The relationship between the length and weight of snail *Nerita lineata* Gmelin 1791 on environmental factors in the mangrove ecosystem

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Abstract. *Nerita lineata* snails are found in the mangrove ecosystem. This snail attaches to the roots of mangroves. This study aims to find the relationship between the length and weight of *Nerita lineata*’s snails to environmental factors. Sampling was carried out using four plots of 0.5m x 0.5m in a 10m x 10m plot. The research station is 3; station A with mangrove age ≤10 years, station B with mangrove age ≤20 years, and station C with mangrove age ≤30 years. Data were analyzed by regression and t-independent test. The length of the snail that is dominant in the mangrove is 22.27 - 25.57 mm and the dominant weight is 4.93 - 6.09 gr. Salinity and pH of seawater significantly affected the length of *N. lineata*’s snail shell. Total organic matter significantly affected the weight of *N. lineata* snails. The average length and weight of *N. lineata* snails at each research station did not differ.

1. Introduction

Mangroves can be defined as the presence of trees that live in (sub) tropical tidal areas 1. Tidal area (intertidal zone) is characterized by environmental factors that have high temperatures, high sedimentation, and high tides. Trees in mangrove ecosystems and canopies are a habitat for various species ranging from birds, insects, mammals, and reptiles. Mangrove roots serve as a place for epibions such as tunicates, sponges, algae, and bivalves. Sediments in the mangrove ecosystem serve as a habitat for a wide variety of infauna and epifauna species while the space between mangrove roots is a refuge and food for motile fauna such as crustaceans, crabs, and fish. Mangrove litter can be detritus and can support food webs in the mangrove ecosystem. The mangrove ecosystem is very important because it can encourage the fisheries sector 1.

Gastropoda is one group of animals that live in a mangrove ecosystem. This group of animals has a shell that is twisted in a direction 2. *Nerita lineata* is a species of the Gastropod group. *N. lineata* with the characteristics of a round (Globose) shell, does not have umbilicus, the surface of the shell is smooth, and threaded to horn 3. *N. lineata* was also found in the mangrove ecosystem in Tongke-­Tongke Village, Sinjai Regency and on Pannikiang Island in Barru Regency, Indonesia 4.

The research on the effect of mangrove structures on the spatial patterns of mangrove snails *Melampus coffeus* in the Brazilian Estuary had done by researcher 5. Deforestation in natural mangrove ecosystems significantly affects the distribution pattern of *M. coffeus*. The density of *M. coffeus* is the same as the density of the tree. Similarly, the tree density and shell length are the same.
The mangrove structure can be viewed from the age of the tree. This mangrove structure will form environmental conditions that will affect the biota in it. This is what drives this research. This study aims to find the difference between the length and weight of Nerita lineata's snail against environmental factors.

2. Experimental

2.1 Material and methods

This research was conducted on mangrove ecosystems in Tongke-tongke Village, Sinjai Regency, South Sulawesi Province, Indonesia for four months from April to July 2019.

![Figure 1. Sampling location](image)

2.1.1 Determination of research stations

Sampling was carried out around 3 mangrove areas. Station A is a mangrove group with an age of ≤10 years, station B is a mangrove group with an age of ≤20 years, and station C is a mangrove group with an age of ≤30 years. The observation plot is determined by the random sampling method. This observation is carried out for four months and sampling is done once every month.

2.1.2 Data collection of N. lineata

Sampling is done at low tide. At each station, a 10 m x 10 m plot is placed in which four small plots are placed each measuring 0.5 m x 0.5 m as a place for sampling. All samples contained in the observation plot (0.5 m x 0.5 m) were collected. All specimens in the plot were taken (if > 50% of the snail's body was included in the plot, it was classified into an observation plot) 6,7. Measurement of the
length of mangrove snails \( N. \text{lineata} \) uses digital calipers with an accuracy of 0.1 mm. Weight measurement using digital scales with an accuracy of 0.01 gr.

2.1.3 Measurement of environmental parameters
Measurement of environmental parameters was carried out in-situ before sampling. Salinity, temperature, and pH are measured directly in the field. Taking sediment samples at each station was taken using 35 mm PVC pipes. Total organic matter was analyzed using Walkley and Black method.

2.2 Data analysis
Data analysis performed was regression analysis and t-independent test with the help of SPSS version 21 software.

3. Results and discussion
Snail \( N. \text{lineata} \) is a type of snail that has not been widely studied in relation to its environmental factors. Most studies discuss the interrelation of these snails with environmental pollution. However, \( \text{Nerita} \), in general, can be used to explain the effect of habitat differences on species morphology.

3.1 The length and weight of mangrove snails \( N. \text{lineata} \)

The maximum length of the mangrove snail \( N. \text{lineata} \) obtained is 31.60 mm and the minimum is 2.40 mm. The average length of snails is 23.29 ± 4.73 mm. The results showed that there were 9 long-size groups of snail shells. Group G (22.27 - 25.57 mm) is the dominant measure in this mangrove. Group A (2.40 - 5.71 mm) is the smallest size group. The length of \( N. \text{lineata} \) in Dumai City is between 4.76 - 19.72 mm.
The maximum weight of the mangrove snail *N. lineata* obtained is 10.54 gr and the minimum weight is 0.24 gr. The average weight of snails is 5.76 ± 2.10 gr. The results showed that there were 9 groups of the size of snails. Group E (4.93 - 6.09 gr) is the dominant measure in this mangrove. Group I (> 9.61 gr) is the smallest size group. The weight of *N. lineata* in Dumai City is between 0.12 - 9.36 gr.

### 3.2 Environmental factors in mangroves

**Table 1.** The mean of the measurement of environmental parameters

| Environmental parameters | Station A        | Station B        | Station C        |
|--------------------------|------------------|------------------|------------------|
| Temperature (˚C)          | 31.00±0.12       | 31.98±0.16       | 32.61±0.05       |
| Salinity (%)              | 20.27±0.07       | 18.60±0.31       | 17.66±0.26       |
| pH                        | 6.02±0.01        | 5.99±0.00        | 5.95±0.00        |
| Total organic matter (%)  | 8.21±0.15        | 8.41±0.12        | 7.99±0.11        |

The results of previous studies showed seawater temperatures between 27˚C to 29.75˚C, seawater salinity between 12 ‰ to 27 ‰, and sediment carbon content between 2.11% to 10.79% 14. When compared to the results of the current study, there are slight differences. This is due to differences in sampling points, mangrove densities, and open sea distance with sampling points.

### 3.3 The relationship between the length of *N. lineata* shell and environmental factors

The level of significance of one-sided correlation coefficient shows the number 0.229 on the relationship of length and temperature which means it does not correlate with each other because the probability is far above 0.05. The relationship between temperature and acidity (pH) shows the number 0.416, which means that it is not correlated because the probability is far above 0.05. The relationship of acidity (pH) and total organic matter shows a number of 0.275, which means it does not correlate with each other because the probability is far above 0.05. The relationship between temperature and total organic matter shows 0.005, which means that it correlates because the probability is far below 0.05. The relationship of length and salinity, length and acidity (pH), total length and total organic matter, temperature and salinity, salinity and acidity (pH), and total salinity and organic matter which shows the number 0,000 which means correlated because probabilities are far below 0, 05.
The ANOVA or F test results with a significance value of 0.000 which shows a probability far below 0.05 so that it can be said that salinity, acidity (pH), temperature, and total organic matter together affect the length of the snail N. lineata. The resulting regression equation:

\[ Y = -11.176 - 0.204X_1 - 0.631X_2 + 9.498X_3 - 0.494X_4 \]  

Where Y is the length of the snail, X_1 is the temperature, X_2 is the salinity, X_3 is the acidity (pH), and X_4 is the total organic matter. The t-test shows that the variable salinity (X_2) is 0.000 and acidity / pH (X_3) is 0.020 which means the probability is far below 0.05 so that both of these variables (salinity and pH) significantly influence the length of the N. lineata snail shell. Temperature variable (X_1) with the number 0.337 and the variable total organic matter (X_4) with the number 0.058 which is above 0.05 so that it does not significantly affect the length of the N. lineata snail shell. Temperature, salinity, sediment carbon content, and nitrogen sediment content do not affect the spread of Gastropods. Gastropod distribution patterns are influenced by environmental factors not observed in the study. Particles and feed can affect Gastropods. Environmental factors that play an important role in snails such as climate, hydrology, vegetation, and sunlight.

3.4 The relationship between N. lineata weight and environmental factors

The level of significance of the one-sided correlation coefficient shows the number 0.000 in relation to total weight and organic matter, salinity and pH, and total salinity and organic matter, which means that they are correlated because the probability is far below 0.05. The relationship between temperature and total organic matter shows 0.005, which means that it correlates because the probability is far below 0.05. The relationship between temperature and temperature is 0.353, weight and salinity are 0.091, weight and pH is 0.351, temperature and pH is 0.416, and total pH and organic matter are 0.275 which means that they are uncorrelated because the probability is far above 0.05.

ANOVA or F test results with a significance value of 0.000 which shows a probability far below 0.05 so that it can be said that salinity, acidity (pH), temperature, and total organic matter together influence the weight of N. lineata snails. The resulting regression equation:

\[ Y = 12.184 - 0.035X_1 + 0.017X_2 - 0.165X_3 - 0.566X_4 \]  

Where Y is the weight of snails, X_1 is temperature, X_2 is salinity, X_3 is acidity (pH), and X_4 is total organic matter. The t-test shows that the total organic material variable (X_4) is 0.000, which means the probability is far below 0.05 so that this variable significantly affects the weight of N. lineata snails. Temperature variable (X_1) with a number 0.734, salinity variable (X_2) with a number of 0.756, and a variable pH (X_3) with a number 0.933 which is above 0.05 so that it does not significantly affect the weight of N. lineata snails. Temperature, salinity, sediment carbon content, and nitrogen sediment content do not affect the spread of Gastropods. Gastropod distribution patterns are influenced by environmental factors not observed in the study. Particles and feed can affect Gastropods. Several factors that can affect the distribution of Gastropods are mangrove density, turbidity, flow velocity, phosphate, nitrate, dissolved oxygen, and others. Weak responses were also found between benthic and sedimentary nutrients. The relationship between snails and environmental factors is not linear but U-shaped.
3.5 The length and weight of mangrove snails N. lineata in the mangrove age group

Table 2. Result of t-test for equality of means (sig) for length

| Station | A  | B  | C  |
|---------|----|----|----|
| A       | 0.371 | 0.143 |
| B       | 0.371 | 0.338 |
| C       | 0.143 | 0.338 |

The results of the analysis showed that there was no difference in the average length of N. lineata's snail shell between the research stations. The average value of shell length in station A is 22.36 mm, station B is 23.26 mm, and station C is 23.87 mm. The resulting difference is not much different.

Table 3. Result of and t-test for equality of means (sig) for weight

| Station | A  | B  | C  |
|---------|----|----|----|
| A       | 0.863 | 0.792 |
| B       | 0.863 | 0.491 |
| C       | 0.792 | 0.491 |

The results of the analysis show that there is no difference in the average weight of N. lineata snails between the research stations. The average value of snail weight at station A is 5.75 gr, station B is 5.68 gr, and station C is 5.87 gr. The resulting difference is not much different. The opposite is found in Dumai City. The difference in the size of N. lineata was found at the two study sites. This difference in size is thought to be caused by the influence of environmental quality such as temperature, salinity, pH, and feed.

4. Conclusion

The length of the snail that is dominant in the mangrove is 22.27 - 25.57 mm and the dominant weight is 4.93 - 6.09 gr. Salinity and pH of seawater significantly affect the length of the N. lineata snail shell. Total organic matter significantly affects the weight of N. lineata snails. The average length and weight of N. lineata snails at each research station did not differ.

Acknowledgment

The researcher expressed his gratitude to the Ministry of Research, Technology and Higher Education of the Republic of Indonesia in the Starter Lecturer Research Scheme 2019 budget year which had provided research funding assistance.

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