Correlation of Epilithic Periphyton with Physical Chemical Parameters in Downstream of Welang River, Pasuruan, East Java

Endang Yuli Herawati[1]*; Sri Sudaryanti[2]; Ekwan Nova Wiratno[3]; Chandika Lestariaji[4]; Aang Setyawan Anjasmara[5]
[1,2,3,4]Department of Aquatic Resources Management, Faculty of Fisheries and Marine Sciences, Brawijaya University, Malang, Indonesia
[5]Aquaculture, Faculty of Fisheries and Marine Sciences, Mulawarman University

Abstrack:- Periphyton is a biota that can adapt and develop well in rivers. Periphyton is an organism that lives attached to a substrate. The aim of this research is to analyze the correlation of periphyton with physicochemical parameters and see the types of periphyton, density, and dominance downstream of the Welang River. This research was conducted in August, September, and October 2024 in Downstream of Welang River, Kraton District, Pasuruan. Indonesia. Periphyton samples were taken by brushing the stone substrate and then identified under a microscope. The results of the research show that the composition of the periphyton consists of three divisions, namely the Chlorophyta, Cyanophyta, and Chrysophyta division, in the Chlorophyta division, 8 genera were found, Cyanophyta 2 genera and Chrysophyta 14 genera. What dominates the downstream waters of the Welang River is the Chrysophyta division, namely the genus *Nitzchia* sp. and *Navicula* sp. The density of Periphyton during the research was found to be moderate. The results of this research are dominant. The diversity index results are in the medium category. Meanwhile, the uniformity index is in the low category. Water quality generally has an average value in the optimum category, but the TSS parameter has a high value that exceeds the threshold. The results of the *Canonical Correlation Analysis* (CCA) analysis show that there is a low-moderate correlation between the abundance of periphyton and the results of the physical and chemical parameters of the waters.

Keywords:- *Chemical, Periphyton, Physical, Welang.*

I. INTRODUCTION

The sustainability of an aquatic ecosystem can be seen from the presence of microalgae because microalgae have a short life cycle and respond quickly if changes occur in an environment. Microalgae also have essential ecological functions, which are used as a reference to determine the stability of ecosystems in waters. The decline in species diversity, decreasing number of individuals, and dominance are caused by unfavorable environmental changes [1]. One of the functions of biological indicators in water is to determine the level of water pollution. Biological indicators for monitoring water quality are macroinvertebrates, fish, plankton, and periphyton [2], [3].

Microorganisms attached to the substrate. Both natural substrates and artificial substrates are called periphyton [4]. Examples of substrates that grow periphyton include stones, plants, and other substrates. The presence of periphyton has many variations, this periphyton can describe the condition of a river. The most common periphyton found are photosynthetic microalgae that rely on minerals for their growth and reproduction [5]. Due to the nature of periphyton attached to this substrate, periphyton has an important role in the food chain which has a role as an indicator of fertility in diversity and ecological status in waters [6]. Assessment of water quality based on biology, especially periphyton, is critical because it can be used to anticipate changes that occur in the environment at a location. Ecology in waters uses communities of periphyton for the purposes of analyzing water quality, where periphyton can be a bioindicator of the condition of the aquatic environment. The diversity of periphyton species found during observations illustrates the structure of the periphyton community [7].

Welang River is one of the rivers in crisis condition and is a priority. The crisis that occurred was caused by land use that began to change. The activities of communities around the river flow are one of the causes of changes in the river. This change in pattern resulted in damage to the Welang River flow environment [8]. Based on the background above, by analyzing periphyton microalgae and water quality in the lower reaches of the Welang River, it is possible to determine the types of periphyton that are abundant and dominant as well as the correlation of abundance with the physics and chemistry of water in the lower reaches of the Welang River.

II. MATERIAL AND METHOD

This research was carried out in August, September, and October 2024 in Hilir Sungai Welang, Kraton District, Pasuruan Regency, East Java. Periphyton sampling was carried out at 3 points. A map of the research location can be seen in Figure 1. Analysis and identification of periphyton and water quality at the Hydrobiology Laboratory, Faculty of Fisheries and Marine Sciences, Brawijaya University, Malang. East Java. Indonesia.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24OCT1857

This research material includes identifying periphyton microalgae communities in the waters of the Welang River. This research was carried out by taking samples directly in the field 2 (two) times, taking samples of periphyton microalgae and physical and chemical water quality. Periphyton samples were taken from the rock substrate. The stones selected are random sampling. This is done every time a sample is taken. The stone is then brushed, and the area is 5x5 cm^2. Using quadrate transects made of aluminum. The part that has been brushed is then sprayed with distilled water and put into a film bottle. Add distilled water to the film bottle until the distilled water volume reaches 100 ml. After that, preserve it with 10% Lugol until it shows a brick red color, then close it and store it in a closed place at a low temperature. And keep away from direct sunlight. Next, observations were made under a microscope with 400x magnification. The process of identification and analysis of periphyton microalgae was carried out in the laboratory.

Fig 1: Map of Research Sampling Points

The physical and chemical parameters measured include temperature, current speed, total suspended solids (TSS), brightness, pH, dissolved oxygen (DO), nitrate, orthophosphate, total organic matter (TOM), and chemical oxygen demand (COD). To analyze the correlation between periphyton density and physical and chemical parameters, it was analyzed using the *Canonical Correlation Analysis* (CCA) application. *Canonical Correlation Analysis* (CCA) is a multivariate analysis that can explain the relationship between biological communities and environmental parameters in ordinate form [9].

III. RESULT AND DISSCUSSION

A. *Community Structure and Density of Periphyton*

Chrysophyta, Chlorophyta, and Cyanophyta divisions. The most common division found in this study was Chrysophyta. The composition of the genera found during research from the Chrysophyta division was 14 genera, such as *Nitzchia*, *Pleurosigma*, *Thalassiosira*, *Pinnuaria*, *Rhizosolenia*, *Melosira*, *Skeletonema*, *Tribonema*, *Neidium*, *Gyrosigma*, *Surirella*, *Cymbella*, *Diatoma* and *Navicula*. The composition of the Chloropyta division is eight genera, including *Pleurotanium*, *Westella*, *Spirogyra*, *Quadrigula*, *Ulothrix*, *Tabellaria*, *Netrium* and *Planktospaeria*. Meanwhile, in the Cyanophyta division, only two genera were found, namely *Oscillatoria* and *Nodularia*. The percentage results for each division can be seen in Figure 2.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24OCT1857

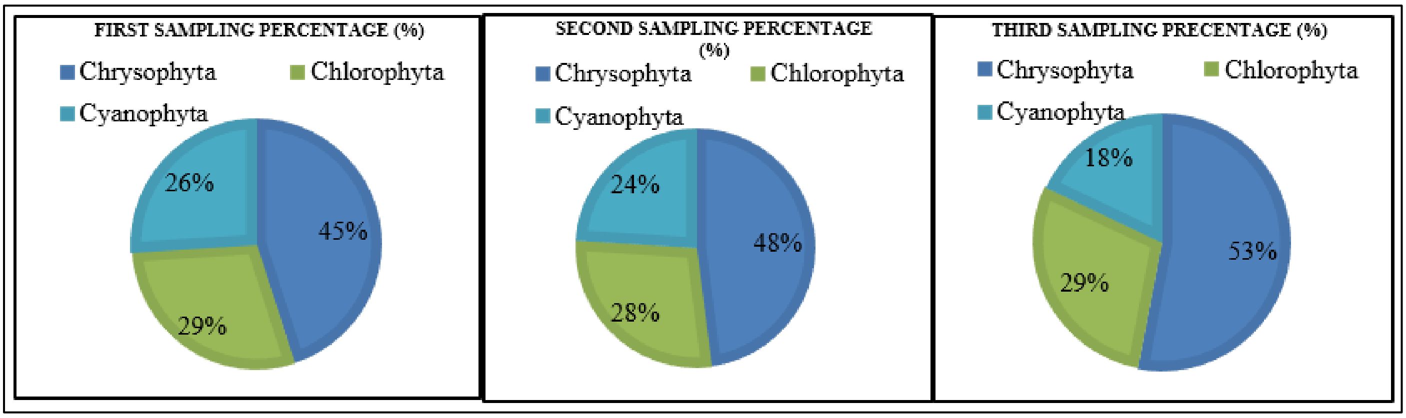

Fig 2: The Percentage Results for Each Division

The results of the first sampling showed that the Chrysophyta division had the highest percentage, namely 45%, from the Chlorophyta division, 29%, while the lowest was from the Cyanophyta division, namely 26%. The second sampling of the Chrysophyta division was still the highest, but the percentage increased compared to the first sampling. The rate was 48%, an increase of 3%. In the Chlorophyta division, the results were 28%, with no increase compared to the first sampling but a decrease of 1%. Meanwhile, the Cyanophyta division in the second sampling obtained a result of 24%. Where the Cyanophyta division also experienced a decrease compared to the results of the first sampling. In sampling the three Chrysophyta divisions, there was an increase of 53%. Meanwhile, Chlorophyta was 29%, and Cyanophyta was the lowest compared to the previous sampling, at 18%.

Chrysophyta with stone substrates are often found because this group has a high ability to stick to the substrate and live. Especially those from the Bacillariophyceae class. Which states that most species from the Bacillariophyceae class have high survival abilities. Species from this group can survive in harmful environments. This is done by increasing mucus on the surface of the body. This group also has gelatin stalks, which are useful for attaching themselves to certain substrates. This stalk has branches. There are short ones, and there are also long ones. So, this group can live on substrates that are under strong currents [10].

The density of periphyton in rivers is influenced by water quality and periphyton's living medium. Periphyton is a producer of oxygen and one of the producers of organic material in rivers [11]. Based on research the results showed that the density of periphyton was in the medium density category. The results density of periphyton can be seen in Figure 3.

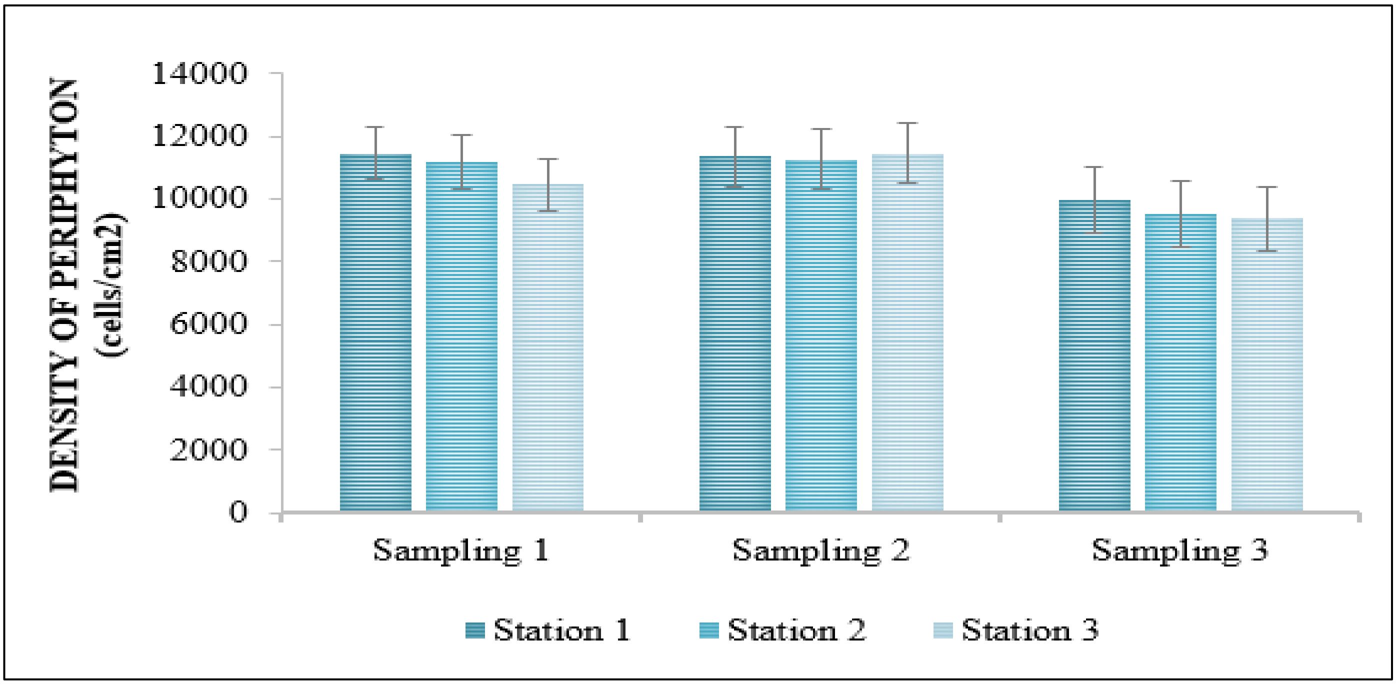

Fig 3: Density of Periphyton (cells/cm^2)

Based on the graph above, it can be seen that the average density of the periphyton value in the first sampling was higher than the periphyton density in the second and third samplings. In the first sampling, the density of periphyton at station 1 was 1142 cells/cm^2, at station 2 the density of periphyton was 11179.3 cells/cm^2 while at station 3 it was 10456 cells/cm^2. The density value at the second sampling at each station was at station 1, the result was 11356 cells/cm^2, at the second station the result was 11259.3 cells/cm^2. At station 3, the results were 11456 cells/cm^2. Meanwhile, in the third sampling at station 1, a value of 9955.6 cells/cm^2 was obtained. At station 2, it was 9540.7 cells/cm^2. At station 3 the results were 9363 cells/cm^2. The density of periphyton in each sampling is influenced by water quality. In the results, the brightness value of the first sampling was higher than that in the second sampling, besides that the values for the nutrients Nitrate and Phosphate in the first sampling were higher than those in the second sampling. Which states that in river waters, the density of periphyton can be influenced by the high or low nutrient content, apart from the intensity of sunlight entering a body of water is also a determining factor identity of periphyton [12].

The results of calculating the density of periphyton downstream of the Welang River in the first, second, and third sampling obtained an average of 10668 cells/cm^2. This means that the downstream area of the Welang River is included in the mesotrophic water category or has a moderate level of fertility. Which states that there are three categories of periphyton density, namely oligotrophic waters, namely waters that have a low level of fertility, namely periphyton density of 0-2,000 cells/cm^2. Furthermore, mesotrophic waters are waters with a moderate level of fertility with a density of periphyton of 2,000-15,000 cells/cm^2. Finally, waters with high fertility are usually called eutrophic, namely with a density of >15,000 cells/cm^2 [10].

B. Diversity Index, Domination Index, and Uniformity Index of Periphyton

The value of the diversity index is used to determine the high or low diversity of species in an environment. If the value of the diversity has a number that exceeds or is equal to 1, then the area's species diversity level is included in the moderate category. If the value is more than 3, then the diversity value of the species is high. However, if it is less than 1, the value is included in the low category [13]. The results of the periphyton diversity index found downstream of the Welang River can be seen in Figure 4.

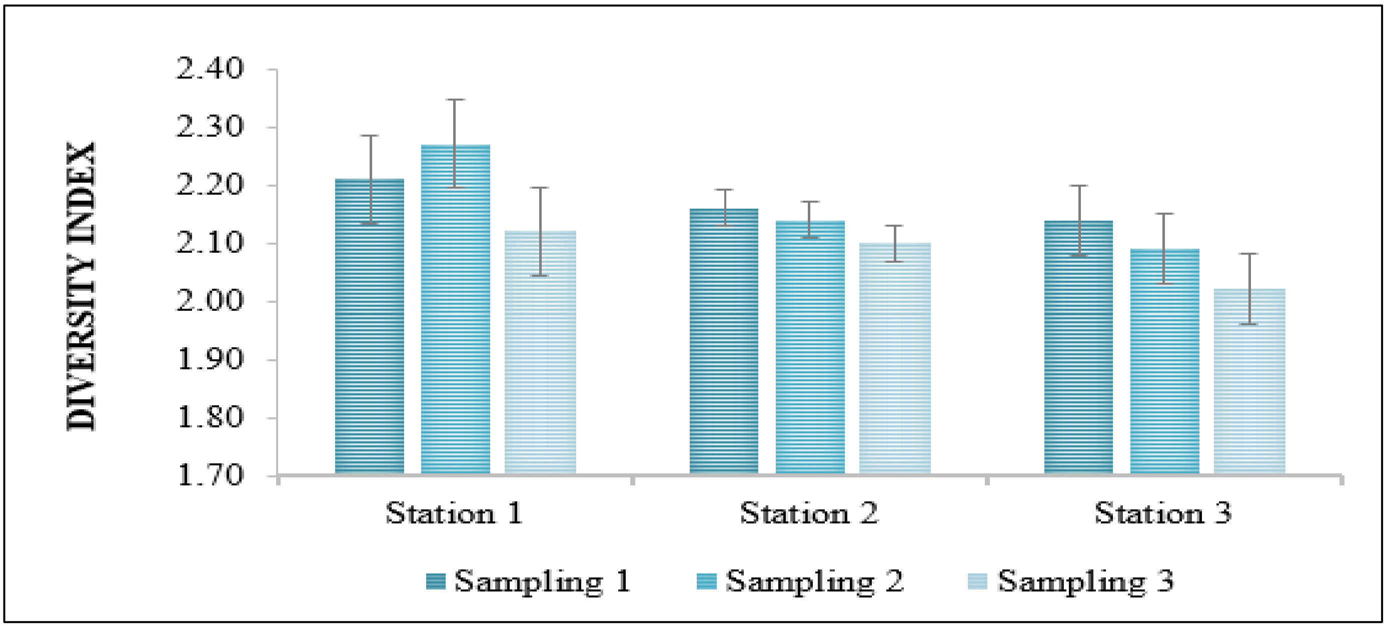

Fig 4: Diversity Index

The results of the diversity index at all stations in the first sampling, second sampling, and third sampling downstream of the Welang River were below three and above 1. This indicates that the diversity index downstream of the Welang River is included in the moderate category. The highest results were obtained in the second sampling at station 1. The lowest results were obtained at station 3 of the third sampling. Although the highest and lowest values were obtained from the research results downstream of the Welang River, the results are still in the moderate diversity category.

Factors that affect diversity downstream of the Welang River are the intensity of incoming light. The brightness results at the time of the first sampling at stations 1 and 2 had higher brightness values than the others. Brightness can affect diversity because it is related to the photosynthesis process of periphyton. One factor affecting the brightness value is TSS, where the further downstream, the higher the TSS content. Stated that the penetration of sunlight into water is brightness, while the amount of suspended solids contained in water can cause turbidity and affect the brightness level in water [14].

The periphyton dominance index is generally used to see whether or not a type of periphyton dominates a body of water. The results of the periphyton dominance index have a range of values between 0 and 1. If the value of the dominance index is smaller and approaches 0, it indicates that in the waters, there is no dominance of one type of species. However, if the results show otherwise if the value obtained is large or close to 1, it indicates the dominance of one particular type of species [14]. The results of the dominance index in the study conducted downstream of the Welang River can be seen in Figure 5.

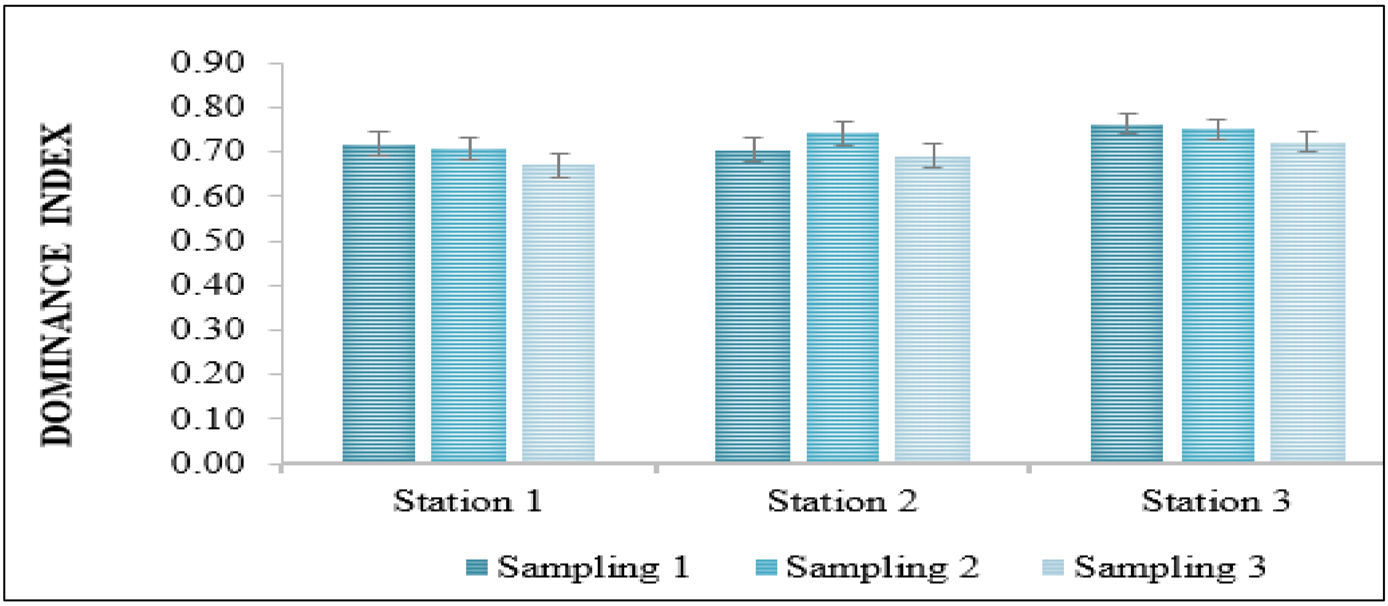

Fig 5: Dominance Index

Results of the dominance index obtained in the study conducted downstream of the Welang River were in the range of 0.67 to 0.75. Where this range is at a number close to 1, that means that dominance occurs in the downstream waters of the Welang River even though the dominance that occurs is not too strong. The periphyton found in large numbers in the study, both the first and second sampling, were from the genus *Navicula* sp. and *Nitzchia* sp. At all stations, *Navicula* and *Nitzchia* were dominant. These types come from the same division, namely Chrysophyta and the class Bacillariophyceae. The Bacillariophyceae class (Diatoms) is a class that has abundant types, and this class is the most commonly found category in all waters. This class is included in the category that is easy to adapt and survive even in bad environments. So, this class is often the dominant type of periphyton compared to other types. In the aquatic environment, the Bacillariophyceae class has an important role. One of them is as a primary producer of food webs in freshwater ecosystems. This class has a shell made of silica that is difficult to destroy. The function of this tool is to attach itself to the substrate, which is strong. This ability causes periphyton from the Bacillariophyceae class to be dominant compared to others in a body of water [15]. Periphyton from the Bacillariophyceae class has a high reproductive ability. If it is in a suitable environmental condition and has a high nutrient content, it can reproduce three times within 24 hours [16].

The group of microalgae that are qualitatively and quantitatively found in various types of river waters are from the Bacillariophyceae class. This group of microalgae is often found in the form of plankton and periphyton. The highest density of periphyton from Diatoms found from the *Navicula* and *Nitzchia* types is also found in stone substrates [11]. Which states that the genus Navicula is widely distributed in every water. This is because *Navicula*has has a high ability to tolerate water conditions. Even in waters with strong currents [17]. *Nitzchia* is a type of species with high adaptability and tolerance to the aquatic environment. Therefore, *Nitzchia* can live even in polluted environments [18].

The uniformity index is the composition of each individual in a species contained in a community scope. The more even distribution of individuals between species, the more balanced the ecosystem will be. To determine the estimation of dominance, the uniformity index can be used. Because the value of this uniformity index will describe the stability of a community in the aquatic environment [19]. The results of the uniformity index can be seen in Figure 6.

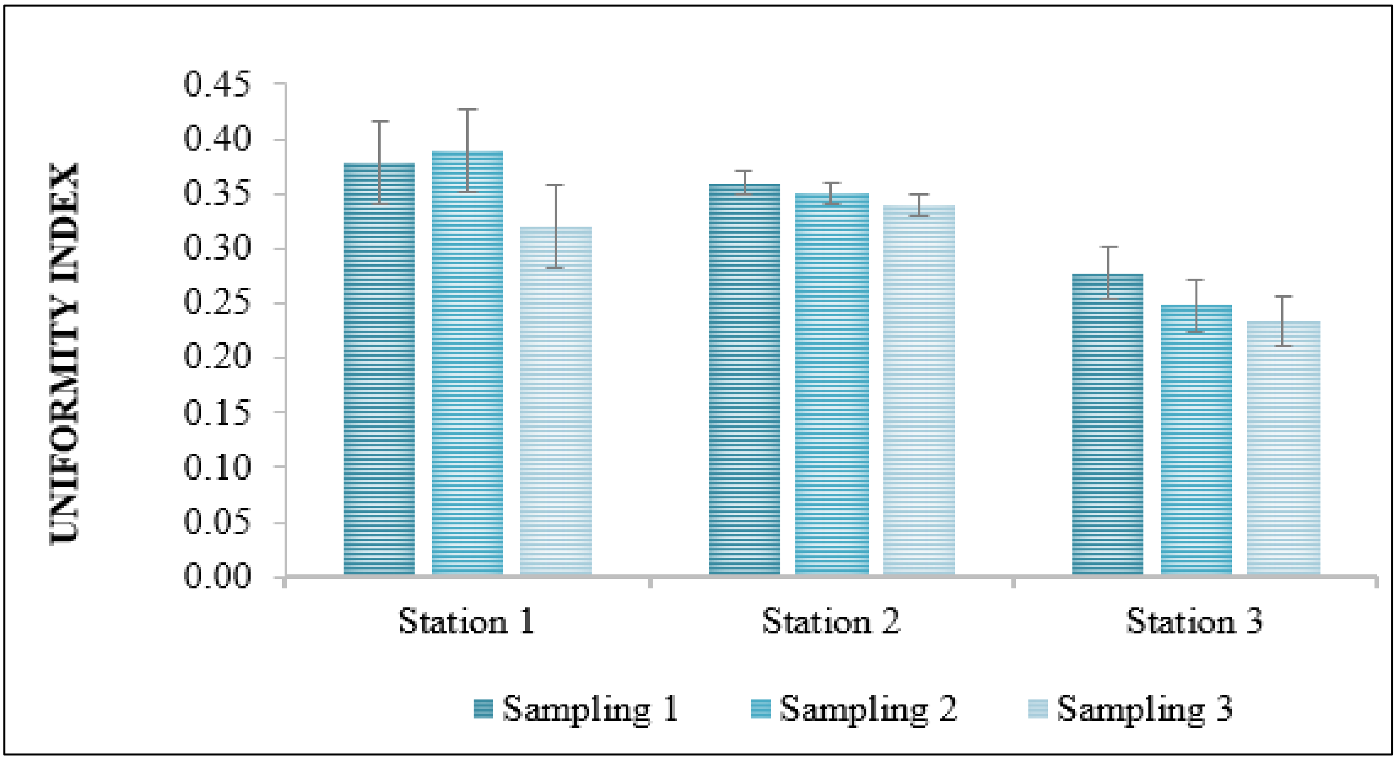

Fig 6: Uniformity Index

The uniformity index of periphyton can be categorized into 3, if the uniformity index is in the range of 0-0.4 then the value is considered low. While the uniformity value is 0.4-0.6 then the uniformity value is included in the medium category. If the uniformity value is in the range of 0.6-1 then the uniformity category is high [20]. The low uniformity index value downstream of the Welang River is related to the dominance downstream of the Welang River. If dominance occurs, the uniformity will be low. Because the uniformity and dominance values have an inverse ratio. Where there is dominance downstream of the Welang River, the uniformity in the Welang River is low. Which states that if a type of species dominates, the uniformity value will be low [21].

Water quality conditions greatly affect periphyton. The results of periphyton density are correlated with water quality using Canonical Correlation Analysis (CCA). Water quality results can be seen in Table 1. The Canonical Correlation Analysis (CCA) results can be seen in Figure 7.

Table 1: Water Quality Result

Station	**Samp. to-**	**Temp. (^oC)**	**Current (m/s)**	**TSS (mg/L)**	**Bright. (cm)**	**pH**	**DO (mg/L)**	**Nitrates (mg/L)**	**Ortho. (mg/L)**	**TOM (mg/L)**	**COD (mg/L)**
1	1	27,1	0,3	128	37,5	7,06	5,3	0,182	0,087	17,9	29
	2	27,4	0,3	122	40	7,04	5,8	0,197	0,129	19,1	28,03
	3	27,2	0,4	130	38	7	5,3	0,171	0,071	18,3	30,2
2	1	27,1	0,3	129	39	7,16	6,2	0,174	0,104	17,2	29,05
	2	27,3	0,3	132	39,5	7,23	6,3	0,182	0,104	18	29,49
	3	27,2	0,4	121	39,5	7,18	5,2	0,166	0,059	18,2	29,7
3	1	28	0,3	132	40,4	7,3	5,78	0,162	0,094	18,4	30,61
	2	28	0,3	135	42	7,45	6,05	0,173	0,111	18,2	29,51
	3	27,8	0,4	141	41,5	7,32	5,03	0,163	0,064	16,9	30,49

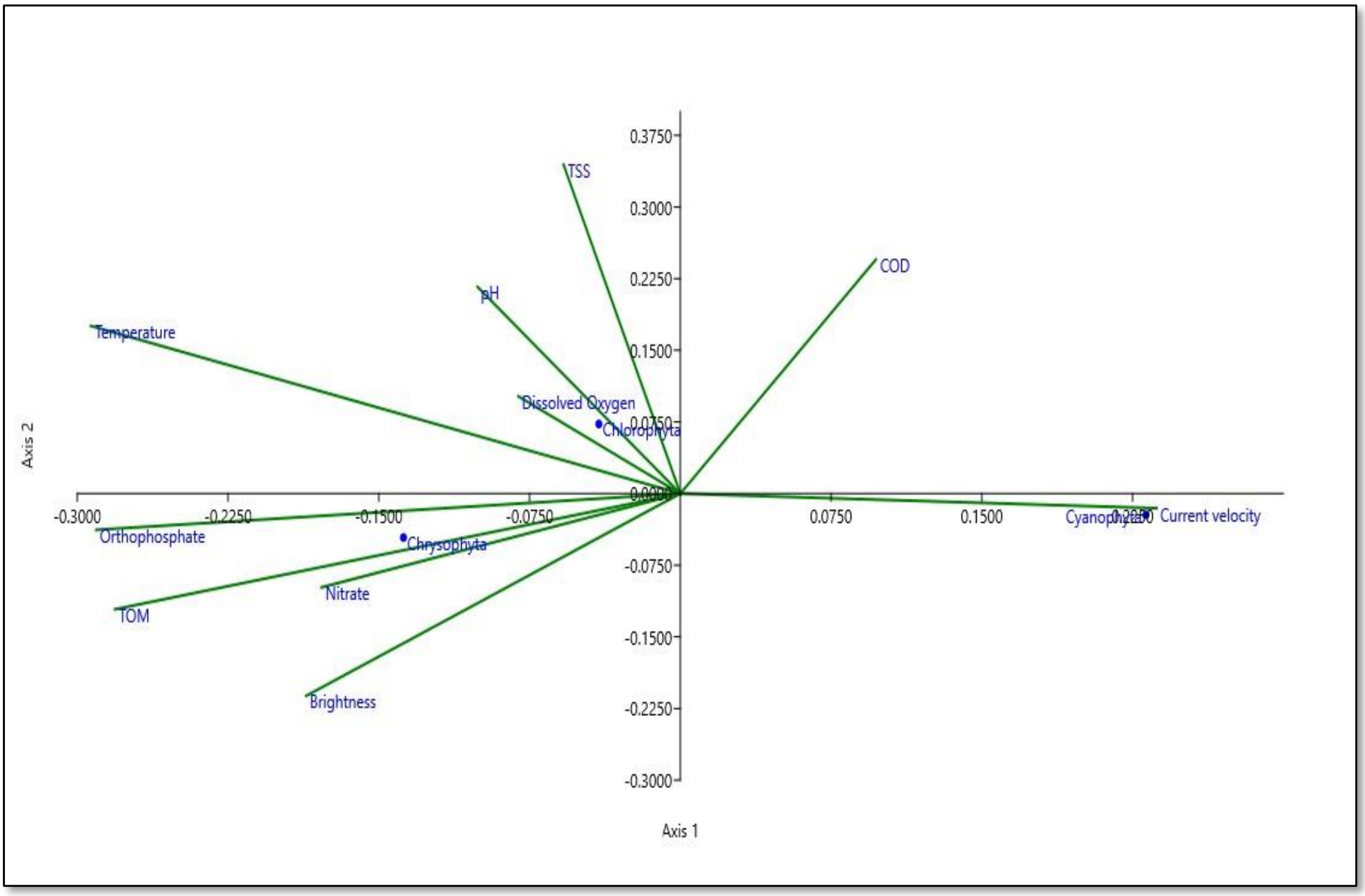

Fig 7: Results of Canonical Correlation Analysis (CCA)

Based on the results of the Canonical Correlation Analysis (CCA) analysis obtained from observations and calculations of density indices (Chrysophyta, Chlorophyta, and Cyanophyta) and water quality measurements in the Lower Welang River, Pasuruan, East Java, it shows that the first Chrysophyta has a correlation relationship with temperature, TSS, COD, pH, Orthophosphate, TOM with low concentrations. Second, Chrysophyta has a relationship with brightness, current velocity, and nitrate at moderate concentrations. Third, Chrysophyta correlates with dissolved oxygen parameters with low concentrations. Fourth, Chlorophyta correlates with temperature, TSS, COD, pH, Orthophosphate, TOM, brightness, current velocity, nitrate, and dissolved oxygen with moderate concentrations. Fifth, Cyanophyta has a correlation relationship with dissolved oxygen with strong concentrations. Sixth, Cyanophyta correlates with nitrate and pH levels with moderate concentrations. Seventh, Cyanophyta has a correlation relationship with temperature, TSS, COD, Orthophosphate, TOM, brightness, and current velocity with low concentrations.

The temperature obtained in the study downstream of the Welang River was 27,2ºC–28ºC. Which states that the intensity of sunlight is a factor that affects the temperature in water [22]. The temperature range in the study was still suitable for the growth of periphyton, which was between 20–30ºC. The current speed value in the study downstream of the Welang River ranged from 0.31–0.41 m/s. This current speed is classified as a moderate current speed. Moderate–current waters have a current speed ranging from 0.25–0.5 m/s [23]. Current velocity is related to the content of pollutant material from the waters [24]. TSS in the study downstream of the Welang River ranged from 121-141 mg/L. this value has exceeded the minimum threshold for category three waters stipulated [25], which is 100 mg/L. The high value of high TSS is caused by the large number of activities that dump garbage and industrial waste into the river. Pollution in rivers is caused by sources of pollution around the river downstream. The decline in environmental quality and changes in land use can result in an increasingly high pollution load [26]. The results of brightness measurements range from 37.5 to 42 cm. In general, brightness is influenced by the intensity of sunlight entering the water body. In addition, the amount of particles in the river can affect the brightness value. Which states that high human activity can produce waste. Waste has an impact on increasing dissolved particles that enter river waters. Both dissolved particles and suspended particles can cause light to be unable to penetrate the bottom of the water [27].

The results of dissolved oxygen measurements in this study ranged from 5.03–6.05 mg/L. Microalgae are a type of oxygen contributor in waters. This oxygen is obtained from photosynthesis activity [28]. The safe limit for dissolved oxygen content in waters is> 5 ppm. In pH measurements, a

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24OCT1857

range of 7 was obtained, the range of 7–9, the pH value is still in a good range for the growth of aquatic biota [29]. Especially for the growth of periphyton in waters. In measuring nitrate and orthophosphate, the results ranged from 0.163–0.197 mg/l and 0.059–0.129 mg/L, respectively. 0.008 mg/L for nitrate and 0.015 mg/L for orthophosphate [30].

IV. CONCLUSION

The composition of periphyton in the downstream waters of the Welang River consists of three divisions, namely the Chlorophyta, Cyanophyta and Chrysophyta divisions, in the Chlorophyta division 8 genera were found, Cyanophyta 2 genera and Chrysophyta 14 genera. The dominant ones in the downstream waters of the Welang River are from the Chrysophyta division, namely the Nitzchia and Navicula genera. The abundance of Periphyton during the study obtained moderate values. The results of this study were dominant. The results of the diversity index are included in the moderate category. While the uniformity index is in the low category. Water quality generally has an average value that is in the optimum category, but the TSS parameter value is high, exceeding the threshold. The results of the Canonical Correlation Analysis (CCA) analysis showed a low-moderate correlation between the abundance of periphyton and the results of the physical and chemical parameters of the water.

ACKNOWLEDGMENT

The author would like to thank the Faculty of Fisheries and Marine Sciences, Brawijaya University, which financially fully supported this research, with PNPB Faculty of Fisheries and Marine Science, Brawijaya University, and various parties who have helped during the research process.

REFERENCES

[1]. O. Silviani, B. Karyadi, D. Jumiarni, and A.R. Singkam, “Study of Microalgae Diversity in Bengkulu Rivers and Lakes as Aquatic Bioindicators. Biosilampari,” Biosilampari Journal: Biology Journal, *4*(2), pp. 127–138, June 2022.

[2]. S. Arsad, K.T. Putra, N. Latifah, M.K. Kadim and M. Musa, “Epiphytic microalgae community as aquatic bioindicator in Brantas River, East Java, Indonesia,” Biodiversitas, *22*(7), pp. 2961–2971, July 2021.

[3]. S.R. Samudar, R. Fitriadi, M. Baedowi, and L.K. Sari, “Pollution level of Banjaran River, Banyumas District, Indonesia: a study based on the Saprobic Index of periphytic microalgae,” Biodiversitas, *23*(3), pp. 1527–1534, March 2022.

[4]. Apriyanti, W. Padmarsari, Y. Hurriyani, and F.W. Hadinata, “Periphyton as a Bioindicator in Pulau Pedalaman Waters, Mempawah Regency, West Kalimantan,” Journal of Tropical Fisheries Management, *7*(1), pp. 29–35, June 2023.

[5]. D.K. Verma, J. Kumar, B.K. Das, A. Alam, D.N. Jha and V.R. Thakur, “Importance of periphyton to the ecology of subtropical river Ganga, India,’ Chronicle of Aquatic Science, *1*(6), November 2023.

[6]. A.D.S. Islam, Suryono, and I. Riniatsih, “Type Composition and Abundance of Periphyton on Seagrass Oceana serrulata Leaves in Water Panjang Island and Prawean Bandengan Beach,” Journal of Marine Research, *12*(4), pp. 692–700, October 2023.

[7]. A.S. Nengsi, T. Dahril, and M. Siagian, “Types and abundance of periphyton in the stone substrate placed in the Tapung River, Tapung District, Kampar Regency, Riau Province,” Student Online Journal, *5*(1), pp. 1–10, May 2018.

[8]. N. Faradiba, Purwadi, and Maroeto, “Erosion Estimation in the Central Region of the Welang Watershed, Pasuruan Regency,” Journal of Soil and Land Utilization Management, *20*(1), pp. 11–19, January 2023.

[9]. A.M. Yuce and A. Gonulol, “Evaluation of the relationship between epiphytic Diatoms and environmental parameters with the Canonical Correspondence Analysis (CCA),” Pakistan Journal of Botany, *48*(4), pp. 1723–1730, August 2016.

[10]. A.D. Agustin, A. Solichin, and A. Rahman, “Analysis of water’s trophic state based on periphyton abundance and types in Jabungan River, Banyumanik, Semarang,” Management of Aquatic Resources Journal, *8*(3), pp. 185–192, July 2019.

[11]. N.T.M. Pratiwi, S. Hariyadi, and D.I. Kiswari, “Periphyton community structure at upstream Cisadane River, Halimun Salak Mountain National Park, West Java,” Indonesian Biology Journal, *13*(2), pp. 289–296, August 2017.

[12]. R. Asra, T.S. Utami, and A. Adriadi, “Diversity and abundance of periphyton plant vegetation in Bento Swampas as water quality bioindicator," Biospecies, *15*(2), pp. 1–10, July 2022.

[13]. D.W.K. Baderan, S. Rahim, M. Angio, and A.I.B. Salim, “The diversity, evenness, and richness of plant species found on the potential geosite of Otonaha Fortress as a pioneer for Geopark Development in the Province of Gorontalo,” Biology of Journal, *14*(2), pp. 264–274, July 2021.

[14]. M. Sirait, F. Rahmatia, and P. Pattulloh, “Comparison of diversity index and dominant index of phytoplankton at Ciliwung River Jakarta,” Journal of Marine Science and Technology, *11*(1), pp. 75, November 2018.

[15]. W.I. Wahyuni, B. Amin, and S.H. Siregar, “Analysis of Nitrate, Phosphate and Silicate Content and Their Effects on Planktonic Abundance in The Estuary Waters of Batang Arau or Padang City West Sumatra Province,” Asian Journal of Aquatic Science, *4*(1), pp. 1–12, April 2021.

[16]. D. Ariana, J. Samiaji, and S. Nasution, “Composition of Species and Density of Phytoplankton in Riau Sea Waters,” Student Online Journal, *1*(1), April 2014.

[17]. N.M. Hamzah, T. Sukmono, and D. Suprayogi, “Diversity and Abundance of Periphyton on Natural Substrates in the Tabir River, Merangin Regency, Jambi,’ unpublished.

[18]. Y. Fitriyah, B. Suladiorno, and N. Widyorini, "Diatom Community Structure in Water Reservoirs for Salt Ponds in Kedung Mutih Village, Wedung District, Demak. Diponegoro," Management of Aquatic Resources Journal, *5*(2), pp. 11–16, April 2016.
[19]. M. Mandolang, J.D. Kusen, V. Warouw, E.Y. Kaligis, J.H. Paulus and U.N.W.J. Rembet, "Target fish communities in coral reef in the traditional zone of Bunaken Island," Tropical Coastal and Marine Journal, *9*(3), pp. 104–110, October 2021.
[20]. F. Meiriyani, T.Z. Ulqodry, and W.A.E. Putri, "Composition and Distribution of Phytoplankton in the Waters of the Way Belau River Estuary, Bandar Lampung," Maspari Journal, *3*, pp. 69–77, April 2011.
[21]. R. Hardianti, L.I. Sari, and W. Kusumaningrum, "Periphyton abundance charateristics of the segrass type *Enhalus acoroides* in Malahing Waters of Bontang City," Aquarine Journal, *8*(2), pp. 20–26, October 2021
[22]. E.S. Oppusunggu, A. Najamuddin, R. Elvince, and L. Wulandari, "The community structure of periphyton in Bakung Merang Canal Palangkaraya City," Journal of Tropical Fisheries, *18*(1), pp. 30–39, February 2023.
[23]. I.A. Yoviandianto, M. Mahmudi, and A. Darmawan, "Mapping of Water Quality Distribution to Support Aquatic Resources Management with Geographic Information Systems, Case in Brantas River, Bumiaji District," Journal of Fisheries and Marine Research, *3*(3), pp. 373–381, October 2019.
[24]. L.C. Permadi, E. Indrayanti, and B. Rochaddi, "Current Study in Sea Waters Around Sumuradem PLTU, Indramayu Regency, West Java Province," Journal of Oceanography, *4*(2), May 2015.
[25]. Minister of Forestry Regulation Number 22 of 2021 concerning Implementation of Environmental Protection and Management.
[26]. D.A.S. Pohan, Budiyono, and Syafrudin, "Analysis of River Water Quality to Determine Designation Reviewed from Environmental Aspects," Environmental Science Journal, *14*(2), pp. 63–71, April 2017.
[27]. M.C. Mainassy, "The Effect of Physical and Chemical Parameters on the Presence of Lompa Fish (Thryssa baelama Forsskål) in the Apui Coastal Waters of Central Maluku District," Journal of Fisheries, *19*(2), pp. 61–66, July 2017.
[28]. L. Khoiriyah, N.L. Fajri, and Adriman, "Types and density of epidendritic biofilms in the swamp waters of Sawah Village, North Kampar District, Terubuk Fisheries Periodical, *47*(3), pp. 21–27, 2019.
[29]. C. Megawati, M. Yusuf, and L. Maslukah, "Distribution of water quality in terms of nutrients, dissolved oxygen and pH in the southern Bali Strait waters," Journal of Oceanography, *3*(2), pp. 142–150, May 2014.
[30]. Decree of the State Minister of the Environment Number 51 of 2004 concerning Regarding Standard Quality of Seawater.