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Structure of Plankton Communities in Cijulang River Pangandaran District, West Java Province, Indonesia

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ABSTRACT

A river is a water ecosystem that plays an important role in the hydrological cycle and functions as a catchment area for the surrounding area. One of the organisms inhabiting river waters is plankton. The purpose of this study was to determine and analyze the structure of the plankton community in the waters of the Cijulang River and to study the relationship between plankton abundance, as well as some physical-chemical parameters of the water. The study was conducted in January, February, and March 2018 on the Cijulang River, at 5 (five) stations with a purposive sampling method. Accordingly, 17 genera were found, from 7 phytoplankton classes, consisting of 6 Bacillariophyceae genera, 1 Clorophyceae genus, 2 Cyanophyceae genera, 3 Zygnematophyceae genera, 2 Desmidiaceae genera, 1 Synurophyceae genus, and 2 Fragillariophyceae genera. Also found were 10 genera from 5 classes of zooplankton consisting of 4 genera Maxillopoda, 2 genera Branchiopoda, 1 genus Gastropoda on veliger fase, 1 genus Ostracoda, and 2 genera Copepoda. The abundance of phytoplankton obtained ranges from 11-57 cells / L, while the zooplankton ranges from 8 – 40 ind/L. The diversity index (H ') = 1.397 - 2.275 and dominance index (D) = 0.022 - 0.294. Physical-chemical parameters of the waters, respectively, were 22 °C - 31 °C, light intensity 47.5 cm - 254 cm, salinity 0 ppt - 20 ppt, and dissolved oxygen 6.2 mg / L - 13.4 mg / L. Ammonia concentration was 0.03 - 0.08 mg / L. All stations had a phosphate value of less than 0.16 mg / L and a silicate concentration of 0.01 - 0.0581 mg / L.

***Keywords*:** cijulang, plankton, community structure, Cijulang River

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1. INTRODUCTION

River is a water ecosystem that plays an important role in the hydrological cycle and functions as a catchment area for the surrounding area. As an ecosystem, river waters are composed of various biotic and abiotic components that interact and influence each other. Components in the river ecosystem will interact with each other to form an energy flow that will create the stability of the ecosystem. One of the biotic components found in the river is plankton. Plankton can be divided into two, namely phytoplankton and zooplankton. Phytoplankton has a very important role in the river ecosystem, because by its nature autotrophs are able to convert inorganic matter into organic matter and produce oxygen which is absolutely necessary for the lives of higher-level creatures. Therefore, zooplankton can utilize phytoplankton as its food source and then it will be utilized by consumers with a higher level.

Rivers are strongly influenced by weather factors, river flow characteristics and the lifestyle of people who live around the banks of rivers. This condition causes the quality and quantity of rivers to be strongly influenced by climate change and the activities of surrounding communities. These factors cause interrelationships between one and the other. If the interaction of some components is disrupted, changes in conditions will occur which will cause the ecosystem to become unbalanced. Characteristics of the Cijulang River have several different salinity in each region due to the influence of tides. The greater the tidal height and the smaller the river discharge, the further the salt water intrusion. Otherwise the smaller the tidal height and the greater the river discharge, the shorter the distance of saltwater intrusion.

Cijulang River plays a major role in the lives of the surrounding community, but because of the many activities around the watershed resulting in Cijulang River can experience changes in the plankton community structure. The existence of plankton and its community structure in the waters of the Cijulang River also has no research data yet.

Community structure is a concept that studies species composition or composition and its abundance in a community. In general, there are three approaches that can be used to describe community structures, namely species diversity, species interactions, and functional interactions. Plankton community structure can change with the influence of water quality. Water quality includes two variables, namely, physical variables (current, water temperature, and light transparency) and chemistry (DO, pH, ammonia, and phosphate) that can affect plankton abundance, diversity, and dominance. Based on the above, the abundance, diversity, and composition of plankton in the Cijulang, the community structure that will be a natural indicator of the waters on the Cijulang River.

The results of this research are expected to provide an overview of the condition of the quality of the waters of the Cijulang River through a description of the biological quality of the waters and as a basis for decision making in the context of river and coastal management and conservation, as well as conservation-based ecotourism.

2. MATERIALS AND METHODS

This research was carried out on the Cijulang River, Kertayasa Village, Cijulang District, Pangandaran Regency, West Java with coordinates 07° 44' 13” 108° 29' 53”. Sampling was done in January-March 2018. Determination of stations was done by purposive sampling as many as 5 stations. Distribution of locations was distinguished based on land use and the hydrological cycle (**Figure 1**). Station 1 is in front of the cave, station 2 is near the residential area and tourism place, the station is located in the mangrove nipah area, station 4 is almost the same as station 3, but the salinity is higher, and station 5 is in the conservation area and mangrove tourism.

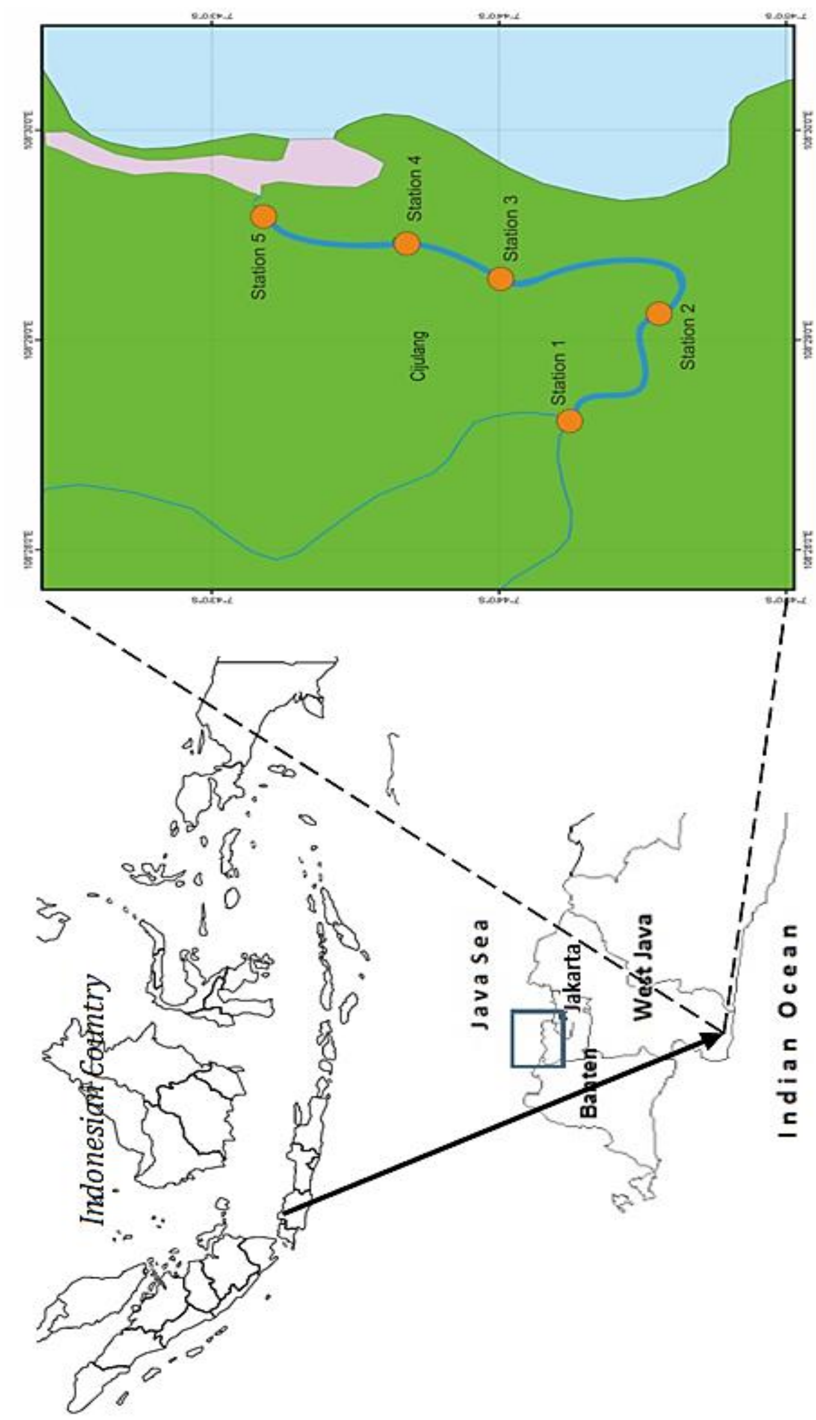

Figure 1. Map of the Cijulang River

Plankton was identified to the genus level by looking at the morphology of the body with the help of the book Planktonology and the book The Marine and Fresh-Water.

Water samples taken one bottle at each station are on the surface with a total of 50 mL, before being put into a sampling bottle, filtering is done using plankton net with a size of 60 μm mesh with a volume of 20 liters. In a 50 mL sampling bottle, 5 drops of lugol were given to preserve the plankton in it. Furthermore, the bottle sample is inserted into the ice box and taken to the laboratory for analysis.

Plankton Abundance

$$N = n \ x \ (\frac{Vr}{Vo}) \times (\frac{1}{Vs})$$

Explanation:

N : plankton abundance (individual / L)
n : identified plankton
Vr : concentrated volume of water
Vo : volume of water examined
Vs : volume of filtered water.

Plankton Diversity Index

$$H' = -\sum Pi \ln Pi$$

Explanation:

H' : Shannon-Wiener diversity index
Pi : ni/N
ni : abundance of species in rank-i
N : total abundance.

The Shannon-Wiener diversity index criteria are divided into 3, namely:

$H' < 1$: Low diversity
$1 < H' < 3$: Medium diversity
$H' > 3$: High diversity.

Dominance

$$D = \sum [\frac{ni}{N}]^2$$

Explanation:

D = Dominance index
ni = Number of individual species-i
N = Total number of individuals.

3. RESULT AND DISCUSSION

3. 1. Physical and Chemical Data of the Cijulang River

The water temperature at Station 3 is higher, presumably because data retrieval is carried out during the day around 12, while Station 1 is done in the morning around 8 o'clock. The temperature pattern of river ecosystems is influenced by various factors, such as: the intensity of sunlight, heat exchange between water and the surrounding air, geographical height, and also the canopy factor (vegetation closure) of trees growing on the edge of the water. Temperatures in the waters affect molecular movements, fluid dynamics, saturation levels of gas solubility, and organism metabolism.

Table 1. Water quality at study site

Parameters	Station 1	Station 2	Station 3	Station 4	Station 5
Temperature (°C)	25.8 ±7 (22-28)	27.3 ±7 (24-30)	28.3 ±6 (26-31)	28.3 ±5.5 (26 – 30,5)	28.5 ±5.5 (26-30,5)
Brightness (cm)	101.2 ±84.5 (47.5-132)	118.7 ±91 (59-150)	205.7 ±133 (121-254)	179.5 ±102.5 (117.5-220)	141 ±49 (101-150)
pH	7.1 ±0.4 (6.9-7.2)	7.1 ±0.3 (7-7.2)	7.1 ±0.2 (7-7.1)	7.0 ±0.2 (7-7.1)	7.0 ±0.3 (6.9-7.1)
Salinity (ppt)	0	1.3 ±2 (0-2)	5.3 ±4 (4.0-7)	7 ±6 (5.0-10)	15.3 ±10 (11-20.0)
DO (ppm)	11.5 ±5.7 (7.7-13.4)	9.3 ±5 (6.2-11.2)	9.5 ±4.1 (7-11.1)	9.7 ±4.7 (6.6-11.3)	10.7 ±6.9 (6.5-13.4)
Ammonia (ppm)	0.036 ±0.02 (≤0.03-0.04)	0.052 ±0.047 (≤0.03-0.08)	0.059 ±0.036 (≤0.03-0.07)	0.046 ±0.029 (≤0.03-0.06)	0.056 ±0.019 (0.05-0.07)
Phosphate (ppm)	≤0.16	≤0.16	≤0.16	≤0.16	≤0.16
Silicate (ppm)	0.05	0.04	0.02	<0.01	<0.01

The lowest brightness in the Cijulang River is 47.5 cm at Station 1, to the highest 254 cm at Station 3. The highest brightness is found at Station 3, this is because the area at Station 3 is very open and there is no canopy that blocks the entry of sunlight to the station. Unlike Station 1, there are many trees around it and the width of the water is smaller than Station 3. Data retrieval time also affects brightness, Station 3 has the highest brightness value because data collection is done during the day while at Station 1 is done in the morning.

The pH range in the Cijulang River is between 6.9 to 7.2 (Table 1). The pH value shows almost the same tendency at each station. Based on the measurement results it can be concluded that the pH range value of the Cijulang River is in the ideal range for plankton growth. The pH condition is still quite in accordance with the life of plankton on the Cijulang River.

The ability of water to bind or release a number of hydrogen ions will indicate whether the solution is acidic or basic. In clean water, the total concentration of H^+ and OH^- ions is in balance, or known as pH = 7.

Aquatic organisms, especially plankton, can live ideally in a smaller pH range or slightly larger than a pH value of 7. Thus the waters of the Cijulang River have the ability to bind and release hydrogen ions quite well. Salinity on the Cijulang River is at the value of 0 ppt at Station 1 up to 20 ppt at Station 5.

The difference in the surface salinity of the Cijulang River at each station was due to the tides that came from Batu Karas Beach. Salinity value can also be affected by rainfall, if rainfall is high then the salinity in these waters will be relatively lower compared to the condition of no rain. This is because at Station 5 is the area closest to the river mouth which causes the salinity at Station 5 to be higher than the other stations.

The range of dissolved oxygen values in the Cijulang River is at 6.2 ppm at Station 2 to 13.4 ppm at Station 1 and Station 5. The highest dissolved oxygen at Station 1 can be caused because Station 1 has a fairly heavy current. Heavy currents cause wider water levels and more chance of oxygen diffusion from the air. The highest dissolved oxygen is also found at Station 5, this is suspected because at Station 5 photosynthesis was carried out by phytoplankton and plants in the waters around the Cijulang River were like mangrove trees.

Ammonia, the ammonia value obtained is relatively small, in fact there are some values that are below the detection limit of the measuring device. The highest ammonia value is at Station 2 with a value of 0.08 ppm and the lowest is almost at each station with different time taking with a value of less than 0.03 ppm. Ammonia has a different value at each station caused by the process of autolysis or excretion of living things that are on the Cijulang River. Values of 0.03 to 0.08 are still a low value for ammonia. Ammonia can come from the decomposition of organic matter through ammonification and the process of cell autolysis and excretion of ammonia by zooplankton can act as a decomposer.

According to ammonia levels in natural waters are usually less than 0.1 mg NH_3 / liter. According to this data, the Cijulang River is still in a good range based on its ammonium content.

Phosphate, the phosphate data obtained during the study is <0.16 at each station. It can be said that the value is not optimum enough for plankton growth. The statement that the low phosphate content in waters can be caused by physical and biological factors such as currents, winds, and phytoplankton abundance.

With a low phosphate value, it can be said that many phytoplankton use phosphate as a source of nutrients for consumption needed for their lives. In addition, this is caused by the properties of phosphate particles which have a particle weight more than the mass of water, so that phosphates will tend to settle in the bottom of the water.

Silicate, Based on the data obtained the highest silicate value is at Station 1 with a value of 0.06 ppm and the lowest at Station 4 and 5 with a value of less than 0.01 ppm. The silicate value obtained decreases from Station 1 to Station 5. Bacillariophyceae class phytoplankton is one of the biological parameters closely related to silicates because of the high and low abundance of Bacillariophyceae in waters, depending on the silicate content.

Phytoplankton, which are mostly found in the Cijulang River, especially at Station 3 and 5 are from the Bachillariophyceae class. On the other hand, at Station 4 and 5 there is an abundance of zooplankton which is greater than at the other stations.

This is thought to be a factor in the small amount of silicates in the Cijulang River. Bachillariophyceae or Diatoms can grow optimally if they are able to effectively absorb available silicates. The higher the effectiveness of silicate absorption by diatoms, the lower the concentration of silicates in a waters. The main source of silicates comes from rock weathering, so that coastal waters generally get a silicate supply through rivers carrying silicate minerals from rock weathering.

3. 2. Plankton Community Structure

Plankton enumeration results show that 17 genera were found from 7 phytoplankton classes consisting of 6 Bacillariophyceae genera, 1 Clorophyceae genus, 2 Cyanophyceae genera, 3 Zygnematophyceae genera, 2 Desmidiaceae genera, 1 Synurophyceae genus, and 2 Fragillariophyceae genera (**Figure 2**). There were also 10 genera from 5 zooplankton classes consisting of 4 Maxillopoda genera, 2 Branchiopod genera, 1 Gastropoda genus in the veliger phase, 1 Ostracoda genus, and 2 genera Copepoda (**Figure 3**).

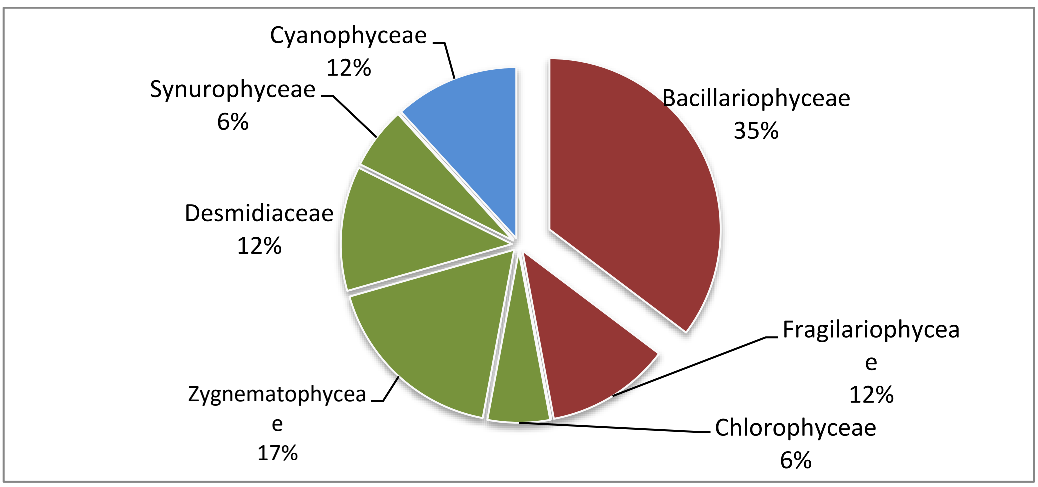

Figure 2. Composition of phytoplankton classes on the Cijulang River.

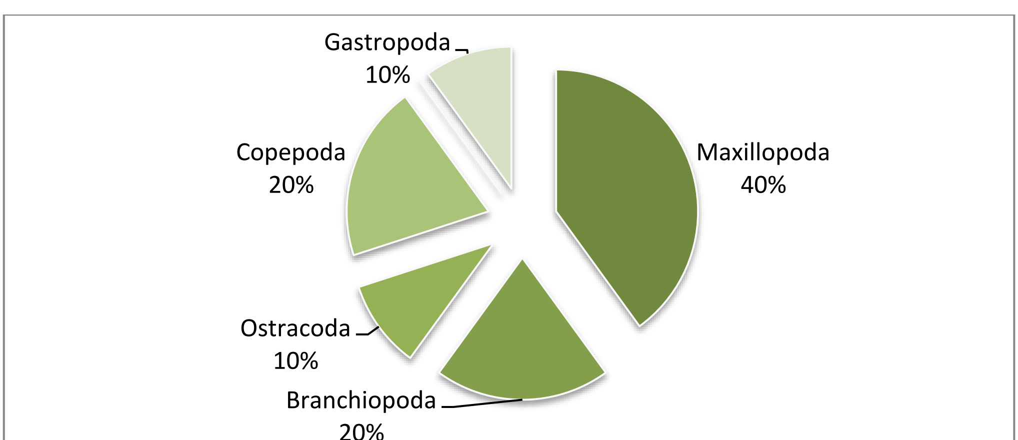

Figure 3. Composition of the Zooplankton class on the Cijulang River

In Figure 2 it indicates that the Bachillariophyceae class has a wide spread with a percentage of 35%. Dominance of Bachillariophyceae is also found in the waters of Jakarta Bay (Yuliana 2012), and in Bojo Waters. This condition is a common thing in fresh or sea waters that the composition of phytoplankton is dominated by the Bachillariophyceae group.

Based on Figure 3, it shows that phylum Arthropoda, especially the Maxillopoda class has the highest spread of 40% and the lowest in the Mollusca phylum in the veliger phase with one class, namely Gastropod with a percentage of 10%. The presence of arthropods is very dependent on environmental factors, namely the abiotic environment and biotic environment.

Abiotic environmental factors can be derived from physical factors, such as temperature, water content, porosity, soil structure, while chemical factors, such as salinity, pH, soil organic matter content, and soil mineral elements. Biotic environmental factors influence the presence and density of Arthropod populations.

Environmental factors that are suitable for the growth and development of zooplankton from phylum Arthropoda cause this phylum to overflow on the Cijulang River, especially the Maxillopoda class.

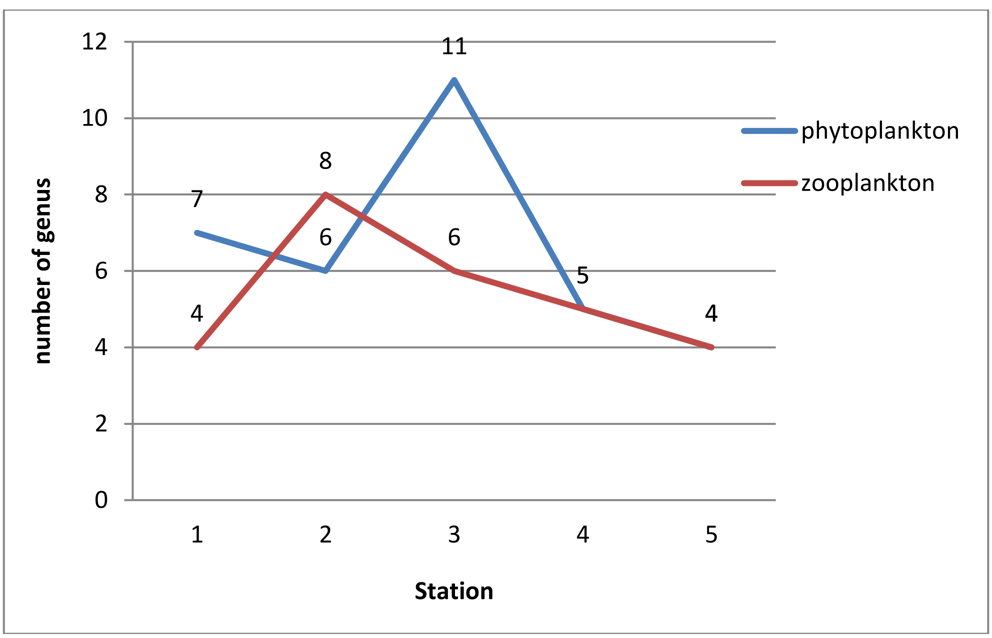

Figure 4. Graph of plankton composition at each station

The graph (**Figure 4**) shows that the comparison of the composition of phytoplankton and zooplankton in the Cijulang River has a reciprocal relationship. The more the number of phytoplankton genus, the fewer the number of genus zooplankton, and vice versa. This is because when the number of phytoplankton is higher, it will be used by zooplankton, which in the next station has more genus numbers. But at Stations 4 and 5, there was a decrease in the number of genera in each plankton.

This is because the waters are not suitable, like a heavy current, so there are only a few planktons that can live and develop properly.

3. 3. Plankton abundance on the Cijulang River

The abundance of plankton on the Cijulang River has quite a variety of values at each station and each month (**Figure 5**). The abundance of identified plankton has varying values at each station, the highest abundance value is at Station 2, especially in March 2018. This is because Station 2 has the physical and chemical characteristics of water that are optimal for the life of plankton, whereas in February it was the lowest abundance compared to January and March. This is because the weather in February is experiencing a rainy season so that the physical and chemical characteristics of water are less suitable for the life of plankton.

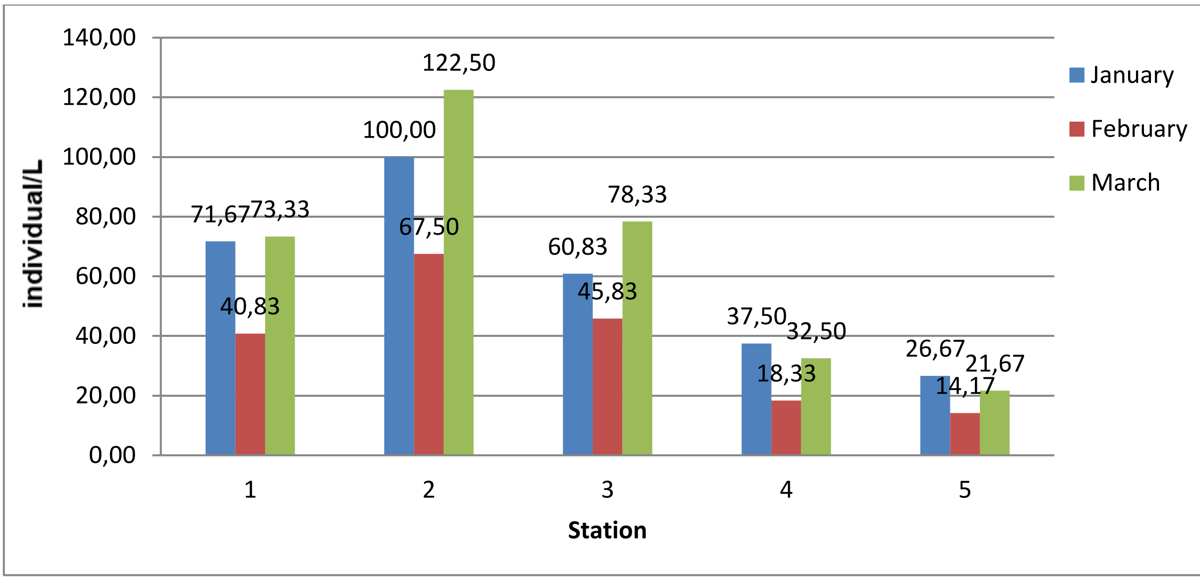

Figure 5. Graph of plankton abundance on the Cijulang River

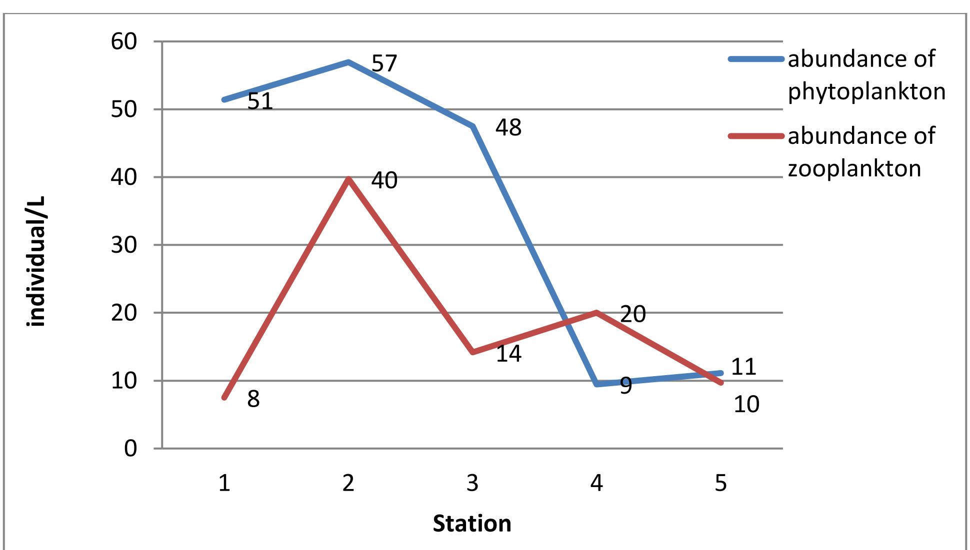

Figure 6. Abundance of phytoplankton and zooplankton during the study

The high abundance value obtained at Station 2 is also caused by environmental parameters that affect the life and growth of the plankton. At this station environmental parameters are said to be in the appropriate range, temperature, pH, and water brightness has optimal values to support the life of plankton, whereas phosphate nutrient is not an optimum value and has not become a limiting factor for the life of plankton.

Plankton abundance (**Figure 6**) is the highest at Station 2, with phytoplankton abundance value of 51 per liter cell and zooplankton abundance of 8 per liter cell. The high abundance of phytoplankton with zooplankton is directly proportional. This is in accordance that most zooplankton depend on nutritional sources in the form of organic matter, both in the form of phytoplankton and organic substances that enter the waters.

3. 4. Diversity index

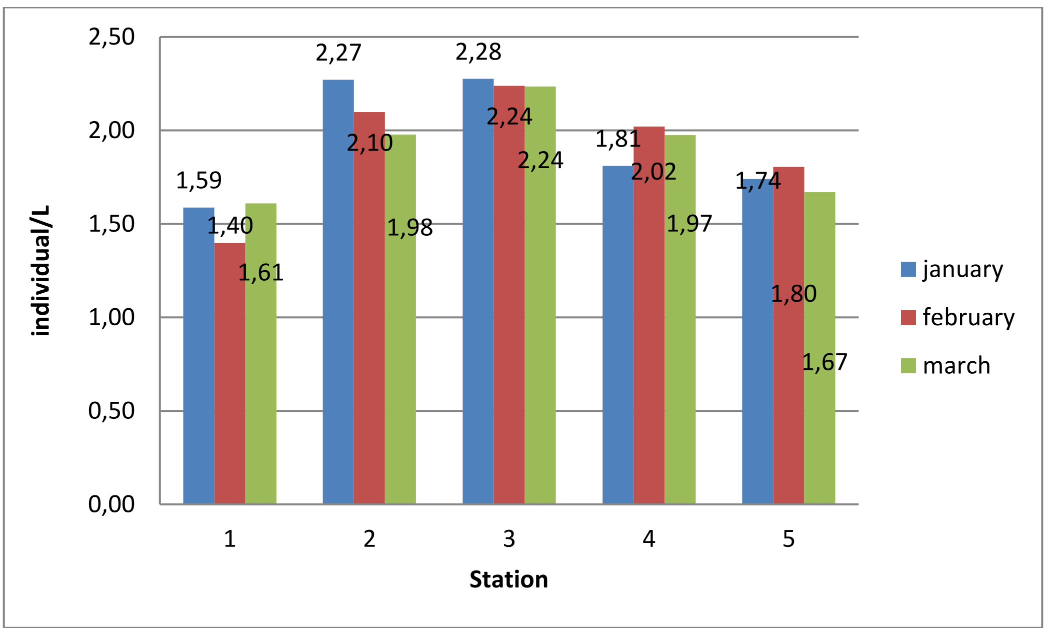

Figure 7. Plankton diversity is average

Calculation results at each station and time of observation show that the plankton diversity index value is included in the medium category as the criteria put forward by Masson (1981) that the value of $H \leq 1$ is included in low diversity and the value of $1 \leq H \leq 3$ is the diversity and stability of the medium category community. The diversity index value obtained ranged from 1.40 - 2.28 (**Figure 7**).

3. 5. Dominance Index

Dominance index (**Figure 8**) illustrates the presence or absence of species that dominate other species. The calculation results show that more have values close to 0 (zero) compared to those near 1 (one). It can be concluded that generally in the waters of the Cijulang River during the study from January to March there was no dominance of plankton.

The plankton community structure, that has been observed, shows that there are no species that predominantly dominate other species, water-physico-chemical parameters are in the appropriate range so the competition does not occur, all species have equal opportunities to grow and develop well. This shows that the condition of the community structure is stable, environmental conditions are quite prime, and there is no ecological pressure on the biota in the habitat.

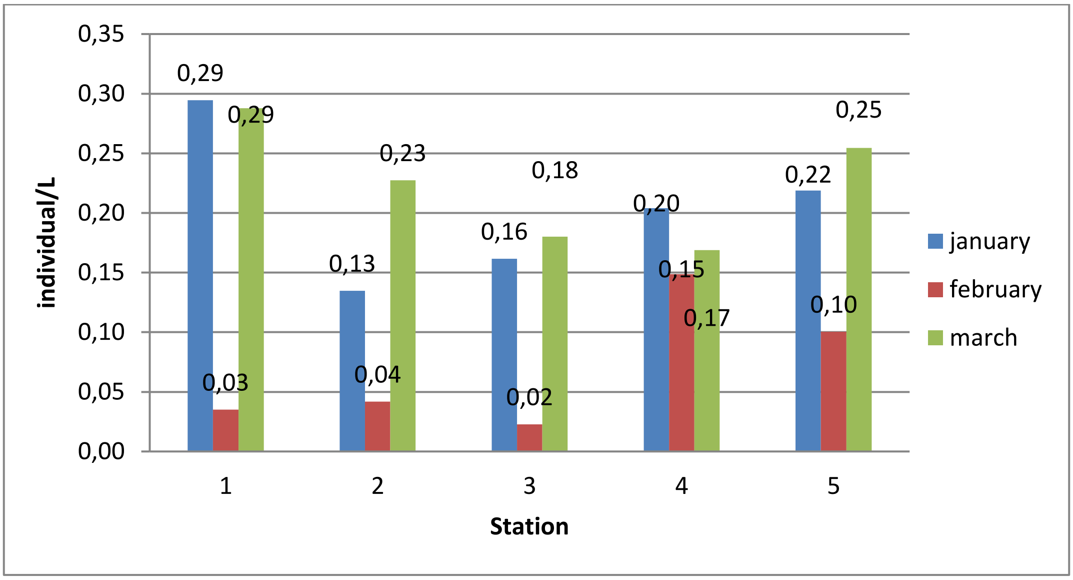

Figure 8. Dominance of plankton from January to March

4. CONCLUSION

The types of phytoplankton obtained during the study amounted to 7 classes and were dominated by the Bachillariophyceae class of 34%, in zooplankton there were 5 classes dominated by Maxillopoda by 40%. The highest number of phytoplankton found at each station is the genus Closterium, and the highest number of zooplankton at each station is the Cyclops genus. The highest plankton abundance value is found at station 2 in March with the value of 122 liters cells, and the lowest at station 5 in February with a value of 12 liters cells. The abundance of phytoplankton ranges from 11 - 57 cells / L and zooplankton ranging from 8 - 40 ind / L. The plankton community has an index of species diversity with moderate diversity values at each station.

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