Length-weight relationship (LWR) of mud crabs (Scylla sp.) in mangrove waters Peukan Bada Aceh Besar as the basic for waters resources development

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Abstract. Mud crab (Scylla sp.) is one of the aquatic resources that has high economic value so that the information on length-weight relationships is important for sustainable fisheries management. The objectives of this study were to determine the abundance of mud crab (Scylla sp.), the sex ratio of mud crab (Scylla sp.) and to analyze the length-weight relationship of mud crabs (Scylla sp.). This study was conducted in April 2019. Sampling of mud crabs (Scylla sp.) was carried out by using a bubu crab trap with the random sampling method. The bubu size is in length 47 cm, width 31 cm and height 19 cm. The sampling at each station was repeated three times during low tide conditions. Sampling location was determined by using the stratified random sampling method. The results of the analysis showed that sampled number of mud crabs (Scylla sp.) in the mangrove waters of Peukan Bada were 90 individu, consisting of 50 female mud crabs and 40 male mud crabs. Therefore, sex-ratio in mud crabs (Scylla sp.) shows that the sex ratio between male and female individuals is still in a balanced state. The growth pattern were negative allometric (b<3), which means that the growth pattern of carapace length is faster than the body weight of mud crabs. The results also showed that the correlation coefficient (r) values for male and female mud crabs were 0.89 and 0.94, respectively. This indicates a close relationship between length and weight of mud crabs. Environmental parameter factors such as salinity and temperature greatly affect the growth pattern of mud crabs and sex ratio in the mangrove waters Peukan Bada, Aceh Besar.

1. Introduction
The area of Peukan Bada Aceh Besar has a large mangrove area with a muddy and sandy substrate. According to Kusmana et al. [1] the mangrove ecosystem plays an important role in supporting the life of the organisms. The presence of mangrove vegetation determines the presence and abundance of marine biota such as Gastropods, Bivalves (Molluscs) and mangrove crabs (Crustacea) [2]. One of the biota that has important economic value is the mangrove crab (Scylla sp.) which lives in relatively...
shallow waters, with a muddy bottom [3]. *Scylla* sp. has strong adaptation to mangrove forests and has a large distribution area due to mud crabs (*Scylla* sp.) have a wide tolerance to abiotic factors, especially at temperature and salinity [4]. The existence of *Scylla* sp. in mangrove habitat is very important to study because of its role in ecological and economic functions. Therefore, it is important to conduct a structured study on the relationship between mangrove crab abundance (*Scylla* sp.) and mangroves abundance, determine the sex ratio of mangrove crabs and the relationship between carapace width and weight of mangrove crabs as an effort for development waters resources.

Several studies on the abundance of mangrove crabs have been conducted, including Putra et al. [5] who studied the abundance of mangrove crabs (*Scylla* sp.) in the mangrove rehabilitation area Pulo Sarok, Singkil District, Aceh Singkil Regency and Kasril et al. [6] examined the factors condition and relationship between length and weight carapace of mangrove crabs (*Scylla serrata*) in Aceh Singkil waters.

Research on the relationship of mangrove crab abundance (*Scylla* sp.) to mangrove density in Peukan Bada District, Aceh Besar has not been conducted yet. Hence, the objectives of this study were to determine the abundance of mud crab (*Scylla* sp.) and the density of mangroves in the Peukan Bada, determine the sex ratio of mud crab (*Scylla* sp.) and the relationship between carapace width and weight of mud crabs (*Scylla* sp.).

2. Material and Methods

2.1. Sampling

This research was conducted on April – May 2019 at the mangrove area of Peukan Bada District, Aceh Besar. Sample identification was carried out at the Marine Biology Laboratory, Faculty of Marine and Fisheries, Syiah Kuala University. The map of the research is shown in Figure 1.

![The Map of Research](image)

**Figure 1.** The map of research

Determination of the station is done using the stratified random sampling method. The number of station points at the research location consists of 3 stations. Station determination is based on mangrove density. Station 1 has a high mangrove density with a density ranging from ≥ 1,500; station 2 has a medium mangrove density with a density ranging from ≥ 1,000 - 1,500 and station 3 has a low mangrove density with a range of <1,000.
Sampling of mud crabs (Scylla sp.) using a bubu crab trap based on the random sampling method, the size of bubu trap in length 47 cm, width 31 cm and height 19 cm. At each observation station, 3 traps were installed with 3 repetitions. The bubu is installed in the afternoon at low tide and is removed in the morning at low tide. The sampling technique for mangrove vegetation is to use a transect squared of 10m x 10m and the number of individuals of each species contained in the 10m x 10m plot is counted. Water quality parameters observed included salinity and temperature.

2.2. Data Analysis
Analysis of the data used to determine mangrove density and the relationship between mangrove crab weight-length includes:
1. Mud crab (Scylla sp.) and mangrove density
   \[ N = \frac{\Sigma n_i}{A} \]
   Note: \( N \) = Species density (ind/m\(^2\)); \( n_i \) = Number of species i (individu); \( A \) = Total area (100 m\(^2\))
2. Sex ratio of mud crab (Scylla sp.)
   \[ \frac{n_{\text{male}}}{n_{\text{female}}} = \frac{n_t}{n_{\text{female}}} \]
   Note: \( n_t \) = total number of mud crabs; \( n \) = number of males / females
3. Length-weight relationship of mud crab (Scylla sp.)
   \[ W = aL^b \]
   Note: \( W \) is total body weight (g); \( L \) is a total length (mm); \( a \) is an intercept regression; \( b \) is the regression coefficient
   Based on the \( b \) value of the regression coefficient, namely value of \( b = 3 \), growth is isometric; Value of \( b \neq 3 \), growth is allometric i.e. allometric is positive if \( b > 3 \) and allometric is negative if \( b < 3 \).

3. Results and Discussion
3.1. Mud crab (Scylla sp.) and mangrove density
The abundance of mangrove crabs (Scylla sp.) in the mangrove area of Peukan Bada District, Aceh Besar ranges from 0.08 ind/m\(^2\) - 0.15 ind/m\(^2\). Station 3 is the location that has the most abundance, namely 0.15 ind/m\(^2\) (Table 1).

| Station | Number of Scylla sp. (ind) | Abundance of Scylla sp. (ind/m\(^2\)) |
|---------|---------------------------|--------------------------------------|
| 1       | 21                        | 0.08                                 |
| 2       | 30                        | 0.12                                 |
| 3       | 39                        | 0.15                                 |
| Total   | 90                        | 0.36                                 |

Note: The area of the bubu trap is 249.147 cm\(^2\)

The abundance of mud crabs at station 3 is thought to be due to the location of this station which is at the estuary. The estuary is a route in and out of mud crabs. Female mud crabs that will lay their eggs into the sea and young crabs that come from the sea to settle in the mangroves will pass through the estuaries. Organic material carried by river currents also settles at the estuary, thus providing food for mangrove crabs.

Based on the observation that the mangrove crab (Scylla sp.) likes mangrove vegetation which has a root system that is able to hold more mud substrate and form a dense root cover at the top, while at the bottom it looks like small caves under the roots which function as feeding grounds.

*Rhizophora apiculata* have a high density because the environment where mangroves grow is very suitable and comparable to the ability of mangroves to live. Noor *et al.* [7] revealed that Rhizophora apiculata species are usually found in areas with smooth and deep mud substrates and do
not like hard substrates mixed with sand. Several studies on the substrate in Peukan Bada District have been carried out by Irham et al. [8] stating that the Peukan Bada District area has sandy mud and muddy sand as a substrate. According to Serosero [9] protected areas such as mangroves with sandy mud substrate and sufficient natural food availability, are preferred habitats for mud crabs.

The mangrove density is one of the main factors supporting the abundance of mangrove crabs in this area. Mud crabs are biota aquatic whose life is greatly influenced by the mangrove forest ecosystem. Research results by Putra et al. [5] stated that the higher the mangrove density value, the higher the abundance of mangrove crab *Scylla* sp. According to Budi et al. [10] the abundance of an organism is influenced by physic-chemical factors which include temperature, salinity, current, pH, water depth, and substrate. Based on the results of temperature measurements in the mangrove rehabilitation area of Peukan Bada, Aceh Besar it ranges from 30 °C - 34 °C and salinity values range from 29 ppt - 34 ppt. Salinity is an environmental parameter that affects biological processes and will directly affect the growth rate of mud crabs (*Scylla* sp.)

### Table 2. Density of Mangrove in the mangrove area of Peukan Bada District, Aceh Besar.

| No | Species                | Station 1 | Station 2 | Station 3 | Density ind/m² |
|----|------------------------|-----------|-----------|-----------|----------------|
| 1  | *Rhizophora apiculata* | 0.23      | 0.30      | 0.28      | 0.27           |
| 2  | *Rhizophora mucronata* | 0.37      | 0.23      | 0.16      | 0.25           |

### 3.2. Sex ratio of mud crab (*Scylla* sp.)

Variations in sex ratios occur due to three factors, namely differences in sexual behavior, environmental conditions and fishing locations [11]. Sex-ratio can describe the condition of population balance so that it becomes the basis for determining the management resource for mangrove crab (*Scylla* sp.) in Aceh Besar District.

### Table 3. The sex ratio of mud crab (*Scylla* sp.) in the mangrove area of Peukan Bada

| Station | N  | Male | Female | Sex-ratio |
|---------|----|------|--------|-----------|
| 1       | 21 | 9    | 12     | 1: 1.33   |
| 2       | 30 | 16   | 14     | 1.1 : 1   |
| 3       | 39 | 15   | 24     | 1 : 1.6   |
| Total   | 90 | 40   | 50     | 1 : 1.25  |

All stations obtained sex-ratio of mangrove crabs 1: 1.25, it was seen that fewer male mud crabs were found than female mud crabs in the Peukan Bada mangrove area. According to Saputra et al. [12] that more female mud crabs mean that the mud crab population is still ideal for sustainability, but if there are more male mud crabs than females it means that the population is not ideal for sustainability.

The number of mud crabs (*Scylla* sp.) obtained during the research consisted of 50 female crabs and 40 male crabs. The mud crabs observed during the study in the Peukan Bada District had carapace widths ranging from 20-104 mm (Figure 2).
La Sara [13] states that mangrove crabs in the juvenile phase have a carapace width <70 mm, a young phase (carapace width from 70 - <120 mm) and an adult phase (carapace width> 120 mm). In this study, it was found that the population size of mud crabs, which mostly consisted of young individuals, showed that the population was growing rapidly. According to Siahainenia [14] the high population of young mud crabs is thought to be due to the low abundance of natural food so that this condition causes large individuals of mud crabs to migrate to areas with relatively high natural food abundance.

3.3. Length-weight relationship of mud crab (Scylla sp.)
The growth pattern of mud crabs can be known from the relationship between carapace length and body weight through simple linear regression analysis. Mud crab body weight can be considered as a function of the length of the carapace [15]. The value of b is the regression coefficient that reflects the growth pattern of mud crabs (Scylla sp.).
In this study, the value of $b$ in female mud crabs is 1.97, so the growth pattern of mangrove crabs is negative allometric. The value of 1.97 indicates that the increase in carapace length is faster than the increase in body weight. The growth pattern of male mangrove crabs is the same, namely negative allometric with a value of 2.28 (Figure 3). According to Hartnoll [16], the difference between negative and positive allometrics is thought to occur due to the influence of external factors such as feed, temperature and genetic factors.

The results of the linear regression calculation of carapace length to the weight of female mud crabs is $y = 0.2591x^{0.9779}$ with a correlation value of $r = 0.9455$. This means that mud crab weight ($y$) has increased by 0.2591 which will affect the carapace length of mud crabs ($x$) by 1.9779. According to Sarwono [17] the correlation with a value of $r = 0.94$ is included in the strong correlation. Likewise, the results of the linear regression calculation of carapace length on the weight of male mud crabs are $y = 0.1609x^{2.2816}$ with a correlation value of $r = 0.8958$. The weight of male mangrove crabs ($y$) increased by 0.1609 which will affect the carapace width of mangrove crabs ($x$) by 2.2816. Based on the graph (Figure 3) shows that there is a close correlation between carapace length and weight of mud crab, which means that carapace length growth has an influence on body weight. In this case the greater the width of the carapace the greater the body weight.

4. Conclusion
Mangrove crabs (Scylla sp.) in Peukan Bada waters have a growth pattern negative allometric, namely the value of $b<3$, which means that the carapace length increases faster than the body weight of mud crabs. The number of mud crabs observed during the study consisted of 50 female crabs and 40 male crabs. The sex ratio shows that the ratio of male and female individuals is still in balance.

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