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Growth, Mortality, Exploitation Rate, and Recruitment of Blood Clam (*Anadara granosa*) in the Rangsang Barat Waters, Riau Province

Pertumbuhan, Mortalitas, Laju Eksploitasi, dan Rekrutmen Kerang Darah (*Anadara granosa*) di Perairan Rangsang Barat Provinsi Riau

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ABSTRACT

Growth, mortality, exploitation rate, and recruitment of *Anadara granosa* cockle in Rangsang Barat coastal waters were studied from July to October 2019. The objective of this research was to study the growth, mortality, exploitation rate, and recruitment of *A.granosa* cockle. Sampling was done monthly at three main stations. The cockle collected from plot 1 x 1 m^2 on quadrat transect. The result showed that the asymptotic length (L_∞) of *A.granosa* was 30.45 mm, the annual growth coefficient (K) was 0.83 per year, the total mortality (Z) was 4.46 per year, natural mortalities (M) were 1.60 per year, and fishing mortalities (F) was 2.86 per year. The rate of exploitation (E = 0.64) of blood clams in Rangsang Barat waters has begun to threaten sustainability. The recruitment occurred every month, the peaks occurred in July (13.83 %), and August (13.08 %).

Keywords: Blood clam, Growth, Mortality, Recruitment

ABSTRAK

Kajian pertumbuhan, mortalitas, laju eksploitasi, dan rekrutmen kerang *Anadara granosa* di perairan pesisir Rangsang Barat dilakukan pada bulan Juli s/d Oktober 2019. Penelitian ini bertujuan untuk mempelajari pertumbuhan, mortalitas, laju eksploitasi, dan rekrutmen kerang darah. Pengambilan sampel dilakukan setiap bulan di tiga stasiun utama. Kerang dikumpulkan dari plot 1 x 1 m^2 pada transek kuadrat. Hasil penelitian menunjukkan panjang asimtotik ($L\infty$) *A.granosa* adalah 30.45 mm, koefisien pertumbuhan tahunan (K) adalah 0.83 per tahun, mortalitas total (Z) sebesar 4.46 per tahun, mortalitas alami (M) sebesar 1.60 per tahun dan mortalitas penangkapan (F) sebesar 2.86 per tahun. Laju eksploitasi (E = 0.64) kerang darah di perairan Rangsang Barat mulai mengancam kelestariannya. Rekrutmen terjadi setiap bulan, puncaknya terjadi pada bulan Juli (13.83 %) dan Agustus (13.08 %).

Kata Kunci: Kerang darah, Pertumbuhan, Mortalitas, Rekruitmen

INTRODUCTION

Blood clams (*Anadara granosa*) are a species of the Genus Anadara that belongs to the Phylum Mollusc, Class Bivalvia, Order Arcoida, and Familia Arcidae (Broom, 1985). This blood clam spreads in the Indo-Pacific region from Africa to Australia, Polynesia, and Japan. Blood clams live mainly in the intertidal zone down to two meters of water, by immersing themselves in sand or silt. *A. granosa* shellfish is a commodity that has high economic value and has quite high nutritional content, namely 19.48% protein and 2.50% fat for fresh clam meat and 23.23% protein and 7.01% fat for boiled clam meat blood (Nurjanah *et al.*, 2005). This commodity is one of the foods that are very popular among people from various regions in Indonesia, including in Riau Province. This causes these clams to be hunted and exploited in large quantities by fishermen as demand continues to increase.

Apart from the coastal waters of Meranti Islands Regency, the potential for blood clams in Riau Province is also found in Rokan Hilir Regency (Efriyeldi & Effendi, 2022) and Indragiri Hilir Regency (Nasution, 2009).

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Until now the blood clams originating from the waters of the Meranti Islands Regency are still to meet the needs of Selat Panjang City and its surroundings. However, the increasing demand for clams in the market; has caused the exploitation of these shellfish resources to tend to take them away by setting aside the principles of preserving these blood clam resources.

Coastal waters that have blood clam resources in the Meranti Islands Regency include the coast of Mekar Baru Village and Rangsang Barat District. The population of blood clams in these waters has not been studied much but has decreased in recent years. This is following the community's recognition that it is starting to be difficult to get shells in large quantities. This is partly because fishermen do not pay enough attention to the size due to the increasing demand.

The blood clam resource for the people of Selat Panjang City and its surroundings is a source of animal protein besides fish. The community obtains these shellfish collectors from fishermen and sells them to Selat Panjang City. This shellfish resource needs to be maintained and even developed by keeping its habitat away from destructive activities through sustainable management. There is no scientific information related to blood clam resources in these waters. so studies are needed to be related to blood clam bioecology in these waters. According to King (1995) that the form of managing bivalve fisheries resources includes making regulations regarding the minimum size that may be caught, limiting the tools used fishing seasons, permit systems, and fishing quotas.

The blood clam population is currently experiencing a lot of pressure in several areas. while in several places scientific information is not available including its existence. such as on the coast of Rangsang Barat. Even though there is already community awareness to protect blood clam resources. the basic knowledge needed to support these activities is still lacking. This basic knowledge includes information on growth and recruitment as well as good habitats for the development of blood clams. Through this research, initial or basic information will be obtained for the sustainable management of blood clams on the coast of Rangsang Barat. Meranti Islands Regency. For this reason, it is very necessary to extract basic information about the environmental quality parameters of shellfish (temperature, pH, salinity, currents, and type of substrate), abundance, length, width, thickness, weight of shellfish, reproduction, and habitat characteristics of blood clams needed to support sustainable resource efforts this clam.

To determine the condition and form of management of the blood clam resource, biological, and ecological information on the clam is needed. This research was conducted to obtain information on the growth, mortality, rates of exploitation, and recruitment of blood clams in Rangsang Barat waters, especially Mekarbaru Village, Rangsang Barat Sub-District.

MATERIALS AND METHOD

This research was conducted in the coastal waters of Mekarbaru Village, Rangsang Barat District. Meranti Islands Regency, Riau Province (Figure 1). A sampling of blood clams (*A.granosa*) was carried out from August to October 2019.

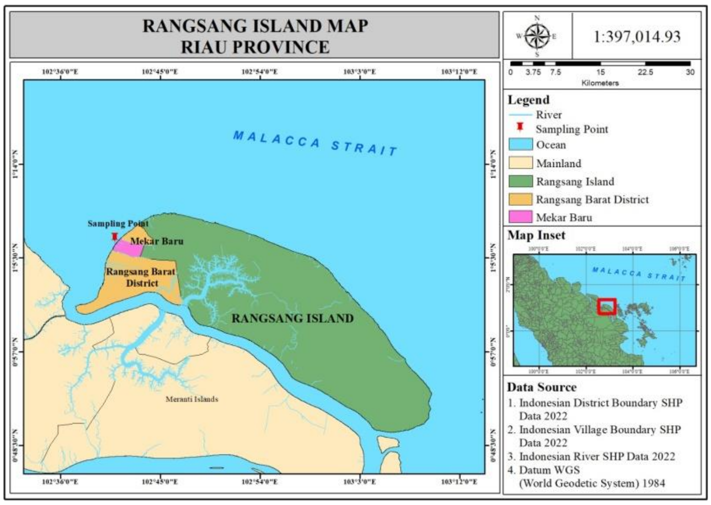

Figure 1. Map of Rangsang Barat waters as a research location

Blood clam sampling and measurement of environmental parameters were carried out at several points where blood clam habitat was found in the waters of Mekarbaru Village. Water samples were taken as much as 500 ml at three points to measure TSS and turbidity to be measured in the laboratory. Sediment samples were taken at three points 500 g each to determine the sediment fraction and organic matter content.

Samples of blood clams were taken directly from the field by hand or using a shovel with the help of fishermen collecting shells of all sizes. The number of blood clams per sampling depends on what is caught. Sample collection was carried out three times for three months. Furthermore, the samples obtained were counted and measured in length.

Growth parameter values K and L∞ were calculated using the shell length frequency method (ELEFAN I) from FiSAT software version 03.1. Estimating the age of mussels at birth (t0) is intended to obtain information about mussels which is also coupled with information on spawning peaks. The value of t0 can be obtained through the values of K and L∞ which are applied in the equation Log 10 (-t0) = -0.3922-0.2752 log10 L∞-1.038 log10 K (Pauly *in* Natan, 2009). K is the growth coefficient L∞ asymptotic length/infinity and t0 (initial condition parameter) is the age when the length is zero.

Natural life span (longevity) is the life span for a species which is defined by Pauly *in* Natan (2009) as the life span that can be achieved by a species in a cohort up to 99% of all cohort members achieve natural death. If you elaborate further on the Von Bertalanffy equation you will get the equation t = log10 (1-Lt/L∞)/K + t0; and if the maximum length (L max) = 0.95 (L∞) is included in the equation above, then the longest life span obtained is t max = 2.9957/K + t0 (Pauly *in* Natan 2009).

Estimation of total mortality (Z) is estimated through a linear relationship between the natural logarithm of changes in the number of clams per time class I and age which is known as the length converted catch curve (LCCC) using the FiSAT program. The addition of the first individual to the scallop population (recruitment) from the length frequency data was analyzed using an approximation method facilitated by the FiSAT software (Sparred and Venema 1999).

RESULT AND DISCUSSION

Growth

Anadara granosa shells that were collected during the study totaled 769 individuals with a length ranging from 10.3 to 29.0 mm. The age group contained in a population shows the structure of the population. Analysis of the growth parameters of blood clams as a whole based on length frequency data obtained during the three months of research using the FiSAT program obtained an asymptotic length or infinity length (L∞) of 30.45 mm with a growth coefficient (K) of 0.83 per year. Based on the growth parameters obtained the Von Bertalanffy growth curve for blood clams was obtained (Figure 2).

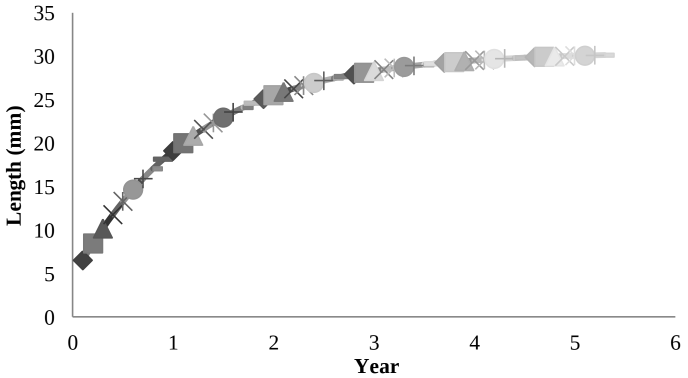

Figure 2. Growth curve of blood clams (*A. granosa*) results of the FISAT program analysis. L∞ = 30.45 mm and K = 0.83 per year

The calculation results show that the t0 value of the combined blood clams without distinguishing between males and females is 0.1921 years or 2.3051 months. Age t0 is an initial condition parameter that determines the point in time when the shell has zero length. Based on the growth parameter values obtained, the Von Bertalanffy equation for blood clams from Rangsang Barat waters is obtained as follows:

$$Lt = 30.45\ (1\text{-}\exp^{0.83(t+0.1921)})$$

Furthermore, based on the results of calculating the life span of blood clams the maximum age (t max) of blood clams living in Rangsang Barat waters is 3.80 years. Information about blood clams in Rangsang Barat waters is still very limited, especially regarding growth parameters. The value obtained in this study is expected to complement existing data and as a future comparison in the same place.

The value of blood clam growth parameters determines the equation and growth curve that is formed. The higher the K value the shorter the time needed to reach infinity. Figure 2 shows that reaching a seashell length of 29.3 mm takes about 3.8 years. The growth coefficient (K) is an important parameter in the von Bertalanffy equation because it can describe the growth rate of blood clams to reach their maximum size and can be used to compare the growth rates of different species or the same species from different environments. The length of infinity shows how much the length of the shell can be achieved by an individual shell. The value of the growth coefficient (K) is an important factor to determine the growth rate of shells reaching infinity size. The value of K differs from one species to another even one species at a different location. The value of the growth coefficient (K) indicates how fast a species reaches infinity length (Sparre & Venema 1998).

The growth rate of blood clams in Rangsang Barat waters is relatively slow compared to the growth rates of some other clams. Based on the von Bertalanffy growth function of Tellina foliacea shells the value of $L\infty$ = 7.70 mm. K = 1.20 per year and t0 = 0.9 years (Negar *et al.*, 2008), which was also lower than that obtained by Kisto *et al.* (2009), the value of the growth coefficient (K) of *Polymesoda erosa* is 1.20 per year (0.10 per month) with an infinity length ($L\infty$) 111.25 mm. Natan (2009) obtained the growth parameters of the tropical mud clam *Anodontia edentula*, including the asymptotic length ($L\infty$) of the male, female, and combined 65.63 mm, 70.88 mm, 70.58 mm, and the growth coefficient (K) values of males, female and a combined 1.3, 1.5, and 1.5 per year.

The growth coefficient (K) of blood clams in Rangsang Barat waters was higher than that obtained by Dang *et al.* (2010) with a growth coefficient (K) for *Ruditapes philippinarum* shells of 0.72 per year, then Bachok & Tsuchiya (2007) obtained an asymptote length ($L\infty$) and a growth coefficient (K) for *Psammotaea elongata* shells respectively 81.34 mm and 0.65 per year. Lower values were also obtained by Efriyeldi *et al*. (2012a) namely, the asymptotic length ($L\infty$) of the Sepetang shells ranges from 84.42 – 91.03 mm and the value of K = 0.50 – 0.60 per year. The growth coefficient (K) of blood clams in Rangsang Barat waters was also higher than that of blood clams in Kendari Bay obtained by Bahtiar *et al.* (2022) which is 0.72 per year, and Basri *et al.* (2019) on pokea shells of 0.56.

Differences in infinity length and K values can be influenced by different water conditions and the genetic factors of a biota. According to Nasrawati *et al.* (2017) that in sub-tropical waters the growth rate of old mussels is slower and they can no longer grow because they have reached their maximum length.

Mortality

The linear equation for estimating mortality obtained from the Length Converted Catch Curve (LCCC) analysis of blood clams in Rangsang Barat waters without distinguishing between males and females is Y = 8.706 - 2.242X with a value of r = -0.9803. The LCCC curve (Figure 3) shows that those who die from being caught are blood clam populations that are relatively older than 1 relatively large year. Large clams have holes that are also bigger and more easily identifiable than small clams. So the possibility of being caught or taken by clam catchers or collectors is also greater besides that what is taken is the large ones with more meat.

The results of the analysis showed that the total mortality (Z) of combined blood cockles (overall) was 4.46 per year, including natural mortality (M) of 1.60 per year and mortality due to capture (F) of 2.86 per year. The mortality value of blood clams due to fishing factors is more or higher than due to natural factors meaning that more blood clams die because they are caught by the community or fishermen than die because of changes in the quality of the aquatic environment. Bahtiar *et al.* (2016) also obtained high mortality due to the capture factor on pokea shells in the estuary section of Lasolo River, Southeast Sulawesi.

The mortality of different blood cockles was obtained by Bahtiar *et al.* (2022) in the waters of Kendari Bay which is higher due to the natural factor (M) of 2.61 per year and the capture factor (F) of 1.29 per year. Efriyeldi *et al.* (2012a) found that the death of shellfish due to natural or environmental factors (M = 0.934 per year) was relatively the same as the mortality rate due to fishing (F = 0.936 per year).

The mortality value for blood clams is relatively lower than that obtained for mud clams by Natan (2009), with a total mortality (Z) value of 4.56 per year. The total mortality (Z) of blood cockles was also lower than that obtained by Del Norte-Campos & Villarta (2010) in *Paphia undulata* namely, Z (6.18 per year), M (1.57 per year), and F (4 .61 per year). This is thought to be related to the catching of blood clams by the community which is still not very high

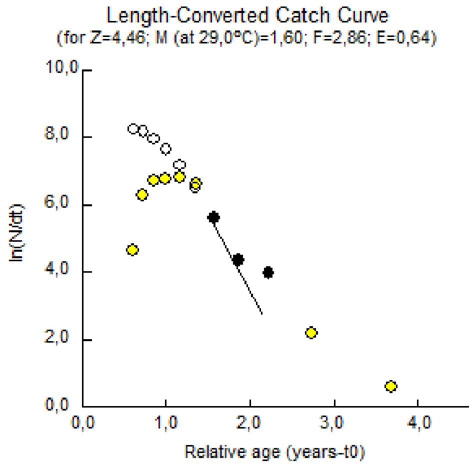

Figure 3. Long catch conversion curve for blood clams

The obtained mortality value indicates that the decrease in the blood clam population is caused by environmental factors rather than capture factors. This environmental factor is not only due to rising temperatures. The input of contaminants from the industry, ports, and cities but also due to the method of catching these clams which must mess up the bottom substrate. This method can cause death for individuals that are not collected due to trampling. Especially small ones that are not far from the surface of the sediment or substrate.

According to Welcomme (1985), natural mortality can be caused by predation, disease, high water temperatures, and low dissolved oxygen in the waters. Meanwhile, King (1995) states that many factors in the marine environment lead to a decrease in the survival of a population which includes unsuitable environmental conditions, lack of food competition, and most importantly predation.

Exploitation Rates

The exploitation rate (E) of blood clams in Rangsang Barat waters is 0.64. This exploitation rate is higher than that obtained by Bahtiar *et al.* (2022) for pokea shells in the waters of Kendari Bay with an E value of 0.29. Based on the F and E values obtained it can be stated that the capture of blood clams in Rangsang Barat waters has so far begun to threaten the sustainability of these blood clam resources. A high exploitation rate was also found by Nurhaida *et al.* (2021) for shellfish on the coast of Gampong Lambadeuk Beach, Peukan Bada District, Aceh Besar District namely E = 0.57. According to Gulland *in* Pauly (1984), the optimum F value is if the F value is equal to M and the optimum E value is 0.5. King (1995) states that in a non-exploited stock, exploitation mortality (F) is 0, then the total mortality value (Z) = natural mortality (M). Del Norte Campos and Villarta (2010) found high shellfish exploitation (catch) of *Paphia undulata* shellfish in the Philippines with an E value of 0.75. He added that this value had not only been over-exploited but also indicated an already serious situation. The value of the exploitation rate of blood clams describes the conditions of utilization of its resources and shows that the level of utilization of blood clams in the Rangsang Barat waters is relatively high. Sparre and Vanema (1998) state that the value of the exploitation rate (E) which is greater than 0.5 indicates a condition of more utilization while the value below it is a condition of low utilization. A relatively high exploitation rate value indicates a relatively high utilization as well, so it needs to be regulated so that the blood clam resource in these waters does not decrease in population. Death can also be due to environmental factors and other factors as stated by Del Norte-Campos (2004) that without capture death in the population is mainly due to old age, disease, or predation. King (1995) states that many factors in the marine environment lead to reduced survival of individuals in populations including unsuitable conditions, and lack of food competition, perhaps the most important of which for all marine species is predation.

Overfishing can affect the structure of the shellfish population in an area. According to Santoso (2022) in addition to reduced catches taking blood clams in excessive quantities is also shown to be smaller in size. According to Basri *et al.* (2019) that information on the level of exploitation is needed for efforts and policies in the form of management so that shellfish resources can be sustainable while still paying attention to and preserving shellfish resources.

Recruitment

The results of the analysis of the FiSAT program show that the addition of new individuals (recruitment) of blood clams in Rangsang Barat waters takes place every month with varying numbers each month. The highest addition of new individuals of blood clams was obtained in July (13.83%) and August (13.08%). Shellfish recruitment every month can be seen in Table 1.

Table 1. Percentage of monthly recruitment of blood clams in Rangsang Barat waters

Month	Recruitment (%)
January	0.44
February	4.65
March	9.20
April	7.30
May	11.19
June	11.75
July	13.83
August	13.08
September	11.79
October	10.92
November	5.87
December	0.00

The addition of new individuals every month with varying percentages was also obtained by Natan (2009) in *Anodontia edentula* shells with recruitment peaks in March (12.67%) and May (20.26%). Efriyeldi *et al.* (2012b) found small shells each month with varying amounts. The addition of new individuals overnight with a high percentage occurred starting in April, May, and June as well as August and September.

Recruitment is closely related to the success of spawning and passing his life. Recruitment will be seen several weeks to several months after spawning occurs that is after the larvae descend to the substrate and become young individuals. King (1995) stated that invertebrates go through the larval phase as plankton at varying times from several days to several months before metamorphosing into juveniles. Suwignyo *et al.* (2005) stated that the life span of veliger larvae as plankton varies from several days to several months depending on the species before finally descending to the substrate. Afiati (2007) stated that the larval period of *Anadara granosa* and *A.antiquata* was relatively short approximately 1 month. Keough and Downes 1982 referred to King (1995) stated that in benthic animals the term recruitment has been used to describe the process of descending to the substrate (settlement) of metamorphosed individuals. He further added that Tridacna clam eggs hatched into ciliated trochophore larvae after 12 hours and developed into veliger larvae two days after fertilization. Veliger larvae need 10 days to settle to the bottom substrate.

Based on the existing recruitment data (Table 1), it can be stated that the blood clam population in the coastal waters of Rangsang Barat will still be guaranteed to be sustainable because new individuals are added every month. although in varying amounts. So far, environmental pressure and community capture have allowed for the sustainability of this clam population. But attention needs to be paid so that there is no continuous decline. Recruitment is greatly influenced by the success of spawning, hatching, and growing into the next stage. The success of this process is greatly influenced by water conditions including temperature due to the rainy or dry seasons. Nabuab & Del Norte-Campos (2006) stated that sexual activity increases during the wet season, while gamete development occurs during the dry season.

Recruitment of mussels in the tropics can take place every month with varying percentages because variations in environmental conditions are not much different each month. According to Kastoro and Sudjoko (1988), clams (*A.antiquata*) spawn throughout the year namely by finding a spawning stage every month. This is because the water temperature conditions are relatively the same and the biological conditions of the waters do not vary. Lauden *et al.* (2001) stated that the pattern of recruitment was visible with the presence of juvenile Donax serra shells sporadically and varied from year to year.

CONCLUSION

The asymptote length (L infinity) that can be achieved by blood clams is 30.45 mm with a growth coefficient (K) of 0.83 per year. The total mortality rate (Z = 4.46) of these blood clams was relatively high and was due to the capture factor (F). The exploitation rate (E) of blood clams in Rangsang Barat waters is high with a value of 0.64. The addition of new individuals (recruitment) takes place every month with varying numbers and the highest occurs in July and August.

REFERENCES

Afiati, N., 2007. Gonad Maturation of Two Intertidal Blood Clams *Anadara granosa* (L.) and *Anadara antiquata* (L.) (Bivalvia: Arcidae) in Central Java. *J Coast develop.*, 10 (2): 105-113.

Bachok, Z., Tsuchiya, M., 2007. Growth of Bivalves Based on Allometric Relationship and a Time Series of Length-Frequency Data. Abstract. *J Sustain. Sci. Manag.*, 2(2).

Bahtiar., Anadi, L., Nurgayah, W., Emiyarti, H.H., 2016. Pertumbuhan, Kematian, dan Tingkat Eksploitasi Kerang Pokea (*Batissa violacea* Var. Celebensis, Von Martens 1897) pada Segmen Muara Sungai Lasolo Sulawesi Tenggara. *Marine Fisheries*, 7(2): 137-147.

Bahtiar, B., Purnama, M.F., Kasim, M., Ishak, E., 2022. Population Dynamics of Blood Clams *Tegillarca granosa* (Linnaeus. 1758) in Kendari Bay, Southeast Sulawesi. Indonesia. *Biodiversitas*, 23(10): 5084-5092. https://doi.org.10.13057/biodiv/d231015.

Basri, S.N., Bahtiar., Anadi, L., 2019. Pertumbuhan, Mortalitas, dan Tingkat Pemanfaatan Kerang Pokea (*Batissa violacea* var. celebensis von Martens. 1897) di Sungai Laeya Konawe Selatan Provinsi Sulawesi Tenggara. *Jurnal Biologi Tropis*, 19(1):79 – 89. https://doi.org./10.29303/jbt.v19i1.1059.

Broom, M.J., 1985. *The biology and culture of marine bivalve mollusk of the genus Anadara.* ICLARM Studies and Reviews 12. 37 p. International Center for Living Aquatic Resources Management. Manila. Philippines.

Dang, C., de Montaudouin, X., Gam M., Paroissin, C., Bru, N., Caill-Milly, N., 2010. The Manila Clam Population in Arcachon bay (SW France): Can it be kept sustainable?. *J Sea Res*., 62(2): 108-118.

Del Norte-Campos, A., 2004. Some Aspects of the Population Biology of the Sunset Elongate Clam *Gari elongata* (Lamarck 1818) (Mollusca. Pelecypoda: Psammobiidae) from the Banate Bay Area. West Central Philippines. *Asian Fish. Sci*., 17: 299-312.

Del Norte-Campos A., Villarta, KA., 2010. Use of Population Parameters in Examining Changes in the Status of the Short-Necked Clam *Paphia undulata* Born. 1778 (Mollusca. Pelecypods: Veneridae) in Coastal Waters of Southern Negros Occidental. *Science Diliman*, 22 (1): 53-60.

Efriyeldi., Bengen, D.G., Affandi, R., Prartono, T., 2012a. Karakteristik Biologi Populasi Kerang Sepetang (*Pharella acutidens*) di Ekosistem Mangrove Dumai. Riau. *Berkala Perikanan Terubuk*. 40 (1): 36 – 44

Efriyeldi., Bengen, D.G., Affandi, R., Prartono, T., 2012b. Perkembangan Gonad dan Musim Pemijahan Kerang Sepetang (*Pharella acutidens*) di Ekosistem Mangrove Dumai, Riau. *Jurnal Maspari* 5 (2) : 137-147.

Efriyeldi., Effendi, I., 2022. Aspects of Reproduction Biology of Blood Cockle (*Anadara granosa*) in Pasir Limau Kapas waters. *AACL Bioflux*, 15(4): 1648-1655.

Kastoro, W.W., Sudjoko, B., 1988. *Pengamatan Beberapa Aspek Kerang Bulu Anadara antiquata (L) dari Perairan Muara Sungai Kamal, Teluk Jakarta*. Biologi Budidaya, Oseanografi, Geologi, dan Konisi Perairan. LIPI. Jakarta. p 30-37.

King, M., 1995. *Fisheries Biology. Assessment and Management*. Blackwell Science. Victoria. Australia.

Kisto., Sya'rani, L., Bambang, A.N., 2009. *Kepadatan dan Pertumbuhan Kerang Kepah (Polymesoda erosa) di Perairan Bontang Kalimantan Timur.* Makalah pada Seminar Nasional Tahunan VI Hasil Penelitian Perikanan dan Kelautan. 25 Juli 2009.

Laudien, J., Brey, T., Arntz, W.E., 2001. Reproductive and Recruitment Patterns of the Surf Clam *Donax serra* (Bivalvia, Donacidae) on Two Namibian Sandy Beaches. *J Mar Sci.*, 23: 53-60.

Nabuab, F., Del Norte-Campos, A., 2006. Some Aspects of the Reproduction in the Elongata Sunset Clam *Gari elongata* (Lamarck 1818) from Banate Bay Area. West Central Philippines. *Sci Diliman*, 18(2): 34-46.

Natan, Y., 2009. Parameter Populasi Kerang Lumpur Tropis *Anodontia edentula* di Ekosistem Mangrove. *J Biol Indones.*, 6(1): 25-38.

Nasution, S., 2009. Biomassa Kerang *Anadara granosa* pada Perairan Pantai Kabupaten Indragiri Hilir. *Jurnal Natur Indonesia* 12(1): 61- 66.

Nasrawati, N., Bahtiar, B., Anadi, L., 2017. Pertumbuhan, Kematian, dan Tingkat Ekploitasi Kerang Coklat (*Modiolus modulaides*) di Perairan Teluk Kendari Sulawesi Tenggara. *Jurnal Sains dan Inovasi Perikanan*, 1(2): 29-36.

Negar, G., Zohre, G., Habib, N., 2008. Population Growth of the Tellinid bivalve *Tellina foliacea* in the Hendijan Coast, Persian Gulf. *Pakistan J Biol Sci*., 11(5): 788-792.

Nurhaida., Sarong, M.A., Saputri, M., Asiah, D., Syafrianti., 2021. Pola Distribusi dan Tingkat Eksploitasi Spesies Kerang pada Kawasan Pesisir Pantai Gampong Lambadeuk Kecamatan Peukan Bada Kabupaten Aceh Besar. *Jurnal Ilmiah Mahasiswa Pendidikan Biologi FKIP USK*, 6(3): 47-54.

Nurjanah., Zulhamsyah., Kustiyariyah., 2005. Kandungan Mineral dan Proksimat Kerang Darah (*Anadara granosa*) yang diambil dari Kabupaten Boalemo. Gorontalo. *Buletin Teknologi Hasil Perikanan*, 8(2): 15-24

Pauly, D., 1984. *Fish Population Dynamics in Tropical Waters: a Manual for use with Programable Calculators*. Manila: ICLARM.

Santoso, P., 2022. Studi Penangkapan Kerang Darah (*Anadara granosa*) Menuju Pengembangan Budidayanya di Kecamatan Kupang Tengah, Kabupaten Kupang. *JVIP*, 2(2): 24 – 31.

Sparre, P., Venema, S.C., 1999. *Introduksi Pengkajian Stok Ikan Tropis. Buku 1: Manual*. Pusat Penelitian dan Pengembangan Perikanan Badan Penelitian dan Pengembangan Pertanian. Jakarta.

Suwignyo, S., Widigyo, B., Wardiatno, Y., Krisanti, M., 2005. *Avertebrata Air Jilid 1*. Penebar Swadaya. Jakarta.

Welcomme, R.L., 1985. *River Fisheries.* FAO. Fisheries Technical Paper. p 262-330