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Phytoplankton Community in The Lembeh Strait, Bitung and Wori Beach, Manado, North of Sulawesi, Indonesia

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Abstract

This study was conducted to understand the phytoplankton community in the Lembeh Strait, Bitung and Wori Beach, Manado. The phytoplankton samples were collected in October 2015 with vertical towing using Kitahara plankton net (mesh size 80 µm). Identification and enumeration were done using Sedgwick Rafter Counting Chamber (SRCC) under 100-400X magnification. There were 24 genera of diatom group and nine genera of dinoflagellate group found in Wori and Lembeh Strait. Total phytoplankton abundance in Wori ranged from 16,293.28 – 464,358.45 cells m^{-3}. Whilst, In Lembeh Strait, Bitung, the highest abundance of phytoplankton was 2,300,407.33 cells m^{-3} and the lowest was 16,089.61 cells m^{-3}. The composition of diatoms and dinoflagellates in Wori and Lembeh Strait was dominated by diatom which ranged from 80.70% to 100.0%. There were 11 dominance genera of diatom and dinoflagellate groups which the mean contribution value above five percent. Those were including six genera of diatom group (*Chaetoceros*, *Bacteriastrum*, *Nitzchia*, *Rhizosoleria*, *Thalassiothrix*, and *Thalassiosira*) and five genera of dinoflagellate group (*Ceratium*, *Prorocentrum*, *Protoperidinium*, *Pyrodinium*, and *Scriepsiella)*. *Chaetoceros* and *Protoperidinium* exhibit the highest genera representation in all diatom and dinoflagellate group among the two locations, with 38% and 36% (respectively) mean contribution. Three genera which commonly known to cause harmful algal blooms (HABs) were observed in those two locations*. Nitzschia* (diatom group), *Prorocentrum*, and *Pyrodinium* (dinoflagellate group). *Nitzschia* was the most frequently found, almost recorded at all station in Wori, Manado and Lembeh Strait, Bitung. The less frequent found of HABs causative organisms in those two locations was *Pyrodinium*.

Key Words**:** Phytoplankton community, Lembeh Strait, Wori Beach, North East Sulawesi, Indonesia.

Introduction

Research on the diversity pelagic marine organisms has been conducted for many years, but no specific attention was given to the diversity of phytoplankton species in the ecosystem. The phytoplankton communities are essential for primary productivity and the food web in the coastal waters. The adjacent offshore marine environments as currents and tides help transport of pelagic phytoplankton cells and benthic algae from the bottom of shallow waters. As the phytoplankton are strongly influenced by their surrounding chemical and structural environment and they provide a useful tool to predict the characters of the complex coastal systems. At the same time, it is possible to find out the environmental factors imprinting and associating with the phytoplankton species assemblages (Senming *et al* 2015).

Lembeh Strait and Wori Beach are two locations in the northern part of Sulawesi that are unique with outstanding universal value for marine biodiversity. These two locations are important area for fisheries, tourism and the other activities which are beneficial for social and community, such as for research and education. Further, the rapid development of the city, factories and ports has been progressing in this area, becoming major factors for the health of Lembeh Strait and Wori Beach ecosystems, such as coral reefs and seagrasses (Azkab and Chen 2015).

As producer, phytoplankton has important role to support the ecosystem. Therefore, the change of the phytoplankton community and structure would affect the diversity of the ecosystem, especially when there is Harmful Algal Bloom species observed in the area (Litchman *et al*, 2010). Phytoplankton has sensitive response to nutrient and pollutants (Wardiatno, Damar and Sumartono, 2004). This high nutrient concentration and pollutants which produced by anthropogenic activities in Lembeh and Wori waters could affect the plankton spatial distribution, abundance, and community structure. However, there is still a few information about the abundance and distribution of plankton in the Lembeh Strait and Wori Beach. In October 18-24, 2015 a survey was carried out in the Lembeh Strait in Bitung and Wori Beach in Manado, Sulawesi, Indonesia to understand the phytoplankton community such as abundance, dominance, composition and distribution assemblages in this area. Further, this information is important as a baseline to develop sustainable environmental management in Bitung and Manado.

Methods

This research was conduc ted in October 2015 in the Lembeh Strait, in Bitung and Wori Beach in Manado, Indonesia. There were 11 sampling stations scattered from the southern to northern part of Lembeh Strait, Bitung, and 11 sampling stations at Wori Beach in Manado, Sulawesi, Indonesia that have been observed since 2012 (Fig. 1).

The phytoplankton samples were collected with vertical towing using Kitahara plankton net (mesh size of 80 µm). Identification and enumeration were done using Sedgwick Rafter Counting Chamber (SRCC) under 100-400 X magnification. Method for collecting phytoplankton was done vertically from 10 meters depth to surface. After hauling, the concentrated samples in the net's bucket was then removed out to another bottle sample and immediately put some fixative buffered formalin solution with concentration 4%.

Phytoplankton enumeration and identification were also done by the fraction method. A 1.0 ml sample was taken using 1 ml stamp pipette then placed in Sedgwick Rafter Counting Chamber (SRCC) counting plate. The fractioned sample was then observed under 4-40X magnification using a Nikon high Power dissecting stereo microscope. Phytoplankton identification process were done using the reference J.H. Wickstead, 1961; Yamaji, 1976; Taylor, 1994; Tan Qi-sheng, 2012 and Omura *et al*, 2012.

Variation in the phytoplankton community among two locations was analysis by applying a cluster analysis on similarity matrix based on the Bray-Curtis similarity index with R statistic software. This matrix was constructed on phytoplankton abundance data which excluding taxa that have mean contribution below 5% to reduce the influence of rare genera. The differences in phytoplankton composition among locations were tested using one-way analysis of similarities (ANOSIM).

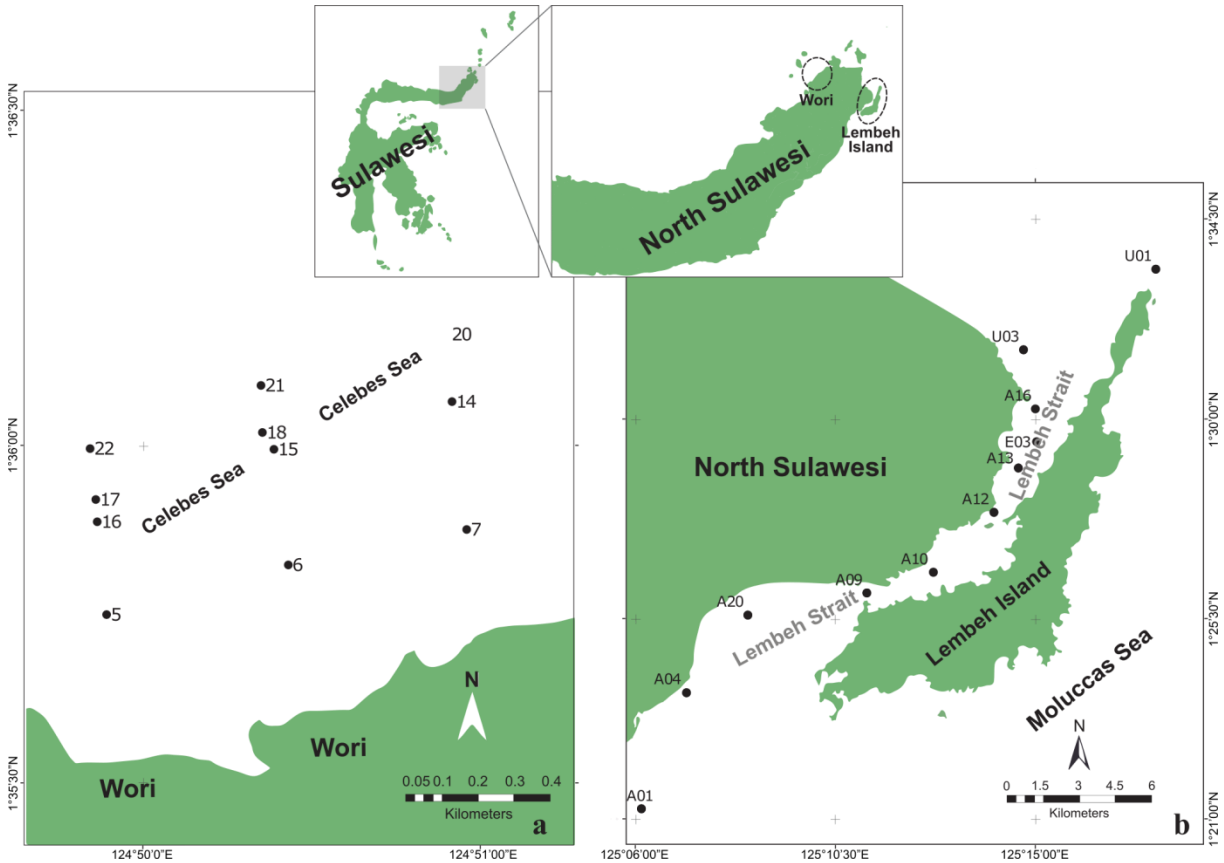

Figure 1. Research stations in the Lembeh Strait in Bitung and Wori Beach in Manado, North Sulawesi, Indonesia.

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Results and Discusions

There were 33 genera observed from 22 stations in the Lembeh Strait at Bitung and Wori Beach at Manado, North of Sulawesi (detail showed in Fig. 2). The phytoplankton community in Lembeh Strait and Wori Beach were mostly composed by diatoms (96.97%) and dinoflagellates (3.33%). There were 24 genera of diatom group and nine genera of dinoflagellate group found in these two locations. Based on the mean contribution at each station among the two locations, there were 11 dominance genera of diatom and dinoflagellate groups which the mean contribution value above five percent. Those were including six genera of diatom group (*Chaetoceros*, *Bacteriastrum*, *Nitzchia*, *Rhizosoleria*, *Thalassiothrix*, and *Thalassiosira*) and five genera of dinoflagellate group (*Ceratium*, *Prorocentrum*, *Protoperidinium*, *Pyrodinium*, and *Scriepsiella*. *Chaetoceros* (diatom) and *Protoperidinium* (dinoflagellate) exhibit the highest genus representation in all diatom and dinoflagellate group among the two locations, with a 38% and 36% (respectively) mean contribution (Fig. 3).

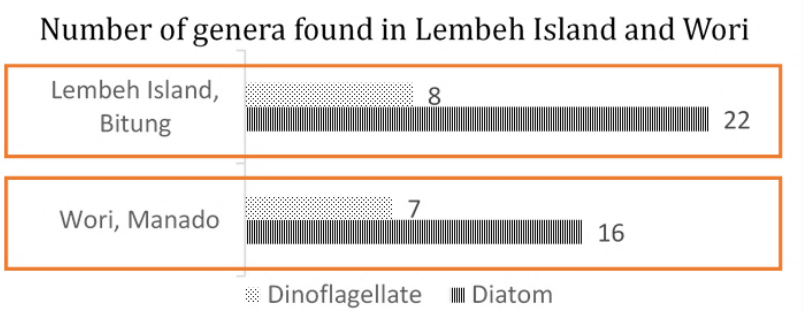

Figure 2. The number of genera found in the Lembeh Strait in Bitung and Wori Beach in Manado, North Sulawesi, Indonesia.

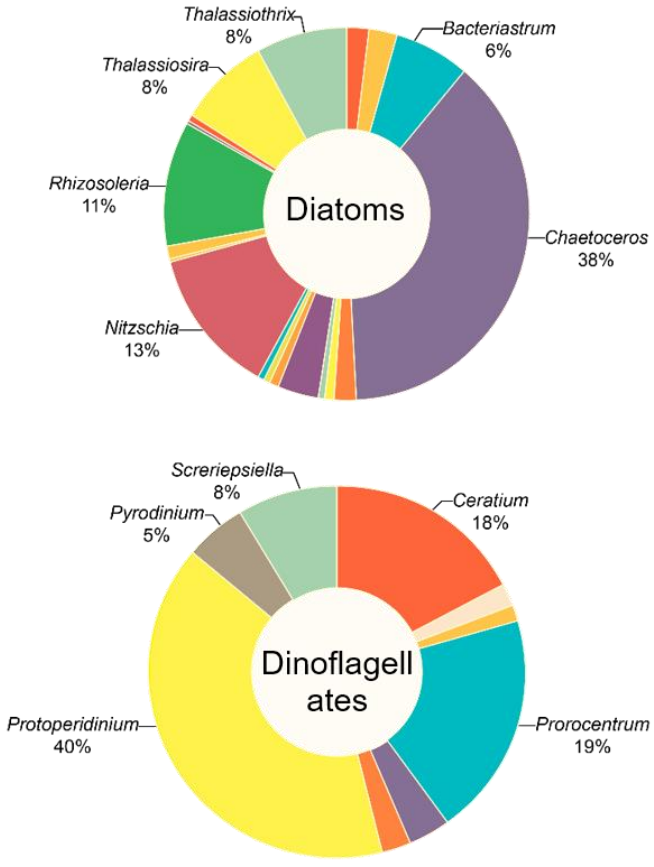

Figure 2. Total mean contribution of Diatom and Dinoflagellates found in Wori and Lembeh Strait.

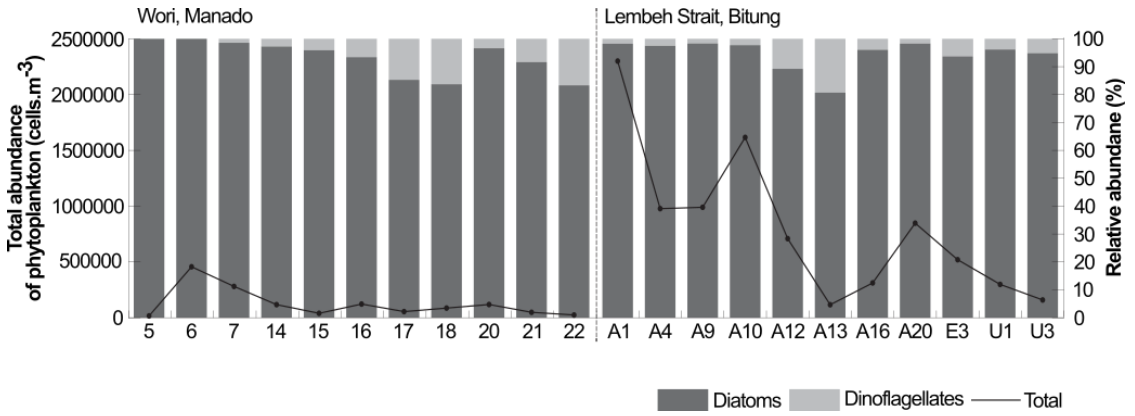

Figure 3. The contribution of diatom and dinoflagellates groups to total phytoplankton abundance (cells m-3) in Wori, Manado and Lembeh Strait, Bitung.

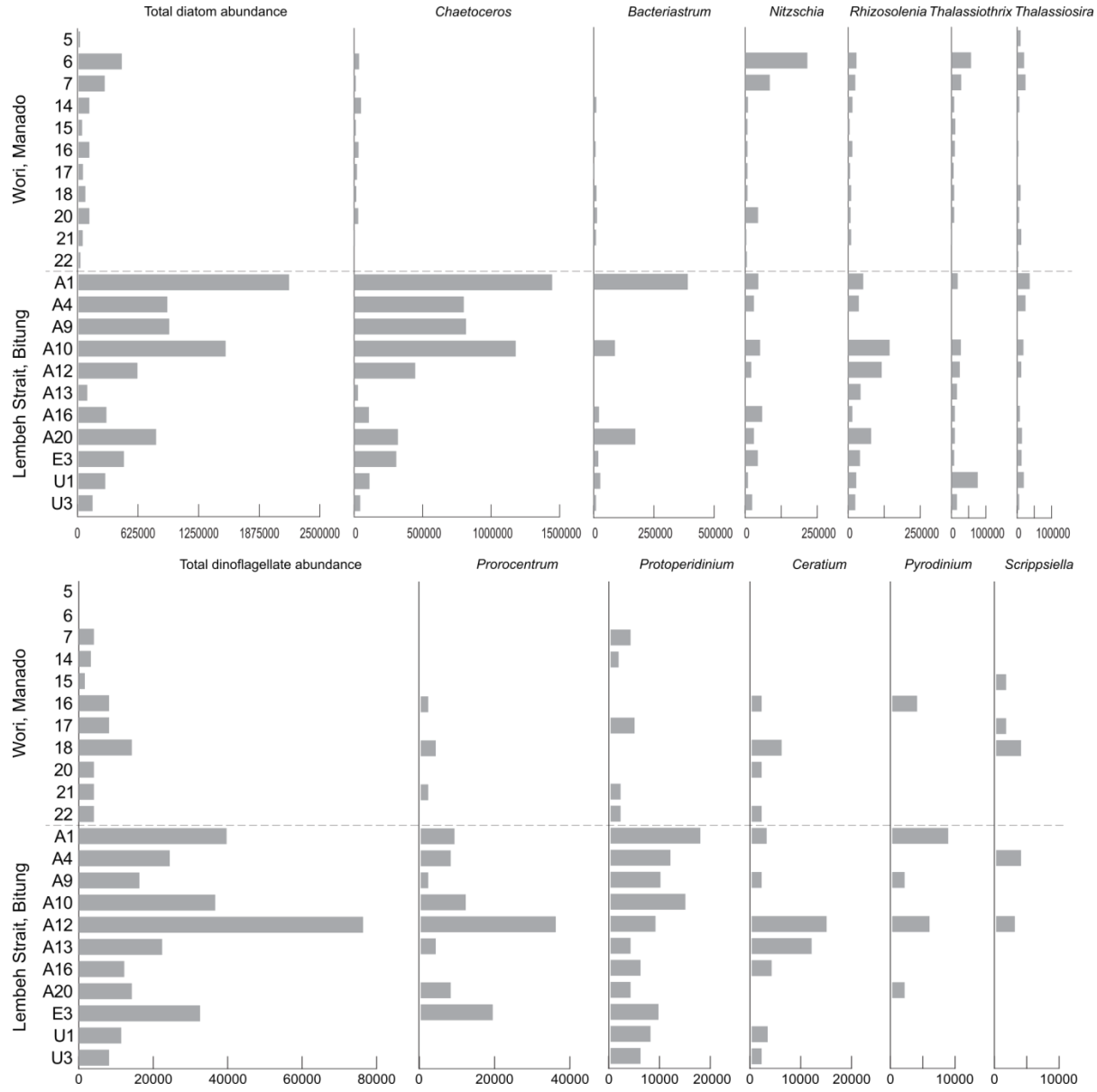

Figure 5. Diatom and Dinoflagellate characterized by dominance in Wori and Lembeh Strait.

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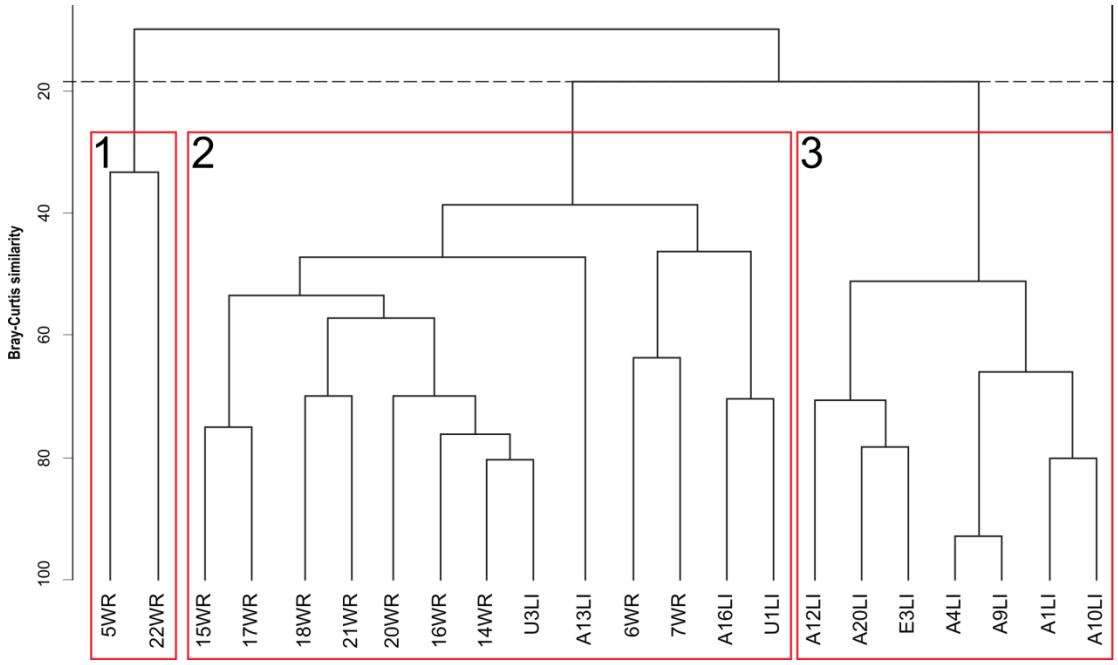

Figure 6. Cluster diagram of sampling stations based on abundance composition of 11 dominance phytoplankton. The scale indicates the Bray-Curtis similarity coefficient. Sufix WR is the stations in Wori, whereas LI is the stations in Lembeh strait.

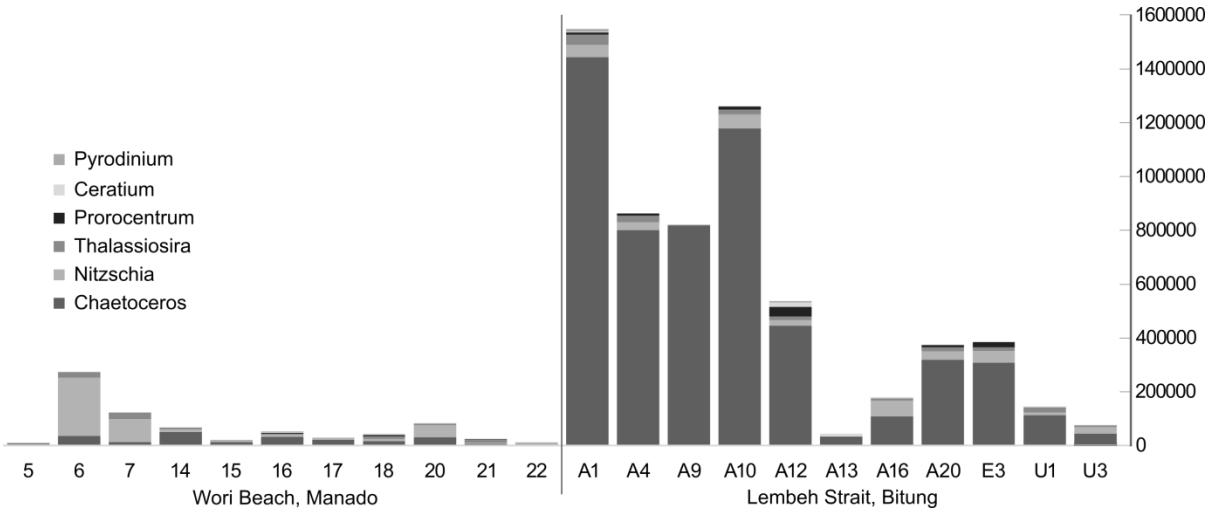

Figure 7. The occurrence of HABs causative organism in Wori Beach and Lembeh Strait.

Abundance of phytoplankton in Wori, Manado were lower than Lembeh Strait. Total phytoplankton abundance in Wori ranged from 16,293.28 – 464,358.45 cell.m^{-3} (station 6 and station 5, respectively), the location is seagrass bed and the deep of two meters. Whilst, In Lembeh Strait, Bitung, the highest abundance of phytoplankton was 2,300,407.33 cell.m^{-3} (station A1), the location is near to Takoki river and the lowest was 16,089.61 cell.m^{-3} (station A13), where there was a jelly fish bloom found at that time. The composition of diatoms and dinoflagellates in Wori and Lembeh Strait was dominated by diatom which ranged from 80.70% to 100.0% (station 5 and 6) (Fig. 4). Total phytoplankton abundance in Wori ranged from 16,293.28 – 464,358.45 cell.m^{-3} (station 6 and station 5, respectively). Whilst, In Lembeh Strait, Bitung, the highest abundance of phytoplankton was 2,300,407.33 cell.m^{-3} (station A1) and the lowest was 16,089.61 cell.m^{-3} (station A13). The composition of diatoms and dinoflagellates in Wori and Lembeh Strait was dominated by diatom which ranged from 80.70% to 100.0% (station 5 and 6).

Diatom community in Wori showed different characteristic compared to Lembeh Strait. Diatom community in Wori characterized by the

dominance of *Nitzschia* (29.9%) with the highest abundance found in station 6, whilst, in Lembeh Strait it was dominated by *Chaetoceros* (65.6%) and the highest abundance found in station A1 (Fig. 5). However, the dinoflagellate community in Wori and Lembeh showed the same characteristic which dominated by *Protoperidinium* (28.35% and 35.13%, respectively). Although, the frequency of *Protoperidinium* occurrence in Wori station were less frequent than in Lembeh Strait stations, which only found in five stations (station 7, 14, 17, 21, and station 22), while in Lembeh Strait, *Protoperidinium* was recorded at all stations.

Phytoplankton community in Wori, Manado and Lembeh Strait can be divided into three main groups at a level of 18.4 Bray-Curtis similarity coefficient (Fig. 6). Group 1 (Station 5 and 22) were characterized by the two least abundance of phytoplankton among all stations. Whilst, Group 2 (Station 6-21, Station A13-16, and Station U3) were the lowest abundance, which below the mean abundance. Station in Group 3 were the station with the high abundance of phytoplankton, higher than the mean abundance.

Interestingly, the highest abundance of phytoplankton observed in station A01, that located outside of the Lembeh Strait close to the open sea. However, many of the stations in Group 3 located close to the mainland. It seemed that the phytoplankton abundance in Lembeh Strait affected by the nutrient from domestic sewage and industrial waste that was accumulated in the river mouth. It showed that nutrient input is the main factors which regulate the phytoplankton abundance and community composition in the coastal waters (Cloern, 2001).

Amongst of the phytoplankton observed, there were six genera of which commonly known to cause harmful algal blooms (HABs) were observed in those two locations. Chaetoceros, *Nitzschia, Thalassiosira* from diatom group, Ceratium, *Prorocentrum*, and *Pyrodinium* from dinoflagellate group. *Nitzschia* was the most frequent found, almost recorded at all station in Wori, Manado and Lembeh Strait, Bitung. The less frequent found of HABs causative organisms in those two locations was *Pyrodinium.* In addition, *Chaetoceros* was observed dominance in Lembeh Strait, Bitung (Fig. 7).

The high abundance of *Chaetoceros* in Lembeh Strait can be potentially threating the biodiversity in this location. The occurrence of HAB event caused by diatom, such as *Nitzschia* and *Chaetoceros* had been recorded in Marina coast of Jakarta Bay with a total abundance of 2.9 x 10^6 cells/m^3 on May and November 2004 (Thoha *et al*., 2007). This event killed several species of small and big fish, crustaceans, and mollusks due to oxygen depletion.

Nowadays, the occurrence of HAB has increasing due to the high input of nutrients and consequent eutrophication of the Bay water. The bloom event commonly occurs after rainfall, where the nutrient from the land accumulated in coastal water that washed out by the rainfall. In the Southeast Asian waters, a variety of the harmful algae has increased in these five years. Most of harmful algae reported were Pyrodinium bahamense before, but now we have Alexandrium spp., and Gymnodinium catenatum at several areas. Red tides of Prorocentrum minimum, P. caudatum, and Cochlodinium polykrioides were reported in Indonesia, Japan, Malaysia, Philippines. Again, such HAB occurrences (Y, Fukuyo 2011); (Thoha *et al*, 2015).

Other red tide occurrences in Jakarta Bay were caused by *Prorocentrum minimum* in September 1992, which caused seawater to become brownish (Widiarti, 2002).

In Kao Bay, Halmahera, East Indonesia, frequent blooms of the toxic dinoflagellate, *Pyrodinium bahamense var, compressum,* occur (Wiadnyana *et al*., 1996; Thoha *et al* 2015). The blooms started at the beginning of the rainy season, causing severe problems to human health. A brownish-red of seawater color change, which by the local people is called “air beracun” (poisonous water) first reported by Sumadiharga (1977). Further, in 1993 Wiadnyana *et al* identified the causative organism. In Ambon Bay, this species also bloomed in 1994, with a cell count of 16 x 10^3 cells/l (Wiadnyana *et al*., 1996).

Wagey *et al* (1998) reported a reddish-brown red tide in Ambon Bay in November 1997, caused by *Alexandrium affine*. Cell counts reached a maximum of 60 x 10^6 cells/l, with an average of 2 x 10^6 cells/l. This was the first report of such a bloom in Ambon Bay.

The results suggest that high abundance of HAB species observed, especially in Lembeh Strait is higher than expected. Therefore, a monitoring activity of its occurrence in Lembeh Strait and Wori Beach is necessary to prevent harmful consequences of such blooms. The monitoring activity can be done by observing the HAB species in column water also in the sediment. Sediment sample provide information of the benthic dinoflagellates and the cyst of dinoflagellates which play important role on initiating bloom event. In addition, it is important to study the movements of this toxic species, regarding locate the possible affected areas and avoid human casualties.

Conclusion

The phytoplankton community in Lembeh Strait and Wori were predominances by *Chaetoceros* sp, *Rhizosolenia* sp, *Nitzschia* sp, and *Thallasiothrix* sp. The dinoflagellates are *Ceratium* sp, *Prorocentrum* sp and *Protoperidinium* sp. Phytoplankton abundance in

Wori, Manado were lower than Lembeh Strait. Total phytoplankton abundance in Wori ranged from 16,293.28 – 464,358.45 cell.m^{-3}. Whilst, In Lembeh Strait, Bitung, the highest abundance of phytoplankton was 2,300,407.33 cell.m^{-3} and the lowest was 16,089.61 cell.m^{-3}. The composition of diatoms and dinoflagellates in Wori and Lembeh Strait was dominated by diatom which ranged from 80.70% to 100.0%.

Proliferation phenomena of harmful phytoplankton are known as Harmful Algal Blooms (HABs). *Prorocentrum* sp and *Pyrodinium bahamense var. compressum* are the main toxic dinoflagellates species which lead toxic events on the Indonesian coasts, especially Jakarta Bay, Lampung Bay and Amboy Bay. In Lembeh Strait and Wori beach, there were six genera which commonly known to cause HABs Chaetoceros, *Nitzschia, Thalassiosira* from diatom group, Ceratium, *Prorocentrum*, and *Pyrodinium* from dinoflagellate group. The increasing occurrence of these organism is a significant and expanding threat to health and the fisheries and shellfish industries. We should concern this HABs because the Lembeh Strait and Wori Beach are locations of fisheries and tourism (Thoha *et al*, 2015).

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