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Research Article

# Freshwater snails: distributional patterns in selected locales along the Chenab River in Gujranwala Division, Punjab, Pakistan

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## ABSTRACT

The diversity and distributional patterns of freshwater snails were investigated from four sites along the Chenab River: Head Marala, Wazirabad, Shahbaz Pur, and Rasool Pur. The hand-picking and hand-scoop methods were applied to collect samples of freshwater snails every two weeks from November 2017 to February 2018. Collected samples of freshwater snails were washed with potable water. The identification of freshwater snails was accomplished by using literature and taxonomic keys. To identify the specimens, the morphometric analysis of the shells was determined using a digital Vernier Caliper. *Melanoides tuberculata* (Müller, 1774), *Viviparus georgianus* (Lea, 1834), *Viviparus ater* (De Cristofori & Jan, 1832) and *Bithynia forcarti* (Glöer & Pešić, 2012) were identified as members of class Gastropoda (Phylum Mollusca). The prevalence rate of *Viviparus georgianus* was found in abundance (64.3 %) followed by *Bithynia forcarti* (16.9 %), *Viviparus ater* (12.7 %), and *Melanoides tuberculata* (6.1 %). Simpson species Dominance (1-D: 0.5376), Simpson's Dominance Index (H: 1.106), and Evenness (0.6906) showed that the four species recorded from the study area were well distributed throughout the study area. This study emphasized exploring the freshwater snails and their diversity along the belt of the river Chenab through selected locales.

**Keywords:** Freshwater; snails; Chenab River; Head Marala; biodiversity.

## INTRODUCTION

Biological resources have been extensively used to measure ecosystem health indirectly by measuring biological diversity (Nwoko et al., 2022; Umar & Hussain, 2023; Umar et al., 2021). Many invertebrate species have been explored and documented for habitat analysis (Hussain et al., 2021). Global biodiversity of many invertebrates such as insects and freshwater snails is threatened by anthropogenic disturbances, predation, habitat degradation, and climate change (Böhm et al., 2021; Czaja et al., 2020; Lopes-Lima et al., 2021; Min et al., 2022; Noureen et al., 2021; Nwoko et al., 2022; Zhou et al., 2024). Snails are primarily marine animals but have successfully invaded the freshwater habitat (Zhou et al., 2024). The diversity of freshwater snails has been explored in different countries i.e., Sudan (Brown et al., 2012), Kenya (Orwa et al., 2015), Cameroon (Koji et al., 2015), India (Sharma et al., 2013), and south-west Nigeria (Oloyede et al., 2017). Freshwater snails have also been explored from different parts of Pakistan such as Kotri (Burdi et al., 2009), coastal areas of Sindh and Baluchistan (Kakar et al., 2017), Manchar Lake(Saddozai et al., 2013), Pothwar region (Afshan et al., 2013), Multan (Murtaza et al., 2020), Southern Punjab (Arshad et al., 2011), Bagh (Faiz & Faiz, 2020) and Margalla foothills (Gondal et al., 2020). Shell colour ranges from yellow brown to black with specific striations and clear markings which act as identification characters between snails of different habitats (Brown, 1994).

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Newly hatched young ones are just like adults but with less curly shells (Parveen et al., 2020). The diversity of freshwater snails is underexplored in the Punjab province, especially along the Chenab River. This study was undertaken to document and report the diversity of freshwater snails along selected locales of the river Chenab, Punjab, Pakistan.

## MATERIALS AND METHODS

### Sampling Sites

During winter, freshwater snails were collected fortnightly alongside the river Chenab from November 2017 to February 2018 by hand scooping (Nandan et al., 2016) and handpicking. The surveys were conducted from four sites of the river Chenab i.e., Head Marala (32° 38' 59.99" N, 74° 29' 59.99" E), Shahbaz Pur (32° 36' 35" N, 74° 16' 20" E), Wazirabad (32° 26' 44.99" N, 74° 06' 57.38" E), and Rasool Pur (29 34' 46" N, 70 32' 02" E). The areas selected spread out but lie within the same broader region concerning its vicinity near the Chenab River.

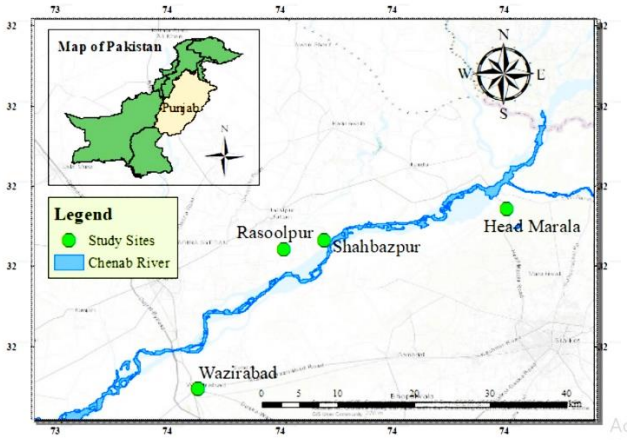


Figure 1. Map showing sampling sites along Chenab river, Punjab, Pakistan.

### Specimen Cleaning and Preservation

Potable water was used in the laboratory to remove debris from collected samples of freshwater snails, and the water was allowed to air dry for 20 minutes at room temperature. In the context of preservation, the specimens were immersed in 95% alcohol for 24 h. The shells with mineral and algae deposits were cleaned for a few minutes using a diluted oxalic acid solution before identification. A soft brush and potable water were used to clean and wash specimens and sculpture shells, respectively (Mandahl-Barth, 1962; Thompson, 2004). For the further process, the identified specimens were allowed to air dry at room temperature for 20 minutes and preserved in alcohol.

### Species Identification

Morphometric analysis was applied to calculate whorl numbers, sizes, patterns and colours from the shell. Published literature and taxonomic keys were followed to identify the freshwater snails (Burdi et al., 2008; Patil & Talmale, 2005; Preston, 1915). To identify the species of freshwater snails, height, diameter, whorls numbers, umbilicus diameter, aperture size, and spire height of the shell were measured with morphometric tools (Khan & Dastagir, 1971).

### Data Analysis

A Digital Vernier Caliper was used to calculate the morphometric measurements of the shells with the unit of millimeters. Freshwater snail abundance at several locations along the Chenab River was evaluated using ecological diversity indices using Shannon Weiner (Okeke et al., 2016) and Simpson's diversity index (Belhiouani et al., 2019; Magurran, 2004; Shannon & Weaver, 1949).

## RESULTS AND DISCUSSION

In district Gujrat, 542 freshwater snails were taken from four different collecting sites. Of these *Viviparus georgianus*, *Viviparus ater*, *Bithynia forcarti*, and *Melanoides tuberculata* species were identified on the basis of morphological measurements. The most prevalent species in this current study was *Viviparus georgianus* (64.34%), while *Melanoides tuberculata* (6.08%) was the least abundant.

**Morphological Identification**

**Viviparus georgianus**

The dextrally coiled, orbicular, and thin shell of *Viviparus georgianus* possesses rounded convex whorls that range 4-5 in number. The shell consists of an ovoid aperture, fine growth lines on the shell sculpture, and dark bands on the yellowish to dusky brownish green colored shell. The umbilicus has either a narrow slit-like opening or is absent. The horny operculum presents concentric growth lines.

**Viviparus ater**

Shell-shaped globes, several whorls range from 4-5, and umbilicus imperforate. The shell colour is ovate-oblong, brown dextral, smooth umbilicus closed and thin. The body whorl is enlarged which is angular from above and inflated from below. Sutures are obliquely depressed, and the aperture is large mango-shaped, pointed above and inflated below. The columella appears twisted and oblique, shell sculpture is spirally striated with a short, thin, and pointed apex.

**Bithynia forcarti**

The conical whitish shell has 5.5 convex whorls with deep and flattened suture. An open umbilicus, smooth surface, and coarsened growth lines characterize the shell. This species can be identified by its ovate opening at the top of the shell, which is angled. In this study, 230 specimens of *Bithynia forcarti* were recorded from selected sites in the Chenab River at Head Marala near District Sialkot.

**Melanoides tuberculata**

The light brown conical shell is maculated with a distinguishing spirally arranged row of rust colour markings underneath the suture. The elongated dextral shell comprises 7 to 11 rounded, convex whorls followed by an oval, paucispiral, and dusky operculum. Upper and middle whorls predominate with significant vertical ribs and absolute striations.

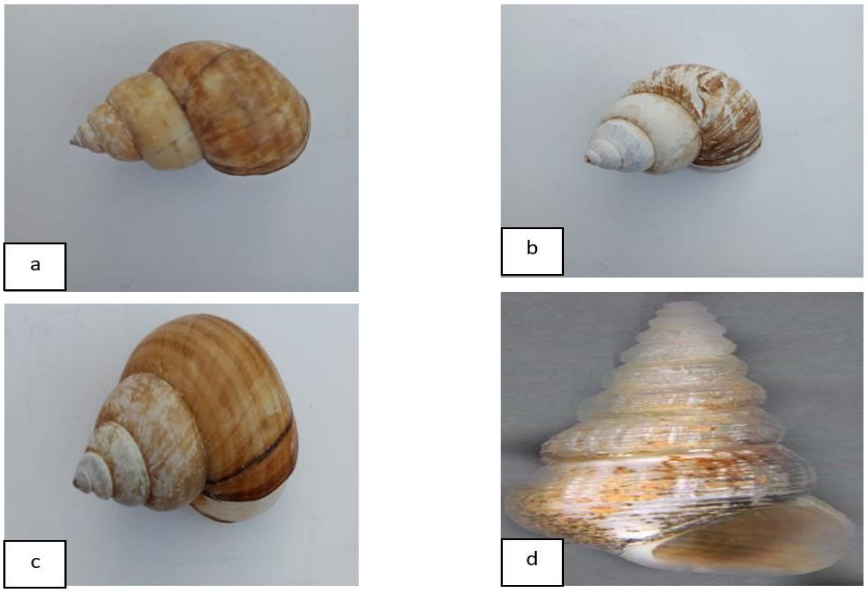


Figure 2. a) *V. georgianus*, b) *B. forcarti*, c) *V. ater*, d) *Melanoides tuberculate*.

**Diversity Indices**

**Overall diversity and abundance of species**

We collected 542 specimens belonging to four species (class Gastropoda) from selected study sites of river Chenab. Among all four species, maximum abundance (no.) was shown by the species *Viviparus georgianus* (296) followed by *Bithynia forcarti* (117), *Viviparus ater* (87), *Melanoides tuberculata* (42) (Table 1). Relative abundance showed that *Viviparous georgianus* (54.61 %) was a highly abundant species followed by *Bithynia forcarti* (21.59 %), and *Viviparus ater* (16.05 %). Whereas *Melanoides tuberculata* (7.75 %) was the least abundant species (Figure 2).

**Abundance of species at different sites**

The data recorded revealed the presence of 143 individuals which was 26.4 % of total freshwater snails representing four gastropod species from head Marala. *Viviparus georgianus* (68.5 %) was the most abundant species whereas *Melanoides tuberculata* (4.2 %) was the least abundant species at Head Marala. In Wazirabad (20.1 %), *Viviparus georgianus* (58.7 %) showed maximum abundance followed by *Viviparus ater* (19.3 %) whereas the lowest abundance

was recorded for *Melanoides tuberculata* (8.3 %). The species abundance at Shahbaz Pur (20.3 %) indicated the highest abundance of *Viviparus georgianus* (45.5 %) followed by *Bithynia forcarti* (30.0 %) whereas *Melanoides*

Table 1. Diversity and abundance of freshwater snails in selected sites in the river Chenab.

| Species | Head Marala | Wazirabad | Shahbaz Pur | Rasool Pur | Total |
|---|---|---|---|---|---|
| *Viviparus georgianus* | 98 | 64 | 50 | 84 | 296 |
| *Viviparus ater* | 21 | 21 | 15 | 30 | 87 |
| *Bithynia forcarti* | 18 | 15 | 33 | 51 | 117 |
| *Melanoides tuberculate* | 6 | 9 | 12 | 15 | 42 |
| Total Collected | 143 | 109 | 110 | 180 | 542 |

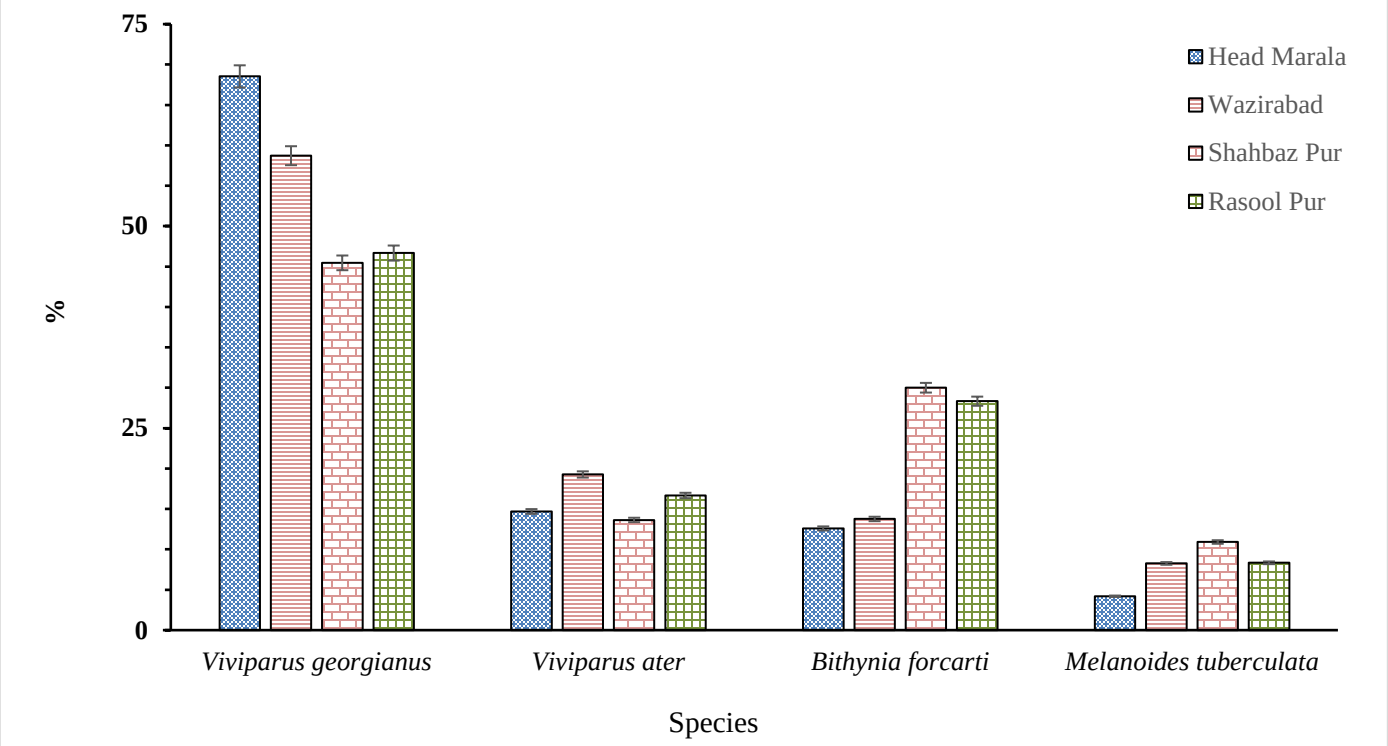


Figure 3. Relative abundance of all species collected from different study sites.

*tuberculata* was the least abundant species (10.9 %). Similarly, the data recorded from Rasool pur (33.2 %) documented maximum relative abundance of *Viviparus georgianus* (Figure 1). The study reveals a community with low diversity, primarily dominated by a few species. The Simpson's index value ranged from 0.67 to 0.49, suggesting moderate diversity across the study sites, with dominance by a single species (Table 2). The Shannon diversity index (H), which considers both the species richness and evenness, ranged from 1.23 to 0.89, indicating a fairly even distribution of species in the study sites.

**Month-wise distribution of species**

The relative abundance of species was checked over three months, October, November and December. The above bar graph illustrates the relative abundance of four species, across four selected locales along Chenab River. The key observations were that the *Viviparus georgianus* had the highest relative abundance with above 80% across all months and locales. *Bithynia forcarti* showed moderate presence ranging between 10% to 30% whereas *Viviparus ater* and *Melanoides tuberculate* showed lower abundance in most cases. The month-wise analysis showed that *V. georgian* dominated these areas while others had varying but lower relative abundance.Temporal variation in the distribution of species could also be observed from the graph. *B. forcarti* was most abundant and *V. ater* with moderate abundance was found across all the areas, whereas, *M. tuberculata* and *V. georgianus* had relatively low abundance and stable presence across all selected locales.

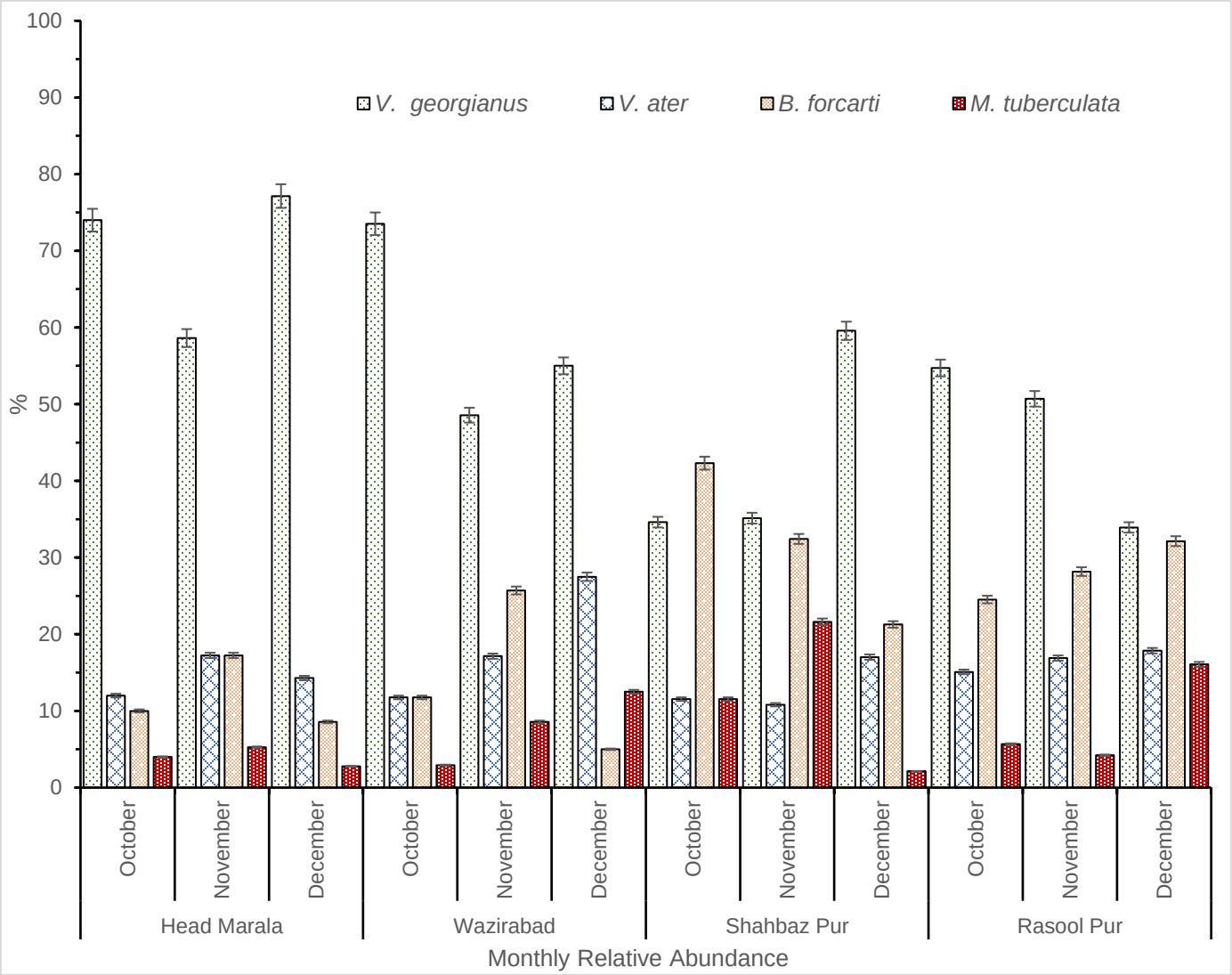


Figure 4. Relative abundance of all species from different study sites over various months.

Table 2. Diversity indices calculated for four sampling sites.

| Indices | Head Marala | Wazirabad | Shahbaz Pur | Rasool Pur |
|---|---|---|---|---|
| Taxa_S | 4 | 4 | 4 | 4 |
| Individuals | 143 | 109 | 110 | 180 |
| Dominance_D | 0.5088 | 0.4076 | 0.3271 | 0.3328 |
| Simpson_1-D | 0.4912 | 0.5924 | 0.6729 | 0.6672 |
| Shannon_H | 0.9346 | 1.1090 | 1.233 | 1.219 |
| Evenness_e^H/S | 0.6365 | 0.7577 | 0.8579 | 0.8457 |
| Brillouin | 0.8895 | 1.049 | 1.172 | 1.178 |
| Menhinick | 0.3345 | 0.3831 | 0.3814 | 0.2981 |
| Margalef | 0.6045 | 0.6395 | 0.6382 | 0.5777 |
| Equitability_J | 0.6742 | 0.7998 | 0.8894 | 0.8791 |
| Fisher_alpha | 0.7637 | 0.8159 | 0.8141 | 0.7248 |
| Berger-Parker | 0.6853 | 0.5872 | 0.4545 | 0.4667 |

Equitability measures the extent of even distribution among species in a community, with values ranging from 0 to 1, where 0 represents the lowest diversity, dominated by only one species. Although only four species were observed, their equitability values ranged from 0.89 to 0.68, reflecting fairly moderate to high diversity at different sites. A

similartrend was also observed in the index values for Menhinick, Margalef, Equitability_J, Fisher_alpha, and Berger-Parker (Table 2).

## DISCUSSION

Different parts of Pakistan have been explored for the diversity of freshwater snails. These studies reported variations in the diversity and abundance of species. For example, 41 species of freshwater snails were documented from the Pothwar region as a result of an extensive study period (Afshan et al., 2014). Similarly, 12 species of freshwater snails were reported from Quetta (Annandale, 1918). From Layari along the River Sindh, 31 species were observed, and 10 species were reported from the Indus River (Afshan et al., 2014; Burdi et al., 2008). *Melanoides tuberculata, Physella acuta, Lymnaea auricularia* and *Lymnaea acuminata f. rufescens* were present in freshwater reservoirs of Quetta, and *Melanoides tuberculata* was the most dominant species (Kakar et al., 2017). The absence of some freshwater snail species was probably due to the lack of their specific required habitat, temperature disturbance, and pollution (Kakar et al., 2017). The greater abundance and dominance of freshwater snails in the water bodies indicate plentiful food, microenvironment, and overall habitat suitability. Similarly, the current study mainly focused on the diversity of freshwater snails in four areas along the Chenab River and results showed the presence of four species' relative abundance. The relative abundance of four species varied across the study area and months. These results were supported by earlier study which revealed impact of months (seasons) and areas on the density and distribution of snails (Razi Jalali et al., 2019) . The current study is the pioneer of freshwater snail diversity in the Chenab River, highlighting the presence of four species and their relative abundance.

## CONCLUSION

Our results demonstrated the presence of four species explored from four locales along the Chenab River. Among the identified species *Viviparous georgianus* was the most abundant and *Melanoides tuberculata* was the least abundant. The current study also highlights the relative abundance of species with *V. georgianus* being consistently dominant across all the areas and months. The freshwater snail diversity specifically *V. ater* and *Melanoides tuberculata* showed the least abundance during diversity indices. These findings provide information about the diversity and relative abundance which could be further used for various conservational purposes.

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