Plankton diversity in intertidal zone kondang merak beach district of malang, east java

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Abstract. Kondang Merak beach is one of the beaches on the southern coast of Malang district, East Java, which is used as a fishing area and marine tourism destination. Beaches in the south of the Java island has a profile is relatively steep, the substrate of coral, and wavy large, it is the influence on water quality and diversity plankton. This study aims to identification of plankton diversity and abundance in the intertidal zone of Kondang Merak beach. Sample taken using transect method at 8 stations. Each station consists of 3 substations namely the upper intertidal zone, the middle intertidal zone, and the lower intertidal zone. Samples were taken at three times different, ie morning, noon, and night, using net plankton no.25. Plankton diversity was analyzed based on Shanon-Wiener diversity index calculations and relative abundance Odum. The results of the study showed that in the intertidal zone of Kondang Merak beach, found out of 43 types of plankton were consist 29 species phytoplankton and 14 species zooplankton. Index diversity of plankton 2.59 included moderate category. The most abundant is Diatome, relative abundance 19.81%, followed Oscilatoria and Closteriopsis longisima 8.47% and 17.57%. The quality of waters still suitable for sustaining life plankton temperature 26.2-29.45°C, brightness infinitely, Total Suspended Solids 0.321-0.488 g, pH 7.8-8.0, salinity 35±‰O, DO 4.08-6.10 ppm, BOD 0.622-0.994 ppm, and CO₂ 20.29-39.45 ppm.

Keywords: intertidal zone, kondang merak beach, Malang district, diversity index, relative abundance of plankton.

Introduction
Kondang Merak beach is one of the beaches on the southern coast of Malang, East Java, which has an important economic function. Apart from being a fishing location, there are also many tourists visited. Malang is one district that has a coastal region with a coastline a longer, has several mainstay fisheries commodities. Organism seabed of Kondang Merak beach, in addition to community life reef building is a group porifera, annelids, flatworm, cnidaria, gastropoda, bivalves, echinodermata, and crustacea[1]. The flora that lives here includes various species of seaweed, which are clearly visible at low tide. Whereas the fish most caught by fishermen are snapper, tuna, mackerel, squid, and octopus. One of the mainstay famous commodities produced by the Kondang Merak fishermen is sea lobster. Therefore this area is made into a fishing village. On the other hand, because it has a beautiful panorama, this beach is visited by many tourists, especially at the weekend or holiday season.

Changes the landscape in the southern coastal area of East Java south traffic lane could potentially caused lead to a decrease quality of waters [2] resulting in increased sedimentation and various human activities. These changes are due to increased human activities such as sand and stone mining, conversion of forests to agricultural land, and tourism activities as well as inorganic waste disposal. These dynamics have a negative impact on the coastal ecosystem, which in turn has an impact on the marine life in it including plankton [3].

The existence of plankton is indirectly related to the water quality in the region [4]. Changing water functions are often caused by changes in the structure and quantitative value of plankton include diversity, abundance, and so on. That is influenced by environmental conditions, food availability, predation, and competition [5];[6]. The existence of plankton greatly affects life in the waters because it plays an important role as food for various marine organisms. Based on the importance of the role of plankton, as well as the lack of information about presence of plankton in the area coastal south of Malang, it is necessary to study their diversity and abundance of plankton in coastal Kondang Merak.
The purpose of this study is to find out the diversity and abundance of plankton in the intertidal zone of Kondang Merak beach, Malang District, East Java.

Methods
Plankton sampling was carried out at Kondang Merak beach in Malang district, using the transect method at 8 stations. The distance between stations is 100 m, and each transect line is divided into 3 substations, namely upper intertidal zone (10m), middle intertidal zone (100 m), and lower intertidal zone (150 m) from the coastline. Plankton sampling was conducted in 3 periods of time, that morning at 06.00-08.00 pm, noon at 12.00-14.00 pm and evening at 21.00-23:00 pm. At each substation, 3 sample points were taken. Taken the plankton using net plankton number 25 at surface depth, 2 meters, and 5 meters. All filtered plankton are preserved in vial bottles that have been given a labeling and contain 4% formalin solution. Physical-chemical parameters of the waters measured include brightness, total suspended solids, temperature, depth, pH, salinity, DO, BOD, and CO₂. Identification of plankton types was carried out at the Ecology Laboratory, Department of Biology, Faculty of Mathematics and Natural Science, Surabaya State University [7][8][9]. Diversity index (H') is calculated using the Shanon-Wiener index [10]:

\[ H' = - \sum p_i \ln p_i \]

Information:
- H' = species diversity index
- \( p_i \) = \( n_i / N \)
- \( n_i \) = Number of individuals of each species
- N = Number of all individuals

with the following criteria:
- H > 3.0 : High diversity
- 1 < H < 3 : Medium diversity
- H < 1 : Low diversity

The relative abundance is analyzed using the following formula [10]:

\[ KR_i = \left( \frac{n_i}{N} \right) \times 100\% \]

Information:
- KRi = relative abundance
- \( n_i \) = Number of individual types i
- N = total individual of all species

Data on physical-chemical parameters including brightness, total suspended solids, water temperature, salinity, pH, DO, BOD, and CO₂ to be analyzed descriptively and compared with quality standard [11].

Result and Discussion
Kondang Merak beach has a relatively flat beach profile, sandy banks and is influenced by fresh water input from the Kondang river with the farthest tide reaching 200 meters. Steep, with large waves and the farthest recedes are only a few tens of meters with rocky or coral substrates. The results of the identification on the coast of Kondang Merak found 43 types of plankton consisting of 29 species of phytoplankton and 14 species of zooplankton. The number of species found at each different sampling time was different. Plankton diversity index on each zones shows the value of varies. Upper intertidal zone has an index diversity is highest 2.71, followed by lower intertidal zone who has 2.55, and the lowest in the middle intertidal zone is 2.51.

Diversity and number of plankton species are affected by sampling time and location. Plankton is more prevalent during the day in the upper intertidal zone, followed by the middle intertidal zone, and at least in the lower intertidal zone. The plankton diversity index in the intertidal zone is 2.59 is demonstrated that the community of plankton in this beach have moderate diversity.
The most abundant phytoplankton is *Diatome, Oscillatoria and Cylindrocystis* with relative abundance of 41.43%, 33.93% and 16.84%, and zooplankton are *Spirostomum ambiguum, Dinoflagellata* and *Dientamoeba* sp. with relative abundance 21.92%, 20.16%, and 7.99% (Table 1).

**Table 1.** Types, Index Diversity and Relative Abundance of Plankton in Intertidal Zone Kondang Merak beach, District of Malang, East Java

| No | Genus / species name PT | The amount of plankton | Diversity index | Relative abundance |
|----|-------------------------|------------------------|----------------|--------------------|
|    | Genus/species name      | PT                     | UI Z | MIZ Z | LIZ | UI Z | MIZ | LIZ | UI Z | MIZ | LIZ |
| 1  | *Spirostomum ambiguum*  | Z                      | 10   | 7    | 8   | 0.1396 | 0.1794 | 0.2405 | 4.50  | 6.60 | 10.81 |
| 2  | *Heteronema acus*       | F                      | 2    | 2    | 1   | 0.0424 | 0.0749 | 0.0582 | 0.90  | 1.89 | 1.35 |
| 3  | *Astasia andeardi*      | Z                      | 3    | 2    | 2   | 0.0582 | 0.0749 | 0.0976 | 1.35  | 1.89 | 2.70 |
| 4  | *Stichosticha secunda*  | F                      | 0    | 1    | 0   | -     | 0.0440 | -      | -     | 0.94 | -    |
| 5  | *Gymnodinium airuginosum* | Z                  | 1    | 0    | 0   | 0.0243 | -      | -      | 0.45  | -   | -    |
| 6  | *Navicula sp.*          | F                      | 7    | 0    | 0   | 0.1089 | -      | -      | 3.15  | -   | -    |
| 7  | *Oscillator*            | F                      | 41   | 15   | 1   | 0.3119 | 0.2767 | 0.0582 | 18.47 | 14.15| 1.35 |
| 8  | *Elatothrik*            | F                      | 5    | 0    | 0   | 0.0854 | -      | -      | 2.25  | -   | -    |
| 9  | *Diatome*               | F                      | 39   | 21   | 3   | 0.3055 | 0.3207 | 0.1299 | 17.57 | 19.81| 4.05 |
| 10 | *Tabellaria*            | F                      | 15   | 0    | 1   | 0.1821 | -      | 0.0582 | 6.76  | -   | 1.35 |
| 11 | *Dinoflagellata*        | Z                      | 28   | 8    | 0   | 0.2611 | 0.1950 | -      | 12.61 | 7.55 | -    |
| 12 | *Cylindrocystis*        | F                      | 6    | 15   | 0   | 0.0976 | 0.2767 | -      | 2.70  | 14.15| -    |
| 13 | *Heribaudiella*         | F                      | 0    | 6    | 0   | -     | 0.1625 | -      | -     | 5.61 | -    |
| 14 | *Stenot*                | Z                      | 2    | 1    | 1   | 0.0424 | 0.0439 | 0.0582 | 0.90  | 0.94 | 1.35 |
| 15 | *Flagilaria*            | Z                      | 0    | 0    | 1   | -     | -      | 0.0582 | -     | -   | 1.35 |
| 16 | *Gyrosigma*             | F                      | 0    | 0    | 9   | -     | -      | 0.2562 | -     | -   | 12.16|
| 17 | *Ulothrix*              | F                      | 6    | 1    | 11  | 0.0976 | 0.0440 | 0.2833 | 2.70  | 0.94 | 14.86|
| 18 | *Closteriopsis longisima* | F                  | 0    | 0    | 13  | -     | -      | 0.3055 | -     | -   | 17.57|
| 19 | *Noctiluca*             | Z                      | 1    | 0    | 0   | 0.0243 | -      | -      | 0.45  | -   | -    |
| 20 | *Roya Anglica*          | F                      | 2    | 0    | 0   | 0.0424 | -      | -      | 0.90  | -   | -    |
| 21 | *Thiospirillum*         | F                      | 7    | 0    | 0   | 0.1090 | -      | -      | 3.15  | -   | -    |
| 22 | *Tribunema*             | F                      | 2    | 0    | 0   | 0.0424 | -      | -      | 0.90  | -   | -    |
| 23 | *Euglena*               | F                      | 18   | 0    | 1   | 0.2037 | -      | 0.0582 | 8.10  | -   | 1.35 |
| 24 | *Diaptomus sp.*         | F                      | 3    | 1    | 0   | 0.0582 | 0.0440 | -      | 1.35  | 0.94 | -    |
| 25 | *Elakothrix Viridis*    | F                      | 2    | 0    | 0   | 0.0424 | -      | -      | 0.90  | -   | -    |
| 26 | *Bonaris Pleurogaster*  | F                      | 2    | 0    | 0   | 0.0424 | -      | -      | 0.90  | -   | -    |
| 27 | *Closteriopsis longisima* | Z                  | 1    | 0    | 0   | 0.0243 | -      | -      | 0.45  | -   | -    |
| 28 | *Leptothrix Ocracea*    | Z                      | 2    | 0    | 0   | 0.0424 | -      | -      | 0.90  | -   | -    |
| 29 | *Thiodictyon sp.*       | Z                      | 2    | 0    | 2   | 0.0424 | -      | 0.0975 | 0.90  | -   | 2.70 |
| 30 | *Ucelous cyclostomatus* | F                      | 0    | 1    | 1   | -     | 0.0440 | 0.0582 | -     | 0.94 | 1.35 |
| 31 | *Kentrospermo Bristole* | F                      | 0    | 2    | 0   | -     | 0.0749 | -      | -     | 1.89 | -    |
| 32 | *Spirogyra*             | F                      | 1    | 0    | 9   | 0.0243 | -      | 0.2562 | 0.45  | -   | 12.16|
| 33 | *Cylindospermum*        | F                      | 1    | 2    | 3   | 0.0243 | 0.0749 | 0.1299 | 0.45  | 1.89 | 4.05 |
The results of measurements of physical and chemical parameters of the waters Kondang Merak beach are still suitable to support the life of plankton. Water temperature 26.2-29.45°C, infinite brightness, total suspended solids 0.321-0.488g, pH 7.8-8.0, salinity 35‰, DO 4.08-6.10 ppm, BOD 0.622-0.994 ppm, and CO2 20.29-39.45 ppm. The waters quality is still in accordance with the quality standards of sea water quality, so it is very supportive for the life of marine life (Table 2).

Table 2. The measurement results of physical-chemical parameters of water at Kondang Merak beach, Malang District, East Java.

| Parameter | Measurement Time |
|-----------|------------------|
|           | UIZ | MIZ | LIZ |
| Physics   | Morning | Noon | Night |
| Temperature (°C) | 27.40 | 27.40 | 27.20 | 29.45 | 28.20 |
| Brightness (m) | ∞ | ∞ | ∞ | ∞ | ∞ |
| Current Strength (m/s) | 0.032 | 0.063 | 0.027 | 0.254 | 0.047 |
| TSS (g) | 0.321 | 0.435 | 0.488 | 0.323 | 0.332 |
| Depth (m) | ± 2.0 | ± 4.8 | ± 6.2 | - | - |
| DO (ppm) | 4.863 | 5.496 | 4.899 | 6.102 | 4.038 |
| BOD (ppm) | 0.718 | 0.718 | 0.718 | 0.994 | 0.622 |
| CO2 (ppm) | 36.475 | 39.45 | 36.571 | 20.29 | 24.584 |
| pH | 7.9 | 7.9 | 7.8 | 8.0 | 8.0 |
| Salinity (%) | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 |

Note: UIZ = Upper intertidal zone; MIZ = Midle intertidal zone; LIZ= Lower intertidal zone

On the beach Kondang Merak found 43 species of plankton that consists of 29 species phytoplankton and 14 species of zooplankton. At each sampling time, shows the different number of plankton species found. The difference due to third sampling time have difference conditions especially water brightness. Likewise between the three zone were found in different plankton abundances, where the highest abundance was in the upper intertidal zone and the lowest was in the middle intertidal zone. This is possible because in the middle intertidal zone the strongest currents are the biggest and the waves are the highest, causing plankton to be carried by currents [4].

Index diversity of plankton showed a different, the most to the least is in the upper intertidal zone (2.71), followed by the lower intertidal zone (2.55), and the smallest is in the middle intertidal zone (2.51). Abundance and distribution of phytoplankton in addition affected [1] by the penetration of light, currents and waves, transparency, pH, salinity, DO, CO2. The value of diversity index of phytoplankton and zooplankton biggest is in the upper intertidal zone were taken during the daytime.
In the intertidal zone on the coast of Kondang Merak has a substrate type of sand and dead coral and has relatively small currents and waves. This causes more plankton species found (27 species). This is due to strong currents and waves in the area that is larger than upper intertidal zone, so that the plankton community tend carried away if the water flow. In the area of the lower intertidal zone has a basic substrate consisting of coral reefs. In this area as many as 25 species of plankton are found. But the abundance of species found in the area this is the smallest when compared to that found in two other locations. That is because in this zone has a coral reef that is habitat for a variety of fish, so that the density of fish in this zone is greatest, plankton consequently suffered the greatest predation than in the two other zones.

The plankton diversity index 2.59 is mean that the beach of Kondang Merak have the diversity of plankton are classified as moderate. The relatively high plankton diversity index shows that the distribution of individuals of each species is high and the stability of the community is also high. [10] states that a community is said to have high diversity if the community consists of many types with large abundance, equal or nearly equal.

The upper intertidal zone has a plankton diversity index of 2.71. This condition shows that its productivity is quite high, the ecosystem is balanced, and the ecological pressure is moderate. In this zone are found 27 species (18 species of phytoplankton and 9 species of zooplankton). This amount is more when compared to the second zone of the other. This is due to the fact that this coastal zone is close to the shoreline and at the bottom there is a lot of seaweed growing so that it is rich in nutrients as raw material for phytoplankton photosynthesis [12]. Type of plankton that dominates in this zone is Oscillatoria (18.48%), Diatomaceae (17.57%), and Dinofagellata (12.62%).

The high number of Oscillatory and Diatome individuals is due to members of phytoplankton that are very suitable for living in clear waters [12].

Plankton diversity index in the middle intertidal zone is 2.51. In this zone discovered 15 types of plankton (11 species of phytoplankton and 4 species of zooplankton). The species is dominated Diatomaceae (19.81%), Oscillatoria (14.15%), and Cylindrocystis (14.15%). The large number of phytoplankton members found in this zone is also due to the beach's physical-chemical factors fulfilling their living conditions, which is 28°C, pH 8, and salinity 35‰.

Lower intertidal zone have diversity index of plankton 2.55 [10]. 15 plankton species are found, consisting of 10 species phytoplankton and 5 species zooplankton. The number of plankton species found in this zone is closely related to the existence of coral reef ecosystems. Coral reefs are able to meet the needs of life for various types of plankton, especially nutrients. The types of plankton that dominate in the lower intertidal zone on are Closteriopsis longisima (17.57%), Ulothrix (14.87%) and Spirofission ambiguum (10.81%).

The relative abundance of plankton in the intertidal zone Kondang Merak beach supreme owned by Diatome by 19.81%, followed by Oscillatoria and Closteriopsis longisima, each with of 18.48% and 17.57%. It is influenced by transparency, temperature, salinity, pH, currents, and available nutrients [1]. That factors are still suitable for supporting the life of plankton, where the water temperature 27.50-29.45°C, pH 7.8 - 8.0, and salinity is 35‰ Diatomaceae are to be one type of phytoplankton that more abundant because environmental conditions of the waters strongly support its existence [2]. Diatomeae are microscopic phytoplankton, have a relatively fast breeding ability and are able to live in a variety of water conditions, especially those with high transparency [9].

Temperature is a limiting factor for growth and distribution of plankton [8]. Plankton can living in optimal at 28-32°C [12], and the difference between day and night is less than 5°C. Temperature waters of the Kondang Merak beach 27.2-29.4°C suitable for the life of plankton because of it difference of day and night just 1°C. Water brightness affects the amount and quality of sunlight in waters [12] that affects the quantity of plankton through the supply of energy to carry out the process of photosynthesis [8]. If the brightness of the Kondang Merak beach waters is not insignificant, it means that up to a depth of 6 meters the transparency of water penetrates to the bottom of the water. Dissolved solids will absorb the incoming light and reduce the penetration of sunlight into the water, so that it can reduce anxiety and disrupt the photosynthesis [9]. Total suspended solid waters of 0.3-0.4 grams
is the amount that a little so life of plankton are not disturbed. Salinity on Kondang Merak beach waters are 35‰, according to the life of plankton. Waters have an average pH between the lowest in the morning of 7.8 to the highest at night of 8. This pH value still strongly supports the growth of marine life [4]; [1] including plankton can live well. The degree of acidity (pH) is important to support the survival of acute organisms, because pH can affect the type and availability of nutrients and the toxicity of the trace elements [12]. Dissolved oxygen levels are 4.0-6.1 ppm. During the day is due to the high activity of phytoplankton photosynthesis, and at night are due to the high metabolic processes of marine life [12]. The highest BOD during the day (0.994 ppm), and the lowest at night (0.622 ppm). In the morning the BOD value is in the range of 0.6-0.9 ppm so that it can be classified in water that has very clean conditions. The difference obtained this, because at noon activity of the metabolism of marine life increases so that the organic content of the water increases [1]. Accumulated organic materials that occur during the day causes high BOD be due to many organisms that decompose the organic compound, this process would cause levels of CO2 to be high due to decomposition of organic compounds between the form of CO2 [9]. Therefore, the CO2 of Kondang Merak beach waters ranges from 20.29-39.45 ppm.

**Conclusion**

Based on the results of research that has been conducted on diversity and abundance of plankton on intertidal zone Kondang Merak beach, Malang district can be concluded:

1. Plankton found on the Kondang Merak beach in Malang district, East Java consists of 43 species, consisting of 29 species of phytoplankton and 14 species of zooplankton.

2. Plankton diversity index on the coast of Kondang Merak in Malang district, East Java of 2.59 shows that it has a diversity of plankton species belonging to the moderate category.

3. The most abundance plankton in Kondang Merak beach is *Diatome*, which relative abundance is 19.81%, followed by *Oscillatoria* and *Closteriopsis longisima*, each of which had a relative abundance of 18.47% and 17.57%.

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**References**

[1] Nybakken, JW and Mark DB. 2005. *Marine Biology an Ecological Approach*, 6th edition. San Francisco: Pearson Education, Inc.

[2] Vatria B. 2010. "Various Human Activities That Can Cause the Degradation of Coastal Ecosystems and Their Impacts". *Bluian Journal*. 9 (1): 47-54.

[3] Simanjuntak, M. 2009. Relationship between Chemical, Physical and Physical Environment Parameters to the Distribution of Plankton in the East Belitung Waters, Bangka Belitung. *Journal of Fisheries*. 9 (1): 31-45.

[4] Novia R, dan Adnan, Ritonga IR. 2016. "Relationship between the physical-chemical parameters of waters with abundance of plankton in the Southwest Indian Ocean". *Depik Journal*. 5 (2): 67-76.

[5] Susiana. 2011. *Diversity and Density of Mangroves, Gastropods and Bivalves in the Perancak Bali Estuary, Script*. Not published. Makassar: Hasanudin University.

[6] Garno, Yudhi Soetrisno. 2008. *Water Quality and Phytoplankton Dynamics in Harapan Island Waters*. Vol. 3, Number 2.

[7] Hutabarat, Sahala and Stetwart M. Evans. 1985. *Key to Zooplankton Identification*. Jakarta: UI Press.

[8] Davis, Charles C. 1955. *The Marine and Fresh-Water Plankton*. Michigan: Michigan State University Press.

[9] Sachlan, M. 1982. *Planktonologi*. Fakultas Peternakan dan Perikanan. Universitas Diponegoro, Semarang, 177 hal (tidak diterbitkan).

[10] Odum, EP. 1993. *Fundamentals of Ecology*. WB Saunders Co. Philadelphia.

[11] MENLH. 2004. *Decree of the Minister of Environment Number: 51/MENLH/2004*. Concerning the Determination of Sea Water Quality Standards in a Set of Regulations in the Environmental Field. Jakarta.

[12] Imran A. 2016. Plankton Community Structure as a Bioindicator of Pollution in the Coastal Waters of West Lombok Coast. *Mandala Education Scientific Journal*. 2 (1): 1-8.