Biodiversity and density of marine intertidal gastropods in tropical seagrass meadows on Gorom Island, East Seram, Maluku, Indonesia

by Husain Latuconsina

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Abstract. Gastropods are benthic invertebrates from the Mollusca phylum that live in association with seagrass meadows on various types of substrates in the intertidal zone. This study aims to analyze the species composition and density of gastropods in seagrass meadows. The study was carried out from November to December 2016 in Rarat Village, Gorom Island, East Seram, Maluku. Estimation of seagrass and gastropods was conducted using a systematic sampling method. Analysis of species composition, density, and regression analyses were carried out to determine the influence and relationship of seagrass communities with gastropods. There were 7 seagrass species from 2 families, including 4 species from the Potomogetonaceae family (*Enhalus accoroides, Thalassia hemprichii, Halophila ovalis, Halophila spinulosa*), and 3 species from the Cymodoceaceae family (*Cymodocea rotundata, C. serrulata, Thalassodendron ciliatum*). A total of 266 individual gastropods, representing 30 species, 13 families, and 4 orders were identified. The highest density was determined for *Conus virgo* (Conidae), the highest number of species was from the family Strombidae (7 species), and Neogastropods was the order that dominated the gastropod community, with a total of 16 species from 8 families. The density of the gastropod community was positively related to the density of seagrass vegetation (r=0.62), but seagrass vegetation only gave a 39% effect on the density of gastropods (R^2=0.39). Important conservation efforts are carried out through monitoring and controlling the flow of rivers that lead to seagrass meadows to support the life of seagrass vegetation and gastropod communities.
Key Words: coastal waters, gastropod density, Mollusca, Rarat village.

Introduction. Seagrass is a coastal waters vegetation that has fully adapted to the marine environment, and grows to form seagrass meadows in coastal waters, estuaries, intertidal to subtidal zones (Waycott et al 2004; Latuconsina 2020). Seagrass acts as a nutrient cycler, supporting aquatic productivity (Erftemeijer et al 1993; Erftemeijer & Middelburg 1995). Seagrass vegetation can grow on various types of substrates, ranging from sandy, muddy, coral rubble to coral reef areas, so that the type of substrate also affects the distribution, species composition and density of seagrass vegetation (Latuconsina & Dawar 2012; Irawan & Nganro 2016; Latuconsina et al 2020).

Gastropods are invertebrates of the classes of the Mollusca phylum associated with seagrass meadows, because, ecologically, gastropods are an important component in the food chain in seagrass meadows whose infauna live on sedimentary substrates or attach to seagrass leaves (Kusnadi et al 2009). The eating habits of gastropods are diverse, being detritus feeders, herbivores (grazers) and scavengers (Severns 2000; Moore 2006; Kusnadi et al 2009). Gastropods have a relatively strong relationship with seagrass vegetation, increasing in density with increasing seagrass vegetation density (Latuconsina et al 2013; Latuconsina & Samal 2020; Fajeri et al 2020).

Ecological studies and gastropod biodiversity studies in seagrass meadows have been widely carried out in Indonesia, including in Lampung (Sari et al 2019), Belitung, Bangka Belitung (Cappenberg & Wulandari 2020), Pramuka Island, Seribu Islands (Ekaningrum et al 2012), Lamongan, East Java (Hitalessy et al 2015), Barrang Lompo islands, Makassar and Tanakeke, Takalar, South Sulawesi (Omar et al 2001; Litaay et al

2017), Talise Island, Wori coast, Minahasa, North Sulawesi, and Tomini Bay, Gorontalo (Arbi 2011; Arbi 2012; Saripantung et al 2013; Sianu et al 2014; Roring et al 2020), Moti Island, North Maluku (Arbi 2011), Osi and Tatumbu Island, Kotania Bay, West Seram, and Kei Kecil Islands, Maluku, (Cappenberg 1996; Kusnadi et al 2008; Latuconsina et al 2013; Latuconsina & Samal 2020); Nabire, Papua (Souisa et al 2019).

The number of studies on gastropod communities in tropical seagrass meadows, especially in Indonesia, shows the large role and potential of seagrass meadows as important habitats for gastropod communities. One area that has the potential for seagrass meadows with various types of substrates and seagrass vegetation in the intertidal zone is in Rarat Village, Gorom Island, East Seram, Maluku. The habitat of seagrass meadows in this area is supporting local fishing activities, one of which is the harvesting of gastropods for consumption needs. However, scientific information regarding the gastropod community is still lacking, so research on the biodiversity and density of gastropods in seagrass meadows in the intertidal zone is very important in supporting seagrass meadow management strategies for sustainable gastropod utilization.

Material and Method. This research was conducted from November to December 2016, in Rarat village, Gorom Island, East Seram, Maluku, Indonesia. The determination of three research stations was done considering that each station was located at the entrance of a small river in the sea (Figure 1). Observations of seagrass vegetation and gastropod communities was conducted using a systematic sampling method (Setyobudiandy et al 2009). Line transects were placed in a quadrant/plot (1 m^2), with a distance between quadrants of 15-20 m and a distance between transects of 50 m placed perpendicular to the shoreline. There was a 100 m distance between research stations (Figure 1).

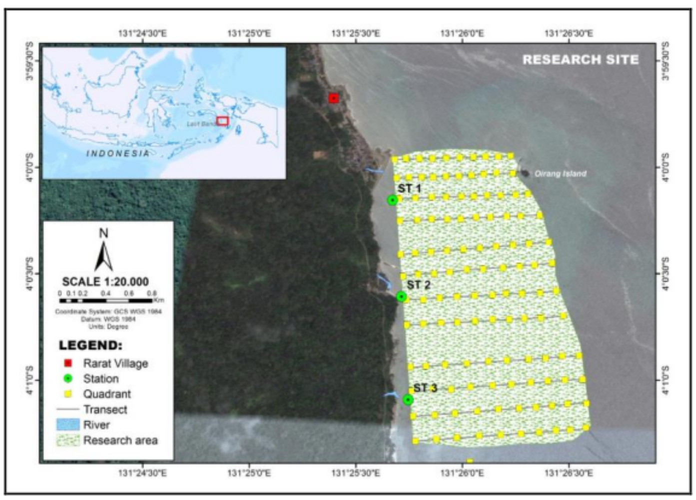

Figure 1. Research location.

Identification of the type of substrate at each station was carried out visually. The substrate was taken at the beginning, middle and end of the transect of each research station. Identification of seagrass species was conducted according to Waycott et al (2004). The identification of gastropods was conducted after Abbott & Dance (1990), Carpenter & Niem (1998), Severns (2000), and www.sealifebase.org.

Data analysis was conducted to determine the ecological parameters of seagrass vegetation and gastropod, namely species composition and density. Gastropod composition was carried out by comparing the number of individuals of each species with the total number of individuals of all species using the following formula (Fachrul 2007):

Sc = ni/N x 100

Where: Sc - gastropod species composition (%); ni - number of individuals of each gastropod species; N - number of individuals of all gastropod species.

Species density is the number of individuals per unit area. The density of each type of seagrass and gastropod was calculated using the formula of Odum (1983):

Di = ni/A

Where: Di - species density (ind m^{-2}); ni -total number of individuals of a species (individuals); A - sampling area (m^2).

Regression and correlation analyses were carried out to determine the effect and relationship between the total density of seagrass vegetation with the density of gastropod communities using Microsoft Excel 2010.

Results and Discussion. Rarat village is included in the territory of the Gorom Island, East Seram, Maluku. It has a very gentle topography, with the potential for extensive seagrass meadows in the intertidal zone. During the lowest tide, most of the seagrass meadows are exposed, and local people carry out activities to collect fishery resources (fish, molluscs, crustaceans) in the seagrass area to meet their food needs (Figure 2). This fact shows the importance of seagrass meadows in the waters of Rarat village, Gorom Island as a food source for local communities. According to Unsworth et al (2010), seagrass meadows play an important role in supporting fishery stocks, food security and fishing activities for coastal communities (Unsworth et al 2014; Unsworth et al 2019).

Figure 2. "Bameti" is the activity of local communities to collect gastropods and other fishery resources at low tide in seagrass meadows in the intertidal zone of Rarat Village, Gorom Island, East Seram, Maluku.

The coastal waters of Rarat village in the intertidal zone have the potential of mixed seagrass meadows and are adjacent to three small river estuaries. Station 1 (131°25'40.369"E and 4°0'9.269"S) contains a small river with an estuary width of 5 m. It is overgrown with three genera of mangroves (*Bruguiera, Rhizophora* and *Nypa*) with low density. Seagrass is growing 70 m from the shoreline towards the sea, in a diverse substrate is dominated by muddy sand (on the beach), but with coarse sand and coral rubble towards the sea near the subtidal zone. The waters are quite protected because there are small islands located close to the sea. Station 2 (131°25'42.862"E and 4°0'36.477"S) has a river mouth with a width of 7 m. There is one genus of mangrove vegetation (*Rhizophora*) with medium density. Seagrass grows 90 m from the shoreline towards the sea, with a predominantly sandy mud substrate on the shore, to coarse sand and coral rubble near the subtidal zone. Station 3 (131°25'44.731"E and 4°1'5.554"S) has a river mouth with a width of 3 m and no mangrove vegetation. The first seagrass growing distance from the shoreline is 50 m towards the sea. The substrate is composed of muddy sand on the beach and coral rubble towards the sea. According to Waycott et al (2004), seagrass vegetation can grow on various types of substrate, being widely distributed in estuaries, coastal waters, intertidal to subtidal zones, and coral reefs.

Biodiversity and density of seagrass vegetation. Observation results on seagrass communities identified seven tropical seagrass species belonging to two families, namely: Hydrocharithaceae family with four seagrass species (*Enhalus accoroides, Thalassia hemprichii, Halophila ovalis*, and *Halophila spinulosa*, and Cymodoceaceae family with three species (*Cymodocea rotundata, Cymodocea serrulata*, and *Thalassodendron ciliatum*). The density level of each seagrass species at the three research stations is presented in Figure 3.

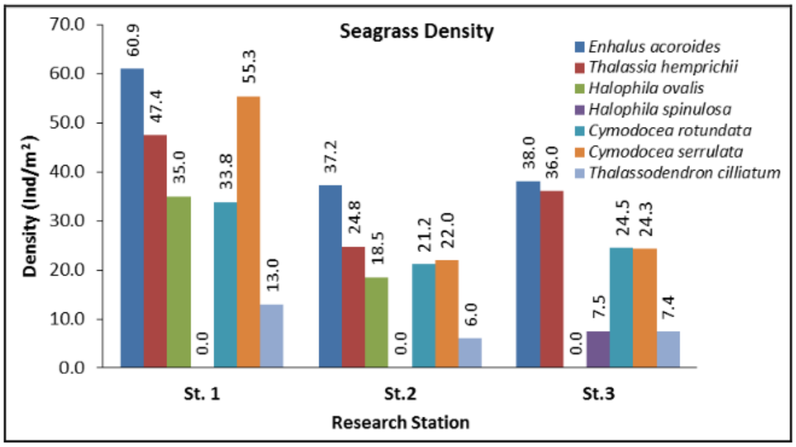

Figure 3. Tropical seagrass vegetation density at three research stations in the intertidal zone of Rarat village, Gorom island, East Seram, Maluku.

Figure 3 shows the highest density of seagrass vegetation at station 1 with a total density of 245.4 ind m^{-2} and the lowest at station 2 with a total density of 129.7 ind m^{-2}. The highest species density is for *E. acoroides*. According to Waycott et al (2004), *E. acoroides* is widely distributed in estuarine, coastal, intertidal to subtidal and coral areas, because it can grow on various types of substrates such as muddy, sandy, and coral rubble. Irawan & Nganro (2016) and Latuconsina et al (2020) found that seagrass *E. acoroides* is widely distributed on various types of substrates in the Inner Ambon Bay, and forms a single vegetation field with a muddy substrate type, as well as in association with other seagrass species to form mixed vegetation with substrate type is muddy, sandy, and coral rubble.

The seagrass with the lowest vegetation density was *T. cilliatum* at all research stations (Figure 3), although it was scattered in all stations. *T. ciliatum* found were not widespread, because they were only found in intertidal areas and associated with corals. According to Waycott et al (2004), *C. serrulata* and *C. rotundata* are usually found in seagrass meadows from coastal areas, coral to subtidal zones, while *T. cilliatum* has a narrow distribution, namely in subtidal and coral zones. For *H. ovalis* and *H. decipiens* are seagrass species that are widely distributed in coastal areas, estuaries, subtidal, and coral reef areas.

Biodiversity, composition and density of gastropods. The number of gastropods found in seagrass meadows at the study site was 266 individuals, representing 30 species, 13 families, and 4 orders. The highest number of gastropod species was from the family Strombidae (7 species), and the order with the dominating number of species was Neogastropod, with 8 families and 16 species (Table 1).

Table 1

Gastropod biodiversity between research stations in tropical seagrass meadows in the intertidal zone of Rarat village, Gorom island, East Seram, Maluku

Order	*Family*	*Species*	*Research Station*		
			St.1	*St.2*	*St.3*
Archaeogastropoda	Trochidae	*Trochus maculatus* Linnaeus, 1758	+	-	-
		Trochus niloticus Linnaeus, 1767	-	+	-
Littorinimorpha	Strombidae	*Strombus* sp.	-	-	+
		Strombus aratrum (Röding, 1798)	+	+	-
		Strombus bulla (Röding, 1798)	-	-	+
		Strombus lentiginosus Linnaeus, 1758	+	-	-
		Strombus luhuanus Linnaeus, 1758	+	+	+
		Strombus urceus Linnaeus, 1758	+	+	+
		Lambis lambis (Linnaeus, 1758)	+	+	+
Neogastropoda	Coniidae	*Conus mangus* Linnaeus 1758	+	-	-
		Conus leopardus (Röding, 1798)	+	+	+
		Conus marmoreus Linnaeus, 1758	+	+	+
		Conus miles Linnaeus, 1758	+	+	+
		Conus virgo Linnaeus, 1758	+	+	+
	Costellariidae	*Vexillum plicarium* (Linnaeus, 1758)	+	+	+
	Cypraeidae	*Cypraea* sp. 1	+	-	-
		Cypraea sp. 2	+	-	-
		Cypraea tigris (Linnaeus, 1758)	+	+	-
		Lyncina vitellus (Linnaeus, 1758)	-	+	-
	Muricidae	*Chicoreus brunneus* (Link, 1807)	-	-	+
	Olividae	*Ancilla* sp.	+	-	-
		Oliva reticulata (Röding, 1798)	+	-	-
	Terebridae	*Terebra subulata* (Linnaeus, 1767)	+	-	-
	Turbinellidae	*Vasum turbinellum* (Linnaéus, 1758)	-	+	+
	Volutidae	*Cymbiola vespertilio* (Linnaeus, 1758)	+	-	-
Neotaenioglossa	Cherithiidae	*Cerithium nodulosum* Bruguière, 1792	+	-	-
		Rhinoclavis articulata (Adams & Reeve, 1850)	-	-	+
		Rhinoclavis aspera (Linnaeus, 1758)	-	-	+
	Ovulidae	*Ovula ovum* (Linnaeus, 1758)	+	-	-
	Tonnidae	*Tonna cepa* (Röding, 1798)	-	+	-

Note: (+) - found; (-) - not found; St - station.

The number of gastropod species found in the intertidal seagrass meadows on Rarat village is relatively high when compared to other findings in several seagrass meadows in Indonesia. Roring et al (2020) found 11 species from 7 gastropod families in Minahasa, North Sulawesi. 12 species from 11 families were found in Tomini Bay, North Sulawesi (Sianu et al 2014). 12 species from 8 families were identified in Belitung Island (Cappenberg & Wulandari 2020). 12 species from 7 families were found in the Riau archipelago (Fajeri et al 2020), 16 species from 8 families in Tangkil Island, Lampung (Sari et al 2019). However, the number of species identified by us is still lower than the number reported by some other authors. Litaay et al (2017) found 34 species from 14 families in Tanakeke Island, South Sulawesi. 38 species from 24 families were found in Osi Island, Kotania Bay, West Seram, Maluku (Cappenberg 1996), 49 species from 12 families in Nabire, Papua (Souisa et al 2019), 80 species from 26 families in Kei Kecil Island, Southeast Maluku (Kusnadi et al 2008), 81 species from 28 families in seagrass meadows on Barrang Lompo Island, South Sulawesi (Omar et al 2001).

Latuconsina et al (2013), Kusnadi et al (2008), Souisa et al (2019), and Latuconsina & Samal (2020) also found the family of Strombidae with the highest number of species in seagrass meadows. According to Kusnadi et al (2009), all species of the family Strombidae are herbivores and live in muddy sand substrates.

The highest gastropod biodiversity was found at station 1, with 21 species from 10 families, while at station 2, 14 species from 7 families were found, and 14 species from 6 families were found in station 3 (Table 2).

Table 2

Number of individuals, composition and density of gastropods between research stations in tropical seagrass meadows in the intertidal zone of Rarat village, Gorom Island, East Seram, Maluku, Indonesia

Family	Species	Station 1			Station 2			Station 3		
		Σ	Sc (%)	D (ind/m²)	Σ	Sc (%)	D (ind/m²)	Σ	Sc (%)	D (ind/m²)
Trochidae	*Trochus maculatus*	7	6.7	0.7						
	Trocus niloticus				5	5.8	0.5			
Strombidae	*Strombus* sp.							2	2.7	0.2
	Strombus aratrum	2	1.9	0.2	7	8.1	0.7			
	Strombus bulla							4	5.3	0.4
	Strombus lengtiginosus	5	4.8	0.5						
	Strombus luhuanus	5	4.8	0.5	4	4.7	0.4	9	12.0	0.9
	Strombus urceus	4	3.8	0.4	9	10.5	0.9	6	8.0	0.6
	Lambis lambis	2	1.9	0.2	5	5.8	0.5	6	8.0	0.6
Conidae	*Conus mangus*	6	5.7	0.6						
	Conus leopardus	6	5.7	0.6	9	10.5	0.9	8	10.7	0.8
	Conus marmoreus	4	3.8	0.4	7	8.1	0.7	5	6.7	0.5
	Conus miles	3	2.9	0.3	5	5.8	0.5	4	5.3	0.4
	Conus virgo	12	11.4	1.2	10	11.6	1.0	11	14.7	1.1
Costellariidae	*Vexilium plicarium*	9	8.6	0.9	8	9.3	0.8	5	6.7	0.5
Cypraeidae	*Cypraea* sp. 1	6	5.7	0.6						
	Cypraea sp. 2	2	1.9	0.2						
	Cypraea tigris	10	9.5	1.0	3	3.5	0.3			
	Lyncina vitellus				2	2.3	0.2			
Muricidae	*Chicoreus bruneus*							3	4.0	0.3
Olividae	*Ancilla* sp.	3	2.9	0.3						
	Oliva reticulate	3	2.9	0.3						
Terebridae	*Terebra subulata*	3	2.9	0.3						
Turbinellidae	*Vasum turbinellum*			0.0	10	11.6	1.0	3	4.0	0.3
Volutidae	*Cymbiola vespertilio*	6	5.7	0.6						
Cherithiidae	*Cerithium nodulosum*	4	3.8	0.4						
	Rhinoclavis articulata							7	9.3	0.7
	Rhinoclavis aspera							2	2.7	0.2
Ovulidae	*Ovula ovum*	3	2.9	0.3						
Tonnidae	*Tonna cepa*				2	2.3	0.2			
	Total	105	100	10.5	86	100	8.6	75	100	7.5

Note: Σ - number of individuals; Sc - species composition; D - density.

The total gastropod density found in the seagrass meadows of Rarat village is high, ranging from 7.5 to 10.5 ind m^{-2}, when compared to the report by Fajeri et al (2020) in the seagrass meadows of Senggarang Besar, Riau Islands, Indonesia, which ranged from 0.35 to 2.95 ind m^{-2}. Other authors alos found a lower density in similar meadows. Latuconsina et al (2013) found a density of gastropods of 1.62–3.52 ind m^{-2} in the seagrass meadows of Osi Island, West Seram, Indonesia, and Latuconsina & Samal (2020) found a total gastropod density range of 1.09–1.14 ind m^{-2} in the seagrass meadows of Tatumbu Island.

The high biodiversity and density of gastropods in tropical seagrass meadows in the intertidal zone in Rarat village, especially at station 1, is thought to be closely related to the high density of seagrass vegetation supported by various types of substrates which are able to provide diverse habitats for gastropod communities (Table 2). The gastropod with the highest species composition and density values, widespread at all observation stations was *Conus virgo* (Table 2). According to Abbott (1991), this species is found mostly on muddy shallow beaches. According to Kusnadi et al (2009), all species of the family Conidae are herbivorous and carnivorous, and live on muddy sand substrates. According to Kusandi et al (2009), gastropods live on the bottom substrate of the waters or attached to seagrass leaves. Thus, the existence seagrass vegetation supports the abundance and biodiversity of gastropods classified as herbivores, but also the filter feeders that absorb organic particles on the substrate.

Relationship between seagrass and gastropod. The higher gastropod community density was found in seagrass meadows with diverse substrates, with the predominance of muddy sand and coarse sand to coral rubble, with a high level of seagrass vegetation density at station 1. The lowest gastropod community density was found at station 3, which has only muddy sand substrate and coral rubble.

The results of the regression analysis show the relationship and influence of seagrass vegetation density on gastropods density in the intertidal zone of Rarat village, East Seram Maluku (Figure 4).

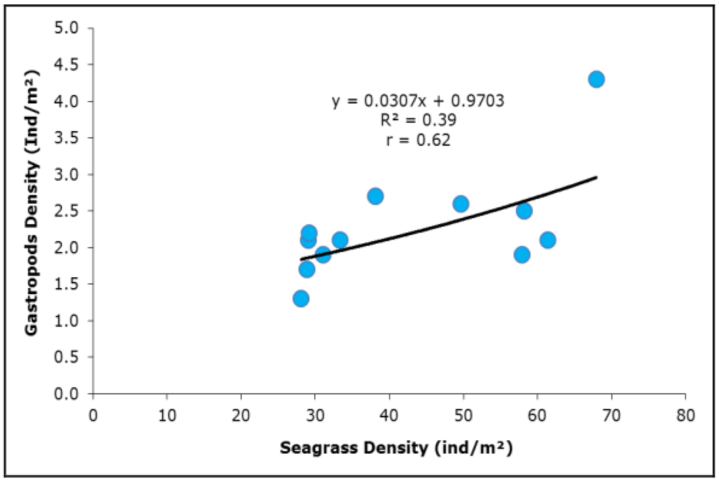

Figure 4. Regression graph of the relationship between tropical seagrass vegetation and gastropods based on the estimated total density on each transect.

Figure 4 shows that the effect of seagrass vegetation density on gastropod community density is only 39% (R^2=0.39), meaning that the seagrass vegetation only has an effect of 39% on the gastropod community density, and 61% of gastropod density in the seagrass meadows is influenced by other factors. Meanwhile, the relationship between seagrass vegetation density and gastropod community density showed a strong relationship of 62% (r=0.62). This phenomenon is suspected to occur because most gastropods are infauna biota that live in substrates where seagrass vegetation grows; thus, not all gastropods have a high dependence directly on seagrass vegetation. As reported by Fajeri et al (2020), from 12 gastropod species associated with seagrass vegetation, 11 species had a negative association with seagrass vegetation, and only one species had a positive association level, namely *Rhinoclavis aspera*. According to Kusnadi et al (2009) and Latuconsina et al (2013), gastropods found in seagrass meadows mostly live on the substrate under the seagrass canopy, and a small part attach to seagrass leaves.

The existence of seagrass vegetation functions as a nutrient cycler and primary producer (Erftemeijer et al 1993; Erftemeijer & Middelburg 1995). It also has roles in binding sediments, and protecting and stabilizing shorelines (Christianen et al 2013; Ondiviela et al 2014). Thus, the presence of seagrass vegetation indirectly plays a role in supporting the density of the gastropod community, because the seagrass meadows is used as a habitat for growth, feeding, protection and support, and other biological activities for the gastropod community.

Thus, efforts to conserve seagrass meadows are important. The efforts should include controlling anthropogenic activities that have a negative impact on seagrass meadows around watersheds, by increasing turbidity and sedimentation. The gastropod community will subsequently be affected. According to Quiros et al (2017), proper management of seagrass meadows should be responsible for the management of adjacent watersheds.

Seagrass meadows can be used as an ecological indicator to see the influence of river flows that carry sediment material and pollution loads to the intertidal zone of Rarat village, Gorom Island, East Seram, which have the potential to affect gastropod communities. According to van Katwijk et al (2011), seagrass systems can respond to the influence of rivers at landscape, ecosystem and individual levels, so that they are suitable as early warning indicators to avoid greater environmental damage.

Conclusions. A total of 266 individual gastropods representing 30 species, 13 families, and 4 orders were identified, showing the high gastropod biodiversity in the seagrass meadows of Rarat village of Gorom Island, Maluku. The highest density of gastropods was presented by *C. virgo* (Conidae). The family with the highest number of species was Strombidae, and Neogastropods was the order with the dominant number of families and species. The density level of seagrass vegetation is influenced by the characteristics of the bottom substrate of the waters. The number and density of gastropod species have a strong positive correlation with the density of seagrass vegetation, and the presence of seagrass vegetation has an indirect effect on the density of gastropods. Management of seagrass meadows in the intertidal zone must consider the presence of watersheds, which play an important role in the dynamics of environmental parameters, thereby affecting the spatial distribution and density of seagrass vegetation, which will affect the biodiversity and density of gastropods.

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

References

Abbott R. T., 1991 Seashells of South East Asia. Graham Brash, Singapore, 145 p.

Abbott R. T., Dance P., 1990 Compendium of seashells. Crawford House Pres, Australia, 411 p.

Arbi C. Y., 2011 [Community structure molluscs in seagrass beds in Talise Island, North Sulawesi]. Oseanology & Limnology in Indonesia 37(1):71-89. [In Indonesian].

Arbi U. Y., 2012 [Mollusc community in seagrass meadows, Wori Beach, North Sulawesi]. Bumi Lestari 12(1):55-65. [In Indonesian].

Cappenberg H. A. W, Wulandari D. A., 2020 [Community structure of molluscs at seagarss beds in Belitung Island, Bangka Belitung Province]. Journal Tropical Marine Science & Technology 11(3):735-750. [In Indonesian].

Cappenberg H. A. W., 1996 [Mollusc community in Kotania Bay, West Seram]. Maluku and Surrounding Waters 11:19-33. [In Indonesian].

Carpenter K. E., Niem V. H., 1998 The living marine resources of the Western Central Pacific. Volume 1. Seaweeds, corals, bivalves and gastropods. FAO Species Identification Guide for Fishery Purposes, Rome, 713 p.

Christianen M. J. A., van Belzen J., Herman P. M. J., van Katwijk M. M., Lamers L. P. M., van Leent P. J. M., Bouma T. J., 2013 Low-canopy seagrass beds still provide important coastal protection services. PLoS ONE 8(5):e62413, 8 p.

Ekaningrum R., Ruswahyuni, Suryanti, 2012 [Abundance of macrobenthos associated with seagrass habitats at different distances in the waters of Pramuka Island, Seribu Islands]. Journal of Management of Aquatic Resources 1(1):1-6. [In Indonesian].

Erftemeijer P. L. A., Middelburg J. J., 1995 Mass balance constraints on nutrient cycling in tropical seagrass beds. Aquatic Botany 50(1):21-36.

Erftemeijer P. L. A., Osinga R., Mars A. E., 1993 Primary production of seagrass beds in South Sulawesi (Indonesia): a comparison of habitats, methods and species. Aquatic Botany 46(1):67-90.

Fachrul F. M., 2007 [Bioecological sampling method]. Bumi Aksara, Jakarta, 198 p. [In Indonesian].

Fajeri F., Lestari F., Susiana S., 2020 [Gastropod association in seagrass ecosystems Senggarang Besar waters, Riau Islands, Indonesia]. Journal of Aquaculture, Coasts and Small Islands 4(2):53-58 [In Indonesian].

Hitalessy R. B., Leksono A. S., Herawati E. Y., 2015 [Community structure and association of gastropods with seagrass plants in Lamongan coastal waters, East Java]. JPAL 6(1):64-73. [In Indonesian].

Irawan A., Nganro M. N., 2016 [Distribution of seagrass in Inner Ambon Bay]. Journal of Tropical Marine Science and Technology 8(1):99-114. [In Indonesian].

Kusnadi A., Hernawan U. E., Triandiza T., 2009 [Molluscs of seagrass bed on Kei Kecil Islands]. LIPI Press, Jakarta, 198 p. [In Indonesian].

Kusnadi A., Triandiza T., Hernawan U. E., 2008 [The inventory of mollusc species and its potency on seagrass bed in Kei Kecil Islands, Southeast Moluccas]. Journal Biodiversity 9(1):30-34. [In Indonesian].

Latuconsina H., 2020 [Tropical aquatic ecology: Basic principles of aquatic biological resources management. 3rd Edition]. Gadjah Mada University Press, Yogyakarta, Indonesia, 284 p. [In Indonesian].

Latuconsina H., Affandi R., Kamal M. M., Butet N. A., 2020 [Spatial distribution of white-spotted rabbitfish *Siganus canaliculatus* (Park, 1797) in different seagrass beds habitats in Inner Ambon Bay]. Journal of Tropical Marine Science and Technology 12(1):89-106. [In Indonesian].

Latuconsina H., Dawar L., 2012 [Ecological study of the seagrass community in the waters of the Osi Island, Kotania Bay, West Seram Regency]. Journal of Fisheries Agribusiness 5(2):12-19. [In Indonesian].

Latuconsina H., Samal S., 2020 [Gastropods community in seagrass meadows of Tatumbu Island Kotania Bay, Mollucas]. Proceedings of the National Life Science and Technology Conference, University of Islam Malang, East Java, Indonesia, pp. 26-33. [In Indonesian].

Latuconsina H., Sangadji M., Dawar L., 2013 [Association of gastropod on the different habitat of seagrass beds in Osi Island - Kotania Bay West Seram]. Journal Torani 23(2):67-78. [In Indonesian].

Litaay M., Deviana M., Prisambodo D., 2017 Biodiversity and distribution of gastropods at seagrass meadow of Balangdatu waters Tanakeke Island South Sulawesi Indonesia. International Journal of Applied Biology 1(12):67-75.

Moore J., 2006 An introduction to the invertebrates. Cambridge University Press, New York, 319 p.

Odum E. P., 1983 Basic ecology. Saunders College Publishing, New York, 612 p.

Omar S. B., Rani C., Haris A., Hade A. R., 2001 Gastropod communities in seagrass beds at Barrang Lompo Island, South Sulawesi. Phuket Marine Biological Center Special Publication 25(1):71-78.

Ondiviela B., Losada I. J., Lara J. L., Maza M., Galván C., Bouma T. J., van Belzen J., 2014 The role of seagrasses in coastal protection in a changing climate. Coastal Engineering 87:158-168.

Quiros T. E. A. L., Croll C., Tershy B., Fortes M. D., Raimondi P., 2017 Land use is a better predictor of tropical seagrass condition than marine protection. Biological Conservation 209:454-463.

Roring R. O., Rangan J. K., Kambey A. D., Kepel R. C., Mandagi S. V., Sondak C., 2020 [Community structure of gastropod in seagrass beds of Waleo Beach waters, North Minahasa Regency]. Journal Ilmiah Platax 8(1):102-109. [In Indonesian].

Sari P. D, Ulqodry T. Z., Aryawati R., Isnaini, 2019 [Association of gastropods with seagrass in the waters of Tangkil Island, Lampung]. Journal of Research Science 21(3):131-139. [In Indonesian].

Saripantung G. L., Tamanampo J. F. W. S., Manus G., 2013 [Community structure of gastropod in seagrass on intertidal area in the Tongkeina Village of Manado City]. Platax Scientific Journal 1(3):102-108. [In Indonesian].

Setyobudiandi I., Sulistiono, Yulianda F., Kusmana C., Hariyadi S., Damar A., Sembiring, Bahtiar, 2009 [Sampling and analysis of marine and fishery data; application of

sampling methods in coastal and marine areas]. Makaira-FPIK, IPB, Bogor, Indonesia, 312 p. [In Indonesian].
Severns P. F., 2000 Tropical seashells of Indonesia. Periplus, Singapore, 64 p.
Sianu N. E., Sahami F. M., Kasim F., 2014 [Diversity and association of gastropods with seagrass ecosystems in the waters of Tomini Bay]. Nikè: Scientific Journal of Fisheries and Marine 2(4):156-163. [In Indonesian].
Souisa M., Leatemia S. P., Talakua S., 2019 [Community structure of gastropods in seagrass meadows at coastal area of Nusi and Gersen, Nabire Regency]. Indopacific Journal of Aquatic Resources 3(2):89-99. [In Indonesian].
Unsworth R. F. K., Nordlund L. M., Cullen-Unsworth L. C., 2019 Seagrass meadows support global fisheries production. Conservation Letters 12(1):e12566, 8 p.
Unsworth R. K. F., Cullen L. C., Pretty J. N., Smith D. J., Bell J. J., 2010 Economic and subsistence values of the standing stocks of seagrass fisheries: Potential benefits of no-fishing marine protected area management. Ocean & Coastal Management 53:218-224.
Unsworth R. K. F., Hinder S. L., Bodger O. G., Culen-Unsworth L. C., 2014 Food supply depends on seagrass meadows in the coral triangle. Environmental Research Letters 9:094005, 9 p.
Van Katwijk M. M., van der Welle M. E. W., Lucassen E. C. H. E. T., Vonk J. A., Christianen M. J. A., Kiswara W., Inayat al Hakim I., Arifin A., Bouma T. J., Roelofs J. G. M., Lamers L. P. M., 2011 Early warning indicators for river nutrient and sediment loads in tropical seagrass beds: A benchmark from a near-pristine archipelago in Indonesia. Marine Pollution Bulletin 62(7):1512-1520.
Waycott M., McMahon K., Mellors J., Calladine A., Kleine D., 2004 A guide to tropical seagrass of the Indo-West Pacific. James Cook University, Townsville, Australia. James Cook University, 72 p.
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