60*	0.50*	0.2	0.3
DO (mg/L)	-0.2	-0.1	0.1	1	-0.15	-0.05	-0.60*	-0.55	-	-0.2	-0.1
Cond (S/m)	0.25	0.3	0.45	-0.15	1	0.85*	0.55*	0.60*	0.55*	0.4	0.3
TDS (mg/L)	0.1	0.4	0.6	-0.05	0.85*	1	0.4	0.5	0.45	0.2	0.25
<i>M. tuberculata</i>	0.80*	0.70*	0.5	-0.6	0.55*	0.4	1	0.80*	0.75*	0.60*	0.50*
<i>B. globosus</i>	0.75*	0.65*	0.60*	-0.55	0.60*	0.45	0.80*	1.00	0.85*	0.60*	0.55*
<i>B. spp.</i>	0.65*	0.55*	0.50*	-0.45*	0.55*	0.45	0.75*	0.85*	1.00	0.70*	0.60*
<i>P. acuta</i>	0.4	0.35	0.2	-0.2	0.4	0.2	0.60*	0.60*	0.70*	1.00	0.85*
<i>R. natalensis</i>	0.2	0.15	0.3	-0.1	0.3	0.25	0.50*	0.55*	0.60*	0.85*	1.00*

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

Key:

Temp (°C)	Temperature (°C)
Turb (NTU)	Turbidity (NTU)
DO (mg/L)	Dissolved Oxygen (mg/L)
Cond (S/m)	Conductivity (S/m)
TDS (mg/L)	Total Dissolved Solids (mg/L)
<i>M. tuberculata</i>	<i>Melanooides tuberculata</i>
<i>B. globosus</i>	<i>Bulinus globosus</i>
<i>B. spp.</i>	<i>Biomphalaria spp.</i>
<i>P. acuta</i>	<i>Physa acuta</i>
<i>R. natalensis</i>	<i>Radix natalensis</i>

DISCUSSION

The species abundance and distribution of freshwater snails in the Donga River exhibit patterns that align with previous findings across various regions. Tukur *et al.* (2024) documented a total of 311 snails representing three distinct species which is a little more abundant than this study which recorded 223 snails which may be due to the number of months sampled and the season the research was done. The study revealed the presence of multiple snail species, including *Bulinus* spp., *Melanoides* spp., and *Lymnaea* spp., which are consistent with findings by Olorunniyi and Olofintoye (2017) and Ronald and Bello (2024), who documented similar species diversity in freshwater systems. These species are significant in the transmission of snail-borne diseases, such as schistosomiasis, as they serve as intermediate hosts for the parasites. In line with Oloyede *et al.* (2016), the Donga River's snail populations also exhibit variations in abundance, likely influenced by environmental factors such as temperature and water chemistry.

The findings from this study also reflect the diversity of freshwater snails found in other Nigerian water bodies, such as the Eleye Dam, where a variety of species, including *Melanoides* spp., *Bulinus* spp., and *Biomphalaria* spp., were abundant (Oloyede *et al.*, 2016). This co-existence of species is indicative of favorable ecological conditions within the Donga River, which may facilitate both the survival and proliferation of various snail species. Ecological changes, such as those caused by water resource development projects, have led to the creation of new habitats that support snail populations, similar to the findings of Ofoezie (1999), who reported an increase in freshwater snail populations following the construction of man-made reservoirs.

The presence of a diverse range of species supports the idea that the Donga River provides a stable environment conducive for snail proliferation, highlighting its potential role in the transmission dynamics of waterborne diseases.

The physicochemical characteristics of the Donga River, including temperature, pH, dissolved oxygen, and conductivity, play significant roles in shaping snail populations, as demonstrated by this study. Temperature, for instance, was found to have a direct influence on snail distribution and abundance, as described by Abe *et al.* (2017). The Donga River's temperature fluctuations likely influence the reproductive cycles and survival of snails, as temperatures between 22°C and 26°C are optimal for snail reproduction, consistent with findings by Nelson *et al.* (2016) and Robert and Janovy (2000).

The pH of the Donga River was slightly alkaline, which is favorable for the survival of many snail species, particularly *Bulinus* spp. and *Biomphalaria* spp., which thrive in waters with a pH range between 6.5 and 8.5 very close to that of River Ibi with a range of 6.94 to 7.07 (Ronald and Bello, 2024). The dissolved oxygen (DO) levels in the river also appear to support snail populations, as snails are more abundant in oxygenated water, consistent with findings by and Njoku-Tony (2011) and Dida *et al.* (2014).

Additionally, the conductivity of the Donga River falls within the range that supports snail populations, as observed by Agi and Okwuosa (2001), who noted that freshwater snails tend to thrive in waters with conductivity levels between 50 and 600 microhms. The river's water current and turbidity levels also appear to influence snail densities,

with snails favoring areas with moderate current and lower turbidity, as observed by Giovanelli *et al.* (2005) and Tela and Usman (2021).

CONCLUSION

The co-existence of multiple snail species in the same habitat, as reported in various locations across Nigeria, reflects the adaptability of these organisms to varying environmental conditions.

Moreover, the physicochemical characteristics of the Donga River, such as temperature, pH, dissolved oxygen, and conductivity, were found to influence snail population dynamics, as similarly observed in other regions. These findings provide insight into the relationship between freshwater snails and their environments, offering potential avenues for future research, particularly in the context of disease transmission and snail conservation.

Conflicts of Interest: The Authors Declares no conflicts of Interest

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