Gastropod Density and Diversity in the Mangrove Forest of Pagatan Besar Village, Tanah Laut Regency, Indonesia

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Abstract

Public awareness and knowledge on mangrove forest biodiversity, especially gastropods, is very limited. This study aims to compare the density and diversity index of gastropod species according to their distance from the coastline and to analyze the relationship of the two with the physical environment around them. Three lanes were placed in the southern part of the mangrove forest. The first lane (LT-1) was placed about 5 m from the coastline towards the sea. The second lane (LT-2) was placed 10 m towards the sea from LT-1 and the third lane (LT-3) was 10 m from LT-2 towards the sea. In each lane there were 10 (1 mx 1 m) plots and the distance between adjacent plots was 10 m. A total of 1.432 Gastropod individuals consisting of 16 species and 7 families were collected from 30 plots. In detail 16 species (927 individuals) were collected from LT-1, 16 species (500 indv) from LT-2, and only 3 species or 5 individuals from LT-3. The density of LT-1, LT-2, and LT-3 species respectively was 92.7; 50.0; and 0.5 indv.m^{-2}, while the diversity index successively was 2.56 (moderate); 2.53 (moderate); and 0.95 (low). Both species density and diversity in lanes that are close to the coastline are higher than in lanes located in the direction of the sea. The base substrate on the path that was close to the coastline was clay, while on the lane that laid in the direction of the sea was sandy loam.

Keywords: *density, biodiversity, gastropod, lane, mangrove*

Introduction

Pagatan Besar mangrove forest in the South Kalimantan Province has been managed sustainably. This forest is not destroyed, mangrove trees are not cut down and not converted into activities or for various other purposes. This forest has been developed by the community as an ecotourism area since 2016. Mangrove planting programs have been carried out to support the development of ecotourism areas. For example, muddy beaches in the southern part of the forest are planted with *Avicennia marina* up to 95%. Other species that are also planted are Rhizophora and Bruguiera.

In regard to sustainable management, the development of the Pagatan Besar Mangrove Forest needs to be socialized to the community (Soendjoto, 2003). For example, regarding the size of the forest area (Riefani *et al*., 2019), as well as biodiversity within the forest, *i.e.* plants (Soendjoto and Arifin, 1999), and animals (Riefani and Arsyad, 2019) including marine organisms, such as gastropods.

Several reports showed that gastropods can be found in mangrove forests (Pribadi *et al*. 2009; Ernanto *et al*., 2010; Darmi *et al*., 2017). This class of animals generally functions ecologically (Setyono, 2006). In aquatic and terrestrial ecosystems, Gastropods are known as food for ecinoderms, fish, birds and mammals (Pawar and Al-Tawaha, 2017). On the other hand, they play a role of mechanically breaking down (decomposition) organic matter, such as leaves through their feeding activities (Kabir *et al*., 2014; Tavares et al., 2015). Some gastropod are even of economic value to the community. Meat of the genus Strombus, for example, can be consumed (Suwignyo, 2005; Rosady *et al*., 2016) and the shell can be used as a raw material for decoration (Supusepa, 2018). The genus Cymatium, Haliotis, Monodonta, Tectus, Trochus, Turbo, Vasum and Vexillum can also be used as food (Supusepa, 2018).

Knowledge about gastropoda population is needed in maintining sustainable management of mangrove forest in the Pagatan Besar Mangrove Forest. This study aims to compare the density index and diversity of Gastropod species according to their

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ijms.undip.ac.id
DOI: 10.14710/ik.ijms.24.4.179-185
Received : 30-05-2019
Accepted : 02-07-2019

distance from the coastline and analyze the relationship between the two and their physical environment. This finding can also be used to increase public awareness about the sustainability of mangrove forest ecotourism areas.

Materials and Methods

Gastropod samples were taken in March-April 2018 from three lanes placed in the southern part of the Pagatan Besar Mangrove Forest, Takisung District, Tanah Laut Regency. Riefani *et al*. (2019) mentions two parts of the Pagatan Besar Mangrove Forest, namely the northern and southern parts. The northern part which is the estimated area of 5.97 ha stretches along 825 m starting from the mouth of the Pagatan Besar River (Tabanio) to the south to the first ulin walkpath. According to Soendjoto (2003), the northern part of the forest naturally formed after a tidal wave in 1985. The southern part, which covers about 4.72 ha, stretches 587 m from the first ulin walkpath to south to the fourth walkpath or muddy area that has no mangrove plants. The southern forest is a concentration of the development of ecotourism area. The muddy area is an area for planting mangrove trees by the communities.

The three lanes were extended from north to south. The first lane (LT-1) was placed about 5 m from the coastline towards the sea. The coastline is a virtual line that is indicated by land covered with grass or sandy land which in daily tides is considered the highest tidal boundary; in certain cases, for example *rob*, this land may be inundated with sea water. The second lane (LT-2) was placed 10 m towards the sea from LT-1 and the third lane (LT-3) was 10 m towards the sea from LT-2 (Figure 1.). In each lane was placed 10 (1m x 1m) plots and the closest inter-plot distance was 10 m.

From each plot Gastropod individuals were collected and grouped according to species. Species were identified according to Nybakken and Bertness (2005), and species diversity index was done with Shannon-Wiener index. Abiotic factors consisting of water temperature, salinity, pH of the substrate, and type of substrate were measured or sampled from 1 plot per lane.

Results and Discussion

Gastropods (n=1.432) found at Pagatan Besar mangrove forest consist of 16 species or 7 families (Figure 2.) with density and diversity as presented in Table 1. The number of these species is less than those found by Siwi (2017) on the Beach Si Runtoh, Baluran National Park, East Java (19 species); Supusepa (2018) in Negeri Tial and Negeri Suli, Maluku (30 and 39 species, respectively); or even Rumahlatu and Leiwakabessy (2017) in the coastal waters of Ambon Island, Maluku (65 species). However, the number of species in the forest is still greater than that reported by Ernanto *et al*. (2010) in Muara Sungai Batang, South Sumatra (10 species), Isnaningsih and Patria (2018) in Tanjung Lesung, Banten (7 species), Maturbongs and Elviana (2016) in Kambapi Coast, Papua (10 species), Nurrudin *et al*. (2015) in Tanjung Jabung Barat, Jambi (15 species), Rangan (2010) in Minahasa, North Sulawesi (9 species), and Puryono and Suryanti (2019) in Pemalang, Central Java (8 species).

Figure 1. The placement of line transects on the Pagatan Besar mangrove forest

Tabel 1. Diversity of Gastropod in the Pagatan Besar mangrove forest

Family and spesies name		LT-1		LT-2		LT-3	
		n	K	n	K	n	K
A.	Potamididae						
1.	*Pirenella retifera*	148	14.8	69	6.9	0	0
2.	*Tectonatica pusilla*	92	9.2	21	2.1	0	0
3.	*Nassarius stolatus*	71	7.1	15	1.5	0	0
4.	*Cerithidea cingulata*	134	13.4	78	7.8	0	0
5.	*Littoraria melanostoma*	64	6.4	52	5.2	3	0.3
6.	*Vexillum rugosum*	28	2.8	17	1.7	0	0
7.	*Cerithideopsilla alata*	38	3.8	21	2.1	1	0.1
B.	Naticidae						
8.	*Cerithidea obtusa*	39	3.9	8	0.8	0	0
C.	Nassariidae						
9.	*Cassidula aurisfelis*	30	3.0	34	3.4	0	0
D.	Littorinidae						
10.	*Cassidula aurisfelis*	21	2.1	17	1.7	0	0
11.	*Cassidula nucleus*	10	1.0	1	0.1	0	0
E.	Costellariidae						
12.	*Littoraria cingulate*	12	1.2	9	0.9	0	0
F.	Ellobiidae						
13.	*Neritina cornucopia*	42	4.2	27	2.7	0	0
14.	*Neritina violacea*	67	6.7	49	4.9	1	0.1
G.	Neritidae						
15.	*Cerithidea decollata*	78	7.8	41	4.1	0	0
16.	*Cerithidea alata*	53	5.3	41	4.1	0	0
	The number of individuals (N)	927	-	500	-	5	-
	The number of species (S)	16	-	16	-	3	-
	Density of all spesies (K)	-	92.7	-	50.0	-	0.5
	Diversity Index (H')	2.56	-	2.53	-	0.95	-

Remark: LT = line transect; K = density (individu.m^{-2})

Species density at LT-1 is higher than LT-2 density and so subsequently density at LT-2 compared to LT-3. From Figure 3, the differences in LT-1 and LT-2 and LT-3 species densities are even striking. All species were found in LT-1 and LT-2, but only three species were found in LT-3, namely *Littoraria melanostoma, Cerithideopsilla alata, and Neritina violacea*. The same thing happens with the species diversity index. The diversity index on LT-1 is higher than that of LT-2 and the diversity index on LT-2 is higher than that of LT-3. The qualitative criteria for LT-1 diversity index are the same as that of LT-2 (moderate). There is only LT-3 having different criteria, low diversity. From these two conditions, the results showed that both Gastropod species density and diversity index were higher in the lane that was closer to the land than the lane that was further from the land or closer to the sea. In other words, the more toward the sea, the lower the density. The same thing happened to the diversity index Gastropoda.These results were obtained under conditions of water temperature of 27—31^{o}C, salinity of 28—31 ppm, pH of substrate of 5.8, 6.2, as well as bottom substrate types of clay and sandy loam (Table 2.).

The difference in density and diversity index of Gastropods from each lane is thought to be caused by differences in organic materials —in terms of the amount and diversity—contained in the substrate or scattered on the floor of mangrove forests. Organic material which is basically a source of food for Gastropods comes from parts of plants that fall in the forest or are carried by ocean / river currents and then accumulate in the mangrove forest. Leaves are an organic material favored by gastropods *Melampus coffeus* because they contain little lignocellulose (Tavares *et al*., 2015). Gastropod abundance is positively affected by the content of organic matter in sediments. but negatively by the content of organic matter in seawater in the mangrove ecosystems of Payum. Merauke waters (Merly and Elviana. 2017).

There are no publications regarding the number and species of plants in the southern part of the Pagatan Besar Mangrove Forest. but a preliminary survey shows that this forest is dominated by api-api (*Avicennia marina*) which are visually 95% still at a sapling level (diameter at breast height less than 10 cm). In the northern forest. the dominance of api-api was reported by Soendjoto and Arifin (1999). In addition to api-api. plant species in the northern forest consisted of bakau (*Rhizophora mucronata*). buta-buta (*Excoecaria agallocha*). nyiri batu (Xylocarpu

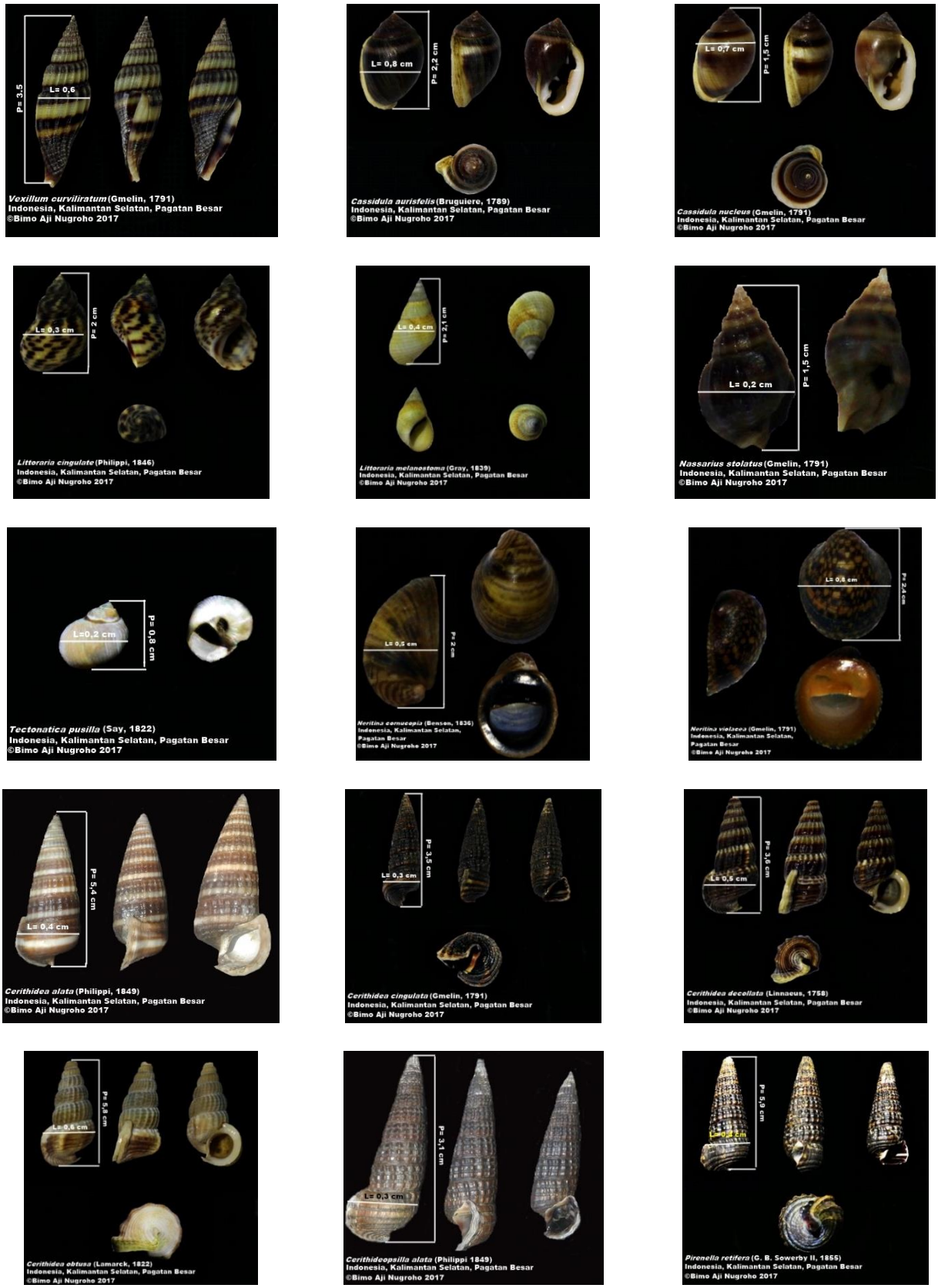

Figure 2. Sixteen Gastropod species found in the Pagatan Besar mangrove forest, Tanah Laut Regency, Indonesia

granatum). rambai padi (*Sonneratia caseolaris*), rambai bogam (S. alba), and 4 species of non-woody plants. As a comparison, the amount of organic matter in litter in the Sepi Bay mangrove forest, Lombok reaches 9.9 tons.ha^{-1}.y^{-1} (Zamroni and Rohyani, 2008).

Organic material is not only from plants, but can also come from parts of animals died directly in the forest or are carried by ocean / river currents. There is no data on the number and species of animals in this condition. However, 60 species of birds (Riefani and Arsyad, 2019) and 4 mudskipper species (Soendjoto, 2019) use the southern forest as their habitat.

Factors affecting Gastropods are not only organic material or biotic components, but also abiotic components or physical environment conditions. Gastropod diversity not only involves food sources, competition and competition, but also the environment (Dahuri *et al*., 2008). There is a positive correlation between Gastropod and physical-chemical factors (temperature, salinity, pH, DO) in the coastal waters of Ambon Island (Rumahlatu and Leiwakabessy, 2017). The number of Gastropod species and individuals in sandy clay substrate is greater than those in sand substrate (Riniatsih and Kushartono, 2009). Gastropods are more commonly found in clay substrate compared to sandy (Rahmasari, 2015).

Sludge substrate is easier to trap or bind organic material as a food source for Gastropods than sand substrate. Sand has greater porosity so that the organic material in it is more easily moved or transported by natural facilities which in the case of mangrove forests are in the form of tides or river water flow. The condition of the substrate is also influenced by the movement of sea or river water that carries certain temperatures, salinity, and pH.

In addition, the condition of the substrate is influenced by sunlight penetration in mangrove forests. Substrates in thick or lush forests are less exposed to light penetration than that in thin or non-forested forests. Thin or non-forested forest refers to lanes far from land or close to the sea.

Table 2. Environment condition of Pagatan Besar mangrove forest during the collecting of Gastropoda samples

Parameter	LT-1	LT-2	LT-3	Comparation
Water temperature (°C)	27	28	31	23.7—30 [1]; 28—29 [2]; 26—27 [3]; 29.9—31.4 [4]
Salinity (ppm)	28	31	30	26—31 [1]; 33 [2]; 29—32 [3]; 30.31—32.02 [4]
pH substrate	5.8	6.0	6.2	3—7 [1]; 5.8—6 [2]
Bottom substrate type	Clay	Sandy loam	Sandy loam	Sandy loam [3]

Remark: 1. Merly and Elviana (2017); 2. Rahmasari *et al.* (2015); 3. Riniatsih and Kushartono (2009); 4. Rumahlatu dan Leiwakabessy (2017)

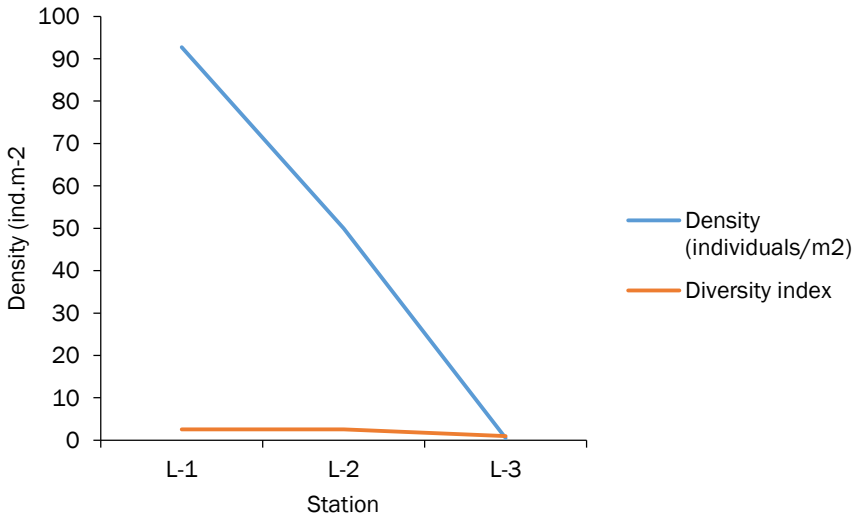

Figure 3. Density and diversity index of gastropods on three line transects in the research area

Conclusion

Gastropods obtained from the Pagatan Besar Mangrove Forest (southern part) consist of 16 species and 7 families. The density and diversity of species in lanes that are close to the coastline (whose substrate is clay) is higher than those close to the sea (whose substrate is sandy loam).

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