Research Article

Physicochemical Profile and Abundance of Freshwater Snails in Mt. Dula-Dula, Damit, Bayog, Zambonga Del Sur

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Abstract

Freshwater snails are crucial components of tropical stream ecosystems, serving as grazers, detritivores, and indicators of environmental change. However, their responses to water quality gradients in upland Philippine freshwater systems remain poorly documented. This study examined the physicochemical profile and snail assemblages across upstream, midstream, and downstream sections of Mt. Dula-Dula, Damit, Bayog, Zamboanga del Sur. Dissolved oxygen (DO), pH, total dissolved solids (TDS), and temperature were measured in situ, while freshwater snails were collected using 3 by 5 meter quadrats and identified morphologically. Species diversity was assessed using Simpson's Diversity Index, and relationships between physicochemical parameters and snail abundance were evaluated using Pearson correlation. All measured water quality parameters met DENR Class C standards, indicating generally suitable conditions for freshwater biota. Three species were recorded: Melanoides tuberculata, Tarebia granifera, and Physella acuta, with M. tuberculata dominating all sites. Overall diversity was low (Simpson's D = 0.13), reflecting community dominance by a single tolerant species. Pearson correlation analysis revealed negative associations between snail abundance and DO, pH, TDS, and temperature, although values remained within acceptable ecological thresholds. The strong dominance of M. tuberculata suggests high ecological plasticity and potential resilience to environmental variation.

These findings provide baseline data on the snail communities of Mt. Dula-Dula and highlight the importance of continued biomonitoring to detect future environmental changes in upland freshwater ecosystems.

Keywords: *abundance, water quality, morphological variation, freshwater snails*

Introduction

Freshwater snails, members of the phylum Mollusca, represent a diverse group of aquatic invertebrates that play crucial ecological roles in nutrient cycling, decomposition, and energy transfer in freshwater ecosystems (Oso & Odaibo, 2021). They are essential components of aquatic habitats, regulating organic matter and primary productivity. As benthic grazers of periphyton, detritus, and biofilm, freshwater snails influence the composition and abundance of other benthic fauna and serve as prey for higher trophic levels, functioning as key intermediaries in freshwater food webs (Tela & Usman, 2021; Okoye et al., 2022).

Globally, freshwater gastropods are highly diverse, with approximately 4,000 described species, reflecting their ecological plasticity and ability to adapt to a wide variety of aquatic habitats (Auta & Tukur, 2024). Their diversity and adaptive responses to environmental conditions make them important indicators of ecosystem health. Freshwater snails also exhibit broad dietary flexibility, feeding on algae, detritus, and suspended organic matter, which enhances their capacity to colonize heterogeneous habitats (Tela & Usman, 2021). Because of their sensitivity to environmental changes, freshwater snails are widely recognized as effective bioindicators of ecological integrity. Physicochemical parameters such as water temperature, pH, dissolved oxygen, and total dissolved solids strongly influence snail physiology, including respiration, feeding, shell formation, and reproduction (Oso & Odaibo, 2021; Okoye et al., 2022).

In tropical regions, variations in these parameters can alter habitat suitability and community composition, particularly for specialist or sensitive snail species. Conversely, generalist taxa such as Melanoides tuberculata and Tarebia granifera exhibit broad tolerance to fluctuating environmental conditions, enabling them to dominate streams and reservoirs subject to moderate to high disturbance (Auta & Tukur, 2024).

In the Philippines, freshwater ecosystems are shaped by elevation, forest cover, precipitation, and human activities, generating spatial and temporal heterogeneity in water quality and biodiversity. Despite this, scientific data on freshwater snail communities and associated water quality in upland areas remain limited. Specifically, Mt. Dula-Dula in Damit, Bayog, Zamboanga del Sur comprises upland, midland, and lowland streams, yet there is little published information on its physicochemical profile or snail distribution.

This study aims to characterize the physicochemical profile, including water temperature, pH, dissolved oxygen, and total dissolved solids, of selected freshwater habitats in Mt. Dula-Dula and to determine how these parameters influence the abundance and distribution of freshwater snails. The findings are expected to provide baseline data that can inform biodiversity conservation, water-quality monitoring, and sustainable management of upland freshwater ecosystems in Zamboanga del Sur.

Material and Methods

Research Design

This study employed a descriptive quantitative research design to assess freshwater snail diversity, abundance, and distribution across the three sampling sites: downstream, midstream, and upstream tributaries of Mt. Dula Dula, Damit, Bayog, Zamboanga del Sur (Bidat et al., 2023; Lewin et al., 2023). This design was appropriate for quantifying snail populations and their relationships with physicochemical parameters, generating baseline ecological data, and identifying environmental factors influencing community composition (Amawulu & Ekwuribe, 2021).

Research Instrument

The freshwater snail sampling method used in this study was adapted from established freshwater snail survey techniques (Hobbs & Harvey, 2020; Bidat et al., 2023). Snails were collected by handpicking along the quadrats. Five 3 × 5 m (15 m^2) quadrats were placed at least 10 m apart in each location to avoid pseudoreplication. Sampling was conducted between 2:00 and 4:00 pm. Collected snails were placed in containers with river water and transported to the laboratory after being frozen for one day.

Physicochemical measurements, including water temperature, pH, dissolved oxygen (DO), and total dissolved solids (TDS), were recorded at each site using a portable DO meter and a pH electrode

(Amawulu & Ekwuribe, 2021; Nwoko et al., 2022). At least three replicate readings were taken at each site. All snail samples were preserved in 95% ethanol after freezing. The relationship between snail abundance, distribution, and physicochemical parameters was later analyzed using statistical methods, including the Pearson correlation coefficient (Lewin et al., 2023).

Research Environment

The map showed Barangay Damit, located in Bayog, Zamboanga del Sur. "A" represented the map of the Philippines, "B" showed Zamboanga del Sur province, "C" highlighted Bayog municipality, "D" focused on Mt. Dula-Dula within Barangay Damit, and "E" indicated a stream north of the mountain. The red solid line outlined the Barangay Boundary, while the black solid line showed Municipal Boundaries. A white dashed line marked a key feature near Mt. Dula-Dula, and a blue dashed line traced the stream. The background used a Google Satellite Hybrid image to show land cover, and the map was created with QGIS Version 3.36.

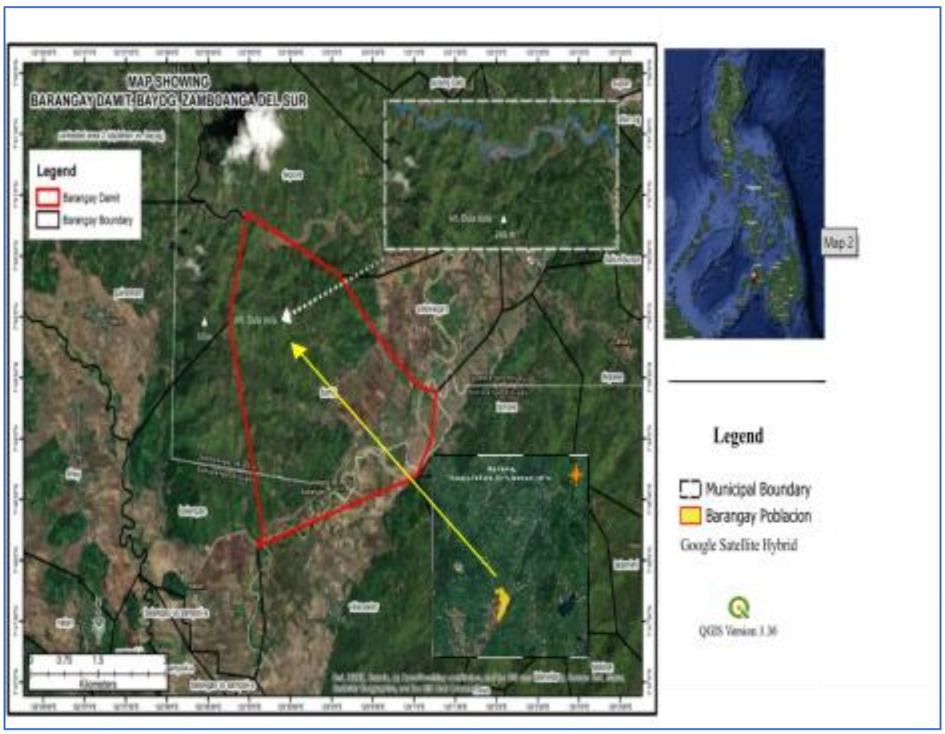

Figure 1. Study area, which included Mt. Dula-Dula in Barangay Damit, Bayog, Zamboanga del Sur.

Data Gathering Procedure

Data on the physicochemical characteristics of the streams and the freshwater snail species were collected through field surveys. The research location was visited for two days and one night, and water samples were taken from all three sites (downstream, midstream, upstream). At least three replicate measurements of temperature, pH, DO, and TDS were taken per site (Linares et al., 2022). Snails were collected using handpicking and quadrat-based sampling methods, placed in water-filled containers, frozen for one day, and transported to the laboratory for preservation and identification. Species richness, abundance, and diversity were evaluated through field observations and laboratory analysis.

Statistical Process

Community metrics, including species richness, relative abundance, and diversity indices (Simpson's Index), were calculated for each sampling site (Bidat et al., 2023; Lewin et al., 2023). Differences across the three sampling sites (downstream, midstream, upstream) were assessed using one-way ANOVA, with significance level set at $p < 0.05$. Relationships between physicochemical variables and snail abundance and distribution were evaluated using Pearson's correlation coefficient (Linares et al., 2022; Nwoko et al., 2022).

Morphological Identification

Freshwater snails were identified morphologically under a stereomicroscope, based on shell shape, sculpture, spire height, aperture features, and the presence of an operculum (Lewin et al., 2023; Bidat et al., 2023). Identification was guided by standard taxonomic keys and verified using digital repositories and photographic databases, including GBIF and iNaturalist, to ensure correct species classification. Shell morphometric comparison followed standard diagnostic traits for distinguishing closely related species (Hobbs & Harvey, 2020).

Result and Discussion

Physicochemical Parameters of Streams in Mt. Dula-Dula

Table 1 provides a summary of the mean values for each parameter across the three areas. The physicochemical conditions of streams in Mt. Dula-Dula were assessed to evaluate environmental factors influencing freshwater ecosystems. Dissolved oxygen (DO) levels averaged 7.6 mg/L downstream, 7.5 mg/L midstream, and 7.53 mg/L upstream, with no statistically significant differences among sites ($p > 0.05$), indicating generally adequate oxygenation to support aquatic life. Such oxygen levels are consistent with patterns in flowing waters, where oxygen availability interacts with organic matter processing and invertebrate distribution (Bernhardt et al., 2018; Mereta et al., 2019).

Table 1. Summary Table of the water parameters in the three streams.

	Water Parameters			
	DO (mg/L)	**TDS (ppm)**	**pH**	**Temperature (^{O}C)**
Downstream	7.6	116	7.67	29.2
Midstream	7.5	80	7.64	29.2
Upstream	7.3	57	7.27	29.1
Mean	**7.5**	**82**	**7.53**	**29.2**

Total dissolved solids (TDS) ranged from 57 ppm upstream to 116 ppm downstream, with a mean of 82 ppm, below thresholds considered harmful to freshwater-snail habitats. The downstream increase in TDS likely reflects solute accumulation along the flow gradient, a pattern observed in other tropical river systems (Oso & Odaibo, 2021; Okoye et al., 2022). Moderate TDS and conductivity can influence snail community composition but generally remain within tolerable ranges for many species (Mereta et al., 2023; Siglos & Lopez, 2025).

The streams exhibited a pH gradient from 7.27 upstream to 7.64 midstream and 7.67 downstream, with a mean pH of approximately 7.5. This range aligns with conditions documented in natural snail habitats in Africa and Southeast Asia, indicating that the streams' acidity/alkalinity is compatible with freshwater-snail ecology (Mereta et al., 2019; Siglos & Lopez, 2025). Slight downstream alkalinity increases may result from local geology or groundwater inputs but remain within tolerable limits for most snail species (Mereta et al., 2023; Okoye et al., 2022).

Water temperature remained stable across sites (29.1–29.2 °C), consistent with tropical-stream conditions. Studies show that many freshwater snails tolerate broad temperature ranges, and stability in temperature may support their metabolic activity and reproduction (Bernhardt et al., 2018; Oso & Odaibo, 2021).

Overall, the measured DO, TDS, pH, and temperature values suggest that streams in Mt. Dula-Dula provide environmental conditions suitable for sustaining freshwater-snail communities. These findings align with other tropical and subtropical freshwater ecosystems where similar physicochemical ranges support snail survival and reproduction, reinforcing the streams' potential as viable habitats for further ecological and biodiversity studies (Bernhardt et al., 2018; Mereta et al., 2019; Mereta et al., 2023; Okoye et al., 2022; Oso & Odaibo, 2021; Siglos & Lopez, 2025).

Freshwater Snail Species Distribution and Abundance

Table 2 presents the results of freshwater snail sampling across upland, midland, and lowland streams in Mt. Dula-Dula, showing the identified species, *Melanoides tuberculata*, *Tarebia granifera*, and *Physella acuta*, and their respective abundance in each sampling area.

Table 2. Snails were present in all the area sites of collections in the three streams.

	Species	**Mean Values per Station**			**Total**	**Simpson's Diversity Index**
		Downstream	**Midstream**	**Upstream**		
1	*Melanoides tuberculata*	63	58	75	196	**0.13**
2	*Tarebia granifera*	7	4	2	13	
3	*Physella acuta*	0	0	2	2	
	Total	**70**	**62**	**79**	**211**	

The freshwater snail community of Mt. Dula-Dula was characterized by the presence of *Melanoides tuberculata* and *Tarebia granifera* across all sampled stream sites, encompassing downstream, midstream, and upstream sections. A total of 196 individuals of *M. tuberculata* were recorded (63 downstream, 58 midstream, 75 upstream), while *T. granifera* was represented by 13 individuals (7, 4, and 2, respectively). *Physella acuta* was observed only in the upstream area, with two individuals, indicating a limited distribution within the system. The overall Simpson's Diversity Index of 0.87 reflected a low level of species diversity dominated by *M. tuberculata*.

Figure 2 presents the freshwater snail species recorded from the three streams in Mt. Dula-Dula, Damit, Bayog, Zamboanga del Sur. The three species identified were *Melanoides tuberculata*, *Tarebia granifera*, and *Physella acuta*. *M. tuberculata* and *T. granifera* (family Thiaridae) are characterized by operculate shells and typically occupy slow-moving or stagnant waters. *P. acuta* (family Physidae) is sinistral and exhibits high ecological plasticity, which allows survival in a wide range of environmental conditions.

Laboratory and field studies indicate that *M. tuberculata* tolerates temperatures between 16–37 °C and salinity fluctuations, which may explain its widespread occurrence and dominance in tropical freshwater habitats (Okumura & Rocha, 2020). Similarly, *T. granifera* demonstrates broad thermal tolerance and can coexist with *M. tuberculata* in natural habitats, suggesting its invasive capacity and ability to colonize diverse freshwater ecosystems (Nguyen et al., 2021; Gerber et al., 2024). *P. acuta* is highly adaptable to variable environmental conditions, including differences in dissolved oxygen, substrate types, and pollutant concentrations such as heavy metals (Spyra et al., 2019; Taybi et al., 2024; Gutiérrez-Gregoric et al., 2024; He et al., 2025).

The dominance of *M. tuberculata* along with the presence of *T. granifera* and *P. acuta* in the streams is consistent with patterns observed globally, where ecologically tolerant generalist gastropods prevail in habitats subjected to environmental variability and anthropogenic disturbance (Okumura & Rocha, 2020; Nguyen et al., 2021; Spyra et al., 2019; Taybi et al., 2024; Gutiérrez-Gregoric et al., 2024).

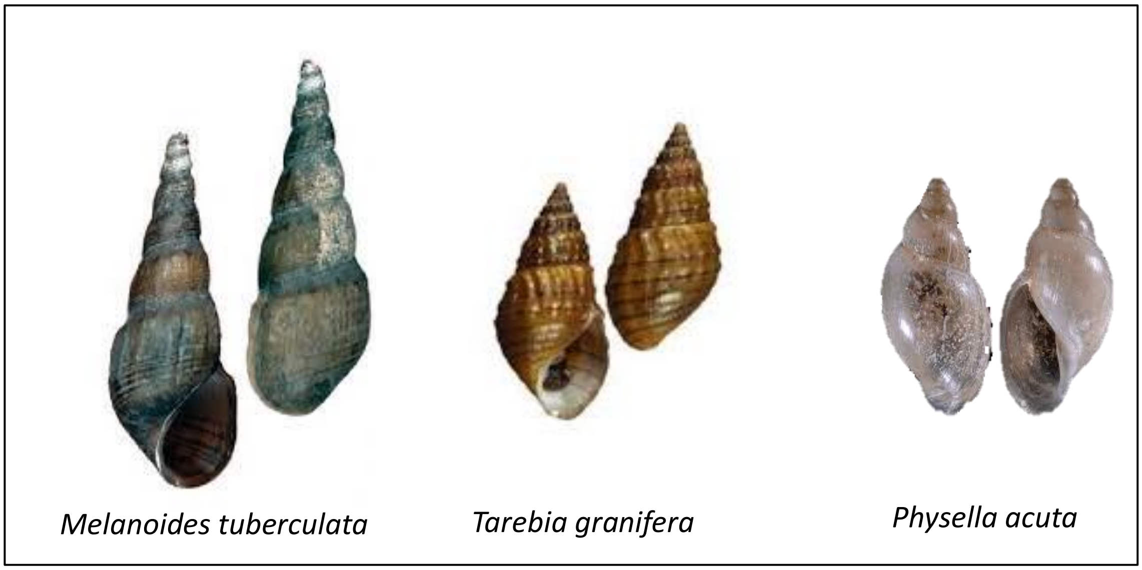

Figure 2. Identified freshwater snail species collected from the three streams.

Correlation Between Physicochemical Parameters and Snail Abundance and Distribution

Dissolved Oxygen and Snail Abundance

Figure 3 shows the relationship between dissolved oxygen (DO) and snail abundance in Mt. Dula-Dula. A moderate negative correlation (r = –0.68) was observed. Snail abundance was highest (79 individuals) at 7.3 mg/L DO, with slight decreases at 7.5–7.6 mg/L. This pattern aligns with previous studies showing that freshwater snails tolerate a wide DO range due to lower metabolic rates and behavioral adaptations, making small DO variations unlikely to substantially reduce abundance (Spyra, 2017; Mereta et al., 2019; Oso & Odaibo, 2021).

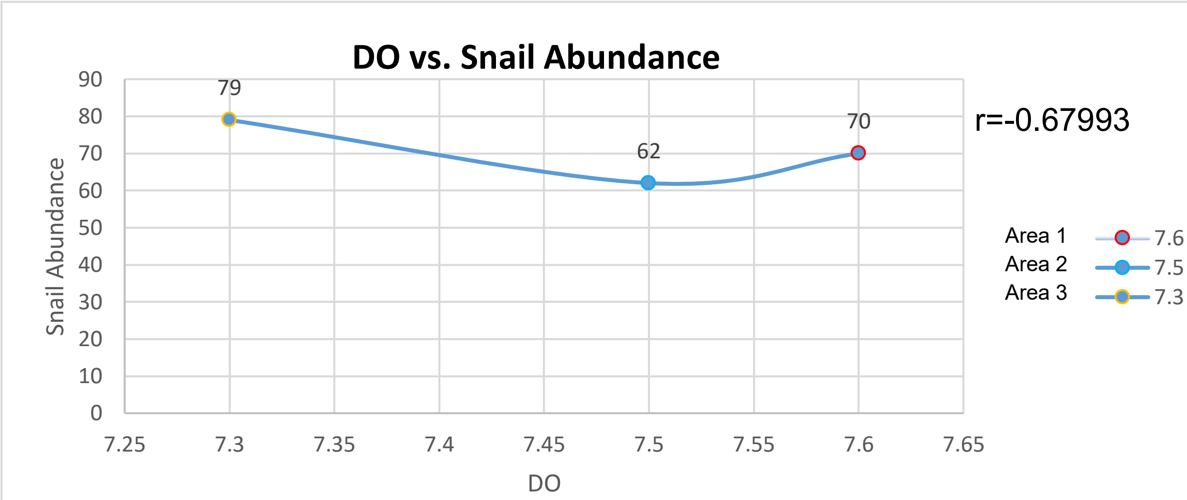

Figure 3. A graphical presentation of the correlation between

Correlation of TDS and Snail Abundance

Figure 4 shows the correlation between TDS and snail abundance. Peak abundance (79 individuals) occurred at 57 mg/L TDS, while higher values (80–116 mg/L) were associated with lower abundance. Elevated TDS can disrupt osmoregulation, shell formation, and reproduction in freshwater snails (Okoye et al., 2022; Oso & Odaibo, 2021).

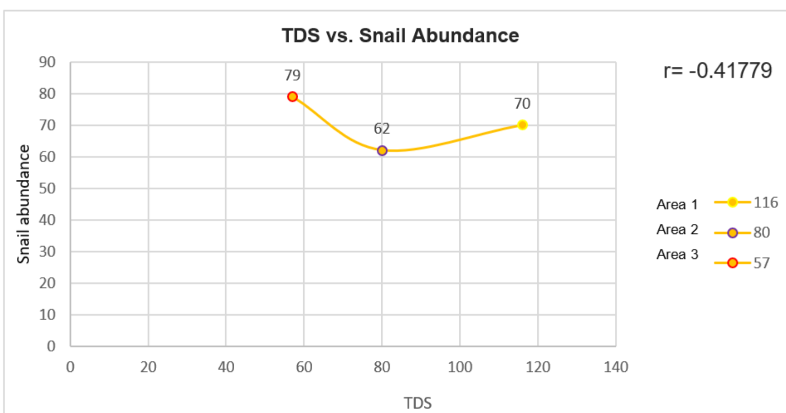

Figure 4. A graphical presentation of the correlation between Total Dissolved Solid and Snail Abundance.

Correlation of pH and Snail Abundance

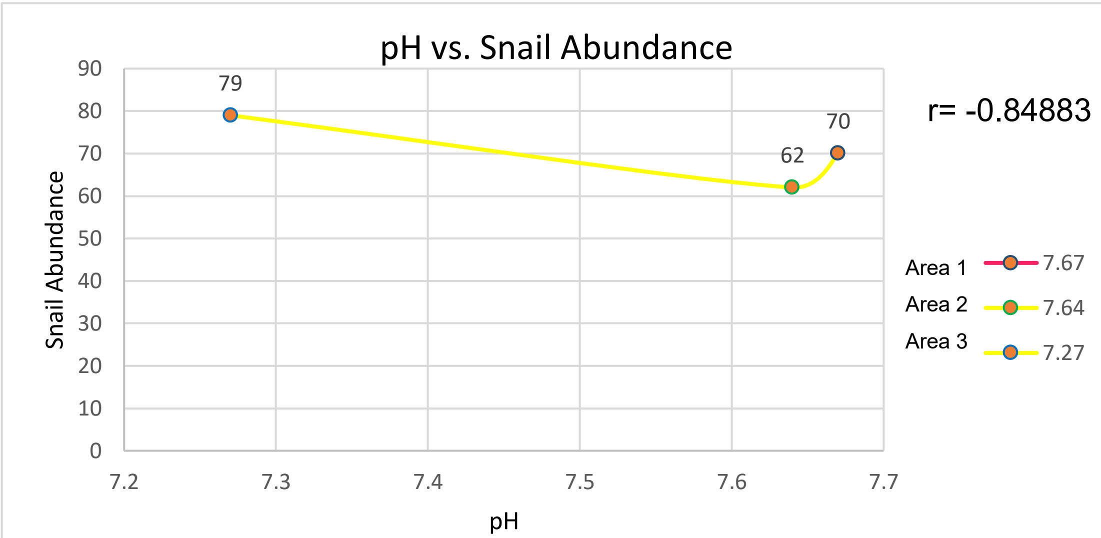

Figure 5. A graphical presentation of the correlation between pH and Snail Abundance.

Figure 5 shows that maximum snail abundance (79 individuals) occurred at pH 7.27. Abundance declined slightly at pH 7.64–7.67. Freshwater snails generally thrive under near-neutral to mildly alkaline conditions that favor shell formation and metabolic activity (Spyra, 2017; Mereta et al., 2019; Okoye et al., 2022).

Correlation of Temperature and Snail Species

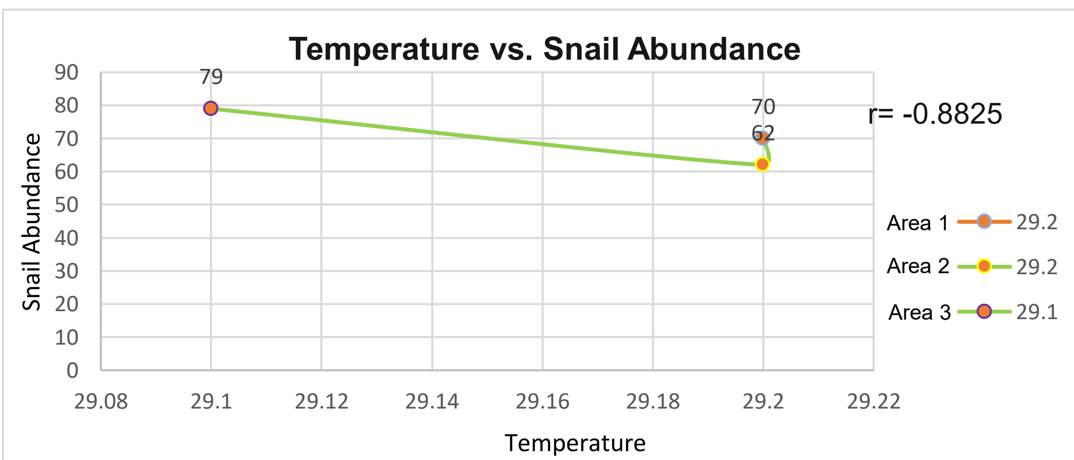

Figure 6. A graphical presentation of the correlation between Temperature and Snail Abundance.

Figure 6 demonstrates a small decline in abundance between 29.1 °C (peak: 79 individuals) and 29.2 °C. Tropical freshwater snails maintain optimal reproduction and survival under stable temperature regimes; slight deviations can reduce population density (Mereta et al., 2019; Okoye et al., 2022).

Conclusion

The assessment of water quality and freshwater snail populations in Mt. Dula-Dula demonstrated that key physicochemical parameters, including dissolved oxygen, total dissolved solids, pH, and temperature, were generally within the standards set by DENR DAO 2016-08 for Class C waters. These conditions provided a suitable environment for aquatic life, although variability in TDS and temperature indicates the need for continued monitoring. Among the three species identified, *Melanoides tuberculata* was dominant across all sampling sites, reflecting its adaptability to diverse environmental conditions, while *Tarebia granifera* and *Physella acuta* were present in lower numbers. Correlation analysis suggested that snail abundance was influenced by moderate dissolved oxygen, low TDS, near-neutral pH, and tropical temperatures, emphasizing the role of local environmental factors in determining species distribution. Future studies should focus on long-term monitoring, the influence of additional environmental variables, and conservation strategies to support freshwater biodiversity in the region.

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