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Initial Study of Spatial Distribution of Freshwater Gastropods in UiTM Negeri Sembilan Reserve Forest

Alya Maisarah Muhammad Radhi[1], Syazuani Mohd Shariff[1,2]*

[1] *School of Biological Sciences, Faculty of Applied Sciences*
Universiti Teknologi MARA (UiTM), Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, MALAYSIA
[2] *ECONATREA Special Interest Group (SIG), School of Biological Sciences, Faculty of Applied Sciences*
Universiti Teknologi MARA (UiTM), Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, MALAYSIA

*Corresponding Author: syazuani@uitm.edu.my
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Abstract

Freshwater gastropods are a highly diverse and ecologically significant group within the phylum Mollusca. They contribute to nutrient cycling, serve as bioindicators, and support aquatic food webs. Despite their ecological importance, very few comprehensive studies on their presence were done in UiTM Negeri Sembilan Reserve Forest. Thus, this study aims to add more knowledge regarding freshwater gastropods by determining the species' occurrence and population density in this area. Collection of samples was conducted from March to April 2024 using a quadrat method at three different sites designated as P1, P2, and P3. Observations revealed the presence of only one species, *Melanoides tuberculata*, with 430 individuals. The density recorded was 277/m^2 (P1), 168/m^2 (P2), and 128/m^2 (P3). This study provides insights into the number of freshwater gastropods from different sites in the area.

1. Introduction

This study was conducted in the UiTM Negeri Sembilan Reserve Forest, which features lowland forests with a freshwater pond. The reason why UITM Kuala Pilah has been chosen as the study site is that it could be a suitable location for researching gastropods due to its diverse range of habitats and proximity to water bodies. The geographical area has a variety of ecosystems, including forests and some bodies of water. These environments are likely to be habitat to freshwater gastropods. Moreover, being situated near water bodies like rivers or ponds, UITM Kuala Pilah provides an opportunity to determine the influence of watery environments on terrestrial gastropod distribution and abundance. Its proximity to water bodies such as tributaries and ponds facilitates the investigation of the influence of aquatic environments on terrestrial gastropod population density. Despite their ecological importance, there needs to be more comprehensive studies on freshwater gastropods in this area. Thus, this study aims to enhance the understanding of freshwater gastropods by determining species occurrence and population density in the UiTM Negeri Sembilan Reserve Forest. The data gathered will contribute to baseline knowledge of local fauna and support efforts to maintain ecological balance, conserve biodiversity, and address gastropod health implications.

Gastropods are ecologically significant and diverse across terrestrial, freshwater, and marine ecosystems worldwide. They are categorized into three main subclasses: Prosobranchia, Opisthobranchia, and Pulmonata. Among these, the Pulmonata is the most successful regarding species number and habitat diversity.

Approximately 4,000 species of freshwater snails exist, with 57 species now extinct. Freshwater snails play crucial roles in nutrient cycling, serve as a food source within aquatic ecosystems, and act as water quality indicators. They also serve as intermediate hosts for various helminthic parasites affecting humans and animals [1]. Freshwater snails' development is influenced by biotic and abiotic factors, including food availability and habitat characteristics such as pH level, humidity, and temperature [2]. The objective of this study is to determine the presence and distribution of freshwater gastropods in UITM Kuala Pilah Reserve Forest. This study only presents the *Melanoides tuberculata* and is limited to the identification and number of individuals of each species.

2. Methodology

2.1.1 Study Site

The UiTM Negeri Sembilan Reserve Forest is located in the Kuala Pilah district, Negeri Sembilan, the forest features an elevation range of 71 m to 142 m, with an average elevation of 132 m. This lowland tropical rainforest is characterized by high humidity and frequent yearly rainfall.

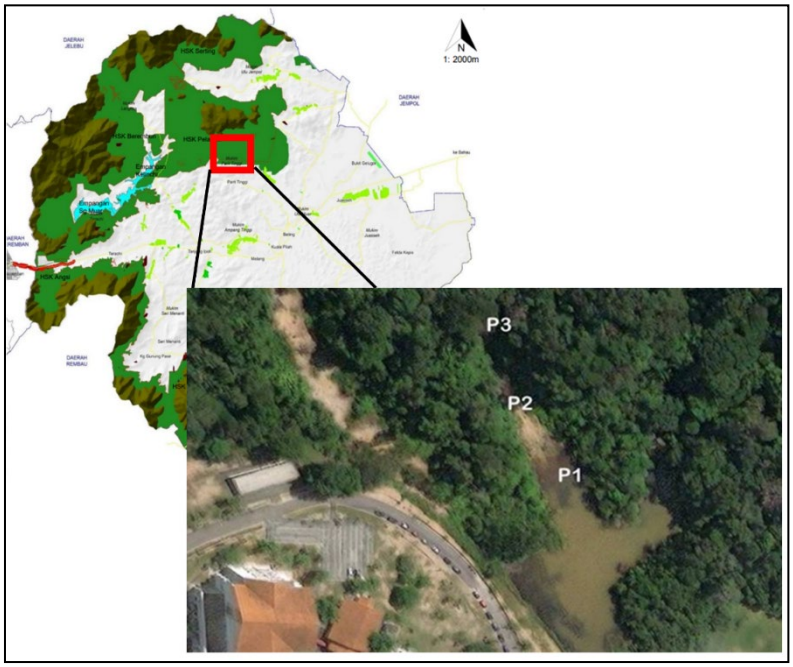

Fig. 1 *The study area (P1, P2 and P3) in UITM Kuala Pilah Reserve Forest*

2.1.2 Field Work Setup

Collection of samples and field observation was conducted from March 2024 until April 2024. Using a random quadrat sampling method, three quadrats (0.5 m x 0.5 m) were established at each site (P1, P2, and P3), with each site separated by a distance of 20 meters (Figures 2 and 3). A board trap was placed above each quadrat frame to facilitate the collection of gastropods. Since gastropods are nocturnal and most active at night, the board trap was designed to attract them to remain beneath the board. Wood debris was placed around the boards to stabilize them and maintain moisture beneath.

Gastropods were collected from both the upper and lower surfaces of the boards every two days, between March and April 2024 for 8 days. After the quadrats were set up, they were left undisturbed for two days before collecting gastropods. Gastropods found on the soil surface, as well as leaves attached to stones near the water bodies, were handpicked. All collected samples were stored in containers that filled with 4% formalin before being sent to the laboratory for further analysis.

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Fig. 2 *The 0.5 x 0.5 m of quadrat frame with board trap used for gastropods assemblage*

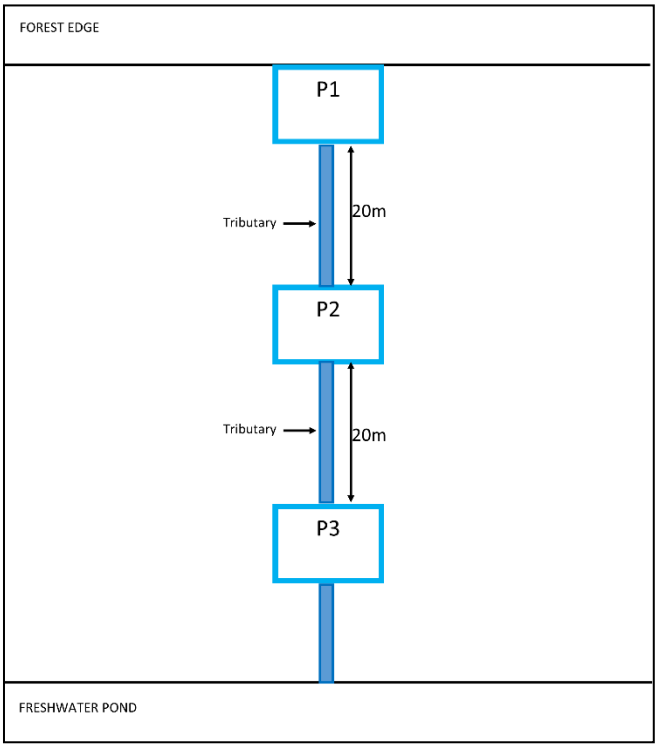

Fig. 3 *Schematic diagram of the study area*

In the laboratory, gastropods were washed with distilled water to remove sediment and surface contaminants before being stored at room temperature. After drying for one week, the samples were sorted by size and examined either using a binocular microscope or directly on the specimen. Identification was based on shell shape, color, and banding patterns. Shell peristoma height, shell width, and shell peristoma width were measured using a vernier caliper. Only specimens with undamaged shells were considered. Gastropods were identified morphologically to the lowest possible taxonomic level using a light microscope. Most individuals were identified to the species or genus level, utilizing the iNaturalist website guide (iNaturalist.org) for reference (Figure 4). After biometric data collection, specimens were fixed in 4% formalin for one week to preserve tissue structure before being transferred to 70% ethanol for long-term storage and preservation.

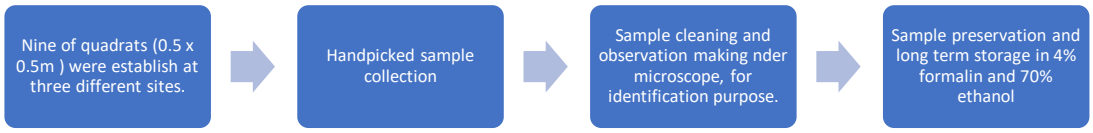

Fig. 4 *Flowchart of methodology*

2.1.3 Data Analysis

It should be noted that this study covered an area of 0.75 m^2 at each site. The gastropod density from each site was calculated using the formula:

$$\text{Density (D)} = \text{Number of Individuals} / \text{area } (m^2) \quad (1)$$

This calculation allows for comparison of gastropod densities across different sites.

3. Results and Discussion

3.1 Gastropod Densities

There was only one gastropod species that was found thriving in all the stations. The gastropod, *Melanoides tuberculata* commonly known as the Trumpet snail belongs to the family Thiaridae (Figure 5). It is a native species characterized by its 10-36 mm size and primarily inhabits freshwater environments in warm-temperate to subtropical climates. It has a broad distribution throughout subtropical-tropical regions of Africa, the Middle East, East Asia and Australia, both in its natural habitats and in areas where it has been due to its high tolerance [3]. This species can withstand wide range and abrupt changes in temperature, pH, and dissolved oxygen levels. Its adaptability enables it to endure pollutants and other habitat modifications.

Fig. 5 *Melanoides tuberculata*

In this study, a total of 430 *Melanoides tuberculata* individuals were recorded. The highest number of individuals, 43, was observed at site P1 during Sampling 2 (S2), while the lowest counts were 3 at site P3 during Sampling 5 and at site P2 during Sampling 8 (Figure 6 and Table 1). Site P1, located near shallow freshwater tributaries (Figure 1 and Figure 7), exhibited the highest abundance. *Melanoides tuberculata* thrive in environments with a depth range of 0.25–3.7 meters and low current velocity streams [4].

Figure 6 shows the total number of individuals per site: 208 at P1, 126 at P2, and 96 at P3. Site P1 had the highest abundance near a freshwater pond (Figure 7). Site P2 is located at the transition between the freshwater pond and the forest edge (Figure 8), while P3 is positioned closer to the forest edge (Figure 9). The observed fluctuations in abundance across sites suggest potential environmental changes or behavioral adaptations over time. Increased abundance in certain quadrats may be linked to favorable pH levels, as gastropods thrive in

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specific pH ranges necessary for optimal shell formation and metabolic functions [5]. Areas with higher organic matter might support greater gastropod populations due to increased food availability [6]. Conversely, lower counts in some quadrats may indicate adverse conditions such as pollution, lack of shelter, or heightened predation pressure [7].

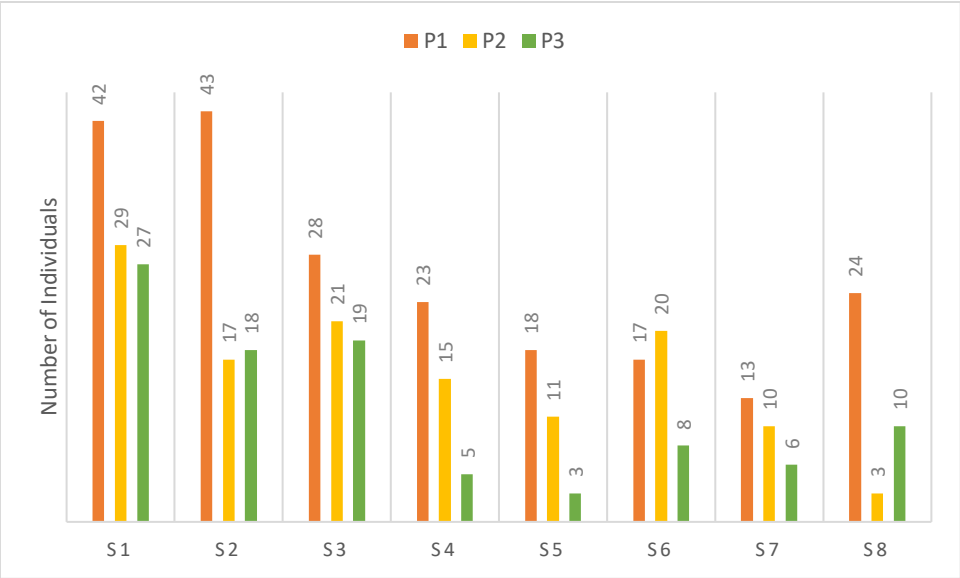

Fig. 6 *Number of individuals of Melanoides tuberculata in UiTM Negeri Sembilan Reserve Forest*

Fig. 7 *The P1 study site. Note: Red box- the quadrate, yellow box – freshwater pond*

Fig. 8 *The study site (P2) at transitional area between pond and forest edge*

Fig. 9 *The study site (P3) near forest edge*

3.2 Population Density

In this study, a total of 430 *Melanoides tuberculata* individuals were recorded. The highest number of individuals, 43, was observed at site P1 during Sampling 2 (S2), while the lowest counts were three at site P3 during The population density of *Melanoides tuberculata* was highest at site P1 (277/m^2), followed by P2 (168/m^2) and P3 (128/m^2) (Table 1). The lowest density at P3 can be attributed to its greater distance from the freshwater pond. While tributaries were present at P3, temperature and water depth factors likely influenced the lower density [8].

Additionally, P3's location near the forest edge exposed it to desiccation, unlike P1, which was closer to the pond and had more stable environmental conditions.

The population density was also affected by desiccation stress, salinity, and sediment characteristics [9]. The study period, March to April 2024, coincided with a period of low rainfall, which influenced water quality and, consequently, the number of gastropods collected [10].

Table1 *Population density (no. of individual /m2) of Melanoides tuberculata in UiTM Negeri Sembilan*

Site	P1	P2	P3
Population density (no. of individual /m^2)	277	168	128

Additionally, vegetation near water bodies, such as the false staghorn fern (*Dicranopteris linearis*, Figure 10), can provide shelter and reduce gastropod predation risk [11]. The absence of aquatic vegetation can increase predator exposure, leading to lower gastropod populations. Moreover, the aquatic vegetation and environment, particularly at P1, are richer in organic matter and nutrients, such as decomposing plants and debris. According to [12], this organic matter accumulates in water bodies and is a crucial food source for gastropods. Quadrats near water bodies benefit from this nutrient influx, supporting larger populations of gastropods. In contrast, P3, being farther from water bodies, likely has lower nutrient availability, which reduces the food resources available for gastropods.

Fig. 10 *False staghorn fern or Dicranopteris linearis at P1*

4. Conclusion

This study identified the species of freshwater gastropods and assessed their population density in the UiTM Negeri Sembilan Reserved Forest. *Melanoides tuberculata* was the only species found (430 individuals), with population densities recorded at 277/m^2 in P1, 168/m^2 in P2, and 128/m^2 in P3. Future research could explore additional habitats and sites not covered in this study to assess the extent of invasion and contribute to understanding the available biodiversity. Expanding the spatial and temporal coverage in future studies would allow for a more comprehensive analysis of the reserve forest's water bodies. Long-term monitoring of *Melanoides tuberculata* population dynamics and their interactions with other species is crucial for understanding their long-term impact in the region.

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Conflict of Interest

Authors declare that there is no conflict of interest regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: ***study conception and design:*** *Alya Maisarah Mohammad Radhi, Syazuani Mohd Shariff;* ***data collection:*** *Alya Maisarah Mohammad Radhi;* ***analysis and interpretation of results:*** *Alya Maisarah Mohammad Radhi, Syazuani Mohd Shariff;* ***draft manuscript preparation:*** *Alya Maisarah Mohammad Radhi, Syazuani Mohd Shariff. All authors reviewed the results and approved the final version of the manuscript.*

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