UMT PRESS
Universiti Malaysia Terengganu Journal of Undergraduate Research
Journal Homepage: https://journal.umt.edu.my/index.php/umtjur/
eISSN: 2637-1138
DOI: http://doi.org/10.46754/umtjur.2026.04.002

MORPHOMOLOGICAL MEASUREMENT OF *Brotia* sp. AND ITS SEDIMENT GRAIN SIZE PREFERENCES AT KEMAMAN AND SETIU, TERENGGANU

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ARTICLE INFO

Article History:
Received: 25 August 2024
Revised: 10 August 2025
Accepted: 21 August 2025
Published: 15 April 2026

Keywords:
Brotia sp., freshwater, morphology, sediment grain size, sustainability.

ABSTRACT

Brotia sp. is a freshwater snail that belongs to phylum Mollusca under the family Pachychilidae. *Brotia* sp. has variations in its morphological characteristics such as shape, size, and occupied different type of environments. However, this species has been reported to be in decline especially in the east coast of Peninsular Malaysia. Currently, there is a gap in determining its morphological features and preferences of sediment chosen by *Brotia* sp. Therefore, this study aims to provide baseline information on morphological features of *Brotia* sp. and to investigate sediment grain size and total carbon content associated with their habitat. Sampling was carried out at two sites which are Felda Cherul, Kemaman and Sungai Sri Bayas, Setiu. All samples were measured for shell length and width. Sediment samples were collected and sieved through seven different mesh sizes. Total carbon in sediment samples was also determined by using Loss on Ignition (LOI) method. 67 individuals from each site were measured. In Kemaman, shell length of *Brotia* sp. ranged from 5.50 to 7.80 cm (mean, 6.57 ± 0.64) meanwhile the width ranged from 1.70 to 2.50 cm (mean, 2.06 ± 0.23). In Setiu, the shell length of *Brotia* sp. ranged from 2.10 to 5.80 cm (mean, 4.28 ± 1.03) and the width ranged from 1.00 to 1.90 cm (1.46 ± 0.25). In addition, the sediment at Felda Cherul, Kemaman had the highest percentage composition of grain size at 500 µm (coarse), accounting for 41%, while the total carbon content in the sediment was recorded at 3.8%. This study provides baseline information about *Brotia* sp. Which is beneficial for the management and sustainability of the species. Further investigation on their ecological importance in the freshwater ecosystem is recommended.

Introduction

Brotia sp. is one of the edible freshwater snails that belongs to family Pachychilidae known as "*siput sedut hitam*" with worldwide distribution (Figure 1). The abundance and size of *Brotia* sp. have decreased over time (based on personal communications with the locals), suggesting that this species is exploited by the locals as a food source from its natural habitat without proper control. Anthropogenic disturbance may also contribute to the reduction in the abundance and size of this species over time. This species is distributed in Southeast Asia, ranging from the foothill of Himalayan mountains in northeastern India and Bangladesh to Myanmar, Thailand, the Malay Peninsula, Sumatra, Java, and Borneo (Kohler & Glaubrecht, 2006). Jambari

(1990) had collected *Brotia* sp. primarily from the plains and hills on the east and west of the central mountain range in Peninsular Malaysia. The family of *Brotia* sp. was previously merged within the so-called "melanians" or "Melaniidae", which represent a polyphyletic assemblage of freshwater snails (Glaubrecht, 1999; Lydeard *et al.*, 2002).

These gastropods exhibit remarkably diverse characteristics, particularly their reproductive system. *Brotia* is well defined based on key morphological characters and analyses of mitochondrial sequences (Kohler *et al.*, 2004). This species has distinctive characteristics, including a shell composed of calcium carbonate, and its traits can be identified based on the shape, size, and colour (Dance, 1992). The *Brotia* sp. has twisted rough body consists of head, foot, and mantle that are covered by single coiled shell (Carpenter & Niem, 1998). According to Campbell *et al.* (1999), snails have radula for crushing up its food. Hickman *et al.* (2015) reported that the muscular foot has flat base for movement, while its operculum is used for protection and to prevent water loss. *Brotia* sp. inhabits flowing water from rivers and creeks (Kohler & Glaubrecht, 2006; Kohler *et al.*, 2009). Most species of *Brotia* are considered to be poorly distributed geographically due to their restricted and isolated habitats (Kohler & Glaubrecht, 2001, 2006). Kohler and Glaubrecht (2001) hypothesized that *Brotia* sp. might represent an ancient lineage of Tertiary or even Mesozoic origin.

Gastropods are known to play important roles in transforming nutrients in sediment (Strong *et al.*, 2008). The downstream changes in flow resistance and sediment transportation are closely related to rate of change in sediment size (Surian, 2002). Sediment is made up of loose particles of sand, silt, and clay. The particle size refers to the diameter of individual grains of sediment (Das, 2016), which is a fundamental descriptive measure in any environment (Mohtar, 2017). Changes in sediment structure may also compromise the existing benthic diversity (Chen & Bendell, 2013). Previous studies conducted in Borneo on *Brotia* sp. was mainly focused on morphology and taxonomy (Kohler *et al.*, 2004). In Peninsular Malaysia, a preliminary survey had been conducted to measure only four individuals of the *Brotia* sp. at Lata Changkah, Setiu, Terengganu (Omar *et al.*, 2016). In order to add more data on this species, studies of similar nature have been conducted at different places in Terengganu. Many freshwater gastropods, including *Brotia* species are sensitive to environmental changes such as pollution, sedimentation, and habitat modification. By linking morphological traits and sediment characteristics to the species' health and abundance, researchers can develop better conservation strategies and monitor environmental impacts.

Figure 1: Photo of *Brotia* sp. in Terengganu

Materials and Methods

Sampling Site

The sampling was conducted at two locations in Terengganu specifically in Felda Cherul, Kemaman (4°07'42" N, 103°09'56" E) and Sungai Seri Bayas, Setiu (5º29'03" N, 102º42'28" E) (Figure 2). Samples were collected by hand during low tide to facilitate easier sampling. Three study plots, each measuring 10 m x 10 m were established. Three replicates of sediment samples were also collected for grain size analysis. The samples and sediments were transferred to a plastic bag and were labelled with date and plot numbers. Figure 3 shows the area in Felda Cherul, Kemaman and Sungai Seri Bayas, Setiu.

Sungai Seri Bayas, Setiu

Cherul, Kemaman

Figure 2: Map of Felda Cherul, Kemaman and Sungai Seri Bayas, Setiu

(a) (b)

Figure 3: Sampling site at (a) Felda Cherul, Kemaman and (b) Sungai Seri Bayas, Setiu

Morphological Characteristics

The shell length (Figure 4) of each individual of *Brotia* sp. was measured.

Figure 4: Measurement of shell length (A-B) and shell width (C-D) of *Brotia* sp.

Sediment Grain Size and Total Carbon

Sediment samples were collected from Felda Cherul, Kemaman and Sungai Seri Bayas, Setiu. However, only the sample from Felda Cherul was analysed for grain size composition because the sample from Sungai Seri Bayas, Setiu was unintentionally destroyed before the process. Due to practical constraints, particularly time limitations associated with final year project, new sediment samples could not be collected; therefore, sediment grain size and total carbon data were not included in this study. Nevertheless, since the sediments at Felda Cherul has not been previously investigated, reporting sediment grain size from this site provides valuable baseline data for future comparisons and long-term monitoring. Sediment samples were air dried prior to analysis. 50 g of dried sediment were crushed with mortar and sieved through a stack of 7 different mesh size on an automated sieve shaker starting with 1,000 µm for very coarse grain (VC1,000), followed by coarse: 500 µm (C500), medium-coarse: 355 µm (MC355), medium: 250 µm (M250), medium fine: 125 µm (MF125), fine: 63 µm (F), and ultra-fine: < 63 µm (UF). The weight of sediment in each sieve was calculated in percentage for grain size composition. 10 grams of sediment sample from the site was burnt in a furnace at temperature of 700°C for approximately 5 hours. The sample was weighted again when cooled to calculate amount of lost carbon. The amount of carbon was also represented in percentage (Jaafar *et al.*, 2018).

Data Analysis

As the data were normally distributed, an independent t-test was used to analyse the differences in mean measurements (shell length and shell width) between samples from Felda Cherul, Kemaman and Sungai Seri Bayas, Setiu using Statistical Package for the Social Sciences (SPSS) software.

Results and Discussions

Morphological Characteristics of Brotia sp.

Table 1 shows the shell length and shell width of *Brotia* sp. from Felda Cherul, Kemaman and Sungai Seri Bayas, Setiu. The length

and the width of *Brotia* sp. of Felda Cherul, Kemaman is considered larger in size compared to the measurement of samples from Sungai Seri Bayas, Setiu. The Independent t-test analysis showed significant difference in terms of two measurements between both sites ($p < 0.05$).

Table 1: The shell length and shell width of *Brotia* sp. from Felda Cerul, Kemaman and Sungai Seri Bayas, Setiu

Morphological Characteristics (cm)	Felda Cherul, Kemaman		Sungai Seri Bayas, Setiu	
	Range	Mean ± SD	Range	Mean ± SD
Length	5.50–7.80	6.57 ± 0.64	2.10–5.80	4.28 ± 1.03
Width	1.7–2.5	2.06 ± 0.23	1.00–1.90	1.46 ± 0.25

Comparatively, Omar *et al.* (2016) recorded that the length and width of *Brotia* sp. measured 2.4 cm and 0.98 cm, respectively, at Lata Changkah, Setiu, Terengganu. Kohler and Glaubrecht (2002) reported that the length and width of *Brotia praetermissa* were 5.84 cm and 2.2 cm, respectively in Borneo. These measurements were smaller than the mean dimensions of *Brotia* sp. recorded in Felda Cherul, Kemaman.

Sediment Grain Size and Carbon Content

The composition for sediment grain size in Felda Cherul, Kemaman is depicted in Figure 5. The highest percentage composition of grain size is coarse (500 µm) at 41%, followed by very coarse grain (1,000 µm) at 34%, with the remaining 25% comprising medium-coarse to ultra-fine grains. According to Ong *et al.* (2012), coarse sediments occurred at higher water movement from rivers during the wet season, while finer sediments are transported out to sea. This explains the higher presence of coarse grains (500 µm) compared to other sediment grain sizes in this study. According to Donohue and Irvine (2003), snail feeding behaviour is affected significantly by sediment particle size, showing increasing severity of impact with decreasing particle size. It is suggested that runoff from subcatchments with soil or bedrock that produce fine-grained sediments may have disproportionate detrimental effects on littoral biota and, therefore, have important implications for ecosystem and biotic community structure.

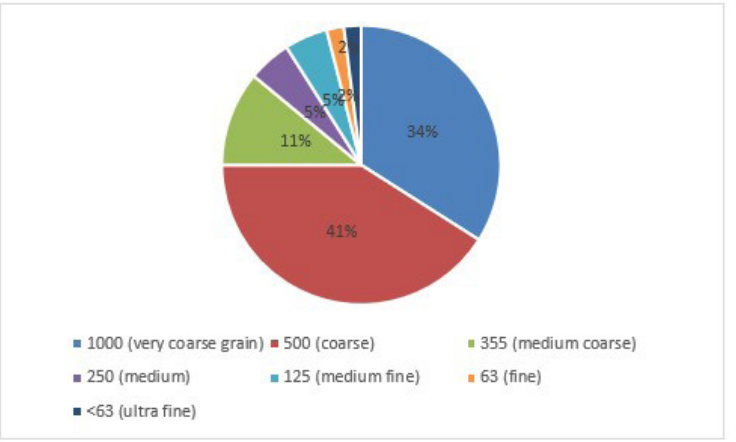

Figure 5: The composition of sediment grain size associated with *Brotia* sp. in Felda Cherul, Kemaman

Total carbon refers to carbon that is contained in soil organic matter (De Falco *et al.*, 2004). The results showed that the total carbon content at Felda Cherul, Kemaman was approximately 3.8%, indicating that *Brotia* sp. prefers sediment with this level of total carbon. Carbon content analysis could not be conducted on the sediment sample from Sungai Seri Bayas, Setiu, as the sample was unintentionally destroyed prior to analysis. According to De Falco *et al.* (2004), sediment grain size influences the total carbon, as smaller grains are associated with higher total carbon levels in soil. As Felda Cherul has not been previously investigated, the sediment grain size data presented here serve as baseline information for future studies and long-term monitoring.

Conclusions

The length and width of *Brotia* sp. in Kemaman were greater than those recorded in Sungai Seri Bayas, Setiu. Regarding sediment grain size, coarse grains (500 μm) were the dominant type in Felda Cerul, Kemaman. This study provides baseline data that can support the management and conservation of *Brotia* sp. and their ecosystem.

Acknowledgements

We would like to thank the Faculty of Science and Marine Environment of Universiti Malaysia Terengganu for providing the necessary equipment and facilities for the completion of this project.

Conflict of Interest Statement

The authors agree that this research was conducted in the absence of any self-benefits, commercial, or financial conflicts and declare absence of conflicting interests with the funders.

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