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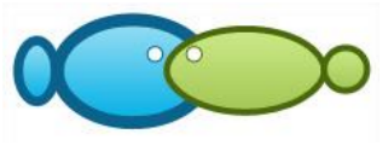

Distribution pattern of gastropods and physical chemical factors in the Kebumen mangrove forest, Indonesia

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Abstract. The mangrove area in Kebumen, Indonesia, is polluted from the jellyfish processing industry waste, which affects the distribution pattern of gastropods. This research aims to determine the distribution pattern of gastropods and provide important information for indicators of mangrove ecosystems changes. This study took place in Kebumen District, Central Java Province, Indonesia, from June to September 2018. Three sampling points were selected: Station A (high mangrove density), Station B (moderate mangrove density), and Station C (low mangrove density). The sampling method used for gastropods was collection from plots of 5x5 m. All gastropods in a plot were collected by hand and extracted from a 10 cm deep layer using a corer with 3 replications for each station. The environmental parameters were determined *in situ*: temperature, salinity, dissolved oxygen (DO), pH, and substrate type. The distribution of gastropods in the Kebumen mangrove forest has a clustered and even pattern. The highest abundance of gastropod species was found in Station 1, *Cerithidea alata* (209±9 ind 25 m^{-2}); in Station 2, *Pirenella cingulata* had the highest abundance (209±16 ind 25 m^{-2}), and in Station 3, *Neritina violacea* was most abundant (202±17 ind 25 m^{-2}). Physico-chemical factors that have a strong influence on gastropod density are water pH (6.92-7.93), dissolved oxygen (DO) (4.13-6.65 mg L^{-1}), substrate type (dust, clay, and sand), and phosphorous concentration (0.25-0.33%).
Key Words: evenness, grouping, mangrove, mollusk, physical chemical factors.

Introduction. Mangroves are one of the coastal ecosystems that have an important role in both ecologic and economic functions. The ecologic function of mangroves is translated to a source of feed for biota such as fish, crabs, shrimp, and others, sanctuaries for biota (Nordhaus et al 2009), a natural barrier blocking storms and tsunamis (Blankespoor et al 2017) and ecosystem carbon stocks (Kauffman et al 2011). The ecosystem is supported by the processes of physico-chemical factors and litter dynamics (Ariyanto et al 2019a), by decomposition processes (Ariyanto et al 2018a), by sources of macro and micro elements (Ariyanto et al 2019b) and sources of amino acids (Ningsih et al 2020). Mangroves provide an ecotourism area in terms of economic function (Surjanti et al 2020).

Gastropods are epifauna animals also found in mangrove ecosystems. Epifauna animals are invertebrates that have a habitat on the surface of sediments. Gastropods are generally epifauna and herbivores (Giesen et al 2006). Gastropods are very sensitive to local disturbances, such as decreased water quality and sediments, supported by limited gastropod mobility (Nordhaus et al 2009). Gastropods are members of the benthic community found in mangrove forests, such as *Cassidula nucleus* and *Cassidula angulifera* (Ariyanto et al 2018b) and *Cerithideopsilla djadjariensis* (Ariyanto et al 2020). Gastropods in a mangrove ecosystem act as a link in the food chain, decomposing litter (Silaen et al 2013), recycling nutrients that can increase primary productivity

(Thilagavathi et al 2013), and acting in primary productivity as a resource for herbivores (Cannicci et al 2008). Benthic communities are a sensitive indicator of changes in pollution levels, so they can be used as biomonitoring tools for evaluating environmental pollution (Bian et al 2016). This research aims to determine the distribution pattern of gastropods in some mangrove areas in Kebumen District, Central Java.

Material and Method. The study area was located in Kebumen District, Central Java Province, Indonesia, and the study was conducted from June to September 2018. Study sites were selected to include different levels of mangrove density exposure. The study area included 3 sampling points: Station 1 (ST1) (high mangrove density, >75%), Station 2 (ST2) (moderate mangrove density, 50-75%), and Station 3 (ST3) (low mangrove density, <50%) (Ministry of Environment 2004). The mangrove canopy was calculated with the hemispherical photography method at one point of taking photos (Jennings et al 1999; Korhonen et al 2007). The coordinates of ST1 are 7°43'08.33"S and 109°23'34.20"E; for ST2 they are 7°43'09.54"S and 109°23'32.77"E; and for ST3 they are 7°43'07.73"S and 109°23'31.47"E.

Gastropods. Sampling of gastropods in each location was conducted based on the Sasekumar method (Sasekumar 1974). The method consists in sampling gastropods in a plot measuring 5x5 m. All gastropods found in the plot were collected by hand and extracted from a 10 cm deep layer, using a corer. Sampling was conducted in three repetitions at each station. The gastropod samples obtained were all cleaned and placed in 5 kg plastic containers for each sampling point of the station. A 70% alcohol solution was added for initial preservation. The containers with samples were transported to the Research Center for Biology Laboratory, Indonesian Institute of Sciences, and Aquatic Laboratory, Jenderal Soedirman University, for identification with reference to Dance (1992) and Dharma (1988).

Environmental parameters. The environmental parameters were determined *in situ*. The physico-chemical parameters of the environment determined were: water pH, soil pH, air temperature, water temperature, salinity, dissolved oxygen (DO), phosphorus, nitrogen, organic matter, pyrite, dust, clay, and sand. Sediment was also collected to determine grain size and the content of organic material with 4 replications per station.

The grain size of sediments and the content of organic matter were determined with the Walkley-Black method (Global Soil Laboratory Network 2020) in the Soil Science Laboratory, State University of Surakarta. For the determination of texture, organic matter was oxidized with H_2O_2 and soluble salts were removed from the soil with HCl, while heating. The remaining material is a mineral and consist of sand, silt, and clay. The sand was separated by wet sieving, while dust and clay were separated by deposition according to Stoke's law.

Organic materials. 0.500 g of sediment were weighed and placed into a 100 mL volumetric flask. 5 mL of $K_2Cr_2O_7$ 1 N were added and the mix was shaked. 7.5 mL of concentrated H_2SO_4 were added, shaked, and left to stand for 30 minutes. The mix was diluted with ionized water, and allowed to cool. The next day, the absorbance of the clear solution was measured using a spectrophotometer at a wavelength of 561 nm. As a comparison, 0 and 250 ppm standards were made by pipetting 0 and 5 mL of 5000 ppm standard solution into a 100 mL volumetric flask.

Total phosphorus. 1 g of soil sample (<2 mm) was weighed and placed into a shaker. 20 mL of Olsen extract were added, and the new solution was mixed for 30 min and filtered. If the solution was cloudy, it was returned to the original filter. 2 mL of solution were extracted and pipetted into a test tube. 10 mL of phosphate dye reagent were added together with the standard series, mixed until homogeneity was achieved, and left for 30 min. The solution absorbance was measured with a spectrophotometer at 889 nm wavelength.

Total nitrogen. 0.5 g of soil sample (<0.5 mm) were weighed and placed into a digest tube. 1 g of selenium mixture and 3 mL of concentrated sulfuric acid were added. The mix was kept at a temperature of 350°C for 3-4 h. The destruction was complete when white steam appeared and a clear extract was obtained (after about 4 h). The tube was removed from the heat and cooled. The extract was diluted with ionized water (50 mL). The extract was mixed until reaching homogeneity and left overnight to allow the particles to settle. The extract was used for N measurement by distillation or colorimetric method.

Data analysis. The pattern of gastropod distribution was determined using the Morisita Deployment Index (Brower et al 1990). The gastropod similarity index was calculated. To see a general description of the gastropod community, a cluster analysis was employed. If there was a special grouping between stations, a SIMPER analysis was carried out to determine the similarity of each group and to know the gastropod species that contributed to the grouping.

Density is the number of individuals per unit area or volume, and was determined based on the formula of Krebs (2009):

Di = ni/L

Where: Di - mangrove density; ni - number of individual species i; L - plot area.

Species distribution. The distribution of mangroves and gastropods was determined by using the variance analysis variance based on Morisita index ($I\delta$) (Morisita 1959):

$$I\delta = [q \sum_{i=1}^{q} \mathrm{Xi}(\mathrm{Xi} - 1)]/[\mathrm{T}(\mathrm{T}\text{-}1)]$$

Where: $I\delta$ - Morisita index; xi - number of individual type X in all plots; q - number of plots; T - number of all individuals in all plots.

The interpretation of the distribution pattern in the research area is the following: if IM is 1, there is a random distribution pattern; if IM>1, there is a clustered distribution pattern; if IM<1, there is an even distribution pattern.

Statistial Analysis. The correlation between gastropod density and environmental physico-chemical factors was analyzed using BIO-ENV. All analyzes were carried out with the PRIMARY V5 software (Clarke & Warwick 2001).

Results and Discussion

Gastropod distribution. Table 1 shows the abundance of gastropods at the study site. 7 families of gastropods were found in this study: Assimineidae, Ellobiidae, Potamididae, Muricidae, Terebridae, Littorinidae and Neritidae. In SA1, *Cerithidea alata* (209±9 25 m^{-2}) had the highest abundance; in ST2, *Pirenella cingulata* had the highest abundance (146±9 25 m^{-2}); in SA3, *Neritina violacea* had the highest abundance (202±17 25 m^{-2}). The distribution pattern of each gastropod species can be observed from the results of the Morisita index analysis (Table 1). The gastropod distribution analysis shows that 4 species are distributed evenly: *Cassidula nucleus, Cassidula aurisfelis, Littoraria melanostoma,* and *Telescopium telescopium*. The other 17 species have a clustered distribution pattern.

Table 1

The abundance and distribution pattern of gastropods in Kebumen Mangrove Forest, Indonesia

Family	Species	SA1			SA2			SA3		
		K	Id	Pattern	K	Id	Pattern	K	Id	Pattern
Assimineidae	*Assimenia brevicula*	142 ±8	0.087	evenly distributed	115±9	0.134	evenly distributed	161±18	0.482	evenly distributed
Ellobiidae	*Cassidula nucleus*	30±5	0.004	evenly distributed	0±0			0±0		
	Cassidula aurisfelis	21±6	0.002	evenly distributed	6±3	0.0003	evenly distributed	0±0		
Potamididae	*Cerithidea quadrata*	78±6	0.026	evenly distributed	0±0			84±7	0.130	evenly distributed
	Cerithidea alata	209±9	0.188	evenly distributed	146±9	0.215	evenly distributed	158±13	0.464	evenly distributed
	Hastula sp.	136±3	0.079	evenly distributed	111±5	0.124	evenly distributed	0±0		
Muricidae	*Pirenella cingulata*	164±18	0.116	evenly distributed	201±16	0.409	evenly distributed	0±0		
Terebridae	*Littoraria melanostoma*	43±11	0.008	evenly distributed	0±0			0±0		
Littorinidae	*Littorina carinifera*	80±7	0.027	evenly distributed	47±4	0.022	evenly distributed	0±0		
	Neritina zigzag	48±6	0.0097	evenly distributed	33±2	0.0107	evenly distributed	0±0		
Neritidae	*Neritina violacea*	204±20	0.179	evenly distributed	193±14	0.377	evenly distributed	202±17	0.759	evenly distributed
	Nerita albicilla	77±6	0.025	evenly distributed	0±0			0±0		
	Nerita antiquata	44±4	0.008	evenly distributed	0±0			0±0		
	Neritina turita	46±3	0.008	evenly distributed	28±2	0.007	evenly distributed	64±3	0.075	evenly distributed
	Neritina lineata	57±3	0.012	evenly distributed	60±3	0.036	evenly distributed	0±0		
	Telescopium telescopium	0±0			0±0			25±6	0.011	evenly distributed
	Vittina variegata	63±1	0.016	evenly distributed	0±0			0±0	0.482	evenly distributed

Note: SA1 - station 1; SA2 - station 2; SA3 - station 3; K - abundance; Id - Morista index.

Patterns of a species grouping usually occur because of limiting factors for the existence of a population. A species grouping is caused by a tendency to defend itself from predators and other unfavorable factors. The limiting factors in the form of food availability and favorable habitat conditions can cause species grouping. Grouping behavior is caused by heterogeneous environments and reproductive models (Pemberton & Frey 1984). Tavares et al (2015) state that clustering is caused by habitat uniformity resulting in grouping in places with available feed. The pattern of distribution of biota is influenced by habitat parameters, which include physico-chemical factors, feed and the adaptability of a biota in an ecosystem (Nagelkerken et al 2008).

N. violacea, Neritina zigzag and *Telescopium telescopium* were found in the Kebumen mangrove forest. The species are also distributed in other places; *T. telescopism* was also found in the mangrove ecsosystem of coastal Banggi, Indonesia (Ariyanto 2019), *N. violacea* was found in China (Wang et al 2019), and *N. zigzag* in Segara Anakan, Indonesia (Pribadi et al 2010). The pattern of grouping similarities and contributions of gastropods was analyzed using multivariate analysis with two approaches (cluster), as presented in Figure 2.

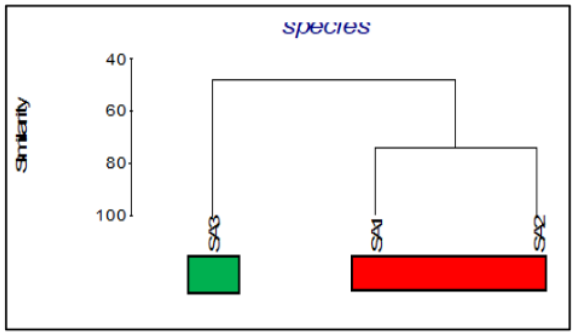

Figure 2. Grouping of gastropods based on clusters (SA1 - station 1; SA2 - station 2; SA3 - station 3).

By cluster analysis, gastropods form two groups, namely group A, present in ST1 and ST2 2, and group B, present in ST3. The pattern of distribution can result in increased competition between individuals in feeding and for space. Organisms that live in groups tend to be strong in competition. Group A has an average similarity of 74.37%. This shows that the gastropod grouping pattern has a high similarity. This can be seen from the contribution of *N. violacea* by 23.12%, *Ceritidhea alata* by 20.58%, *Pirenella cingulata* by 17.94%, and the three types of gastropods, *Hastula* sp., *Littorina carinifera* and *N. lineata*, which have the similarity value of 6.63%. The similarity of gastropods between stations from the similarity matrix results are presented in Table 2.

Table 2

The percentage of similarity index (%) of gastropods between Station 1, Station 2 and Station 3

No	*Stations*	*SA1*	*SA2*	*SA3*
1	SA1	-	-	-
2	SA2	73.93	-	-
3	SA3	46.63	48.96	-

Note: SA1 - station 1; SA2 - station 2; SA3 - station 3.

ST1 and ST2 have the highest species similarity, 73.93%. The average similarity of ST1 and ST2 shows a high homogeneity of species. Meanwhile, ST1 and ST3 have the lowest species similarity, 40.95%. The average similarity of ST1 and ST3 shows a low homogeneity of species, with a variety of contributions from each species.

The physico-chemical parameters are presented in Table 3. The correlation between gastropod density and physico-chemical factors that have the same value is 1.

Table 3

Physico-chemical parameters at each station

Parameter	*Station*		
	SA1	*SA2*	*SA3*
pH	6.92±0.13	6.93±0.13	7.93±0.02
Water Temperature °C	26.83±0.55	28.59±1.09	27.25±1.66
Salinity psu	20.58±0.53	21.14±0.54	28.08±0.61
DO mg L^{-1}	4.13±0.13	4.33±0.62	6.65±0.11
Total P (%)	0.25±0.06	0.23±0.07	0.33±0.09
Total N (%)	2.42±0.97	1.31±0.49	1.80±0.38
Organic materials (%)	31.81±19.36	20.00±0.83	16.77±2.59
Dust (%)	42.08	41.64	40.51
Clay (%)	44.67	44.21	42.80
Sand (%)	13.25	14.16	16.68

Note: SA1 - station 1; SA2 - station 2; SA3 - station 3; DO - dissolved oxygen; P – Phosphorous; N - Nitrogen.

Acidity (pH). The pH value in ST1, ST2 and ST3 are 6.92±0.13, 6.93±0.13, and 7.93±0.02, respectively. Compared to the two research stations, ST3 has the highest value. Moiseenko (2005) states that aquatic biota has a pH tolerance limit that varies and is influenced by various factors such as temperature, DO, organic matter, and others. Aquatic biota prefers pH between 7 and 8, and is sensitive to changes in pH (Abdel-Gawad & Mola 2014). pH values close to 5 or 9 are less favorable for some macrobenthos organisms.

Dissolved oxygen. The DO levels in ST1, ST2 and ST3 were 4.13±0.13 mg L^{-1}, 4.33±0.62 mg L^{-1}, and 6.65±0.11 mg L^{-1}, respectvely. Oxygen levels in the waters are influenced by temperature, bacterial activity, salinity, atmospheric pressure, season (Tian et al 2013), and water depth (Feresin et al 2010).

Substrate. Substrates contained clay, silk, and sand, in the following percentages in the 3 stations: SA1 - 42.8%, 44.67%, 13.25%; SA2 - 41.64%, 44.21%, 14.16%; SA3 - 40.51%, 41.80%, 16.68%. Skilleter & Warren (2000) explain that the basic substrate is a very important component for the life of benthic organisms. Substrate particle size is one of the main ecological factors influencing the macrobenthic community structure. The distribution of macrobenthos can clearly correlate with the type of substrate. Macrobenthos with digging properties (deposit eaters) tend to be abundant in mud sediments and soft sediments containing high organic matter (Dittmar & Lara 2001).

The substrate in a mangrove community is determined by geological and geomorphological processes that can change sediment characteristics, so that it is suitable for mangrove growth and development (Lovelock et al 2007). Sand substrate and coral fragments can be tolerated by the mangrove genus *Rhizophora*. *Rhizopora mucronata* has the ability to be more tolerant to sand and other more dense substrates (Lee et al 2014). The particle size and type of substrate is one of the ecological factors affecting organic matter and the spread of macrozoobenthos. The substrate can capture larger organic matter. Organic material can accumulate in muddy waters. Substrate and fine particles facilitate the absorption of organic matter. This type of soil occurs in areas affected by high and low tides, such as mangrove forests. Mangroves will retain seawater runoff, rich in sulfate and iron-containing clay deposits. Furthermore, Gao et al (2019) argue that soil texture and organic matter have a dominant role in mangrove distribution.

Phosphorous. Phosphorus and nitrogen are important nutrients in the waters. Both of these nutrients have limited existence and are needed for the growth of phytoplankton and diatoms (Boyd et al 2002). The phosphorus content was 0.25±0.06%, 0.23±0.07%

and 0.33±0.09% in ST1, ST2 and ST3, respectively. Phosphorus is used by phytoplankton in the form of orthophosphate and accumulates in the body of fish or shrimp through the food chain. Phosphorus not absorbed by phytoplankton will be bound by soil. The ability to bind is influenced by the clay content of the soil. The higher the content of clay is in the soil, the higher is the ability of the soil to bind phosphorus. Most phosphorus is bound by soil and a small portion is dissolved in water (Boyd et al 2002).

Nitrogen. The nitrogen in the study location was 2.42±0.97%, 1.31±0.49%, and 1.80±0.38% in ST1, ST2 and ST3, respectively. Nitrogen is an important ingredient in mangrove ecosystems. High and low nitrogen levels are related to the organic content of the mangrove ecosystem. The abundance of mangrove roots can increase the nitrogen content in the soil (Reef et al 2010; Goncalves Reis et al 2017). Organic nitrogen results from dead plankton and residues from aquatic animals that settle to the bottom. Nitrogen in soil organic material will be mineralized to ammonia and returned to the water, being reused by phytoplankton.

Temperature. The water temperatures were 28.17±2.17°C, 28.67±2.04°C, and 29±0.62°C, in ST1, ST2, and ST3, respectively. Temperatures were normal at the research locations, so they were suitable for the survival of marine organisms. Water temperature is a physical parameter that can affect the life patterns of aquatic biota such as distribution, abundance, and mortality (Brower et al 1990), changes in composition, abundance, and diversity of macrobenthos (Nagelkerken et al 2008), oxidation rate and oxygen solubility (Marshall & McQuaid 2020). Temperatures above 20°C will result in reduced gastropod activity. The optimal temperature for gastropod life is between 25 and 31°C (Marshall & McQuaid 2020). The temperature of a body of water is influenced by season, latitude, altitude of sea level, air circulation, cloud cover, water flow, and depth of water body, among others (Effendi 2003). Temperature can affect the activity of an organism either directly or indirectly. Direct influences manifest on growth, reproduction, and metabolism. Indirect effects influence the environment, and then the organism, like the processes of increasing accumulation of various substances in the water and decreasing oxygen levels. High temperatures can cause oxygen levels to decrease and pH to increase.

Salinity. Salinity values were 20.58±0.53 psu, 21.14±0.54 psu, and 28.08±0.61 psu in ST1, ST2 and ST3, respectively. Low salinity was observed in each station due to sampling in the rainy season. The occurrence of high and low tides caused fluctuations in the estuarine area. When the low mass of water entering the estuary comes from the river, it causes low salinity, while the high tide (the mass of water entering the estuary coming from the sea) increases the salinity. Changes in salinity are influenced by water circulation patterns, evaporation, rainfall, and river water flow. Veiga et al (2016) state that salinity can affect the variation of gastropods.

Organic materials. Some organic material comes from the debris of mangrove trees. The lowest organic matter content was in ST3, 16.77%. Station 3 is the least vegetated location, thus more lacking in mangrove litter. The station with high organic material is ST1, with 31.81%. ST1 is the station with the most mangrove vegetation. The organic matter is a food source for biota. Leaves, twigs, branches and plant roots form highly needed organic matter in the soil for the food chain, affecting the mangrove community structure. Reef et al (2010) state that mangrove litter is an important source of organic matter in the food chain in the aquatic environment. A content of forest organic matter higher than 20% shows that an area has a very high fertility rate, because falling mangrove leaves will accumulate on the bottom and decomposed. A higher density of mangroves produces more litter.

Conclusions. 17 species of gastropods were found. 4 species, *C. nucleus, C. aurisfelis, L. melanostoma,* and *T. telescopium* were evenly distributed. 13 species were distributed in groups, namely: *A. brevicula, C. quadrata, C. alata, Hastula* sp., *P. cingulata, L.*

carinifera, N. zigzag, N. violacea, N. albicilla, N. antiquata, N. turita, N. lineata, and *V. variegata*. Patterns of grouping occurred because of the limiting factor of mangrove density. The results of the SIMPER analysis of Group A show an average similarity of 74.37%. This shows that the gastropod grouping pattern has a high similarity. The contribution of *N. violacea* was of 23.12%, *Ceritidhea alata* 20.58%, *Pirenella cingulata* 17.94%. *Hastula* sp., *Littorina carinifera* and *N. lineata* had the same similarity value of 6.63%. The similarity of species between ST1 and ST2 was 73.93%. ST1 and ST3 had the lowest species similarity, 40.95%.

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Conflict of Interest. The authors declare that there is no conflict of interest.

References

Abdel-Gawad S. S., Mola H. R. A., 2014 Macrobenthic invertebrates in the main channel of Lake Nasser, Egypt. The Egyptian Journal of Aquatic Research 40(4):405-414.

Ariyanto D., 2019 Food preference on *Telescopium telescopium* (Mollusca: Gastropoda) based on food sources in mangrove ecosystem. Plant Archives 19(1):913-916.

Ariyanto D., Bengen D. G., Prartono T., Wardiatno Y., 2018a Short communication: The relationship between content of particular metabolites of fallen mangrove leaves and the rate at which the leaves decompose over time. Biodiversitas 19(3):780-785.

Ariyanto D., Bengen D. G., Prartono T., Wardiatno Y., 2018b The association of *Cassidula nucleus* (Gmelin 1791) and *Cassidula angulifera* (Petit 1841) with mangrove in Banggi Coast, Central Java, Indonesia. AACL Bioflux 11(2):348-361.

Ariyanto D., Bengen D. G., Prartono T., Wardiatno Y., 2019a The physicochemical factors and litter dynamics (*Rhizophora mucronata* Lam. and *Rhizophora stylosa* Griff) of replanted mangroves, Rembang, Central Java, Indonesia. Environment and Natural Resources Journal 17(4):11-29.

Ariyanto D., Bengen D. G., Prartono T., Wardiatno Y., 2020 Distribution and abundance of *Cerithideopsilla djadjariensis* (Martin 1899) (Potamididae) on *Avicennia marina* in Rembang, Central Java, Indonesia. Egyptian Journal of Aquatic Biology and Fisheries 24(3):323-332.

Ariyanto D., Gunawan H., Puspitasari D., Ningsih S. S., Jayanegara A., Hamim H., 2019b The differences of the elements content in *Rhizophora mucronata* leaves from Asahan Regency, North Sumatra, Indonesia. Polish Journal of Natural Sciences 34(4):481-491.

Bian B., Zhou Y., Fang B. B., 2016 Distribution of heavy metals and benthic macroinvertebrates: Impacts from typical inflow river sediments in the Taihu Basin, China. Ecological Indicators 69:348-359.

Blankespoor B., Dasgupta S., Lange G. M., 2017 Mangroves as a protection from storm surges in a changing climate. Ambio 46:478-491.

Boyd C. E., Wood C. W., Thunjai T., 2002 Aquaculture pond bottom soil quality management. Pond dynamics/Aquaculture Collaborative Research Support Program, Oregon State University, Corvallis, 45 p.

Brower J., Zar J. H., van Ende C., 1990 Analysis of communities. In: Field and laboratory methods for general ecology. 3rd Edition. Brown Publishers, Dubuque, 237 p.

Cannicci S., Burrows D., Fratini S., Smith III T. J., Offenberg J., Dahdouh-Guebas F., 2008 Faunal impact on vegetation structure and ecosystem function in mangrove forests: A review. Aquatic Botany 89(2):186-200.

Clarke K. R., Warwick R. M., 2001 An approach to statistical analysis and interpretation. 2nd Edition. PRIMER-E, Plymouth, 176 p.

Dance S. P., 1992 SHELLS: The visual guide to over 500 species of seashell from around the world. Dorling Kindersley, London, 256 p.

Dharma B., 1988 [Indonesian snails and shells I]. PT Sarana Graha, Jakarta, Indonesia, 111 p. [In Indonesian].
Dittmar T., Lara R. J., 2001 Driving forces behind nutrient and organic matter dynamics in a mangrove tidal creek in North Brazil. Estuarine, Coastal and Shelf Science 52(2):249-259.
Effendi H., 2003 [Study of water quality for the management of resources and the aquatic environment]. Kanisius, Yogyakarta, Indonesia, 257 p. [In Indonesian].
Feresin E. G., Arcifa M. S., Sampaio da Silva L. H., Esguícero A. L. H., 2010 Primary productivity of the phytoplankton in a tropical Brazilian shallow lake: experiments in the lake and in mesocosms. Acta Limnologica Brasiliensia 22(4):384-396.
Gao Y., Zhou J., Wang L., Guo J., Feng J., Wu H., Lin G., 2019 Distribution patterns and controlling factors for the soil organic carbon in four mangrove forests of China. Global Ecology and Conservation 17:e00575, 14 p.
Giesen W., Wulffraat S., Zieren M., Scholten L., 2006 Mangrove guidebook for Southeast Asia. FAO and Wetlands International, 186 p.
Goncalves Reis C. R., Bielefeld Nardoto G., Oliveira R. S., 2017 Global overview on nitrogen dynamics in mangroves and consequences of increasing nitrogen availability for these systems. Plant and Soil 410(1-2):1-19.
Jennings S. B., Brown N. D., Sheil D., 1999 Assessing forest canopies and understorey illumination: Canopy closure, canopy cover and other measures. Forestry 72(1):59-73.
Kauffman J. B., Heider C., Cole T. G., Dwire K. A., Donato D. C., 2011 Ecosystem carbon stocks of micronesian mangrove forests. Wetlands 31(2):343-352.
Korhonen L., Korhonen K. T., Stenberg P., Maltamo M., Rautiainen M., 2007 Local models for forest canopy cover with beta regression. Silva Fennica 41(4):671-685.
Krebs C. J., 2009 Ecology: The experimental analysis of distribution and abundance. 6th Edition. Pearson Benjamin Cummings, 655 p.
Lee S. Y., Primavera J. H., Dahdouh-Guebas F., Mckee K., Bosire J. O., Cannicci S., Diele K., Fromard F., Koedam N., Marchand C., Mendelssohn I., Mukherjee N., Record S., 2014 Ecological role and services of tropical mangrove ecosystems: A reassessment. Global Ecology and Biogeography 23(7):726-743.
Lovelock C. E., Feller I. C., Ellis J., Schwarz A. M., Hancock N., Nichols P., Sorrell B., 2007 Mangrove growth in New Zealand estuaries: The role of nutrient enrichment at sites with contrasting rates of sedimentation. Oecologia 153(3):633-641.
Marshall D. J., McQuaid C. D., 2020 Metabolic regulation, oxygen limitation and heat tolerance in a subtidal marine gastropod reveal the complexity of predicting climate change vulnerability. Frontiers in Physiology 11:1106, 12 p.
Moiseenko T. I., 2005 Effects of acidification on aquatic ecosystems. Russian Journal of Ecology 36(2):93-102.
Morisita M., 1959 Measuring of the dispersion and analysis of distribution patterns. Memories of the Faculty of Science, Kyushu University. Series E: Biology 2:215-235.
Nagelkerken I., Blaber S. J. M., Bouillon S., Green P., Haywood M., Kirton L. G., Meynecke J. O., Pawlik J., Penrose H. M., Sasekumar A., Somerfield P. J., 2008 The habitat function of mangroves for terrestrial and marine fauna: A review. Aquatic Botany 89(2):155-185.
Ningsih S. S., Ariyanto D., Puspitasari D., Jayanegara A., Hamim H., Gunawan H., 2020 The amino acid contents in mangrove *Rhizophora mucronata* Leaves in Asahan, North Sumatra, Indonesia. E3S Web of Conferences 151:01047, 3 p.
Nordhaus I., Hadipudjana F. A., Janssen R., Pamungkas J., 2009 Spatio-temporal variation of macrobenthic communities in the mangrove-fringed Segara Anakan lagoon, Indonesia, affected by anthropogenic activities. Regional Environmental Change 9(4):291-313.
Pemberton S. G., Frey R. W., 1984 Quantitative methods in ichnology: spatial distribution among populations. Lethaia 17:33-49.
Pribadi R., Hartati R., Suryono C. A., 2010 [Gastropod species composition and distribution in the Segara Anakan Mangrove Forest Area, Cilacap]. ILMU KELAUTAN

Indonesian Journal of Marine Sciences 14(2):102-111. [In Indonesian].
Reef R., Feller I. C., Lovelock C. E., 2010 Nutrition of mangroves. Tree Physiology 30:1148-1160.
Sasekumar A., 1974 Distribution of macrofauna on a Malayan mangrove shore. The Journal of Animal Ecology 43(1):51-69.
Silaen I. F., Hendrarto B., Nitisupardjo M., 2013 [Distribution and abundance of gastropods in the mangrove forest of Teluk Awur Jepara]. Management of Aquatic Resources Journal (MAQUARES) 2(3):93-103. [In Indonesian].
Skilleter G. A., Warren S., 2000 Effects of habitat modification in mangroves on the structure of mollusc and crab assemblages. Journal of Experimental Marine Biology and Ecology 244:107-129.
Surjanti J., Soejoto A., Seno D. N., Waspodo, 2020 Mangrove forest ecotourism: Participatory ecological learning and sustainability of students' behavior through self-efficacy and self-concept. Social Sciences & Humanities Open 2(1):100009, 6 p.
Tavares D. S., Maia R. C., Rocha-Barreira C., Matthews-Cascon H., 2015 Ecological relations between mangrove leaf litter and the spatial distribution of the gastropod *Melampus coffeus* in a fringe mangrove forest. Iheringia, Serie Zoologia 105(1):35-40.
Thilagavathi B., Varadharajan D., Babu A., Manoharan J., Vijayalakshmi S., Balasubramanian T., 2013 Distribution and diversity of macrobenthos in different mangrove ecosystems of Tamil Nadu coast, India. Journal of Aquaculture Research & Development 4(6):1000199, 12 p.
Tian C., Pei H., Hu W., Xie J., 2013 Phytoplankton variation and its relationship with the environmental factors in Nansi Lake , China. Ecosystem Ecology 185:295-310.
Veiga M. P. T., Gutierre S. M. M., Castellano G. C., Freire C. A., 2016 Tolerance of high and low salinity in the intertidal gastropod *Stramonita brasiliensis* (Muricidae): Behaviour and maintenance of tissue water content. Journal of Molluscan Studies 82:154-160.
Wang P., Zhu P., Wu H., Xu Y., Liao Y., Zhang, H., 2019 The complete mitochondrial genome of *Neritina violacea*. Mitochondrial DNA Part B 4(2):2942-2943.
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*** Ministry of Environment, 2004 [Standard criteria and guidelines for determining mangrove damage]. Jakarta, 8 p. [In Indonesian].

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