Growth pattern and abundance of *Varuna Literatta* (Fabricius, 1798) in the new industrial area in the north coast of Gresik, East Java

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Abstract. *Varuna literatta* (Fabricius, 1798) is one of the organisms that inhabit the estuary area facing the sea and will enter the estuary area at high tide. *V. literatta* has been caught throughout the year in its whole form or its eggs are used to meet human consumption needs as a source of animal protein, besides that *V. literatta* has a very important role in maintaining the balance of aquatic ecosystems. The presence of *V. literatta* in the waters as a decomposer which is able to provide the nutrients needed by primary producers in these waters. On the other hand, there has been no attempt to domesticate *V. literatta*, because according to the IUCN 2021 *V. literatta* in Southeast Asia is a species that has not been evaluated. This status can cause a decrease in the population of *V. literatta* because there is no regular evaluation and there are no rules that regulate the catch of *V. literatta*. This is reinforced by information obtained from fishermen that the catch of *V. literatta* from year to year is decreasing. This study aims to obtain information including reproductive aspects of *V. literatta* in an industrial area located on the coast of Gresik Regency. Sampling was carried out at three stations (Kalimireng river, Mengare river, Kalilamong river) at each high tide from June-August 2021. The samples obtained were then counted and differentiated between males and females, then body length and weight were measured to determine growth patterns and abundance. The results showed that the male and female *V. literatta* had a negative allometric growth pattern. The growth of *V. literatta* is also differentiated by sex. The highest abundance of *V. literatta* was obtained from Manyar station.

1. Introduction
The existence of *V. literatta* which is very important in supporting the balance of the ecosystem is currently being threatened due to the emergence of a new industrial area on the north coast of Gresik Regency, East Java. Changes in the quality of seawater and estuaries that are the habitat of *V. literatta* caused by industrial waste are thought to affect its abundance, growth pattern and reproductive cycle. In addition, the existence of *V. literatta* is also threatened due to unrestricted fishing in these waters which are places for the growth of *V. literatta*. This is indicated by the decrease in catches from time to time. The catch is not only taken as a whole, but the eggs inside the mother are also taken to be processed into crab eggs coulinary.
This research is important to do considering the role of *V. literatta* as a recycler of nutrients in the food chain, its existence can be used as a buffer for an aquatic ecosystem which can indirectly affect the primary production supply of a waters which will affect the diversity and abundance of other aquatic organisms which in turn affect the diversity and abundance of other aquatic organisms. will ultimately support national food security due to the availability of abundant and diverse fishery products. On the other hand, efforts to domesticate *V. literatta* have never been carried out, because based on IUCN 2020 data [1] *V. literatta* in Southeast Asia is a fish species that has not been evaluated (not evaluated), this status could lead to a decline in the population of *V. literatta*. Currently, information about *V. literatta* is still very limited, including about its ecology and biology. The results of this study can be used as information for decision makers to take policies for conservation purposes. In addition, the results of the study will be useful as information for domestication of *V. literatta* in the future to prevent the extinction of *V. literatta*. The specific objective of this study was to examine the abundance, growth pattern and reproductive aspects of *V. literatta* caught in a new industrial area on the north coast of Gresik, East Java.

2. Materials and methods

2.1 Study Area

It was carried out in the industrial area of the north coast of Gresik including the estuary in Manyar Gresik (Kalimireng), the mangrove area in Mengare Gresik, and Kali Lamong in Roomokalisari. The first and third stations (Kalimireng and Kali Lamong) are one of the estuaries of the Bengawan Solo rivers which is flanked by two large industrial complexes, while the second station (Mengare) is located relatively further from the industrial area. This research was carried out from June-August 2021

2.2 Specimen collection

The data collection method is sampling at three research stations that have been surveyed and interviews with local fishermen in advance, namely the determination of waters that have been known previously and to determine the composition of water quality parameters as well as a sampling technique based on the characteristics or properties that are determined to achieve the goal. certain.

Samples of *V. literatta* were caught by using a net that was placed at low tide and then samples of crabs were taken at low tide which had previously experienced high tide. Sampling of *V. literatta* is carried out twice a month. Furthermore, the number of crabs caught was counted and then each individual crab was measured for the width of the carapace, the weight of the crab was weighed

2.3 Data Analysis

2.3.1 Abundance of *V. literatta*. To determine the abundance of crabs using the formula [2]:

\[ N = \frac{\Sigma n_i}{A} \]

Information:
N = abundance of type I crabs (ind/ha)
ni = number of individuals of type i
A = area of sample observation (ha)

2.3.2 The relationship between carapace width and body weight. To analyze the growth pattern of the *V. literatta*, a simple linear regression analysis was carried out, to see the relationship between the width of the carapace of the *V. literatta* and its body weight. The formula used according to Effendie, 1997 [2], namely:

\[ Y = a + bX \]

To estimate the growth rate of the two parameters observed can be assessed from the value of b which can be calculated by the formula below:
b = \frac{N \times \sum \left( \log W \times \log L \right) - \left( \sum \log W \times \sum \log L \right)}{N \times \sum \log^2 L - \left( \sum \log L \right)^2} - \frac{\sum \log W}{N} \log L

\log a = \frac{\log W}{N} - b \frac{\log L}{N}

Information:
N = number of male or female crabs (tails)
W = body weight (grams)
L = carapace width (cm)

2.3.3 V. literatta growth pattern. The growth pattern is described in two forms, namely isometric and allometric. For these two patterns, equation [2] applies, namely:

\[ W = aL^b \]

Information:
W = crab body weight (gr)
L = carapace width of crab shells (cm)
a and b = constant

The parameter correlation of the carapace width and weight relationship can be seen from the value of the constant b (as an estimator of the degree of closeness of the relationship between the two parameters), namely, with the hypothesis:
1. If the value of b = 3, then the relationship is isometric (the growth pattern of carapace width is the same as the pattern of weight growth)
2. If b \neq 3, then the allometric relationship is:
   a. If b > 3 then allometric is positive (weight gain is more dominant)
   b. If b < 3 then allometric is negative (increase in carapace width is more dominant)

The test used is a partial test (t test) with the hypothesis:
H0: b = 3 (isometric)
H1: b \neq 3 (allometric)

\[ T_{hitung} = \frac{b_1 - b_0}{S_{b1}} \]

At the 95% confidence interval, compare the T count value with the T table value then the decisions taken to determine the growth pattern are:
T count > T table: reject the null hypothesis (H0)
T count < T table: failed to reject the null hypothesis (H0)

The close relationship between the length and weight of the crabs is shown by the correlation coefficient \( r \) obtained from the formula R2: where R is the coefficient of determination. A value close to 1 (r > 0.7) describes a close relationship between the two, and a value away from 1 (r < 0.7) describes a close relationship between the two.

2.3.4 Condition factor. Condition factor analysis was used to determine the effect of the environment on the growth of crabs by comparing the diameter and weight of individuals by looking at their habitat conditions. Bad habitat conditions will cause weight loss and vice versa if the environment in the habitat is good then body weight will increase. [3]. After the width and weight growth patterns are known, then the condition of the crab can be determined.

a) If the growth of crabs is isometric (b=3) then the equation used is:

\[ K = \frac{W \times 10^5}{L^3} \]

b) If the growth of crabs is an allometric growth model (b\neq 3) then the equation used is:
\[ K = \frac{W}{aL^b} \]

Information:
\( K \) = condition factor
\( W \) = body weight of sample crabs (grams)
\( L \) = the width of the carapace of the sample crab (cm)
\( a \) = constant
\( b \) = intercept

3. Result and Discussion

*V. literatta* has a square carapace, smooth surface; straight front; anterolateral edge each with 3 very wide and sharp teeth. The legs are Dactylus-shaped, propodus, lined with long, dense setae. *V. literatta* is light brown to brownish gray on the dorsal surface [4].

3.1 Abundance of *V. literatta*

The abundance of *V. literatta* at each sampling station varied in each sampling period, except at the third station or in Kalilamong where *V. literatta* was not found at the time of sampling. The abundance of *V. literatta* is shown in Table 1.

|   | Station I | Station II | Station III |
|---|-----------|------------|-------------|
| I | 23        | 15         | 0           |
| II| 10        | 8          | 6           |
| III| 10     | 8          | 6           |
| IV| 35        | 17         | 6           |
| V | 48        | 17         | 0           |
| VI| 19        | 16         | 0           |
| Total| 145 | 81   | 18          |

Table 1 shows that the greatest abundance was at the first station or in Kalimireng with a total of 145 individuals. Compared to the other two stations, the first station or the Kalimireng River is surrounded by many industries and flanked by two large industrial complexes so it is possible that there is a lot of organic matter that can trigger the growth of feed for *V. literatta*, which indirectly becomes an attractive location for *V. literatta* to find food.

The greater abundance of *V. literatta* was found at Kalimireng station, presumably because the location of the Kalimireng river is directly opposite the sea, this is in accordance with Devi's statement [5]

3.2 Width Distribution Of Carapaces *V. literatta*

The distribution of the carapace width of *V. literatta* in general is shown in Figure 1 below.
Based on the picture above, the carapace width of all the areas used as research sites, most of them measuring between 3.26-3.51 (80 fish), then as many as 51 tails have a shell width between 3-3.25 cm. The *V. literatta* found in the three stations were *V. literatta* in the megalopa and young crabs, because the adult *V. literatta* will move to the sea to spawn until the zoea stage [6]. This statement is in line with that conveyed by Ng [7] that *V. literatta* which is included in Varunidae spends their juvenile period in fresh water.

### 3.3 Correlation between carapace width and body weight

The relationship between carapace width and body weight of *V. literatta* was grouped into sexes, namely male and female in each study area. More details can be found in Figure 2-7 below,
Figure 4. Correlation of carapace width with male body weight of V. literatta in Mengare.

Figure 5. Correlation of carapace width with body weight of female V. literatta in Mengare.

Figure 6. Correlation of carapace width with body weight of male V. literatta in Kalilamong.
Figure 7. Correlation of carapace width with body weight of female *V. literatta* in Kalilamong.

In the Kalimireng study area, the coefficient of determination (R^2) of male and female *V. literatta* was 0.938 (94%) and 0.946 (95%) respectively, with the equation for the growth pattern of male *V. literatta* being \( W = -0.215L^{2.635} \) and \( W = -0.3022L^{2.770} \) for females. In the study area, the coefficient of determination (R^2) of male and female *V. literatta* was 0.963 (96%) and 0.942 (94%) respectively, with the equation for the growth pattern of male *V. literatta* being \( W = -0.279L^{2.757} \) and \( W = -0.310L^{2.820} \) for females. In the Kalilamong research area, the coefficient of determination (R^2) of *V. literatta* and female crabs was 1 (100%) and 0.481 (48%) respectively, with the equation for the growth pattern of male *V. literatta* being \( W = 2.074L^{(-1.472)} \) and \( W = 0.382L^{1.547} \) for females.

3.4 Growth Pattern of *V. literatta*

The results of the t-test for the value of b for male and female *V. literatta* showed that the p value was smaller than =5%. The growth pattern of male and female *V. literatta* in the three regions showed a constant value of b < 3, negative allometric, or it can be said that the growth of carapace width was more dominant than the growth of body weight as shown in Table 2.

| Area       | Sex     | b       | Growth Pattern | Pattern         | \( P \) value | Growth Pattern     |
|------------|---------|---------|----------------|-----------------|---------------|-------------------|
| Kalimireng | Male    | 2.635   |                | \( w = -0.215L^{2.635} \) | 0.000         | Negative allometric |
|            | Female  | 2.770   |                | \( w = -0.302L^{2.770} \) | 0.000         | Negative allometric |
| Mengare    | Male    | 2.757   |                | \( w = -0.279L^{2.757} \) | 0.000         | Negative allometric |
|            | Female  | 2.820   |                | \( w = -0.310L^{2.820} \) | 0.000         | Negative allometric |
| Kalilamong | Male    | -1.472  |                | \( w = 2.0739L^{(-1.472)} \) | 0.000         | Negative allometric |
|            | Female  | 1.547   |                | \( w = 0.3822L^{1.547} \) | 0.012         | Negative allometric |

In both male and female *V. literatta* the negative allometric pattern. The allometric growth pattern is the increase in length that is not in line with the increase in body weight [8]. In *V. literatta* is occurred because female crabs use more food intake for moulting and the process of gonad maturity (laying eggs). The growth of female *V. literatta* tends to be broader carapace because the female crab will moult every time perform the copulation process. In male *V. literatta* moulting occurs less frequently, food intake tends to be used to lengthen and enlarge the chelae (claws), which play an important role in the marriage process. This corresponds to Mahapatra's observations [9] which shows...
that *V. literatta* is male have very large claws compared to females of the same size. Therefore, if there are at the same carapace width, male *V. literatta* tended to be heavier, because their claws added body weight. Every time there is a release of the shell (moulting) crab body will gain weight about 1/3 times of earlier and the carapace width will increase by 5-10 mm (approximately 2 times the original size) in adult crabs.

### 3.5 Condition Factor

The results of the calculation of the male and female *V. literatta* condition factors in each study area can be seen in Table 3.

| Area    | Sex    | Condition Factor (K) | K Mean    |
|---------|--------|-----------------------|-----------|
| Kalimireng | Male  | 2.121-3.627          | 2.851 ± 0.315 |
|          | Female | 1.407-1.904          | 1.654 ± 0.114 |
| Mengare   | Male  | 7.183-17.726         | 12.042 ± 2.602 |
|          | Female | 1.307-1.819          | 1.578 ± 0.115 |
| Kalilamong | Male | 1.041-1.318          | 1.180 ± 0.152 |
|          | Female | 5.775-6.600          | 6.317 ± 0.335 |

Table 2 above shows favorable conditions to support the physiological processes of crabs such as the good relationship between crab body weight and length, and good growth in crabs. Table 2 also shows that the condition factor at Kalimireng and Mengare Stations for *V. literatta* males is better than females, but on the contrary what happens at Kalilamong Station which shows that the condition factor is better in females than males.

### 4. Conclusion and Suggestion

*V. literatta* caught in this study were dominated by an average carapace width of 3.26-3.51 cm. Male and female *V. literatta* had a negative allometric growth pattern with a condition factor of more than 1, which means that the sampling location was still relatively good for the growth of *V. literatta*. However, because the aquatic environment plays an important role in the existence of aquatic organisms that support the stability of the ecosystem, the balance of the environment still needs to be considered. This research should be continued to see the abundance and growth pattern as well as to look at the biological aspects of *V. literatta* in other seasons.

### 5. References

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6. Acknowledgments
Thank you to the research institute and community service, Universitas Brawijaya for funding this research, apart from that, thanks to the students involved and colleagues and those who have helped carry out this research.