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Size Structure and Growth of Snail *Terebralia palustris* in Mangrove Ecosystem on Pannikiang Island

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Abstract: *Terebralia palustris* is a snail that lives in the mangrove ecosystem. This needs to be done considering that the condition factor (Ponderal Index) and size structure can be a reference for snail management later. Research on the condition factor (Ponderal Index) has never been studied. This research was conducted from August 2018 to July 2019 on Pannikiang Island. Sampling in December 2018 and January 2019 was not performed for weather reasons. The research stations were A and B. Sampling used one large plot measuring 100 m2, and inside, it contained four small plots measuring 0.25 m2 (0.5 m x 0.5 m), which were placed randomly. Data analysis used regression. The condition factor was calculated based on the growth pattern of the total length and weight of the snail's body. The measurement results obtained ten size groups in males and 11 in females. The length (SL) and weight (W) in female snails were more significant than in males. The test results showed that each month of observation showed negative allometry. The snail condition factor fluctuated.

Keywords: Pannikiang; Ponderal Index; *Terebralia palustris*

Introduction

Terebralia palustris is abundant and conspicuous in muddy mangroves and generally lives in brackish water. The maximum shell length of *Terebralia palustris* is 19 cm and mostly 12 cm (Carpenter & Niem, 1998). The shell size of *Terebralia palustris* is three to four times the size of *Terebralia sulcata* and about twice the size of *Terebralia semistrata* (Houbrick, 1991). The shell is large, elongated, and thick. The color of the shell is dark brown to bluish-black. The aperture is shiny and blackish brown with a light brown columella (Carpenter & Niem, 1998). The systematics of the mangrove snail *Terebralia palustris* are as follows (WoRMS, 2011): Kingdom Animalia, Phylum Mollusca, Class Gastropoda, Order Caenogastropoda, Superfamily Cerithioidea, Family Potamididae, Genus *Terebralia*, Species *Terebralia palustris* Linnaeus, 1767.

The length-weight relationship is calculated using the formula $W = aL^b$. The b value will vary according to location, sex, and gonad maturity. The growth rate of individual lola snails in different locations is different. This difference is mainly because the Lola snail population in different locations has different development stages, physiological conditions, genetic conditions, and physicochemical factors (Pauly, 1984).

Isometric growth (b = 3) is an organism's growth characterized by an increase in length proportional to the increase in weight. Positive allometric growth ($b > 3$) indicates the growth of an organism whose weight gain is faster than its length gain. In contrast, negative allometric growth ($b<3$) is the growth of organisms characterized by an increase in length faster than the increase in weight (Andy Omar et al., 2016).

Samu et al. (2012) found that male lola snails only showed an isometric growth pattern with a length-weight relationship equation of $W=0.0009L^{2.80}$, while samples from Porto Village, the length-weight relationship equations of female and male lola snails were $W=0.2606L^{1.38}$ and $W=0.2563L^{1.39}$, respectively. These two equations indicate that the growth pattern of

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female and male lola snails in this village is negative allometric.

The condition factor or ponderal index indicates the condition of the biota, both in terms of physical capacity and survival and reproduction. For commercial use, knowledge of animal conditions can help determine the quality and quantity of meat available (Andy Omar, 2013).

The relative condition factor is the deviation of the measurement of a particular group of individuals from the average weight to length in their age group, length group, or part of the population (Weatherley, 1972 in Andy Omar, 2013). Each increase in animal material weight increases in length during growth, where the linear ratio will remain constant. In this case, it is assumed that the ideal weight equals the cube's length and applies to small or large animals. A change in weight without being followed by a change in length or vice versa will cause a change in the comparison value (Efendie, 2002).

Aspects of size distribution, length-weight relationships, and condition factors. This aspect has yet to be studied, especially on Pannikiang Island, Barru Regency.

Method

1. Research Design

The research was conducted from August 2018 to July 2019. Sampling was not carried out in December 2018 or January 2019 due to harmful weather factors, and it was not possible to take samples. The research location was in the mangrove area of Pannikiang Island, Barru Regency. Sampling was carried out around the mangrove area of Pannikiang Island, Barru Regency. The random sampling method determined the research station (Figure 1).

Figure 1. Research location

At the station, a large plot measuring 100 m^2 was placed, and inside it, four small plots measuring 0.25 m2 (0.5 m x 0.5 m) were placed randomly. All *T. palustris* specimens in the plot were taken (if >50% of the snail's body was included in the plot, then it was classified into an observation plot) (Penha-lopes et al., 2009; Samsi & Karim, 2019; Susan et al., 2012).

A digital caliper with an accuracy of 0.01 mm was used for morphometric measurements of the mangrove snail shell—an Ohaus balance with an accuracy of 0.1 g for weight measurement. Boats were used as a means of transportation to the location and research stations.
The sampling points were placed in open areas to make it easier to take samples. The sampling points shifted every month by ± 10 m. The distance between stations ranged from 2.8 km. The location of each research station on Pannikiang Island is as follows:

a. Station A is at the northernmost tip of Pannikiang Island, and its substrate is sandy clay dominated by *Rhizophora*. The distance of the sampling point from the beach is <10 m.
b. Station B is the southernmost tip of Pannikiang Island, and its substrate tends to be sandy, dominated by *Rhizophora*, and is close to residential areas. The distance of the sampling point from the beach is <100 m. The condition of the sampling point is that there is much plastic waste.

2. Laboratory Observation Method

Morphometric measurements, namely the length of the shell, are measured from the anterior end to the posterior end using a digital caliper with an accuracy of 0.01 mm and weighed using an Ohaus Precision Plus digital scale with an accuracy of 0.1 g. Shell length data is also used to determine the size distribution.

3. Data Analysis

Shell Length-Weight Relationship and Condition Factor
The growth pattern of mangrove snails can be known through the relationship between shell length and body weight of mangrove snails, which is analyzed through the power regression equation relationship as follows (Ricker, 1975):

$$W = aL^b \text{ or } \log W = \log a + b \log L \quad (1)$$

Note: W = body weight (g), L = shell length (mm), a and b = constants.
A t-test is conducted to test whether the constant b equals three (isometric or allometric). Observations of the length-weight relationship are carried out based on gender and observation time.
The condition factor is calculated based on the growth pattern of the total length and weight of the snail's body.

If the growth pattern is allometric, the condition factor can be calculated using the formula (Efendie, 1979):

$$K = \frac{W}{aL^b} \quad (2)$$

Note: K = condition factor; W = body weight (g); L = total length (mm); a and b = Constants obtained from the regression

Result and Discussion

1. Size Structure

The measurement results showed ten size groups in males and 11 size groups in females (Figures 2 and 3). In the male size group, class H, with a size range of 85.0 - 96.1 mm, had the most significant number of individuals, 168, and classes B and D had no individuals. The largest size group was class J, with a size range of > 107.5 mm. Class J had 12 males.

In the female size group in class I, the size range was 93.3 - 103.7 mm, with the most significant number being 398 individuals. Size classes B, C, and E without individuals. The largest class is class K, with a size range of > 114.2 mm and eight females. This size range value also shows that the size of the female is longer than the male. The size of the female is longer than that of the male because it is related to reproduction. Namely, the female can produce eggs.

Zabarun et al. (2016) found fewer results. Namely, there were only six size groups in the sand clam Modiolus modulates in the waters of Bungkutoko, Kendari City—several factors, such as feed availability, environmental conditions, etc., caused this.

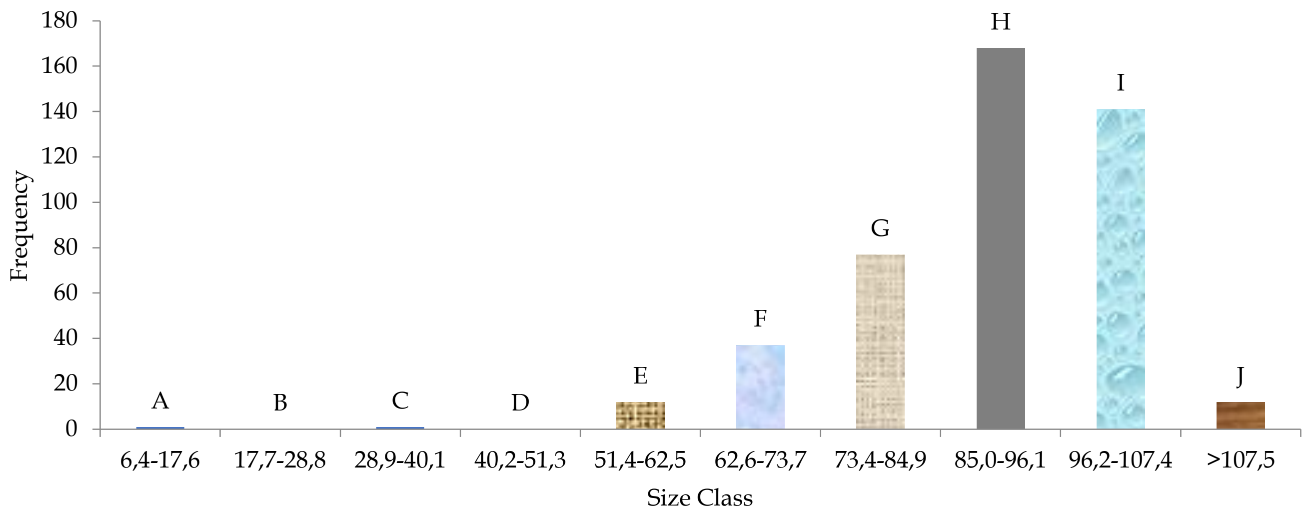

Figure 2. Length size classes in male *T. palustris*

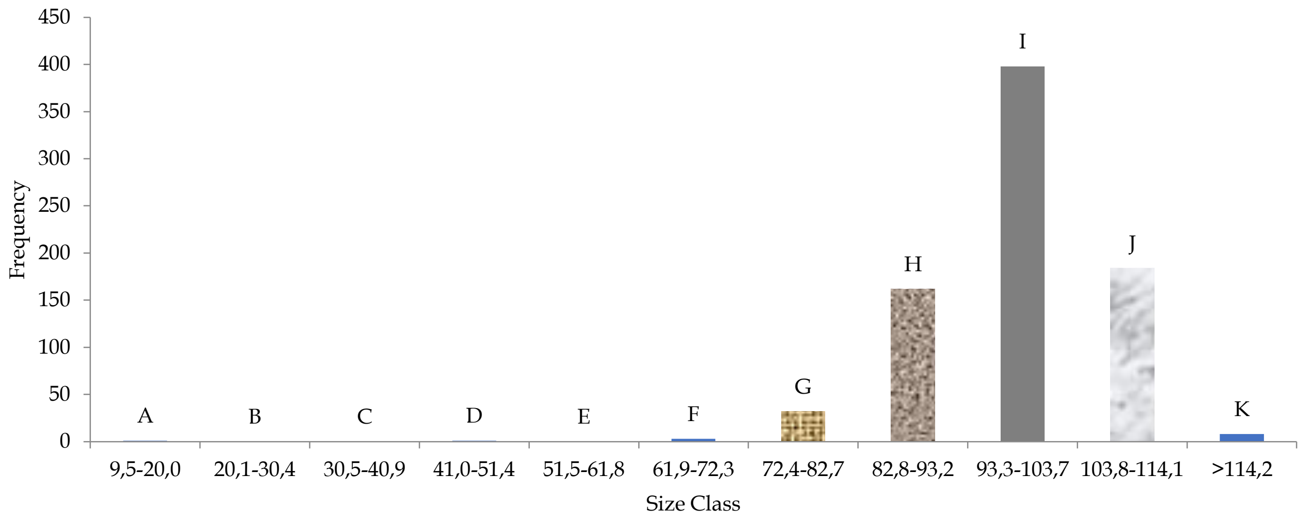

Figure 3. Length size classes in female *T. palustris*

2. *Length-Weight Relationship*

The test results show that every month of observation shows negative allometry except in June 2019, which shows positive allometry. Positive allometric growth (b>3) indicates the growth of an organism whose weight gain is faster when compared to its length gain, and negative allometric growth (b<3) is the growth of an organism characterized by a faster length gain than weight gain (Efendie, 1979). In June 2019, it was suspected that the environmental conditions of the snails were optimal, so the weight gain was faster than the length gain due to reproductive preparation.

Table 1. Length-weight relationship of *Terebralia palustris* snails

Observation Month	Sex	Regression Equation	n	Growth Type
	Male	$y = 0{,}00257x^{2{,}17114}$	98	Negative allometric
August 2018	Female	$y = 0{,}00178x^{2{,}24116}$	98	Negative allometric
	Combined	$y = 0{,}00009x^{2{,}88892}$	296	Negative allometric
	Male	$y = 0{,}00043x^{2{,}55309}$	49	Negative allometric
September 2018	Female	$y = 0{,}00072x^{2{,}42777}$	30	Negative allometric
	Combined	$y = 0{,}00019x^{2{,}71224}$	187	Negative allometric
	Male	$y = 0{,}001557x^{2{,}28132}$	38	Negative allometric
October 2018	Female	$y = 0{,}00153x^{2{,}27050}$	65	Negative allometric
	Combined	$y = 0{,}00013x^{2{,}80819}$	205	Negative allometric
	Male	$y = 0{,}00144x^{2{,}30470}$	33	Negative allometric
November 2018	Female	$y = 0{,}00120x^{2{,}33432}$	69	Negative allometric
	Combined	$y = 0{,}00014x^{2{,}79673}$	212	Negative allometric
	Male	$y = 0{,}00078x^{2{,}44259}$	30	Negative allometric
February 2019	Female	$y = 0{,}00243x^{2{,}17899}$	65	Negative allometric
	Combined	$y = 0{,}00013x^{2{,}80819}$	205	Negative allometric
	Male	$y = 0{,}00081x^{2{,}42872}$	36	Negative allometric
March 2019	Female	$y = 0{,}00088x^{2{,}39805}$	89	Negative allometric
	Combined	$y = 0{,}00020x^{2{,}71026}$	227	Negative allometric
	Male	$y = 0{,}00036x^{2{,}60356}$	27	Negative allometric
April 2019	Female	$y = 0{,}00145x^{2{,}29674}$	80	Negative allometric
	Combined	$y = 0{,}00010x^{2{,}87421}$	219	Negative allometric
	Male	$y = 0{,}00059x^{2{,}50089}$	41	Negative allometric
May 2019	Female	$Y = 0{,}00651X^{1{,}97574}$	72	Negative allometric
	Combined	$y = 0{,}00014x^{2{,}79580}$	216	Negative allometric
	Male	$y = 0{,}00073x^{2{,}45136}$	25	Negative allometric
June 2019	Female	$y = 0{,}0213x^{2{,}20823}$	74	Negative allometric
	Combined	$y = 0{,}00008X^{2{,}90707}$	192	Negative allometric
	Male	$y = 0{,}00138x^{2{,}31562}$	42	Negative allometric
July 2019	Female	$y = 0{,}00937x^{1{,}89043}$	101	Negative allometric
	Combined	$y = 0{,}00006x^{3{,}00126}$	252	Positive allometric*

Observations of the relationship between snail length and weight predominantly show negative allometric growth, so the growth type of *T. palustris* snails on Pannikiang Island is negative allometric.

The combination is the number of males, females, and juveniles of *T. palustris* snails. The differences that occurred in July indicate that the snails are fat due to food sources and supportive environmental factors, and it is suspected that this type of growth does apply to this species, especially on Pannikiang Island. *Allometric* is an approach used to determine the effect of changes in the allometric slope. A relative decrease in variance will indicate the extent to which the slope changes in producing diversity of traits across populations and species (Voje et al., 2013).

Gafnie et al. (2018) also found negative allometric results in *Littorina melanostoma*. The coefficient of determination (R2) value in all months of observation was> 0.90. This shows that the length of *T. palustris* snails affects the total weight of the snails by > 90% each month.

3. *Condition Factor (Ponderal Index)*

Condition factors are used to determine plumpness in the form of numbers and indicate physical condition and reproductive activity (Rahmawati et al., 2013). The condition factor of *T. palustris* snails fluctuates. This is because environmental factors also fluctuate. Béjaoui et al. (2017) also found fluctuating condition factors. This fluctuation is caused by several factors that were not studied, both internal and external factors. Internal factors are generally difficult to control, including heredity, sex, age, parasites, and disease (Efendie, 2002).

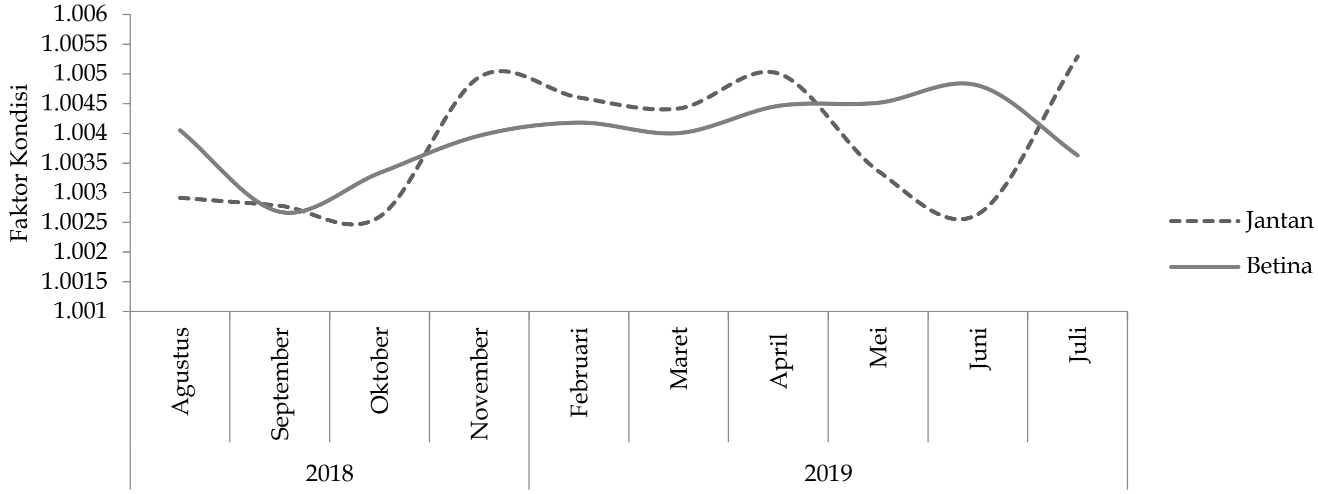

Figure 4. Condition factors every month

Male and female condition factors fluctuate every month. Male and female fluctuations co-occur from November to April, while other months show that male and female condition factors do not co-occur. This is influenced by reproductive activity and environmental factors. The graph also shows that male and female condition factors do not occur in the same month. The highest male condition factor is in July, while the highest for females is in June.

The intensity of snail feeding can also cause an increase in the condition factor value. Young snails eat more often because of their body growth, while adult snails eat for gonad development.

Conclusion

The measurement results obtained ten size groups in males and 11 in females. Female snails' length (SL) and weight (W) are more significant than males'. The test results show that each month of observation shows negative allometry. The condition factor of T. palustris snails fluctuates.

Author Contributions

The researchers involved are A. N. Samsi and Rusmidin. Conceptualization, A. N. Samsi; data curation, A. N. Samsi; formal analysis, A. N. Samsi; funding acquisition, A. N. Samsi and Rusmidin; investigation, A. N. Samsi; resources, A. N. Samsi and Rusmidin; methodology, A. N. Samsi; project administration, A. N. Samsi; resources, A. N. Samsi and Rusmidin; software, A. N. Samsi; validation, A. N. Samsi and Rusmidin; visualization, A. N. Samsi; supervision, A. N. Samsi; writing - original draft, A. N. Samsi; writing - review & editing, A. N. Samsi.

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Conflicts of Interest

The authors declare no conflict of interest.

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