Relationship between substrate characteristics and abundance of Polychaeta in Tanjung Tiram Waters, Batubara Regency, Sumatera Utara Province

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Abstract. The existence of polychaeta in water is very important to support the life of organisms and illustrate the fertility of the waters. This study aims to measure the content of C-organic in the substrate and determine the relationship of substrate characteristics to the diversity of polychaeta. This research was conducted in the waters of Tanjung Tiram, Batubara Regency, North Sumatra Province in June-July 2019. Determination of the location of sampling using a purposive sampling method at three stations. Intake of C-organic and Polychaeta by placing 3 plots horizontally at each observation station. The results obtained by an average of C-organic content with a range of values of 0.56% - 2.48%, found 12 species of polychaeta and diversity values ranging from 0.52 to 1.92, including the medium category. Pearson's correlation between polychaeta diversity and C-organic has a negative relationship.

1. Introduction
Tanjung Tiram waters area has a variety of potential resources, namely biological and non-biological resources. One living biological resource is the polychaeta class of the Annelida phylum. Polychaeta is a benthic animal which is commonly found on substrate waters. However, besides having great potential, the variety of human activities around the waters can cause a decrease in the quality of the waters of Tanjung Tiram which can affect changes in the composition of the biota, especially benthic animals. The organic matter in the water has fluctuated due to variations in the amount of good input from waste industrial, domestic, agricultural and other sources. All organic ingredients contain carbon elements. C-organic is the amount of carbon contained in the substrate.

Polychaeta found in the substrate directly utilizes C-organic. Total C-Organic on the substrate can have an impact on the abundance of polychaeta. Polychaeta or commonly known as sea worms, can be found in sedimentary habitats of mud, sand, gravel and rocks. Polychaeta including marine organism that are tolerant of contamination and live in and on surface sediments, moreover polychaeta is often used in biomonitoring the health of the marine environment as an indicator of organic pollutant [1]. This research really needs to be done to find out the C-organic content in several regions with different characteristics that can affect the abundance of polychaeta. Besides that, there is no preliminary information about polychaeta, therefore this study will provide an overview of the fertility of these waters and can be an additional source of information on environmental management of the region further.
2. Material and methods

2.1 Study area
This research was conducted in June - July 2019 in Tanjung Tiram Waters, Batubara Regency, North Sumatra Province (Figure 2). The study was conducted at three stations with a description of the area at each station, namely Station I is located at the coordinates of 3 ° 13 '55 "LU and 99 ° 35'92" East, known as a bar or sandbar. This area is adjacent to the offshore and is strongly influenced by tidal activity, so that when the tide water will form a vast land, and at high tide the area will sink. Station II is ± 300 meters from station I and is located at the coordinates of 3 ° 13 '94 "NU and 99 ° 35'33" East, this station is an area adjacent to community settlements so that many find the influence of human activities. Whereas station III is located at the coordinates of 3 ° 13'06 "LU and 99 ° 35'44" East. This location is a natural mangrove forest area and is affected by tidal activity.

2.2 Procedures
Polychaeta and substrate sampling is done at low tide to facilitate sampling. The polychaeta sampling method is carried out by making squares / plots 1m x 1m and placing squares systematically in a horizontal way at a predetermined research location. The number of plots used at each transect station is 3 plots. So that the total number of plots in one location is 9 different plots. Intake of polychaeta taken in each plot transect using a Parallon pipe to a depth of 30 cm, then carried out separation with the substrate then stored in a plastic bag. Separation between polychaeta and substrate is done in the field with the help of water and filters. Polychaeta samples that had been separated from the substrate were put into a sample bottle that was given 70% alcohol to be identified in the Aquatic Environment Laboratory of the Aquatic Resources Management Study Program, Faculty of Agriculture, University of North Sumatra. The step that will be taken in identifying polychaeta is to make observation by adjusting the morphology of the species level sections by referring to the books of [2], [3] and [4]. The observation is documented.

Measurement of water chemical physics parameters taken during high tide conditions. insitu and exitu. The parameters measured directly are temperature, Water of Transparency, depth, pH of water, dissolved oxygen (DO) and salinity. While the parameters measured exitually were total nitrogen, phosphating, substrate texture and organic C. The substrate sampling is done using a Parallon pipe embedded in the substrate to a depth of 30 cm. Substrate samples are filtered using a filter to separate it from polychaeta. Measurement of substrate sample analysis to determine the value of C-organic and fractions is carried out at the Palm Oil Research Centre (PPKS) Medan.

2.3 Data analysis

2.3.1 Abundance. According to Krebs (1989), the abundance of polychaeta is calculated as follows, where D is abundance (ind/m²), ni is number of individuals of a type and A is wide area.

\[ D = \frac{n_i}{A} \]  

(1)

2.3.2 Relative abundance. According to Shannon - Wiener, relative abundance can use the following formula, where KR is relative abundance (%), ni is number of individuals per species, and N is the total number of individuals.

\[ KR = \frac{n_i}{N} \times 100\% \]  

(2)

2.3.3 Diversity index. Diversity index is calculated by the Shannon-Wiener formula, where H’ is shannon-Wiener diversity index and Pi is proportion of the number of individuals of the i-th species to the total number of individuals, i.e. Pi = ni / N with ni: number of species i; N: total number of species
\[-\sum_{i=1}^{S} P_i \ln P_i\] (3)

Criteria of diversity: \(H' < 1 = \text{low}, 1 < H' < 3 = \text{moderate diversity} \text{ and } H' > 3 = \text{high diversity}\)

2.3.4 Evennes index. Evennes index can be calculated using the formula [5]. Where \(E\) is species evenness index, \(H'\) is species diversity index and \(S\) is number of organisms.

\[E = \frac{H'}{\ln S}\] (4)

Criteria of evennes: \(E < 0.4 = \text{small population uniformity}, 0.4 < E < 0.6 = \text{moderate population uniformity} \text{ and } E > 0.6 = \text{high population uniformity}\)

2.3.5 Dominance index. The dominance index of gastropod organisms can be calculated using the formula [5]. Where \(C\) is domination index, \(n_i\) is number of individuals per species, and \(N\) is total number of individuals

\[C = \sum \left(\frac{n_i}{N}\right)^2\] (5)

Criteria of Dominance: \(C\) approaching 0 \((C < 0.5) = \text{no species dominates and } C\) approaching 0 \((C > 0.5) = \text{there is a type that dominates}\)

2.4 Correlation test

Correlation test is used to find out the relationship of a dependent variable that is abundance with an independent variable that is the physics of water chemistry. Correlation analysis used is the SPSS Pearson correlation which functions to measure the strength of the linear relationship between the two variables. If the relationship between the two variables is not linear, then the Pearson correlation coefficient does not reflect the strength of the relationship between the two variables being studied [6].

3. Results and discussion

3.1 Population abundance

The highest abundance of polychaeta from all stations was found in station II with a value of 26.44 ind/m², while the lowest abundance at station 3 was 8.22 ind/m². Population abundance at the observation station can be known at Station II has the highest type, namely Capitella capitata with the amount ranging from 31 - 40 ind/m², and the lowest type of Nephthys sp is around 3-5 ind/m². While the lowest population abundance at station III with the highest type of Nereis divercolor ranges from 6-7 ind/m² and the lowest type is Namalycastis rhodochorde around 2-3 ind/m².

It can be seen that the highest population abundance is at Station II, this is because at this station there are many organic materials from the influence of community waste in the form of domestic waste or ship cleaning waste. Although the oxygen content at Station II is the lowest, many Capitella capitata types are found in the range of 31-40 ind/m². This is in accordance with [7] which states that Capitella sp is a species that is able to survive in conditions of low DO and high H₂S, this species is able to reproduce well, has a short life cycle. Therefore, it can continuously replenish the sediments affected by pollution. Capitella does not use tolerance as an adaptation but rather adapts to continuous reproduction. This species is able to absorb dissolved organic matter, and is always active and foraging on the surface.

3.2 Relative abundance

From the results of research conducted on the waters of Tanjung Tiram, Batubara Regency, North Sumatra Province, the highest average relative abundance was found in the Capitella capitata type at Station II with a relative abundance of 44.84%, while the lowest average relative abundance was found
in the species namely Namalycastis rhodochorde at station III is 10.75%. Relative abundance can be seen in Table 1.

It can be seen that the relative abundance of polychaeta in the type of Capitella capitata is not found at stations I and III. This shows that the Capitella capitata polychaeta types are found in many environments that find waste due to human activities such as ship cleaning and domestic waste has been polluted. Can be known from the blackish sediment colour due to the waste that settles to the substrate base. This is in accordance with [8] which states that the Capitella capitata worm will be very prominent in the mouth of the river polluted by waste, in waters that are highly polluted this type of worm can reach 96% of the total macrobenthos.

**Table 1.** The relative abundance of polychaeta

| No | Species                  | Station I | Station II | Station III |
|----|--------------------------|-----------|------------|-------------|
| 1  | Lumbrineris sp           | 14.30     | 0          | 17.63       |
| 2  | Namalycastis rhodochorde | 0         | 0          | 10.75       |
| 3  | Nereis virens            | 13.53     | 0          | 24.27       |
| 4  | Nereis divercolor        | 11.77     | 0          | 26          |
| 5  | Perinereis nuntia        | 13.42     | 0          | 21.35       |
| 6  | Arenicola sp             | 0         | 18.15      | 0           |
| 7  | Nephthys sp              | 14.30     | 5.02       | 0           |
| 8  | Terebelides sp           | 11.77     | 7.58       | 0           |
| 9  | Capitella capitata       | 0         | 44.84      | 0           |
| 10 | Amphinome sp             | 0         | 17.19      | 0           |
| 11 | Owenia sp                | 0         | 7.22       | 0           |
| 12 | Schistomaringos sp       | 20.91     | 0          | 0           |

Total 100 100 100

3.3 Index of diversity, evenness and dominance of polychaeta

Based on the results of data processing, the average diversity index value obtained at station I was 1.92, at station II was 0.84, and at station III it was obtained at 0.52. The highest diversity was found at station I. The evenness index value obtained from the data processing showed that station I was 0.99, station II was 0.47, and station III was 0.32. The highest evenness was found at station I. While the dominance index obtained at station I was 0.55, at station II was 0.27, and at station III was 0.22. The highest dominance is at Station II. The results of polychaeta uniformity and dominance index can be seen in Table 2.

**Table 2.** Polychaeta diversity, evenness and dominance index

| Station | H’   | Category | E   | Category | C   | Category |
|---------|------|----------|-----|----------|-----|----------|
| I       | 1.92 | Moderate | 0.99| High     | 0.15| No dominance        |
| II      | 0.84 | Low      | 0.47| Moderate | 0.27| No dominance        |
| III     | 0.52 | Low      | 0.32| low      | 0.22| No dominance        |

From the calculation of diversity index (Table 2) shows that the highest diversity index value is in station I with medium category based on Shannon Wiener diversity index $H' >1 <H <3$ is medium category. The lowest diversity value is found at stations II and III, this is allegedly due to the low value
of dissolved oxygen obtained due to the high organic input material so as to make the uneven number of species found. This is in accordance with [1] which states that the diversity index values describe conditions related to the function of each species to the preservation and carrying capacity of ecosystems. The high value of the diversity index is due to the almost even number of individuals in a location. Conversely, the presence of a dominant species will cause a low diversity index value.

3.4 Substrate texture

The results of substrate texture and substrate type analysis and C-organic content obtained from each observation station showed that the highest percentage of fraction was dominated by sand at each station, and the lowest percentage of fraction was clay. While the highest C-organic content is found in station III with values ranging from 2.15 - 2.48% and the lowest is found in station I with values ranging from 0.56 - 1.05%. The results of measurement of substrate quality and percentage of C-organic are presented in Table 3.

The highest C-organic content is found in station III (Table 3), this is due to the presence of organic material input from the river and the observation station is a natural mangrove ecosystem so that it gets additional organic material from mangrove litter. This is in accordance with [9] which states that the mangrove forest ecosystem is one ecosystem that has high productivity compared to other ecosystems. Organic material from the decomposition of mangrove forest litter is an ecological chain that connects with the surrounding waters.

The lowest C-organic value is found at station I (Table 3) because the basic substrate is sand with coarse particle size. So, it has a weak ability to maintain organic material content. Besides this station has the highest Water of Transparency (Table 4) compared to the other two stations, the low Water of Transparency indicates the amount of organic matter. This is in accordance with [10] which states that the smaller the size of sediment particles, the greater the content of organic matter. High level of Water of Transparency affects nutrients in the waters.

| Station | Deuteronomy | Fraction | Texture Type | C-organic |
|---------|-------------|----------|--------------|-----------|
|         | % Sand | % Dust | % Clay |           |
| I       | 94     | 0      | 6      | Sand      | 0.77     |
|         | 92     | 3      | 5      | Sand      | 1.05     |
|         | 96     | 1      | 3      | Sand      | 0.56     |
| II      | 66     | 26     | 8      | Sandy loam | 2.17     |
|         | 66     | 23     | 11     | Sandy loam | 2.10     |
|         | 68     | 19     | 13     | Sandy loam | 2.00     |
|         | 68     | 26     | 6      | Sandy loam | 2.48     |
| III     | 70     | 21     | 9      | Sandy loam | 2.28     |
|         | 68     | 23     | 9      | Sandy loam | 2.15     |

3.5 Water quality

From the measurement results of water physics-chemical parameters carried out in the waters of Tanjung Tiram can be seen in Table 4. It is known that the low dissolved oxygen at the observation station due to the many waters of the tanjung oyster found the influence of community activities such as domestic waste, cleaning waste fishing boats, and activities crossing sea transportation, and organic matter. Polychaeta is able to live in low oxygen conditions [11]. Therefore, the amount of dissolved oxygen obtained in the study still supports the life of polychaeta. This is in accordance with [8] which states that the organism's need for oxygen varies relative to species. The minimum dissolved oxygen content is 2 ppm under normal conditions and sufficient to support the life of the organism.

The salinity measurement results at the observation station (Table 4) show the variation in values that are influenced by the movement of currents in the waters and the location of the observation station.
located in the estuary, so that it is influenced by fresh water and sea water input. However, the salinity conditions in the study in Tanjung Tiram waters did not have a significant influence on polychaeta. This is consistent with [12] which states that variations in salinity are clearly visible in the estuary region, it is caused by estuary areas affected by the occurrence of sea tides and ebb and the entry of fresh water from the mainland. Tides occur resulting in strong vertical stirring, so salinity can vary.

| Station | Temperature (°C) | Salinity (ppt) | DO (mg/l) | Depth (cm) | Water of Transparency (cm) | pH  |
|---------|------------------|---------------|-----------|------------|---------------------------|-----|
| 1       | 29.67            | 17            | 2.77      | 46.67      | 24.00                     | 7.77|
| 2       | 29.33            | 16            | 2.03      | 38.33      | 10.17                     | 7.79|
| 3       | 29.67            | 14.67         | 2.40      | 48.67      | 20.17                     | 7.77|

3.6 Correlation analysis of polychaeta diversity and abundance with C-organic, % fraction and nitrogen total

Diversity is negatively correlated with organic C, because the type of diversity found is the errantia group. Erantia worms are a group of worms that move freely and like sandy substrates. According to [12] who stated that the way of life of Polychaeta divided into two groups, namely swimming and floating. Errantia subclass including Polychaeta who lived freely, namely swimming and crawling on the seabed. While the relationship between abundance and negative sand fraction is low, because the highest abundance obtained at the observation station is at station 2 which has percentage of clay greater than station 1. Sandy clay texture so that it is able to store organic C better than station 1 which has a substrate sandy. This is in accordance with [13] who stated that the smaller the size of sediment particles, the greater the content of organic matter.

Table 5. Correlation Analysis results between polychaeta diversity with chemical physics parameters

| Correlation   | Diversity | Relationship Level | Abundance | Relationship Level |
|---------------|-----------|--------------------|-----------|--------------------|
| C-organic     | -.859     | Very strong        | .111      | Very Low           |
| %Sand         | .853      | +Very Strong       | -.311     | Low                |
| % Dust        | -.810     | Very strong        | .206      | Low                |
| % Clay        | -.748     | Strong             | .590      | +Medium            |
| Nitrogen Total| -.808     | Very strong        | .426      | +Medium            |

Note: (+) is positively related, (-) is negatively related.

4. Conclusions

The C-organic value obtained in the substrate in the study in Tanjung Tiram waters in the Coal District of North Sumatra Province was at station I ranged from 0.56 to 1.05, at station II ranged from 2 to 2.17, while at station III ranged from 2.15 to 2.48. The relationship of substrate characteristics to the abundance of polychaeta in Tanjung Tiram waters in the Province of Coal, namely the diversity of polychaeta with C-organic is very low. This shows that the value of C-organic can affect the abundance of polychaeta.

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