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Biological status of blue swimming crab population (*Portunus pelagicus*) in Estuarine Water at Langsa City

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ABSTRACT

Many factors encourage the exploitation of the blue swimming crab in the estuarine water of Langsa City. Therefore, maintaining crab populations in nature through fishing regulation becomes an important effort. Evaluation of the biological aspects of the blue swimming crab population the estuarine waters of Langsa City has the main role in the arrangement of regulation. This study aimed to determine the biology of the blue swimming crab population in the estuarine waters of Langsa City. This research was carried out in August 2022 in the estuarine waters of Langsa City. The method used was the survey method. The crab samples were taken randomly from the crab fishermen as much as 10% of the catch. Sampling once a week at 2 different location points for 1 month. The results showed that the relationship between carapace width and weight of male and female blue swimming crabs (*Portunus pelagicus*) had a negative allometric growth pattern because of the value of b < 3, namely 1.22 and 1.21. The sex ratio of blue swimming crabs was not 1:1 or unbalanced. Gonadal maturity of male crabs was highest in level I, meanwhile the female could achieve the gonadal maturity in level V. During the research, the water quality of estuarine waters was in optimum condition.

Introduction

Blue swimming crab (*Portunus pelagicus*) is a type of crab from the Portunidae family that lives in shallow waters up to a depth of 50 m with a substrate of mud, sand, and muddy sand *(Nuraini et al,* 2017). This species has a blue dot on the male carapace and a brown dot on the female one. The carapace of the blue swimming crab is flat and round with thick thorns in a number nine (Fujaya 2008).

The habitat of blue swimming crab is the shallow bottom of estuarine waters with sandy mud substrate. It is stated by Suharta (2015) that a blue swimming crab is an animal whose habitat is at the bottom of the waters which is influenced by environmental conditions. Blue swimming crabs live in relatively shallow waters, especially waters with sandy mud bottom characteristics around the coast. This species has a very wide habitat covering the seabed, mangrove areas and is sometimes found swimming in the open sea as an adult.

Blue swimming crabs will migrate to higher salinity waters to hatch their eggs and produce young crabs which are returned to estuarine waters (Jafar 2011). Therefore, the population of blue swimming crab is most in estuarine waters.

The estuarine waters of Langsa City, Aceh Province are a primary source of saline water for some activities of fish culture in pond (Isma and Isma 2019). According to Isma and Isma (2020), there are 3,315.54 Ha of estuarine ponds distributed in Langsa

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City, while 1,800.067 Ha of estuarine ponds are distribution around estuarine waters of Kuala Langsa. In addition, estuarine waters also become an appropriate habitat for several marine commodities, such as blue swimming crabs. Therefore, it certainly leads to some fishing activity in estuarine waters at Langsa City.

Inappropriate fishing activities that are done by people can threaten the sustainability of certain commodities populations in the estuarine waters of Langsa City, particularly the blue swimming crab population. The exploitation through fishing activities seldomly occurs on caught blue swimming crabs. According to Jauhari (2013), some stakeholders in region of north waters of Jawa-Indonesia have taken some actions to overcome the illegal fishing of blue swimming crab, namely not to catch blue swimming crabs sizes of less than 8 cm and female one which is in reproductive period.

Sunarto *et al.* (2010) revealed that sustainability of exploitation could impact the decrease of blue swimming crab source. Moreover, the production necessary for blue swimming crab culture still relied on nature. Therefore, determination of biological status of blue swimming crabs in the estuarine waters of Langsa City is important, as an initial step to countermeasure actions for blue swimming crab sustainability.

The morphological and reproductive performances of blue swimming crabs in estuarine waters of Langsa City need to be studied as parts of biological status information of blue swimming crabs. The information certainly supports fishing regulation arrangements. This is also stated by Haser *et al.* (2022) which biological aspect of local fish including sex ratio, length-weight relationship, condition factor, maturity size, fecundity, and reproductive potential information is needed to ensure the sustainability of fisheries in a certain areas.

This study purposes to investigate the biological status of blue swimming crabs in the estuarine waters of Langsa City. Several aspects studied are sex ratio, relationship of length and width of carapace, weight, gonadal maturation, and fecundity of blue swimming crab.

Materials and Methods

Location and time of research

This research was carried out in August 2022 and took place in the estuarine waters of Langsa City. The research was conducted for one month. Sampling of blue swimming crabs was done in every 1 week at 2 different location points. Sampling locations were at 8 location points that can be seen in Figure 1 below.

Sampling method

Sample collection was conducted randomly, as much as 10% of the caught yield. The samples taken would be observed, namely: sex ratio, carapace length and width, weight, gonadal maturity level, gonadal maturity index, and fecundity.

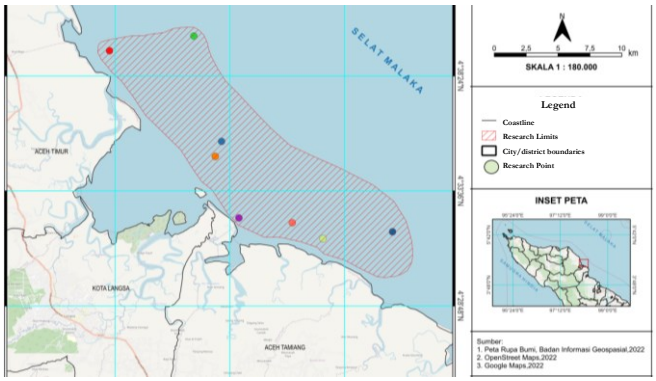

Figure 1. Sampling location of this research

Data analysis

Sex ratio

The observation of sex ratio in blue swimming crab was done visually by looking at the morphology and secondary sex characteristics of the blue swimming crab. Sexual characteristics could be seen from the color and shape of the abdomen on the crab. Then, the sex ratio was calculated by comparing the number of captured male and female crab samples.

The sex ratio value was known by calculating the number of male and female crabs from all samples taken. Determining the balance of the sex ratio was done through calculating by using the X_2 test (Chi-square) as follows:

$$X^2 = \sum_{i=1}^{k} \frac{(Oi - ei)}{ei}$$

Oi = sum of male and female frequencies
ei = expected number of male and female crabs
k = number of observed groups

Carapace length and width

Carapace length and width (Figure 2) were measured using a caliper (accuracy 0.01 mm). Carapace length was measured from the anterior (where the eyes were) to the posterior end (where the abdomen was). Then, measuring the width of the carapace was started from the left side to the right side, namely from the tip of the longest lateral spine on the leaft side to the right side.

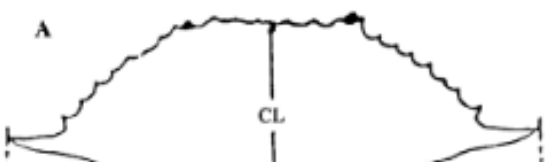

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Figure 2. Length and width measurement of crab (Josileen 2013)

Weight measurement

The weight of the blue swimming crab and the eggs of the female crab were measured using a digital scale (with an accuracy of 0.01 gr). The relationship of both the width and weight of the crab was described in two growth patterns, namely isometric and allometric. For these two patterns, the equation applied was (Effendi 2002):

$$W = aL^b$$

W = Total weight of crab (grams)
L = Total width of the crab (mm)
a and b = constants of the regression results

Gonadal maturity level

Determination of gonadal maturity level in blue swimming crab was done by visual observation on the morphology of the crab gonads. Observation was conducted by looking at the color of the gonads of male and female crab (Sunarto 2012).

Gonadal maturity index

Gonadal maturity index was the ratio of gonad weight to body weight. The calculation of the gonadal maturity index used the formula according to Effendi (Effendi 2002) as follows.

$$IKG = \frac{Bg}{Bt} \times 100\%$$

IKG = Gonadal Maturity Index (%)
Bg = gonad weight (grams)
Bt = total body weight (grams)

Fecundity

Fecundity is the total number of eggs produced by a female broodstock in one spawning period. The calculation of the fecundity value used the following formula:

$$F = n\frac{G}{g}$$

F = Fecundity (grain)
n = Number of eggs observed under a microscope (grain)
G = Weight of total eggs (grams)
g = Weight of eggs sample (grams)

Water Quality Measurement

Water quality parameters measured include temperature, salinity and pH. temperature and salinity measurements were taken at the beginning and end of the the end of the study at high tide, using thermometer and handrefractometer. pH measurements were taken at the beginning and end of the study using pH paper.

Results

Sex ratio

There were 43 blue swimming crabs observed taken from caught yield from local fishermen, namely 19 individuals of male crabs and 24 individuals of female crabs. The graph describing the comparison of male and female crabs is presented in Figure 3 below.

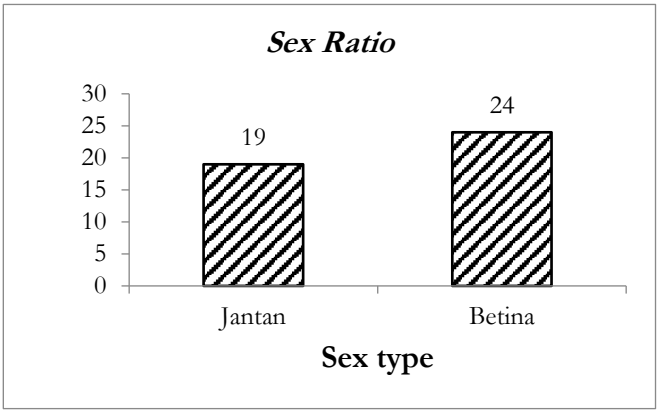

Figure 3. Sex ratio of blue swimming crabs in estuarine waters of Langsa City

The results of this study showed that the number of female crabs was higher than male ones in the estuarine waters of Langsa City. As much as 56% of obtained samples were female crabs. Statistical analysis showed that $X_{count} > X_{table}$, which meant that the male and female crabs caught by fishermen in the Estuarine Waters of Langsa City were not balanced.

Correlation of carapace width and body weight

The correlation of the width and weight of blue swimming crabs in estuarine waters of Langsa City is shown in Figure 4 below. Based on the regression result, b value of carapace width and body weight correlation of male crab was 1.218. This value was less than standard value of b or b<3. Therefore, it

indicated a negative allometric growth pattern of male blue swimming crab, where the growth in carapace width was faster or dominant than the growth in weight.

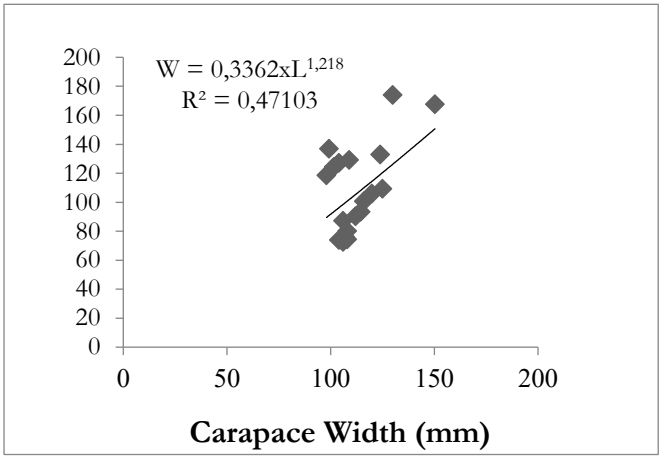

Figure 4. Correlation of width and weight of male blue swimming crabs

According to Figure 4, the carapace width and body weight of male crabs in estuarine waters of Langsa City were not closely related with an R^2 value of 0.47. This showed that the increase carapace width was faster than the increase of the body weight of the male blue swimming crabs.

Furthermore, the correlation of both carapace width and body weight of female blue swimming crabs was shown in Figure 5. The correlation of both width and weight of the female crab was represented by b value as much as 1.207.

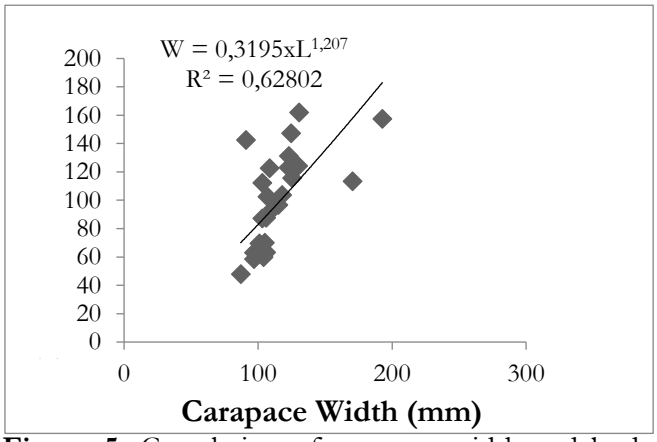

Figure 5. Correlation of carapace width and body weight of female blue swimming crabs

Based on Figure 5, the b value of female crabs was lower than the b value of male crabs. The b value less than 3 indicated that the growth pattern of the female crab population was negative allometric. It meant that the growth in carapace width faster than body weight in female blue swimming crabs.

Accroding to the graph above, the carapace width and weight of the female crabs were not related with an R^2 value of 0.62. This showed that the increase in carapace width of female crabs was faster than the increase in body weight of the crabs.

Gonadal maturity level

The result of gonad observation in male blue swimming crabs in estuarine waters of Langsa City is shown by Figure 6 below.

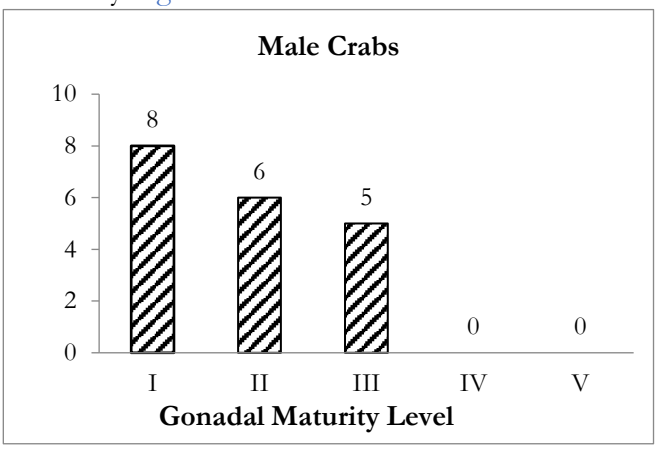

Figure 6. Gonadal maturity level of male blue swimming crabs

Based on Figure 6, the gonadal maturity of male blue swimming crabs in level I (unmature) were 8 individuals (42%), in level II were 6 individuals (32%), in level III were 5 individuals (26%). The highest number of gonadal maturity of male blue swimming crabs was in level I. Furthermore, the number of female crabs with their maturity level is shown by Figure 7 below.

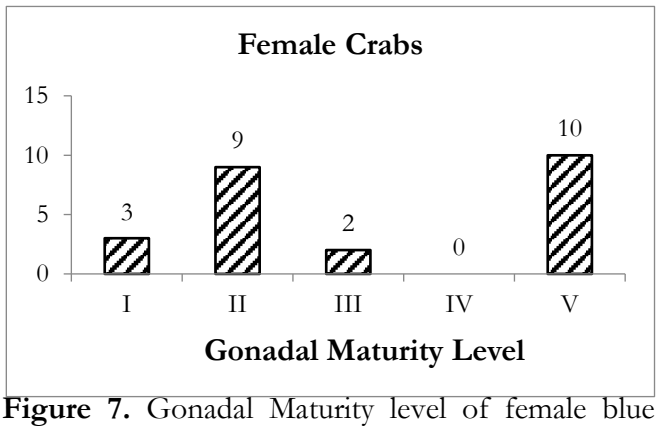

Figure 7. Gonadal Maturity level of female blue swimming crabs

Based on Figure 7, the gonadal maturity level of females in level I were 3 individuals (13%), in level II were 9 individuals (38%), in level III were 2 individuals (8%), and in level V were 10 individuals (42%). Then, overall gonadal maturity level of catched blue swimming crabs, namely in level I were 11 individuals (26%), in level II were 15 individuals

(35%), in level III were 7 individuals (16%), and in level V were 10 individuals (23%). Several factors worked and influence reproductive performance of blue swimming crabs, such as environmental conditions.

Gonadal maturity index

Gonadal maturity index is the ratio of gonad weight to body weight. The gonadal maturity index results for male and female crabs can be seen in Table 1 below.

Table 1. Gonadal maturity index of blue swimming crabs in estuarine waters of Langsa City

Maturity level	Male	Female
1	0,1085%	9,0663%
2	1,0907%	5,3101%
3	1,5246%	6,5480%
5	-	18,1750%

The results of the gonadal maturity index for male crabs showed that male crabs in level I were 0.1085%, in level II were 1.0907%, and in level III were 1.5246%. While, gonadal maturity index for female exhibited that female crabs in level I were 9.0663%, in level II were 5.3101%, in level III were 6.5480%, and in level V were 18.1750%.

Fecundity

The parameter fecundity was observed in female blue swimming crabs. There were ten individuals which were weighed their gonads and bodies. A representative graph describing carapace width with the number of eggs of female blue swimming crabs is shown by Figure 8.

Discussion

Sex ratio is the ratio of the numbers of male and female organisms. Observation of sex ratio is a very important factor because it can be used to obtain information on male and female blue swimming crab proportions in nature and can also be used to determine crab spawning abilities.

Based on the results, the numbers of male and female crabs in estuarine waters of Langsa City were unbalanced. There were more female crabs (56%) than male crabs (44%) in the waters. Differences in the sex ratio between males and females could occur due to spawning and fishing seasons. This is in accordance with the statement of Elyuna (2005) that the factors causing differences in the ratio between males and females are biological factors such as spawning. On the other hand, Azmi *et al.* (2018) mentioned that an unbalanced proportion in sex ratio could be leaded by extreme environmental conditions, such as salinity up to 50 ppt and temperature ranging from 32-34°C in the dry season.

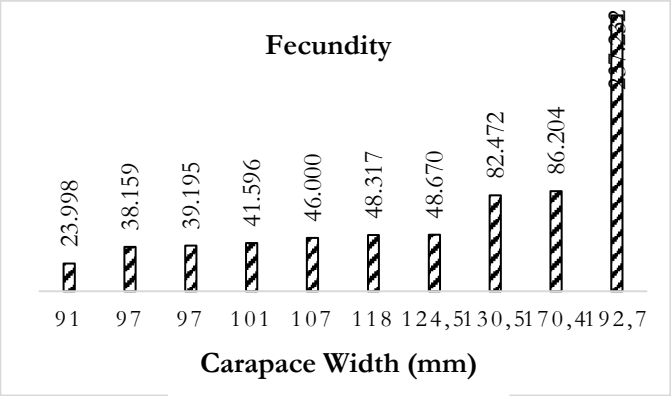

Figure 8. Fecundity of female blue swimming crabs based on carapace width

Water quality

Some parameters of water quality of estuarine waters were measured during the research. The values of water quality parameters are shown by Table 2 below.

Table 2. Water Quality of estuarine water of Langsa City

Water quality			
Temperature (°C)	pH	DO (ppm)	Salinity (ppt)
30 – 30.4	7 – 7.46	5.2 – 5.3	32

Female crabs preferred to the waters with high salinity, especially for spawning. Therefore, they spread to deeper waters than male crab existence. Male crabs preferred to low salinity waters, so they spread around shallow coastal waters. The number of caught female crabs compared to male crabs indicated that the composition of the crabs in these waters was in good condition. This showed that one male crab could fertilize more than one female crab. As with the statement given by Gumelar (2016) the higher the composition of female crabs, the greater the level of recruitment produced.

The growth pattern of the male blue swimming crab population was negative allometric meaning that the growth in carapace width was faster than body weight. Then, a similar result was also shown by the growth pattern of female blue swimming crabs in estuarine waters of Langsa City. According to Annur *et al.* (2021), the physiological situation in crabs had an irreversible effect on various factors to in

determining the obesity rate. Then, Okon and Sikoki (2014) revealed that parameter b value might vary seasonally and even daily, and between habitats.

The result for parameter b value for the male crab was higher than female crab had. The growth pattern was negative allometric. It meant that male crabs were heavier than female ones in these estuarine waters. The difference of b value indicated that the male crab was bigger than the female crab (Sunarto *et al.* 2010). Lighter female crabs could be led by females expend more energy for reproduction, while males use more energy for growth.

From the overall gonadal maturity level of male and female crabs, the highest percentage of male crabs were in level I of gonadal maturity. This was due to several factors, such as environmental conditions. (Febri, 2017), reported that the environmental condition of Langsa estuary waters had started to be polluted due to the impact of domestic waste disposal, this was due to a lack of public awareness. However, for the crabs habitat in the estuary of Langsa City, it is still very supportive, considering that the condition of the mangrove forest vegetation is still very good (Febri *et al*, 2017).

According to Chande and Mgaya (2003), male crabs liked relatively shallow waters such as around coastal waters. Whereas, the female crabs existed in level V of gonadal maturity. According to Romimohtarto (2005) blue swimming crabs head to deeper areas to face the spawning season which occurs throughout the year with the peak occurring in December, March, July and September.

Blue swimming crabs in estuarine water of Langsa City had a gonadal maturity index of less than 20% which meant the individual could spawn several times a year. Changes in index value were closely related to the stage of gamete cells development and these values also related to changes in the level of gonadal maturity. Blue swimming crabs that have a gonadal maturity index value of less than 20% can spawn many times a year (Sumassetiyadi, 2003).

The other aspect of biological performance was the fecundity of the blue swimming crab. The fecundity of 10 female crabs with egg weights ranged from 7.1-72.1 grams, then fecundity ranged from 23,998 - 237,232 eggs, while carapace width varied in size 91-192.7 mm and body weight achieved 58.6-161.9 grams. Large female crabs would produce a large number of eggs, meanwhile small crabs would produce a small number of eggs. Fecundity certainly had a relationship with the carapace width (L) and weight (W) of the crab (Soundarapandian & Tamizhazhagan 2009; Akbar *et al.*, 2023).

The results of estuarine water quality showed that temperature ranged from 30-30.4ºC. According to Saraswati *et al.* (2017) the optimum temperature of water in an estuary area is 28ºC-32ºC. Then, pH parameter in the Estuarine Waters of Langsa City showed a range from 7-7.46. Amri *et al.* (2018) revealed that the pH required in estuary waters was in the range of 7.6-8. Furthermore, the results of dissolved oxygen (DO) in the estuarine waters of Langsa City were in the concentration of 5.2-5.3 ppm. The source of oxygen in the waters comes from air diffusion, photosynthesis of phytoplankton and aquatic plants as well as rainwater and surface runoff (Sagita *et al.*, 2016). In addition, salinity in the estuarine waters was 32 ppt which was optimum salinity for organisms. The optimum salinity of a waters ranges from 32.0-34 ppt (Purba *et al.* 2017). According to Jansen (2016), salinity variations in estuary waters changed throughout the year along with the tidal cycle.

Conclusion

The sex ratio of blue swimming crabs in estuarine waters of Langsa City was in unbalanced proportion, which female crabs higher than males. Then, analysis of the correlation of both carapace width and weight of blue swimming crab was classified as negative allometric. Gonadal maturity of male crabs was most in level I, while the females could achieve gonadal maturity in level V. Then, fecundity of female crabs followed the size of carapace width. Finally, water quality of estuarine waters was in optimum condition.

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