Correlation of dissolved detergent content with diatom abundance in Air Hitam strait waters, Meranti island regency, Riau

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Abstract. This research was conducted in April 2007 in the waters of Air Hitam Strait, in the Regency of Meranti Islands. It aimed to determine the correlation of dissolved detergent content with diatomic abundance in the waters of Air Hitam Strait. The research was carried out under survey method. Detergent levels were measured and abundance of diatoms in the waters was counted simultaneously. The results showed that the detergent content in these waters ranged from 0.5714 - 0.8095 mg/l and the abundance of diatoms ranged from 95.83 to 137.84 cells/l. It was noted that there was a very strong correlation between the content of dissolved detergent with diatoms population in the waters. The presence of detergent in the water may cause environmental problems related to the decrease in dissolved oxygen content.

1. Introduction
Most households use detergent for cleaning both clothes and house appliances. It because the detergent is able to reduce tension of water surface by releasing ion that loves water (hydrophilic) and that hate water (hydrophobic) [1]. There are two types of common detergent uses in the field, these are hard detergent or non-biodegradable (Alkyl Benzene Sulfate) and soft detergent or biodegradable (Lauryl Sulfuric Acid). Detergent is consisted of surfactant as the main component, and then are builders, filter, and additive substances. The types of builder substances are sodium tripolyphosphate, acetate, silicate, and citrate, while the filter substances is sodium sulfate and the additive substances are used for deodorizing, whitening, and coloring.

Detergent can lead to water deterioration if it flows into waters. It enhances organic content in the water that needs more oxygen to oxidize. This condition can reduce dissolved oxygen drastically while Bio-Oxygen Demand tends to increase and at the end, it will deteriorate the ecosystem in the waters. Detergent polluted waters can be thread to the food chain in the water ecosystem; it is especially on phytoplankton, zooplankton/protozoa and cyanobacteria. If these organisms (nekton) are not available, it will be harmful to all organisms in the waters. The impact of detergent on aquatic biota depends on its concentration in the waters. The higher the concentration detergent in the water the higher the impact might be.

Diatom is kind of phytoplankton that belong to Bacillariophyceae. It is common plankton in the sea [2]. Diatom plays important role in the ecosystem. It is able to change sun energy into organic compound as food for other organisms, and its existence is common in waters. In the food chain, it known as the first tropic level or primary producer that is dominant in the waters.

The waters of Air Hitam Strait is located in the mid-eastern part of Sumatra island that is between 0° 42’30” - 01° 28’ 0” North dan 102° 12’ 0” - 103°10’ 0” East. This region consists of lowland that sago and mangrove are common vegetation near the coast. One of local activity is to produce sago from the sago tree and some others work as fisher, public services, local traders, and unskilled laborers. People uses its coastal area as residents, ports and other purposes and the activities of the people is relatively high in the coastal areas. The high level of community activities and uses of detergent as cleaning agents can give impact on the coastal waters and might also harmful to other organisms. This study was carried
out to have a look the correlation of dissolved detergent on the abundance of diatom in the waters of Air Hitam Strait, Meranti regency, Riau province.

2. Materials and Methods
This study was carried out in April 2017 in the waters of Air Hitam Strait, Meranti Regency, Riau Province. Samples were collected from three different locations; they were near estuary with mangrove ecosystem (Station 1), in the area closer to local residence and main port (Station 2), and in the area near local ports and mangroves ecosystem (Station 3). Three sampling points were chosen at each station for sampling and measurements (Figure 1.)

![Figure 1. Stations and sampling points at the study areas; A,B,C mean stations and 1,2,3 are sampling points](image)

Survey method was used at this study while samples of detergent from the field were analyzed in the lab with MBAS method and spectrophotometry UV-Vis[3]. The diatoms identification referred to [4] and the abundance of these diatoms was calculated with a formula as follow [3];

\[ N = \frac{[(x)(z)]}{[(y)(v)]} \]

Where \( N \) = abundance of diatom (cell/liter), \( x \) = volume of filtered-water (125 ml), \( y \) = volume of samples under cover glass of microscope (0.08 ml), \( v \) = volume of filtered-water (50 liter) and \( Z \) = number of cells found in the samples.

The association of diatoms against the dissolved detergents was also calculated to find out its correlation [5].

3. Results and Discussion

3.1. Dissolved detergent
Water samples were collected from three different sites, starting from upstream (station 1) to downstream (station 3). Based on the lab analysis, the dissolved detergent was different between stations. It increases from the first station to the second station and it slightly decreases to the third stations; however, there is a tendency that it increases from upstream to downstream as seen on figure 2.
Figure 2. The average of dissolved detergents at each station; 1, 2, 3 are the stations names or sites.

The concentration of detergent in the second station was the highest while the lowest one was in the first station; the concentration values were 0.8095 mg/l and 0.5714 mg/l consecutively.

Low detergent concentration in the station 1, probably related to good condition of mangrove and relatively further from the local residence. In addition, detergent concentration decreases with the distance of source of pollutants [6].

The distribution of detergent in this coastal water might also relate to oceanographic condition. At low tide, current flows from the east to the west and turn to the north combining with the current of Malacca Strait. Besides, the activity of local community in the main port using detergent for cleaning might also enhanced its concentration in this area.

3.2. The occurrence and abundance of diatoms

The occurrence of diatom in the study area is varied between sampling point of each station. It ranges from 5 to 8 species in the first station and it between 4 to 5 species for both two other stations (table 1).

Table 1. Species of diatoms in each stations and sampling points in the waters of Air Hitam Strait, Meranti Regency, Riau Province.

| No. | Species         | Stations |
|-----|-----------------|----------|
|     |                 | A1 | A2 | A3 | B1 | B2 | B3 | C1 | C2 | C3 |
| 1   | Bacillariasp    | *  | *  | *  | *  | *  | *  | *  | *  | *  |
| 2   | Coscinodiscussp | *  | *  | *  | *  | *  | *  | *  | *  | *  |
| 3   | Fragilariasp    | *  | *  | *  | *  | *  | *  | *  | *  | *  |
| 4   | Gramatophorasp  | *  | *  | *  | *  | *  | *  | *  | *  | *  |
| 5   | Guinardiasp     | *  | *  | *  | *  | *  | *  | *  | *  | *  |
| 6   | Isthemiaisp     | *  | *  | *  | *  | *  | *  | *  | *  | *  |
| 7   | Nitzschia sp    | *  | *  | *  | *  | *  | *  | *  | *  | *  |
| 8   | Rhizosoleniasp  | *  | *  | *  | *  | *  | *  | *  | *  | *  |
| 9   | Rhabdhonemasp   | *  | *  | *  | *  | *  | *  | *  | *  | *  |
| 10  | Thalassionemasp | *  | *  | *  | *  | *  | *  | *  | *  | *  |
|     | Total Species   | 5  | 8  | 6  | 5  | 5  | 4  | 5  | 4  | 5  |

*Found species

*aStation’s name or station’s number,

*bSampling sites

Based on the figures in table 1, even though the range number of species in the first station is higher than the other two stations, however, its total number of species is the same with third station; that is nine species found. The most interesting is that Nitzschia sp occurred in all sampling sites. In contrast, Fragilariasp is the only species found in one of sampling point of the third station. The existence of
these two species will be interested for more study; it is especially on its relation to the habitat condition and the limiting factors for these two species.

The abundance of species was also varied in each stations of this study (see table 2 and figure 3). The figure 3 shows that the species of diatoms are more abundance in the first station, and then it decreases to the second station and a little bit increases in the third station; the abundance ranges from 95.83 Cell/l to 137.84 Cell/l (see table 2).

The first station is located near estuary with good condition of mangrove trees, while the second station is closer to the main port and the local residence. Nutrient rich flowing waters and low concentration of detergent near the first station might be the main factors to enhance the diatoms to grow and it is even better than the two other locations. Higher level of detergent at the second station was followed by the increase of bio oxygen demand and it lead to the decrease of dissolved oxygen near the station. Low dissolved oxygen in the waters will also lead to anaerobe oxidation, increasing hydrogen sulfide gases (H$_2$S) that toxic to the environment and it even harmful to diatoms and other biota.

However, other environmental factors also play an important role to diatoms to grow, instead of dissolved detergent only.

**Figure 3**. The average abundances of Diatom at each stations of Air Hitam Strait.

Some species can adapt to environmental change. *Nitzschia seriata*, for example, is very resistance in the rich organic waters and keep survive with that environmental condition [7]. Furthermore, [8] divided waters into three types based on the abundance of phytoplankton. The first category is oligotrophic waters, that is low fertility level of waters with only has zero – 2000 cells of phytoplankton per liter. The second category is mesotrophic waters, fairly fertility waters, with 2,000 – 15,000 cell/l. The last one is eutrophic waters, the highest fertility waters, with more than 15,000 cells of phytoplankton per liter. Due to the criteria as above, the waters in Air Hitam Strait can be categorized as the waters with low level of fertility waters (oligotrophic waters).

### 3.3. The correlation diatoms against dissolved detergent

Figure 4 showed correlation between dissolved detergents and diatoms at each station and sampling points. These two data showed that there is strong negative association between diatom abundance with dissolved detergent in the waters with correlation index ($r = -0.9311$). This index means that the increase of dissolved detergent in the water column is potentially reducing the diatom abundance in the waters of Air Hitam Strait. The main chemical content of detergent is consisted of surfactant, builder, filter, and additive substances [8]. In addition, these substances are toxic and can deteriorate aquatic biota and water environment. Some biotas of diatoms are not tolerant to the additive substances; such as whitening, coloring, and fragrance.
Additional data such as organic content, phosphate, BOD$_5$, DO, and Sulfuric acid gases were also measured. The analysis on these data showed that the abundance of diatom is directly proportional to phosphate and dissolved oxygen concentration in the waters. However, it is inversely proportional to detergent, BOD$_5$, and H$_2$S. According to [9], the existence of bubbles at the surface of waters is another limiting factor on oxygen concentration. Meanwhile, dissolved oxygen is one of indicators to state the water quality, because the aquatic biota need it for oxidation and reproduction processes. In addition, dissolved oxygen is also important for aquatic animals for metabolism process [10]. The dissolved oxygen in the waters of Air Hitam Strait ranges from 5.5 – 6.2 mg/l, where it is relatively in a good condition. Other oceanographic parameters such as visibility and current speed are also important physical parameter that influence the abundance of diatom in the study areas.

Statistical analysis showed that the abundance of diatom is directionally proportional on water visibility, and inversely proportional on current speed. The visibility of waters in the study area ranges from 0.55-0.65 m. The highest one was found at station 1 and that was the reason why the abundance of diatom at that station is relatively high. The distribution of diatom is also related to the speed of water current. The current speed at this study area ranges between 0.20-0.30 m/sec. The highest figure of diatom was also found at the station 1 with the lowest current speed.

4. Conclusion
Detergent concentration in the waters of Air Hitam Strait was ranged from 0.5714 mg/l – 0.8095 mg/l. The highest concentration was at the Station 2 and the lowest one was at the Station 1. The abundance of diatom found during study ranged from 95.83-137.84 cell/l. The highest abundance was at...
the Station 1 and the lowest was at the Station 2. The type of waters at Air Hitam Strait is categorized as oligotrophic waters, in term of the diatom abundance. In addition, there was strong and negative correlation of detergent concentration on the abundance of diatom at this study area. In another word, the higher the dissolved detergent in the waters, the lower the abundance of diatom in the waters.

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