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DENSITY AND DISTRIBUTION PATTERNS OF FULL-BLOODED CLAM (*GELOINA EXPANSA*; MOUSSON, 1849) IN MANGROVE ECOSYSTEMS

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ABSTRACT

Geloina expansa is a clam found in mangrove forests. The high level of public consumption and high economic value, is suspected as the cause of overfishing. It is not impossible that continuous harvesting will result in a decrease in the population of *G. expansa*. The habitat of *G. expansa* has experienced a lot of land conversion and this will result in a decrease in the natural carrying capacity of its habitat. The purpose of this study was to determine the distribution and density, distribution pattern and size distribution of the population of *G. expansa* based on the ecology of its habitat in West Malangke waters. The method was carried out randomly, the transect was placed in a 5x5 m2 sample plot with 3 replications and collected directly by hand. Sampling was carried out on each plot at the lowest ebb. Environmental parameters measured in the field included salinity, temperature and substrate while parameters measured in the laboratory were total organic matter (TOM). The density value of *G. expansa* in the intertidal zone was 9.90 ind/m2 while in the subtidal zone it was 0.78 ind/m2. The distribution pattern found in the intertidal and subtidal zones is clustered. The size distribution of *G. expansa* in the intertidal zone found that the dominant *G. expansa* was adult size, and the lowest was in the old size class while in the subtidal zone the dominant size was young and the lowest was in the old size class. Zone and type of substrate affect the existence of *G. expansa*. *G. expansa* was found more in the intertidal zone than in the subtidal zone and clay-type of substrates were a determining factor for the presence of full-blooded clams while clay and sand-type substrates were limiting factors for the presence of full-blooded clams.

Keywords: Density, Distribution Pattern, Size Distribution, *Geloina expansa*

INTRODUCTION

Geloina expansa is a species of clam found in mangrove forests. Generally, *G. expansa* lives by immersing itself on the bottom of the waters (infauna) (Tamsar et al., 2013). In Java, *G. expansa* is named as kepah clam or full-blooded clam (Ningsi et al., 2016). In West Malangke District, kepah clams or full-blooded clams have regional names, namely Joi.

The habitat of *G. expansa* is in the mangrove ecosystem and lives in intertidal areas. At high tide, *G. expansa* actively filters out food suspending in the water, whereas at low tide, *G. expansa* reduces food intake and doesn't even take food. The way to eat *G. expansa* is by means of a suspension feeder or filter feeder and this way of eating will cause *G. expansa* to accumulate heavy metals into its body. Phytoplankton and organic matter floating in the water column are food for *G. expansa*. *G. expansa* lives by immersing itself in sediments so that organic and inorganic materials contained in the sediment will be ingested into *G. expansa*'s body. The method of taking food from *G. expansa* is done by inhaling water containing phytoplankton into the inhalant siphon which is at the bottom (ventral). Then the water flows upward (dorsal) by passing a pair of gills that have hairs (cilia) and produces lumps of mucus (mucus) in the surface area. Unneeded lumps will be excreted through the shell's body cavity in the form of pseudofaeces or fake excrement (Dwiono, 2003).

Reproduction of mussels is hermaphroditic, male and female gonads are in the same individual, but in certain cases it is difficult to distinguish between males and females (Broom, 1985). Reproduction of clams is done by releasing sperm and eggs into the water column at night. Fertilization or fertilization occurs outside the body (water column). Spawning activity at night or during high tide is related to security instincts, i.e., to avoid eggs from predators and efforts to spread zygotes widely through tidal currents. (Hickman, 1992).

People in coastal area use *G. expansa* as food source to fulfill nutritional needs for the local community (Rumbiak et al., 2014). *G. expansa* is widely traded in traditional markets both locally and outside the region because people often use *G. expansa* as a food source to increase nutritional needs and have high economic value. the selling price of *G. expansa* will be higher if it has been processed (Supriyantini et al., 2007). The shellfish group had a protein content of 53.91%, an iron content of 74.9%, a cholesterol content of 145.77 mg/100 g and a zinc content of 8.6 ppm (Sukina et al., 2020). In north of Luwu Regency, these clams are widely traded in traditional markets with prices ranging from IDR. 5,000 to IDR. 10,000/tray. Apart from being used to meet the needs of animal consumption, the full-blooded clam community is also collected to make handicrafts from full-blooded clam shells. In this regard, research related to *G. expansa* is very important to be conducted because it may generate the high level of public consumption and high economic value, it is worried that overfishing will occur. it is not impossible that continuous harvesting will result in a decrease in the population level of *G. expansa*. in addition, the habitat of *G. expansa*, i.e., mangrove and estuary ecosystems, has experienced a lot of land conversion and this will result in a decrease in the natural carrying capacity of its habitat.

The purpose of this study was to determine the distribution and density, distribution pattern and size distribution of the *G. expansa* population based on its ecological habitat in West Malangke waters, North Luwu Regency.

MATERIALS AND METHODS

This research was carried out from August to December 2021 in West Malangke District, North Luwu Regency (Figure 1).

Figure 1 Map of The Location of The *Geloina expansa* in West Malangke District, North Luwu Regency, South Sulawesi Province

Materials and Methods

The tools used in this study were GPS (Global Positioning System) to determine the coordinates of the research location, boats were used for transportation to the research point, cameras were used to photograph research activities, writing instruments (slates, waterproof paper and OHP pens) used to record research data, roll meter was used to measure distance, raffia rope was used to demarcate the 5 x 5 m2 observation area, 1 x 1 m2 quadrante transect was used to demarcate the sampling area, plastic samples were used to store full-blooded shellfish samples, vernier calipers were used to measure the diameter of full-blooded clam shells, bottles were used to store water samples, pipettes were used to take water samples, refractometers were used to measure water salinity and thermometers were used to measure temperature. The materials used in this study were labels to mark the plastic samples, KMnO4, Na2C2O4, H2SO4 and Aquades.

Research stations used line transect method from land to sea along the mangrove forest zoning, each line transect used 4 transects in the intertidal zone and in the subtidal zone (maximum depth of 2 m at high tide). In the intertidal and subtidal zones, transects were placed systematically randomly as stations with the distance between plots based on the width of the intertidal and subtidal zones, and each transect was placed in a 5 x 5 m2 sample plot. Sampling of shells at each station was carried out by taking all the shells in the 5 x 5 m2 quadrant transect with 3 repetitions. Sampling was carried out on each plot at the lowest ebb. Collection of G. expansa was carried out in a 5 x 5 m2 observation transect. In each of these plots sub-plots with five points were made, where each point used a 1 x 1 m2 transect. G. expansa which is in the map is taken directly by hand. The shells obtained were put into a plastic sample, then washed with clean water and then counted to see the density and distribution pattern of G. expansa and to measure the diameter and length of the shell to see the size distribution between stations using a vernier caliper. Environmental parameters measured in the field included water salinity, temperature and substrate while parameters measured in the laboratory were total organic matter (BOT). Determining the type of substrate can be distinguished manually, namely by taking wet soil and then massaging it between the thumb and forefinger while feeling the roughness, fineness and roughness of the type of substrate in the form of the presence of grains of sand, dust and clay (Sugiharyanto and Khotimah, 2009).

Total organic matter content in the sample using the calculation formula:

$$DOM\ (mg/L) = \frac{(x - y)\ x\ 3.16\ x\ 0.01\ x\ 1000}{mL\ Sample}$$

Where:

x : Quantity (ml) $KMnO_4$ for sample.
y : Quantity (ml) $KMnO_4$ for aquadest (blank solution).
31.6 : Half of $KMnO_4$ BM, because every mole of $KMnO_4$ releases 5 oxygen.
0.01 : $KMnO_4$ Normality

Analysis Methods

The density of *G. expansa* can be determined using the formula density (D) is the number of individuals per unit area:

$$D = \frac{Ni}{A}$$

Where:
D = Clam Density (ind/m^2)
Ni = Number of individuals (Ind)
A = Area of Sampling Plot (m^2)

The distribution pattern of G. expansa was determined using the Morisita Distribution Index (Krebs et al., 1989), namely:

$$Id = \frac{n \sum x2 - N}{N\,(N-1)}$$

If,
Id < 1, distribution pattern of individuals spesies is uniform
Id = 1, distribution pattern of individuals spesies is random
Id > 1, distribution pattern of individuals spesies is clumped

Notes:
Id = Morisita Distribution Index
n = Number of Sampling Plot
ΣX^2 = Total Number of Individuals Obtained
N = Total Number of Individuals Contained in n Plots

Measurement of the size distribution of *G. expansa* shells was carried out by measuring the length of the shells of *G. expansa* taken from all observation stations

To determine the density of *G. expansa* between stations and between zones (intertidal zone and subtidal zone) a significant difference test was carried out using One Way Anova at 95% confidence level; To see the pattern of distribution of *G. expansa* between stations and between zones (intertidal zone and subtidal zone), a descriptive method was carried out by looking at the results of calculating the Morisita distribution index formula; To see the size distribution between stations and between zones (intertidal zone and subtidal zone) was done descriptively by looking at the results of classifying between zones based on the size of the shell.

RESULTS AND DISCUSSION

Measurement of oceanographic parameters was carried out to get an overview of the general condition of the waters in West Malangke Subdistrict. Based on the measurements of oceanographic parameters, the results were shown in Table 1.

Table 1 Environmental Parameter districtMeasurement Value

Variable	Station	Zone	Min	Max	Average ± SD	Quality Standard
Temperature (ºC)	1	Intertidal	33	33	33 ± 0.58	29 - 30 ºC
		Subtidal	34	35	35 ± 0.58	
	2	Intertidal	32	32	32 ± 0.00	
		Subtidal	33	33	33 ± 0.00	
	3	Intertidal	30	31	30 ± 0.58	
		Subtidal	33	33	33 ± 0.00	
	4	Intertidal	36	36	36 ± 0.00	
Salinity (‰)	1	Intertidal	11	12	11 ± 0.58	25-40 ‰
		Subtidal	12	15	13 ± 1.73	
	2	Intertidal	0	0	0 ± 0.00	
		Subtidal	0	0	0 ± 0.00	
	3	Intertidal	2	3	2 ± 0.58	
		Subtidal	0	0	0 ± 0.00	
	4	Intertidal	4	4	4 ± 0.00	
DOM (Mg/L)	1	Intertidal	31.16	38.74	35 ± 3.86	< 30 Mg/L
		Subtidal	45.69	57.70	50 ± 6.60	
	2	Intertidal	27.37	41.90	33 ± 7.90	
		Subtidal	29.26	53.91	45 ± 13.56	
	3	Intertidal	24.21	30.53	27 ± 3.16	
		Subtidal	73.50	81.72	78 ± 4.30	
	4	Intertidal	15.36	27.37	23 ± 6.33	

Based on the results of the measurements, the temperature at each station is different, the highest temperature is at station 4 and the lowest temperature is at station 3. The average temperature obtained ranges from 32 - 36ºC, with a temperature quality standard of 29 - 30ºC, which means water conditions at each station does not fulfill the optimal range.

Salinity at each station is different, the highest salinity is at station 1 and the lowest salinity is at station 2. The average salinity ranges from 0 - 12‰. With the standard quality of salinity is 25 - 40 ‰, water conditions at each station do not enter the optimal range.

Based on the results of measurements, the DOM value of the waters at each station is different, the highest DOM value is at station 1 in the subtidal zone and the lowest is at station 4 in the intertidal zone. At each station, the average DOM of the waters was 42, 39, 53 and 23 respectively. With a temperature quality standard of <30 ºC, the water conditions at each station did not fulfill the normal range, this caused the small size of the shell at *G. expansa*.

Identification of the type of substrate obtained by the condition of the substrate at each station is displayed in Table 2.

Table 2 Substrate Type Identification Value at Each Station

Station	Zone	Sediment
1	Intertidal	Clay
		Clay
		Sandy Loam
	Subtidal	Sandy Clay Loam
		Loamy Sand
		Loamy Sand
2	Intertidal	Clay
		Clay
		Cleyey Clay
	Subtidal	Sand
		Sand
		Sand
3	Intertidal	Sandy Clay Loam
		Sandy Loam
		Sandy Loam
	Subtidal	Sandy Clay
		Sandy Clay
		Sandy Clay
4	Intertidal	Sandy Clay Loam
		Sandy Clay Loam
		Sandy Clay Loam

In intertidal zone, the dominant type of substrate is clay, whereas, in the subtidal zone, the dominant type of substrate is sand.

There were 594 individual of *G. expansa* in the intertidal zone and 35 individuals in the subtidal zone. The amount of *G. expansa* obtained varied at each station. The number of individual of *G. expansa* in the intertidal zone at each station was 244, 145, 91 and 144 individuals respectively and in the subtidal zone at each station were 35, 0 and 0 individuals respectively.

From the results of the research that has been done, the density values of *G. expansa* are different in each zone. The results of the analysis of the density values of *G. expansa* in each zone showed significantly different results ($p < 0.05$), which means that density simultaneously affects the water zones as shown in Figure 2.

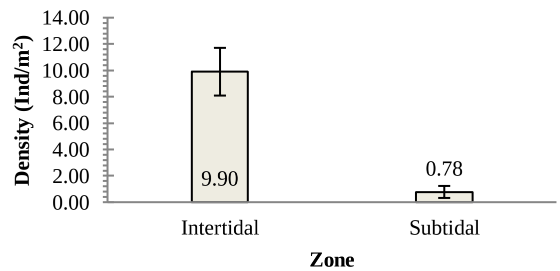

Figure 2 Density of *G. expansa* in Intertidal and Subtidal Zones

The highest density results were found in the intertidal zone with a value of 9.90 ind/m2 while the lowest density value in the subtidal zone was 0.78 ind/m2.

The density values obtained in the intertidal zone is shown in Figure 3.

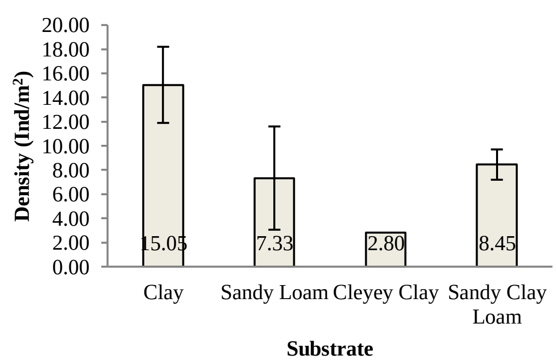

Figure 3 Density of *G. expansa* in The Intertidal Zone by Substrate Type

The highest *G. expansa* density was found on a clay type substrate with a density of 15.05 ind/m2, while the lowest

G. expansa density was on a clay type of substrate with a density value of 2.80 ind/m2.

The density values obtained in the subtidal zone can be seen in Figure 4.

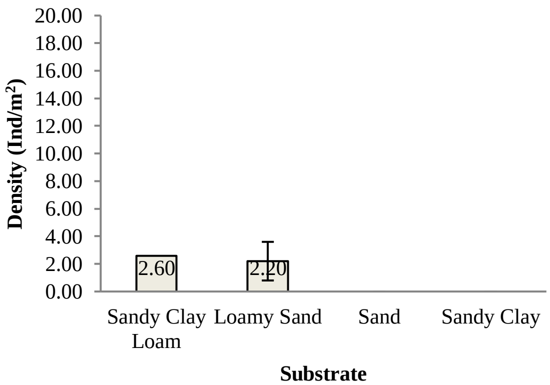

Figure 4 Density of *G. expansa* in Subtidal Zone by Substrate Type

The highest *G. expansa* density was found in sandy loam type substrates with a density of 2.60 ind/m2, while the lowest was found in sand and sandy clay types with a density value of 0.00 ind/m2.

The high density of *G. expansa* in the intertidal zone is thought to be caused by the condition of the substrate in the intertidal zone in accordance with the habitat of *G. expansa*, i.e., clay substrate, whereas in the subtidal zone, the substrate is sand as shown in Table 2.

According to Fitriana (2006), the state of the surrounding substrate may affect the abundance of shellfish. According to Nayli (2018) the habitat of clams is living in muddy areas of the mangrove ecosystem. This opinion was also clarified by Riniatsih and Kushartono (2009) The texture of the mud bottom substrate has a high organic matter content compared to the texture of the sandy bottom substrate. This is because the finer the texture of the basic substrate, the greater its ability to capture organic matter. This shows that the substrate can affect the organic matter content and the smaller the particle size of the sediment, the greater the organic matter content.

According to the results obtained, it is suspected that clay-type substrates are the determining factor for the presence of full-blooded clams, while clay and sand-type substrates are the limiting factors for the presence of full-blooded clams. Razak (2002) explained that sandy substrates have a higher oxygen content due to the presence of cavities for oxygenation compared to muddy substrates, but muddy substrates have a higher nutrient content than sandy substrates. Machrizal (2014) explained that clay type substrates have unique properties, when in a dry state the substrate will harden and when in a wet state the substrate will become sticky. Allegedly because of this, there are few shells found, the substrate will harden more easily if it is dry (remaining) so that it can cause the death of the shells because they can experience drought and difficulty in taking food due to the low water content in the soil. According to Putri et al., (2016), the abundance of shells can be affected by the type of clay substrate. In addition, according to Fitriana (2006), low clay content tends to increase the abundance of shellfish. Meanwhile, according to Heriyani et al., (2015). its low ability to bind organic matter causes sand-type substrates to contain less organic matter and this is clarified by Puspasari et al., (2012) that sand substrates tend to make it easier for shellfish to move places but the nutrient content is very low. According to Putri et al., (2016), clay-type of substrates have a higher nutrient content than sand-type substrates. This is a suitable habitat for mussels with a larger type of clay substrate compared to sand type substrates. Putri et al., (2016) concluded that sand and clay type substrates are substrates that are not preferred by shellfish and have a small number of individuals due to the lack of organic matter content in the sand, and according to Machrizal (2014), the unique properties of clay can affect the activity of shellfish at low tide..

Table 3 Distribution Pattern *G. expansa* at Every Station

Zone	Statiom	Distribution Pattern	Class
Intertidal	1	2.16	Clumped
	2	2.52	Clumped
	3	2.97	Clumped
	4	2.97	Clumped
Subtidal	1	2.04	Clumped
	2	-	-
	3	-	-

Putri et al., (2016) also clarified that, the greater the amount of clay-type substrate, the better the organic matter and the abundance of shellfish can also increase. From the results of the research that has been done, it is found that the distribution pattern of *G. expansa* is different from each station. The results of the analysis of the distribution pattern of *G. expansa* in each research zone and station is displayed in Table 3Based on the table, the value of the Index of Diversity *G. expansa* contained in the intertidal zone at each station is 2.16; 2.52; 2.97 and 2.97 which show that the distribution pattern of *G. expansa* is clustered whereas, in the subtidal zone at station 1, i.e., 2.04 which shows that the distribution pattern of *G. expansa* is clustered and there are none at stations 2 and 3.

The ID values of *G. expansa* in the mangrove ecosystem were 2.16; 2.52; 2.97 and 2.97 which means the value of the mortality index is greater than 1 (> 1) this indicates that the resulting distribution pattern is clustered.

According to Manalu (2019), the pattern of distribution of organisms can occur in clumped (groups) if the habitat provides sufficient food sources, so that it does not cause competition between organisms and their numbers will remain abundant even though the food sources are the same. This is also clarified by Simanullang (2018) who explains that a clustered dispersal pattern can occur if ID > 1 is obtained, this clustered dispersal pattern can also occur if individuals tend to be attracted to certain areas of their habitat. According to Kresnasari (2010) in Deni et al., (2020) states that the distribution pattern of full-blooded mussels is related to behavior, reproductive strategies, food availability and environmental conditions. According to Broom, (1985) the reproduction of mussels is hermaphrodite. Reproduction of clams is done by releasing sperm and eggs into the water at night. Fertilization or fertilization occurs outside the body or in the water column (Hickman, 1992). Therefore, the distribution in clumped can help clams in the reproductive process so that the reproductive process can be fertilized quickly. And according to Dalimunthe (2021) explains that this type of distribution pattern in groups can be caused by a population of shellfish that have the properties that gather and live in the same habitat.

The decline in the number of individual G. expansa is thought to be due to the influence of continuous harvesting by the community. Bahtiar (2008) explained that if the catch is too high then the clam population can decrease continuously and at a certain level the full-blooded clam can experience extinction. In addition, environmental factors such as temperature and salinity at each station are also not suitable for *G. expansa* habitat because the temperature and salinity values exceed the quality standards or optimum limits of *G. expansa*. According to Islami (2013) temperature and salinity are two of the many factors of environmental conditions that have an effect on bivalves, not only from the stages of larval development and life, but can affect the physiological functions of bivalves. Temperature and salinity also have an effect on the defense mechanisms carried out by bivalves against physiological changes in environmental conditions. Temperature also directly affects the activities of bivalves such as growth and metabolism and even causes death of bivalves.

The frequency and percentage values based on the size class in the intertidal zone obtained is shown in Figure 5.The highest frequency value is in the adult size class with a total value of 37 ind with a percentage of 73.33% and the lowest frequency value is in the old size class with a total value of 0.00 ind

The frequency and percentage values based on the size class in the subtidal zone obtained can be seen in Figure 6. The highest frequency value is in the young size class with a total value of 2 ind with a percentage of 62.86% and the lowest frequency value is in the old size class with a total value of 0.00 ind.

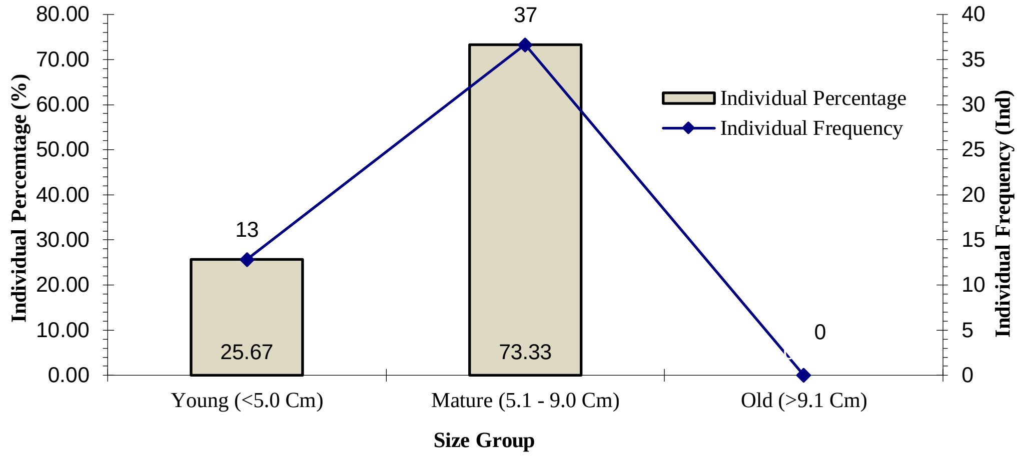

Figure 5 Frequency by Size Class in The Intertidal Zone

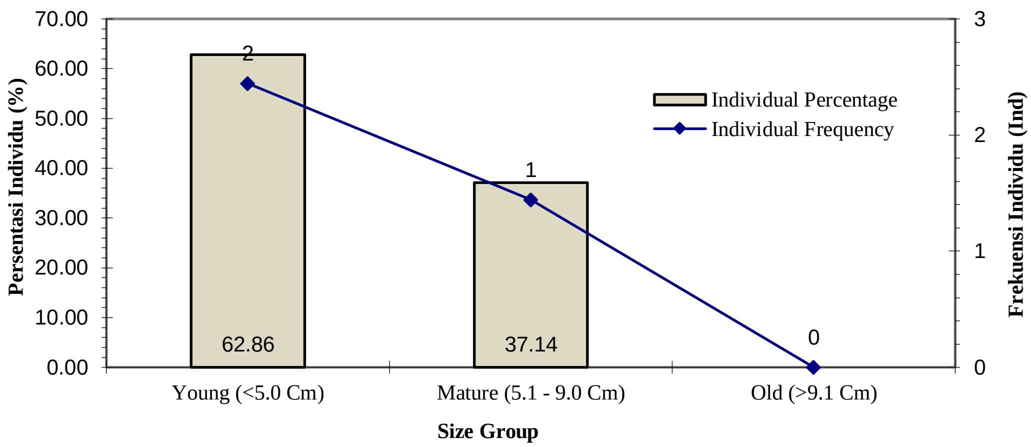

Figure 6 Frequency by Size Class in The Subtidal Zone

Old size *G. expansa* (> 9.1 cm) was not found in the intertidal and subtidal zones, this is thought to be due to the high DOM content in West Malangke Subdistrict which causes a decrease in dissolved oxygen content in the waters, the high content of DOM is thought to be due to the many community activities and activities in tourist areas and areas near ponds which are intensive discharges from pond outlets. Residential activities can also affect due to the presence of organic waste from the community which can cause a decrease in dissolved oxygen. In addition, the substrate in the intertidal zone is a clay type substrate that is suitable for the full-blooded clam's habitat.

Yuningsih et al., (2014) explained that contaminants from organic waste can reduce dissolved oxygen in water. Dissolved oxygen levels can be reduced to zero due to the decomposition of organic matter. According to Tuheteru (2014), organic matter content is one of the most important factors in the life of clams, because organic matter can be used by shells for shell growth, addition of cells and the formation of various organisms in their bodies. In addition, the results obtained by the type of substrate can also affect the presence of *G. expansa*, it is suspected that clay-type substrates are a determining factor for the presence of full-blooded clams while clay and sand-type substrates are limiting factors for the presence of full-blooded clams.

The number of old clams (> 9.1 cm) is limited, this is because local people catch these shells very high. According to Sanda et al., (2021) the size of young mussels ranged from 34.2 – 50.1 mm, mature mussels ranged from 50.2 – 90.1 mm and old mussels ranged from 90.2 – 118.1 mm. Meanwhile, according to Tamsar et al., (2013) states that the male clam with the smallest length is 2.6 cm while the largest length is 9.6 cm. Female shells have the smallest length of 2.6 cm and the largest length is 8.7 cm. According to Dwiono (2003) states that the maximum size of the shell length can reach 110 mm. Full-blooded clams are related to behavior, reproduction, availability of food and environmental conditions. According to Islami (2014) explained that the results of the development of gonads in shells can vary, and can be affected by temperature, seawater salinity, availability of food sources and decreased organic matter in waters. According to Widyastuti (2011) explains that gonadal maturity usually occurs when the length of the shell has reached 18-20 mm. The size of mussel sexual maturity is at shell length measuring 21-25 mm. The size of gonadal maturity can be related to growth, environmental influences and reproductive strategies. Mussels will continue to spawn after experiencing gonad maturity, but this can depend again on their spawning cycle because each animal species is not the same size and age at gonadal maturity.

CONCLUSION

The density value of *Geloina expansa* in the intertidal zone is higher than in the subtidal zone, the density value obtained in the intertidal zone is 9.90 ind/m2 while the lowest density value in the subtidal zone is 0.78 ind/m2. The distribution patterns found in the intertidal zone and the subtidal zone are grouped with ID values in the intertidal zone respectively 2.16; 2.52; 2.97 and 2.97 and the subtidal zone at station 1 is 2.04 and there is no subtidal zone at stations 2 and 3. The size distribution of *G. expansa* in the intertidal zone and subtidal zone showed that the dominant *G. expansa* was adult size (5.1 – 9.0 cm), and the lowest frequency value was in the old size class (> 9.1 cm) while in the subtidal zone the dominant size was young (< 5.0 cm) and the lowest frequency value is in the old size class (> 9.1 cm). The influence of the zone and the type of substrate greatly affect the existence of *G. expansa*. This clam was found more in the intertidal zone than in the subtidal zone and clay-type substrates were a determining factor for the presence of full-blooded clams while clay and sand-type substrates were limiting factors for the presence of full-blooded clams.

REFERENCES

Amin R, Bambang A.N, dan Suprijanto J. 2008. Sebaran Densitas Sumberdaya Kerang Kepah (Polyeosda Erosa) Di Perairan Pemangkat Kabupaten Sambas. Kalimantan Barat.

Bahtiar, Yulianda F dan Setyonobudiandi I. 2008. Kajian Aspek Pertumbuhan Populasi Pokea (Batissa violacea celebensis Martens, 1897) Di Sungai Pohara Sulawesi Tenggara. Jurnal Ilmu-ilmu Perairan dan Perikanan Indonesia 15 (1) : 1-5.

Broom M. J. 1985. The Biology and Culture of Marine Bivalve Molluscs of the Genus Anadara. ICLARM Studies and Review 12, 37 p.

Dalimunthe T. A. E. S. 2021. Kepadatan, Distribusi, Dan Pola Pertumbuhan Kerang Bulu (Anadara antiquata) Di Pantai Kuala Putri, Kabupaten Serdang Bedagai. Skripsi. Program Studi Biologi Fakultas Matematika dan Ilmu Pengetahuan Alam Universitas Sumatera Utara.

Deni, Warsidah dan Nurdiansyah S.I. 2020. Kepadatan Dan Pola Distribusi Polymesoda Erosa Di Ekosistem Mangrove Desa Peniti, Kabupaten Mempawah Kalimantan Barat. Jurnal Laut Khatulistiwa 3 (1) : 1-8.

Dwiono S.A.P. 2003. Pengenalan Kerang Mangrove, Geloina Erosa Dan Geloina Expansa. Jurnal Oceana 28 (2) : 31–38.

Fitriana Y. R. 2006. Keanekaragaman dan Kemelimpahan Makrozoobentos di Hutan Mangrove Hasil Rehabilitasi Taman Hutan Raya Ngurah Rai Bali. Jurnal Biodiversitas 7 (1) : 67-72.

Heriyani M, Subiyanto dan Suprapto D. 2015. Jenis Tekstur Tanah Dan Bahan Organik Pada Habitat Kerang Air Tawar (Famili: Unionidae) Di Rawa Pening. Jurnal Diponegoro Journal Of Maquares Management Of Aquatic Resources 4 (1) : 64-73.

Hickman C. S. 1992. Reproduction and Development of Trochacean Gastropods. Jurnal The Viliger 35 (4) : 245 – 272.

Islami M. M. 2013. Pengaruh Suhu dan Salinitas Terhadap Bivalvia. Jurnal Oceana 38 (2) : 1-10.

Islami M. M. 2014. Bioekologi Kerang Kerek Gafrarium tumidum Röding, 1798 (Bivalvia: Veneridae) Di Perairan Teluk Ambon, Maluku. Skripsi. Sekolah Pascasarjana Institut Pertanian Bogor.

Krebs, C.J. 1989. Ecological Methodology. Harper Collins Publisher, Inc. New York

Machrizal R. 2014. Studi Ekologi Kijing (Glauconome virens Linnaeus, 1767) Di Ekosistem Mangrove Belawan. Skripsi. Program Pascasarjana Fakultas Matematika dan Ilmu Pengetahuan Alam Universitas Sumatera Utara.

Manalu L. Y. 2019. Kepadatan Populasi dan Pola Distribusi Gastropoda Cerithidea quoyii di Hutan Mangrove Perairan Desa Sungai Cingam Kecamatan Rupat Kabupaten Bengkalis Provinsi Riau. Skripsi. Fakultas Perikanan dan Kelautan Universitas Riau, Pekan Baru.

Nayli Z. 2018. Keanekaragaman Bivalvia Pada Kawasan Ekosistem Mangrove Kecamatan Kuta Raja Kota Banda Aceh Sebagai Penunjang Praktikum Ekologi Hewan. Skripsi. Fakultas Tarbiyah Dan

Keguruan Universitas Islam Negeri Ar-Raniry Darussalam, Banda Aceh.

Ningsi A, Tuwo A dan Haris A. 2016. Hubungan Panjang Dan Bobot Kerang Totok (Polymesoda Erosa) Pada Ekosistem Mangrove Di Kabupaten Sinjai Sulawesi Selatan. Jurnal Balik Diwa 7 (1) : 41-46.

Putri A. M. S, Suryanri dan Widyorini N. 2016. Hubungan Tekstur Sedimen dengan Kandungan Bahan Organik dan Kelimpahan Makrozoobenthos di Muara Sungai Banjir Kanal Timur Semarang. Jurnal Saintek Perikanan 12 (1) : 75-80.

Puspitasari R, Marsoedi, Sartimbul A dan Sahartati. 2012. Kelimpahan Foraminifera Bentik Pada Sedimen Permukaan Perairan Dangkal Pantai Timur Semenanjung Ujung Kulon, Kawasan Taman Nasional Ujung Kulon, Banten. Jurnal Penelitian Perikanan 1 (1) : 1-19.

Razak A. 2002. Dinamika Karakteristik Fisika-Kimiawi Sedimen dan Hubungannya dengan Struktur Komunitas Moluska Bentik (Bivalvia dan Gastropoda) di Muara Bandar Bakali Padang. Skripsi. Program Pascasarjana Institut Pertanian Bogor.

Riniatsih I dan Kushartono E. W. 2009. Substrat Dasar dan Parameter Oseanografi Sebagai Substrat Dasar dan Parameter Oseanografi Sebagai Penentu Keberadaan Gastropoda dan Bivalvia di Penentu Keberadaan Gastropoda dan Bivalvia di Pantai Sluke Kabupaten Rembang. Jurnal Ilmu Kelautan 14 (1) : 50-59.

Rumbiak A, Tamanampo J.F.W.S dan Manu G.D. 2014. Karakteristik Morfometrik Dan Faktor Kondisi Kerang Totok (Polymesoda Erosa) Di Hutan Mangrove Desa Nusajaya Kecamatan Waslei Selatan Kabupaten Halmahera Timur Maluku Utara. Jurnal Ilmiah Platax 2 (3) : 110–120.

Sanda L. O. M. J, Ramli M, Asriyana dan Bahtiar. 2021. Sebaran Kepadatan Dan Ukuran Kerang Totok Polymesoda erosa (Jutting 1953) Di Hutan Mangrove Teluk Kendari Sulawesi Tenggara. Jurnal Saintek Perikanan: Indonesian Journal of Fisheries Science and Technology 17 (2) : 81-89.

Sari S, Pratomo A dan Yandri F. 2013. Hubungan Kerapatan Mangrove Terhadap Kelimpahan Pelecypoda Di Pesisir Kota Rebah Kota Tanjungpinang. Kepulauan Riau.

Setyono D.E.D. 2006. Karakteristik Biologi Dan Produk Kekerangan Laut. Jurnal Oceana 31 (1) : 1–7.

Simanullang Y. A. A. 2018. Studi Kelimpahan Dan Pola Pertumbuhan Kerang Kepah (Meretrix meretrix) Di Perairan Estuari Suaka Margasatwa Karang Gading Kabupaten Deli Serdang. Skripsi. Program Studi Manajemen Sumberdaya Perairan, Fakultas Pertanian, Universitas Sumatera Utara.

Sugiharyanto dan Khotimah N. 2009. Diktat Mata Kuliah Geografi Tanah (PGF-207). Diktat. Jurusan Pendidikan Geografi Fakultas Ilmu Sosial dan Ekonomi Universitas Negri Yogyakarta.

Sukina B, Ahmad dan Rasmaniar. 2020. Kandungan Gizi Kerang Bakau (Telescopium Telescopium), Kerang Kalandue (Polymesoda Erosa), Dan Kerang Darah (Anadara Granosa L.) Dari Kota Kendari. Jurnal Sains Dan Teknologi Pangan 5 (2) : 2814–2823.

Supriyantini E, Widowati I dan Ambariyanto. 2007. Kandungan Asam Lemak Omega-3 (Asam Linolenat) Pada Kerang Totok Polymesoda Erosa Yang Diberi Pakan Tetraselmis Chuii Dan Skeletonema Costatum. Jurnal Ilmu Kelautan 12 (2) : 97–104.

Supriyantini E, Nuraini R. A. T dan Fadmawati A. P. 2017. Studi Kandungan Bahan Organik Pada Beberapa Muara Sungai Di Kawasan Ekosistem Mangrove, Di Wilayah Pesisir Pantai Utara Kota Semarang, Jawa Tengah. Jurnal Buletin Oseanografi Marina 6 (1) : 29-38.

Tamsar, Emiyarti dan Nurgayah W. 2013. Studi Laju Pertumbuhan dan Tingkat Eksploitasi Kerang Kaladue (Polymesoda erosa) pada Daerah Hutan Mangrove di Teluk Kendari. Jurnal Mina Laut Indonesia 2 (6) : 14-25.

Tuheteru M, Notosoedarmo S dan Martosupono M. 2014. Aspek Biologi Geloina erosa Di Hutan Mangrove. Prosiding Seminar Nasional Raja Ampat. Waisai – 12 – 13 Agustus 2014. Program Studi Magister Biologi, Universitas Kristen Satya Wacana.

Widyastuti A. 2011. Reproduksi Kerang Darah (Anadara sp.). Jurnal Oseana 36 (2) : 11-20.

Yuningsih H. D, Soedarsono P dan Anggoro S. 2014. Hubungan Bahan Organik Dengan Produktivitas Perairan Pada Kawasan Tutupan Eceng Gondok, Perairan Terbuka Dan Keramba Jaring Apung Di Rawa Pening Kabupaten Semarang Jawa Tengah. Jurnal Diponegoro Journal Of Maquares Management Of Aquatic Resources 3 (1) : 37-43