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The abundance and diversity of Mollusks in mangrove ecosystem at coastal area of North Sulawesi, Indonesia

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Abstract. *Baderan DWK, Hamidun MS, Utina R, Rahim S, Dali R. 2019. The abundance and diversity of Mollusks in mangrove ecosystem at coastal area of North Sulawesi, Indonesia. Biodiversitas 20: 987-993.* The study reported in this paper sought to analyze the abundance and diversity of Mollusks species in the coastal mangrove areas of Panango in North Sulawesi, Indonesia. Data collected in the study lent support to policy making in reducing the loss of marine biotic species in the coastal mangrove areas. Data collection used stratified-random sampling method (plot size was 10 m x 10 m) with three plots at each research station was used. Data analyzed by Odum formula for abundance, Shannon Wiener index for diversity and evenness index for evenness. The samples were collected from 2 research station covering 15 sampling sites. This research found 14 families of mollusks comprised of 11 gastropod families (21 species) and bivalve families (3 types). The highest of the relative density was found in *Terebralia* sp (24,24%), and the lowest relative density was obtained (1,52%) in the following species: *Spondylus violaceus*, *Conus* sp., *Semiricinula turbinoides*, and *Faunus ater*. The diversity index of mollusks species (Gastropoda and Bivalvia) at the observation station was classified as a high category, indicating by H' >3,32 (Station I H'= 2,19 and Station II H'= 2,12). The evenness value in range 0,4<e<0,6. This indicates that the Mollusks species found in the research site had a medium amount. This study suggests a need to regulate mangrove areas of Panango for sustainable mangrove ecosystems management.

Keywords: Abundance, bivalvia, diversity, gastropods, Panango

INTRODUCTION

The coastal ecosystem is essential in maintaining environmental and climate balance. Mangrove ecosystem is among the examples of such an ecosystem that plays a significant ecological role. Mangrove ecosystem is located between the mainland and the sea, where changes continually occur, allow varied species of biota possess the ability to continuously adapt with such a unique environment (Kordi 2012). Lisna et al. (2017) further argue that the mangrove ecosystem significantly contributes to the life of the organisms in the coastal and marine areas.

The function of mangrove as the habitat for the aquatic animal is due to the fact that the area provides weathered materials or weathering litter that further turn into nutrients. Furthermore, the mangrove and other organisms, e.g., Mollusks (gastropods and bivalves) family benefit from the nutrients within the area. Dewiyanti and Sofyatuddin (2011) further emphasize the notion of the contribution of mangrove areas to providing food for diverse macrofauna unique to this area, such as crabs.

Macintosh et al. (2002) point out that Mollusks is among the organisms that significantly contribute to the ecological function of mangrove. These organisms serve as a bioindicator or aquatic ecosystem; some examples of the Mollusks are from *macrozoobenthos* phylum, i.e., Gastropods and Bivalvia. Yap and Noorhaidah (2011) add that gastropods can function as *biomonitor*. Some kinds of Mollusks such as Potamididae family, Neritidae, and Cerithidea are the species of the habitat of mangrove. (Arbi 2008; Cappenberg 2006). However, the gastropods should possess some characteristics, such as non-migratory, excessive in its number, having a high lifespan tend to have a large size, and coming into contact with basic sediments. The group of Mollusks of mangrove as the part of the mangrove ecosystem has an important role either direct or indirect role to support the function of mangrove.

Panango is among the coastal areas in the South Bolaang Mongondow District, North Sulawesi Province with an abundance of mangrove tree species spreading in the Tomini Bay. The areas are maintained with a variety of mangrove trees, such as *Rhizophora* spp, *Bruguiera gymnorrhiza*, *Sonneratia alba*, *Nypa fruticans*, *Xylocarpus granatum*, *Avicennia* spp, *Derris trifoliata*, and *Ipomea pes-capra*e. Panango also functions as a conservation area for fish and clam population. The coastal community utilizes the coastal area for fisheries, some of the well-known fish species are *Carangoides* sp. and *Siganus* sp.

However, the details on the species of Mollusks in the area are left unexplored. This suggests an immediate action to discover the abundance and diversity of Mollusks as the element of the mangrove ecosystem.

This study is aimed at analyzing the abundance and variety of Mollusks in the coastal area of Panango. It is expected that this study provides a grounding for the decision-making process in designing policy to prevent the decline in the number of aquatic species in such area.

MATERIALS AND METHODS

Study area

This research was conducted at the coastal area of Panango, South Bolaang Mongondow District, North Sulawesi Province, Indonesia (Figure 1) for three months starting from December 2017 to March 2018. The research site was 2 station and 15 sample point. The methods used explorative survey method. The primary data were generated by identifying all Mollusks species, i.e. gastropods and bivalves, the abundance and diversity of Mollusks in the research site. The level of diversity of the organism was analyzed using *stratified random sampling* (Figure 2).

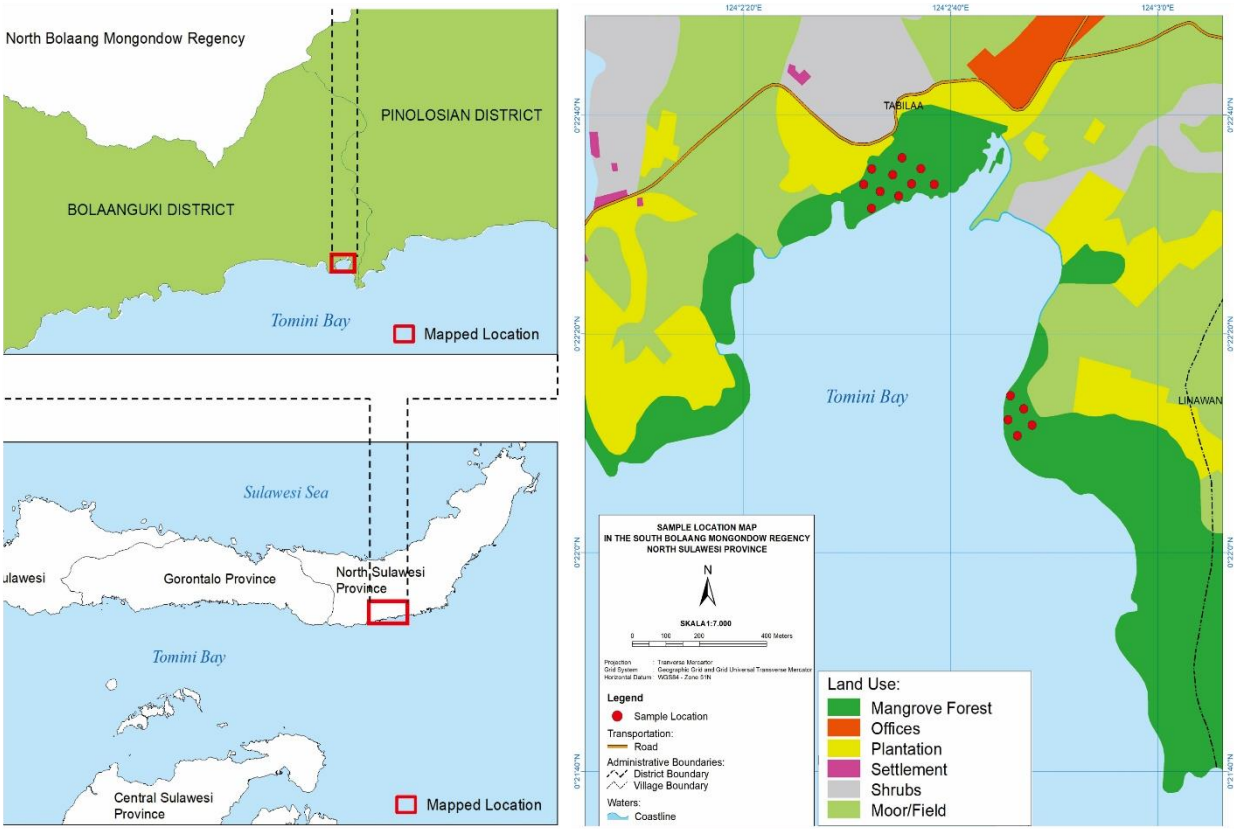

Figure 1. Research site, mangrove ecosystem at Panango Coastal Area, North Sulawesi Province, Indonesia

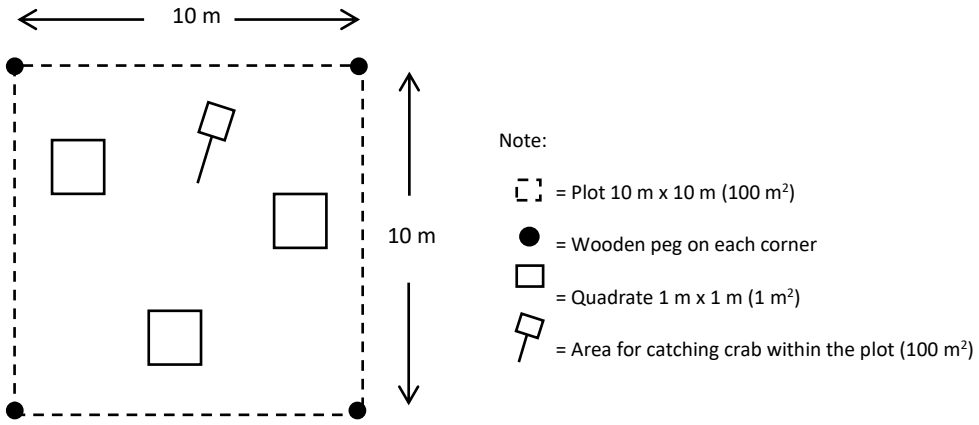

Figure 2. Determining the location of transect and plot in a site area (Chapman 1998)

Generating the data on the abundance and diversity of mollusks

The sampling of Mollusks (Gastropods and Bivalvia) was conducted using *stratified random sampling*. There were three plots of the samples consisted of three with the dimension 10 m x 10 m (100 m^2) on each site area. The sample was taken from each plot by using a quadrate measuring at 1 m x 1 m (1 m^2); there are nine quadrates in total in each site. Every 100 m^2 in each plot was scrutinized to collect the Mollusks sample that was yet to be found in the quadrate 1 m^2.

The Mollusks samples were collected from the 1 m^2 quadrate that was positioned randomly under the peg in the mangrove area, this quadrate must be positioned in an area where Mollusks are easily spotted. All the Mollusks were collected from the surface of the substrate and were excavated from the sediment to a depth of 20 cm for 15 minutes. The parts of the tree, i.e., stem and branch, were observed to a height of 1.5-2.0 m from the mud surface to collect the sample of species. Rotten wood was also examined to collect other species of Mollusks. The gathered samples were released to its habitat immediately once the data, such as the number and the information regarding the species, were recorded. Only the samples where the data are not that detailed were identified in a laboratory, with use literature by result of Dharma et al. (2005) study, recent and fossil Indonesian shells, and Marwoto et al. (2011) study, freshwater conch of Java Island (Molluscs; Gastropoda).

The following is used to calculate the abundance of each species using Odum and Barrett formula (2004).

$$K = \frac{\text{the amount of the species i}}{\text{the number of individuals of all species}} \text{ x } 100\%$$

The abundance criteria: Michael (1995)

0 : nothing
1-10 : less
11-20 : enough
>20 : many

Besides, it also calculates the index of the diversity and the evenness (Krebs 1972), the following is:

$$\mathbf{H'} = -\sum \mathbf{Pi \ ln \ Pi}$$

Where:

H' : diversity index Shannon-Wiener
Pi : ni/N is the comparison of the number of species (ni) to the total of individuals (N).

$$\mathbf{E} = \frac{\mathbf{H'}}{\mathbf{H' \ maks}} = \frac{\mathbf{H'}}{\mathbf{ln \ S}}$$

Where:

E : evenness index
H' : diversity index
H' max : maximum diversity
S : the number of species

The evenness criteria:

E value	Condition of community structures	Category
>0.81	Very equally	Very good
0.61-0.80	More equally	Good
0.41-0.60	Equally	Medium
0.21-0.40	Fairly equally	Poor
<0.20	Not equally	Very poor

RESULTS AND DISCUSSION

Mollusks classification

Based on the result in Table 1 shows that 14 families of Mollusks comprising 11 gastropods family (21 species) and three Bivalvia families (three species) has discovered. The gastropod families consist of Potamididae, Muricidae, Conidae, Ellobiidae, Pachychilidae, Littoriniae, Assiminidae, Tochidae, Phytiidae, Turrilellidae, and Neritidae. The Bivalvia families are Arcidae, Cyrenidae, and Spondylidae.

Table 1. Mollusks classification discovered in two research sites, Panango Coastal Area, North Sulawesi, Indonesia

Class, Family	Species	Station I	Station II	No. of ind.
Gastropod				
Potamididae	*Cerithidea quadrata*	-	✓	32
	Cerithideopsis largillierti	-	✓	
	Telescopium telescopium	-	✓	
	Terebralia sp.	✓	✓	
	Terebralia sulcata	✓	✓	
Littorinidae	*Littoraria scabra*	✓	✓	24
	Littoraria pallescens	-	✓	
	Littoraria lutea	-	✓	
Neritidae	*Nerita planospira*	-	✓	31
	Vittina coromandeliana	-	✓	
	Vittina turrita	-	✓	
Muricidae	*Chicoreus capucinus*	✓	✓	11
	Hexaplex trunculus	✓	✓	
	Semiricinula turbinoides	✓	-	
Ellobiidae	*Ellobium aurisjudae*	-	✓	8
Ellobiidae	*Phytia* cf. *savaiensis*	-	✓	1
Turritellidae	*Turritella terebra*	✓	-	7
Assimineidae	*Metassiminea* sp.	✓	-	6
Tochidae	*Monodonta labio*	✓	-	5
Conidae	*Conus* sp.	✓	-	1
Pachychilidae	*Faunus ater*	✓	-	1
Bivalvia				
Arcidae	*Anadara* cf. *antiquata*	✓	-	19
Cyrenidae	*Geloina expansa*	-	✓	2
Spondylidae	*Spondylus violaceus*	✓	-	1
Total				149

Notes : ✓: found-: not found

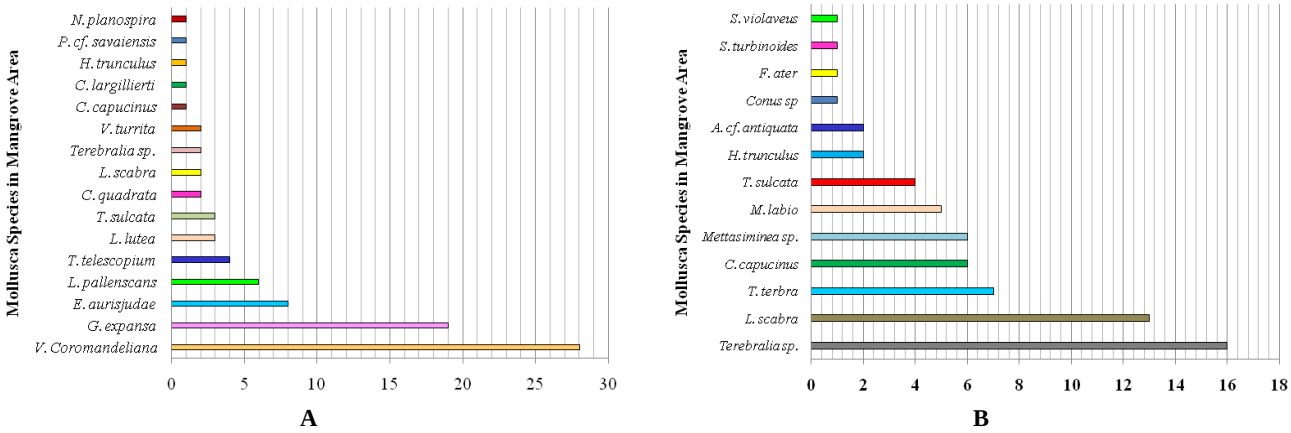

Figure 3. Number of individual and abundance of mollusks in the research sites, Panango Coastal Area, North Sulawesi, Indonesia. A. Station 1, B. Station 2

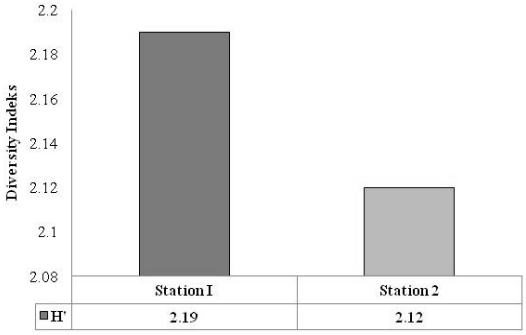

Figure 4. Mollusks diversity index in the research site, Panango Coastal Area, North Sulawesi, Indonesia

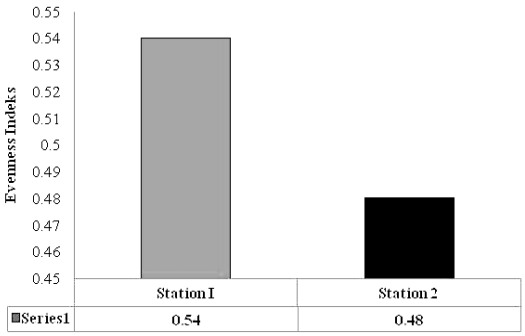

Figure 5. The evenness index of mollusks in research site, Panango Coastal Area, North Sulawesi, Indonesia

Number of individuals and the abundance of mollusks in the research site

It is revealed that the species *Terebralia* sp. has the highest value of relative abundance in station I. In addition, the relative abundance of Potamididae family is valued at 24.24% with a total of 16 samples (individuals) collected. Species with the lowest value of relative abundance are *S. violaceus*, *Conus* sp., *S. turbinoides*, and *Faunus ater*; each of these species is valued at 1.52%. In station II, the species *Vittina coromandeliana* family Neritidae, with the value of relative abundance 33.33% (28 individuals), outnumber other species with the lowest value, such as *Chicoreus capucinus*, *Cerithideopsis largillierti*, *Hexaplex trunculus*, *Phytia* cf. *savaiensis*, and *Nerita planospira* with the percentage at 1.19% each. Figure 3 provides detailed information regarding this.

Mollusks diversity in the research site

The index of the diversity of Mollusks in the site area is considered high with H' >3.32; it ranges from 2.19-2.12; this is depicted in the following Figure 4.

Mollusks evenness in the research site

The evenness index can be described as a community condition in a particular ecosystem. The evenness index (E) reflects the wealth of each species. The index value of the evenness which is close to 1 is representing the amount of the individual that is relatively similar, moreover, if it is close to 0, it means that the amount of the individuals of the species are different. The result of the calculation of the evenness index in the mangrove of Panango has the value 0,54 which means that each species living in this area has the evenness of mollusks are medium. This is based on the evenness index criteria that is 0,4<e<0,6. This showed that the condition of the community structures is in the equally level or in a "medium" category. The evenness index of Mollusks presented in Figure 5.

Environmental factor in the research site

The environment factor has an important role to support the growth of all living things including Mollusks, making the environment an important part of this research. The parameter measured during the sample collections is pH and temperature. The measurement results showed a varied pH, ranging from 6-7.4 with the lowest values in the station I transect 3. The salinity in the station I transect 1 and station II transect 3 outweighs those in other stations with the value of 30 ppt. The temperature of the aquatic environment in the observation station ranging from 28.5-30^{o}C. This is caused by the rain occurred during the observation which increases the volume of the water in the areas. These stations are also located next to the sea whereas the salinity of the water almost reaches the value of those of saltwater. The pH of the aquatic environment is neutral and even close to the alkaline.

Table 2. The result of measurement on environmental factor in the research site, Panango Coastal Area, North Sulawesi, Indonesia

Station	Coordinate point	Transect	Environ parameter		
			pH	Sal. (ppt)	Temp. (°C)
I	N 0°22' 14.430" E 124°2' 45.802"	1	7.4	30	30
	N 0°22' 13.562" E 124°2' 46.770"	2	7.2	29	28.8
	N 0°22' 11.820" E 124°2' 47.638"	3	6.0	28	28.5
II	N 0°22' 34.262" E 124°2' 36.067"	1	7.0	27.8	28.5
	N 0°22' 34.352" E 124°2' 34.116"	2	7.3	29.4	28.6
	N 0°22' 33.766" E 124°2' 32.939"	3	7.4	30	29.7

Discussion

Macrozoobenthos is a decomposer that breaks down weathered leaves where bacteria and fungi further turn the organic material into protein and carbohydrate (Fitriyani et al. 2016). Such organic materials, spread by organic litter that fell onto the soil, significantly contribute to the mangrove forest. The litter that will be decomposed into nutrients serves as the energy resources of *macrozoobenthos*. This nutrients also help the growth of mangrove trees.

This research reveals that the Mollusks families in the site area are Potamididae, Littorinidae, Neritidae, dan Cyrenidae; these families are common to the mangrove ecosystem. These families are categorized as Gastropoda. In the station II, there are many Gastropoda found during the research. They can adapt well to the mangrove environment. Therefore, they can live longer than other classes. Maturbongs et al. (2017) stated that one of Gastropoda dominating in the mangrove site is Potaminidae family.

Some Mollusks living in the center of the forest is *C. quadrata, T. telescopium, N. planospira, E. aurisjudae, L. scabra,* and *C. capunicus.* The number of *L. scabra* species dominates other species discovered in the area, such as in station I and II. In these stations, the fishing net whose function is to catch the organic litter is put between mangrove trees. Its location is distant from the tide and is a shady area. Budiman (1991) suggests that the *L. scabra* species lives on the stem, branch, root, and leaf of a mangrove tree. It can survive by only consuming water splash from the tide. The distribution of this species is determined by factors, such as the function of an area as the shelter for the Mollusks and the type of vegetation. This Mollusks can crawl to a higher place by its slime in most of the vegetation.

A condition of the environment of the research site is considered optimum for Mollusks to survive and reproduce thanks to the temperature ranging from 28.5-30°C. These findings are in line with Hicks and McMohan (2002) explaining that the optimum temperature for Mollusks ranges from 15-28°C while the best temperature range for Bivalvia is 20-30°C.

The level of acidity in the research site is between 6.0-7.4 by which suitable for Mollusks. If the pH is higher than 9 and lower than 5, Mollusks will be unlikely to survive in this area. This finding resonates with the results seen in Russel-Hunter (1968); Alfitriatissulus (2003) that the best pH to support the life of Mollusks ranges from 6.5-7.5. Salinity in the site of research ranges from 27.8-30 ppt where it is considered by Nybakken (2004) as a suitable salinity level for Bivalvia to survive.

Based on the measurement results, it is obtained that the water temperature in the research site is 28.5-30°C which also suitable for Mollusks. This is emphasized by Hicks and McMohan (2002) that generally the optimum temperature for Mollusks is 15 -28°C. Furthermore, the optimum temperature for Bivalvia is 20-30°C. Masrur (2015) stated that the optimum temperature for Gastropoda is 25-32°C. If the temperature is above 32°C, the metabolic process will be interrupted. Moreover, the optimal temperature for Bivalvia is 25-28°C. If the temperature is higher than the optimum one, it is not suitable for its growth. The change of the temperature beyond the limit of the optimum one will affect the decrease of the growth and organism reproduction.

It can be concluded that the biotic mostly found in Panango is Mollusks (Gastropoda and Bivalvia). There are 11 Gastropoda families covering 22 species, and 3 families of Bivalvia covering 3 species. The Gastropoda families are Potamididae, Muricidae, Coccidae, Ellobidae, Pachychilidae, Littorinidae, Assimineidae, Tochidae, Phytiidae, Turritellidae, and Neritidae families. Moreover, the Bivalvia families are Arcidae, Cyrenidae, dan Spondylidae families. Purnama et al. (2011) stated that a community could be considered to have a high species diversity if that community is arranged by many species with similar types. On the contrary, if the community is arranged by little types of living things and these little types are dominant so that the diversity of the species is low. The high diversity showed that a community has a high complexity because there is also a high interaction among the species. Therefore, in community with high diversity, there will be energy transfer, predation, competition, and division of the niche, then theoretically it would be more complicated. The index of the abundance is seen by the criteria so that the community in the research site is categorized in a "very equally or even" with a very good category.

The value of evenness in the research site $0.4<e<0.6$. This indicates that the Mollusks species found in the research site had a medium amount. This condition also describes that there is no competition among the Mollusks species in acquiring food source and place or space (Capanberg 2016). Odum and Barrett (2004) argued that the evenness of the species would be high if there will be a dominated individual by a particular species, besides, the more value of the evenness, the more diversity of the community. Therefore, the index value of the evenness of the species can be used in order to describe the stability of the community.

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