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Effect of Water Quality on Community Structure of Bivalve at Segoro Tambak Estuary, Sidoarjo, East Java, Indonesia

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Abstract: Identification **of** water quality is an important factor because water supports the community structure of an organism. Bivalves are one of bioindicators in aquatic ecosystems in Segoro Tambak Estuary, which receive wastewater from landfill waste disposal. The bivalve community structure needs to be evaluated because the environmental changes that occur in waters can lead to structural changes of the bivalve community. The sampling was conducted in January – March, 2018. The water quality and environmental parameters observed were dissolved oxygen (DO), biochemical oxygen demand (BOD), temperature, salinity, current speed and wind speed. The bivalve community structure can be seen from the composition, diversity (H'), evenness (E) and dominance (C). The results showed that the water quality of Segoro Tambak Estuary was in accordance with the standard of quality of life of marine biota, temperature 28-30.6ºC, DO 5.6-5.9 ppm, salinity 29-36 ppt, BOD 44.80 with current speed 0.68-1.81 cm/s and wind speed 2.12-3.72 knots. The dominant bivalve species found in the waters of Segoro Tambak Estuary were *Anadara granosa*, *Anadara inequivalvis*, *Anadara gubernaculum*, *Paphia undulata* and *Mactra* sp. The lowest diversity value was observed in January (0.61) and the highest was observed in March (1.38). The highest evenness value observed in March (0.86) and the lowest in January (0.56). The lowest dominance value was seen in February (0.28) and the highest value in January (0.68).

Key words: Water quality, community structure, bivalve, East Java.

Introduction

Sidoarjo Regency is a developing region that has progressed quite rapidly (Ayunita, 2014; Moko and Wiweka, 2012), with the potential of industry, tourism, trading and small or medium enterprises. The direct impact was waste generated from industrial and household activities. Liquid waste generated by industry exits in the flowing river and affect estuary waters (Harlyan and Sari, 2015; Rahardja et al*.,* 2013; Sari et al., 2018). One of the estuaries that received the impact is Segoro Tambak Estuary, which is located at the coastal area of Sedati Subdistrict, Sidoarjo Regency (Sari et al., 2019).

The impact of waste leads to water pollution that disrupts the ecological system. Bivalves are organisms that can be used as a bioindicator in aquatic ecosystems (Macintosh et al., 2002). Bivalves or shellfish can

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be found in estuary because they have a sedentary lifestyle and have the ability to respond to the water conditions at individual, as well as community level (Dewi et al., 2018; Liyana et al., 2018; Pursetyo et al., 2015). The higher the level of water pollution, the lower is the abundance of bivalves. However, if the level of pollution in waters is low, then the abundance of bivalves in waters will increase (Riniatsih and Kushartono, 2009).

The previous research work on bivalves in Sedati water area has been carried out by Zakaria (2017) who discusses the relationship of body length and condition factors of saltwater bivalves (*Anadara* sp.). However, no research has been conducted on bivalve community structures in Sedati waters. Hence, research on bivalve community structure needs to be done, because the changes of environmental parameters that occur in waters can cause shifting structure of the bivalve community (McKeon et al., 2015).

The study is beneficial as it provides information to the public about effect of water quality on bivalve community structure at Segoro Tambak Estuary, Sedati, Sidoarjo, East Java, Indonesia. This is a basic knowledge and source of information regarding the connection of environmental habitat and bivalves.

Materials and Methods

The research method used in this research is a survey method with the determination of the station, which is carried out using purposive sampling technique. Determination of the sampling point is carried out using stratified random sampling or layered random sampling, which is a sampling conducted from the coast to the sea.

Determination of Sampling Locations

The location of the observation was determined based on the representation of the research area, which is Segoro Tambak Estuary, Sedati, Sidoarjo. This location is a fishing area that has bivalve resource potential. Sampling was carried out at three points with five replications for each point. Sampling was conducted every month, from January to March, 2018. Determination of the location point of study was carried out using Global Positioning System (GPS) and preliminary research was carried out to determine the coordinates and find out the activity at the research location.

Table 1: The coordinates of the sampling location

Location		*Coordinate point*	
		Longitude	*Latitude*
Segoro Tambak	1.5 km	07° 20.361′	112° 51.336′
	1.75 km	07° 20.360′	112° 51.468′
	2 km	07° 20.369′	112° 51.633′

Water and Substrate Sampling

Substrate sample from the bottom of water were taken using Ekman Grab at each point. Sediment samples were put in zip lock plastic that has been labeled with names (station names, point and repetition of retrieval), then stored in ice cooler box and transported to laboratory for further observation. Observation of fractions and substrate type was carried out in Soil Mechanics Laboratory of Civil Engineering Faculty of Engineering and Planning of Institut Teknologi Sepuluh November Surabaya. The organic matter contents of the samples were analysed in the Nutrition and Food Laboratory of Public Health Faculty, Universitas Airlangga Surabaya.

Bivalves Sampling

Bivalvia samples were collected using a specialised fishing gear (local name: garits). Then the samples were stored in a cooler box and transported to the Laboratory of Anatomy and Aquaculture of Faculty of Fisheries and Marine Universitas Airlangga Surabaya for further analysis.

Composition

The composition of bivalves at Segoro Tambak Estuary, East Java was identified by referring to Tunnell (2010), Gosling (2003), Abbott and Dance (1998), Palomares and Pauly (2018), website was made about marine life and previous research regarding the identification of bivalves in the coastal waters of Sidoarjo (Ambarwati and Trijoko, 2011).

Diversity Index (H')

Diversity index (H') is a mathematical measure that describes the diversity of species in a given community (Taqwa, 2010). Species diversity was calculated using the Shannon-Wiener diversity index formula (Krebs, 1989).

Evenness Index (E)

Evenness is an individual composition of each species which is found in the community (Krebs, 1989).

Dominance Index (C)

Dominance index is mathematical measure of each species value in relation with community as a whole (Krebs, 1989).

Results and Discussion

Water Quality Conditions in Segoro Tambak Estuary

Environmental parameters of Segoro Tambak estuary are presented in Figures 1 to 4, and important values of bivalve community are presented in Figure 5. Observations taken in January showed a lower value of diversity and evenness compared to dominance values (Figure 5). The existence of a certain type of dominance in the sampling location has been recorded. The low diversity index in January can be caused by the low BOD in the waters. The BOD value indicates the content of organic matter in waters (Dewi et al., 2017). Organic matter that settles at the bottom of the water is a source of food for macrozoobenthos organisms in the form of 88% mud (Putri et al., 2016). Bivalves prefer habitats with sandy substrate bases to muddy sediments on the bottom surface of the substrate; this is related to biota's behaviour either to get food with filter feeders or to dig holes to avoid predators (Hasan et al., 2017).

Observations in February and March showed higher values of diversity and evenness compared to dominance values (Figure 5). These results indicate that the number of individuals in each type is relatively same and there are no certain types of individuals who dominate. In addition, it also shows that the environmental conditions are suitable for bivalve life. Diversity index describes the ecological balance in a community, the higher the value of diversity, the better the quality of the environment and the bivalve life (Akhrianti et al., 2014).

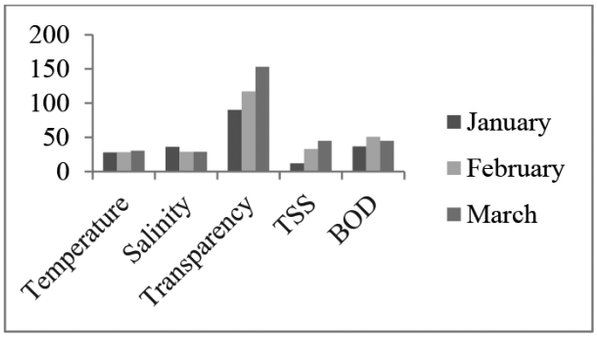

Figure 1: Temperature, salinity, transpatency, TSS and BOD of Segoro Tambak Estuary.

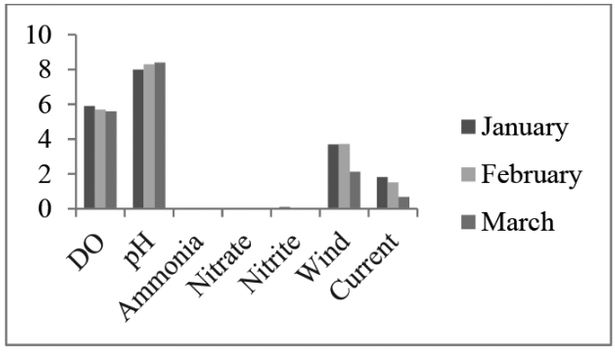

Figure 2: DO, pH, Nitrate, Nitrite, wind current of Segoro Tambak Estuary.

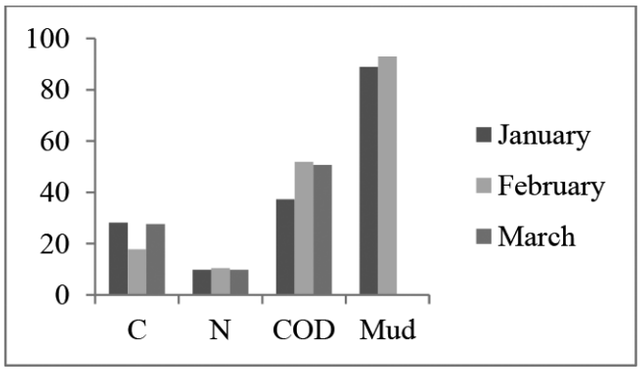

Figure 3: Substrate of the bottom of Segoro Tambak Estuary (carbon, nitrogen total, COD and Mud).

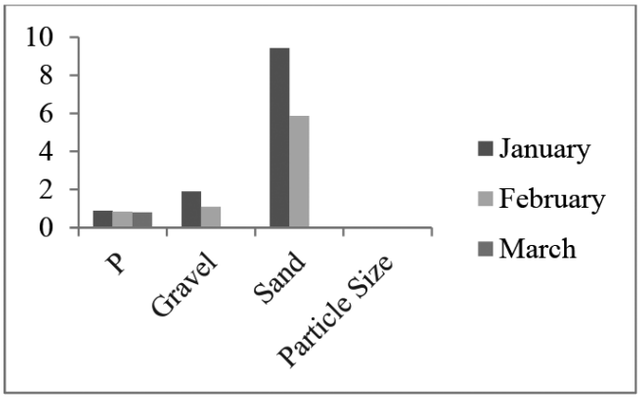

Figure 4: Substrate of the bottom of Segoro Tambak Estuary (phosfor, gravel, sand and particle size).

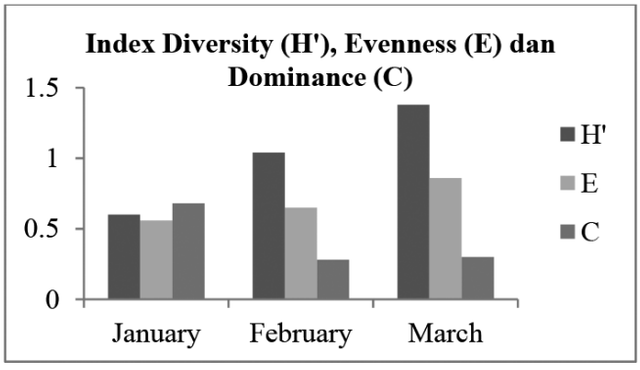

Figure 5: Diversity Index (H'), Evenness (E) and Dominance (C) Bivalvia in Segoro Tambak Estuary from January to March 2018.

Overall, water conditions such as temperature, DO, pH and salinity in the Segoro Tambak Estuary from January to March are still at tolerance values for bivalve life and in accordance with the standard of living quality of marine biota according to standard of Indonesian ministry of environment.

The temperatures ranged from 28 to 30.6ºC, which was suitable for bivalve growth and comparavity to the results by Broom (1985) that is 25-32.5ºC. The DOs ranged from 5.6 to 5.9 ppm which was suitable for marine biota life, that is, > 5 ppm (Minister of Environment Decree, 1998). Water pH ranges from 8 to 8.4 which is reported to be suitable for marine biota life (Minister of Environment Decree, 1998). Water salinity at the time of the study ranged from 29 to 36 ppt, reported tolerable to bivalve life, which is comparative to 26-35 ppt (Broom, 1985).

The impact of winds and currents in these waters caused an increase in the diversity index from January to March. In January, wind speeds and currents were higher than in February and March. The current speed reached 1.84 cm/s in January while in March, the current speed was lower at 0.68 cm/s. This result is in accordance with Andri et al. (2012), who reported that macrozoobenthos prefer calm-flowing waters and have inherent properties or relatively mobile life, which means an increase in current speed will reduce macrozoobenthic diversity in the waters another factor being fishing activities. Excessive fishing contributes to the decrease in bivalvia in the intertidal zone (Novoa et al., 2016). The total fishing of shells in Sedati waters, Sidoarjo has reached 1,553,772 kg and it was categorized as overfishing according to WWF (2017).

Bivalve or shellfish includes phylum Mollusca because they are triploblastic and the body is soft (Subekti et al., 2015). Phylum Mollusca are referred as bivalve because it has two valves (Gosling, 2003). The differences in the character of bivalves that can be used as a reference for identification are the gill structure, type of life, shell morphology, hinge and ligament growth, shell texture, size and shape of the pallial line (Tunnell, 2010). There are two orders found which are Arachnid and Veneridae. According to Breiter-Hahn et al. (1984) members of the Arcoida order are species that have different plates and hinges showing different structures, which is flat and irregular lamella structures. There are three orders, specifically, Arcidae, Veneridae and Mactridae. According to Ambarwati and Trijoko (2011), most members of Arcidae live in intertidal zone and shallow waters and the Anadara genus are shallow diggers on mud and sand substrate. Veneridae are large, flattened like axes and have “heel” which is mainly used for digging, it also has a deep pallial groove, little shell ornaments and the shell is smooth (Ambarwati and Trijoko, 2010). Mactridae is known as the Atlantic surf clam family, which lives in the bottom on sand and mud (Ambarwati and Trijoko, 2015).

A. granosa, *A. inequivalvis* and *Paphia undulata* belong to the *Arcidae* family with the highest presence at Segoro Tambak Estuary. *A. granosa* and *A. inaequivalvis* are included in *Arcidae* family. The *Arcidae* family has a cosmopolitan nature and is spread in tropical and subtropical waters, Riniatsih and Widianingsih (2007). In addition, Lindawaty et al. (2016) also states that *Anadara* sp. is one of the bivalve class biota that lives in the sea, especially in the littoral zone, partly in tidal and fresh water areas, and it is also found in the bottom of sandy and muddy waters. The value of bivalvia evenness during the study ranged from 0.61 to 1.38. The highest value evenness at Segoro Tambak Estuary at that time of the study was in March (0.86). Meanwhile, the lowest value was in January (0.56). The low value of evenness shows that the number of species that live in the area is small. The high or low value of species evenness can be caused by several things, such as the number or type of individual, the dominance of certain types and the substrate of the bottom waters, which is the habitat of bivalves (Irawan, 2008).

Conclusion

The results showed that the quality of water in Segoro Tambak Estuary is in accordance with the standard of quality of life of marine biota, temperature 28-30.6ºC, dissolved oxygen (DO) 5.6-5.9 ppm, salinity 29-36 ppt, BOD 44.80 with current speed 0.68-1.81 cm/s and wind speed 2.12-3.72 knots. The dominant bivalve species found in the waters of Segoro Tambak Estuary were *Anadara granosa, Anadara inequivalvis, Anadara gubernaculum, Paphia undulata* and *Mactra* sp. The lowest diversity value was in January, which was 0.61 and the highest was in March at 1.38. The highest evenness value in March was 0.86 and the lowest was in January at 0.56. The lowest dominance value in February was 0.28 and the January high was 0.68.

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