Detection of HABs in the Coastal Waters of Maros, South Sulawesi, Indonesia

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Abstract

The presence of harmful phytoplankton (HABs) can be caused by an increase in the fertility of water. This occurs because the waters get a nutrient supply from anthropogenic activities. The research aims to determine the abundance of harmful phytoplankton (HABs) in the Maros waters, South Sulawesi, Indonesia. The research employed one Way Anova and Principal Component Analysis. The results show that there are 22 genera of phytoplankton that have been detected, 4 genera include HABs, Ceratium, Dinophysis, Gymnodinium, and Protoperidinium. Based on its impact, HABs have a low proportion of which is about 2% when compared with the genus of phytoplankton, which is not HABs 98%. The oceanographic parameters show HABs cannot develop due to the concentration of nitrates and salinity as well as low temperatures, even though the brightness and orthophosphate are at high values.

Keywords: *Phytoplankton, HABs, Coastal Water.*

1. Introduction

Biological indicators that affect water quality is the existence of phytoplankton [1]. Phytoplankton is instrumental in the main source of food for organisms at the tropical level in marine waters. However, in certain conditions, these microorganisms can precisely lower the water quality if the amount is over (blooming), especially if the abundance is harmful phytoplankton (Harmful Algal Blooms, HABs). Of course, its presence can harm the lives of other aquatic organisms, including humans. Through the food chain, the accumulation of toxins in the body of the organism that consumes HABs is able to cause health problems, even death in humans [2], [3], [4]. Some HABs found in Indonesian sea waters are from the Dinophyceae group, such as Alexandrium, Gymnodinium, Dinophysis, and Diatom group, such as Pseudonitszchia [5]. Research conducted in the coastal waters of the city of Makassar by Tambaru *et al.* (2018) has also detected the emergence of seven genus HABs from the Dinophyceae class, namely Protoperidinium, Gymnodinium, Ceratium, Prorocentrum, Gyrodinium, Gonyaulax, and Dinophysis [6].

Phytoplankton is instrumental in the main source of food for organisms at the tropical level in marine waters. However, in certain conditions, these microorganisms can precisely lower the water quality if the amount is over (blooming), especially if the abundance is harmful phytoplankton (Harmful Algal Blooms, *called* HABs). Of course, its presence can harm the lives of other aquatic organisms, including humans. Through the food chain, the accumulation of toxins in the body of the organism that consumes HABs is able to cause health problems even death in humans [2], [3] as one of the central issues in the global economy [7] towards sustainable development goals.

The emergence of HABs can be triggered by increased seawater fertility. This occurs because the waters get a nutrient supply from anthropogenic activities in the mainland [8]. The high concentration of nutrients can lead to blooming phytoplankton, including HABs. Of course, it can have an impact on water stability in supporting the lives of other organisms. As a result, the mass deaths of fish and other biotas may occur due to the accumulation of toxins produced by HABs. The other impact, oxygen concentration will have decreased the cause used by bacteria in describing the organism that is experiencing death. This causes the waters to become critical. Such an incident occurs much in the seawater in some parts of the world, including Indonesia [9], [10]. One of the waters that have gained nutrient supply from anthropogenic activities in the mainland is the coastal waters of Maros, South Sulawesi, Indonesia. The occurrence of nutrient enhancement can trigger the emergence of HABs. Therefore, to observe this, research directly directed to detect the emergence of harmful phytoplankton (HABs) in the coastal waters of Maros South Sulawesi.

2. Research Method

2.1. Time and Research Site

The study was held in June until December 2018. Water sampling for phytoplankton identification, including HABs, is performed on three stations in the coastal waters of the Marusu district of Maros Regency. These three stations are the I-influenced station of the Mambue River, the II station is influenced by the Kuri Lompo River, and the III station is affected by the Marusu River (Figure 1). The identification of the phytoplankton in the Plankton laboratory at the brackish water cultivation research and Fisheries Counseling (BRPBAP3) Maros. Measurement of water quality is conducted in Chemical Oceanography Laboratory, Department of Marine Sciences, Faculty of Marine Sciences and Fisheries, Hasanuddin University.

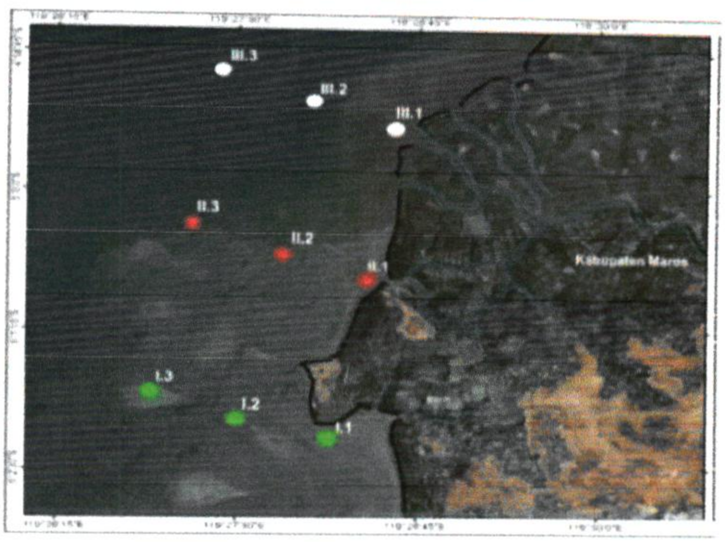

Figure 1. Research Site in The Waters of Maros, South Sulawesi

2.2. Identification of Phytoplankton and HABs in Laboratories

Identification of phytoplankton, including HABs, is done using Sedgwick Rafter Counting Cell (SRCC) with the help of a microscope associated with the computer. SRCC is installed in the table of the microscope, then samples of water taken in the field are inserted as much as 1 ml using a drip pipette. After that, SRCC closed with glass cover. Focus and enlargement of the microscope adjusted, further, identification is performed. The type and amount of phytoplankton obtained is then recorded. To calculate the abundance of phytoplankton, including HABs used calculations based on APHA (1989) [11]. The identification was made until the genus level using plankton identification books compiled by Newell (1977), Yamaji (1960) and, Plankton BRPBAP3 Maros identification instructions [12], [13].

2.3. Measurement of Oceanographic Parameters

Measurement of oceanographic parameters such as temperature, salinity, brightness, depth, current velocity, and dissolved oxygen (DO) is carried out directly in the field along with water sampling for the purpose of identifying phytoplankton including HABs. In addition, water sampling is also carried out for measurements of other values of oceanographic parameters such as pH, nitrate, and orthophosphate that are later implemented in the laboratory.

2.4. Data Analysis

Analysis of the abundance type of Fitopankton, including HABs based on the research station, used One Way Anova. To test the linkage between oceanographic parameters with the abundance of phytoplankton, including HABs analyzed using Principal Components Analysis (PCA).

3. Research Results and Discussion

3.1. The abundance of Phytoplankton Including HABs

Based on the results, the identification of phytoplankton was found in three main classes and 22 genera of phytoplankton. The first class was Bacillariophyceae with 16 genera, the Asterionellopsis, Bacteriastrum, Biddulphia, Chaetoceros, Coscinodiscus, Cocconeis, Cyclotella, Ditylum, Hemiaulus, Melosira, Navicula, Nitzchia, Odontella, Pleurosigma, Rhizosolenia, and Thallassionema. The second class is Cyanophyceae with 2 genera, namely Oscillatoria and Synechocystis. The third class is Dynophyceae with 4 genera Ceratium, Dinophysis, Gymnodinium, and Protoperidinium.

In general, the abundance of phytoplankton between stations found varied. On the station, I, the abundance of recorded phytoplankton ranges between 3688-5241 cells/L with an average abundance of 4371 cells/L. On station II, the abundance of phytoplankton ranges between 3997-5904 cells/L with an average abundance of 4757 cells/L. On the III station, the abundance of phytoplankton ranges between 1340-4825 cells/L with an average abundance of around 2588 cells/L (Figure 2).

Despite the difference between the stations, but based on the test results, one way ANOVA obtained the result that the abundance of phytoplankton between stations does not exhibit differences ($p > 0.05$). This means that the distribution of the abundance of phytoplankton per station is considered uniform.

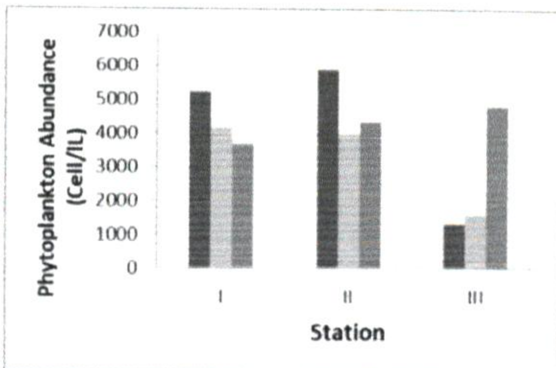

Figure 2. The abundance of Phytoplankton by Station

When compared to research ever conducted in the waters of Maros, such as research conducted by Tambaru (2008), it can be explained that the abundance of phytoplankton in this study was found to be lower. The abundance range of phytoplankton acquired in this study is 2588-4757sel/L (Figure 2). Meanwhile, research conducted by Tambaru (2008) ranged from 4703-7667sel/L [17]. In other studies, as implemented by Rashidy et al. (2013), it also shows the same thing that the abundance of phytoplankton in this study was found to be lower. The abundance of phytoplankton from the results of his research gets the range between 1000 - 9165 cells/L in the coastal waters of the village Tekolabbua District Pangkep [15]. From the search results in both Tambaru Research (2008) and Rashidy et al. (2013) can be explained that the main reason why in this study found lower abundance due to nutrients concentration (nitrate and orthophosphate) was at a low concentration when compared to both studies.

During the study, Chaeroceros was a genus of phytoplankton, which had the highest percentage of 83%, followed by Hemiaulus with a percentage of 7%, then Nitzschia with a percentage of 2%. For the other genus shows a uniform percentage of 0.1%-1%. Chaetoceros more dominant found is due to this genus has high adaptability to the changing environment [16]. In the change of nutrient concentration towards low concentrations, the genus is still adaptable [17]. Nowadays, the presence of Chaetoceros in marine waters is increasingly gaining serious attention from environmentalists. It is not included in the HABs group, but it can interfere with the lives of other marine organisms, such as fish, because it can interfere with breathing if it is consumed too much.

3.2. The abundance of Potentially Dangerous Phytoplankton (HABs)

From the results of the identification, the type of harmful phytoplankton (HABs) obtained as many as 4 genera, all of which are in the class group Dynophycea Ceratium, Dinophysis, Gymnodinium, and Protoperidinium. These four types of HABs are a group of causes of toxin producers [17]. The meaning is that the compound metabolites produced by this group are toxic. If the compound of this metabolite accumulates in other marine organisms such as shells and fish, it can impact poisoning in humans who eat it [16].

By Deskriftif, Ceratium has horns and two flagella. The Genus is considered damaging to the aquatic environment as it can cause oxygen deficiency or decreased water oxygen levels. In addition, Ceratium can result in mass deaths of marine biota due to decreased oxygen levels if its population [2]. Furthermore, Dinophysis is considered a group of HABs because it contains Diarrhetic toxin Shellfish Poisoning (DSP), which can cause poisoning if consuming shellfish contaminated by the toxin [18]. This is in line with the opinion of Nontji (2008) That poisoning symptoms can be caused by Dinophysis is Diarrhetic Shellfish Poisoning (DSP) which is a symptom of diarrhea caused by poison okadaic acid. Then, Gymnodinium is a genus HABs that causes red tide and oxygen depletion in the waters [16]. Gymnodinium can cause Paralytic Shellfish Poisoning (PSP) when shellfish are consumed, which can cause paralysis [19]. Then, Protoperidinium contains toxic Azaspiracids. The character of the poison is almost similar to the poison DSP (Diarrhetic Shellfish Poisoning), which can cause nausea in the sufferer within 3-5 days [20].

Furthermore, based on the distribution HABs in each station can be explained that on the station, I found 2 genera, namely genus Ceratium and Protoperidinium, on station II also found 2 genus Ceratium and Protoperidinium, and on the station III found 4 genus Ceratium, Dinophysis, Gymnodinium. From the distribution, it was seen that the four genera of HABs were all found in station III. This is likely to happen because the III station is suspected of having a much higher nutrient concentration compared to other stations. This allegation is justified considering that the station III is influenced by the Maros River, which carries a lot of nutrient loads derived from household and agricultural waste and aquaculture [14].

Based on the abundance of HABs, it is noted that on the station I ranged between 29-81 cells/L with an average abundance of 60 cells/L, II station ranges between 18-38 cells/L with an average abundance of 29 cells/L, and station III ranges between 54-186 cells/L with an average abundance as much as 106 cell/L (Figure 3). From the results of the sump is seen that the abundance of HABs is found highest on river III and lowest on station II. Although the abundance of HABs between stations looks different but based on the test results, one way, ANOVA is not showing a noticeable difference ($p > 0.05$). This means the abundance of HABs is considered the same or no real difference on various stations during the study.

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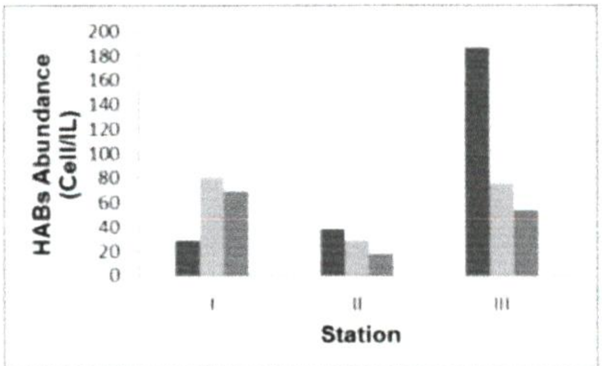

Figure 3. Abundance HABs Based on Station

Largely, the genus HABs detected during the study were a group of the Dynophyceae classes. This can be justified as the genus of the Dynophyceae group is known to have the most toxic type [21].

3.3. Comparison of The Abundance of Phytoplankton Non-HABs and HABs

During the study, a comparison of the abundance between the genus phytoplankton non-HABs and HABs (Fig. 4) showed that non-HABs phytoplankton had a much higher percentage of 98% when compared to the Phygenplankton genus HABs (2%). This indicates that the waters of Maros still belong to good water categories and are not yet harmful to other organisms. However, along with the emergence of the four genus HABs has been an early warning that the waters need to be continuously maintained and monitored so that HABs are not growing.

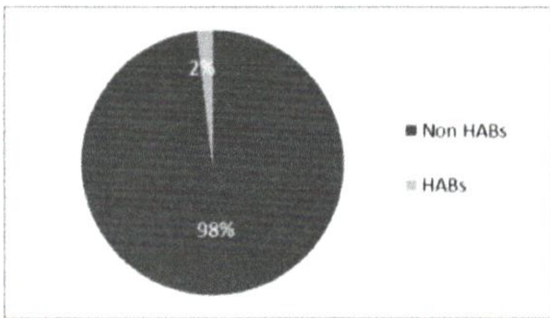

Figure 4. Comparison of Fitoplankton Non-HABs and HABs

3.4. Analysis of Phytoplankton Ecology Index

The value of the ecological index of phytoplankton (Non-HABs and HABs) in the coastal waters of Maros can be described through the value of diversity index (H '), uniformity (E) and Dominance (D) for all Research locations (table 1). Analysis of the ecological Index of phytoplankton (Non-HABs and HABs) was conducted to test the life stability of the genus phytoplankton in the research site. The explanation of each index will be discussed later.

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Table 1. Ecological Indices of Phytoplankton (Non-HABs and HABs)

Station	Diversity Index (H')	Uniformity Index (E)	Dominance Index (D)
I	0.52	0.20	0.83
II	0.81	0.31	0.66
III	1.27	0.45	0.52

Table 1 clearly shows that the Diversity Index (H ') obtained a value ranging between 0.52 – 1.27. This indicates that the value of the diversity index is relatively low, based on the Keanekaragamn index category described by Odum (1993) [21]. If the diversity index (H ') value is below 2.30, then the diversity of organisms is low. According to Mason (1981), based on the value obtained can be explained that the growth and development of the types of phytoplankton do not go optimally so that the effect of the low value of diversity index. From identification of the number of types of phytoplankton showing many types of phytoplankton, there is little. The uniformity index (E) value between stations (table 1) ranges between 0.1981-0.4499. The range of values obtained is dim. It is demonstrated that the distribution of the types of phytoplankton is not spread evenly. This means that each type of phytoplankton has a low abundance and only some kind of high. This situation can be associated with environmental conditions that may be depressed [22].

The value of Dominance index (D) between stations found the value ranges between 0.5238 – 0.8253 (table 1). From the results, it can be explained that the index value is high. This means that there are certain types of phytoplankton that dominate. From the results of the identification exposing it, some types of phytoplankton, such as Chaetoceros, have a much higher abundance and are dominant when compared to other types.

Based on the explanation of the three indices above can be explained that the cause of low index value of diversity and uniformity and the high index of dominance due to water is not in stable and optimal conditions in support of the life of phytoplankton. The condition can be justified; this is due to low concentrations of nitrates and orthophosphates. This affects the development of phytoplankton. In addition, the brightness is quite low at each station; this also causes the growth and development of certain types of phytoplankton not to grow well. Only certain types, such as Chaetoceros, can respond to environmental conditions that are not optimal.

3.5. Association of Oceanographic Parameters with HABs

The linkage between the abundance of phytoplankton causes HABs against oceanographic parameters analyzed using the Principal Component Analysis (PCA) method (Figure 5). Based on the results of PCA analysis showed that on a station I was characterized by the high temperature and pH values, but obtained a low value for current velocity and nitrate. Temperature and pH can affect the growth and presence of HABs. The limit of organism tolerance to pH is Varius [22]. At Station I, The average pH value obtained is 7.89. The pH value is still in accordance with the growth of phytoplankton. Furthermore, on the Station I, the average value of the temperature obtained is 31 ° C. The value of temperature obtained is still in accordance with the life of phytoplankton. Ecologically, the temperature is very important in determining the efficacy of phytoplankton in water. The seawater temperature range between 29.8 – 31 °c is still within normal limits for the life of HABs [22].

In Figure 5 It appears that the Station II is characterized by DO (dissolved oxygen) and salinity, which is quite high with a low number of HABs. In line with the previous explanation that in the fact that the number of HABs found in Station II is lower. It is similar to Station I. This means that HABs cannot develop both on Stations I and II. Furthermore, the environmental characteristics on station III can be mentioned, such as brightness, depth, and high orthophosphate that supports the development of HABs. In fact, the four genus HABs was detected at the station. However, the development of HABs in the massif is not the case. This is due to the low value of nitrates and salinity that become the development inhibitory factor.

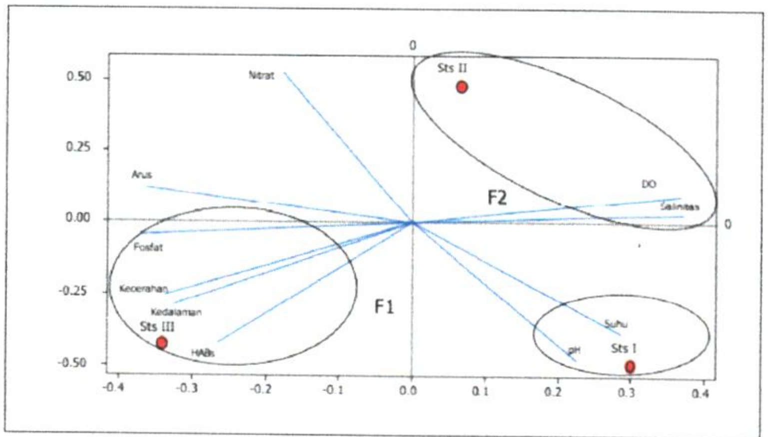

Figure 5. PCA Result

4. Conclusion

It can be concluded that the existing HABs in the waters of Maros South Sulawesi are Ceratium, Dinophysis, Gymnodinium, and Protoperidinium. However, although HABs are detected appearing in these waters, the number is still much lower compared to Non-HABs phytoplankton. The oceanographic parameters show HABs cannot develop due to the concentration of nitrates and salinity as well as low temperatures, even though the brightness and orthophosphate are at high values. It is advisable to do research on the presence of harmful phytoplankton (HABs) based on the difference in the season.

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