E-ISSN: 2347-5129
P-ISSN: 2394-0506
(ICV-Poland) Impact Value: 76.37
(GIF) Impact Factor: 0.549
IJFAS 2023; 11(1): 31-35
© 2023 IJFAS
www.fisheriesjournal.com
Received: 28-10-2022
Accepted: 30-11-2022

Rizki Oktavian
Marine Science Postgraduate, Faculty of Fisheries and Marine Science, IPB University, Dramaga Bogor, West Java, Indonesia

Dietriech G Bengen DEA
Department of Marine Science and Technology, Faculty of Fisheries and Marine Science, IPB University, Dramaga Bogor, West Java, Indonesia

Nyoman MN Natih
Department of Marine Science and Technology, Faculty of Fisheries and Marine Science, IPB University, Dramaga Bogor, West Java, Indonesia

Corresponding Author:
Rizki Oktavian
Marine Science Postgraduate, Faculty of Fisheries and Marine Science, IPB University, Dramaga Bogor, West Java, Indonesia

Bivalve Spat (*Anadara granosa*) recruitment in rehabilitation mangrove ecosystem of Rangsang Island, Riau province

Rizki Oktavian, Dietriech G Bengen, Nyoman MN Natih

DOI: https://doi.org/10.22271/fish.2023.v11.i1a.2766

Abstract
Southeast Asia's mangrove areas are inhabited by several bivalves, such as the blood clam (*Anadara granosa*), which are widely distributed in intertidal areas. The importance of economic value of bivalves causes the availability of seeds to be very important. Knowing the abundance and life cycle of bivalves (*Anadara granosa*) is the right step in estimating the ideal time to collect bivalves in an ecosystem. This study aimed to determine the abundance and time of attachment of bivalves (*Anadara granosa*) seeds in the rehabilitation mangrove ecosystem on Rangsang Island, Riau. The sampling method used is purposive sampling, consisting of two subzones, and each subzone is located in the intertidal zone, namely at the point of the highest tide and the highest low tide in the mangrove forest area. The results showed that *A. granosa* was more common in December (79100 ind/100 m^2) with an average length of 7.67 (±3.94). The relationship between mangrove density and abundance of *A. granosa* has a strong relationship in December and January, with the length range of *A. granosa* being influenced (strong category) by pH and temperature.

Keywords: *Anadara granosa*, bivalves**,** mangrove, recruitment

1. Introduction
The mangrove areas of Southeast Asia are inhabited by several bivalves, such as blood clam (*Anadara granosa*), sipetang clam (*Pharella acutidens*), green clam (*Mytilus viridis*), dan lokan clam (*Polymesoda erosa*), widely distributed in the intertidal (an area affected by tides); such as coasts, river estuaries, and swamp formed in the mud substrate of mangrove trees (Dolorosa & Dangan-Galon, 2014) [1].
Clams that live in mangrove forests have an age development stage known as trochophore (planktonic larvae), which floats in the water column, then becomes a veliger (shelled larvae). Next, they become pediveliger (seed candidate) until they finally settle in a substrate known as spat (seed) (Islami, 2013) [3]. The stages of age development in mangrove clams into adult clams are called spat. Spat (seed) are small-sized juveniles settled on the bottom of waters with shell shapes like adult clams (Ngo dan Quach, 2010) [4]. Spat growth to become adult mussels occurs in mangrove ecosystems, especially brackish waters.
The economic value of bivalves causes the availability of seeds to be very important. Knowing the species, abundance, and life cycle of bivalves is the proper step in estimating the ideal time to collect bivalves in an ecosystem. It is also become the right step in cultivation activities. For example, Dolorosa and Dangan-Galon (2014) [1] explained that the highest percentage of *Polymesoda erosa* seeds (Geloina) attached to the mangrove forest substrate occurred in April (14,41%) and September (12,18%). In cultivating bivalves, the availability of seeds is beneficial because the growth rate of bivalves seeds is much higher than the population in nature (Ngo & Quach, 2010) [4].
Many biotic and abiotic factors affect the abundance of bivalves and the variability of attachment time. Among the most important is the reproductive cycle of adult clams and the mortality rate of larvae due to predation. In addition, changes in a population's abundance and spatial distribution during early benthic life stages can also arise from later attachment (Islami *et al*., 2013) [3].

Bivalves that live in mangroves are a source of highly nutritious food and have high economic value. It makes many people who work as fishermen make mangrove clams their primary prey. The existence of human activities in the coastal waters of Rangsang Island, Meranti Archipelago Regency of Riau province, can cause changes in aquatic habitats where aquatic organisms live. High fishing activity can also cause changes in habitat, and the clam population's structure will change. The life cycle and reproductive patterns will also change with this environmental change.

Habitat changes affect adults and young individuals such as juveniles (Agususilo, 2010) [2]. Therefore, there is a need for deeper knowledge to support the cultivation of mangrove bivalves, one of which is by studying the species, abundance, and time attachment of bivalves seeds.

Species, abundance, and time of attachment of bivalved seeds to the mangrove forest substrate on Rangsang Island of Meranti Regency have just been known today. Against this background, studying the abundance and time of attachment of bivalve (*A. granosa*) seeds in the rehabilitated mangrove ecosystem is necessary.

Research Method

The method used in this research is a survey method, by observing the research location directly, measuring and taking samples in the field, the species and abundance are analyzed in the laboratory.

Research Location

The study was conducted in the rehabilitation mangrove ecosystem on Rangsang Island, Meranti Archipelago Regency, Riau (Figure 1).

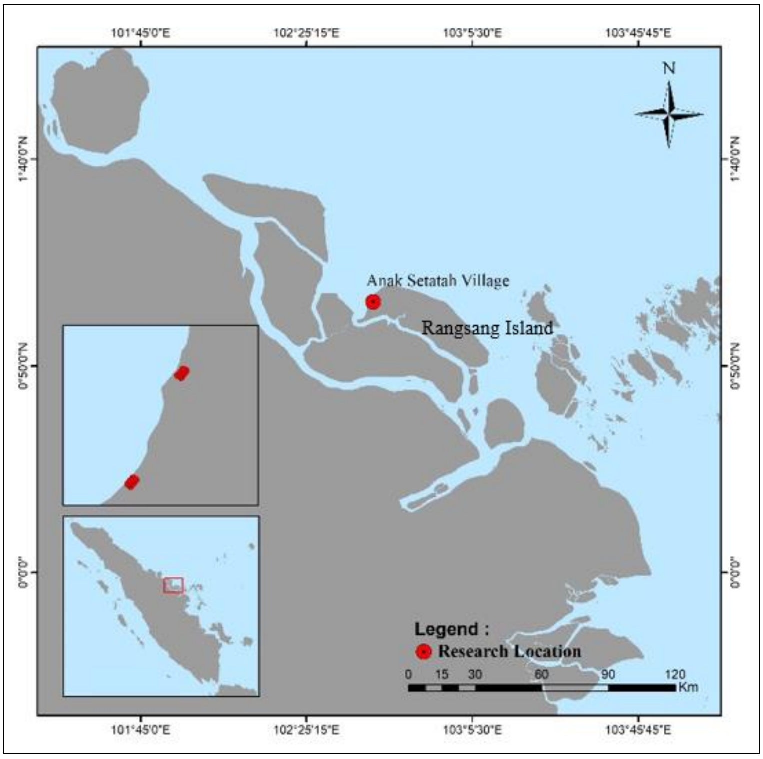


Fig 1: Map of research location in Rangsang Island, Riau

The sampling location of bivalve spat of *A. granosa* was determined upper subzone (Lower) at the lowest tide area and is on the coast. The distance between subzones is 50 meters, and each subzone is laid out 3 square plots/plots in the form of a collector (net) measuring 1x1 m (1 m^2) with a mesh width of 1x1 mm (1 mm^2) adapted to the condition of the mangrove forest substrate as a sampling point. As a place by purposive sampling. It consists of 2 (two) subzones, and each subzone was located in the intertidal zone. The point of the highest tide and the highest low tide in the mangrove ecosystem area is subzone 1. It is located in the lower subzone (Upper) in the area of the highest tide. Subzone 2 is located in the to attach bivalves seeds, a collector (net) is used.

Bivalve spat sampling of *A. granosa*

Bivalve spat sampling was carried out at low tide by lifting the collector (net) and washing it in a tub to get the attached clam seeds. Collector removal is carried out once a month in November 2020, December 2020, and January 2021. First, a sampling of bivalves entangled in the collector was done by hand, then put into a filter bucket. Next, the substrate was filtered using a 1 mm mesh sieve. Bivalves seeds found were put into plastic bags and then given 10% formalin. Finally, samples are taken to the Marine Biology Laboratory to be washed, counted, and classified.

Sediment sampling

The sediment contained in each subzone was taken using a shovel at a depth of 10 cm, put into plastic as much as 500 grams, and then into an ice box to cool (Juandi, 2013) [14]. Finally, an analysis of sediment samples was carried out in the laboratory to determine the type and fraction of sediment and analysis of the organic matter.

Environmental characteristics measurement

Water quality parameters are measured at high tide around the subzone area. Water quality parameters include pH, salinity, and temperature. First, measure the degree of acidity by dipping the pH indicator into the water and seeing the color changes, then compare it with the standard pH color on the pH indicator box. Next, salinity is measured using a hand refractometer calibrated with distilled water. A sufficient amount of seawater is dripped with a dropper, and look at the number shown, then recorded the number in ppt units. Finally, measure temperature using a thermometer inserted into the water, then wait a while and record the numbers shown on the tool in units of °C.

Mangrove density and bivalve spat abundance of *A. granosa*

Mangrove density and bivalve spat abundance of *A. granosa* was calculated using Odum (1993) [15] and Kurniawan (2016) [13].

Result and Discussion

Mangrove Density

The density condition of the rehabilitation mangrove ecosystem in Anak Setatah Village, Rangsang Island of Riau, is classified as dense, with an average density value of 2283.33 individuals/ha. The total distribution of mangrove density at each station can be seen in Figure 2.

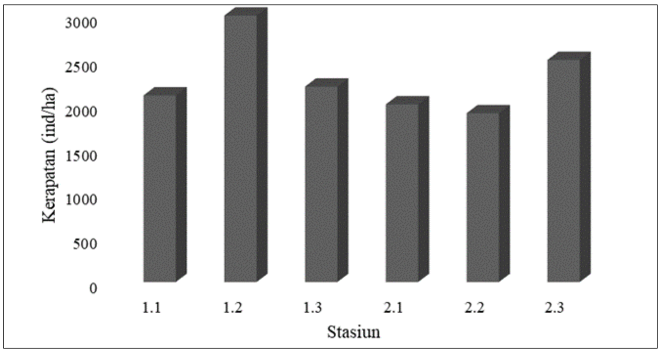


Fig 2: Distribution of Mangrove Density in the Mangrove Ecosystem Rehabilitation of Rangsang Island, Riau

The highest mangrove density was found at Station 1.2 with a density value of 3000 ind/ha, and the lowest was found at Station 2.2 at 1900 ind/ha. Based on the Minister of Environment Decree 201 (2004), all stations fit the good criteria where the mangrove density value of 1500 ind/ha falls into the high-density criteria (density). However, the density values at each station are influenced by the number of individual mangroves. The same study conducted by Nadeak *et al*. (2020) [12] found that the density of mangroves in several Mangrove Ecosystem areas on Rangsang Island of Riau is in the dense category with the highest density value of 2266.7 ind/ha.

Species in the rehabilitated mangrove ecosystem on Rangsang Island of Riau consisted of *Avicennia alba* and *Avicennia marina*. Both of these species have characteristics that are resistant to high salinity; according to Harnani (2017) [19], the distribution of *Avicennia*, especially *A. alba*, is spread throughout Indonesia. Furthermore, according to Khairijon *et al*. (2015) [11], these two species also prefer mud substrate conditions, where environmental conditions in the Mangrove Rehabilitation Ecosystem on Rangsang Island of Riau have suitable environmental conditions.

Variation of environmental characteristics

Environmental characteristics in the mangrove ecosystem rehabilitation of Rangsang Island are shown in Table 1.

Table 1: Environmental Characteristics of the Rehabilitation Mangrove Ecosystem on Rangsang Island, Riau

Time	Temperature (°C)	pH	Salinity (PPT)
November 2020	27.80	7.67	28.67
December 2020	27.83	7.62	28.17
January 2021	27.33	7.77	28.33

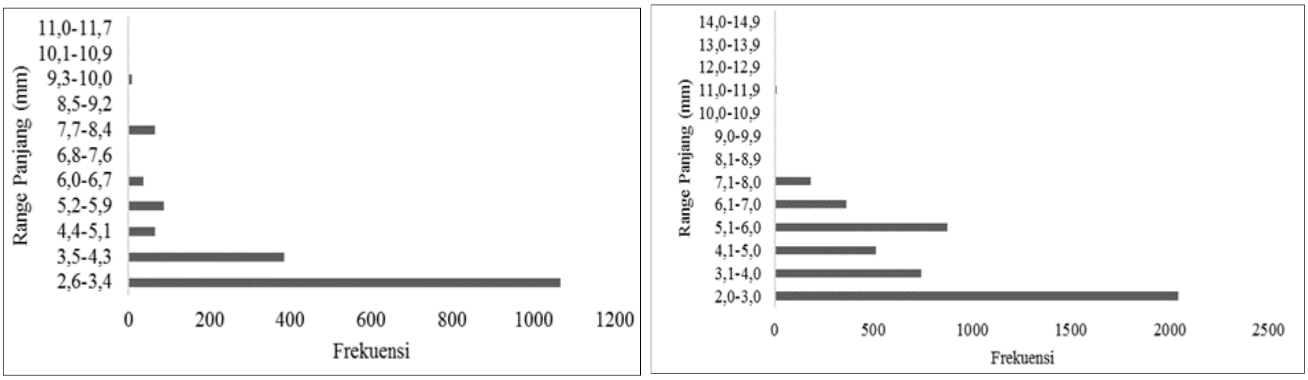
The distribution of temperature, pH, and salinity values at three months of observation in the mangrove ecosystem of Rangsang Island of Riau did not significantly differ. The water temperature range is 27.33-27-80 C, the pH range is 7.62-7.77, and the salinity range is 28.17-28.67 ppt. Environmental characteristics such as temperature, pH, and salinity are in the excellent category for the life of *A. granosa*. According to Winanto (2004) [20] and Oktaviani *et al*. (2018) [17], the temperature range for living bivalves is 27-31 C, then according to Lukmana (2021) [18], a good salinity range is no more than 35 ppt, and a pH range is 7-8.5.

Abundance and length of bivalves Spat (*A. granosa*)

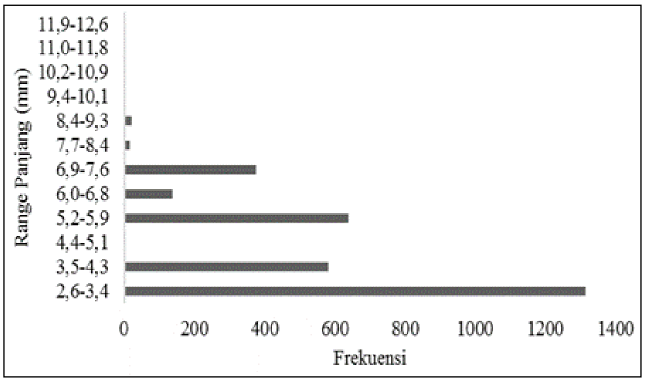
The abundance and average length of *A. granosa* found at the study site are shown in Table 2. The results found at the study site were different for three consecutive months. *A. granosa* found in November 2020 was 3096 ind with an abundance of 51600 ind/100m2 and an average length of 7.19 (±2.41) mm. Furthermore, in December 2020, 4746 ind was found with an abundance of 79100 ind/100m2 and an average length of 7.67 (±3.94) mm. In January 2021, it was found about 1719 individuals with an abundance of 28650 ind/100m2 and an average length of 6.11 (±2.52).

Table 2: Abundance Distribution and Average Length of *A. granosa*

Time	Abundance (Ind/100 m^2)	Average length (mm)
November 2020	51600	7,19 (±2,41)
Desember 2020	79100	7,67 (±3,94)
January 2021	28650	6,11 (±2,52)



A **B**



C

Fig 3: Distribution Range of *A. granosa* Length in Rangsang Island, Riau (A) November 2020 (B) December 2020 (C) January 2021

The highest abundance and average length of *A. granosa* were found in December 2020, then the lowest value was found in January 2021. Therefore, the distribution of *A. granosa* length in different months was caused by differences in the values of environmental characteristics in those three months, which can be seen in Figure 3. According to Amalia (2010) [7], several things cause the difference in length, one of which is temperature.

Relationship between Spat bivalve (*A. granosa*) and mangrove

Figure 4 shows the relationship between the abundance of *A. granosa* and mangrove density at three months (November 2020, December 2020, and January 2021). The results show different regression values (R2) at three months of measurement. It means that the recruitment of *A. granosa* bivalve spats may vary from month to month.

Figure 4 (A) shows the relationship of mangrove density to have an influence of 64.15% on the abundance of *A. granosa*, then Figure 4 (B) explains that the density of mangroves has a reasonably significant influence on the abundance of *A. granosa*, which is 82.57%, and Figure 4 (C) shows that mangrove density has an effect of 92.36% on the abundance of *A. granosa*.

The relationship between mangrove density and abundance of *A. granosa* is in the strong category in December 2020 and January 2021, while the relationship between mangrove density and abundance of *A. granosa* in November 2020 is in the strong category. This categorization is based on Tanjung (2010) [8] and Siahaan (2014) [9] writings which state that weak strength with R^2 = 0.00-0.25, moderate strength with R^2 = 0.26-0.50, strong strength with R^2 = 0, 51-0.75, and the strength is very strong with R^2=0.77-1.00.

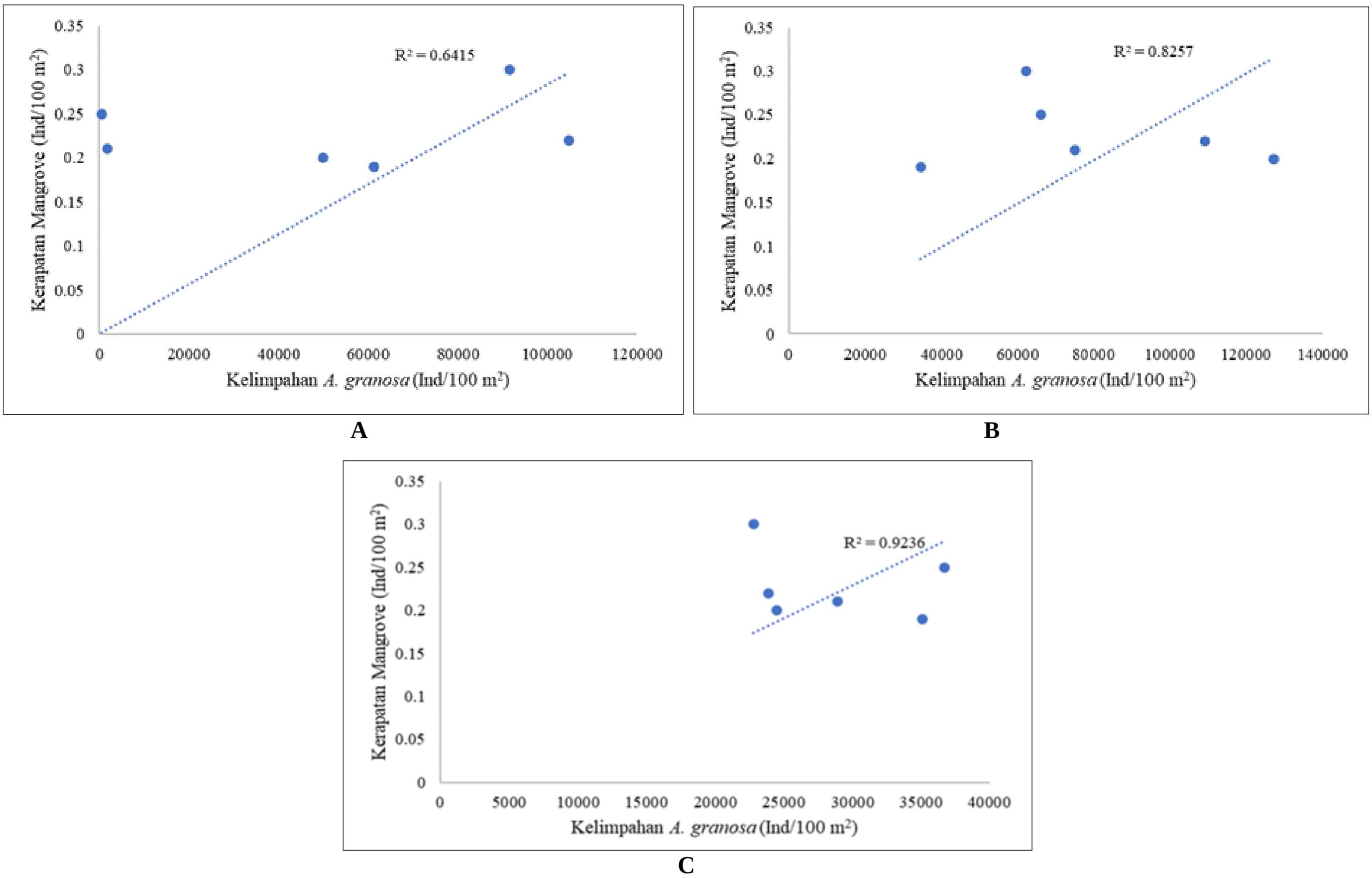


Fig 4: Relationship between Spat Abundance of Bivalve *A. granosa* and Mangrove Density in Rangsang Island, Riau (A) November 2020 (B) December 2020 (C) January 2021

Correlation of average length of *A. granosa* with environmental characteristics

Table 3 shows the correlation value between the average length *A. granosa* with environmental characteristics (temperature, pH, and salinity) from 3 months sampling.

Table 3: Correlation value between average length *A. granosa* with environment characteristic

Parameter	Correlation Value	Interception
Temperature	0,97	Very Strong
pH	-0,99	Very Strong
Salinity	-0,11	Not Strong

Based on the correlation values shown in Table 3, temperature and pH strongly influence the average length of *A. granosa*, while salinity has no strong effect.

Conclusion

The distribution of abundance and length of *A. granosa* bivalve spats in the rehabilitation mangrove ecosystem of Rangsang Island differed every month (November, December, and January). However, the highest average abundance and length were found in December (79100 ind/100 m2 and 7.67 (±3.94) mm with an average mangrove density of 2283.33 ind/ha. Spat length of *A. granosa* bivalves (strong category) is affected by pH and temperature.

Acknowledgement

The author thanks Dr. Hawis Madduppa (deceased), who has guided the research process so far and Prof. Dietriech G. Bengen as the principal supervisor has helped me in completing my current journal; also my second supervisor, Nyoman Metta N Natih, Ph.D. The authors also thank the field team who have helped facilitate field data collection on Rangsang Island, Riau.

References

1. Dolorosa RG, dan Dangan-Galon F. Population Dynamics of the Mangrove Clam Polymesoda erosa (Bivalvia: Corbiculidae) in Iwahig, Palawan, Philippines. International Journal of Fauna and Biological Studies. 2014;1(6):11-15.
2. Agususilo S. Kelimpahan Larva Anadara spp. (Bivalvia: Arcidae) di Perairan Bojonegara, Teluk Banten, Banten [Disertasi]. Fakultas Perikanan dan Ilmu Kelautan, Institut Pertanian Bogor. Bogor; c2010.
3. Islami MM. Pengaruh Suhu dan Salinitas Terhadap Bivalvia. Oseana. 2013;38(2):1-10.
4. Ngo dan, Quach KL. Reproductive Biology of Mud Clam Geloina Coaxans in Mangrove Forest of Ca Mau Province, Mekong Delta, Vietnam. International Conference Marine Biodiversity of East Asian Seas Proceedings: Status, Challenge; c2010.
5. Wahyuni I, Indah JS, dan Bambang E. Biodiversitas Mollusca (Gastropoda dan Bivalvia) sebagai Bioindikator Kualitas Perairan di Kawasan Pesisir Pulau Tunda, Banten. Biodidaktika. 2017;12(1):45-56.
6. Broom MJ. The biology and culture of marine bivalve mollusks of the genus Anadara. ICLARM. Philippina; c1985. p. 44.
7. Amalia DR. Rekruitmen Populasi Kerang Darah (*Anadara granosa*) di Perairan Pesisir Banten. IPB: Bogor; c2010.
8. Tanjung A. Biologi dan Ekologi Sipetang (*Pharus* sp.) Hutan Mangrove Stasiun Kelautan. Lembaga Penelitian Universitas Riau. 35 hal; c2010.
9. Siahaan RM, Fajri NE, dan Adriman. Mangrove Density Relationship with Abundance of Bivalva in Sungai Alam Village Bengkalis Sub District Bengkalis Regency Riau Province. JOM; c2014.
10. Bening dan Purnomo. Keanekaragaman dan Kelimpahan Bivalvia di Pantai Barung Toraja Sumenep, Madura. Lentera Bio. 2019;8(3):249-254.
11. Khairijon, Sofiyanti N, dan Fadli. Korelasi Antara Kerapatan Avicennia Dengan Karakteristik Sedimen Di Kawasan Hutan Mangrove Desa Sungai Rawa Kabupaten Siak, Riau. Prosiding Semirata; c2015. p. 300-309.
12. Nadeak P, Mubarak, dan Efriyeldi. Mangrove Forest Effect on the Coastline in Rangsang Island Riau Province. Asian Journal of Aquatic Sciences. 2020;3(1):29-37.
13. Kurniawan M. Jenis dan Kelimpahan Benih Bivalvia di Subzona Intertidal Kawasan Hutan Mangrove Desa Selat Baru, Kabupaten Bengkalis [Skripsi]. Fakultas Perikanan dan Ilmu Kelautan. Universitas Riau. Pekanbaru; c2016.
14. Juandi B. Shellfish Abundance Relationship Sipetang (*Pharella acutidens*) And Other Macrozoobenthos in Mangrove Forest Dumai Riau University Marine Station. Fakultas Perikanan dan Ilmu Kelautan, Universitas Riau. Pekanbaru; c2013.
15. Odum EP. Dasar-Dasar Ekologi. Diterjemahkan oleh Tjahjono Samingan. Gadjah Mada University Press. Yogyakarta; c1993.
16. Keputusan Menteri, Negara Lingkungan, Hidup Nomor 201 tahun. Tentang Kriteria Baku dan Pedoman Penentuan Kerusakan Mangrove; c2004.
17. Oktaviani T, Cokrowati N, dan Astriana BH. Tingkat Kelangsungan Hidup Spat Kerang Mutiara (*Pinctada Maxima*) dengan Kepadatan Yang Berbeda di Balai Perikanan Budidaya Laut (BPBL) Lombok. Journal Kelautan. 2018;11(1):47-55.
18. Lukmana A. Pola Pertumbuhan Dan Distribusi Kerang Darah (*Anadara granosa*) di Muara Sungai Tanjung Balai Asahan Sumatera Utara. USU: Sumatera Utara; c2021.
19. Harnani BRD. Kemampuan *Avicennia Marina* dan *Avicennia Alba* Untuk Menurunkan Konsentrasi Tembaga (Cu) di Muara Sungai Wonorejo, Surabaya; c2017.
20. Winanto T. Memproduksi Benih Kerang Mutiara Seri Agribisnis. Panebar Swadaya. Jakarta; c2004.