Species morphometric of Anadara Shell in Tanjungbalai aquatic North Sumatera Province, Indonesia

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Abstract. This research was conducted from October to November 2016 The samples was taken from 3 stations with repeating 3 times in Tanjungbalai Aquatic of North Sumatra Province. Regression equation for relationship length, height, and thickness of Anadara granosa, Anadara gubernaculum dan Anadara inaquivalvis shell to wet weight of flesh i.e Y = 2.950x – 1.3328, Y = 3.246x – 0.8254, Y = 3.01x – 0.5625, Y = 2.143x – 1.0492, Y = 2.2876x – 0.5419, Y = 1.7524 – 0.1926, Y = 2.6734x – 0.9413, Y = 2.6422x – 0.6525, Y = 2.315x – 0.2351. While for correlation coefficient relationship length with wet weight of A. granosa, A. gubernaculum, A. inaquivalvis of 0.796; 0.747; 0.899. Correlation coefficient height with wet weight were found of 0.821; 0.729; 0.909. Correlation coefficient thickness with wet weight of flesh were found of 0.798; 0.754; 0.910.

1. Introduction
Tanjungbalai aquatics are one of the aquatics located in the east coast of North Sumatera and it was a bivalve catching area and has used by the surrounding community as a source of daily income. Several types of Bivalvia that are often found and abundant in the Tanjungbalai aquatics are (Anadara granosa), (A. gubernaculum), and (A. inaequivalvis) [1].

Bivalve class belongs to the phylum of mucous with cupped shells which are generally bilateral symmetry by functioning the abductor and reductor muscles. On the dorsal body, there are ankle teeth and ligaments, on the mouth is equipped with labial palp without jaw and radula. The habitat of the bivalve is in the sea, brackish water, lakes, rivers, ponds, and swamps [2].

The abundance of shells at Tanjungbalai aquatics makes this city dubbed as a city of shells. Several research on the shells biological aspects were conducted at Tanjungbalai aquatics. However, the research about the morphometrical and dimensional relationship of the shell to the shell meat weight for Anadara species is rarely done, so it is necessary to research the morphometrics of Anadara shell at the aquatics of Tanjungbalai. Anadara shell which found in Tanjungbalai aquatics are known as a blood-shells a feather-shells and it was the most popular shell by the surrounding community. the pattern of allometric growth in A. granosa, A. gubernaculum, and A. inaequivalvis at Tanjungbalai aquatic.

2. Materials and methods
This research was conducted from October to November 2016 at Tanjungbalai aquatics. The sampling was taken by using a seashell scratching-catch equipment.
The methodology which is used to determining the location of research is purposive sampling, i.e. determination of location based on reviewing the purpose of research [3]. The location of research was divided into 3 stations with every 3 weeks repeating times. The first station is the estuary which is the border to the mangrove forest. The second station is the sea area, and the third station is the sea area which is the border to the land.

Bivalve sample was taken by using the 0.39 x 0.24 m bivalve scratching-catch equipment with 3 repeating times. Bivalve sample was carried to the laboratories for identified-process by using a [4] and [5], then calculated by individual amount for each species in the measurement of length, height, and thickness of the shells by a calliper and measurement of wet meat weight by analytic scale.

2.1. Data analysis
The Relationship between shells and meat weight. Shells and meat weight are added together to ease the data analysis. Morphometric related to growth characteristic which can be calculated using the formula. Determination of isometrics and allometric growth characteristic based on a regression equation formula [6].

\[ Y = aX^b \text{ or } \log Y = \log a + b \log X \]  

(1)

Where :
Y = Anadara shell meat weight
X = shell dimensions (length, height, and thickness in cm)
a+b = constant

if the b value equal to 3 then it has an isometric characteristic, b < 2 means negative allometric, b > 3 means positive allometric.

Microsoft excel. The calculation of correlation coefficients is performed to find out the relationship of length, height, shells thickness (shell dimensions), and meat weight. The calculation of correlation coefficients using a Microsoft excel software. Correlation coefficients characteristic depends on [7] was showed in Table 1.

Table 1. Interpretation of correlation coefficients

| Coefficients Intervals | Related Level |
|------------------------|---------------|
| 0.800 – 1.000          | Very High     |
| 0.600 – 0.800          | Strong        |
| 0.400 – 0.600          | Normal        |
| 0.200 – 0.400          | Low           |
| 0.000 – 0.100          | Very Low      |

Figure 1. Shell length (a), Shell height (b), Shell thickness measurement
3. Result and discussion
Data analysis was conducted by putting the data of length and weight into a logarithmic form than processed in an Anadara species which has gained consist of 3 types, i.e. A. granosa as many as 55 shells, A. gubernaculum as many as 220 shells, and A. inaequalvis as many as 82 shells.

3.1. Shell biology of Anadara

![Figure 2](image)

**Figure 2.** Anadara granosa (Linnaeus, 1758) (a), Anadara gubernaculum (Reeve, 1958) (b), Anadara inaequalvis (Bruguiera, 1792) (c)

Classification of Anadara granosa: Kingdom: Animalia, Phylum: Molluscs, Class: Bivalve, Order: Arcoida, Family: Arcidae, Genus: Anadara, Species: Anadara granosa (Linnaeus, 1758). Morphology: medium to large-sized shells and twisted; thick and heavy shells, thicker in the ventral; white outer shell, white inner or young cream; hairless shell, bulging oval shape and unbalanced; has rib (about 18) and width between ribs is narrower than rib size; covered with yellowish-brown periostracum to blackish brown; perpendicular joints; obtained sizes: 1.7 - 4.3 cm; live immersed in mud or sandy mud in the littoral area; local name: blood shells; chaff shells.

Classification of Anadara gubernaculum: Kingdom: Animalia, Phylum: Mollusc, Class: Bivalve, Order: Arcoidea, Family: Arcidae, Genus: Anadara, Species: Anadara gubernaculum (Reeve, 1958). Morphology: medium to large-sized shell and it has a pattern of spirals; Rather thick shells, thicker in the ventral; the outer shell is black, while the inside is white or young creamy; the shells have a black furry, the rectangular shape is bulging and unbalance; has rib (about 32 ribs) and width between narrow rib and small rib; length is bigger than height, the inside of the tooth line shell is clearly visible; covered with a blackish-brown periostracum; perpendicular joints; obtained sizes: 1.6 - 5.0 cm; habitat: live immersed in sandy mud in the littoral area; local name: feather shell.

Classification of Anadara inaequalvis: Kingdom: Animalia, Phylum: Molluscs, Class: Bivalve, Order: Arcoidea, Family: Arcidae, Genus: Anadara, Species: Anadara inaequalvis (Bruguiera, 1792). Description: medium to large-sized shells and umbo; the shell is not too thick rather thin, more thickened in the ventral section; brownish-white outer shell covered with blackish-brown feathers, white inside, oblong and oblong rectangular shape; has rib (about 34 ribs) and width between rib is narrower than rib width; covered with blackish periostracum; the posterior part is slightly curved; perpendicular joints; size obtained: 4.4 - 5.2 cm. habitat: live immersed in mud or sandy mud in the littoral area; local name: feather shells.

3.2. The relationship of shells dimension and flesh weight of A. granosa
The amount which is obtained in Anadara granosa species are 55 individuals to be measured the length, height, and thickness of the shells and to be measured the wet weight of the shell’s flesh.
Table 2. Regression equation, feature of growth and correlation of *Anadara granosa*

| No. | Measurement | Regression equation | Feature of growth | Correlation | Annotation |
|-----|-------------|---------------------|-------------------|-------------|-----------|
| 1   | Length      | \( y = 2.9508x - 1.3328 \) | Negative allometric | 0.796       | Picture 4 |
| 2   | Height      | \( y = 3.246x - 0.8254 \) | Positive allometric | 0.821       | Picture 5 |
| 3   | Thickness   | \( y = 3.01x - 0.5625 \) | Positive allometric | 0.798       | Picture 6 |

*Figure 3.* The relationship between shell length and flesh wet weight of *A. granosa*.

*Figure 4.* The relationship between height and flesh wet weight of *A. granosa*.

*Anadara granosa* growth was looked from regression value of the relationship between shell length to the wet weight of flesh have a regression value (b) are 2.950 with negative allometric growth pattern (b<3), regression value of the relationship between shell height to wet weight of flesh are 3.246 with positive allometric growth pattern (b>3), regression value of the relationship between shell thickness to wet weight of flesh are 3.01 with positive allometric growth pattern (b>3). Negative allometric is a weight growth is faster than a length increase whereas is a positive allometric. This is accordance with [8], a positive allometric growth stated if the value of b>3 which signifies that the weight growth is faster than the increase of length, while a negative allometric stated if b<3 which signifies that the length increase is faster than weight growth.
Figure 5. The relationship between shell thickness and wet weight of flesh *A. granosa*

The results of the calculation of the correlation coefficient on *Anadara granosa* between the length of the shell and the weight of the wet flesh, between the height of the shell and the weight of the wet flesh, between the thickness of the shell and the weight of the wet flesh have the highest correlation value between the height of the shell and the weight of the wet flesh of 0.821. In *Anadara gubernaculum* the highest correlation value between shell thickness and weight of wet flesh is 0.756. In *Anadara gubernaculum* the highest correlation value between shell thickness and wet flesh weight was 0.910. [7] states that the correlation value of 0.800 – 1.000 has a very high relationship. 0.600-0.800 has a strong relationship.

3.3. The relationship of shells dimension and flesh weight of *A. gubernaculum*

The amount which is obtained in *Anadara gubernaculum* species are 220 individuals, to be measured in length, height and thickness, and flesh wet weight.

| No. | Measurement | Regression equation | Growth feature | Correlation | Annotation |
|-----|-------------|---------------------|----------------|-------------|------------|
| 1   | Length      | $Y = 2.1434x - 1.0492$ | Negative allometrics | 0.747 | Picture 7 |
| 2   | Height      | $Y = 2.2876x - 0.5419$ | Negative allometrics | 0.729 | Picture 8 |
| 3   | Thickness   | $Y = 1.7524x - 0.1926$ | Negative allometrics | 0.754 | Picture 9 |

The results of *Anadara gubernaculum* shell growth research seen from the regression value of the relationship between the length of the shell to the wet weight of the flesh has a regression value (b) of 2.143, the regression value of the relationship between the height of the shell against the wet weight of the flesh by 2.287, and the regression value of the relationship between the thickness of the shell against the wet weight flesh of 1.752. The growth pattern of the dimensions of the shell to the weight of the wet flesh of the *Anadara gubernaculum* shell is allometric negative (<3 Based on the research bout comparison between thickness shells and wet weight of flesh other Bivalvia Meretrix meretrix species also have allometric negative [9]. Same as the result of [10] length and total weight relationship of *A. gubernaculum* was negative allometric growth type (b<3). Growth patterns between the dimensions of the shell on the wet weight of the flesh using morphometric data of length, height and thickness of the shell and the weight of the wet flesh. Growth patterns are calculated to find out how the growth patterns of an organism. Growth between length and weight is also influenced by several factors. According to [8], growth is a biological process formulated as an increase in length and weight in a certain period. Growth is influenced by two factors, namely
internal (internal) and external (external) factors. Internal factors include heredity, age, parasites, and disease, while external factors are food and temperature.

**Figure 6.** The relationship between shell length and wet weight of flesh *A. gubernaculum*

**Figure 7.** The relationship between shell height and wet weight of flesh *A. gubernaculum*

**Figure 8.** The relationship between shell thickness and wet weight of flesh *A. gubernaculum*
3.4. The relationship of shells dimension and wet weight of flesh *A. inaequivalvis*

The amount which is obtained in *Anadara inaequivalvis* species are 82 individuals, to be measured in length, thickness, and flesh wet weight of the shell.

| No. | Measurement | Regression equation | Growth feature            | Correlation | Annotation |
|-----|-------------|---------------------|---------------------------|-------------|------------|
| 1   | Length      | $Y = 2.6734x - 0.9413$ | Negative allometric       | 0.899       | Picture 10 |
| 2   | Height      | $Y = 2.6422x - 0.6525$ | Negative allometric       | 0.909       | Picture 11 |
| 3   | Thickness   | $Y = 2.315x - 0.2351$ | Negative allometric       | 0.910       | Picture 12 |

![Figure 9](image9.png) The relationship between shell length and wet weight of flesh *A. inaequivalvis*

![Figure 10](image10.png) The relationship between shell height and wet weight of flesh *A. inaequivalvis*
Figure 11. The relationship between shell thickness and wet weight of flesh A. inaequivalvis

*Anadara inaequivalvis* shell growth seen from the regression value of the relationship between the length of the shell to the wet weight of the flesh has a regression value (b) of 2.673, the regression value of the relationship between the height of the shell against the wet weight of the flesh 2.642, and the regression value of the relationship between the thickness of the shell to the weight of the wet flesh is 2.315. The growth pattern of the dimensions of the shell to the weight of the wet flesh of *Anadara inaequivalvis* shells is allometric negative (b <3). This is following [11] that shells consist of positive allometric growth, meaning that weight gain is more dominant than length increase. Allometric is negative, length increase is more dominant than weight gain. Increasing the size of the shell against the weight of the flesh is not always directly proportional to the existence of several causes. [12] stated that shell growth is not always directly proportional to weight gain, due to differences in spawning time, so that shells that have not spawned are heavier than shells that have spawned.

4. Conclusions

The type of *Anadara* results is *Anadara granosa*, *Anadara gubernaculum*, and *Anadara inaequivalvis*. Growth comparison between shell length and weight was considered as positive allometric, between shell high and weight was considered as negative allometric, between shell thick and weight was considered as negative allometric of *A. granosa* while *A. gubernaculum* and *A. inaequivalvis* growth comparison between shell length and weight, between shell high and weight, between thickness shell and weight was same as negative allometric.

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