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MORPHOLOGICAL MEASUREMENT AND ABUNDANCE OF MANGROVE CLAM *(Geloina expansa)* AND ITS SEDIMENT GRAIN SIZE PREFERENCES AT PULAU SUTUNG AND PULAU BUSUNG, SETIU WETLANDS, TERENGGANU

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Abstract: *Geloina expansa* is an infaunal filter-feeding clam species found in mangrove forests. They are important for both the human and aquatic ecosystems. There is not a lot of information about the morphological measurement, abundance and sediment grain size at Pulau Sutung and Pulau Busung. This study aims to determine the shell size measurements, the abundance and the composition of sediment grain size in these sites. Line transects were used for samples and sediment collection in a plot at Pulau Sutung and Pulau Busung. Twenty samples from each site were measured. The grain size and total carbon percentage were obtained using a sieve shaker and ignition method. Independent t-tests were conducted using SPSS for abundance density and measurements between the two sites. 155 specimens (Pulau Sutung = 90; Pulau Busung = 65) were collected. However, the abundance density between the two sites was insignificant. The most dominant grain size in Pulau Sutung was C500 whereas VC1000 was dominant in Pulau Busung. Mean shell length (= 55.35 mm ± 6.39) and height (= 52.51 mm ± 6.14) in Pulau Busung was greater than in Pulau Sutung (= 53.21 mm ± 6.39; = 51.10mm ± 6.49), respectively. However, the mean shell width in Pulau Sutung (= 31.30 mm ± 3.20) was greater than in Pulau Busung (= 31.19 mm ± 4.05) but measurements were insignificantly different between the sites. This result will be useful to establish a baseline of data and also for the management and sustainability of the species. Future studies must be done by considering water parameters and collecting more samples from more sites in Setiu Wetlands.

Keywords: Abundance, bivalve**,** *Geloina expansa*, sediment, sustainability.

Introduction

Geloina expansa or a mangrove clam is a bivalve species which most Malaysians normally call 'lokan' (Figure 1). They are found in the aquatic environment of the mangrove forest area. It is classed under Family Cyrinidae and its shell shape is trigonal-ovate by outline (Albert *et al*., 2022) and shell colours are greenish-brown and yellowish-brown (Poutier, 1998). *G. expansa* is infaunal and feeds through filter feeding (Printrakoon *et al*., 2008). They are important to humans as food sources and medicine (Mohd Hamdan *et al*., 2020) and to aquatic ecosystems as bioindicators (Yahya *et al*., 2020).

Mangrove forests are dominated by mangrove trees that grow in coastal areas in subtropical and tropical regions, which have warm and humid climates. Mangrove trees are highly adaptive to high salinity and the anaerobic conditions of the mangrove ecosystem (Kathiresan & Bingham, 2001). The Setiu Wetlands, Terengganu has a mangrove forest with 33 mangrove tree species (Salim *et al*., 2020). The richness of natural resources in Setiu Wetlands mangrove forest is important to the livelihood of the locals (Ling *et al*., 2013).

Sediment grain size is crucial for bivalves' burial activity and juveniles' growth, survival and settlement (Tezuka *et al*., 2013; Fiori & Carcedo, 2015; Joo *et al*., 2021). The size of bivalves can influence their burial capability

and also influence people's preferences when harvesting (Dolorosa & Dangan-Galon, 2014; Fiori & Carcedo, 2015). Harvesting of *G. expansa* has no restriction due to their Least Concern status (Anunciado *et al*., 2021)**.** Yahya *et al*. (2018) stated that the harvest level is optimal in Setiu Wetlands so their population is maintained. However, their abundance can drop if not harvested sustainably (Anunciado *et al*., 2021), Alongi (2002) also stated that the mangrove ecosystem has been threatened by human activities. In Setiu Wetlands, Salim *et al*. (2020) reported that many mangroves were converted into aquaculture and infrastructural sites. There is very limited information about the morphological characteristics and abundance of *G. expansa* and its sediment grain size in Pulau Busung and Pulau Stung, Setiu Wetlands. Therefore, this study was conducted to determine the measurement of the length, height and width and the abundance of *G. expansa*, and its sediment grain size preferences in these locations.

Figure 1: Photo of *Geloina expansa* in Setiu Wetlands

Materials and Methods

Sampling Site

This study was conducted at Pulau Sutung (5° 39’ 54.0576” N, 102° 44’ 4.8156” E) and Pulau Busung (5° 39’ 15.1812” N, 102° 44’ 55.374” E). Both are located in the Setiu Wetlands (Figure 2). Setiu Wetlands (5°41’19”N, 102°42’4”E) is located in the Setiu District, Terengganu, Malaysia.

Figure 2: Study sites at Pulau Sutung and Pulau Busung in Setiu Wetlands (Source: Google Maps)

Sampling Site and Morphological Experiment

The sampling method used three transect lines (30 m) that were parallel to each other and the distance between the lines was 20 m during low tide. Three quadrats (1 m x 1 m) were placed randomly along every 10 m of the line. The *G. expansa* specimens were obtained through handpicking. Then, the collected specimens were put into plastic bags labelled with quadrat number, transect number and site name. Twenty individuals of *G. expansa* were taken out randomly of the sediment for morphological study. The length (the longest anterior-posterior distance of the shell), height (dorsoventrally) and width (lateral axis between two valves) of the samples were measured by using a vernier caliper to the nearest 0.1 mm (Yahya *et al*., 2018).

Sediment Analysis

Prior to analysis, sediment samples were air-dried under sunlight for seven days. After they had dried, 400 g of sediments were ground using pestle and mortar to dry the sediments completely. Then, the 400 g of sediments were sieved through a stack of seven different mesh sizes on an automated sieve shaker, which started with 1000 µm for very coarse grain (VC1000), followed by coarse: 500 µm (C500), medium coarse: 355 µm (MC355), medium: 250 µm (M250), medium fine 125 µm (MF125), fine: 63 µm (F63) and ultra-fine: < 63 µm (UF). The sieve shifting took about 15 minutes. The sediment grain size for each layer was represented in percentage (Jaafar *et al*., 2018). The loss on ignition method was used to determine the total carbon in a sediment samples. Ten (10) grams of sediment sample from each site were burnt in a furnace at a temperature of 700°C for approximately 5 hours. The samples were weighed again after cooling to obtain the amount of carbon that had been lost. After that, the amount of carbon was calculated and represented in percentages (Jaafar *et al*., 2018).

Data Analysis

Independent t-test was used to analyze the difference of mean abundance density (ind/m^2). Mean abundance density was measured by dividing the total number of individuals in three transects (9 quadrats) with quadrat size (9 m^2) and mean measurements between Pulau Sutung and Pulau Busung by using SPSS software. It was decided to use an independent t-test after conducting a normality test using SPSS software to determine whether the data is normally or not normally distributed.

Results and Discussion

Measurements of G. expansa

The external morphology of *G. expansa* between the two populations was measured and recorded (Table 1). Based on Table 1, the length and height of *G. expansa* of Pulau Busung could be considered larger in size than Pulau Sutung. However, the Independent t-test analysis showed an insignificant difference in terms of the two measurements between both sites. There was also no significant difference in terms of *G. expansa* width between the two sites. Studies have been done only on the measurement of the length of *G. expansa* which ranged from between 10.50 mm to 72.50 mm in Setiu Wetlands (Yahya *et al*. (2018). These measurements are lower than this present study (Table 1). According to Argente and Ilano (2021), *G. expansa* with length of around 61 mm are below two years of age. Syahputri *et al*. (2023) stated *G. expansa* with sizes of 51 mm to 90 mm are considered mature adults. Therefore, it can be assumed that most *G. expansa* collected in Pulau Sutung and Pulau Busung were also two years and below based on their mean lengths and may be mostly adults. Based on Purroy *et al*. (2018), differences in shell sizes can be influenced by water temperature and food availability that affect shell growth. Fiori and Carcedo (2015) stated that the size of the shell can impact the speed of bivalves to bury themselves completely which larger the shell size the longer the time for complete burial.

Table 1: The morphological measurement of *G. expansa* from (Pulau Sutung and Pulau Busung)

Morphological Characteristics (mm)	Pulau Sutung		Pulau Busung	
	Range	Mean ± SD	Range	Mean ± SD
Length	45.42 - 63.17	53.21 ± 6.39	41.90 - 58.80	55.35 ± 6.39
Height	33.99 - 60.00	51.10 ± 6.49	41.65 - 63.75	52.51 ± 6.14
Width	26.00 - 34.76	31.30 ± 3.20	23.62 – 34.75	31.19 ± 4.05

G. expansa Abundance in Pulau Sutung and Pulau Busung

Based on Figure 3, the total number of *G. expansa* collected from both study sites was 155 individuals. Pulau Sutung had more individuals with 90 individuals collected compared to Pulau Busung with 65 individuals. In Pulau Sutung, transect 2 had 35 individuals which is the most whereas transect 3 was the least with 25 individuals. Transect 3 (27 individuals) in Pulau Busung had the most specimens followed by transect 2 (20 individuals), and transect 1 (18 individuals) had the least samples.

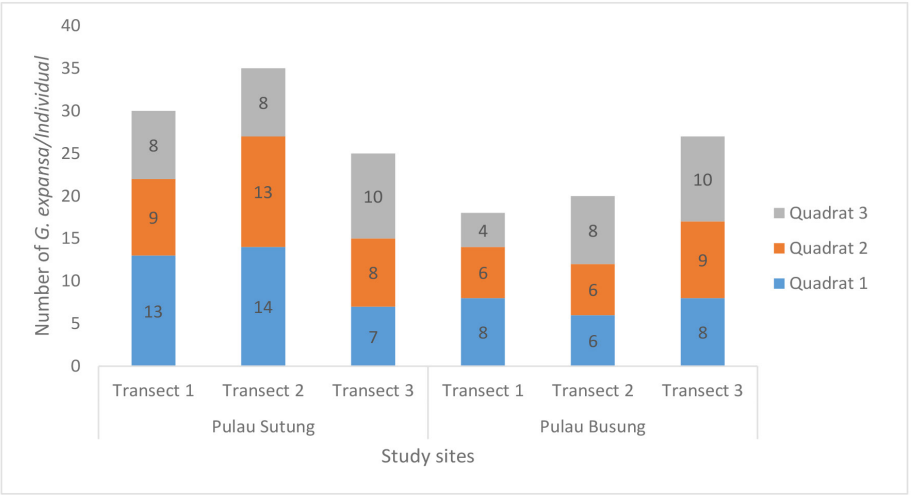

Figure 3: Number of individuals of *G. expansa* at Pulau Sutung and Pulau Busung

Pulau Sutung had a mean abundance density of 10 individuals/m^2 which is greater than in Pulau Busung (7.22 individuals/m^2). Hence, *G. expansa* abundance in Pulau Sutung is denser compared to Pulau Busung. However, the independent t-test analysis showed that there were no significant differences of mean abundance density between Pulau Sutung (= 10 ± 1.67) and Pulau Busung (= 7.22 ± 1.57). A Study by Bahari *et al*. (2021) in an unspecified area of Setiu Wetland found the abundance density of *G. expansa* ranges from 21 to 47 individuals/m^2 which is greater than this study's findings. *G. expansa* were mostly found in areas with *Avicennia* sp. mangrove trees. However, mangrove trees in this study's plots were unidentified. As stated before that the mean abundance density had no significant difference between the two sites. However, *G. expansa* were seen more at Pulau Sutung as compared to Pulau Busung and that can be explained based on Elisabet *et al*. (2010) findings where *G. expansa* was abundant in areas with numerous mangrove trees. This is in line with this study although the

plot in Pulau Sutung consisted of many young and short mangrove trees and the plot was situated near to denser mature mangrove trees. A study site in Pulau Busung also comprised of young mangrove trees but not as many as Pulau Sutung. Mangrove trees function as shades to cover the *G. expansa* and protect it from getting hit by high intensity of sunlight. Moreover, the trees produce more organic matter which a food source for bivalves (Elisabet *et al*. (2010). This may explain the high abundance of *G. expansa* and carbon content at Pulau Sutung compared to Pulau Busung.

Sediment Grain Size and Total Soil Carbon Percentage

Based on Figure 4, coarse grain size (C500) was the most dominant in Pulau Sutung which at 36%. The second most dominant were very coarse grain size (VC1000) and medium coarse grain size (MC355) which shared the same percentage value of 17%. Next, the ultra-fine grain size (UF < 63) was the lowest consisting of 6% followed by fine grain size (F63) which was 2%. Also, in Figure 4, very coarse grain size (VC1000) dominated at Pulau Busung with a value of 36%. Coarse grain size (C500) was the second most dominant consisting of 36%. Next, the least dominant grain size which was ultra-fine grain size (UF < 63) was only one percent less than fine grain size (F63). Meanwhile, the total carbon percentage of the Pulau Sutung sediment sample was 1% which was greater than Pulau Busung's sediment sample (0.5%).

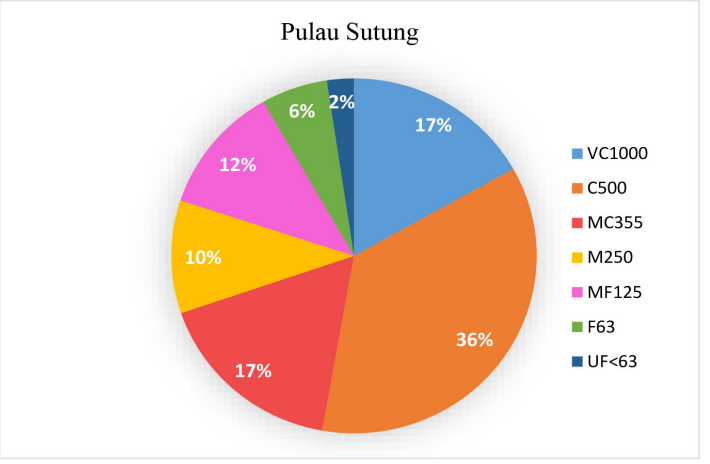

Figure 4: Composition of grain size (%) of Pulau Sutung and Pulau Busung in Setiu Wetlands

Coarse grain size (C500) was the second most dominant consisting of 36%. Next, the least dominant grain size which was ultra-fine grain size (UF < 63) was only one percent less than fine grain size (F63). Meanwhile, the total carbon percentage of the Pulau Sutung sediment sample was 1% which was greater than Pulau Busung's sediment sample (0.5%).

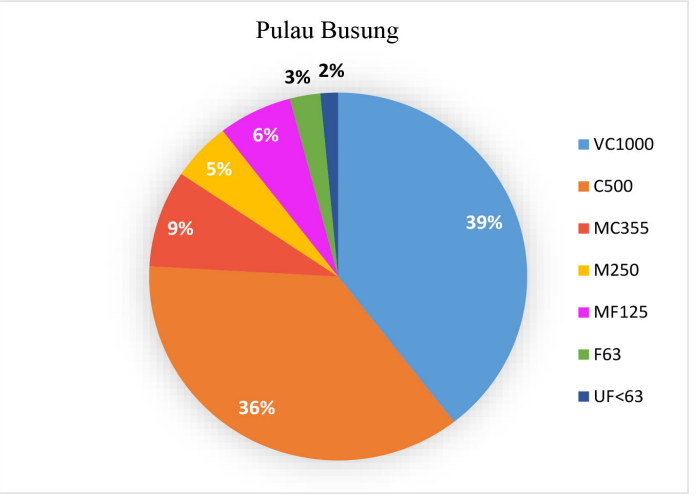

Figure 4: Composition of grain size (%) of Pulau Sutung and Pulau Busung in Setiu Wetlands

Coarse grain size (C500) being dominant in Pulau Sutung is in line with two study plots. and ultra-fine size (UF < 63) being the least dominant is in lines with all plots in Setiu Wetlands by Bahari *et al*. (2021) and found the highest abundance density of *G. expansa* was found in the plot where medium fine grain size (MF125) is dominant. MF125 grain percentages was lesser in Pulau Sutung and Pulau Busung which might be the reason for the lesser abundance density compared to Bahari *et al.* (2021). In addition, M125 in Pulau Sutung was two times bigger than in Pulau Busung which might explain the higher abundance in Pulau Sutung, De La Huz *et al.* (2002) found that younger Donax sp. were able to burrow quicker in medium and coarse sediments (M250-VC1000) while larger, but older of the same species burrowed faster in fine to medium grain size (MF125-C500). Fiori and Carcedo (2015) stated bivalves take a shorter burial time in grain size MF125 to C500, but a longer time in grain size UF < 63 to MF125 and grain size C500 to VC1000. However, it is difficult to estimate the actual preferred grain size of *G. expansa* in P. Sutung and P. Busung since correlation analysis between grain size and abundance was not done because of insufficient samples of sediment. The metabolic rates in bivalves are high in fine and medium grain size compared to coarse to very coarse size. The weak and low cohesion ability of larger grain sizes would result in a high loss of energy for bivalves compared to smaller grain sizes (De La Huz *et al*., 2002). Syahputri *et al*. (2023) stated that smaller sediment sizes could contain more organic matter. Pulau Sutung has a higher composition of small grain sizes than Pulau Busung which might cause Pulau Sutung to have more carbon content than Pulau Sutung.

Conclusion

In conclusion, the morphological characteristics, the abundance and the sediment grain size preferences of *G.expansa* from two different sites have been determined. However, the length, height, width, and abundance for both sides were not significantly different. Meanwhile, for sediment grain size, C500 grain size was dominant in Pulau Sutung whereas VC1000 was dominant in Pulau Busung. UF < 63 grain size was the least dominant at both sites. This result will be useful to establish a baseline of data and also for the management and conservation of *G.expansa* and their ecosystem.

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