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The distribution patterns and biomass of bivalves in Segoro Tambak estuary, Sedati, Sidoarjo, East Java

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Abstract. Indonesia's marine waters have a variety of flora and fauna species that live and associate therein. This study used an observation method with a descriptive analysis. The results showed that the bivalvia distribution pattern in Segoro Tambak Estuary looked diverse with a distribution index value of <1 which was in the range of 0.3 - 0.4. The highest average bivalve biomass was temporally at 2.02 ton/km^2 in March, and the lowest biomass was 0.95 ton/km^2 in January. The highest total average density was 6 ind/10m^2 in March and the lowest was 3 ind/10m^2 in February. Low wind and current speeds in March caused the highest density and biomass. The content of the organic matter was the following: BOD in the range of 33.38 to 53.89 mg/l from the threshold of <20 mg/l and COD in the range of 242.6-643.11 mg/l from the threshold of 80 mg/l. This showed very high values and far exceeded the threshold, but bivalves can still live in these waters because bivalves are aquatic bioindicators. The bivalve life of Segoro Tambak Estuary is also supported by muddy substrate conditions that are suitable for bivalve life.

1. Introduction

Indonesia's marine waters consist of various species of flora and fauna that live and are associated therein [1,2]. Approximately 80% or about 8.000 species live in the various depths of Indonesia's marine waters, and the rest are in freshwater [3]. Bivalves are a type of mollusk that live in both freshwater and marine water, mostly as a microphagous. Bivalves as an organism are generally found in marine waters, especially in coastal zones or littoral zones that are widely used by most people [1,2]. The bivalve class includes various kinds of shellfish and mussels as a component of the food chain, and they can also be indicators of water quality monitoring [3,4]. Many bivalves have an economic meaning, namely as food sources such as *Anadara granosa, Anadara antiquate, Anadara gubernaculum* and *Anadara inaequivalve* [5].

The spread of bivalves in water is determined by the abiotic, biotic and bivalve tolerance of each of the involved environmental factors. The abiotic factors include water chemistry, the type of substrate, food availability and biotic factors such as the life cycle patterns that are associated with bivalve distribution patterns [6]. Distribution patterns can be defined as patterns of distance between individuals within a population of boundary [7]. Random distribution is a rare thing in nature [8]. Similar distributions can occur when competition between individuals is hard enough that there is an interaction of positive antagonism that encourages the sharing of the same space. However, the most common pattern of spread is clustering [7].

An estuary is closed water located in the downstream part of a river that is linked with the sea, and it is very possible that a mixture between the two will occur [9]. Mixing these two water masses can result in physical changes such as sedimentation. These physical changes can have a major influence on the biota that need to adapt to their environment. The estuary area is a habitat for various kinds of benthic animal organisms, one of which is bivalves [1]. Segoro Tambak Estuary is a location used for fishing for shellfish by the local community [10]. The work of shell fishing is done in the traditional way, but the exploitation of these resources tends to override the principles of natural resource sustainability. The pressure related to the preservation of the shell resources at Segoro Tambak Estuary is feared to increase with the advance in the activity of the people in the region.

So far, there has been no specific research conducted that examines the distribution patterns and biomass of the bivalves at Segoro Tambak Estuary. The purpose of this study was to determine the distribution patterns and biomass of the bivalves at Segoro Tambak Estuary, Sedati, Sidoarjo, East Java.

2. Material and methods

2.1 Place and time of research

This research study was carried out at Segoro Tambak estuary, Sedati, Sidoarjo, East Java in January - March 2018.The sample processing was carried out in the Laboratory of Anatomy and Aquaculture Faculty in the Fisheries and Marine sector at Universitas Airlangga, in the Laboratory of the Research and Standardization Agency (BARISTAND) Surabaya, in the Nutrition Laboratory of Public Health Faculty Universitas Airlangga and in the Soil Mechanics Laboratory of Institut Teknologi Sepuluh.

2.2 Tools and material

The tools that were used in this research study included a boat, trawl, basket, water samplers, ice cooler box, plastic bag, refractometer, thermometer, Secci Disk, pH pen, paper tags, permanent marker, Ekman Grab, Global Positioning System (GPS), bivalvia samples, seawater, sediment, HNO3 solvent and ice cubes.

2.3 Method

This study used an observation method with descriptive analysis, carried out by describing the data collected, without intending to make conclusions that applied to the public.

2.4 Bivalve sampling

Bivalve sampling was carried out using a trawl. A trawl is an item of fishing gear made out of semi-circular iron with its sides having a dividing net. The maximum number of trawls used in one boat is three [11]. Garments that have been equipped with a rope are lowered to the bottom of the water and pulled by the boat for one minute at a speed of 3-4 m/min at a predetermined point. Later on, the trawl can be lifted out of the water after three minutes. The bivalves that were already clean from the mud were put into a plastic clip that had been labeled and distinguished by repetition. The bivalve samples that have been in a plastic bag were then put into a cooler box that already contained ice cubes. After that, the bivalve samples that had been labeled were transported using a vehicle to the Laboratory of Anatomy and Cultivation in the Faculty of Fisheries and Marine in University Airlangga to observe their biomass.

2.5 Sediment sampling

The sediment sample was taken using an Ekman grab device at the same point as the bivalve sampling. According to[12], the Ekman grab is suitable for soft sediment sampling from a boat because it only can be done at each point on the spot and does not need to be repeated. The Ekman grab was sunk to the bottom of the water, and then the ballast iron was pushed into the water so then the Ekman grab could be closed. The closed Ekman grab was then lifted onto the boat to handle the sediment. After that, the sediment sample was put into a cooler box to be taken to the Soil Mechanics

Laboratory of the Institut Teknologi Sepuluh November, Surabaya and the Nutrition Laboratory of the Public Health Faculty of Universitas Airlangga, Surabaya to test the organic substrates and ingredients in the sediment.

2.6 Water sampling
Seawater sampling was taken to obtain data on the water quality. The water sample was taken from the boat using a water sampler at a depth that was 30 cm below the surface of the water and the collected sample was put into a bottle. The water sample was immediately stored in a cool box filled with ice cubes at a temperature of ± 4^o C. Storing the sample at a temperature of ± 4^o C can preserve a sample for up to 1-2 days in storage. The water samples obtained were immediately taken to the Laboratory of Research and Standardization Agency (BARISTAND) in Surabaya to be tested for ammonia, nitrite, nitrate and COD.

2.7 Data analysis
The data analysis was carried out descriptively, which is a matter of describing the data that has been obtained. The research data was processed using calculation parameters with the identification data as a reference. The calculation parameters that were used included a distribution index (Id), density index (Q) and a biomass index (B).

2.7.1 Distribution Index

$$\boldsymbol{Id = \frac{n \sum Xi^2 - N}{N\,(N-1)}}$$

Information:
Id = Morisita index
n = Number of sampling points
N = Total amount of individuals obtained
Xi = Amount of individuals in each point

The results of the Morisita index were grouped as follows:
Id <1 : Various distribution patterns
Id = 1: Random individual distribution patterns
Id> 1: Grouped individual distribution patterns

2.7.2 Density Index

$$\boldsymbol{D = v\ x\ t}$$

Information:
D : Long Sweep or / Distance swept (m)
v : Withdrawal Speed (Km/hour)
t : Withdrawal time (hours)

2.7.3 Biomass Index

$$a = D\ x\ h$$

Information:
a : Unit length of swept area (m^2)
D : Long Sweep or / Distance swept (m)
h : Trawl length (m)

$$\boldsymbol{Q = \frac{Cw}{\frac{a}{Cf}}}$$

Information:
Q : Density per sweep area (ind/m²)
Cw : Fishing Results (ind)
a : Length of sweep area (m^2)
Cf : Breakout factor (0.4)

3. Results and discussion

3.1 Results

Segoro Tambak Estuary is a clam fishing area. It is the meeting place for several river streams that have a more varied mixture of water and organic matter. The dominant bivalves that live in Segoro Tambak Estuary include Anadaragranosa, Anadarainequivalvis, Anadara gubernaculum, Mactra sp. and Paphia undulate, which are on average 3-6 cm long and 4-5 cm wide. The most common bivalve species that can be found is Anadaraina equivalvis and the least common is Mactra sp. The results of the bivalve identification from Segoro Tambak Estuary can be seen in Figure 1.

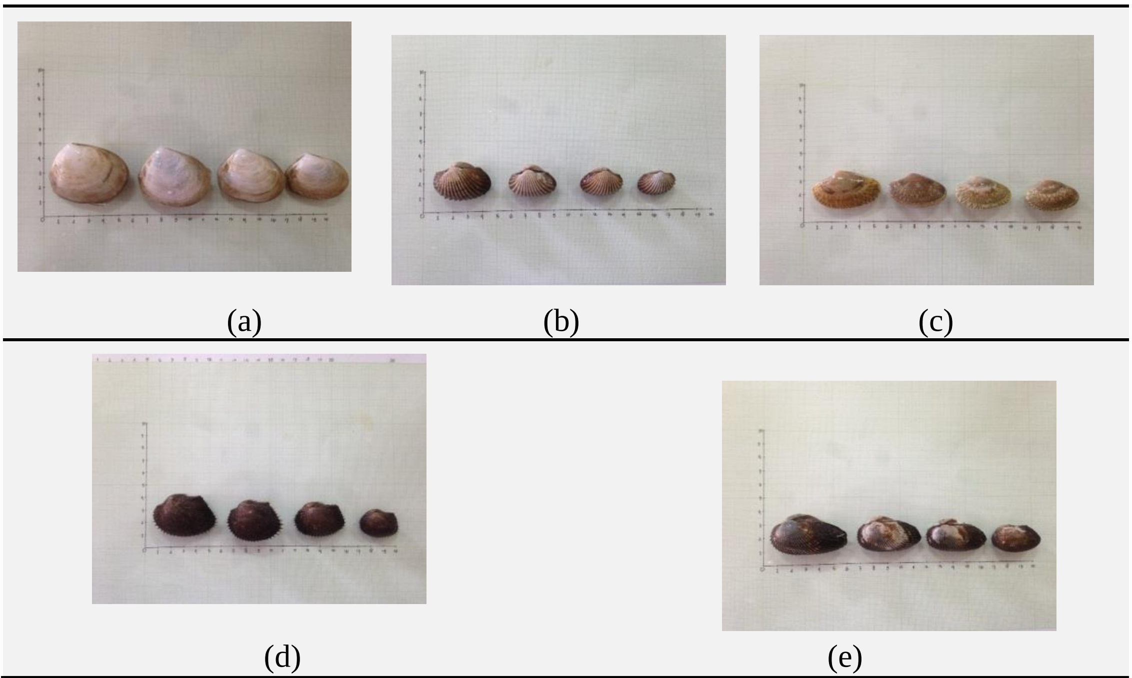

Figure 1. The results of the bivalve identification from the dominant method of fishing at Segoro Tambak Estuary: (a) *Mactra* sp., (b) *Anadara granosa*, (c) *Anadara gubernaculums* (d) *Anadara inaequivalvis* and (e) *Paphia undulata*.

The results of the research at Segoro Tambak Estuary undertaken for three months of observation showed that the bivalvia distribution pattern at Segoro Tambak Estuary looked to be diverse with a distribution index value of <1, which is in the range of 0.3 to 0.4. The bivalve distribution pattern data can be seen in Table 1.

Table 1. The bivalve distribution patterns in Segoro Tambak Estuary for the January - March 2018 period.

Period	Distribution Index Value	Distribution Pattern
January	0,35	Similar
February	0,38	Similar
March	0,4	Similar

The average biomass value of the highest bivalves was temporarily 2.02tons/km^2 in March and the average biomass value of the lowest bivalves was temporarily 0.95tons/km^2 in January. The temporarily average biomass data of the bivalve at Segoro Tambak Estuary can be seen in Figure 2.

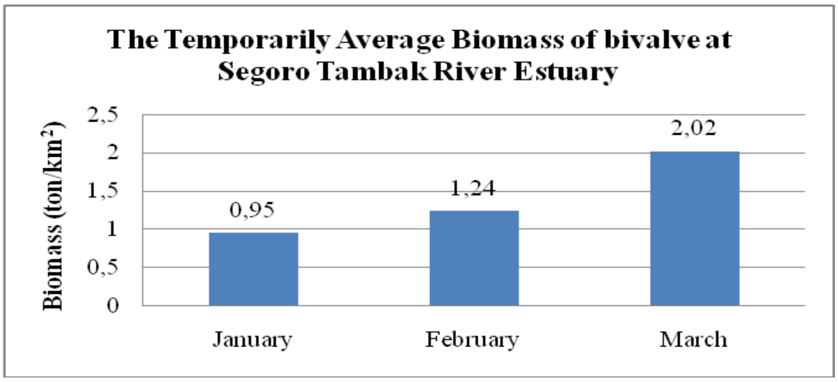

Figure 2. The temporary average biomass data for bivalves at Segoro Tambak Estuary

The highest total average density value was 6ind/10m^2 in March and the lowest density value was 3 ind/10m^2 in February. The density average of the bivalves at Segoro Tambak Estuary can be seen in Figure 3.

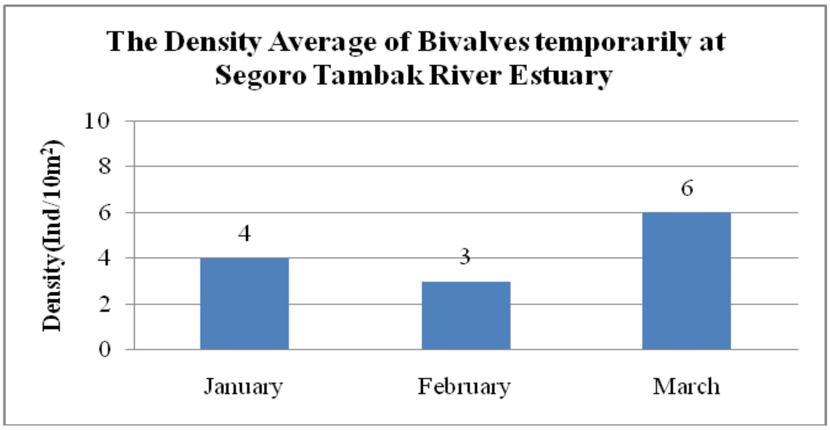

Figure 3. The density average data of bivalve temporarily at Segoro Tambak Estuary temporarily

The test results focused on the sediment fraction of Segoro Tambak Estuary examined at the Soil Mechanics Laboratory of Institut Teknologi Sepuluh November Surabaya showed that Segoro Tambak Estuary was dominated by mud. The results of the Segoro River Estuary sediment testing in the January to March period can be seen in Table 2.

Table 2. Test results of Segoro Tambak Estuary in the January to March period.

	Parameter	Unit	Value
Organic Matter	C	%	24,76-31,25
	N	%	9,25-10,73
	P	%	0,74-0,98
	COD	-	49,79-58,64
Fraction	Gravel	%	1,91`
	Sand	%	9,43
	Mud	%	88,67
	Particle Size	Mm	<0,075
	Substrate Size	-	Muddy

The results of the water quality measurements were obtained from direct measurements in the field and also from in the laboratory. Data on the water quality of Segoro Tambak Estuary in the January to March period can be seen in Table 3.

Table 3. The results of the water quality measurements from Segoro Tambak River Estuary in the January to March Period

Parameter	Unit	Test Result	Quality Standard
Temperature	°C	27,7-30,8	28-32
Ph	-	7,9-8,4	6, 5-8,5
DO	Ppm	5,16-6,53	>5
Salinity	Ppt	28-36	-
Transparency	M	0,8-2	>3
Suspended Solids (TSS)	mg/l	8-48	80
Free Ammonia (NH3-N)	mg/l	<0.0113	0,016
Nitrate (NO3-N)	mg/l	<0,011-<0.030	0,008
Nitrite (NO2-N)	mg/l	0,012-0,03	0,06
BOD	mg/l	33,38-53,89	<20
COD	mg/l	242,6-643,11	80

Information: Results of the Primary Data Processing
Quality standards based on the Minister of Environment Decree No. 51 of 2004

The data on the oceanographic conditions that included wind speed and current speed were obtained from the Tanjung Perak Maritime Meteorology Station in Surabaya. The data of the wind and current speed of Segoro Tambak Estuary can be seen in Table 4.

Table 4. Data on the wind and current speed at Segoro Tambak river.

Month	Wind Speed (knot)	Current Speed (cm/second)
January	3,70	1,81
February	3,72	1,51
March	2,12	0,68

Information: Secondary Data (Tanjung Perak Maritime Meteorology Station, Surabaya, 2018).

3.2 Discussion

The biomass and dispersal of the bivalves in the water is determined by the biotic and abiotic environment, and also the bivalve tolerance of each of the environmental factors [6]. These physical changes can have a major influence on the biota when it comes to them adapting to their environment. The input of the water that comes from the river flow in Segoro Tambak Estuary will also affect the life of the biota inside it. Segoro Tambak Estuary has more than one flowing river, so it has a high content of organic matter [13]. Mixing the two water masses can lead to physical changes such as sedimentation [9].

The bivalve distribution pattern in Segoro Tambak Estuary looks similar to the temporary observations with a distribution value of <1. This is supported by the statement of [14] who revealed that the value of the Morisita index (Id <1) showed that the pattern of the distribution of the biota in the waters was identical. The diversity distribution pattern can occur because bivalve larvae are not settled in the water or substrate when the time comes to metamorphose into adulthood. Larvae react to certain physical chemical factors such as what is present if the substrate is not in a good state. If the biota it requires is not permanent, then there is no metamorphosis [15].

The oceanographic conditions also have an effect on the bivalve distribution patterns in water. This is related to the wind and the current speed. The highest density and biomass documented occurred in March. This is because the wind and the current speed in March had the lowest value compared to

January and February. The current is a limiting factor because it can affect bivalve life; this is where a strong current will blow the organism, so then only certain types are able to survive [16].

Segoro Tambak Estuary is water that is related to mangrove areas, which is the main cause of the high organic matter content level in these waters. Bivalves can still live in this condition despite the high levels of BOD and COD that are far beyond their usual limit. These conditions are because the nature of bivalves is as a bioindicator; it can withstand high BOD and COD conditions, but bivalves do more osmoregulation processes than just digest food, causing the biomass values to be low. Thus the regulation of mollusk osmoregulation is a special adaptation technique that will keep them alive in a new environment, where there is an imbalance in the amount of water needed to maintain their body fluids wherever they live [17].

4. Conclusion
The highest average bivalve biomass and density was in March. The pattern of bivalvia distribution and biomass in Segoro Tambak Estuary was influenced by environmental conditions, oceanographic conditions and the fishing activities done by local fishermen.

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