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DENSITY AND MORPHOMETRIC CHARACTERISTICS OF *Anadara antiquata* IN THE SEAGRASS BED OF BADAK BADAK ISLAND, BONTANG CITY

Kepadatan dan Karakteristik Morfometrik Anadara antiquanta di Padang Lamun Pulau Badak Badak, Kota Bontang

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ABSTRACT

Anadara antiquata is a zoobenthic associated with seagrass beds and plays an important ecological role in coastal ecosystems, as a source of animal protein and economic value. This study aims to determine the density and morphometric characteristics of *A. antiquata* in the seagrass beds of Badak Badak Island, Bontang City. The research was carried out in September 2023 – March 2024. The research station is divided into 3 stations, each station is divided into 3 zones, namely the highest tide zone, the highest tide, the lowest tide and the lowest tide. Seagrass and mega *A. antiquata* samples were collected using 50x50 cm quadrant transects. Data analysis includes seagrass density as well as density and morphometrics of *A. antiquata* as well as correlation analysis between seagrass variables and *A. antiquata*. Seagrass beds are composed of *Enhalus acoroides* and *Cymodocea rotundata* with an average density of *A. antiquata* reaching 27 individuals/m^2 and the density of *A. antiquata* is positively correlated with the density of seagrass stands. Characteristics of shell height and width in a ratio of 1:1.63.

Key words: *Anadara antiquata*, Bontang city, morphometric, seagrass bed.

ABSTRAK

Anadara antiquata merupakan hewan bentik yang berasosiasi dengan padang lamun dan berperan ekologis penting di ekosistem pesisir, sebagai sumber protein hewani serta bernilai ekonomis. Penelitian ini bertujuan untuk mengetahui kepadatan dan karakteristik morfometrik A. antiquata di padang lamun Pulau Badak Badak, Kota Bontang. Penelitian dilaksanakan pada bulan September 2023 – Maret 2024. Stasiun penelitian terbagi dalam 3 stasiun, setiap stasiun terbagi dalam 3 mintakat yaitu mintakat pasang tertinggi, antara pasang tertinggi-surut terendah dan surut terendah. Pengambilan sampel lamun dan mega A. antiquata menggunakan menggunakan transek kuadran 50x50 cm. Analisis data meliputi kerapatan lamun maupun kepadatan dan morfometrik A. antiquata serta analisis korelasi antar variabel lamun dan A. antiquata. Padang lamun disusun oleh Enhalus acoroides dan Cymodocea rotundata dengan kepadatan rata-rata A. antiquata mencapai 27 individu/m^2 dan kepadatan A. antiquata berkorelasi positif terhadap kerapatan tegakan lamun. Karakteristik tinggi dan lebar cangkang dengan rasio 1:1,63.

Kata Kunci : Anadara antiquata, Kota Bontang, morfometrik, padang lamun.

INTRODUCTION

Anadara antiquata lives by immersing itself in sand or mud which has a tube called a siphon, which consists of a channel for entering water and another channel for removing it (Arwin *et al*., 2016). The significance of the presence of *A. antiquata* (zoobenthic) in waters is that the higher the abundance of zoobenthic, the lower the total suspended solids content in the water (Mustofa, 2018). The distribution pattern *of A. antiquata* tends to be clustered (Silaban *et al*., 2021). The association of bivalves in seagrass beds is an important ecological indicator (Basmalah *et al*., 2022). *Anadara* sp. associated with seagrass beds (Riniatsih & Munasik, 2017) and *Anadara antiquata* is a fishery commodity with economic value (Sinaga *et al*., 2018).

Seagrass beds are important coastal ecosystems (Kusuma, 2022) especially in shallow waters (Ariasari *et al*., 2022) which support aquatic productivity (Hidayati *et al*., 2022) and habitat for bivalves (Annisa *et al*., 2024). The diversity of seagrass species that make up the fields forms habitat characteristics for bivalve species and *A. antiquata* (Silaban *et al* ., 2021; Basmalah *et al*., 2022) and contributes to the distribution of nutrients to the biota in the surrounding waters (Sari *et al*., 2023). .

Seagrass beds in Badak Badak Island waters tend to be mono-specific composed of *E. acoroides* (Ananda *et al*., 2024; Setiawan *et al*., 2024). Zulhariadi *et al*., (2017) reported that seagrass beds dominated by *Enhalus acoroides* with a muddy substrate type tend to have an abundance of *Anadara* sp. higher than the seagrass beds composed of *Thalassia hemprichii*. There is a relationship between the density of *E. acoroides* and the abundance *of Anadara* sp. This prompted research on the morphometric characteristics of feather clams (*Anadara antiqunata*) in seagrass beds in the waters of Badak Badak Island, Bontang City.

RESEARCH METHODS

Time and place

This research was carried out in September 2023 – March 2024 in the seagrass beds of the waters of Badak Badak Island, Bontang City (Figure 1). Implementation of Water Quality data analysis carried out at the Water Quality Laboratory of the Faculty of Fisheries and Marine Sciences and analysis of Substrate results carried out at the Soil Laboratory of the Paperta Agroecotechnology Department, Mulawarman University.

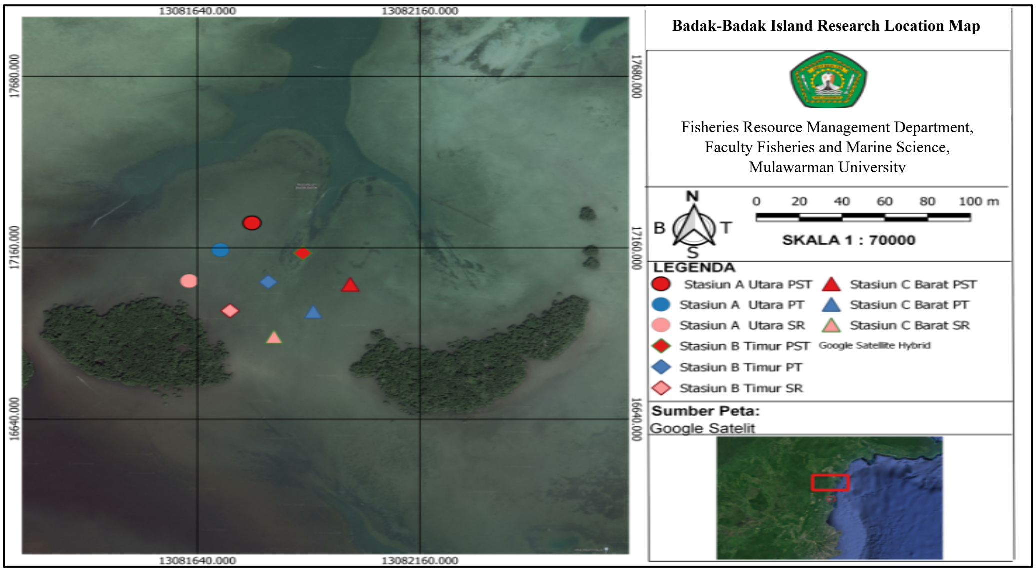

Figure 1. Map of research locations

Tools and materials

The tools used in this research were a 50×50 cm quadrant transect, small scope, *sieve net* , sample bag, modified *corer* , stationery, camera, GPS, cool box, jergen, *hand refractometer,* pH, *vernier calipers* and thermometer. The materials used in this research were distilled water, water samples, 70% alcohol, *Anadara antiquata samples* and substrate.

Determination of Research Stations

This research consists of 3 stations, namely AA1U representing the northern part, AA2T representing the eastern part and AA3B representing the western part of the seagrass beds in Badak Badak Island waters (Figure 1).

Research Parameters

Physico-chemical parameters of waters include: temperature, brightness, turbidity, speed current, salinity, pH, and oxygen dissolved (DO). Basic substrate parameters include texture. Seagrass parameters includes: density seagrass. *Anadara* mega parameters *antiquata* includes: total length (PT), width shell (LC), and weight body (BT).

Sampling

Water Physical -Chemical Parameters Water measurements and sampling for water physical-chemical parameters are carried out at high tide and measurement turbidity , nitrates and phosphates done in the laboratory

Substrate Parameters

Taking the basic substrate is carried out at the time recede using a modified *corer (* English *et al*., 1994). After that, the samples are put in sample plastic which has been coded according to the station and sub-station.

Seagrass Parameters

Seagrass sampling at each station was divided into three zones, namely seagrass beds at Highest Tide (PT), Between Highest and Lowest Tide (APS) and Lowest Tide (SR) using a quadrant transect method measuring 50 × 50 cm and a distance between transects of 100-150 cm. m (English *et al* ., 1994). Each seagrass plot found had its stands counted and the number of seagrass stands recorded on the transect.

Anadara* parameters *antiquata

Sampling of *A. antiquata* at each station was divided into three zones, namely seagrass beds at Highest Tide (PT), Between Highest and Lowest Tide (APS) and Lowest Tide (SR) and sampling was carried out at low tide using a 50 × 50 cm quadrant. and the *A. antiquata individuals* measured were mega-sized. Then the samples obtained are cleaned and put into plastic bags that have been given a code, the samples are taken to the laboratory for analysis.

Data analysis

Density *Anadara antiquate*

Calculation density shell hair obtained of the number of individuals something type per area area sampling data which can be formulated as follows (Silaban *et al*., 2021), namely: Di = ni/A

Information: Di = specific density (indv./m ^{2}); ni = number of individuals of a species (indv.) ; A = area of sampling area (m^2).

Density seagrass

Density seagrass that is, the total number of individuals type seagrass something the type being measured. Density types can be counted use formula (Fachrul, 2007) , namely : Ki = ni/A

Information : Ki = Density of the ith type; Ni= Total number of individuals of type i ; A= Total sampling area (m ^{2}).

Correlation density *Anadara antiquata* to density seagrass and Correlation Morphometrics Shell

Determination correlation between density *A. antiquanta* and density seagrass nor correlation between height and width shell, height and total weight of the shell as well as width and total weight of the shell were used for analysis correlation *Pearson's Product Moment* (Fakhri *et al* 2016; Ananda *et al*., 2024).

$$r_{XY} = \frac{n\sum XY - \sum X \sum Y}{\sqrt{n\sum X^2 - (\sum X)^2}\sqrt{n\sum Y^2 - (\sum Y)^2}}$$

Note: r = coefficient correlation; X= density *A. antiquanta* (variable morphometrics); Y = density seagrass (variable morphometrics).

The r value is between -1 to +1 (Abdullah & Susanto, 2015), namely: r = -1: the relationship between X and Y is perfect and negative; r = 0 : the relationship between X and Y is very weak ; r = 1 : the relationship between X and Y is perfect positive .

RESULTS

Physico-Chemical Parameters of Water

The results of measurements of the physico-chemical parameters of waters and basic substrates are presented in Table 1 below. The variables temperature, salinity, pH, dissolved oxygen and brightness are within the quality standard criteria, while the turbidity value exceeds the required quality standards (Table 1).

Table 1. Physico-chemical parameters of waters and basic substrate

No.	Parameter	Unit	Range	Mean(±SD)	Baku Mitu*
Physics -Water Chemistry					
1.	Temperature	°C	29.9 - 30.3	30.1 ± 1.17	28-30
2.	Salinity	$^0/_{00}$	31.5 - 32.0	31.8 ±0.50	33-34
3.	pH	-	8.1 - 8.2	8.2 ± 0.06	7-8.5
4.	Oxygen dissolved	mg/l	6.8 - 7.4	7.1 ± 0.31	>5
5.	Brightness	m	0.85 - 1.97	1.3 ± 0.08	>3
6.	Turbidity	NTU	6.95 - 7.52	7.2 ± 0.31	5
7.	Speed Current	m/s	0.23 - 0.56	0.4±0.17	-

Basic Substrate				
1.	Texture	*Clay sand*	*Clay sand*	*Sand clay*

*PP RI No. 22 of 2021

Seagrass Density

The seagrass species found consisted of 2 species, namely *Enhalus acoroides* with a density range of 184-216 individuals/m ^{2} with an average of 170 individuals /m ^{2} and *Cymodocea rotundata* ranging from 0-200 individuals/m ^{2} with an average of 22 individuals. /m ^{2} (Figure 2).

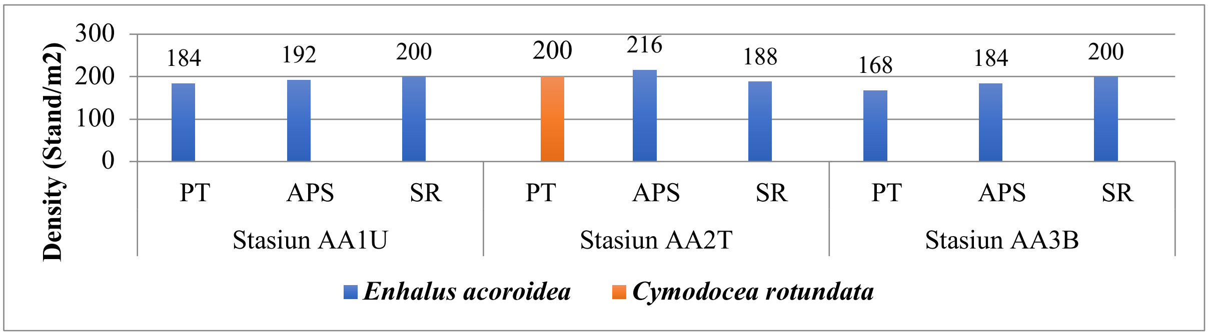

Figure 2 . Density of seagrass species

Density and morphometrics *of Anadara antiquata*

The density of *A. antiquanta* based on stations is divided into three zones, namely Highest Tide (PT), Between Highest and Lowest Tide (APS) and Lowest Tide (ST) as shown in Table 2. Density ranges from 12 – 52 individuals/m ^{2} with an average 26.7 individuals/m ^{2} (Table 1).

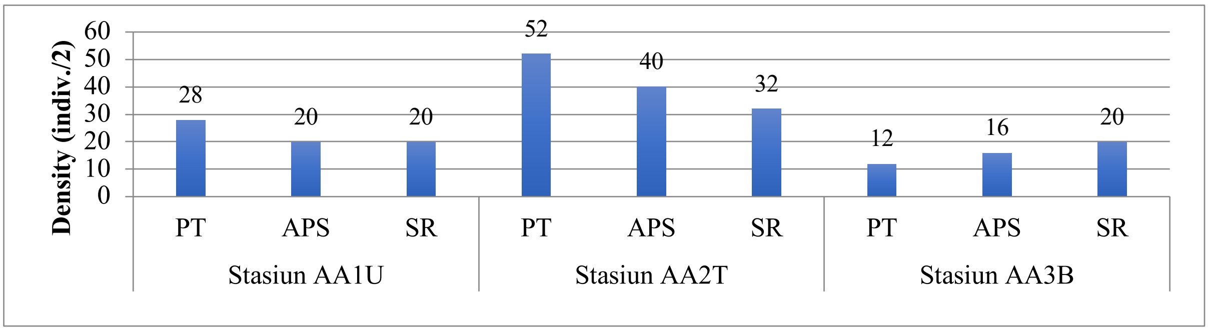

Figure 2. Density of *Anadara antiquanta*

The morphometric characteristics *of A. antiquata* include shell height , shell width and total weight as shown in Table 3. Shell height ranges from 2.88-3.25 cm, shell width ranges from 4.71-5.24 cm and shell weight ranges from 13-20 cm. cm (Table 3).

Table 3. Density and morphometrics *of Anadara antiquata*

Variable	AA1U Station		AA2T Station		AA3B Station	
	Range	Average	Range	Average	Range	Average
Shell height (cm)	2.89–3.24	3.08	2.97 –3.25	3.11	2.88–3.13	3.02
Shell width (cm)	4.72–5.24	4.94	4.71 –5.23	4.90	4.73–4.82	4.76
Total weight (gr)	15-20	18.53	13-20	18.32	14-20	18.5

Table 4. Correlation of Shell Height, Shell Width and Total Shell Weight

	Shell Width	Total Weight
Shell height	r = (+) 0.854	r = (-) 0.663
Shell width		r = (-) 0.117

Anadara antiquanta **density and seagrass density**

positive relationship between *A. antiquanta* density and seagrass density reached r=0.588 (Table 5).

Table 5. Correlation of *A. antiquanta density* and seagrass density

	Density of *A. antiquanta*
Seagrass density	r = (+) 0.588

DISCUSSION

Basic Physico-Chemical Parameters of Water and Substrate

Based on Table 1, it shows that the range and average of temperature, salinity, pH and water brightness in seagrass beds are still within the quality standard range, and the range and average of dissolved oxygen content is greater than 5 mg/l, in accordance with PP No. 22/2021. The range and average of temperature, salinity and pH still support seagrass life within the natural range, such conditions can also be seen in seagrass beds in the waters of Lantung District. North Minahasa with a range of 29.2-30.5 ^{o}C with an average of 29.9 ^{o}C, salinity ranging from 28.4-29.5 $^{0}/_{00}$ with an average of 29.1 $^{0}/_{00}$ and a pH of around 6, 5-10.3 with an average of 8.5 which is able to support the life of 7 seagrass species with a seagrass cover value range of 61.4-69.9% (Sipayung *et al* ., 2023). Likewise, Fahruddin *et al* . (2023) reported that the temperature range was 28-29 ^{o}C with an average of 28.4 ^{o}C, salinity ranged from 32.7-33 $^{0}/_{00}$ with an average of 32.91 $^{0}/_{00}$ and pH ranged from 7.3-7 .5 with an average of 7.4 supports the life of 4 species of seagrass with a density ranging from 473-800 individuals/m ^{2} with an average of 533 individuals/m^{2}.

The range and average measured dissolved oxygen content tends to be higher than the required quality standard for dissolved oxygen content, namely 5 mg/l (Table 1). The tendency for high dissolved oxygen content shows that seagrass beds are suppliers of dissolved oxygen through the process of photosynthesis. This can also be seen in the dissolved oxygen content in seagrass beds in Bahoi Village, North Sulawesi, which ranges from 8.4 to 8.6 mg/l on average. -an average of 8.5 mg/l (Fahruddin *et al* ., 2017), likewise the dissolved oxygen content in the seagrass beds of West Kupang, East Nusa Tenggara ranges from 5.7-7.2 mg/l with an average of 6.5 (Suhendar *et al. a* l., 2023)

The range and average brightness is below the required quality standard, namely greater than 3 m (Table 1), but the brightness conditions are measured down to the bottom of the water, in other words, seagrass beds can receive optimal sunlight. Similar conditions can also be seen in the results of brightness measurements in seagrass beds in the waters of Pengujan District. Bintan is 100% or up to the bottom of the waters (Sari, *et al* ., 2021). This is related to seagrass habitat in shallow waters (Ariasari *et al* ., 2022).

The range and average of turbidity tends to exceed the quality standards, this is related to the location of the P. Badak Badak seagrass beds at the mouth of the Tanjung Limau river and the characteristics of the basic substrate. The same thing can also be found in the seagrass beds of Sanur Beach, Bali Province, with white sand; coarser, slightly finer grains, coral fragments tend to be found in fewer species than white sand substrate types; fine grains, a little fine mud (Junaidi, 2016). The impact of increasing turbidity in seagrass beds drives a decrease in seagrass nutrition (Bulmer *et al* ., 2023).

The current speed range is around 0.23-0.56 m/s with an average of 0.4 m/s, indicating that the current speed tends to be maximum in supporting seagrass growth. Dahuri (2003) stated that a current speed of 0.5 m/s can support maximum seagrass growth. However, the range and average when compared with the current speed in other seagrass meadows tends to be higher than the current speed in the seagrass meadows of Pengujan Village Waters, which is around 0.021-0.052 m/s with an average of 0.04 m/s and the current speed 0.021 m/s tends to have a higher seagrass density than seagrass beds which have higher current velocities (Sari *et al* ., 2021). Salahuddi n *et al* . (2022) reported that current speeds ranging from 0.03-0.04 m/s support *E. acoroides leaf growth rates* ranging from 0.38-0.40 cm/day with an average of 0.39 cm/day.

The texture of the basic substrate tends to be clayey sand to sandy clay and in general the texture tends to be clayey sand (Table 1). The texture characteristics of the substrate are relatively similar to the characteristics of the *Anadara gubernaculum substrate* in muddy sand and rocky sand with a relative density ranging between 47%-96% with an average of 77.5% (Alwi *et al* ., 2020). Rada *et al* . (2020) reported on seagrass beds in Tanjung Batu Village, Kab. The Konawe Islands show that the clayey sand-based substrate texture tends to have a higher number of species and individual density of bivalves than the sand-textured basic substrate. The sand and mud substrate type is the habitat *of A. antiquata* and this type of substrate has better capacity in trapping organic material as a food source and makes it easier for *A. antiquata* to bury itself in the substrate (Silaban *et al* ., 2021).

Seagrass Density

Based on Figure 3, it shows that the density of *E. acoroides* tends to dominate each station, while *C. rotundata* is only found at AA2T Station, especially at the Highest Tide Zone (PT). The higher density of *E. acoroides* than *C. rotundata* is related to the characteristics of the clay sand and sand clay substrate as well as high turbidity (Table 1). The highest seagrass density was at AA2T Station, then AA1U at AA3B Station (Figure 2). There is a tendency for high density of seagrass at Stations AA2T and AA1U related to the texture of the bottom substrate being clayey sand and Station AA3B has a sandy clay texture (Table 1). Rosalina *et al.* (2018) reported that seagrass beds in Kab. South Bangka Province. Bangka Bitung with a sandy loam substrate tends to have a higher density of seagrass stands (38-93 stands/m ^{2}) than the density of seagrass stands on a sandy substrate (4 stands/m ^{2}). Likewise, the basic substrate characteristics of seagrass meadows in Poton Bako Hamlet, Jerowaru, East Lombok are sandy mud and muddy sand with the species that make up the seagrass meadows consisting of *E. acoroides* , *Halodule pinifolia* , *Halophila ovalis* , *H. minor* and *C. rotundata* with a range of total cover seagrass 20.74-43.75% with an average of 31.44% (Afrijal *et al* ., 2023). These conditions indicate that seagrass tends to use soft substrates as its habitat (Latuconsina, 2020).

Enhalus acoroides tends to dominate at each station, this condition is related to high water turbidity. The trend of increasing turbidity has an impact on decreasing seagrass species diversity, as shown by Hidayat *et al* . (2018) stated that low turbidity (0.73-0.80NTU) has a high diversity of seagrass species, namely (10 species) with a cover range of 55.36-59.38%. Likewise, the report by Martha *et al* . (2019) stated that in seagrass beds that had a turbidity value of 0.66 NTU, 6 species of seagrass were found with a density reaching 1,888 stands/m ^{2} , while in seagrass beds with a turbidity range of 5.13-5.53 NTU, 4-5 species were found with a density range. 242-257 stands/m ^{2} .

***Anadara antiquata* Density and Its Relationship with Seagrass Density**

The density of *A. antiquata* ranges from 12 – 52 individuals/m ^{2} with an average of 27 individuals/m $^{2.}$ This density tends to be higher than the density of *A. antiquata* in the waters of Wangi-Wangi Selatan District. Wakatobi ranges from 0.04-0.94 individuals/m ^{2} with a basic substrate texture of fine sand to mud (Dayanti *et al* ., 2017). Likewise, Silaban *et al* . (2021) reported that the habitat of *A. antiquanta* associated with stands of *E. acoroides* with a muddy sand substrate texture had an individual density range of 0.05-1.11 individuals/m ^{2}). Density of *Anadara* sp. in the Ulee Lheue Waters in Banda Aceh, it ranges from 3-50 individuals/m ^{2} with an average of 27 individuals/m ^{2} with a basic substrate texture of sandy clay loam to clayey sand. These conditions indicate that the main habitat based on the basic substrate of *A. antiquanta* is a sandy loam to clayey sand substrate.

Based on the stations, it shows that the highest density is at Station AA2T then at Stations AA1U and AA3B (Figure 3). The high density at AA2T Station with an average of 41 individuals/m ^{2} is related to the texture of the sandy clay substrate. However, this is different from the density at AA1U Station, which has a sandy clay substrate texture with an average density of 23 individuals/m ^{2} . This condition makes it possible for the association of *A. antiquanta* with differences in the stand density *of E. acoroides* and the presence of *C. rotundata* at Station AA2T (Figure 3). Likewise, the density of *A. antiquanta* at Station AA3B reached 16 individuals/m ^{2} with seagrass beds composed of *E. acoroides* with a clay sand substrate type.

Based on the data, it shows that in the Highest Tide (PT) zone, *A. antiquata individuals were found* to be higher than in the Highest-Lowest Tide (APS) and then Lowest Tide (SR) zones (Figure 3). This is related to variations in the density of *E. acoroides* and the combined presence of the density of *C. rotundata* . Based on the correlation test, it shows that the relationship between *A. antiquata density* and seagrass density shows a correlation value of r = (+) 0.588. This condition also shows that apart from the texture of the substrate as its habitat, the association of *A. antiquanta* with the density and species of seagrass, especially with the density of *E. acoroides* and the combination between the seagrass species that make up the seagrass meadow, create the characteristics of the habitat of *A. antiquata.*

Morphometric Characteristics of *Anadara antiquata Shells*

The shell height *of A. antiquanta* ranges from 2.88-3.25 cm with an average of 3.07 cm and the shell width ranges from 4.71-5.24 cm with an average of 4.87 cm. Based on this average, the ratio of shell height and width is 1:1.63. The relationship between shell height and width is positively correlated with r=(+)0.854 (Table 5) with a coefficient of determination of 72.93%. Likewise, Jafar *et al* . (2023) reported the results of measurements of *A. antiquanta shells* in the waters of Barru Regency, that the shell height ranged from 1.3-2.35 cm with an average of 1.98 and the shell width ranged from 2.0-3.9 cm with an average 3.13 cm and with a shell height to width ratio of 1:1.63. Likewise, the ratio between shell height and width with *A. antiquanta shells* in Talibula Village, Sikka Regency with the largest percentage reaching 78% ranges from 2.50-3.49 cm and shell width ranges from 4.0-4.99 cm with a percentage of 77% obtained ratio 1:1.67 (Alfarizi *et al* . 2024). This shows that the morphological characteristics of the shell height and width of *A. antiquanta* in tropical waters are relatively the same.

The total weight of the shell ranged from 13.0 to 20.0 gr with an average of 18.45 gr. Based on the total weight being connected to the height and width of the shell, the correlation value between height and total weight of the shell is negatively correlated r=(-)0.662. (Table 5) And shell width was related to total shell weight, negatively correlated r=(-)0.177 (Table 5). This shows that there is no positive relationship between increasing the height and width of the shell on the total weight of the shell.

CONCLUSION

The conclusions are:

1. The density of *A. antiquata* ranges from 12 – 52 individuals/m ^{2} with an average of 27 individuals/m ^{2} and is associated with stands of *E. acoroides* and *C. rotundata* which have a clayey sand texture.

2. The shell height of *A. antiquanta* ranges from 2.88-3.25 cm with an average of 3.07 cm and the shell width ranges from 4.71-5.24 cm with an average of 4.87 cm with a ratio of 1:1.63 with a correlation value of 0.854.
3. The total weight of the shell ranged from 13.0 to 20.0 grams with an average of 18.45 grams and there was no positive relationship with increasing height and width of the shell on the total weight of the shell.

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