Pattern of relative growth in cockle *Anadara antiquata* in Ihamahu coastal waters, Central Maluku

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Abstract. *Anadara antiquata* is economically important species for fisheries and belong to phylum mollusc which also found in Maluku. However, the density of population begins to decrease recently due to high exploitation by people. The objective of the present study was to analyze relative growth pattern of *A. antiquata* including size distribution and growth pattern based on shell dimensions. The study was conducted from December 2016 to February 2017 in Ihamahu coastal waters. Data were collected by using purposive random sampling. All the individuals of *A. antiquata* found were measured the length, width and height by using a vernier caliper to the nearest 0.01mm. Data were analyzed by using SPSS 20 and Microsoft Excel software. The results indicated that the *A. antiquata* mostly found in seagrass bed with a muddy substrate. The size distribution of shell dimensions was different during sampling. Overall, the length ranged from 15.87 mm to 57.5 mm, the width from 15.50 mm to 48.60 mm and the height was from 9.36 mm to 35.9 mm. The population of *A. antiquata* consisted of juvenile and mature size. The mature size (> 30 mm) was more dominant in the population. The *A. antiquata* showed allometric relative growth pattern based on shell dimensions.

1. Introduction

Maluku province is known as Thousand Island archipelago which having high biodiversity of marine and fisheries resources such as fish, echinoderms, molluscs, algae. Mollusc is one of the marine and fisheries resources which has been utilized by coastal communities in Maluku due to easily collected during low tide. Some species are usually consumed or sold by local people namely the top shell (*Trochus niloticus*), abalone (*Haliotis* spp.), blood cockle (*Anadara granosa*), and ark cockle (*Anadara antiquata*).

Ihamahu is a coastal village and has three keystone ecosystems, mangrove, seagrass and coral reef. Beside of the three ecosystems, there are at least nine coastal lagoon ecosystems with differences in size and they distribute along the coast [1]. Therefore, this village has a special and unique environmental condition where high diversity and potency of marine species. Some previous studies have shown that the lagoon ecosystems in Ihamahu village had high potency and diversity of marine resources inhabiting lagoon ecosystems [2, 3, 4].

There has been coastal environmental degradation in Ihamahu village mostly due to anthropogenic activities such as collecting marine resources during low tide (day and night), domestic waste, bridge building, fishing and uphill development [5]. One of the species collected during low tide is the arc cockle, *A. antiquata* by the local community in Ihamahu village for their daily needs due to its delicious meat. The continual utilization of this shellfish by local communities will decline the number of this species in the future. Recently, it is difficult to collect this species in large size. Therefore, the in-depth study is needed to sustain this commercial species of marine mollusc.
Growth is one of the important events in the life history of an organism besides reproduction. Growth in molluscs is usually determined by measuring the shell linear increment which is then converted to somatic growth. This conversion was done by using the relationship between body (tissue) weight and shell size [6]. Knowledge of growth of organisms is crucial in understanding their life history. Information on growth is useful for management of the species. By understanding the growth of the species and its relationship to reproduction, further knowledge will be gained on the status of the species, aiding decisions on whether they could be exploited or have already been overexploited.

Information available on the growth of *A. antiquata* is limited. Some previous studies have shown different growth of *A. antiquata* [7, 8, 9]. Shell size determined the growth rate of *A. antiquata*. The shell size 30 mm grow faster than the 40 and 50 cm shell [7]. Also, the growth coefficient for this species was 0.23/year and lifespan was 12.04 year [8]. Whereas, water quality and food availability also affected the growth rate of this species [9]. The objective of the present study was to analyze relative growth pattern of *A. antiquata* including size distribution and growth pattern based on shell dimensions.

2. Materials and Methods

2.1. Study sites

Geographically, Ihamahu village located at 03º30’15”S–03º31’42”S and 128º41’13”E–128º41’25”E (figure 1). It has various substrates such as coarse sand, medium sand, and pebbles. There were seven species of seagrasses found namely *Enhalus acoroides*, *Thalassia hemprichii*, *Cymodocea rotundata*, *Cymodocea serrulata*, *Halophila minor*, *Halodule uninervis* and *Syringodium isoetifolium*.

2.2. Sampling and handling procedure

Fieldwork was carried out from December 2016 to February 2017. Samples were taken using purposive random sampling in the intertidal area zone without replacement [10]. A quadrate 1 x 1 m was used to collect the *A. antiquata*. All individuals of *A. antiquata* within a quadrate were counted and collected. Approximately 30–50 individual were collected at each sampling time depending on their abundance. When samples were collected, the shell length, width and height were measured in situ (figure 2) using a vernier caliper to the nearest 0.1 mm.

2.3. Data analysis

The relationship between shell length (SL) and width (SW) as well as height (SH) was analyzed by fitting simple linear regressions [12]. The patterns of growth were analyzed by using a regression equation which was \( \log y = \alpha \log x \pm \log b \) where \( y \) is the dependent variable, \( x \) is independent variable; \( b \) is constant, and \( \alpha \) is the regression coefficient (constant differential growth ratio). This equation was used to assess the allometric status [13]. A slope (b) less than 1 indicates negative allometry, while (b) greater than 1 indicates positive allometry. If a slope is not significantly different from 1, there is isometry [14]. The slope of two-regression lines was analyzed using student t-test [15] SPSS 20 and Microsoft Excel software.
3. Results and Discussion

3.1. Size distribution of Anadara antiquata

Overall, the shell dimensions including length, width and height were quite different monthly (table 1). The shell length (SL) ranged from 15.87–57.5 mm, the shell width was from 15.51–48.6 mm and the shell height was from 9.36–35.9 mm. As the shell length is the main parameter of growth, the results indicated that the population of *A. antiquata* could be divided into two groups which were juvenile and mature.

The mature size was more dominant (91.85 %) than the juvenile size (8.15 %). Mostly the shell length of juvenile size for *A. antiquata* was less than 30 mm in Tanzania and the mature size was more than 31.33 mm [16]. The shell length was higher in Ihamahu coastal waters than that found in Lada Bay, Sunda Strait [17]. Similarly, the length of *A. antiquata* was slightly high in Ihamahu coastal waters compared to *A. antiquata* in Banten waters with 54.35 mm [18]. The maximum shell length for this species was 100.5 mm and common 70 mm [11]. The maximum shell length was different because of the different environmental condition, difference sampling time and fishing pressure activity in the area.
Table 1. Formatting sections, subsections and subsubsections.

| Month   | Shell length (SL) | Shell width (SW) | Shell height (SH) |
|---------|-------------------|------------------|-------------------|
| December| 15.87-49.7 (37.10±1.03) | 15.51-35.56 (26.43±0.69) | 9.36-33.12 (22.60±0.71) |
| January | 26.1-52.79 (40.92±1.27) | 18.9-40.52 (30.69±0.94) | 15.7-31.81 (25.3±0.80) |
| February| 15.87-57.5 (42.47±1.03) | 35.5-48.6 (31.71±0.83) | 9.36-35.9 (26.58±0.70) |
| Pooled  | 15.87-57.5 (40.08±0.66) | 15.51-48.6 (29.48±0.51) | 9.36-35.9 (24.78±0.45) |

The size distribution (SL) of this edible cockles *A. antiquata* was shown in figure 3. It could be seen from figure 3 that during the sampling time the population of *A. antiquata* was mostly composed of mature size. Based on the class interval, the dominant size classes were 35–40 mm and 40–45 mm in shell length (SL). The smallest and the largest size class were found in small number. The shell length was more than 50 mm found only in small proportion 5.92% respectively. It was probably caused by exploitation. Local women and children are always gathering this species during low tide especially for large size.

![Figure 3](image_url)

**Figure 3.** Size frequency distribution (SL) of *A. antiquata* found in Ihamahu coastal waters.

### 3.2. Growth pattern of *Anadara antiquata*

A total of 135 individuals of *A. antiquata* were used in this study collected from December 2016 to February 2017. The first reference dimension was shell length (SL) and dependent variables were shell width (SW) and shell height (SH). The result indicated all dimensions of shell increased as increasing in size.
A. antiquata showed a straight line which is evidence that the shell length (SL) is highly associated with shell width (SW) and shell height (SH) (figure 4). In other words, an increase in shell length resulted in increasing shell width and shell height.

There was a relationship between shell lengths (SL) against other parameters. This species showed a strong correlation between SL against SW (r = 0.837, t = 17.6, p < 0.01), and SL against SH indicated very strong correlation (r = 0.941, t = 32.2, p < 0.01). This suggests that the increase in shell length (SL) contributed more to the increase in shell height (SH).

Similarly, the shell width (SW) also associated with shell height (SH) (figure 5). The relationship between SW and SH was also strong (r = 0.857, t = 19.21, p < 0.01). Increasing in shell width (SW) as a second reference dimension resulted in increasing in shell height (SH) as a dependent variable (figure 5).

![Figure 4.](image1)

**Figure 4.** The relationship between shell length (SL) to other parameters for A. antiquata.

![Figure 5.](image2)

**Figure 5.** The relationship between shell width (SW) to shell height (SH) for A. antiquata.
The simple linear regression of shell dimensions was given in Table 2. This species exhibited allometric growth. The value of the slope (b) ranged from 0.637 to 0.751, indicating that this species showed negative allometric. If the slope (b) less than 1 showing negative allometric. The concept has been applied to understand the relative growth pattern of the organisms such as macroinvertebrates [14].

Table 2. The linear regression equation of shell parameters dimension for A. antiquate (* = p < 0.01; - = negative allometric).

| Shell parameters (mm) | Equation          | Correlation Coefficient (r) | SE  | t value | P   | Allometric status |
|-----------------------|-------------------|-----------------------------|-----|---------|-----|------------------|
| Shell length with     |                   |                             |     |         |     |                  |
| SW                    | \( y = 0.646x + 3.581 \) | 0.837                       | 0.37| 17.6    | *   | -                |
| SH                    | \( y = 0.637x - 0.749 \) | 0.941                       | 0.20| 32.2    | *   | -                |
| Shell width with      |                   |                             |     |         |     |                  |
| SH                    | \( y = 0.751x + 2.625 \) | 0.857                       | 0.51| 19.21   | *   | -                |

Some previous studies of A. antiquata on length-weight relationship also showed allometric growth [3, 9, 16]. Even though no studies on the growth of A. antiquata based on shell geometry were available for comparisons, the use of shell dimension in the present study to determine growth pattern is still useful. The shell length, shell width or shell height was commonly used to estimate the growth in molluscs [13, 19, 20].

4. Conclusion
The maximum length recorded of A. antiquata was 57.5 mm. Whereas the maximum width was 48.60 mm and the height was 35.9 mm. The size distribution of shell dimensions was different during the time of sampling. The population of A. antiquata was dominant in size 35–40 mm and 40–45 mm showing mature individuals. However, the largest size was found in small numbers. The A. antiquata showed negative allometric relative growth pattern based on shell dimensions. To sustain the species for the future, some recommendations are needed namely some period and area to be closed for fishing activity (closed season) to allow this species reached maximum size and recovered after spawning.

References
[1] Sahetapy D 2006 Diversity ecosystem and coastal resources in Ihamahu village, Saparua sub-regency, Central Maluku regency, Indonesia (Unpublished)
[2] Tubalawony S 1990 The abundance of fish in seagrass bed Ihamahu coastal waters BSc Honour Thesis (Maluku: Fishery and Marine Science Faculty Pattimura University)
[3] Selanno D A J, Loppies C Z and Tuhumury S F 2006 J. Ichthyos 5 3742
[4] Selanno D A J, Tuhumury S F, Uneputty P A, and Matruty D 2014 Empowerment and strengthening of economic of sea cucumber fishers in Central Maluku and South east Maluku by environmental systems approach Research report MP3EI (Maluku: Pattimura University)
[5] Selanno D A J, Natan Y, Uneputty Pr A and Lewerissa Y A 2013. Empowerment and strengthening of economic of sea cucumber fishers in Central Maluku and South east
Maluku by environmental systems approach Research report MP3EI (Maluku: Pattimura University)

[6] Hughes R N 1986 A functional biology of marine gastropods (Great Britain: Croom Helm Ltd.) p 245
[7] Nurdin J, Marusin N, Izmiarti, Asmara A, Deswandy R and Marzuki Z 2016 Makara Sains 10 96101
[8] Pattikawa J A 2007 J. Ilmu Kelautan 12 18196
[9] Setiawan A, Bahtiar and Wa N 2016 J. Manajemen Sumberdaya Perairan 1 13-27
[10] Khouw A S 2009 Methods and quantitative analysis in marine bioecology (Jakarta: P4L.DKP) p346
[11] Poutiers J M 1998 The Living Marine Resources of the Western Central Pacific 1 Seaweeds, coral, bivalvia and gastropods, ed K.E. Carpenter and V.H. Niem (Rome: FAO Species Identification Guide For Fisheries Purposes)
[12] Fowler J and Cohen L 1990. Practical statistic for field biology. vol vii (Wiltshire : John Willey and Sons Redwood Books) p227
[13] Mieskiewicz A G 1980 A comparative study of the biology of Nerita species from the Townsville region, North Queensland, Honour thesis, JCUNQ p 96
[14] Gayon, J 2000. History of the concept of allometry. American zoologist. 40 748-758
[15] Zar J H 1999. Biostatistical analysis. Fourth edition, (New Jersey: Prentice Hall International, Inc.) p 663