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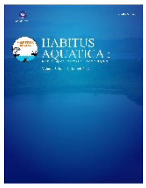

Biodiversity and relationship between phytoplankton and aquatic environment in the Majakerta coastal waters, Indramayu, West Java, Indonesia

Keanekaragaman hayati dan hubungan fitoplankton dengan lingkungan perairan di perairan pesisir Majakerta, Indramayu, Jawa Barat, Indonesia

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ABSTRAKr4 dwuq

Kawasan pesisir Majakerta memiliki potensi sumber daya perikanan yang tinggi dan banyak dimanfaatkan oleh masyarakat sekitar. Fluktuasi lingkungan perairan di sekitar kawasan pantai dapat mempengaruhi kelestarian fitoplankton. Pengambilan sampel penelitian ini dilakukan setiap bulan sekali di empat stasiun yang tersebar dari sungai ke laut dari Desember 2014 hingga Mei 2015. Penelitian ini bertujuan untuk mengevaluasi keanekaragaman hayati dan hubungan fitoplankton dengan kondisi lingkungan perairan di wilayah pesisir tersebut. Berdasarkan pengamatan, fitoplankton di kawasan pesisir Majakerta terdiri dari enam kelas, yaitu Bacillariophyceae (36 genus), Cyanophyceae (7 genus), Dinophyceae (5 genus), Chlorophyceae (4 genus), Zygnemaphyceae (2 genus) dan Euglenophyceae (2 genus). Berdasarkan indeks keanekaragaman fitoplankton dapat disimpulkan nilainya relatif rendah. Terdapat dua kelompok habitat, yaitu kelompok 1 (Stasiun 1 dan 2; sungai dan muara) dan kelompok 2 (Stasiun 3 dan 4; laut), yang memiliki pengaruh terhadap parameter: kekeruhan, pH, dan salinitas.

Kata kunci: indikator biologi, lingkungan perairan, polusi

ABSTRACT

Coastal area of Majakerta has a high potential fishery resource and it is commonly utilized by the surrounding community. The fluctuation on the aquatic environment around the coastal area can affect the sustainability of the phytoplankton. Sampling of this study was conducted once in each month at four stations distributed from river to the sea from December 2014 to May 2015, aiming to evaluate biodiversity and relationship between phytoplankton and the aquatic environmental condition in that coastal area. Based on the observation, phytoplankton in Majakerta coastal area consisted of six classes, i.e., Bacillariophyceae (36 genera), Cyanophyceae (7 genera), Dinophyceae (5 genera), Chlorophyceae (4 genera), Zygnemaphyceae (2 genera) and Euglenophyceae (2 genera). Based on the phytoplankton diversity index, it can be inferred that the value is relatively low. There were two habitat groups, namely group 1 (Station 1 and 2; river and estuary) and group 2 (Station 3 and 4; sea), which have influencing parameters: turbidity, pH, and salinity.

Keywords: aquatic environment, biological indices, polluted

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1. Introduction

Majakerta Beach is one of the coastal areas in West Java Province of Indonesia which has a large enough potential for fishery resources. In this area, the Majakerta River flows from the mainland (from the south) to the Majakerta beach and empties into the Java Sea (in the north). The Majakerta beach is also a fishing ground for fish, shrimp, and various other marine biotas, which is quite potential fisheries production for the people who live in the coastal area. Various kinds of activities are found around these waters, including agriculture, fish auction sites and fishing ports, settlements and industries, which allow various wastes from these activities to pollute the surrounding waters.

Suppose there is waste and pollution occurs in that waters. In that case, it is estimated that it will have a bad impact on various community activities in the area, especially fish in the waters that are the main target of the community's catch, which in turn will also affect the lives of fishermen and disrupt the availability of protein needs for the surrounding community.

Various environmental factors, including nutrition, can cause variations in the size structure of the phytoplankton community (Kotchum & Suco 2014). Nutrient load input from human activities and industrial activities around the estuary can lead to changes in the condition of the physical and chemical parameters, which leads to the abundance and growth of plankton. Information on the environmental conditions that include physics, chemistry and biology as phytoplankton in the waters of the Majakerta river estuary has not been studied; hence, the study to determine the condition of these waters is needed. This information can then be used as a basis for managing and using Majakerta river estuary water resources sustainably.

Several research activities in this area were carried out, i.e. biology long whisker catfish (*Macrones gulio*) (Sulistiono et al., 2017), the biology of eel goby (*Taenioides anguillaris*) (Sari et al., 2016), the biology of eel-tailed Catfish (*Plotosus canius*) (Muharram et al. 2016), and zooplankton community structure (Widyarini *et al.* 2017), but there are no publications on phytoplankton in the region.

Therefore, the information on the biodiversity and relationship between phytoplankton and aquatic environment condition (physico-chemical parameters of water) is required to analyze matters affecting the sustainability of the aquatic ecosystem. This study aims to examine the phytoplankton community structure and its relation to the condition of the water quality in the Majakerta river estuary, Indramayu Regency.

2. Materials and Methods

2.1. Time and Location

This research was conducted for six months from December 2014 to May 2015 with intervals of data collection every one month. The samples were taken along the estuary of Majakerta River, Indramayu (Figure 1).

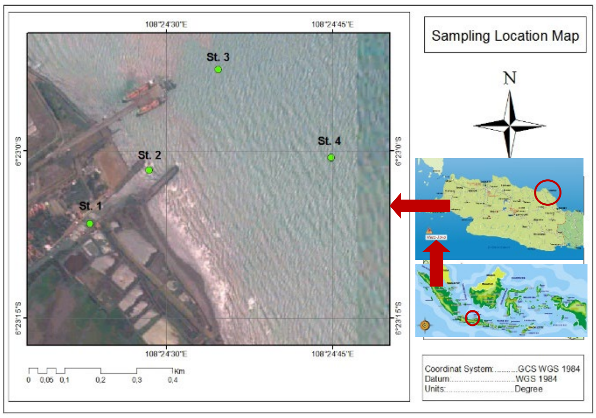

Figure 1. Sampling stations in Majakerta estuary waters, Indramayu, West Java, Indonesia. (Note: St=Station).

Sample analysis was conducted in Macro Biology Laboratory 1 of Ecobiology and Environmental Resource Conversation Division, and Macro Biology Laboratory 1 of Environmental Productivity Division, IPB. Figure 1 shows the location of sampling stations of plankton and physical-chemical parameters measurement in Majakerta estuary, Indramayu.

Table 1. Water quality parameters observed in Majakerta estuary waters, Indramayu.

Parameter	Unit	Equipment/Method	Analysis
Physical			
Temperature	°C	Thermometer/*Conductivity*	*In situ*
Turbidity	NTU	Turbidimeter/*Nephelometric*	*In situ*
Secchi Depth/Transparency	cm	Secchi Disk/Visual	*In situ*
TSS	mg/L	Gravimetric	Laboratorium
TDS	g/L	TDS meter	Laboratorium
Chemical			
Salinity	PSU	Refractometer	*In situ*
pH	-	pH indicator	*In situ*
DO	mg/L	DO meter	*In situ*
Nitrit (NO_2-N)	mg/L	Spectrofotometer/*Sulfanilamide*	Laboratorium
Nitrat (NO_3-N)	mg/L	Spectrofotometer/*Phenate*	Laboratorium
Amonia (NH_3-N)	mg/L	Spectrofotometer/*Brucine*	Laboratorium
Ortofosfat	mg/L	Spectrofotometer	Laboratorium

2.2.Methods of Data Collection

Sampling of phytoplankton was carried out at 4 stations that had been set in the form of a purposive sampling strategy. The stations were determined based on the increase of the salinity gradient, from low to high salinity. Station 1 is located in the water bodies with low salinity (around 0 PSU). Station 2 is located in the estuary of the river, with salinity ranging from 4 to 13 PSU. Meanwhile, Station 3 and Station 4 are located in sea areas with higher salinity values (ranging from 17 to 31 PSU). The sampling sites are presented in Figure 1.

Samples of plankton were collected by filtering 100 L of seawater by means of a 30 µm-sized plankton net and then placed in a 50 mL *polyethylene* bottle preserved by 1% lugol's solution (APHA AWWA WEF 2005).

Phytoplankton species identification was performed by microscope of Olympus CH-2 with 10x10 and 10x40 magnification. Samples of phytoplankton were analized by using 1 mL *Sedgwick-Rafter Counting Cell* (SRC) and using species identification book of Mizuno (1979), Yamaji's (1979) and Tomas (1955; 1963 and 1985).

Water quality parameters were measured in-situ, as listed in Table 1. Observations and measurements of water quality were carried out in situ and laboratory towards several water quality parameters (Table 1).

2.3. Abundance of Phytoplankton

Phytoplankton observation was conducted by calculating the phytoplankton abundance with Sedgwick-Rafter Counting Cell (SRC), census methodology. Moreover, the abundance of phytoplankton was calculated with the following formulation (APHA 2005):

$$K=\frac{1}{A}\times\frac{B}{C}\times\frac{V}{v}\times n$$

Note, K is phytoplankton abundance (cell/m^3); A = volume of filtered water sample; B=total area/container area of Sedgwick-Rafter Counting Cell (mm^2); C=observation area (mm^2); V=volume of filtered water; v=concentrate volume of Sedgwick Rafter Counting Cell (ml); n=number of observed phytoplankton.

2.4. Data Analysis

Three indices were used to obtain the estimation of species diversity, species evenness, and species dominance:

1. Species diversity was determined following Shannon-Wiener's Index (Odum 1993) using the formula:

   $$H' = (\Sigma\ pi \ln pi)$$

   Notes, pi = n/N, N = Number of individual species, N = total density of all organisms.

2. Evenness was calculated using the formula (Odum 1993):

   $$E=\frac{H'}{\ln S}$$

   Notes, H' = species diversity, S = species richness.

3. Species dominance was calculated by using Simpson Dominance Index (Odum 1993) with the following formulation:

$$C = \sum_{n=1}^{n} \left(\frac{ni}{N}\right)^2$$

Notes, ni = the number of individuals of each species, N = the total number of individuals.

2.5. Determination of Similar Characteristics Among Stations

The determination of similar characteristics among the stations was determined by using Bray-Curtis and Canberra index. The result of index calculations is presented in the form of dendrogram to describe the classifications of observation stations. Thus, clusters will be formed out of stations that have water quality characteristics in common.

Based on the biological parameters, including the abundance of phytoplankton, similar characteristics among the stations were determined by Bray-Curtis Index (Brower and Zar, 1990). The determination of the Bray-Curtis Index was obtained from the following formulation:

$$B = \frac{\Sigma_{i=1}^{n} |X_{ij}\text{-}X_{ik}|}{\Sigma_{i=1}^{n}\ X_{ij}+X_{ik}}$$

Notes:
B : Index of similarities of Bray-Curtis
Xij, Xik : Abundance of type of species at each stasiun (j,k)
n : Total number of speciest being compared

The level of commonality among the observation stations based on physical and chemical parameters (temperature, salinity, pH, dissolved oxygen, and turbidity) can be determined by using Canberra index (Brower and Zar 1990). The selection of Canberra index was determined through the following formulation:

$$C = \frac{1}{n}\left[\sum_{i=1}^{n}\left(\frac{|X_{ij} - X_{ik}|}{X_{ij} + X_{ik}}\right)\right]$$

Notes:
C : Index of similarities of Canberra
Xij, Xik : Value of water quality parameter of -i at each stasiun
n : Total number of species being compared

2.6. Analysis of Relationships Among the Influential Principal Environmental Parameters

Principal Component Analysis is a descriptive statistical multivariable method which presents maximum information within a certain matrix in the form of information graphics. Data matrix consists of abundant plankton variables as individuals (lines) and physical and chemical parameters (temperature, transparency, turbidity, TSS, TDS, nutrient, phosphate) of the waters as quantitative variables (column). Principal Component Analysis can provide an easily-read or interpreted overview on data structure by only serving important information. The results of this Principal Component Analysis will show a correlation between parameters on each station.

3. Result and Discussion

3.1. Phytoplankton Composition

Based on the phytoplankton identification results from 5 observing stations in Majakerta estuary waters, there were six classes of phytoplankton i.e. Bacillariophyceae (36 genera), Cyanophyceae (7 genera), Dinophyceae (5 genera), Chlorophyceae (4 genera), Zygnematophyceae (2 genera) and Euglenophyceae (2 genera). The composition of phytoplankton during the observation period in the waters can be seen in Figure 2.

Figure 2 shows the composition of the total class (%) and phytoplankton abundance (%) based on the classes during the study. Bacillariophyceae has the highest composition among the stations (Figure 2a). The composition of phytoplankton abundance is also dominated by the Bacillariophyceae class (Figure 2b).

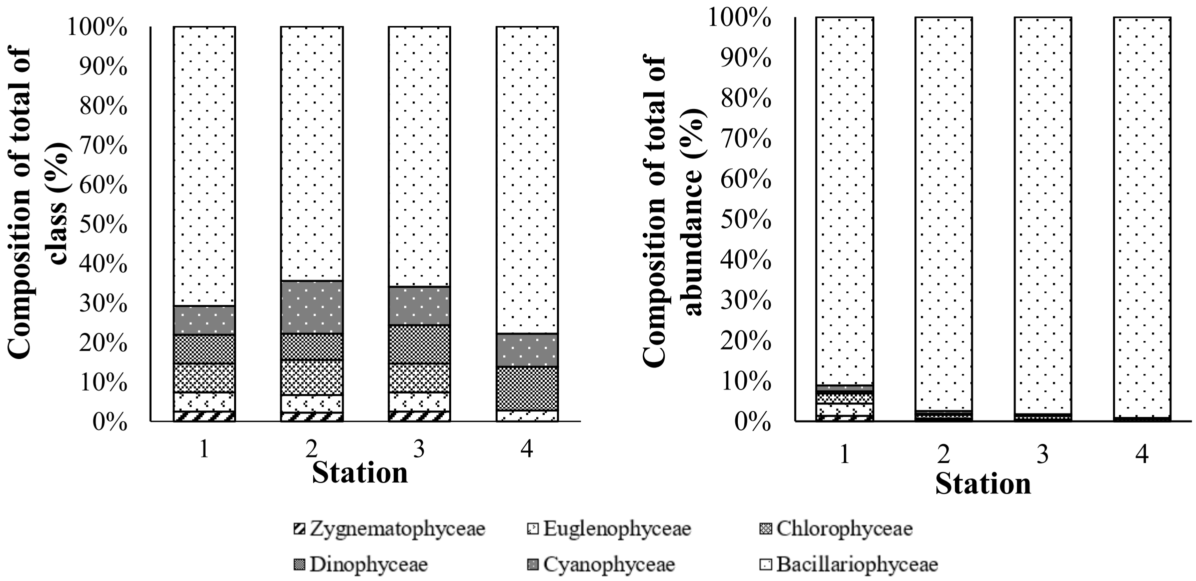

Figure 2. Composition percentage of the total order (a) and abundance (b) of phytoplankton on each station during the study.

3.2. Phytoplankton Performances

During the study conducted from December 2014 to May 2015, phytoplankton abundance distribution shows that (Figure 3) Station 3 and 4 are higher than Station 1 and 2. This is due to the physical condition of waters; including high transparency and low turbidity and TSS.

3.3. Diversity, Evenness, and Dominance

Phytoplankton community structure is determined by its species diversity. The index value of phytoplankton diversity, evenness, and dominance (Table 2) can also be used to examine the ecological condition of Majakerta estuary waters.

Figure 4 shows that total phytoplankton abundance during the observation and has a tendency to increase. The highest total phytoplankton abundance was found in April, gradually decreasing.

Based on the results, it can be inferred that the diversity of the phytoplankton community in Majakerta estuary waters was still in a low category and had an unstable community. However, this indication cannot be solely used as an indicator of a community's quality. Several other factors also influence the community structure quality, such as the dominant species, nutrient levels, light availability, etc.

3.4. Water Quality and Nutrient Condition

This research measured water quality parameters were temperature, transparency, turbidity, TSS, TDS, DO, pH, salinity, orthophosphate, nitrate, nitrite, and ammonia (Table 3). In some parameters, it can be seen that the differences between Station 1 and 2 (river) and Station 3 and 4 (sea) are significant.

3.5. Spatial Cluster

Based on the analysis result of community similarity used as an approach for habitat grouping, there is a habitat classification in the form of dendrogram determined by phytoplankton abundance as presented in Figure 5.

Figure 5 shows the cluster of habitat based on the phytoplankton abundance with the same pattern. On the habitat classification, the similarity rate of phytoplankton abundance is as much as 75%. Station 1 has similarities with Station 2 as much as 83.81%, while Station 3 and 4 have a similar rate of 98.31%.

Besides the phytoplankton abundance, habitat similarity index can also be seen on the factors of physical and chemical waters (Figure 6). The classification based on physical-chemical parameters shows that there were three classifications, i.e. Station 1. Station 2. and Station 3 with 4 with a commonality of as much as 91.05 %.

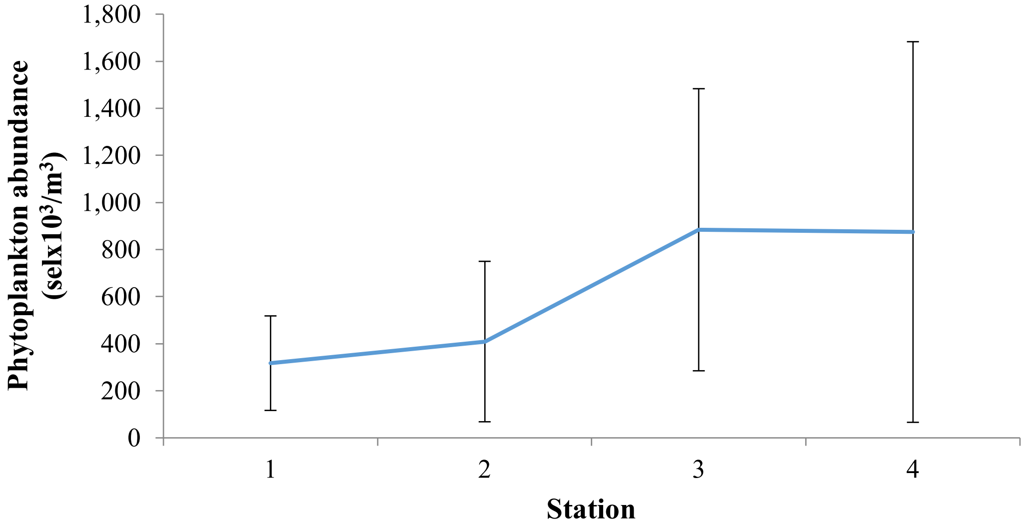

Figure 3. The total of phytoplankton abundance (cell/m^3) on each observation station (bars are standard deviation).

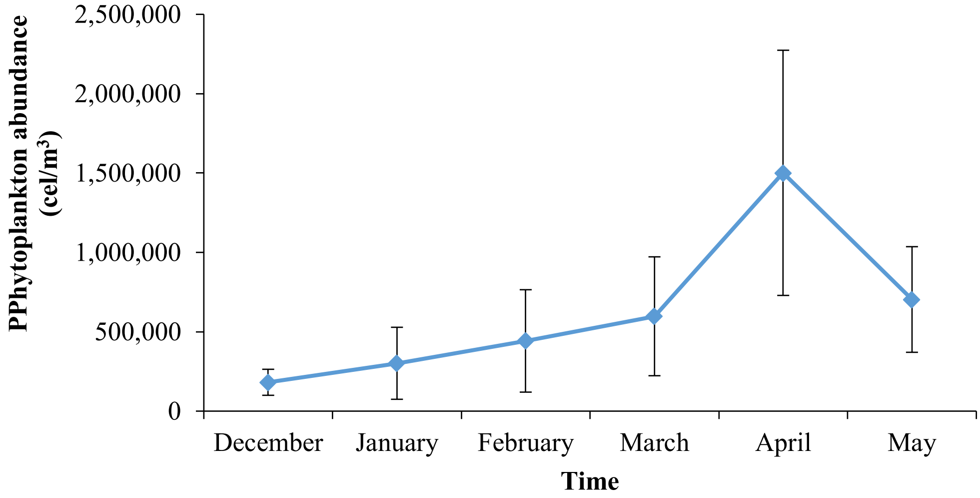

Figure 4. Total of phytoplankton abundance (cell/m^3) on each observation period.

Table 2. Diversity index value (H'), evennes index (E) and dominance index (C) of phytoplankton in Majakerta estuary waters.

Index	Observation Period					
	Des	Jan	Feb	Mar	Apr	May
H'	1.94-2.34	1.89-2.11	2.29-2.63	2.00-2.64	1.42-2.28	2.03-2.43
E	0.58-0.73	0.14-0.67	0.69-0.78	0.64-0.83	0.51-0.76	0.68-0.78
C	0.15-0.32	0.20-0.26	0.10-0.18	0.09-0.20	0.14-0.40	0.12-0.20

Table 3. Water Quality and Nutrient Parameters in Majakerta estuary waters.

Parameter	Units	St 1	St 2	St 3	St 4
Physical					
Temperature	ºC	29.95 ± 1.348	30.90 ± 0.79	28.27 ± 3.76	28.70 ± 3.32
Tranparency	cm	29.50 ± 3.54	80.50 ± 2.12	113.50 ± 6.36	123 ± 16.97
Turbidity	NTU	47.80 ± 14.99	39.95 ± 25.24	2.25 ± 1.39	2.56 ± 0.47
TSS	mg/L	42.00 ± 36.37	20.00 ± 6.00	11.00 ± 5.19	8.33 ± 0.57
TDS	g/L	12.15 ± 15.48	10.50 ± 11.09	24.86 ± 31.11	24.91 ± 0.11
Chemical					
DO	mg/L	7.82 ± 1.88	7.53 ± 2.30	6.60 ± 5.10	5.40 ± 3.74
pH		7.00 ± 0	7.00 ± 0	7.33 ± 0.58	7.33 ± 0.58
Salinity	PSU	0 ± 0	8.50 ± 4.23	25.67 ± 4.96	28.83 ± 2.56
Ortophospat	mg/L	0.021 ± 0.014	0.019 ± 0.002	0.006 ± 0.003	0.008 ± 0.006
Ammonia	mg/L	0.416 ± 0.353	0.252 ± 0.249	0.140 ± 0.159	0.141 ± 0.136
Nitrate	mg/L	1.153 ± 1.287	0.851 ± 0.664	0.074 ± 0.043	0.33 ± 0.021
Nitrite	mg/L	0.010 ± 0.012	0.012 ± 0.014	0.004 ± 0.004	0.006 ± 0.007

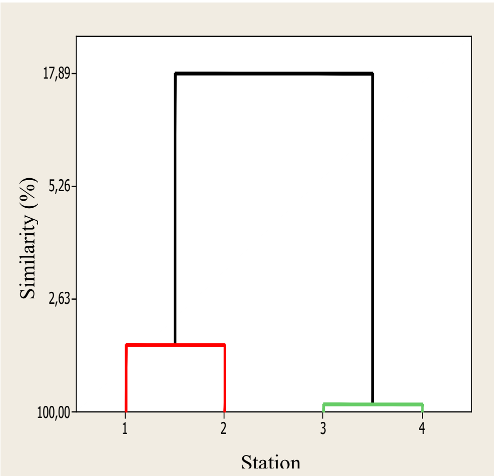

Figure 5. Station classification based on the similarity of phytoplankton abundance during the research.

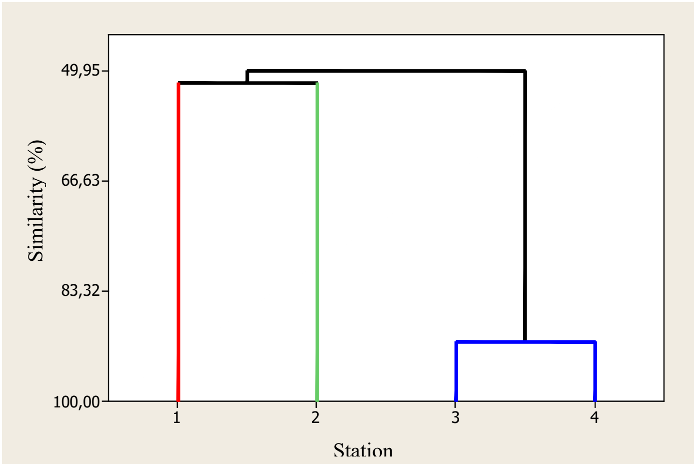

Figure 6. The station cluster was based on the similarity in physical and chemical water parameters during the research.

3.6. Relation Analysis on Physical, Chemical, and Biological Parameters

Physical-chemical parameters used in Principal Component Analysis included temperature, turbidity, transparency, TSS, TDS, salinity, pH, DO, nitrite, nitrate, ammonia, and phytoplankton abundance. Thus, a biological parameter that was used is the phytoplankton abundance. Principal Component Analysis shows that primary and secondary components' rooted sign can explain 91% and 6.9% of total diversity. The results show that Station 3 and 4 were signified more on the presence of phytoplankton, salinity, and brightness. Water quality parameters that signify Station 1 and 2 were temperature, turbidity, nitrate, and ortho-phosphate. The result of Principal Component Analysis is presented in Figure 7.

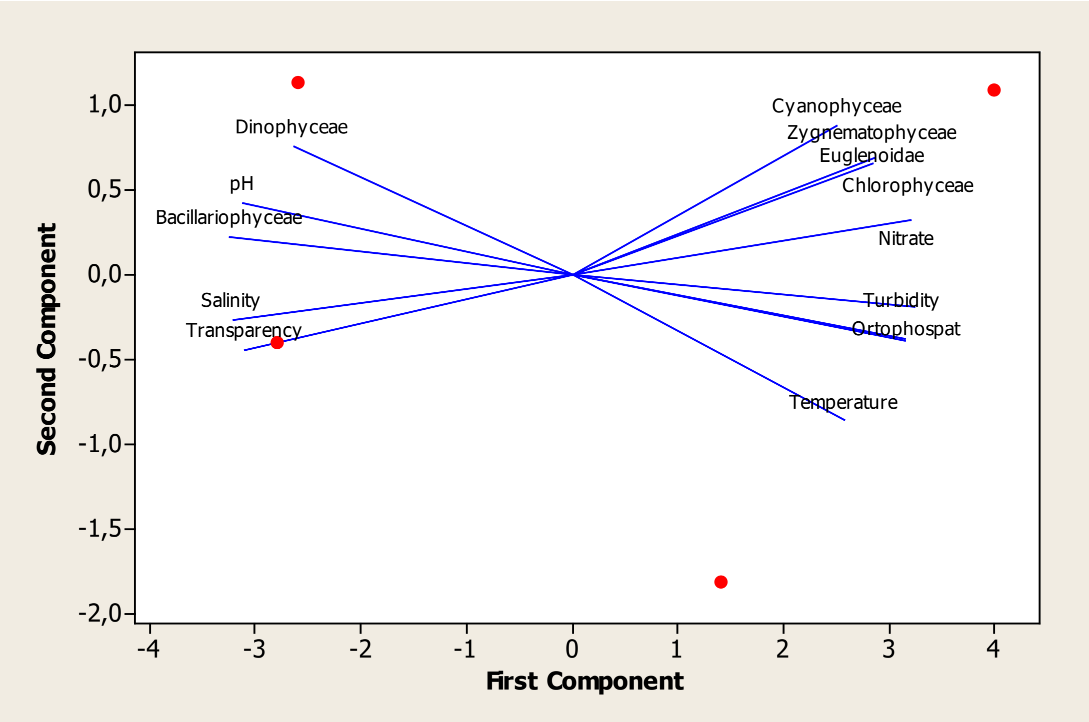

Figure 7. The tendency of water quality parameter and phytoplankton abundance on each observation station.

3.7. Discussions

On some waters, estuaries are the waters that have distinctive characteristics due to the mixture of freshwater and sea water. This area has roles in transitioning from aquatic ecosystem. The environmental condition of estuary waters has huge variations within various parameters. This can be seen from the fluctuated salinity, temperature variation, tidal influence and freshwater inflow. This condition creates a signified environment for organisms in the estuary area. Most of these areas are dominated by substrates out of fine sediments brought by both sea and freshwater, which occasionally bring nutrient substances beneficial for the growth and development of phytoplankton organisms.

Phytoplankton composition was dominated by Bacillariophyceae class (diatoms) with the percentage based on the type amount as much as 21% and the abundance of 14.560.420 (cell/m^3). Diatoms consisted of orde Centrales and Pennales, and the amount of Pennales is found in higher amount than that of Centrales; however, the abundance of Centrales is far higher than that of Pennales.

Genera of Centrales identified were *Coscinodiscus*, *Melosira*, *Biddulphia*, *Chaetoceros*, and *Triceratium*. While identified Pennales are *Amphora*, *Amphiprora*, *Coconeis*, *Fragilaria*, *Navicula*, *Nitzschia*, *Pleurosigma*, and others. Some diatoms which were found were freshwater diatom. This was presumably caused by the river estuary waters which is the transitions of freshwater and sea water. The dominant species of the diatoms found is *Thalassiothrix*.

Cynaophyceae has less amount and abundance compared to Bacillariophyceae. Within this class, 7 genera were found, consisting of *Chaelosphaerium*, *Policystis*, *Trichodesmium*, *Oscillatoria*, *Nodullaria*, *Nostoc* and *Richellla*. Meanwhile, Dinophyceae, Chlorophyceae, Zygnemaphyceae and Euglenophyceae are which occasionally show up with few amount of types and abundance. Genera found in Dinophyceae class were *Peridinium*, *Ceratium*, *Pyrocystis*, *Goniaulax*, and *Dinophysis*. Genera found in the Chlorophyceae class were *Pediastrum*, *Selenastrum*, *Spirulina*, *Ankistrodesmus*. Genera found in Zygnemaphyceae class were

Spirogyra and *Zygnema*, and Genera found in Euglenophyceae were *Euglena* and *Phacus*. Phytoplankton found in that waters in line with the previous studies (Sanaky 2003; Isnaini 2012; Sutomo 2013; and Wulandari 2015).

The total composition of phytoplankton type in each observation station was dominated by Bacillariophyceae, ranging between 65.85 and 77.78%. Thus, Cyanophyceae was in the range between 7.32 and 13.33%. While Dinophyceae and Chlorophyceae, each was ranging between 6.67 and 11.11% and 0-8.89%. The phytoplanktons which had the least composition were Zygnema and Euglenophyceae. Each ranges between 0-2.44 % and 2.78-4.88%. Bacillariophyceae dominates the phytoplankton abundance in that waters, which is in line with the study conducted by Damar (2003), Asmara (2005), Sachoemar and Hendiarti (2006), Isnaini (2012), Sutomo (2013), and Karuwal (2015) who state that phytoplankton that commonly has a high type of diversity in the sea is Bacillariophyceae.

According to Nontji (2007), that was presumably due to the organisms from Bacillariophyceae class which had cosmopolite characteristics with high rate of toleration and adaptability towards the changing in sea environment. Generally, phytoplankton species which were commonly found were *Thalassiothrix* (3.597.220 cell/m^3), *Nitzschia* (1.831.210 cell/m^3), and *Chaetoceros* (1.454.240 cell/m^3).

Phytoplankton abundance in each study station was ranging from 317.360 to 884.105 cell/m^3 in which the abundance level in Station 3 and 4 (sea) was relatively higher than that in Station 1 and 2 (river). Station 3 and 4 were located in coastal areas while Station 1 and 2 were still parts of river estuaries. The high level of phytoplankton abundance in Station 3 and 4 was assumed due to the physical condition of the waters including high brightness, low turbidity and TSS.

The availability of abundant nutrients is the primary food source of phytoplankton. Meanwhile, the low level of phytoplankton abundance in Station 3 and 4 was assumed due to less supportive physical condition of the waters including high level of turbidity and TSS and low transparency because the number of activities around the river estuary cause the sediments on the bottom to lift up to the surface. The high level of turbidity can also obstruct the sunlight to pass through the waters. Therefore, that particular area is considered to be unable to support the sustaining lives of phytoplankton and the photosynthesis process cannot occur optimally.

Physical-chemical parameters of waters are affected by seasons and places. The results of physico-chemical measurements of the parameters that, when viewed from the optimal range for the life of aquatic organisms are still in the normal range. It affects the lives of plankton and organisms in these waters. The water temperature among observation stations during the study ranged from 28.27 to 30.90 ºC. Temperature values did not differ significantly between stations, presumably because of the relatively similar solar radiation levels. Such temperature conditions are still quite suitable for plankton life. According to Effendi (2003) an optimum temperature range for growth of plankton is 20-30 ºC. Salinity values between stations observations during the study ranged from 0 to 28.83 PSU. Nontji (2008) stated that in general the range of salinity good for plankton life is 11-40 PSU. Sucahyo (1995) stated that the plankton diversity is heavily influenced by salinity, either quantitative or qualitatively. Marine phytoplankton generally lives well on a range of salinities above 20 PSU as Bacillariophyceae class (Sachlan 1972).

Table 3 shows that Station 1 and 2 had a high level of nutrients compared to Station 3 and 4. According to Nybakken (1992), an estuary is an area that acts as the piling of organic matters carried by the river or sea. Nevertheless, the high level of nutrients cannot guarantee the high abundance of phytoplankton, for the available nutrients may not be used by the phytoplankton. The level of nutrients which is very high can negatively affect to the waters; e.g. when the phytoplankton blooming occurs, the lives of other organisms in the waters were in danger.

During the three month-observations (March-May), phytoplankton abundance increase was relatively high. Raitsos et al, (2012) stated that in the sea waters, phytoplankton has a significant role in the utilization process and energy transfer. Consequently, the high population of zooplankton can only be reached when the amount of phytoplankton is sufficient. Nevertheles, in reality, the situation does not always occur, for the low substance of zooplankton is commonly found despite the high level of phytoplankton.

The diversity index value of phytoplankton which was calculated tended to be higher than that of the zooplankton as it is presented in Table 2 and 3. In line with the range of Shannon-Wiener Index value, phytoplankton diversities in Majakerta Estuary are classified as low. The evennes index value of phytoplankton on each station is relatively high showing that the number of individuals of each type is spread evenly. It is supported by the lower dominance index value.

Phytoplankton community structure is also influenced by physical-chemical parameters of the waters (Table 3). Based on the calculation, on the similarity rate of 75%, 2 major groups are formed (Figure 5) and 3 groups were grouped to observe the similarity of the stations based on the environmental parameters (Figure 6). Station 1 and 2 are combined into group 1 on the observation of similar station based on the phytoplankton abundance, while group 2 consists of Station 3 and 4. This shows that the stations had high similarity rate of abundance level and environmental parameters in relation to the station locations which were close to one another. The similarity rate of the environment is also shown by similar types of identified organisms. In group 1 (river), the identified freshwater type of phytoplankton is matched with the low salinity on this station e.g. genera from *Frustulia*. *Chaelosphaerium*, *Pediastrum*, *Spirulina*, and *Spirogyra* while group 2 (sea), the identified types are genera from *Thalassiothrix*, *Nitzschia*, *lauderia*, and *Melosira*.

On 75% of similarity rate, group 2, which consists of Station 3 and 4 have similarities on abundance level and environmental parameter. This is correlated with the location of stations in estuary and in the sea; therefore, the measured environmental parameters, including salinity, transparency and pH have similar results. The other cause is the same topographic condition in which it is lacking of mud sediment in these stations, which makes the environmental parameter level in these waters similar. The types of ogranisms which are identified in these waters are almost the same as those in Bacillariophyceae class. The high salinity level in these locations makes only the sea phytoplankton be identified more frequently.

By conducting this research, the potential of Majakerta Estuary as the habitat for diverse organisms, particularly phytoplankton, can be developed. The high level of phytoplankton abundance in the waters can be an indication that the fishery potential was considered as high. In reference to the explanation above, the phytoplankton community structure in the waters of Majakerta Estuary can be essential information for fishery resource production to be improved and maintained.

4. Conclusion

Phytoplankton in the waters of Majakerta Estuary consists of six classes, i.e. Bacillariophyceae (36 genera). Cyanophyceae (7 genera), Dinophyceae (5 genera), Chlorophyceae (4 genera), Zygnematophyceae (2 genera) and Euglenophyceae (2 genera). The stability of phytoplankton community structure is classified as low. There are two habitat groups i.e. Station 1 and 2 (river) group and Station 3 and 4 (sea) group. The parameters of transparency, pH, and salinity are considered to be the influencing parameters on phytoplankton community structure in Majakerta Estuary waters.

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