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GASTROPOD COMMUNITY STRUCTURE IN THE INTERTIDAL ZONE OF PASUMPAHAN ISLAND, PADANG CITY, WEST SUMATRA PROVINCE

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ABSTRACT

Pasumpahan Island is one of the islands located in West Sumatra Province which has various activities of daily life, especially in the intertidal zone; it is suspected that it can interfere with the existence of aquatic organisms one of which is gastropods. Studying the structure of gastropod communities in the intertidal zone is an interesting natural laboratory to study. This research was conducted from December 2021 to January 2022 on Pasumpahan Island Padang City West Sumatra Province. The purpose of this study was to determine the structure of the gastropod community which includes species, abundance, diversity, uniformity, dominance, and distribution pattern of gastropods. As supporting data in this study, several environmental parameters were also measured which included water quality, sediment type, and sediment organic matter content. The research method used is a survey method, where sampling using the quadrat transect method is carried out at 3 stations. Based on the results of the study found 13 species of gastropods. The most common species found at all stations was *Pythia scarabaeus,* where the gastropod abundance values obtained between stations ranged from 2,78 to 5,00 ind/m^2. The value of the species diversity index ranged from 1,50 to 2,02, which was moderate, the uniformity index value ranged from 0,77 to 0,88, which was high uniformity, and the dominance index value ranged from 0,16 to 0,29, meaning that there were no species found dominates and the value of the distribution pattern ranges from 1,31 to 2,47 with a clustered distribution pattern.

Keywords: Community Structure, Gastropods, Intertidal Zone, Pasumpahan Island

1. INTRODUCTION

Pasumpahan Island is one of the islands located in West Sumatra Province. This island is a tourist destination that is in great demand by local and foreign tourists. In the intertidal zone on Pasumpahan Island, there are various activities, such as fishing activities, places for ships to dock, and tourism activities, which of course can affect habitat conditions and environmental factors for gastropods. In addition, as a result of the various activities carried out that contributes to pollution in the island's waters it can cause a decrease in water quality, and disturb the ecological value of these waters, especially in the intertidal zone.

The intertidal zone is the narrowest area when viewed from its area, but this area usually has various important ecosystems from an ecological perspective, including the abundance and diversity of organisms contained therein. Along with the utilization of potential natural resources to meet human needs as well as the many activities carried out in this zone, it is a threat to biota, especially gastropod species.

From a scientific standpoint, studying the gastropod community structure in the intertidal zone of Pasumpahan Island is an interesting natural laboratory to study. The Gastropod community structure of the mollusk phylum is influenced by changes in environmental factors such as temperature,

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salinity, pH, DO, type of substrate, and organic matter. Environmental factors in an ecosystem will affect the abundance, diversity, and distribution of fauna that live in it. Gastropods have an economic role that provides benefits for human life, including as a food source of animal protein such as *Bellamya sumatraensis*, materials for the handicraft industry, jewelry, and mixed ingredients for poultry food such as *Pomacea canaliculata*.

Besides that, much research has been done on the structure of gastropod communities in waters of various regions, including Pulau Kasiak Pariaman Utara Beach, West Sumatra[1], and mangrove ecosystems in Mengkapan Village, Sungai Apit District, Siak Regency, Riau Province[2] and ecosystems Sandy Beach in the conservation area of Pariaman City, West Sumatra Province[3]. Meanwhile, in the intertidal zone of Pasumpahan Island, there has been little research done so far on the structure of the gastropod community.

2. RESEARCH METHOD

Time and Place

This research was conducted from December 2021 - January 2022. The research location is in the intertidal zone of Pasumpahan Island, Padang City, West Sumatra Province (Figure 1). Gastropod identification and counting activities as well as analysis of sediment samples were carried out at the Marine Biology Laboratory, Department of Marine Science, Faculty of Fisheries and Marine, Universitas Riau.

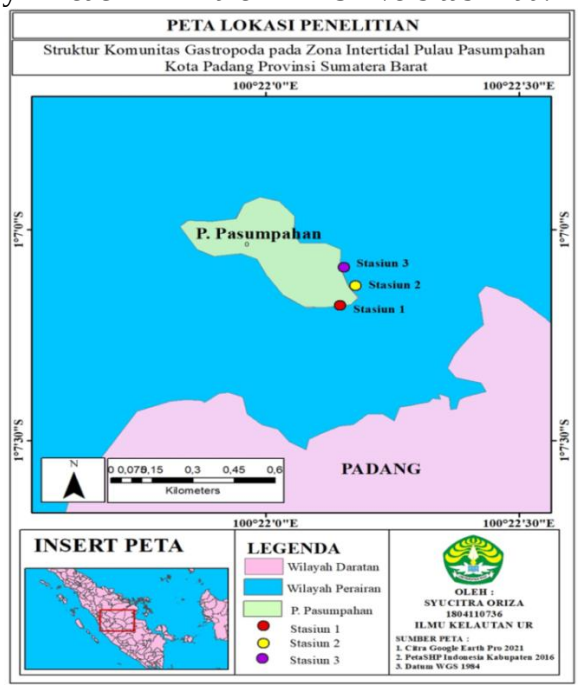

Figure 1. Map of research locations

Methods

The method used in this study was a survey method, namely direct observation of the research area and sampling and measurement of aquatic environment quality parameters in the field. Parameters to be measured include gastropod species, abundance, diversity, uniformity, dominance, distribution patterns, water temperature, and salinity, degree of acidity, total organic matter, and sediment type. Then the samples were identified and analyzed at the Marine Biology Laboratory, Department of Marine Science, Faculty of Fisheries and Marine, Universitas Riau.

Procedure

The research station was determined using a purposive sampling technique, the research sample taking already represented the environmental characteristics on Pasumpahan Island, Padang City, West

Sumatra Province as the research location. Each research station is divided into three subzones, namely: 1) upper intertidal zone, 2) middle intertidal zone, and 3) lower intertidal zone. Each research station has 3 transects with a distance of 30m between transects, each transect consists of 3 plots with a plot size of 1 x 1 m^2 squared with a distance of 5m between plots. Furthermore, measurements of water quality parameters including temperature, pH, and salinity were carried out.

In this study, sediment samples were also taken to measure organic matter and sediment fractions. Sediment samples were taken using a pipe with a diameter of 10 cm plugged to a depth of 15 cm.

Data Analysis

Gastropod samples brought to the laboratory were then washed with fresh water, and then the gastropods were identified and grouped into labeled trays according to the station points. Samples were identified based on the shape obtained using the identification book[4]. Then the number of species obtained was calculated.

Gastropod Abundance

According to Brower & Zar[5] density is calculated using the following formula:

$$D = ni/A$$

Information:

Di = the abundance of i-th individual species (ind/m^2)
ni = Number of Individuals of the type i obtained
A = Plot area of type i found (m^2)

Gastropod Diversity Index

The gastropod species diversity index is based on the Shannon Wienner formula[6] with the following formula:

$$H' = -\sum_{i-1}^{s} pi\ (\ln pi)$$

Information:

H' = species diversity index
pi = ni/N
ni = Number of individuals in type i
N = Total number of individuals
s = Number of species caught

Gastropod Uniformity Index

The species uniformity index is calculated using the Shannon-Wiener formula[7] namely:

$$E = \frac{H'}{H'max} = \frac{H'}{\ln (s)}$$

Information:

E = Uniformity index
H' = Shannon-Wiener diversity index value
S = Number of species

Gastropod Dominance Index

The dominance index is used to determine the type of gastropod that dominates in an area, calculated using the Simpson formula[7], namely:

$$C = \sum_{i=1}^{s} (ni/N)^2$$

Information:

C = dominance index
ni = Number of individuals of each species
N = Total number of individuals of all species
s = Number of individuals caught

Gastropod Distribution Pattern

Gastropod distribution patterns are calculated using the Morisita index formula[7] as follows:

$$Id = N\ \frac{\sum x^2 - \sum x}{(\sum x)^2 - \sum x}$$

Information:

Id = Spread index morisita
N = Number of sampling plots
Σx = Number of individuals per plot
Σx^2 = The sum of squares of individual plots

Sediment Fraction and Total Organic Matter

The analysis carried out was the analysis of sediment fractions using 2 methods, namely the wet sieving method and the pipette method. The multilevel

sieve method is used to obtain Ø-1 – Ø4, while for the pipette method; a volumetric pipette is used to obtain Ø5 - Ø7. To analyze the type of sediment fraction, refer to Rifardi[8].

The concentration of total organic matter in sediments is carried out using a formula that refers to[9] as follows:

$$BOT = \frac{(Wt-C)-(Wa-C)}{Wt-C} \times 100\%$$

Information:

Wt = the total weight (crucible + sample) before burning,
Wa = the total weight (crucible + sample) after burning, and
C = weight of the empty crucible

The data obtained in the form of calculations are presented in the form of tables and graphs which are analyzed descriptively and then narrated descriptively. To determine the differences in the abundance of gastropods between stations and sub-zones, a one-way ANOVA statistical test was carried out.

3. RESULT AND DISCUSSION

Water Quality

Water quality parameters, both physical and chemical, are carried out to see whether the environment is still good or not. Water parameters measured include salinity, pH, and temperature. Water quality parameters were measured at each research sampling point for 3 (three) repetitions. The results of water quality measurements on Pasumpahan Island can be seen in Table 1.

Table 1. Average results of Pasumpahan Island water quality measurements

No	Parameter	Unit	Station		
			I	II	III
1	Temperature	˚C	30	30	32
2	Salinity	ppt	31	31	32
3	pH	-	6,5	6,6	6,6

The results of temperature measurements at each station ranged from 30 – 32^{0}C. According to Prasetia et al.[10] said that the optimum temperature for gastropods in the range of 30 – 32^{0}C still looks good for breeding and carrying out metabolic processes. Salinity values at the study sites ranged from 31 – 32 ppt, this value is still in a state that supports the life and sustainability of gastropods. In general, gastropods live at a salinity in the range of 28 - 34 ppt[9]. Based on the pH value at the study site ranged from 6.5 to 6.6 which is normal and can still be tolerated by gastropod life. According to Fachrul[11], gastropods generally require a water pH between 6.5 – 8.5 for survival and reproduction. So it can be concluded that the water quality on Pasumpahan Island is still relatively good for the survival of gastropods.

Sediment Type

The sediment types that predominate on Pasumpahan Island are gravel and sand. The highest percentage is at station III with a lower sampling point of 87.50% and the lowest percentage is at station II with a lower sampling point of 2.00%. The type of sediment at each station is based on the proportion of gravel, sand, and silt content classified according to Sheppard's triangle. The weight percentage of the sediment fraction and type is presented in Table 2.

According to Nyabakken[12] gastropods live in sediments to determine lifestyle, absence, and type of organisms. In addition, the sediment texture is a place to stick and crawl or walk.

Total Organic Matter in Sediments

Based on the analysis of organic matter content carried out at the Marine Chemistry Laboratory, the average value of sediment organic matter content at station I: 2.97%, station II: 2.91% and station III: 2.25%. The results of the analysis of total organic matter content in sediments in Pasumpahan Island waters can be seen in Table 3.

Table 2. Sediment fraction percentage (%) and sediment type

Station	Plot	Average Sediment Fraction (%)			Sediment Type
		Gravel	Sand	Mud	
I	Lower	74,56	22.75	2.69	Sandy gravel
	Middle	42,46	54,29	3,25	Pebbled sand
	Upper	34,46	61,66	3.89	Pebbled sand
II	Lower	70,15	27.85	2.00	Sandy gravel
	Middle	58.35	38,49	3,16	Sandy gravel
	Upper	16,32	79,77	3.92	Sand
III	Lower	87.50	9,42	3.08	Gravel
	Middle	81,72	16,27	2.01	Gravel
	Upper	17,71	78,72	3.57	Sand

Table 3. Sediment organic matter (%)

Point sampling	Station		
	I	II	III
Lower	3,11	2.76	1.88
Middle	2.95	3.00	1.91
Upper	2.86	2.98	2.97
Average	2.97	2.91	2.25

From the results obtained it was concluded that the three stations were included in the very low criteria. This is presumably due to the type of substrate at the research site, namely sandy gravel, which allows good oxidation due to the presence of larger pore water. Sandy sediments are generally poor in nutrients and vice versa, finer substrates are rich in nutrients. The basic substrate with coarse particles has a low organic matter content. The existence of organic matter in marine ecosystems is very important and can be used as a controller for the abundance, metabolism, and distribution of marine and coastal organisms[13].

Types and Abundance of Gastropods

Observations on the type of gastropods obtained consisted of 9 families, 12 genera, and 13 species (Table 4).

Table 4. Types of gastropods

Family	genus	Species
Elobiidae	Pythia	*Pythia scarabaues*
Cypraeidae	Cypraea	*Cypraea annulus*
Turbinidae	Turbo	*Turbo argyrostomus*
Conidae	conus	*Conus coronatus*
		Conus ebraeus
Mitridae	Cencilla	*Cancilla isabella*
	Strigatella	*Strigatella retusa*
Cerithiidae	Clypemorus	*Clypeomorus batillariaeformis*
	Rhinoclastic	*Rhinoclavis sinensis*
Pisaniidae	Cantharus	*Cantharus rubiginosus*
	Engine	*Engine search*
Naticidae	Mammilla	*Mammilla sebae*
Strombidae	Strombus	*Gibberulus strombus*

The most common gastropod species found from all stations was Pythia scarabaues from the Elobiidae family. According to Kinasih[14] *P.scarabaues* is a gastropod species whose general habitat is in coastal environments, especially near mangrove forests, and can also live on medium sandy to muddy substrates. Several

points in the location of Pasumpahan Island still have mangrove forest vegetation, this is a factor that dominates *P.scarabaeus* to live in that environment. In addition, the aquatic environment at the study site which is still normal is also the cause of the many species found.

The results of the calculation of gastropod abundance values vary at each station and between sub-zones. The abundance of gastropods between stations in Pasumpahan Island waters was 2.78 – 5.00 ind/m^2. The highest abundance was at station III, namely, 5.00 ind/m^2, while the lowest abundance was at station II, namely 2.78 ind/m^2 (Table 5).

Table 5. The abundance of gastropods (ind/m^2) between stations in the intertidal zone of Pasumpahan Island

Station	Mean ± Std.Deviation
I	4.56 ± 0.665
II	2.78 ± 0.265
III	5.00 ± 0.455
Average	4.11 ± 0.461

Gastropod abundance between sub-zones in Pasumpahan Island waters was also calculated where the results obtained were 2.22 – 5.33 ind/m^2. The highest abundance was in the Upper sub-zone, namely 5.33 ind/m^2 and the lowest abundance was in the Lower sub-zone, namely 2.22 ind/m^2 (Table 6).

Table 6. The abundance of gastropods (ind/m^2) between sub-zones in the intertidal zone of Pasumpahan Island

Sub Zone	Mean ± Standard Deviation
Upper	5.33 ± 0.616
Middle	4.78 ± 0.541
Lower	2.22 ± 0.201
Average	4.11 ± 0.452

Based on the results of the calculation analysis, the highest abundance was found at station III, namely 5.00 ind/m^2. This is thought to be caused by the coconut vegetation and the large amount of coral rubble that gastropods can use as shelter from the crashing waves. In addition, environmental factors that are still relatively good, not polluted, and far from local community activities are one of the factors for the high abundance at the station.

Gastropod abundance at stations I and II was relatively low compared to station III, namely 4.56 ind/m^2 and 2.78 ind/m^2. This is presumably because station I is in the tourist area of Pasumpahan Island and station II is where fishing boats and tourist boats anchor, where human activity affects the area so that the habitat of the gastropods is disturbed.

According to Nurfakih et al.[13] environmental factors greatly affect a community and the abundance of gastropods. The existence of gastropods is strongly influenced by habitat conditions and high human activity in these habitats. In addition, the abundance and distribution of gastropods are influenced by food availability, predation, and also competition. The existence of gastropods in waters is strongly influenced by environmental conditions, both biotic and abiotic. Environmental factors that can affect the existence of gastropods are temperature, salinity, pH, substrate, dissolved oxygen, and brightness**.**

Diversity Index (H'), Uniformity Index (E), and Dominance (C)

Based on the analysis performed, the average value of the diversity index, uniformity index, and dominance index of gastropod species at station I was obtained, namely diversity index: 1.50, uniformity index: 0.77, and dominance index: 0.29. At station II, diversity index values were obtained: 1.72, uniformity index: 0.88, and dominance index: 0.21. At station III, the diversity index value was obtained: 2.02, uniformity index: 0.84, and dominance index: 0.16 (Table 7).

Table 7. Diversity index, uniformity, and dominance index

Observation Station	(H')	(E)	(C)
I	1.50	0.77	0.29
II	1.72	0.88	0.21
III	2.02	0.84	0.16

Gastropod diversity index (H') in the intertidal zone in Pasumpahan Island waters for each station obtained values ranging from 1.50 to 2.02. The diversity index according to Kinasih[14] is a vegetation parameter that is very useful for comparing various communities, especially for studying the influence of environmental, and abiotic factors on a community or determining community succession and stability. A community is said to have high species diversity if the community is composed of many species with relatively the same abundance[11].

Meanwhile, according to Fachrul[11,] a community is said to have high species diversity if the community is composed of many species with the same abundance of species. Conversely, if the community is composed of very few species and if only a few species are dominant, the species diversity is low. In accordance with the gastropod species diversity index which stated $1.0 \leq H' < 3.0$ indicating that the criteria for diversity at station I, station II, and station III included the category of moderate diversity, moderate distribution of the number of individuals, sufficient productivity, fairly balanced ecosystem conditions, pressure medium ecological and water stability has been moderately polluted.

Gastropod uniformity index (E) in the intertidal zone in Pasumpahan Island waters for each station obtained values ranging from 0.77 to 0.88. Following the species uniformity index which states $0.6 \leq E \leq 1.0$, it can be concluded that the uniformity at station I, station II, and station III is included in the high uniformity category, this is because the types of gastropods found at each observation station vary and there are no different species dominates. According to Hendri *in* Ernanto et al.[15] if the E value is close to 1 (> 0.5) it means that the uniformity of organisms in water is in balance, and there is no competition for either place or food. The index value of diversity and uniformity of biota in waters is highly dependent on the number of species in the community.

According to Saleh et al.[16] the smaller the value of a uniformity index (E), the smaller the species uniformity in the community. The more species found, the greater the diversity and uniformity, although this value is highly dependent on the number of individuals of each species and vice versa.

Dominance index (C) of gastropods in the intertidal zone in Pasumpahan Island waters for each station obtained values ranging from 0.16 to 0.29, it can be concluded that no species dominates at the study site. The dominance index is a description of the domination pattern of a species over other species in an ecosystem community[17]. The higher the dominance index value of a species illustrates a pattern of domination centered on certain species or the community is more suitable for certain species. Conversely, if the dominance index value is lower it indicates that there are no dominating species, which means that there is no significant competition for space food or a place to live for these organisms[18].

Gastropod Distribution Pattern

The distribution pattern (Id) of gastropods in the intertidal zone in Pasumpahan Island waters obtained results ranging from 1.31 to 2.47, overall at each station, it was clustered. Gastropod distribution patterns can be seen in Table 8.

This grouping behavior is caused by several factors, including environmental conditions, type of substrate, eating habits, and method of production. In addition, the way of life of this group of biota shows a strong tendency to compete with another biota, especially in terms of food[19].

Table 8. Gastropod distribution pattern

Observation station	id	Distribution pattern
I	2.47	group
II	1.56	group
III	1.31	group

The distribution pattern of biota is influenced by the type of habitat which includes physicochemical factors of the waters as well as food and the adaptability of biota in an ecosystem. Distribution occurs in groups because it is influenced by the habitat which provides sufficient food sources so that competition does not occur and the amount is abundant even though the food sources are the same. In addition, environmental factors such as temperature, pH, salinity, and substrate are also within the optimal range to support the life and distribution of gastropods[20].

4. CONCLUSION

The types of gastropods found at the research location on Pasumpahan Island consisted of 9 (nine) families, 12 (twelve) genera, and 13 (thirteen) species. Gastropod species found in all research stations consisted of *Pythia scarabaues, Cypraea annulus, Turbo argyrostomus, Conus coronatus, Conus ebraeus, Cancilla isabella, Strigatella retusa, Clypeomorus batillariaeformis, Rhinoclavis sinensis, Cantharus rubiginosus, Engina mendicaria, Mammilla sebae*, and *Strombus gibberulus*. The species found were dominated by *Pythia scarabaues* from the Elobiidae family. The mean abundance at all stations ranged from 2.78 – 5.00 ind/m^2. Gastropod diversity index (H') values at the study site were categorized as moderate. The Gastropod uniformity index (E) is high, and the dominance index (C) indicates no dominating species. Gastropod distribution patterns between observation stations are grouped.

REFERENCES

1. Marnis A. *Gastropod community structure in the intertidal zone on the Kasiak Island Beach, Pariaman Utara, West Sumatra Province.* Faculty of Fisheries and Marine. Universitas Riau. Pekanbaru, 2019.
2. Sulastri D. *Community Structure of gastropods in the mangrove ecosystem in Mengkapan Village, Sungai Apit District, Siak Regency, Riau Province.* Faculty of Fisheries and Marine. Universitas Riau. Pekanbaru, 2018.
3. Tamba RA, Tanjung A, Elizal. Gastropod lifestyle in the breakwater and sandy beach ecosystems in the conservation area of Pariaman City, West Sumatra Province. *JOM Fakultas Perikanan dan Ilmu Kelautan, Universitas Riau*, 2013.
4. Carpenter KE, Niem VH. *The living marine resources of the western central pacific volume 2. Cephalopods, crustaceans, holothurians, and sharks*. FAO Species Identification Guide for Fishery purposes. Rome, 1998.
5. Brower JE, Zar JH. *Field and laboratory methods for genus ecology. 2nd edition*. Wm.C. Brown Publishers. Dubuque, IA, 1977.
6. Kasry A, Fajri NE, Agustina R. *Aquatic ecology practicum guide.* Faculty of Fisheries and Marine Sciences, University of Riau. Pekanbaru, 2012.
7. Fajri N. Community Structure of macrozoobenthos in Kuwang Wae Coastal Waters, East Lombok Regency. *Journal of Education,* 2013; 8(2): 81-100.
8. Rifardi. Deposisi sedimen di perairan laut dangkal. *Indonesia Journal of Marine Sciences*, 2008; 13(3):147-152.
9. Satria M. *Gastropod diversity and distribution in Berakit Village Waters, Bintan Regency*. Faculty of Marine and Fisheries. Raja Ali Haji University. Tanjung Pinang, 2014.

10. Prasetia MN, Supriharyono, Purwanti F. Hubungan kandungan bahan organik dengan kelimpahan dan keanekaragaman gastropoda pada kawasan Wisata Mangrove Desa Bedono Demak. *Journal of Maquares*, 2019; 8(2) : 87-92.
11. Fachrul MF. *Bioecological sampling methods*. Earth Script: Jakarta, 2007.
12. Nybakken JW. *Biologi laut. Suatu pendekatan ekologis*. PT. Gramedia Pustaka Utama : Jakarta, 1992.
13. Nurfakih A, Suryono CA, Sunaryo. Studi kandungan bahan organik sedimen terhadap kelimpahan bivalvia di Perairan Semarang Bagian Timur. *Journal of Marine Research*, 2013; 2(3):173-180. https://doi.org/10.14710/jmr.v2i3.3146
14. Kinasih AG. Study of the relationship between macrobenthos community structure and water quality at the Wonorejo Mangrove House. *Maritime and Fisheries National Seminar. Tunjungan-Surabaya*, 2018.
15. Ernanto R, Agustriani F, Aryawati R. Gastropod community structure in the mangrove ecosystem at the Batang Ogan Komering Ilir River Estuary. *Maspari Journal*, 2010; 1(2): 73-78.
16. Saleh S, Abdul HO, Sitti N. Gastropod community structure in the seagrass ecosystem in Dudepo Village. *Fisheries and Maritime Scientific Journal*, 2017; 5(3): 68-77.
17. Mawazin. Species diversity and composition of logged over peat swamp forest in Riau. *Indonesian Forest Rehabilitation Journal*, 2013; 1(1) : 59 - 73.
18. Hermanses E. Gastropod communities in the intertidal area of Likupang Beach, Ambong Village, Likupang Timur District, Minahasa Utara Regency. *Platax Scientific Journal*, 2018; 6(2):58-65.
19. Mardatila S. Density, diversity and distribution patterns of gastropods in Lake Diatas, Solok Regency, West Sumatra Province. *Journal of Biocelebes*, 2016; 10(2):25-31.
20. Idrus S, Alwi D, Nurafni, Kadafi M. Diversity and distribution patterns of gastropods in the seagrass ecosystem in the waters of Pandanga Village, Morotai Island Regency, Maluku Utara Province. *Marine Journal of Marine Science*, 2021; 3(2): 80-89.