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Diversity of Gastropod and Bivalve Molluscs in Kaisu Mangrove Forest of Sarmi Regency, Papua Province, Indonesia

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Abstract

Molluscs are an important part of the mangrove ecosystem. Scientific information related to gastropods and Bivalvia in Kaisu mangrove is not known. Thus, this study aims at identifying the diversity of molluscs (gastropod and Bivalvia) in Kaisu mangrove forest. This study has used descriptive method with observation techniques. The observation station was determined using purposive sampling considering the zonation of mangrove vegetation. The taken data were analyzed qualitatively and quantitatively based on each parameter. The results of the study show that, in Kaisu mangrove forest of Bongga District, Sarmi Regency, 10 species of molluscs were identified with 1804 individuals consisting of 8 species of gastropoda (Telescopium telescopium, Steno melani, Nerita articulate, Ellobiumaurisjudae, Cheritidea obtuse, Indothais gradate, Spherassimineamimata, Littorariamelanostoma) and 2 species of Bivalvia (Geloinaexpansa, Anumalocardisquamasa). The dominance index of the mollusca species of this mangrove forest was 0.74, indicating the dominance of Telescopium telescopium with species diversity index of 0.27 (low category) and a species evenness index of 0.32 (low category).

Keywords: Molluscs; Bivalvia; Mangrove forest; Ecosystem

1 Introduction

The main text of the article should appear here. Headings and subheadings should be formatted using the relevant button from the "Apply Style" dialog box. Mangrove plays an important role in the lives of wildlife including birds, mammals, reptiles, fishes and other organisms such as mollusks (1). It is a biologically diverse ecosystem, rich in organic matter and nutrients, and supports a large biomass of flora and fauna (2). It is considered among the world's most productive ecosystems (3). High rates of tree and plant growth, coupled with anaerobic, water-logged soils that slow decomposition, result in large long-term carbon © storage within the mangroves (4). From an economic point of view, mangroves have a very high economic and ecological value because of the wide range of ecosystem goods and services they offer (5).In addition, mangroves also perform, free-of-cost, many important functions that support the often-dense coastal populations (6). Molluscs are the second species-rich phylum in the world after arthropods (7). They are soft-bodied, unsegmented animals, with a body organized into a muscular foot, a head, a visceral mass containing most of the organ systems, and a fleshy mantle that secretes the calcareous shell(8). According to Brusca & Brusca (9), Mollusca consists of seven classes, namely Polyplacophora (chiton), Gastropod (snail), Bivalvia(clam), Scaphopoda (hornshell), Cephalopoda (squid or chiton), Aplacophora and Monoplacopora. Bivalves play a vital role in the ecosystem of mangrove forest and in the lives of coastal humans (9). Bivalve molluscs are a valuable source of high-quality proteins, minerals and vitamins (10).

Crustaceans and molluscs play important roles in the mangrove ecosystem, processing mangrove-derived and algal detritus through their feeding and bioturbation activities (11). According to Pramudji (12), Mollusca-inhabiting mangrove forests in Indonesia are generally dominated by gastropods, which are around 61 species. Gastropod in mangrove ecosystems has both ecological and economical significances. Gastropod (limpets, snails, whelks, slugs) is by far the most diverse group of molluscs with about 100,000 species (0.5 mm to 100 cm long) that inhabit all marine, freshwater and terrestrial habitats (13). From ecological perspective, gastropod is a type of fauna that have a role in a food chain. Gastropods are detritus-eaters that have function in tearing and minimizing newly fallen litter, and accelerating litter decompositions through microorganisms (12), (14). Gastropods have economic value as they are used by coastal community as food, for instance, Terebraliapalustris, Telescopium telescopium, and Cerithideaobtusa (14). The total area of mangrove forests in Papua Island, including Papua and West Papua, is estimated to reach 1.3 million ha (1). The mangrove areas in Papua covers the North and South coasts of Papua Island, SaireriBay, Mamberamo River, HomblotBay, Wasoki Bay, Ansus, the Eastern part between Biak and Yapen Islands. In the Southern Part of West Papua, mangroves flourish along the Waigeo coast

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and the northern part of Barai peninsula around Bintuni Bay;the mangroves in Bintuni are the most significant ecosystem in storing large amounts of carbon (15).

Sarmi Regency has several locations of mangrove forests distribution, including along the East coast. The distribution of mangroves in the area is not only potentially related to ecological function but also related to the socio-economic conditions of the community. Ecologically, mangrove forest has an important role as a buffer zone which protects the coast from Pacific Ocean waves. Mangroves play an important role in buffering coastlines against storm surges and tsunamis through wave attenuation (16). For socio-economic matters, mangroves provide benefits for coastal communities' livelihoods. The socio-economic value of the mangrove is likely to be more than double of the direct forest product value through the ecosystem linkage with the aquatic production and the effect on fishery (17). A number of potentials inhabiting fauna such as fish, shrimp, and crabs are an important part of the mangrove ecosystem. Similarly, Mollusca groups (gastropod and Bivalvia) also play an important role in mangrove ecosystem and people's lives. Yet, scientific information related to Mollusca groups in Kaisu mangrove is not known for certain. Therefore, the aim of the research is to examine the diversity of molluscs (gastropod and Bivalvia) in Kaisu mangrove forest.

2 Material and Methods

The study was carried out in Kaisu mangrove (study area) forest in the District of Bonggo in Sarmi Regency, Papua Province of Indonesia in a span of two months. The equipment used to conduct the study were Global Positioning System, levers, plastics, collection bottles, tweezers, digital camera, Vernier caliper, surgical boards, gauges, raffia and stationery.

This study used observation methods to conduct the research. Purposive sampling was used for observation station. The characteristics and species of Kaisu mangrove forest are relatively similar with a forest width of approximately 150-350 m. Considering the condition, 2 sampling stations were determined in one transect 320 m long with site I position (75 m from land-sea point) dominated by Rhizophorasp, Avicenniasp, Bruguera gymnorhiza), and site II (position 250 m from point 0 or 175 m from site I which was presented by species like Rhizophorasp, Bruguera gymnorhiza and Sonneratiasp). Each site had one observation plot with size of 20 m × 20 m. To determine the species and number of individuals, variables such as morphological characters of molluscs (gastropod and Bivalvia) in the form of color and body size (length, width, diameter expressed in cm) were observed. General condition of the study site was documented.

The samples of Mollusca (gastropod and Bivalvia) were collected at low tide and on sunny day. The collected samples were preserved using alcohol 70% and put into specimen box. The samples were identified using the journal (18), (19), (20), (21). The collected data were analyzed qualitatively and quantitatively based on each parameter and then presented in tables and figures (charts, graphs and photographs). To determine the abundance of species in the area, the equations was used as follows:

$$A = \frac{xi}{ni}$$

where A is abundance (number of individual / $20m^2$); xi is number of individuals; and ni is number of squares. The concentration of individual species of Mollusca was determined using index of domination (C) as followed:

$$C = \left(\frac{ni}{N}\right)^2$$

where C is index of dominance; ni is number of individuals of a species; and n is number of individuals of all species. Domination is a community characteristic that shows the abundance of species in a region (22), (23), (24), (25). The criteria of domination index according to are as follows: 0 <C <0.5 = There are no dominant species; 0.5> C> 1 = There are dominant species. To determine the diversity of Mollusca as an indicator of habitat, species index diversity (H) according to Shanon and Wiener (1949) in Magurran (26) was used with the equation:

$$H = -\sum\left[\frac{ni}{N}\right]\ln\left[\frac{ni}{N}\right]$$

where H is diversity index (Shanon-weinner index); ni is number of individuals of a species, N is number of individuals of all species. The evenness of species of Mollusca at the study site was analyzed using the index of evenness (e), according to Pielou (27), Odum (23), and Bratawinata (28) as follows:

$$e = \frac{H'}{LogS} = \frac{H'}{Hmax}$$
$$Hmax = 2\ln s$$

where e is species evenness index; H is species diversity index; S is number of species. Evenness index according to Krebs(29) in Sinery (30) ranged from 0-1, where: 0.6-1 = high species evenness; 0.4 <e <0.6 = moderate species evenness; 0–04 = low species evenness.

3 Results

3.1 Species Composition

Based on identification of the morphological characteristics, 10 species of Mollusca were identified in Kaisu mangrove area, i.e., 7 families and 8 species of gastropod, 2 families and 2 species of bivalves (Table 1 and Table 2).

3.2 Domination, Diversity and Evenness Index of Mollusca

This research used the dominance, diversity and evenness index to analyze the level of species domination, variation of species and evenness of species, as indicators of community stabilization in Kaisu mangrove forest. The dominance, diversity and evenness index of Mollusca species in Kaisu mangrove area are presented in the following Figure 1. The results of the study showed that Telescopium telescopium was the species with the highest number of individuals found at the study sites. In comparison, the number of species such as Littorariamelanostoma and Anumalocardi, squamasa was smaller in number.

Table 1: Composition of Mollusca in Kaisu Mangrove Forest

No	Family	Species	Individual	Percent (%)
Gastropoda				
1	Potamididae	Telescopium telescopium, Linnaeus, 1758	1550	85,92
2	Thiaridae	Steno melania, Fischer, 1885	100	5,54
3	Neritidae	Neritaarticulat, Linnaeus, 1758	55	3,05
4	Ellobiidae	Ellobiumaurisjudae, Roding, 1798	51	2,83
5	Potamididae	Cheritideaobtusa, Lamarck, 1822	23	1,27
6	Muricidae	Indothaisgradata, Jonas, 1849	7	0,39
7	Assimineidae	Sphaerassimineaminiata	4	0,22
8	Littorinidae	Littorariamelanostoma, Gray, 1839	2	0,11
Bivalvia				
9	Corbiculoidea	Geloinaexpansa, Mousson, 1849	10	0,55
10	Veneridae	Anumalocardisquamasa, Linnaeus, 1758	2	0,11
Amount			1804	100

Table 2: Composition of Mollusca by Site

No	Species	Individual	
		Site I	Site II
1	*Telescopium telescopium*, Linnaeus, 1758	1500	50
2	*Steno melania*, Fischer, 1885	100	
3	*Neritaarticulata*, Linnaeus, 1758	30	25
4	*Ellobiumaurisjudae*, Roding, 1798	51	
5	*Cheritideaobtusa*, Lamarck, 1822		23
6	*Indothaisgradata*, Jonas, 1849		7
7	*Sphaerassimineaminiata*	4	
8	*Littorariamelanostoma*, Gray, 1839		2
9	*Geloinaexpansa*, Mousson, 1849	10	
10	*Anumalocardisquamasa*, Linnaeus, 1758	2	
	Amount	1697	107

Note: Site I: mud substrate (land / mid zone),
Site II: Mud substrate with sand (mid zone and sea)

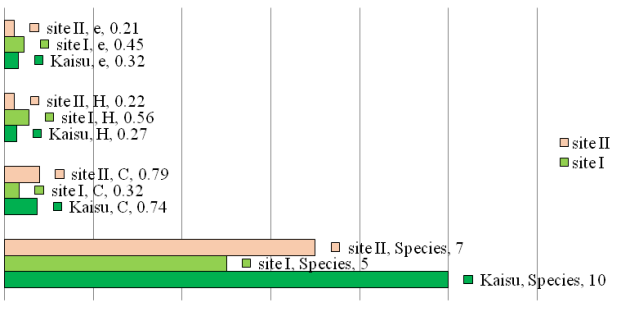

Figure 1: Domination index (C), diversity index (H) and evenness index (e) of Mollusca in Kaisu mangrove forest

This result proves that the distribution of the species at the two observation sites were different. Site I had the deepest zoning in the mangrove formation with a slightly hard substrate. Site II was located in the middle zonation closer to the outer area and contained muddy substrate. Anchor root plants (Rhizopora sp.) dominated the location. The 10 species of Mollusca were identified in the observation sites and only 2 species, i.e., Telescopium telescopium and Nerita articulate, could be found at both the observation sites.

The study revealed that the evenness of Mollusca in Kaisu mangrove area is low due to the identified of 10 species of mollusks but the presence of only 2 species (20%) at the two observation sites. This shows the adaptive advantage of Telescopium telescopium and Nerita articulate as compared to other species in Kaisu mangrove area. It is observed that mangrove vegetation Rhizophora influences the evenness of Mollusca in the study site along with Sonneratia sp, Avicennia sp and Bruguera gymnorhiza, which are considered as a source of organic material and habitat for molluscs. Also, the condition of mud substrate which dominated Kaisu mangrove forest area became a factor that affected the presence of Mollusca in this forest. Nurrudin, Hamidah, & Kartika (31) observed out that the characteristics of the habitat and environmental conditions such as temperature, pH, salinity and types of substrate greatly influence the presence of Mollusca besides the condition of the mud substrate. They are among the dominant group in structuring the mangrove ecosystem and also constitute a component of fouling communities (32). Bivalve and gastropod are considered as the main molluscs of mangrove forests and comprise an important trophic component of detritus-based food webs. Gastropods have high distribution in the mangrove forests probably due to their mobile characteristic, while bivalves are often confined to a narrow seaward zone, due to feeding, larval settlement restrictions and sediment texture such as low pH and high organic matter (33).

4 Discussion

The data presented in Table 1 revealed that composition of the Mollusca in Kaisu mangrove forest was less compared to the study by in the vicinity of TPI Parit 7, Tungkal I Village, Tanjung Jabung Barat, which found 15 species(31). Similarly, other studies have identified 33 species of gastropods in the mangrove ecosystem in the Gugus Pari Island, 19 species of gastropods in the Cilacap mangrove ecosystem, 16 species of gastropods in the mangrove forests of TelukAwurJepara, 29 species of gastropods in the mangrove forest area of Segara Anakan Cilacap,14 species of Gastropods and 5 species of Bivalves in Aceh Besar, and 14 families of molluscs comprising 11 gastropod families (21 species) and bivalve families (3 types) in North Sulawesi (34), (35), (36), (37), (38). The detection of many species of gastropods found in these studies was due to the wider research location and longer sampling time. In comparison, the location of the present research was not large, and the sampling time was limited. All the identified species in our study were inhabitants of the mangroves as detailed below.

- *Telescopium telescopium, Linnaeus, 1758. Telescopium telescopium* belonged to gastropod group and accounted for the highest number of individuals in the study sites. It lives

in mangroves and could be found on mangrove floors with brackish condition (39).

- *Steno melania, Fischer, 1885. Steno melania* accounted for the second-largest number of individuals. This species inhabited mangrove forests in both waterlogged and dry mud substrate with limited distribution and could be found only in site II.
- *Neritaarticulata, Linnaeus, 1758. Neritaarticulata* accounted for the third-largest number of individuals of the gastropod species. The species was found on mud substrates and fairly distributed on the location.
- *Ellobiumaurisjudae, Roding, 1798. Ellobiumaurisjudae* accounted for the fourth-largest gastropoda individuals found in the study site. This species was found on the mud substrate and documented only at site I.
- *Cheritideaobtusa, Lamarck, 1822.* This gastropod species was found on muddy substrates and only at the site II. According to, *Cerithideaobtusa* is commonly found in roots and stems of mangroves as well as mud substrates across the Asia-Pacific (21), (40).
- *Indothaisgradata, Jonas, 1849. Indhothaisgradata* species of gastropod was found only at site II. They inhabit both hard and soft substrata and were found on muddy substrates (41).
- *Spherassimineamimata. Spherassimineamimata* gastropod species were documented only at site I. Only a few individuals of this species were found on a muddy substrate.
- *Littorariamelanostoma*, *Littorariamelanostoma* was a species of gastropod recorded only at site II. A few individuals of thespecies was found on muddy substrate. They survived on mangrove leaves and brown algae as food sources, with significant differences among the three mangrove forests, and showed significant seasonal variation in its diet (42).
- *Geloinaexpansa, Mousson, 1849. Geloinaexpansa* belonged to Bivalvia group and was documented only at site I. The clams, known locally as Omapoko or Siini and Kawe or Kae, are used as protein source by local people and the species was found on muddy habitat as well as other species (43).
- *Anumalocardisquamasa, Linnaeus, 1758. Anumalocardisquamasa* belonged to Bivalvia group and was found only at site I. This species was found on muddy habitat with limited number of individuals. They are widespread species which reside in 2-4 cm depth stratum (44), (45).

Fig.1 presents that the dominance index of the Mollusca species in Kaisu mangrove was 0.74 (close to 1). This indicated the dominance of certain species, especially Telescopium telescopium, particularly in site II, as there was no apparent dominance of certain species in site I. The criteria for dominance index according to were $0 < C < 0.5$ = there was no dominant species; $0.5 > C > 1$ = There were dominant species(23). The result shows that diversity index of Mollusca in Kaisu mangrove forest was 0.27. Observation also indicated species diversity of site II was higher than site I; however, diversity at both sites was considered in the low category. Species diversity was considered high if the species diversity index was more than three ($H \geq 3$), medium if species diversity index was between one to three ($1 < H < 3$) and low if species diversity index was less than one ($H < 1$). Based on these criteria, the diversity of Mollusca species in Kaisu mangrove forest area was considered low.

Analysis of species evenness level shows that value of evenness index of Mollusca species in Kaisu mangrove forest was 0.32, in which site I was 0.45 and site II was 0.21. (Krebs, 1978) in (Odum, 1993) stated that the evenness value was considered high when $e \geq 0.6$, moderate when $e = 0.4 < e \leq 0.6$ and low when $e = 0 < e \leq 0.4$. Based on the criteria, the evenness index of Mollusca in Kaisu mangrove forest was low, including at site I and site II. The value of species evenness index, according to, ranged from 0 to 1 (46), (47). According to Santosa (48) amd Sinery (30), the evenness index of species indicated the size or proportion of individuals of each species in a community. If each species had similar number of individuals, then the community had maximum value of evenness index, which is the relative abundance of species (47). It is high if all species have similar distribution (i.e., similar population density)(49).

5 Conclusions

The study concludes based on the result of the analysispresence of 10 species with 1804 individuals consisting of 8 species of gastropda (Telescopium telescopium, Steno melani, Nerita articulate, Ellobiumaurisjudae, Cheritidea obtuse, Indothais gradate, Spherassimineamimata, Littorariamelanostoma) and 2 species bivalvia (Geloinaexpansa, Anumalocardisquamasa) in the Kaisu mangrove forest area of Bongga District, Sarmi Regency. The dominance index of the identified Mollusca in Kaisu area was 0.74, with dominance of Telescopium telescopium with the species diversity index of 0.27 (low category) and species evenness index of 0.32 (low category).

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Competing interests

The authors declare that there is no conflict of interest that would prejudice the impartiality of this scientific work.

Authors' contribution

All authors of this study have a complete contribution for data collection, data analyses and manuscript writing

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