Species Diversity of Marine Bivalves from the Strait of Rupat Island Riau Province, Indonesia

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Abstract A survey of marine bivalves for species diversity was conducted at five locations in the current study; three stasiun at Dumai City beach those are Silensing, Bandar Bakau, Basilam Baru, Srí Tanjung, and Pulau Payung beach of Rupat Island Strait, Riau Province, Indonesia. The goal of this study was to learn more about the marine bivalves that live in the Rupat Island strait. From July to August 2020, marine bivalves were collected during spring low tides from intertidal zones and shallow coastal waters. From the Strait of Rupat Island, 13 bivalves belonging to 11 genera, 11 families and 8 orders were discovered. During the research, bivalves from the families Pectinidae, Placunidae, Arcidae, Trapezidae, Veneridae, Ostreidae, Corbiculidae, and Psammobiidae were recorded during the study. The number of bivalves in each family reveals that two species belongs to the Arcidae family and two to the Cyrenidae family. Corbiculidae, Placunidae, Trapezidae, and Psammobiidae each had one species reported. The abundance of each species found was extremely low, it is not feasible to be presented quantitatively. The most common species encountered in the strait were Anadara granosa, Polymesoda erosa, Polymesoda expansa, and Pharella acutidens. The anthropogenic activities of Dumai City and Rupat Island, such as the discharge of industrial wastes, residential sewage, overfishing, habitat loss, overharvesting and tourism, could cause variations in bivalves abundance in the Strait of Rupat Island.

1. Introduction

The population of organisms that live on or in the bottom of water bodies is known as benthic fauna, and many of them are permanently anchored to the bottom. Benthic macrofauna refers to larger, more apparent benthic creatures with a body size of more than 1 mm, feeding tactics, reproductive techniques, and a range of body shapes. Feeding activities, food availability, prey-predator relationships and species removal, reproductive effects on breeding, dispersal, spawning and settlement behavioral effects that induce movement and aggregation, presence of symbiotic organisms, growth and mortality are all important biological factors that influence the distribution pattern and community structures of macrobenthos [1].

Transitional ecosystems rely heavily on benthic invertebrates. By filtering phytoplankton and then serving as a food supply for larger creatures like fish, primary production can be linked to higher trophic levels [1]. They also rework sediments to shape and oxygenate the bottom, and they play an important function in breaking down organic material before bacterial remineralization [3]. Humans consume a variety of benthic invertebrates, mainly clams, while others, such as worms, are used as...
recreational fishing bait [2]. Biological markers such as benthic communities are frequently utilized [1]. Because of their limited movement, which limits their capacity to evade dangerous situations, they are well-suited to detecting various types and levels of stress [4]. Some sessile intertidal creatures are the best sources of bioactive substances, and a few of them, such as heavy metals, are also employed in ecotoxicological studies [5].

Bivalves, as filter feeders, can assist in purification of contaminated marine waters [6], serve as vital linkages between primary detritus and consumers, and play a key role in nutrient recycling in the seagrass zone [7]. Members of this class are diverse, plentiful, commercially important, and contribute significantly to fishery production [8]. Bivalves (clams and oysters) are important to many people’s livelihoods and have been exploited for food, adornment, pearls, lime, and medicine all across the world. Crustaceans and bivalves are the most common marine invertebrates consumed in Western society. Mollusks, along with fish and prawns, are delicious and high in protein. Essential amino acids are abundant in molluscan proteins, which are required for growth, reproduction, and vitamin synthesis. The bivalves are also recognized for being high in protein, amino acids, carbohydrate, lipid, vitamins, fatty acids and minerals.

Minerals such as zinc, iron, calcium, potassium, copper and phosphorus are also abundant in mollusks. They also supply high-quality protein that contain all of the required amino acids for human body maintenance and growth [9]. Finding the similar results on the nutritional status of marine bivalves [10,11,12,13,14]. Bivalve mollusks have been proposed as a biomonitor for metal contamination in marine habitats. There have also been reports of bivalve species being used for biomonitoring and bioindication [15,16,17,18].

Unrestricted harvesting and habitat degradation have been found in numerous studies to pose a hazard to the molluscan population [19]. The recent growth in human activity near the Strait of Rupat Island such as fishing and tourism, has accelerated the uncontrolled exploitation of natural resources. Since the beginning of Crude Palm Oil (CPO) production (as many as thirteen CPO Industries located in Dumai), Oil and Natural Gas Commission (ONGC), International Port, Container Freight Stations (CFS), sedimentation, tourism, reclamation and others activities, the coastal environment of Rupat Strait waters has been under significant stress.

Despite the fact that numerous studies have been conducted to assess the species variety of marine bivalves in Riau province waters, no scientific research have been conducted on species composition of marine bivalves on Rupat Island, necessitating the current study. The study’s goal is to assess the species diversity of Bivalve at Strait of Rupat Island in relation to anthropogenic inputs from either in Rupat Island or Dumai city, a port and industrial center.

2. Materials and Methods

2.1. Area of Study

Geographically, the strait of Rupat Island from Lat. 1°41' 37“ - 1°43' 19“ N to Long. 101°24' 15“ - 101°27' 08“ E, between Dumai city coast in the mainland of Sumatera and Rupat Island coast (Figure 1). Rupat Strait waters is a semi-closed waters, which makes these waters have changing currents which are included in the mixed tidal type, which tends to double daily. Bengkalis Regency has a tropical climate which is strongly influenced by the nature of the sea climate with temperatures ranging from 26-32 °C and humidity of 85 percent. The rainy season runs from September to January 2020, with average annual rainfall ranging from 900 to 1,500 mm and less than 110 days of rain.
Figure 1. The map of Rupat Strait showing the position of each observation station

2.2. Strategy of Sampling
The current research was conducted over a four-month period, from June to September 2020. Five spots were purposively chosen as study sites namely, Silensing, Bandar bakau, Basilam Baru, Sri Tanjung, and Pulaubayng shore. Bivalves were obtained by hand picking method from intertidal regions and swallow coastal waters that were primarily overrun by mangroves. The study locations were inspected periodically during low tides. Mussels and oysters were gathered by scrapping the substratum with knives or spatulas, while faunal bivalves were recovered by digging the substratum by hand [20]. All bivalve specimens were cleaned in seawater to remove the debris, then transferred to a clean plastic container filled with seawater and kept out of direct sunlight before being delivered to the University of Riau’s Marine Laboratory.

Each specimen’s morphological traits, such as shell morphology, hinge ligament, radial ribs, cardinal teeth, and growth lines. The specimens were cleaned with tap water before being preserved in a 10% formaldehyde-seawater solution and then transferred to 90% ethanol. Empty shells were washed and rinsed in water containing mild detergent to remove the hard outer covering and reveal the original colours.

2.3. Bivalves Identification
Using conventional taxonomic keys [21,22] and Marine Species Identification Portal website (http://species-identification.org), all collected bivalves were photographed and identified up to species level. The World Register of Marine Species (WRoMS) website (http://www.marinespecies.org) was used to look up scientific names and classifications for bivalves.

3. Results and Discussion
Rupat Island is an island located in the eastern part of the island of Sumatra which is quite large, including the province of Riau, precisely in Bengkalis Regency. In the north facing directly to the Malacca strait and in the south there is a strait that separates the mainland of Sumatra Island from Rupat Island. Both sides of the strait are still overgrown by mangrove forests which are the habitat of various species of bivalves. Information on the species composition and fisheries of these organisms is very important as a basis for management. A from the waters of Rupat island, 14 species of bivalves discovered divided into 12 genera, 12 families, and 7 orders (Table 1 and Figure 2).
Bivalves from several families were studied in this study such as Solenidae, Arcidae, Pharidae, Cyrenidae, Pholadidae, Placunidae, Glauconomidae, Pectinidae, Veneridae Isognomonidae, Ostreidae, and Pinnidae were observed. The number of bivalves in each family reveals that two species belongs to the Cyrenidae family and two to the Arcidae family. One species each were identified from families Solenidae, Pharidae, Glauconomidae, Pholadida, Placunidae, Pectinidae, Veneridae, Isognomonidae, Ostreidae, and Pinnidae (Table 1).

Among those species, *P. expansa* and *P. acutidens* were found in most of the areas. This indicates that this species is the most commercially exploited in the region. Generally, shellfish hunting in the Rupat strait mangrove forest is a secondary source of income for coastal communities. However, population of Bivalves in the area is very low and no longer feasible to rely on as an economic support for shellfish fishing communities these days.

Table 1. Species diversity of bivalve from the strait of Rupat waters.

| Order     | Family    | Genera      | Species               |
|-----------|-----------|-------------|-----------------------|
| Adapedonta| Solenidae | Solen       | Solen lamarckii       |
| Adapedonta| Pharidae  | Pharella    | Pharella acutidens    |
| Arcida    | Arcidae   | Anadara     | Anadara granosa       |
| Arcida    | Arcidae   | Anadara     | Anadara antiquata     |
| Venerida  | Cyrenidae | Polymesoda  | Polymesoda expansa    |
| Venerida  | Cyrenidae | Polymesoda  | Polymesoda eosa       |
| Venerida  | Glaucnonomidae | Glaucnonome | Glaucnome virens     |
| Myida     | Pholadidae| Pholas      | Pholas orientalis     |
| Pectinida | Placunidae| Placuna     | Placuna placenta      |
| Pectinida | Pectinidae| Pecten      | Pecten nobilis        |
| Verseroida| Veneridae | Meretrix    | Meretrix meretrix     |
| Ostreida  | Isognomonidae | Isognomon  | Isognomon ephipium   |
| Ostreida  | Ostreidae | Saccostrea  | Saccostrea cuculata   |
| Ostreida  | Pinnidae  | Atrina      | Atrina pectinata      |

The highest species diversity was found at Sri Tanjung (Site 4) Southeast of Rupat Island, while the second high species diversity was found at Pulau Payung (Site 5) which is in the southwest region of Rupat Island (Table 3). This is thought to be due to the condition of the beach which has a muddy sand substrate with a sloping beach and is overgrown with mangrove forests of the Evecennia which are quite good condition. Each family contains only one species, except for the families Arcidae and Cyrenidae, each of which has two species.

Bivalves species that are relatively widely distributed in the waters of the Rupat strait are *P. acutiden, A. granosa*, and *P. expansa*, while the other species are only found at certain stations (Table 2). In this study, it was difficult to do quantitatively because of the low level of individual Bivalvia at each observation station.

Unlike the case with the diversity in Sri Tanjung and Pulau Payung, Bandar Bakau, Selinsing and Basilam Baru which are on the coast of Dumai city, have lower diversity, especially Bandar Bakau. Low species diversity of bivalves recorded from Bandar Bakau coast could be attributed to the stresses due to fishing and physical and chemical stresses resulting from urban, industrial, and port activities from Dumai city. Competition for space and food, as well as zonation in soft sediments and stable substrates [23] and increased exposure to wave action [7], as well as changes in the physical and chemical characteristics of the water as a result of anthropogenic effects on the ecosystem [24,25].

Bandar Bakau is actually a mangrove ecotourism in the city of Dumai with an area of about 26 hectares which is managed by a community group that loves marine nature. The community-managed mangrove forest is about 2 KM from Dumai City Center, in the midst of the activities of the port, palm oil processing industry, public port, and residential areas. This could be also be linked to the turbid
waters of these two places, which provide the necessary food for bivalves while simultaneously providing protection from shellfish collectors [6].

Table 2. Frequency of species bivalves found at each sites of Rupat Strait waters.

| No. | Species                        | Study Sites |
|-----|--------------------------------|-------------|
| 1   | Solen lamarckii                | x           |
| 2   | Pharella acutidens             | x x x x     |
| 3   | Anadara granosa                | x x x       |
| 4   | Anadara antiquata              | x           |
| 5   | Polymesoda expansa             | x x x x x   |
| 6   | Polymesoda erosa               | x x         |
| 7   | Glauconome virens              |             |
| 8   | Pholas orientalis              | x x         |
| 9   | Placuna placenta               | x           |
| 10  | Pecten nobilis                 | x           |
| 11  | Meretrix meretrix              | x x         |
| 12  | Isognomon ephipium             | x           |
| 13  | Soccastrea cucculata           | x x         |
| 14  | Atrina pectinata               | x           |

Number of species: 4 4 3 11 7

The low diversity of bivalves in this area is most likely due to physico-chemical factors such as slope, amount of light available, tidal exposure circulation, turbidity, substratum, sediment grain size turbulence of water salinity of water, oxidation reduction state, organic content, availability of elements and dissolved oxygen as well as nutrients [1,26]. For defining benthos distribution patterns, numerous parameters, such as locale, distance from the shore, depth, river proximity and local oceanographic phenomena such as bottom currents, appeared to be important [27]. It is also linked to these places’ stable physico-chemical conditions [23], as well as habitat stability and wave intensity [8]. The regional distribution of benthos has been linked to both tidal exposure period and sediment particle size [28].

The establishment of national and international private companies in Dumai, such as public and special ports, oil and gas processing firms, palm oil processing, bulking, biodiesel, cement gaskets and so on. The Rupat Strait is used to dispose of waste and effluent water from petrochemical complex and other enterprises.
**Figure 2.** Species of bivalves recorded along the Strait of Rupat during the study.

Marine pollution occurs when detrimental or potentially hazardous effect come from the introduction of particles, chemicals, industrial and residential wastes, noise or the spread of invasive creatures into the ocean, with the majority of marine pollution occurring on land. Many potentially harmful substances cling to microscopic particles, which are deposit or filter feeders. Toxins are concentrated upward in ocean food chains in this fashion. Many particles interact chemically in a way that depletes oxygen, generating anoxia in estuaries. When pesticides are introduced to the marine ecology, they are swiftly absorbed by the food webs.

Once these pesticides enter food webs, they can trigger mutations and diseases that are hazardous to humans as well as the entire food chain. These hazardous metals have the potential to enter marine
food chain. Tissue matter, biochemistry, behavior, reproduction and growth in marine life can all be affected. In addition, many animal meals contain a lot of fish meal or fish hydrolysate. Toxins from the sea can be transported to land animals, and then end up in meat and dairy products.

Marine bivalves have been threatened by unregulated harvesting, habitat degradation, poor waste disposal, plastic wastes and oil pollution from boat discharge. Runoff from rivers that drain to the shore can cause habitat loss in the coastal area. Each trawling operation causes the benthic populations to dwindle, destroying the marine environment [29]. Sedimentation, residential sewage disposal, industrial waste, overfishing and tourism are among difficulties that bivalves in the Rupat Strait face.

Because no previous reports on bivalve species from Rupat strait waters exist, the data reported here can be used as a baseline for understanding the state of bivalves and the impact of industrial development on them, as well as for improved management of marine bivalves.

4. Conclusion
The finding of this investigation revealed that the Strait of Rupat Island is home to a wide array of bivalves. All of the families recorded in the study are dominated by bivalve species from Veneridae and Arcidae families. Bivalves in close proximity to human populations have fewer species, whereas those in a community away from human activity have a more diversified collection of species. Variations in species abundance could be the result of anthropogenic activity in Dumai City and Rupat Island. Overfishing, habitat loss, sewage, wastes and effluents disposal, reclamation, sedimentation and tourism will all have an impact on the coastal ecology. The current data on marine bivalve species diversity could serve as a baseline for future monitoring of anthropogenic effects on bivalves in the Rupat Island Strait.

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