Analysis of chlorophyll-a and phytoplankton abundance in Ujung Pancu Waters, Aceh Besar, Indonesia

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Abstract. Phytoplankton plays the important role as primary producers which determine the productivity of the waters. The purpose of the research was to determine the abundance of phytoplankton and the distribution of the chlorophyll-a at Ujong Pancu Waters, Aceh Besar, Indonesia. This research was conducted from November 2017 to January 2018. Samples were collected from five observation stations using purposive sampling method. Samples then were identified to figure out the species of phytoplankton and the chlorophyll-a was analyzed using spectrophotometric method. It was obtained 17 species of phytoplankton from those sites, and Chaetoceros sp. (469 ind/l) was the most abundant species from class of Bacillariophyceae. The chlorophyll-a concentration was obtained ranged from 0.32 - 2.05 μg/l.

1. Introduction
Phytoplankton communities have the most important role in biodiversity and biota productivity in a marine environment. Phytoplankton as the primary producer in waters is very decisive for all over waters productivity [1], especially to support the fishery resources. Phytoplankton succession can occur in a short time, so it is often used to monitor environmental changes [2, 3]. The availability of nutrients is the main factor controlling the production process and growth of phytoplankton [4]. Particularly, the existence of phytoplankton also related to supply nitrate and phosphate in waters [5-8], as both N and P are considered as key factor for phytoplankton fluctuations [1, 8, 9].

Phytoplankton abundance and Chlorophyll-a concentration play an important role in affecting the trophic level of waters. Chlorophyll-a is decisive to photosynthesis process of phytoplankton; therefore, measurement of chlorophyll-a is highly related to the abundance of phytoplankton on sites. Though, the amount of chlorophyll-a in each autotroph individual is different and depends on their size of chloroplast [10].

Ujung Pancu has a marine area that plays an important role for the surrounding community. In 2020 Ujong Pancu has been designated by the ministry of marine and fisheries as a Regional Waters Conservation Area (KKPD). On the other hand, the local community uses these waters as an area for fishing, supported by the high abundance of fish, besides this area also continues to develop as a tourist area. One of the supporting factors for the aquatic environment in this area is the presence of coral reefs around Ujong Pancu, close to the small island called Pulau Tuan. Those specifically support the ecosystem of fish, which have a diversity of coral species and are dominated by Acropora, Porites and Pocillopora [11].
Despite the number of important studies have been carried out in this area, such as those conducted by [12] that reported the condition of corals and invertebrates; [13] that reported the study of current patterns; [14] studied Gastropods and Bivalves; [15] concerned in Serranidae; but those are still not sufficient to support the sustainability of environmental conservation efforts. Since it is known that anthropogenic factors can lead to nutrient enrichment, the specifics may occur in coastal waters, a study of the condition of phytoplankton in the waters becomes important to be figured out to prevent the occurrence of excessive algae growth and pollution of marine waters [16]. This study focused on determining the abundance of phytoplankton and the distribution of the chlorophyll-a at Ujong Pancu Waters, Aceh Besar, Indonesia. In addition to concentration of chlorophyll-a and nitrate-phosphate, other water quality parameters also reported in this study include temperature, salinity, depth, brightness and pH.

2. Material and Method

2.1. Study area
This research was located in waters of Ujung Pancu, Aceh Besar, Indonesia. In the vicinity of the research location there is a small island used as a conservation area, called Pulau Tuan. Seawater samples of Ujung Pancu were collected from 5 sites (Figure 1). Phytoplankton was identified at Laboratory of Marine Biology, Marine and Fisheries Faculty, and Chlorophyll-a and other physical-chemistry parameters were analyzed at Laboratory of Chemistry, Teacher Training and Education Faculty, Syiah Kuala University.

![Figure 1](image)

**Figure 1.** Sampling sites located in waters of Ujung Pancu, Aceh Besar, Indonesia

2.2. Samples collection and processing
Data collection was conducted from November 2017 to January 2018. Phytoplankton samples were collected from surface water using filtration method. This method was applied by taking 100 liter of surface water then was filtered by plankton net. Filtrats were kept into 40 ml sampler and conserved by adding 2 – 3 drops of formaline 4%. Especially for chlorophyll measurement, the samples were
stored in a low temperature, placed into the dark bottles, and taken to the laboratory for filtration. Planktons were identified using microscope. Samples (0.05 ml each) were placed on microscope slide, then were observed using microscope magnification of 4x10, repeated three times. Identification of plankton was figured out based on [17-19].

For chlorophyll-a analysis, water samples were firstly vacuum filtered using the milipore whattman papers GF/C 42 µm. The papers were folded in square shape into a small size then were covered using aluminum wrap, and kept at 4°C. The folded papers then were grinded by adding 3.5 - 5 ml of acetone 90%. Further, the grinded papers were put in tubes and each tubes of sample added 5 ml of acetones 90% before kept at 4°C for 1 hour. The extract then spinned using centrifuge at 3000 rpm for 15 minutes. Then, samples were analyzed using spectrophotometer at wave length 665 nm, 645 nm, 630 nm, and 750 nm. Water quality parameters, i.e. temperature, salinity, depth, brightness, and pH were carried out in situ. While nitrate and phosphate were analyzed at the Laboratory of chemistry, Teacher Training and Education Faculty, Syiah Kuala University.

3. Result and Discussion

3.1. Chlorophyll-a and Water Quality parameters

The existence and composition of phytoplankton species are also regulated by physico-chemical characters of water, such as temperature, salinity, nutrients and pH [20]. The temperature recorded at the surface area during field data collection showed normal values (27-28 °C). The effect of temperature on the presence of plankton does not show a significant correlation [21]. On the other hand, the effect of temperature is known to have varying effects on different types of phytoplankton [22]. Temperature often has a positive correlation with increasing light conditions. Based on the measurement of water brightness, it was known that the waters around Ujung Pancu was in good condition. Even so reports from the local community stated that the waters around the study area might be formed turbid when the strong current was occurred. This study also revealed that the pH value of the studied sites was on the alkaline side, it ranged from 8.30 to 8.60 (Table 2).

| Parameter              | Station 1 | Station 2 | Station 3 | Station 4 | Station 5 |
|------------------------|-----------|-----------|-----------|-----------|-----------|
| Chlorophyll-a (µg/l)   | 2.05      | 0.43      | 0.42      | 0.32      | 0.44      |
| Nitrate (mg/l)         | 0.90      | 0.88      | 0.84      | 0.80      | 0.87      |
| Phosphrate (mg/l)      | 0.04      | 0.03      | 0.03      | 0.02      | 0.03      |
| Temperature (°C)       | 28.00     | 27.00     | 28.00     | 28.00     | 28.00     |
| pH                     | 8.60      | 8.50      | 8.50      | 8.30      | 8.30      |
| bottom depth (m)       | 4.00      | 3.50      | 6.50      | 13.00     | 15.00     |
| Brightness (m)         | 4.00      | 3.50      | 5.75      | 11.35     | 11.35     |
| Salinity (ppt)         | 33.00     | 33.00     | 33.00     | 33.00     | 33.00     |

Chlorophyll-a is often be used to classify the trophic condition of a waters. The highest chlorophyll-a was found at station 1 with a value of 2.05 µg/l. This is also in line with the finding of the highest concentration of nitrate and phosphate at station 1 as well. Nutrients determine the growth rate of phytoplankton and the efficiency of photosynthesis, and so are nitrate and phosphate [22].

Nutrient thresholds in marine waters are relatively difficult to determine, but following [23] it is stated that the set limits are ≤0.25 mg / l and ≤0.059 mg/l, respectively for nitrate and phosphate. Referring to this information, the phosphate and nitrate contained in Ujung Pancu have exceeded the threshold value. Compared to other stations, station 1 is closest to the mainland and the presence of anthropogenic activity is strongly suspected to have made this location the highest chlorophyll-a, nitrate and phosphate. Apart from anthropogenic activities, the area around Ujung Pancu has also
undergone many changes in land use, becoming a pond cultivation area. This situation may lead to the increase of ecological pressure due to being dumped into the sea.

3.2. Identification and phytoplankton abundance
The phytoplankton community in the study area is represented by a total of 4 class that has 17 species (Figure 2); i.e. the most abundance groups was of Bacillariophyceae (67%), followed by Coscinodiscophyceae, Midiophyceae, and Dinophyceae (15%, 13%, 5%), respectively.

![Figure 2. Class abundance (%) of phytoplankton on sites](image)

Previous study in other waters in Indonesia, such in Teluk Banten waters, [24] reported that Bacillariophyceae was also the most abundant phytoplankton in the waters with the composition found was 97.68%, and in Teluk Jakarta by [25], that Bacilloriophyceae was also found most than 58%.

| Class               | Spesies        | Abundance (Ind/l) | total (Ind/l) |
|---------------------|----------------|-------------------|--------------|
|                     |                | St 1  | St 2  | St 3  | St 4  | St 5  |             |
| Bacillariophyceae   | *Chaetoceros sp.* | 44    | 7     | 33    | 253   | 132   | 469         |
|                     | *Rhizosolenia sp.* | 44    | 11    | 11    | 44    | 11    | 121         |
|                     | *Melosira sp.*   | 11    | 11    | 11    | 33    | 44    | 110         |
|                     | *Haslea sp.*     | 11    | 0     | 0     | 0     | 0     | 11          |
|                     | *Psando-nitzscha sp.* | 0   | 11    | 0     | 11    | 22    | 44          |
|                     | *Lioleoma sp.*   | 0     | 11    | 0     | 0     | 0     | 11          |
|                     | *Navicula sp.*   | 0     | 11    | 0     | 0     | 0     | 11          |
|                     | *Odontella sp.*  | 0     | 0     | 11    | 0     | 0     | 11          |
|                     | *Asterionellopsis sp.* | 0  | 0     | 0     | 0     | 22    | 22          |
| Midiophyceae        | *Ditylum sp.*   | 33    | 33    | 11    | 66    | 7     | 150         |
|                     | *Planktoniella sp.* | 11    | 11    | 22    | 11    | 22    | 77          |
| Dinophyceae         | *Ceratium sp.*  | 22    | 22    | 11    | 11    | 0     | 66          |
| Coscinodiscophyceae | *Guinardia sp.* | 0     | 11    | 0     | 0     | 0     | 11          |
|                     | *Coscinodiscus sp.* | 0   | 11    | 11    | 22    | 11    | 55          |
|                     | *Leptocylindrus sp.* | 11    | 22    | 11    | 0     | 0     | 44          |
|                     | *Stephanopsis sp.* | 0    | 0     | 0     | 11    | 11    | 22          |
|                     | *Bacteriastrun sp.* | 22    | 22    | 11    | 0     | 0     | 55          |
The highest abundance of phytoplankton found was *Chaetoceros* sp., and scattered on five sites of observation. While the smallest abundance of phytoplankton i.e *Lioelema* sp., *Navicula* sp., *Odontella* sp., *Guinarna* sp., and *Haslea* sp. were only found on site 2 and 3 which was close to the land.

[26,27] stated that some species of Bacillariophyceae and Midiophyceae had the carotene and xanthophyll pigment such *Melosira nummuloides* and *Ditylum brightwelli*. Obviously, both were found on site 4 and 5. This explains the low content of chlorophyll-a on sites, while the abundance of phytoplankton was high.

4. Conclusion

It was obtained 17 species of phytoplankton from those sites, and *Chaetoceros* sp. (469 ind/l) was the most abundant species from class of Bacillariophyceae. The chlorophyll-a concentration was obtained ranged from 0.32 - 2.05 μg/l. While the nutrient content of nitrate and phosphate on sites were ranged from 0.8 – 0.9 mg/l and 0.019 – 0.036 mg/l, respectively.

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