Length-weight relationship of *Lingula* sp. in Aceh Southern Shore

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**Abstract.** The purpose of this study was to determine the growth pattern of *Lingula* sp. based on its morphometric analysis. The method used in this research is purposive sampling method. The results showed that the number of *Lingula* sp. less in the Ujong Pancu beach area (66 individuals) when compared to the Syiah Kuala beach area (169 individuals). Based on the weight value of *Lingula* sp. in the Syiah Kuala area (5,861-7,786 g) it was higher than the Ujong Pancu area (0.082-2.007 g), and the length value was higher in the Syiah Kuala coastal area (39.6-49.4 mm) than the Ujong Pancu beach area (19.8-29.6 mm). Besides that, from the calculation of the value of length and body weight, it was found that the value of b at both stations was b > 3 (Ujong Pancu, b = 1.9568 and Syiah Kuala, b = 2.896) so that the growth pattern of *Lingula* sp. classified as negative allometric whereas the length growth is faster than body weight, and the water quality factor in the Ujong Pancu beach area and the Syiah Kuala beach masig are within the normal life limits of *Lingula* sp.

1. **Introduction**

Brachiopods are shelled invertebrate fossils. Askepasma saroconcha Topper, a Paternide, is the oldest Brachiopoda known to originate from pre-trilobitic strata from South Australia [1]. The Brachiopoda phylum is a marine invertebrate that lives as benthic [2], and has existed since the Cambrian era [3]. These animals have shells like Mollusks (with two shells), but they are very different [4]. The *Lingula* shell opening is in front, unlike shells whose shell openings are at the bottom [5]. In general, Brachiopods live on the substrate, through a stretch of muscle called a pedicle. To supply food and oxygen, Brachiopods have a lophophore which functions to move the surrounding water so that the circulation of oxygen and food in and out of the body can occur [6-8].

*Lingula* sp. is one of the genera of the Brachiopoda phylum located in the intertidal zone or an area that is still affected by tides and is referred to as a living fossil. *Lingula* sp. known as Lampshell, because of its shape which resembles an oil lamp, with a size usually of 5 - 80 mm. Some fossils even up to 30 cm [9].
**Lingula** sp. widespread in the tropics, especially in the Pacific regions such as the Indo-Malayan islands, Japanese waters, China, and the Philippines. Some research that has been done stated that there are several types of **Lingula** sp. living in eastern Indonesian waters, namely the Ambon, Banda, Seram, and Kalimantan waters [10], Lubuk Damar [11] and Agustina et al. [24]. Lingula species found in these waters include **Lingula Lingula**, **Discinisca hiensis**, and **Tugulorbynchia doderbini**.

The existence of Brachiopoda **Lingula** sp. also found in Aceh's coastal waters. In general, the existence of **Lingula** sp. not so well known among the people of Aceh, because only a few areas in the waters of Aceh contained this biota, especially the waters of Ujong Pancu, Syiah Kuala, Banda Aceh City so that the community's knowledge was still very little about the biota. Therefore, it is necessary to study the growth of **Lingula** sp. in Ujong Pancu beach, Peukan Bada District, Aceh Besar Regency, and Syiah Kuala beach, Banda Aceh City.

2. Materials and Methods

2.1. Site and Time

This research was conducted in April 2018 in Pantau Ujong Pancu Lambadeuk village, Peukan Bada subdistrict, Aceh Besar regency, and Syiah Kuala Beach, Deah Raya village, Syiah Kuala district, Banda Aceh City (Figure 1). The analysis of the growth of **Lingula** sp. which includes length and weight measurements made at the Biology Faculty of FKIP Unsyiah and determination of Physico-chemical parameters was done based on In-situ.

![Figure 1. Location of Lingula 's Research](source: Google Map 2018 WGS 1984)

2.2. Data collection

The method used in this study was purposive sampling, a sampling technique with specific considerations [12]. **Lingula** sp. obtained was put into a sample bag, then they were identified in the Laboratory of Marine Biology, Faculty of Maritime Affairs and Fisheries, Syiah Kuala University. 1m x 1m quadratic transects were placed at the specified point. Sampling in the form of **Lingula** sp. done at low tide where each plot was diged using a machete by combing the area until a certain depth was obtained. The depth of sampling was based on the consideration that most Brachiopods can immerse themselves in a substrate base (infauna) up to several cms (such as 5-10 cm) [13]. Substrate samples obtained from the excavation are then put into plastic samples and then taken to the Laboratory for analysis.
Along with biota sampling, measurements were carried out directly or in situ for some Physico-chemical parameters. Physico-chemical parameters include salinity with a hand refractometer, pH with a pH meter, temperature, and dissolved oxygen with a DO meter. Morphometric parameters observed included length and total weight. *Lingula* sp. measure the length from the anterior end to the posterior end (including this pedicle) using calipers with an accuracy of 0.01 mm [14](Figure 2).

![Figure 2. Morphometric measurements](image)

The measurement of the total weight of *Lingula* sp. was done by cleaning the biota of the remaining sand particles that were still attached to the shell of *Lingula* sp. using running water, then weigh the overall weight of *Lingula* sp. along with the shell using Ohauss scales with an accuracy of 0.0001 g.

2.3. Data Analysis
Analysis of data about the growth pattern of *Lingula* sp. was observed with the growth [15] pattern formula as follows: \( W = a L^b \), where: \( W \) = weight of *Lingula* sp. (g); \( L \) = length (mm); \( a, b \) = constant. 

The value of \( b \) from the results of this calculation can reflect the growth pattern of *Lingula* sp. If the value of \( b = 3 \), then the pattern of growth isometric or weight growth is equivalent to the growth of *Lingula* sp. Meanwhile if the value of \( b \neq 3 \), then the growth pattern is allometric. [15] stated that if the value of \( b < 3 \) is called negative allometrics (the increase in length is faster than weight gain), and if the value of \( b > 3 \) is called a positive allometric (weight gain is faster than the increase in length).

Data from the calculation of class intervals of the length and weight of *Lingula* sp. obtained aimed to see the weight and length of *Lingula* sp. obtained based on the measurement of weight and length of *Lingula* sp. that has been measured. The steps in calculating class intervals can be seen as follows:
1. Range = Highest value - lowest value
2. Many classes = \( 1 + 3.3 \times \log (n) \)
3. Length of class = Range / many classes

3. Results and Discussion
3.1. Growth Pattern of *Lingula* sp.
Based on research conducted at Ujong Pancu Beach and Syiah Kuala Beach, the number of *Lingula* sp. in the Ujong Pancu beach area was less when compared to the Syiah Kuala beach area. *Lingula* sp. obtained in the Ujong Pancu area amounted to 66 in numbers, while in the Syiah Kuala area totaled of 169. The difference in the number of *Lingula* sp. obtained in Ujong Pancu and Syiah Kuala because of *Lingula* sp. in the coastal area of Ujong Pancu more widely used by the surrounding community to be consumed and sold to support their daily needs. Length and body weight data *Lingula* sp. obtained at the two stations are shown in the following graph (Figure 3).
Figure 3. *Lingula* sp. (a) in the Ujong Pancu beach area (left), (b) in the Syiah Kuala beach area (right).

Ujong Pancu area (a) shows $y = 0.0013x^{1.9568} (W = 0.0013L^{1.9568})$ with a constant value of $b = 1.9568$ and a constant value $a = 0.0013$. The Syiah Kuala region (b) shows the value of $y = 0.0001x^{2.8096} (W = 0.0001L^{2.8096})$ with a constant value of $b = 2.8096$ and a constant value of $a = 0.0001$, based on the values obtained from both stations shows a value of $b < 3$ which means the allometric growth pattern negative.

To make it easier to read the number of lengths and weight values of *Lingula* sp. found in Ujong Pancu and Syiah Kuala areas, it is necessary to divide the class based on the amount of data that had been obtained. The data can be seen in Figure 4.

Figure 4. Weight of *Lingula* sp. (a) Ujong Pancu (left) (b) Syiah Kuala (right).

Based on the graph above can be seen differences in the number of individuals obtained based on the length and weight of *Lingula* sp. which had already been calculated. Graph (a) shows for *Lingula* sp. at Ujong Pancu beach and graph (b) shows for *Lingula* sp. in Syiah Kuala beach, which shows that the highest number/individual was obtained at Ujong Pancu beach with a weight of 0.082-2.007 g with the number/individual obtained as many as 42 individuals and the lowest obtained at a weight of 2.008-3.933 g with the number/individual obtained as many as 7 individuals. In the graph (b) shows that the highest number/individual obtained in the Syiah Kuala beach area weighing 5,861-7,786 g with the number/individual obtained as many as 59 individuals and the lowest obtained at weight 15,492-17,418 g with the number/individual obtained as many as one individual.

Graph (a) represents *Lingula* sp. at Ujong Pancu beach and graph (b) represents *Lingula* sp. in Syiah Kuala beach which shows that the highest number/individual was obtained in the Ujong Pancu beach area at a length of 19.8-29.6 mm with the number/individual obtained as many as 26 individuals and the lowest obtained at a length of 39.6-49.4 mm and 90 - 98.8 mm, which is the number/individual obtained by 1 individual. Graph (b) shows the length of *Lingula* sp. in Syiah Kuala beach the highest number/individual was obtained at length 39.6-49.4 mm with the number/individual obtained as many as 98 individuals and the lowest obtained at length 79.1-88.9 mm with the number/individual obtained as many as one individual.
Environmental factors are factors that affect the life of an organism in its development process, so it is very essential to note and measure. Environmental parameters measured in this study were temperature, salinity, and pH. The value of the measurement of environmental parameters at Ujong Pancu and Syiah Kuala beach can be seen in table 4.1 below:

| No | Parameters          | Ujong Pancu | Syiah Kuala |
|----|---------------------|-------------|-------------|
| 1. | Temperature ( °C )  | 31–38       | 30–34       |
| 2. | Salinity ( ppm )    | 24–35       | 25–30       |
| 3. | pH                  | 7.2–7.5     | 7.2–7.4     |

The difference in the number of *Lingula* sp. obtained in Ujong Pancu and Syiah Kuala areas caused by *Lingula* sp. in the coastal area of Ujong Pancu more widely used by the surrounding community to be consumed and sold to support their daily needs. The Syiah Kuala region (b) shows the value of $w = 0.0001L^{2.8096}$ with a constant value of $b = 2.8096$ and a constant value of $a = 0.0001$. Based on the values obtained from both stations shows a value of $b < 3$ which means a negative allometric growth pattern. [15] states that negative allometric growth is faster than weight gain.

Negative allometric growth in *Lingula* sp. considered being related to its flat and elongated shape. To achieve this shape, increasing the length of the shell is faster than increasing weight. Judging from the way of life this form makes it easy for *Lingula* sp. in adapting to their environment like capturing food. *Lingula* sp. has a unique shape that has an accomplice to push the body of *Lingula* sp. surface and pull the body to the substrate. During low tide *Lingula* sp. will attract the body into the substrate and during the tide *Lingula* sp. will push the body to the surface to catch food, so that its flat and elongated shape is very beneficial for *Lingula* sp. to push and pull *Lingula* sp. to capture food [16, 17].

Based on Table. 1, the temperature value in the Ujong Pancu region ranged from 31-38 °C and in the Syiah Kuala region ranged from 3-34 °C. According to [18] and [19], this value is a reasonable range and can support the life of organisms such as Brachiopoda, and the optimal temperature for shellfish life ranges from 28-34 °C. The temperature range value at station one had the highest temperature value when compared to station two which was 38 °C. This is because water samples were taken during the day and in that area, almost no vegetation was blocking the surface of the water. High temperatures at station one could affect the activity and stimulate or inhibit the proliferation of aquatic organisms.

The range of salinity values in the Ujong Pancu area ranges between 24-35 and in the Syiah Kuala region ranging from 3-34 ppm. According to [20], normal seawater salinity at 25-35 ppm salinity. Based on the statement, salinity values at station one and station two are still normal to support the life of *Lingula* sp. The same thing was found in the [13], that the *Lingula* was able to become a euryhaline biota capable of living at a salinity of 20 - 50 ppm. Location Station one is in an arid area where when the tide is low no trees were found around the area. In addition, there is no intake of freshwater from the
soil so salinity in the area is higher. In contrast to Station two, where the intake of freshwater from drainage and flow from the ground in the form of water areas such as ponds so that water tends to settle in the area, besides that the area also had mangrove forests so it is rich in nutrients to support the life of organisms.

Rominoh [21] stated that the pH of aquatic biota can live in a decent pH range of 5-9. If the water changes suddenly so that the pH value exceeds this range, it will produce physiological pressure from the biota that lives in it and can end in death. Based on this statement, the pH value in the Ujong Pancu area was still feasible to support the life of Lingula sp. namely with pH ranging from 7.2-7.5 as well as in the Syiah Kuala region with pH values between 7.2-7.4. Based on [22] stated that for temperature parameters with a quality standard of 28-32 °C, the pH value is 7-8.5, and the salinity value is 33-34 %.

Lingula sp. live in a shallow water base, not colonized, muddy area sand can move with dukel that serves as a stalk. Sludge is mostly organic matter particles from various types of shells where life is good. Shellfish generally bury their bodies in sandy or muddy sediments [23]. Based on the analysis conducted by [24], it was stated that the type of substrate obtained at Ujong Pancu beach and Syiah Kuala beach in general was a type of mud sand sediment, so based on the statement, the sediment types from Ujong Pancu beach and Syiah Kuala beach supported Lingula sp. following the statement of [22].

4. Conclusions

The conclusion obtained from the research activities that had been carried out is the growth of Lingula sp. tends to form negative allometric patterns, which is an increase in length faster than weight gain, as well as physical-chemical factors of the water environment classified as normal and support the life of Lingula sp. on Ujong Pancu beach and Syiah Kuala beach Banda Aceh city.

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