Abundance and composition of phytoplankton communities in middle stream of Citanduy river, West Java

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Abstract. The relationship between phytoplankton composition and environmental conditions in their habitat provides an important role for their as an assessment of the status and quality of river waters and the management of these waters. The aim of this research was studied of composition and abundance of phytoplankton communities in Citanduy River, particularly in middle stream. The study has conducted in April, July, and October 2018. The study location consists of 4 stations. The research has measured the abundance index, diversity index, and dominance index of plankton. The physico-chemical waters parameters which was measured consist of temperature, pH, DO, depth, transparency, nitrite, ammonia, nitrate, total phosphate, and chlorophyll-a. Phytoplankton of Citanduy River consists of 4 classes. The abundance index of phytoplankton was around 2,578-7,366 cells/L; diversity index of phytoplankton is around 0.48-2.57, while the highest dominance index was Pediastrum sp with 0.56. Based on multiple regression analysis, the abundance of phytoplankton in April was influenced by nitrates and temperature. The abundance of phytoplankton in July is influenced by nitrite and ammonia. Meanwhile, in October, phosphate and oxygen parameters affect the abundance of phytoplankton. The Citanduy River is still in the stable category because the water quality is still in a sufficient condition for aquatic biota, especially phytoplankton. The ammonium and total phosphate of BBWS station in October were higher than standard. The high concentration of nitrogen and phosphorus nutrients is the results from the surrounding land for rice fields, plantations, fish farming, and waste disposal.

1. Introduction

Citanduy River is located in Central Java and West Java with 365,172 Ha. The upper stream of Citanduy River comes from Cakrabuana Mountain (1,921 m dpl), West Java and it flows to Central Java [1]. Citanduy watershed consist of 11 districts/cities i.e. Banyumas, Brebes, Ciamis, Cilacap, Garut, Banjar, Tasikmalaya, Kuningan, Majalengka, Sumedang, and Tasikmalaya. This watershed has a big role on continuity of Segara Anakan estuary ecosystem life. Citanduy is one of West Java watershed priority in erosion treatment, sedimentation, and waste. The environment problems in Citanduy watershed are artificial fertilizers usage that contain high nitrogen and phosphate, and also water pollution by domestic waste from households [2]. The amount of Citanduy erosion is the largest contributor to the silt deposited in Segara Anakan [3]. The changes in Citanduy River ecosystem are currently affecting the animal life population in that area.
The existence of human activities in around Citanduy River will affect the water quality and disrupt the phytoplankton life in these waters. Phytoplankton is a group of photosynthetic microscopic organisms that live in various types of aquatic habitats [4]. Each phytoplankton types have different adaptability to the environmental conditions with their habitat. The relationship between phytoplankton composition and environmental conditions provides an important role for phytoplankton as an assessment of status and quality of waters. It also will affect to the management of these waters.

The objectives of this study are to analyze the composition, abundance, diversity, and dominance of phytoplankton in Citanduy River, particularly in middle stream. We expected that the result could give the information related on the status and water quality of Citanduy River.

2. Materials and methods

2.1. Sample collection
The study is located in middle stream of Citanduy River, West Java Province, Indonesia (Figure 1). The study has been conducted in April, July, and October 2018. There are four stations for phytoplankton sampling and measurement of water quality. Phytoplankton was collected using vertical sampler and sieved through 20 μm plankton net. In laboratory, phytoplankton cells were counted and estimated as number of cells/l after concentrating the sample and taking 1 ml aliquots of the concentrate in a Sedgwick rafter cell.

There were 9 water quality parameters were sampled, which consist of physical and chemical parameters. Water was taken by using a water sampler volume of 2 liters at surface water. Water samples slowly lifted and opened the water faucets expenditure, and then the water was poured into the sample bottles of water and closed. Measurement and analysis of water quality parameters referred to SNI and APHA [5]. Temperature, pH, transparency, and DO were measured in situ, while nitrite, ammoniac, nitrate, total phosphate, and chlorophyll-a were analyzed in Laboratory of Research Institute for Inland Fisheries and Extension Palembang.

Figure 1. Citanduy river.
2.2. Analysis

The analysis of phytoplankton community includes composition, abundance, diversity, and dominance. The composition and abundance of plankton species were determined by microscopic observation. The abundance of phytoplankton was calculated using the following formula [6]:

\[ N = n \times \frac{1}{V_d} \times \frac{V_t}{V_{cg}} \times \frac{0_t}{0_p} \]

- **N**: Phytoplankton abundance (cells/l)
- **n**: Number of organisms recorded
- **O_t**: Area of field Sedgwick Rafter Cell (SRC) (mm²)
- **O_p**: Area of field of microscope (mm²)
- **V_t**: Volume of bottle sample (ml)
- **V_{cg}**: Volume of SRC (ml)
- **V_d**: Volume of filtered water (l)

The abundance and biodiversity of phytoplankton indicate the level of stability the ecosystem and also as an indicator of the water productivity level and fisheries potential. The diversity index was calculated using Shannon-Wiener diversity index [7]:

\[ H' = -\sum pi \ln pi \]

- **H'**: diversity index
- **pi**: proportion of each species

In addition to species diversity, the level of species dominance was also analyzed using Dominance Index formula [8]:

\[ D = \sum \left( \frac{n}{N} \right)^2 \]

- **D**: Dominance index
- **n**: Number of its organisms
- **N**: Total number of organisms

The factor of water productivity in Citanduy River is determined by relation between phytoplankton abundance and water quality parameters through multiple regressions. The multiple regression analysis produces a significant value that affects the value of the abundance of phytoplankton. The multiple regression equation can be described as follows [9]:

\[ Y = a + b_nX_n \]

- **Y**: Phytoplankton abundance
- **a**: Constanta
- **b_n**: Regression coefficient
- **X_n**: Independent parameter

3. Results and discussion

The composition of Citanduy River’s phytoplankton consists of 5 classes (Figure 2), namely Chlorophyceae (27 genera), Bacillariophyceae (17 genera), Cyanophyceae (7 genera), Dinophyceae (2 genera), and Euglenophyceae (3 genera). The total abundance of phytoplankton ranged from 2,578-
7,366 cells/L. The highest abundance of phytoplankton is in Manganti which is dominated by the Chlorophyceae and Bacillariophyceae classes. Chlorophyceae is a class of phytoplankton that is abundant in tropical lake waters [10, 11]. Meanwhile, Bacillariophyceae is a class of phytoplankton that is composite, resistant to extreme conditions, adaptable and has high reproductive [12, 13]. In this study, Chlorophyta was almost found in every month of observation and stations. It is because this class is the most abundant algae in fresh water so that its existence can be more than other classes. Otherwise, Euglenophyceae and Dinophyceae were only found in July during the summer or dry season. Both of these phytoplankton have locomotion and are often found in dry season [4].

The phytoplankton found during the study is influenced by seasonal succession of plankton. The highest total phytoplankton abundance occurred in October when it beginning of dry season. The process of decomposition of organic matter runs fast because the water-remaining mass in the river is longer so that the nutrient elements can be optimally utilized by phytoplankton to grow [14], the water flow is not too heavy and makes it easier for sunlight to penetrate into the water [15]. Meanwhile, the lowest total phytoplankton abundance occurred in April when the rainy season. The characteristics of phytoplankton will always move with the water currents. The sunlight penetration, low temperature, and low transparency influenced the phytoplankton growth.

![Phytoplankton abundance](image)

**Figure 2.** The composition of Citanduy river phytoplankton

**Table 1.** The total abundance of Citanduy river phytoplankton (cell/L) in April-October 2018

| No | Species          | BBI | Manganti | Ciamis | BBWS |
|----|------------------|-----|----------|--------|------|
| 1  | *Amphora sp*     | 0   | 0        | 0      | 0    |
| 2  | *Aulacoseria sp* | 0   | 0        | 0      | 0    |
| 3  | *Coscinodiscus sp* | 0   | 0        | 0      | 0    |
| 4  | *Cyclotella sp*  | 16  | 24       | 0      | 10   |
| 5  | *Cymbella sp*    | 0   | 4        | 26     | 8    |
| 6  | *Diatoma sp*     | 20  | 66       | 14     | 0    |
| 7  | *Fragilaria sp*  | 0   | 0        | 0      | 0    |
| 8  | *Diploneis sp*   | 0   | 26       | 0      | 0    |
| 9  | *Navicula sp*    | 18  | 26       | 0      | 0    |
| 10 | *Neidium sp*     | 0   | 0        | 0      | 0    |
| ID | Species          | C1  | C2  | C3  | C4  |
|----|------------------|-----|-----|-----|-----|
| 11 | Nitzschia sp     | 18  | 10  | 46  | 0   |
| 12 | Pinnularia sp    | 0   | 0   | 0   | 0   |
| 13 | Stauroeneis sp   | 0   | 0   | 0   | 0   |
| 14 | Stephanodiscus sp| 0   | 0   | 0   | 0   |
| 15 | Suriella sp      | 8   | 0   | 0   | 0   |
| 16 | Synedra sp       | 34  | 36  | 18  | 0   |
| 17 | Tabellaria sp    | 14  | 0   | 20  | 8   |

**Cyanophyceae**

| ID | Species          | C1  | C2  | C3  | C4  |
|----|------------------|-----|-----|-----|-----|
| 1  | Aphanocapsa sp   | 0   | 0   | 0   | 0   |
| 2  | Chrococcus sp    | 0   | 0   | 0   | 0   |
| 3  | Gomphosphaeria sp| 0   | 0   | 0   | 0   |
| 4  | Merismopedia sp  | 0   | 0   | 0   | 0   |
| 5  | Microcystis sp   | 86  | 0   | 0   | 0   |
| 6  | Oscillatoria sp  | 104 | 0   | 44  | 24  |
| 7  | Sphaerocystis sp | 692 | 224 | 0   | 36  |

**Chlorophyceae**

| ID | Species          | C1  | C2  | C3  | C4  |
|----|------------------|-----|-----|-----|-----|
| 1  | Actinastrum sp   | 0   | 0   | 0   | 0   |
| 2  | Ankistrodesmus sp| 0   | 0   | 0   | 0   |
| 3  | Chlorella sp     | 0   | 0   | 0   | 0   |
| 4  | Cladophora sp    | 74  | 0   | 0   | 0   |
| 5  | Closteria sp     | 0   | 12  | 6   | 10  |
| 6  | Coelastrum sp    | 0   | 0   | 0   | 0   |
| 7  | Crucigenia sp    | 0   | 0   | 0   | 0   |
| 8  | Desmidium sp     | 0   | 0   | 0   | 0   |
| 9  | Elakatothrix sp  | 22  | 0   | 0   | 0   |
|10  | Eudorina sp      | 32  | 0   | 0   | 0   |
|11  | Gloeocystis sp   | 0   | 64  | 24  | 0   |
|12  | Gonkinia sp      | 0   | 0   | 0   | 0   |
|13  | Gonium sp        | 0   | 0   | 0   | 0   |
|14  | Mogeotia sp      | 0   | 108 | 0   | 0   |
|15  | Pandorina sp     | 0   | 0   | 0   | 0   |
|16  | Pediastrum sp    | 36  | 64  | 0   | 0   |
|17  | Pleurococcus sp  | 0   | 0   | 0   | 0   |
|18  | Scenedesmus sp   | 90  | 26  | 14  | 0   |
|19  | Schroederia sp   | 16  | 6   | 0   | 8   |
|20  | Selenastrum sp   | 40  | 0   | 42  | 10  |
|21  | Spaerochystis sp | 0   | 0   | 0   | 0   |
|22  | Sphaerocystis sp | 0   | 0   | 0   | 0   |
|23  | Spondylosium sp  | 0   | 16  | 0   | 24  |
|24  | Stauroastrum sp  | 0   | 6   | 24  | 0   |
|25  | Tetradron sp     | 0   | 0   | 0   | 0   |
|26  | Tetraspora sp    | 44  | 0   | 0   | 0   |
|27  | Ulothrix sp      | 0   | 0   | 0   | 0   |

**Euglenophyceae**

| ID | Species          | C1  | C2  | C3  | C4  |
|----|------------------|-----|-----|-----|-----|
| 1  | Euglena sp       | 0   | 0   | 0   | 0   |
| 2  | Phacus sp        | 0   | 0   | 0   | 0   |
| 3  | Trachelomonas sp | 0   | 0   | 0   | 0   |
| No | Species          | BBI  | Manganti | Ciamis | BBWS |
|----|------------------|------|----------|--------|------|
| 1  | *Peridinium sp*  | 0    | 0        | 0      | 0    |
| 2  | *Dinophysis sp*  | 0    | 0        | 0      | 0    |

July 2020

**Bacillariophyceae**

| No | Species          | BBI  | Manganti | Ciamis | BBWS |
|----|------------------|------|----------|--------|------|
| 1  | *Amphora sp*     | 0    | 0        | 0      | 0    |
| 2  | *Aulacoseria sp* | 362  | 0        | 20     | 0    |
| 3  | *Coscinodiscus sp* | 0  | 0        | 0      | 2    |
| 4  | *Cyclotella sp*  | 308  | 38       | 4      | 24   |
| 5  | *Cymbella sp*    | 0    | 0        | 0      | 0    |
| 6  | *Diatoma sp*     | 0    | 0        | 0      | 0    |
| 7  | *Fragilaria sp*  | 0    | 0        | 0      | 0    |
| 8  | *Gyrosigma sp*   | 0    | 0        | 0      | 0    |
| 9  | *Navicula sp*    | 12   | 8        | 2      | 14   |
| 10 | *Neidium sp*     | 0    | 0        | 0      | 12   |
| 11 | *Nitzchia sp*    | 0    | 0        | 0      | 0    |
| 12 | *Pinnularia sp*  | 2    | 4        | 0      | 14   |
| 13 | *Stauroneis sp*  | 1212 | 0        | 0      | 0    |
| 14 | *Stephanodiscus sp* | 0  | 0        | 0      | 0    |
| 15 | *Surirella sp*   | 0    | 0        | 0      | 0    |
| 16 | *Synedra sp*     | 702  | 0        | 2      | 22   |
| 17 | *Tabellaria sp*  | 0    | 0        | 0      | 0    |

**Cyanophyceae**

| No | Species          | BBI  | Manganti | Ciamis | BBWS |
|----|------------------|------|----------|--------|------|
| 1  | *Aphanocapsa sp* | 0    | 18       | 120    | 0    |
| 2  | *Chroococcus sp* | 92   | 92       | 172    | 874  |
| 3  | *Gomphosphaeria sp* | 0  | 0        | 0      | 0    |
| 4  | *Merismopedia sp* | 6   | 50       | 18     | 0    |
| 5  | *Microcystis sp* | 0    | 2        | 0      | 0    |
| 6  | *Oscillatoria sp*| 22   | 2        | 0      | 8    |
| 7  | *Sphaerocystis sp* | 0  | 0        | 0      | 0    |

**Chlorophyceae**

| No | Species          | BBI  | Manganti | Ciamis | BBWS |
|----|------------------|------|----------|--------|------|
| 1  | *Actinastrum sp* | 8    | 0        | 0      | 30   |
| 2  | *Ankistrodesmus sp* | 0  | 4        | 0      | 2    |
| 3  | *Chlorella sp*   | 0    | 0        | 0      | 0    |
| 4  | *Cladophora sp*  | 0    | 0        | 0      | 0    |
| 5  | *Closterium sp*  | 0    | 0        | 0      | 0    |
| 6  | *Coelastrum sp*  | 20   | 2        | 4      | 0    |
| 7  | *Crucigenia sp*  | 12   | 0        | 0      | 0    |
| 8  | *Desmidium sp*   | 0    | 74       | 12     | 0    |
| 9  | *Elakatothrix sp* | 0   | 0        | 0      | 0    |
| 10 | *Eudorina sp*    | 0    | 0        | 0      | 0    |
| 11 | *Gloeocystis sp* | 0    | 2        | 6      | 4    |
| 12 | *Golenkinia sp*  | 0    | 0        | 4      | 0    |
| 13 | *Gonium sp*      | 0    | 10       | 0      | 0    |
| 14 | *Mougeotia sp*   | 0    | 0        | 0      | 0    |
| No | Species          | BBI  | Manganti | Ciamis | BBWS |
|----|------------------|------|----------|--------|------|
| 15 | Pandorina sp     | 0    | 76       | 10     | 0    |
| 16 | Pediastrum sp    | 1364 | 60       | 92     | 6    |
| 17 | Pleurococcus sp  | 4    | 0        | 0      | 0    |
| 18 | Scenedesmus sp   | 10   | 4        | 0      | 26   |
| 19 | Schroederia sp   | 0    | 0        | 0      | 0    |
| 20 | Selenastrum sp   | 0    | 0        | 0      | 4    |
| 21 | Spaeochystis sp  | 0    | 0        | 0      | 0    |
| 22 | Sphaerocystis sp | 0    | 12       | 12     | 0    |
| 23 | Spondylosium sp  | 0    | 0        | 0      | 0    |
| 24 | Staurastrum sp   | 4    | 2        | 0      | 4    |
| 25 | Tetraedron sp    | 0    | 4        | 0      | 2    |
| 26 | Tetraspora sp    | 0    | 8        | 0      | 0    |
| 27 | Ulothrix sp      | 0    | 0        | 0      | 0    |

**Euglenophyceae**

| No | Species          | BBI  | Manganti | Ciamis | BBWS |
|----|------------------|------|----------|--------|------|
| 1  | Euglena sp       | 0    | 30       | 28     | 10   |
| 2  | Phacus sp        | 0    | 2        | 0      | 4    |
| 3  | Trachelomonas sp | 14   | 20       | 8      | 0    |

**Dinophyceae**

| No | Species          | BBI  | Manganti | Ciamis | BBWS |
|----|------------------|------|----------|--------|------|
| 1  | Peridinium sp    | 502  | 38       | 30     | 40   |
| 2  | Dinophysis sp    | 0    | 2        | 0      | 0    |

October 2018

| No | Species          | BBI  | Manganti | Ciamis | BBWS |
|----|------------------|------|----------|--------|------|
| 1  | Amphora sp       | 18   | 40       | 142    | 40   |
| 2  | Aulacoseria sp   | 0    | 0        | 0      | 0    |
| 3  | Coscinodiscus sp | 0    | 0        | 0      | 0    |
| 4  | Cyclotella sp    | 24   | 0        | 0      | 78   |
| 5  | Cymbella sp      | 0    | 0        | 0      | 0    |
| 6  | Diatoma sp       | 0    | 38       | 84     | 160  |
| 7  | Fragilaria sp    | 0    | 0        | 244    | 458  |
| 8  | Gyrosigma sp     | 20   | 0        | 4      | 80   |
| 9  | Navicula sp      | 54   | 0        | 116    | 220  |
| 10 | Neidium sp       | 0    | 0        | 0      | 0    |
| 11 | Nitzchia sp      | 60   | 40       | 158    | 260  |
| 12 | Pinnularia sp    | 20   | 0        | 0      | 240  |
| 13 | Stauroneis sp    | 0    | 0        | 24     | 0    |
| 14 | Stephanodiscus sp| 0    | 0        | 0      | 0    |
| 15 | Surirella sp     | 60   | 0        | 72     | 0    |
| 16 | Synedra sp       | 100  | 138      | 0      | 378  |
| 17 | Tabellaria sp    | 0    | 0        | 154    | 0    |

**Cyanophyceae**

| No | Species          | BBI  | Manganti | Ciamis | BBWS |
|----|------------------|------|----------|--------|------|
| 1  | Aphanocapsa sp   | 0    | 0        | 0      | 0    |
| 2  | Chrococcus sp    | 0    | 0        | 0      | 0    |
| 3  | Gomphosphaeria sp| 320  | 0        | 0      | 0    |
| 4  | Merismopedia sp  | 0    | 0        | 4      | 0    |
| 5  | Microcystis sp   | 0    | 0        | 0      | 0    |
The diversity index of Citanduy river phytoplankton ranged from 0.48-2.57 (Figure 3). The highest phytoplankton diversity index is in Manganti when July, the dry season. According to Shannon-Weiver the diversity index score of 0-2 $H'$ is on category of moderate until stable. Dwirastina and Wibowo [7] stated that the high number of species is follow with the high diversity. Furthermore, the highest dominance index of phytoplankton was *Pediastrum sp* from Chlorophyceae classes with 0.56. This species is a colony pytoplankton that usually live in shallow waters, stirred water bodies, temperature range 21.29°C -28.29°C, and pH range 6.87-8.73 [4].

| 6 | Oscillatoria sp | 0 | 0 | 58 | 180 |
| 7 | Sphaerocystis sp | 0 | 0 | 0 | 0 |

**Chlorophyceae**

| 1 | Actinastrum sp | 0 | 0 | 2 | 18 |
| 2 | Ankistrodesmus sp | 58 | 0 | 0 | 0 |
| 3 | Chlorella sp | 98 | 0 | 38 | 0 |
| 4 | Cladophora sp | 0 | 0 | 4 | 0 |
| 5 | Closterium sp | 0 | 0 | 0 | 0 |
| 6 | Coelastrum sp | 0 | 0 | 0 | 0 |
| 7 | Crucigenia sp | 0 | 0 | 0 | 0 |
| 8 | Desmidium sp | 0 | 0 | 2 | 0 |
| 9 | Elakatothrix sp | 0 | 0 | 0 | 0 |
| 10 | Eudorina sp | 0 | 0 | 0 | 0 |
| 11 | Gloeocystis sp | 0 | 0 | 0 | 0 |
| 12 | Golenkinia sp | 0 | 0 | 0 | 0 |
| 13 | Gonium sp | 0 | 0 | 0 | 0 |
| 14 | Mougeotia sp | 0 | 0 | 0 | 0 |
| 15 | Pandorina sp | 0 | 0 | 0 | 0 |
| 16 | Pediastrum sp | 242 | 5398 | 206 | 538 |
| 17 | Pleurococcus sp | 0 | 0 | 0 | 0 |
| 18 | Scenedesmus sp | 218 | 0 | 316 | 202 |
| 19 | Schroederia sp | 0 | 0 | 0 | 0 |
| 20 | Selenastrum sp | 0 | 0 | 0 | 0 |
| 21 | Spaerochystis sp | 0 | 0 | 0 | 0 |
| 22 | Spheerocystis sp | 0 | 0 | 0 | 0 |
| 23 | Spondylosium sp | 0 | 0 | 0 | 0 |
| 24 | Stauroastrum sp | 0 | 20 | 0 | 20 |
| 25 | Tetraedron sp | 80 | 0 | 0 | 300 |
| 26 | Tetraspora sp | 0 | 0 | 0 | 0 |
| 27 | Ulothrix sp | 0 | 20 | 0 | 20 |

**Euglenophyceae**

| 1 | Euglena sp | 0 | 0 | 0 | 0 |
| 2 | Phacus sp | 0 | 0 | 0 | 0 |
| 3 | Trachelomonas sp | 0 | 0 | 0 | 0 |

**Dinophyceae**

| 1 | Peridinium sp | 0 | 0 | 0 | 0 |
| 2 | Dinophysis sp | 0 | 0 | 0 | 0 |
**Figure 3.** The diversity index of Citanduy River phytoplankton

**Table 2.** NO\textsubscript{2}, NH\textsubscript{3}, and NO\textsubscript{3} of Citanduy River in April-October 2018.

| No | Station         | April NO\textsubscript{2} (mg/L) | July NO\textsubscript{2} (mg/L) | Oct NO\textsubscript{2} (mg/L) | April NH\textsubscript{3} (mg/L) | July NH\textsubscript{3} (mg/L) | Oct NH\textsubscript{3} (mg/L) | April NO\textsubscript{3} (mg/L) | July NO\textsubscript{3} (mg/L) | Oct NO\textsubscript{3} (mg/L) |
|----|-----------------|----------------------------------|---------------------------------|-------------------------------|---------------------------------|---------------------------------|-------------------------------|---------------------------------|---------------------------------|-------------------------------|
| 1  | BBI             | 0.016                            | 0.039                           | 0.004                         | 0.151                           | 0.482                           | 0.001                         | 3.235                           | 3.112                           | 0.880                         |
| 2  | Bendungan Manganti | 0.028                         | 0.014                           | 0.001                         | I-IV                            | 0.062                           | 0.198                           | 0.001                           | I-IV                            | 3.076                           | 0.190                           | 0.170                         |
| 3  | Ciamis          | 0.025                            | 0.015                           | 0.001                         | 0.042                           | 0.067                           | 0.003                         | 3.886                           | 3.428                           | 1.450                         |
| 4  | BBWS            | 0.016                            | 0.013                           | 0.001                         | 1.138                           | 6.016                           | 4.581                         | 6.942                           | 7.775                           | 6.224                           | 6.281                         |

*value is bigger than standard (NH\textsubscript{3} ≤0.5 mg/L).

**Table 3.** TP, Chl-a, and pH of Citanduy River in April-October 2018.

| No | Station | April TP (mg/L) | July TP (mg/L) | Oct TP (mg/L) | April Chl-a (mg/m\textsuperscript{3}) | July Chl-a (mg/m\textsuperscript{3}) | Oct Chl-a (mg/m\textsuperscript{3}) | April pH | July pH | Oct pH |
|----|---------|-----------------|----------------|--------------|--------------------------------------|--------------------------------------|--------------------------------------|----------|--------|--------|
| 1  | BBI     | 0.032           | 0.137          | 1.138        | 6.016                                | 4.581                                | 6.942                                | 7.66     | 6.66   | 6.66   |
| 2  | Bendungan Manganti | 0.082          | 0.893          | 0.869        | I-IV                                 | 8.400                                | 3.842                                | 10.810   | 6.66   | 7.66   |
| 3  | Ciamis  | 0.062           | 0.211          | 1.236        | 9.303                                | 6.725                                | 12.258                               | 7.66     | 6.66   | 6.66   |
| 4  | BBWS    | 0.040           | 0.209          | 10.585*      | 7.775                                | 6.224                                | 6.281                                | 7.66     | 6.66   | 6.66   |

*value is bigger than standard.

**Table 4.** DO, temperature, and transparency of Citanduy River in April-October 2018.

| No | Station | April DO (mg/L) | July DO (mg/L) | Oct DO (mg/L) | April Temp (°C) | July Temp (°C) | Oct Temp (°C) | April Transparency (cm) | July Transparency (cm) | Oct Transparency (cm) |
|----|---------|-----------------|----------------|--------------|-----------------|----------------|---------------|--------------------------|------------------------|-----------------------|
| 1  | BBI     |                 |                |              |                 |                |               |                          |                        |                       |
| 2  | Bendungan Manganti |             |                |              |                 |                |               |                          |                        |                       |
| 3  | Ciamis  |                 |                |              |                 |                |               |                          |                        |                       |
| 4  | BBWS    |                 |                |              |                 |                |               |                          |                        |                       |
Based on the relationship between phytoplankton abundance and water quality parameters, the abundance of phytoplankton in April is influenced by nitrates (NO$_3$) and temperature. The abundance of phytoplankton in July is influenced by nitrite (NO$_2$) and ammonia (NH$_3$). Meanwhile, in October, total phosphate (TP) and dissolved oxygen (DO) affect the abundance of phytoplankton. Nutrients factors influence the growth of phytoplankton. So, the increase of the nutrient elements will encourage the growth of phytoplankton and increase water productivity. However, the dynamics of phytoplankton in the waters are not only influenced by nutrients, but also by temperature, light intensity, and water transparency [4]. Therefore, the physical and chemical characteristics of river waters can provide an overview of the composition and biomass of phytoplankton in the waters.

Several commonly-occurring sources of nitrogen (nitrate, nitrite, and ammonium ions) are potentially available to “algae”. Furthermore, phosphorus is essential to the function and growth of all plants [16]. Therefore, river which is located in urban areas show an increase of nitrogen and phosphorus nutrient concentrations, and encourage the water productivity. The ammonium and total phosphate of BBWS station in October were higher than standard of Government Regulation No. 82 2001. This is due to the large amount of urea content and the ammonification process that comes from the decomposition of organic matter by microbes. In addition, this station near central city and residence area where most of the population conduct daily activities around the river. Domestic and industrial wastewater affect the ammonia levels in these waters. The high concentration of nitrogen and phosphorus nutrients in the middle stream of Citanduy River is the results from the surrounding land for rice fields, plantations, fish farming, and waste disposal. The Citanduy watershed has changed forest area which can disrupt the hydrological cycle in its watershed [3].

The physical parameters that influence the life of phytoplankton consist of temperature, transparency, and DO value. Temperature plays an important role in the chemical and biological processes of waters. The nitrate values of Citanduy waters ranged from 0.17-3.88 mg/L, nitrite ranged from 0.0007-0.039 mg/L, ammonia 0.0006-2.353 mg/L, and DO value 0.032-10.58 mg/L. While, the value of water temperature in the Citanduy River during the study ranged from 26.85°C-28.88 C. Chlorophyta and diatoms will grow well in the temperature range of 30°C-35°C [7].

The transparency is an indicator of aquatic productivity related to photosynthesis and plankton respiration processes. Low transparency causes low light intensity to enter the waters, so that the photosynthesis process of phytoplankton is inhibited and not optimal. The range of Citanduy River transparency during the study is 10-55 cm. This low value is due to the low river depth at the time of study. It appears that the turbidity condition of Citanduy water which is brown, indicates that the river flow carries a sediment load. Based on Soewandita and Sudiana’s study in 2007, the sedimentation load of the S. Citanduy flow was around 5 million m$^3$/year. Land degradation in the upstream area of Citanduy watershed can be seen from the existence of steep sloping areas that are used for agricultural cultivation areas [17].

Dissolved oxygen concentration is an important parameter to determine the quality of the aquatic environment, a limiting factor for the aquatic environment, and is used as an indication of the presence of organic matter pollution. Dissolved oxygen content should not be less than 4 mg/L, so that aquatic organisms can live. The value of dissolved oxygen in Citanduy River ranges from 4.2-12.4 mg/L. The dissolved oxygen levels in water are generated by the photosynthesis process from phytoplankton and oxygen diffusion from the atmosphere.

Chlorophyll-a is found in all photosynthesizing plants. It has direct role in eutrophication. Bellinger and Sigee [4] classified the trophic state of lake based on chlorophyll-a content, i.e. ultra-
oligotrophic, oligotrophic, mesotrophic, eutrophic, and hypertrophic with each value <1; 1-2.5; 2.5-8; 8-25 and > 25 μg/L. From this study, the Chlorophyll-a of Citanduy River has range from 3.842-12.258 mg/m³. Based on the trophic state, Citanduy River is categorized on mesotrophic-eutrophic level.

4. Conclusion
In conclusion, the physicals-chemicals of the middle stream of Citanduy River still on the stable category because it was still in a sufficient condition for aquatic biota, especially phytoplankton. The ammonium and total phosphate of BBWS station in October were higher than standard. The high concentration of nitrogen and phosphorus nutrients is the results from the surrounding land for rice fields, plantations, fish farming, and waste disposal. The total abundance of phytoplankton ranges from 2,578-7,366 cells/L, the phytoplankton diversity index ranges from 0.48-2.57, while the highest dominance index was Pediastrum sp with 0.56.

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