



Abundance, Morphometrics, Length-Weight Relationship, and Condition Factors of Lola Snails (*Rochia Niloticus* L) in the Waters of Sarang Island, Belakang Padang, Batam

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ABSTRACT

Lola snails (*Rochia niloticus*) are biota that are widely consumed by coastal communities in Batam waters. Although it is not a primary commodity, its economic potential makes it vulnerable to overexploitation. This research aims to collect comprehensive data regarding the abundance, morphometrics, and weight-length relationship of Lola snails in the waters of Sarang Island, Batam. Sampling was carried out at 3 locations, including Kajang, Piring, and Layang Islands. The Lola snail sampling method was carried out using purposive sampling. Water quality measurements are carried out in situ. Morphometric data were collected by measuring the body dimensions of Lola snails using digital calipers. Abundance was determined based on the number of individuals per unit area, and the length-weight relationship was analyzed using linear regression to determine growth patterns. The research results show that the condition of the aquatic environment still meets the environmental quality standards set by the Ministry of Environment No. 51 of 2004. The abundance of Lola snails was in range of 0.22- 0.97 ind/m², and the highest was found on Kajang Island. The results of morphometric measurements showed that the highest shell length, weight, and shell width were observed in Lola snail samples from Kajang Island with values of 48.40 ± 25.28 mm, 68.77 ± 101.55 mg, and 44.42 ± 23.28 mm. There is a relationship between the growth patterns of Lola snails caught at three stations which have negative allometric growth patterns, where Kajang Island, Piring Island, and Layang Island have negative allometric growth patterns ($b < 3$) with exponential values of 0.9685, 1.5121, and 2.5471, respectively. The value of relative weight condition factor (Wr) shows a value close to 100 on Kajang, Piring, and Layang Island, namely 102.753 and 104.812, 99.654, which indicates that Lola snails were in good condition during the research.

Introduction

Sarang Island is located in Belakang Padang District, Batam City, which is within the Riau Islands Province, Indonesia. Geographically, this island is located near the border with Singapore, making it part of a group of small islands scattered in the strategic waters of the Singapore Strait. Sarang Island's position in international waterways marks the importance of this region from a geopolitical and economic perspective because it is traversed by various maritime trade activities. Sarang Island is surrounded by several other small islands, such as Mekan Island, Peranak Island, Piring Island, Layang Island, and Kajang Island. The geographical

conditions of this region are characterized by varied topography and shallow waters rich in marine ecosystems, such as coral reefs and mangrove forests, which play an important role in supporting local biodiversity (Ramses *et al.*, 2018).

One gastropod species often found in the waters of the small rocky islands around the Sarang Island area is the Lola snail, or *Rochia niloticus*. The Lola snail *R. niloticus* is a biota that is consumed by local people; although it is not a favored commodity, exploitation that does not take into account sustainability can lead to population scarcity in nature. This type of gastropod is known not only

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for the economic value of its shell but also for its meat, which the community can use as a protein source (Subhan, 2014). The Lola snail *R. niloticus* provides great benefits for coastal communities on small islands because it can increase their income with a high selling value and growing demand (Abukena et al., 2014).

The *R. niloticus* is a species with significant economic value and has long been an object of exploitation by coastal communities (Pratiwi and Utami, 2022). In some areas, the level of exploitation has even reached the stage of overexploitation. In addition, the *R. niloticus* shell has high commercial value in domestic and international markets because it contains a layer of pearls. This layer is used as a raw material for making excellent-quality buttons, jewelry, and nail dye.

Seasnail *R. niloticus* is an economically and ecologically important species, as an herbivore that helps maintain ecosystem balance by controlling algae growth (Triandiza et al., 2024). The utilization of *R. niloticus* in Indonesia has been going on for a long time, where its meat is consumed by coastal communities because of its high protein content, and *R. niloticus* shells are a high-value commodity in the national and international markets, thanks to their pearl layer, which is used as a raw material for making buttons, jewelry, and nail polish with superior quality (Marasabessy et al., 2024).

Aquatic resources are one of the important components in the ecosystem that support the life of various organisms, including mollusks such as Lola snails (*Trochus niloticus*). The abundance of *R. niloticus* can be influenced by various environmental factors, such as water quality, food availability, and interactions with other species. When water quality parameters exceed quality standards, this can result in disruptions to the ecological functions of aquatic ecosystems. In addition, there is a decrease in seawater quality, which includes physical, chemical, and biological aspects (Wahyuningsih et al., 2021). These impacts lead to a decrease in the usability, productivity, carrying capacity, and capacity of aquatic resources, which in turn can reduce the wealth of natural resources.

According to research by Yusal and Hasyim (2022), good water quality, including brightness, DO, pH, temperature, depth, salinity, and sediment nitrate, positively affects the abundance of mollusks in a water body. Correlation analysis at the 99% confidence level ($\alpha = 0.01$) indicated a highly significant relationship between water physicochemical parameters. The highest correlation

coefficient was identified between salinity and temperature ($r = 0.891$), followed by the correlation between salinity and pH ($r = 0.849$), both of which indicated a very strong relationship. Meanwhile, the correlation between pH and temperature showed a strong relationship with a coefficient value of $r = 0.665$. The three parameters show positive correlations that range from strong to very strong, indicating that an increase in one of the parameters will be followed by a proportional increase in the other parameters, and vice versa in conditions of decreasing parameter values (Yolanda, 2023).

In addition, the water temperature gradient is a determinant factor that affects the distribution pattern of biota, the metabolic process of organisms, and the level of oxygen utilization in marine water systems (Yusal and Hasyim, 2022). Sediment phosphate distribution, nitrate and phosphate levels in the water column, and acidity (pH) levels that exceed the threshold of marine water quality standards result in the disruption of meiofauna populations in the region (Yusal and Hasyim, 2022). Therefore, it is important to conduct in-depth observations of the factors affecting the abundance of *R. niloticus* in the waters of Sarang Island. This study will explore the relationship between body length and *R. niloticus* Lola snails' weight. Previous studies have shown that morphometric relationships can provide insights into the growth and health of snail populations (Utami et al., 2024). Morphometric studies of *Trochus niloticus* revealed differentiation in growth patterns based on geographic location. Specimens observed on Enggano Island showed positive allometric growth characteristics, indicated by a more significant rate of weight increment than shell height increase. In contrast, *T. niloticus* populations on Pasaran Island and Kaung Island showed a negative allometric growth pattern, where the rate of shell height increment was more progressive than weight increment. Analysis of condition factors ranging from 1.0048 to 1.0130 indicates that environmental parameters in Bengkulu and West Nusa Tenggara waters are still within the optimal tolerance range to support the growth and viability of *Trochus niloticus* populations (Silubun and Almohdar, 2022). Length-weight relationships are a fundamental aspect of fisheries research, playing a role in the development of growth-weight equations to be applied in fisheries stock assessment models (Utami et al., 2022). This analysis allows the estimation of biomass based on length measurements, provides information on the physiological condition of Lola snails, and supports the comparison of life history parameters between populations in different regions

for a given species (Kara *et al.*, 2018; Ndome *et al.*, 2012). Condition is an important indicator used to assess the welfare of a species among different populations. This parameter is influenced by a number of factors, including food availability and environmental variation (Rodriguez *et al.*, 2017).

Morphometrics of the *R. niloticus*, which includes measurements of body size and shape, is an important aspect of this study. Morphometric measurements can provide information about the health and condition of snail populations and their reproductive potential. Morphometric analysis of mollusks can be used to determine genetic variation and adaptation of species to the environment (Utami *et al.*, 2024). Apart from that, the relationship between the length and weight of *R. niloticus* was also the main focus of this research. This relationship can provide insight into the growth and development of snails in their natural habitat and help understand the species' reproductive and survival patterns. The existence of a significant relationship between snail body length and weight can be used as an indicator of population health (Utami *et al.*, 2022). Research on the abundance and morphometric characteristics of *R. niloticus* in the waters of Sarang Island, Belakang Padang District, Batam City, is very relevant to understanding population dynamics and potential utilization. This study is expected to obtain comprehensive data on the abundance and morphometric characteristics of *R. niloticus* and their length-weight relationship in the waters of Sarang Island. These findings are expected to contribute to the sustainable management of aquatic resources and support conservation efforts of mollusk species in the area. In addition, the results of this study are also expected to serve as a reference for further research on the ecology and biology of *R. niloticus* and similar species in Indonesian waters.

This study aims to collect comprehensive data on the abundance, morphometrics, length-weight relationship, and condition factors of *R. niloticus* in Sarang Island waters. Furthermore, morphometric analysis will be conducted by measuring the snail's body dimensions using a digital measuring device,

and length-weight relationships will be analyzed using linear regression to determine growth patterns. The findings of this study are expected to contribute to the sustainable management of aquatic resources and support conservation efforts of mollusk species in the area. In addition, the results of this study are also expected to serve as a reference for further research on the ecology and biology of *R. niloticus* and similar species in Indonesian waters. Thus, this research not only focuses on scientific aspects but also seeks to provide practical benefits for local communities and aquatic resource managers. It is hoped that the results of this study can encourage awareness of the importance of preserving aquatic ecosystems and support broader conservation efforts in Indonesia. Sarang Island is located in Belakang Padang District, Batam City, which is within the Riau Islands Province, Indonesia. Geographically, this island is located near the border with Singapore, making it part of a group of small islands scattered in the strategic waters of the Singapore Strait.

Materials and Methods

This study was conducted from August to October 2024 in the marine waters of Sarang Island, Batam City. Data from *R. niloticus* were taken from 3 sampling stations, as shown in Figure 1. The sampling location was carried out on the Kajang, Piring, and Layang Islands. The locations were chosen with special consideration to ensure the presentation of optimal research results. This data collection was carried out by involving three stations and data collection to ensure the variation and accuracy of the results obtained. There are three research stations that have been determined, namely Station I on Kajang Island (N= 1°7'31.254"; E= 103°50'39.63"), Station II on Piring Island (N= 1°7'3.204"; E = 103°50'29.508"), and Station III on Layang Island (N= 1°7'59.772"; E = 103°51'0.666").

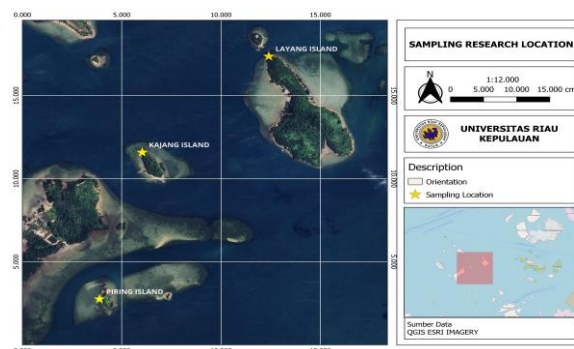


Figure 1. Research location map.

Equipment and Materials

Data collection and measurement of water quality parameters used in this study include various equipment such as roll meters, snorkeling equipment, stationery, underwater cameras, GPS for determining coordinate points, digital calipers (accuracy 0.01 mm), digital scales (accuracy 0.01 g), cameras, and sample bags.

While water quality measurement equipment includes a thermometer, refractometer, DO meter, pH meter, Sechi disk, TDS meter, and buoys. Water quality parameters are measured in situ.

Sampling

Determination of research station points was carried out using the purposive sampling method. Purposive sampling allows researchers to select sampling locations based on certain criteria that are considered important for analysis. In the context of this study, the sampling location refers to the habits of fishermen in finding Lola snails. The *R. niloticus* sampling process was carried out during the day in the intertidal zone with the help of snorkeling equipment. The collection of *R. niloticus* was carried out using a sweeping technique referring to the protocol developed by Underwood and Chapman (2013).

The observation process involves observing from a distance of 20 meters forward, with a sweep of 5 meters to the left and 5 meters to the right on each repetition. Each station point was observed in two repetitions with a distance of 20 meters for each repetition. These steps were implemented to ensure the accuracy and reliability of the data obtained from this study. These locations were selected with special consideration to ensure optimal representation of the research results. Identification of *R. niloticus* refers to Dance (1992), Poutiers (1998), Dharma (1998), and Santhanam (2019).

Station I is more dominated by less dead and rocky boulders. At station II, the substrate is dominated by rocky rock and muddy sand. Meanwhile, station III is dominated by small rocks and coral and coral fractures.

Water quality measurement

Environmental quality measurements were conducted to understand the factors that influence the abundance of *R. niloticus*. Water temperature measurement utilized a digital thermometer in degrees Celsius (°C), while acidity level (pH) measurement employed a portable pH meter. Water salinity measurement used a refractometer in per mil units (‰), while dissolved oxygen (DO) measurement utilized a meter in milligrams per liter (mg/L). Total Dissolved Solids (TDS) measurement employed a TDS meter in milligrams per liter (mg/L). Water clarity measurement utilized a Secchi disk in meters (m), and current velocity measurement used a current meter in meters per second (m/s). The measured values were compared with the seawater quality standards for biota referring to the Ministry of Environment number 51 of 2004.

Morphometric measurements

The *R. niloticus* samples were collected in coastal ecosystems and morphologically identified based on a guidebook (Santhanam, 2019). Lola snail samples were then measured for shell morphometrics, including shell length (SL), shell width (SW), aperture width (APW), aperture height (APH), diameter (D), and shell weight (Weight/W). Morphologically, the measurement of Lola snail height was measured starting from the bottom of the body whorl to the tip of the apex. The diameter of the Lola is measured from the longest end to the end of the shortest part at the bottom of the Lola snail shell. shell height (height), which is the distance from the top of the shell to the end of the bottom of the shell. Shell width (width-W) The width of the shell, which is the widest distance between the left and right sides of the shell. Shell diameter (diameter-D), which is the diameter of the shell usually measured at the widest part of the shell. Aperture height (APH) is the height of the shell opening, which is the vertical length of the hole or shell opening from top to bottom. Aperture width (APW) is the width of the shell opening, which is the horizontal distance at the widest part of the shell opening. The morphometric measurements of Lola snails are illustrated in Figure 2 below.

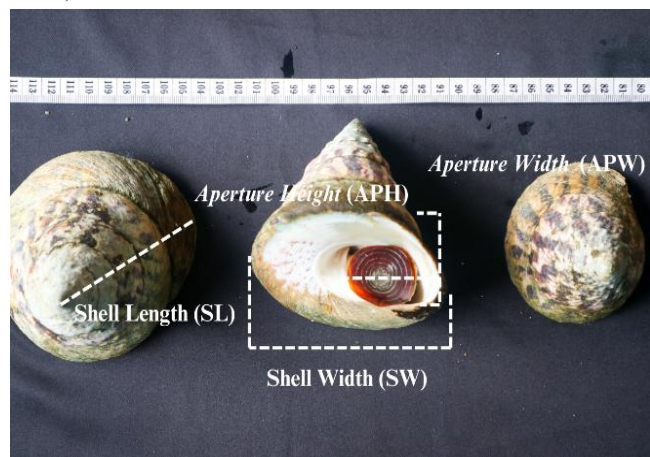


Figure 2. Morphometric measurements of *R. niloticus*.

Data Analysis

Abundance

The abundance of Lola snails was calculated based on the number of individuals per unit area. The abundance of Lola snails at each station was calculated and converted into units of individual/m² using the formula (Brower *et al.*, 1990).

$$Di = \frac{Ni}{A}$$

Description: Di = Number of individuals of Lola snail biota per unit area (m² individuals). Ni = Number of individual Lola snail biota in the transect quadrat. A = Area of the sampling quadrat transect (m²).

Length-Weight Relationship and Condition Factor

The length-weight relationship is one of the most commonly used methods to estimate the biomass of marine life. In this study, the measured variables include total length and weight (De-Robertis and Williams, 2008).

$$W = aL^b$$

Where W is shell weight (grams), L is shell length (mm), a and b are constants. If b=3, it indicates isometric growth, while b≠3 indicates allometric growth. If b<3, it indicates that length increases faster than weight. Conversely, if b>3, it means that the weight increases faster than the length.

Condition Factor Analysis

Relative weight condition factor (Wr) and Fulton coefficient (K) were used to evaluate the condition factor of each individual Lola snail sample. Relative weight (Wr) is determined based on the Rypel and Richter (2008) equation as follows:

$$Wr = (W \times W_s) \times 100$$

Where Wr is the relative weight, W is the weight of the Lola snail (g), and Ws is the standard weight (g) predicted from the same sample because it was calculated from a combined length-weight regression through the distance between species:

$$W_s = a L^b$$

The condition factor is an index value that indicates the health condition of the biota (Gundo *et al.*, 2014). The Fulton condition factor was calculated based on Muchlisin *et al.* (2010) as follows:

$$K = WL^{-3} \times 100$$

Where K is the condition factor, W is the weight of the Lola snail (g), L is the length of the Lola snail (mm), and -3 is the length coefficient to ensure that the K value tends to one.

Results

Abundance

Abundance is the number of individuals caught per unit area of the sampling area. In this study, the total number of Lola snails found was 170 individuals. The abundance of Lola snails *R. niloticus* at the 3 research stations is shown in Table 1.

Morphometrics

Details of the morphometric measurements of Lola snails are presented in Figure 3, while Table 2 consists of the measured value of Lola snails from three sampling locations. The findings of the study at Layang Island showed an average shell length of 48.40±25.28 mm with a size range of 26.00-113.00 mm, an average body weight of 68.77±101.55 g with a range of 9.00-379.00g, and a shell width of 44.42±23.28 mm with a range of 14.00-110.0 mm. Aperture size at this station had APW values of 24.20±12.23 mm with a range of 11.00-83.00 mm and APH 19.41±10.12 mm with a range of 10.00-47.00 mm. The comparison of the result in details is presented in Figure 4.

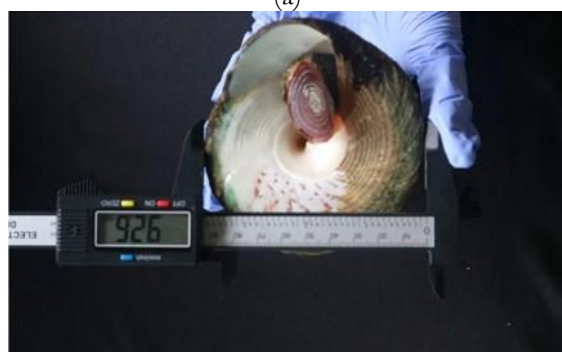
Length-Weight Relationship

Based on the results of the analysis of the length and weight relationship of *R. niloticus* at each station (Figure 5), the calculation of the length-weight relationship on the island of Kajang resulted in a linear regression equation $y = 7.782e^{0.0272x}$, with a coefficient of determination (R²) = 0.1532, regression value (r) = 0.39, and the number of individuals found as many as N = 11. On Piring

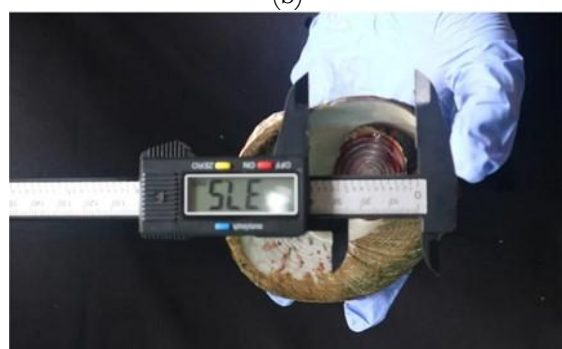
Island, a linear regression equation $y = 5.21e^{0.0421x}$, with a coefficient of determination (R^2) = 0.4904, regression value (r) = 0.70, and the number of individuals found was $N = 13$. On Layang Island, a linear regression equation $y = 3.9202x - 120.95$, with a coefficient of determination (R^2) = 0.9523, regression value (r) = 0.96, and the number of individuals found was $N = 146$.



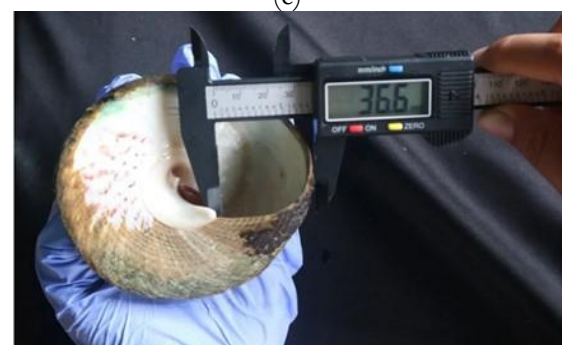
(a)



(b)



(c)



(d)

Figure 3. Lola snail measurement (a) Shell Length (SL), (b) Shell Width (SW), (c) Aperture Width (APW), Aperture Height (APH).

Condition Factors

The condition factor of Lola snails at the research location differs between stations, as presented in Table 3. Kajang Island has a Fulton condition factor value (K) = 6.44, relative weight condition factor value (Wr) = 102.753, Piring Island has a Fulton condition factor value (K) = 7.04, relative weight condition factor value (Wr) = 104.812, while Kajang Island has a Fulton condition factor value (K) = 6.33, relative weight condition factor value (Wr) = 99.654.

Water Quality

The results of the water quality analysis at the three sites are presented in Table 4. Generally, the parameters of water quality conditions support aquatic ecosystems. The average dissolved oxygen (DO) of 9.2 mg/L meets the quality standard (>5 mg/L), indicating good aeration conditions. Water temperature averaged 30.33°C, slightly exceeding the quality standard (28-30°C), which can affect oxygen solubility and biological activity. The average pH value of 8.65 indicates an alkaline trend, which is above the optimal range (7-8.5) and could potentially affect the chemical balance and aquatic biota. Total Dissolved Solid (TDS) varied between sites with an average of 48876.7 mg/L. Although there are no set quality standards, high TDS values can impact light penetration and overall water quality. Water salinity was relatively stable, with an average of 28.66 ppm, reflecting balanced estuary conditions. An average current velocity of 4.87 m/s supported nutrient distribution, although high currents in some locations could potentially increase substrate erosion. However, the water brightness showed an average result of 2.66 m, which is below the quality standard (>3 m), indicating that the turbidity level is quite high and can limit light penetration, thus impacting primary productivity and aquatic bottom ecosystems. Overall, the water quality was rated as good in terms of oxygen and salinity, but the parameters of temperature, pH, and brightness require attention to maintain ecosystem stability and prevent potential degradation of the aquatic environment.

Table 1. Results of Lola Snail Abundance at 3 sampling locations.

No	Location	Number of Individuals	Area (m ²)	Abundance (ind/m ²)
1	Kajang Island	11	50	0.22
2	Piring Island	13	100	0.13
3	Layang Island	146	150	0.97

Table 2. Morphometric size of *R. niloticus* in Sarang Island waters

Body Size	Measure Values (interval and average ± stdav.)					
	Kajang Island		Piring Island		Layang Island	
	interval	avarage	interval	avarage	interval	Avarage
SL	30.00-43.00	37.63±4.81	25.00-50.00	35.17±9.28	26.00-113.00	48.40±25.28
W	15.00-33.00	23.00±8.91	10.00-34.00	19.00±10.89	9.00-379.00	68.77±101.55
SW	35.00-42.00	38.67±2.80	32.00-46.00	37.29±5.15	14.00-110.0	44.42±23.28
APW	16.00-27.00	21.43±3.95	18.00-33.00 9	26.25±7.41	11.00-83.00	24.20±12.23
APH	18.00-26.00	21.29±2.93	10.00-23.00	14.86±5.37	10.00-47.00	19.41±10.12

Description: Shell Length (SL), Shell Width (SW), Aperture Width (APW), Aperture Height (APH).

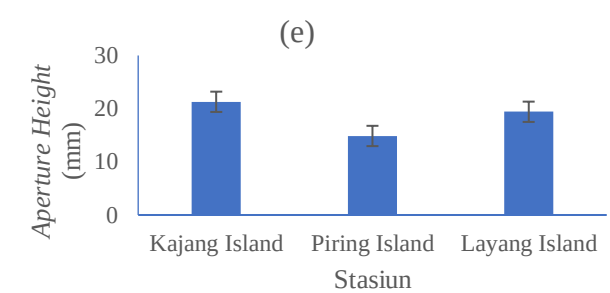
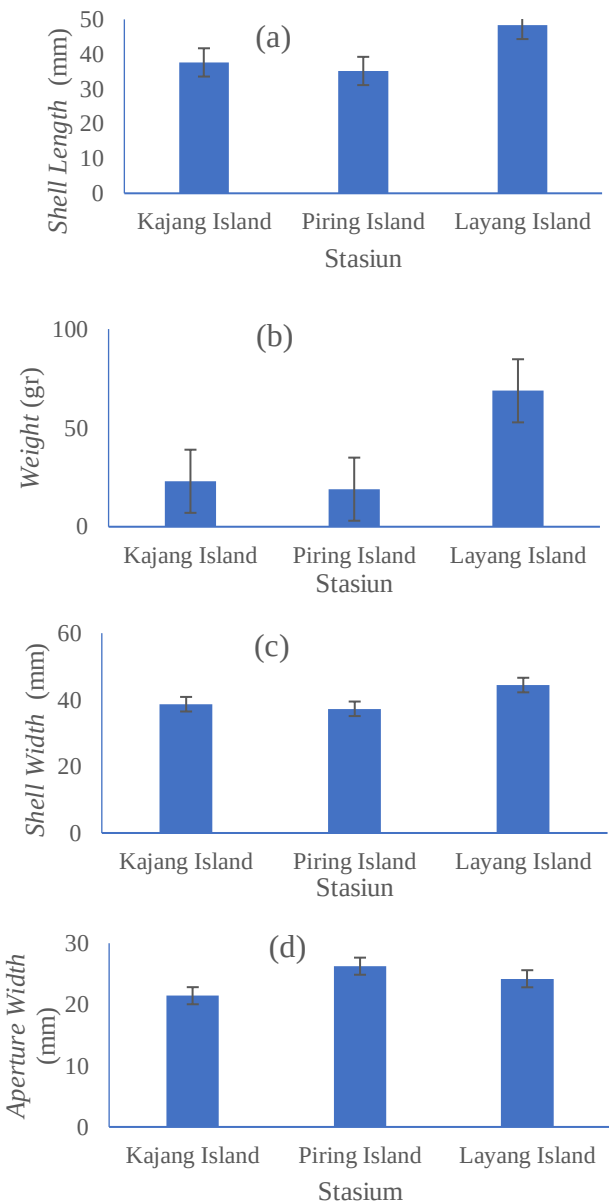


Figure 4. Morphometrics based on average size seasnail *R. niloticus*: (a) Shell Length (SL) Weight (W), (c) Shell Width (SW), (d) Aperture Width (APW), (e) Aperture Height (APH).

Discussion
Abundance of Lola snails *Rochia niloticus*

Distribution analysis showed that the Lola snail was more commonly found on Layang Island, with a total of 146 individuals, while on Piring Island, there were 13 individuals, and only 11 individuals were found on Kajang Island. The Abundance of *R. niloticus* on Kajang Island has an abundance of 0.22 ind/50m² with a number (N) of 11 individuals, Piring Island has an abundance of 0.13 ind/100m² with N=13 individuals, and Layang Island has an abundance of 0.97 ind/150m² with N= 146 individuals.

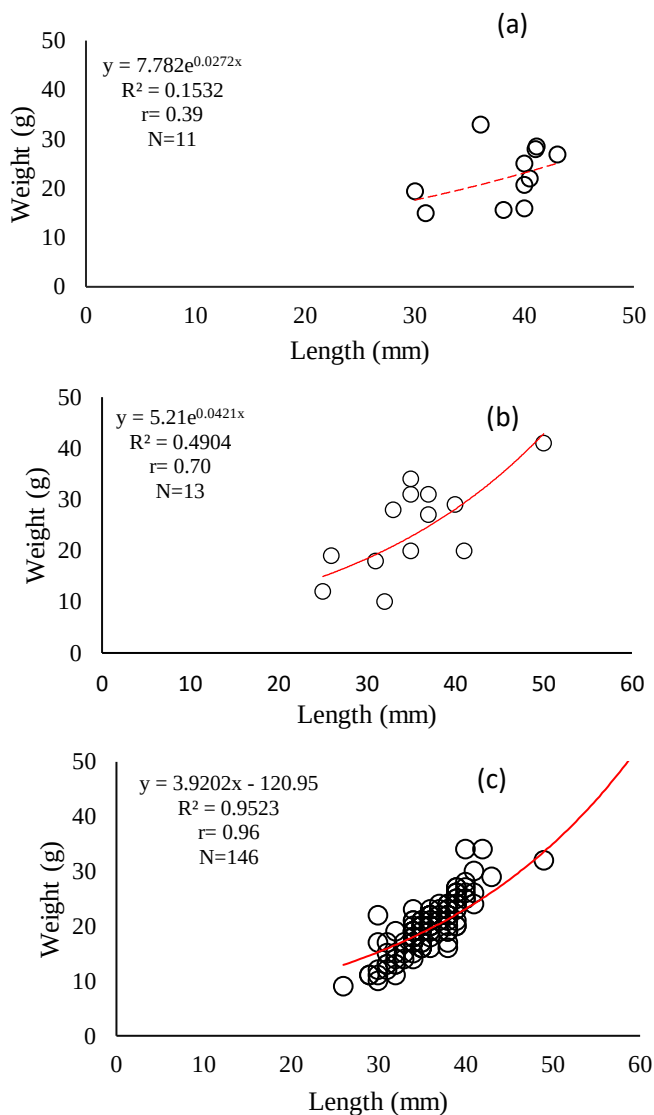


Figure 5. Length-Weight Relationship: (a) Kajang Island, (b) Piring Island, and (c) Layang Island.

The abundance of *R. niloticus* sunfish snails at the three observation stations showed a close relationship with the substrate at each location. The substrate serves as a shelter, food source, and protection for *R. niloticus* sunfish snails, which are highly dependent on the availability of epilithic algae growing on rock surfaces or dead coral breaks. The difference in abundance between these three stations reflects the role of substrate in supporting *R. niloticus* sunfish populations. Substrates that are rich in algae and have many refugia, such as small rocks and coral breaks, are more favorable for snail survival than substrates that are sand or mud, which are less favorable for snails.

At Station I, the substrate is dominated by sand with a few rocks and dead coral fragments, resulting in an abundance of *R. niloticus* of 0.22 individuals/m². Based on water quality parameters, DO of 8.4 mg/L and a temperature of 30°C

indicate fairly good conditions, but sandy substrates tend to be less than ideal for the survival of *R. niloticus* due to the lack of shelter and food sources. Salinity of 31 ppm and TDS of 31,070 mg/L are considered stable. However, low water clarity (2 meters) can reduce photosynthesis of basal organisms, which has an impact on nutrient availability.

Muddy substrates dominate Station II, with an abundance of *R. niloticus* of 0.13 individuals/m². Despite high DO (9.4 mg/L) and stable temperature (30°C), muddy substrates usually have lower water circulation, which can affect oxygen availability in the bottom layer. In addition, high TDS (73,400 mg/L) compared to other stations, can reduce the quality of the substrate and affect the existence of organisms supporting the ecosystem. This is in line with the relatively low brightness value of 2-3 meters, thus limiting light penetration and affecting primary productivity.

In contrast to the previous two stations, Station III showed much better conditions for the survival of *R. niloticus*, with the highest abundance of 0.97 individuals/m². The substrate, dominated by small corals and coral breaks, provided a more ideal habitat with sufficient cover and food sources. Water conditions were also favorable, with DO reaching 9.8 mg/L and temperatures of 31°C, which are optimal for marine organisms. The salinity of 29 ppm and TDS of 42,160 mg/L were more stable compared to Station II, which may have contributed to a better substrate for *R. niloticus*. In addition, the higher current velocity (6.834 m/s) favored the circulation of nutrients and oxygen in this area, improving the overall habitat quality. The high abundance at Layang Island is strongly suspected to be influenced by the substrate characteristics of the site, which is dominated by small corals and coral fragments. Broken coral substrates have a significant influence on the abundance of epifauna, including mollusks such as snails, and the study found that epifauna was more abundant on broken coral substrates compared to sand or seaweed substrates (Setyaboma et al., 2015). Such substrates are likely to provide ideal shelter, facilitate snail movement and support their survival by providing sufficient food resources. Complex substrate conditions, such as on Layang Island, can also reduce predation risk, allowing snail populations to develop more optimally.

Table 3. Fulton condition factor (K) and relative weight condition factor (Wr) of Lola snails in the study site

Location	Condition Factor	
	K	Wr
Kajang Island	6,44	102,753
Piring Island	7.04	104,812
Layang Island	6,33	99.654

Table 4. Results of water quality measurements and substrate conditions

No	Parameters	Unit	Kajang Island	Piring Island	Layang Island	Average	Quality standards
1	Dissolved Oxygen (DO)	mg/L	8,4	9,4	9,8	9,2	>5
2	Temperature	°C	30	30	31	30,33	28-30
3	Total Dissolved Solid (TDS)	mg/L	31070	73400	42160	48876,7	-
4	pH	-	8,557	8,6	8,8	8,65	7-8.5
5	Salinity	ppm	31	26	29	28,66	-
6	Current speed	m/s	2,386	5,419	6,834	4,87	-
7	Water brightness	m	2	3	3	2,66	>3

According to previous research by [Abukena et al. \(2014\)](#), population growth in Lola snails in the waters of the Banda Naira islands of Central Maluku Regency is a concept known as autocatalytic growth, which is when the number of individuals in a population continues to increase as long as environmental factors, both biotic and abiotic, continue to support their survival and reproduction. This indicates that the substrate and environmental conditions dominated by small coral rocks and coral breaks may support Lola snails' abundance more than the substrate and environmental conditions on the Kajang and Piring Islands. On the other hand, the substrate on Kajang Island and Piring Island may not be as ideal as Layang Island. Substrate structures that are less supportive, such as the dominance of sand or larger and more unstable coral fragments, can limit the movement of Lola snails, reduce the availability of shelter, and reduce the availability of suitable microhabitats. These factors could be the cause of the low abundance and abundance of snails in both locations.

Ecologically, Lola snails are known to be very dependent on dead coral or rocky sand substrates for shelter and food sources. Therefore, differences in substrate conditions between the three locations could be one of the main factors influencing distribution and broadcasting. Previous research ([Siahainenia et al., 2024](#)) showed that the number of individuals, the *R. niloticus* had the highest potential in the flat reef zone and the lowest potential in the edge reef zone and vice versa when viewed from

biomass, the greatest potential was found in the edge reef area, while the potential the smallest is in the seagrass zone. In addition, environmental stress, such as changes in air quality and temperature, can also affect Lola snail populations. Locations with better air quality and low sedimentation levels tend to support population growth. Layang Island, which may have better air quality and minimal disturbance, could be an ideal habitat for the survival of the *R. niloticus*.

Besides that, other environmental factors, such as the presence of pollutants that pollute the waters, will impact the population of benthic biota, such as Lola snails. Animals that live on seabed substrates with low mobility are relatively more exposed to and accumulate pollutants from the environment ([Stewart et al., 2021](#)). In connection with this, various previous studies reported that biota from Batam City waters had high levels of metal pollution, especially Pd, Cd, and Cu. ([Amelia et al., 2019](#); [Ismarti et al., 2017a](#); [Ismarti et al., 2017b](#))

Morphometrics

At the Piring Island location, 11 individual Lola *R. niloticus* snails were found with morphometric characteristics showing an average shell length of 37.63 ± 4.81 mm with a range of 30.00-43.00 mm, body weight of 23.00 ± 8.91 g with range 15.00-33.00 g, and shell width 38.67 ± 2.80 mm with a range 35.00-42.00mm. The aperture size shows an APW value of 21.43 ± 3.95 mm with a range of

16.00-27.00 mm and an APH of 21.29 ± 2.93 mm with a range of 18.00-26.00 mm.

At the Kajang Island location, 13 individuals of *Lola R. niloticus* snails were found, with the results of morphometric measurements showing an average shell length of 35.17 ± 9.28 mm with a range of 25.00-50.00 mm, body weight 19.00 ± 10.89 g with a range of 10.00-34.00 g, and shell width 37.29 ± 5.15 mm with a range 32.00-46.00mm. The aperture size at this station has the highest APW value of 26.25 ± 7.41 mm with a range of 18.00-33.00 mm and the lowest APH of 14.86 ± 5.37 mm with a range of 10.00-23.00 mm.

The morphometric measurements and environmental parameters results show significant variations between research stations, with different size distribution patterns and abundance. This variation is clearly visible between morphometric size classes, where Layang Island shows a much wider size range than the other two stations, indicating a higher diversity of population structure at that location.

The maximum shell length (SL) of the *R. niloticus* in this study was 113 mm, much smaller than all the measurements obtained in previous studies in several different locations, namely in Australia 150.1 mm (Nash, 1985). Japan 132.7 mm (Honma, 1988), Maluku 123.8 mm (Arifin, 1993), Wallis Island 122.3 mm (Lemouellic and Chauvet, 2008), Banda Neira Islands 123.57 (Abukena et al., 2014) and Rhun Island, Central Maluku 118.9 mm (Siahainenina et al., 2024). This indicates that the maximum size of the *R. niloticus* has decreased.

Length-Weight Relationship

The Lola samples found were 170 individuals, namely 11 individuals on Kajang Island, 13 on Piring Island, and 146 individuals on Layang Island. The total length collected was 30 mm – 43 mm on (Kajang Island), 25 mm – 50 mm (Piring Island), and 26 mm – 113 mm (Layang Island). The total weight collected was 15 g – 33 g (Kajang Island), 10 g – 34 g (Piring Island), and 9 g – 379 g (Layang Island). The growth pattern of *Rochia nilotica* is presented in (Figure 5).

The results of the analysis of the length-weight relationship of the Lola snail have a regression equation $y = 0.9685x - 0.4298$ with a value = 0.65064 ($W = 0.65064 L^{0.9685}$) with a coefficient of determination (R^2) = 15.32% on the island Kajang, $y = 1.5121x - 2.2271$ with a value = 0.107841 ($W = 0.107841 L^{1.5121}$) with coefficient of determination (R^2)=49% on Piring Island, $y = 2.5471x - 6.1368$

with value $a=0.00216$ ($W = 0.00216 L^{2.5471}$) with coefficient value (R^2)=93.26%.

The results showed that the growth pattern of the *Lola R. niloticus* snail at all stations had a negative allometric growth pattern ($b < 3$), with exponential values of 0.9685, 1.5121, and 2.5471 for each location, respectively Kajang Island, Piring Island, and Layang Island. The same results show a negative allometric growth pattern on Enggano Island, Sumbawa (Setyaboma et al., 2015). Meanwhile, different results were obtained from *R. niloticus* in the Kei Islands, which showed a positive allometric growth pattern (Effendi, 2002). Negative allometric growth indicates that the food supply on Kajang, Piring, and Layang Islands is lacking, so the increase in length is more dominant than weight. High exploitation of *R. niloticus* by local communities, especially young individuals, could contribute to this phenomenon. In young individuals, the growth process is more concentrated on shell development, leading to faster shell growth than body weight (Mulki et al., 2014; Saleky et al., 2016). Differences in growth patterns that occur in the same species are influenced by several variables, including sample size, sex differences, and other external factors, such as environmental conditions that support the growth development of this species (Innal et al., 2015).

Condition Factors

The condition factor is the plumpness of the Lola snail, which is expressed in numbers based on length and weight data. The condition factor shows the condition of the Lola snail in terms of its physical capacity to survive and reproduce. The condition factors measured in this study show that the condition of Lola snails in the waters is still in good condition, where the Fulton condition factor (K) ranges from 6.33 to 7.04. This is in accordance with the opinion of Effendi (2002) that if the K value ranges between 1-3 then the Lola snail is in good condition in terms of physical capacity for survival and reproduction. The relative weight condition factor (Wr) value is close to 100 on Kajang Island, Piring Island, and Layang Island, 102.753 and 104.812, 99.654. Condition factors indicate that the aquatic environment is in good condition and that there is a balance between prey and predators in the environment (Ramses et al., 2020a; Ramses et al., 2020b). Furthermore, Muchlisin et al. (2017) said that the value of the condition factor, with values tending to be close to 100 (one hundred), means that the biota is in very good condition. Ubay et al. (2021) stated that

condition factors are influenced by various external environmental factors and biological factors, including the maturity of the gonads for reproduction. Differences in fishing locations can also cause variations in the value of this condition factor carried out in three different locations so that the availability of food in each location is also different. This is supported by Effendi (2002) that variations in the value of this condition factor can be caused by various factors including food, age, gender, and gonad maturity level.

Environmental Quality Parameters

The results of seawater quality parameter measurements show that the water conditions at the three observation stations mostly meet the seawater quality standards for marine biota, as regulated in the Decree of the Minister of Environment Number 51 of 2004.

Dissolved oxygen (DO) concentrations were monitored at Stations 1, 2, and 3 at 8.4 mg/L, 9.4 mg/L, and 9.8 mg/L, respectively, far above the minimum threshold of 5 mg/L. This indicates very good conditions to support the life of marine organisms. Seawater temperatures range from 30°C to 31°C at all stations, with small variations and still within the maximum change limit of $\pm 2^\circ\text{C}$ from natural conditions. Conditions like this generally do not disrupt the balance of the marine ecosystem. Temperature can affect the biological activity of *R. niloticus*, where the optimal temperature for its activity is in the range of 31°C (Yi and Lee, 1997).

For the Total Dissolved Solids (TDS) value between observation stations, the highest TDS value was recorded at 73,400 mg/L at Station 2 (Piring Island), much higher than Station 1 Kajang Island (31,070 mg/L) and Station 3 Layang Island (42,160 mg/L). The TDS value can affect water clarity and light visibility, thus impacting the primary productivity of the marine ecosystem. In addition, the pH value ranged from 8.55 to 8.8, where Station 3 showed a pH slightly higher than the normal limit (7.5–8.5). The pH value can affect the chemical stability of seawater. The optimum pH value creates stable environmental conditions, thus supporting the survival of various species (Nybakken, 1992).

The salinity value at the three stations ranged from 26 ppm to 31 ppm, with variations still within the maximum change limit of 5% of the seasonal average. This condition indicates that the salinity of the waters is relatively stable and supports the life of marine biota. The measured current speed also varied, Station 1 recorded 2,386 m/s, while Stations 2 and 3 were 5,419 m/s and 6,834 m/s respectively.

These varying current speeds support the circulation of nutrients and oxygen, which are important for the sustainability of the ecosystem. The current speed of 0.68 m/s plays a role in increasing the circulation of nutrients in the waters, supporting the distribution of resources and preventing the dominance of one species, thus maintaining the balance of the ecosystem (Akbar et al., 2019). Furthermore, the water clarity value ranges from 2–3 meters, indicating a high concentration of suspended particles or biological activity, such as plankton that limits light penetration in the waters.

Overall, the seawater quality at the three observation stations is still relatively good based on the main parameters such as DO, temperature, pH, salinity and TDS. However, regular monitoring is needed to ensure that the seawater quality continues to support the sustainability of marine biota including the *R. niloticus* snail.

Conclusions

The research results show that the condition of the aquatic environment still meets the environmental quality standards set by the Ministry of Environment No. 51 of 2004. The abundance of Lola snails was in the range of 0.22–0.97 ind/m², and the highest was found on Kajang Island with 146 individuals. The results of morphometric measurements showed that the highest shell length, weight, and shell width were observed in Lola snail samples from Kajang Island with values of 48.40 ± 25.28 mm, 68.77 ± 101.55 mm, and 44.42 ± 23.28 mm. Analysis of the relationship between the length and weight of Lola snails *R. niloticus* on Kajang Island has a regression equation of $y = 0.9685x - 0.4298$ with a value of $W = 0.65064$ L 0.9685 with a coefficient of determination (R^2) of 15.32%. While on Piring Island $y = 1.5121x - 2.2271$ with a value of $W = 0.107841$ L 1.5121 with a coefficient of determination (R^2) of 49%, and on Layang Island $y = 2.5471x - 6.1368$ with a value of $W = 0.00216$ L 2.5471 with a coefficient value (R^2) = 93.26. All locations show that the growth pattern of *R. niloticus* is negative allometric ($b < 3$) with exponential values of 0.9685, 1.5121, respectively. and 2.5471. The value of the relative weight condition factor (Wr) shows a value close to 100 on Kajang Island, Piring Island, and Layang Island, namely 102.753 and 104.812, 99.654, which indicates that Lola snails were in good condition during the research. The condition factor value indicates that the environment is in good condition and that there is a balance between prey and predators.

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