Asian Journal of Fisheries and Aquatic Research

5(4): 1-8, 2019; Article no.AJFAR.54784
ISSN: 2582-3760

Perifiton Community Structure in Citarik River

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJFAR/2019/v5i430083
Editor(s):
(1) Dr. Bruno Fiorelini Pereira, Professor, Federal University of West of Bahia, Brazil.
Reviewers:
(1) Ronald Bartzatt, University of Nebraska, USA.
(2) Leonel Pereira, University of Coimbra, Portugal.
Complete Peer review History: http://www.sdiarticle4.com/review-history/54784

Original Research Article

Received 09 December 2019
Accepted 13 February 2020
Published 25 February 2020

ABSTRACT

The purpose of this research is to determine the condition of waters in the Citarik River with the periphyton community as a bio indicator. This research was conducted from March-April 2019. The research method used was a survey method at 4 station points, five times sampling with a span of 7 days. The smallest periphyton abundance is in station IV which is 22 ind/cm^2 and the most is in station I which is 18278 ind/cm^2. Comparison of species deficit values at each station is different, this is influenced by different physical and chemical parameters. The dominance index value in the waters of the Citarik River ranges from 0.1 to 0.8 and the diversity index value ranges from 0.2 to 0.9. The results showed the Citarik River was in a mildly polluted condition.

Keywords: Pollution; periphyton; Citarik River.

1. INTRODUCTION

Administratively, the Citarik River is located in Bandung Regency, Garut Regency and Sumedang Regency with a length of 39.64 km and an area of 4,315.41 ha [1]. The Citarik River has an upstream in the Kareumbi Masigit Forest Conservation Area of the Sumedang Regency and empties into the Citarum River in the Bandung Regency [2].

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Citarik River is widely used by local residents for drinking water, irrigation, agriculture, animal husbandry, industrial and household waste disposal. The problem of the Citarik River has started from the headwaters of the river namely environmental degradation, especially land and water resources. Among the triggers is the way farmers treat land and waters in the upper reaches of the Citarik River that are not appropriate. In the downstream problems arising from anthropogenic activities such as dumping waste into river bodies from household and industrial activities, causing water quality downstream in the downstream [3].

The entry of wastes from anthropogenic activities causes the presence of water quality and organisms in the waters of the Citarik River also disturbed. Estimation of water quality can be done by looking at the physical, chemical and biological parameters of the waters. In estimating the quality of waters using biological parameters can be done by identifying the presence of periphyton [4].

Periphyton is a group of aquatic microorganisms that grow and live attached to or attached to the surface of objects in the river such as wood, stems of aquatic plants, and so on. Changing water quality will affect the presence of periphyton both biomass and community structure [5]. Various activities in the Citarik River basin are thought to affect organisms in the river including the periphery. The purpose of this research is to determine the level of pollution in the waters of the Citarik River by using the periphyton community as a bioindicator of pollution.

2. MATERIALS AND METHODS

Research was carried out in March 2019 - April 2019 with sampling locations conducted at 4 station points. Station 1 in the Gunung Kareumbi area of Leuwiliang Village. Station 2 is located in Panenjoan Village, Station 3 is located in Haur Pugur Village, and Station 4 is located in Langensari Village. The research location is shown in Fig. 1.

The tools used in this study were 50 x 10 cm bamboo, brushes, mines, sample bottles, plankton net, dipper, cool box, pH meter, DO meter, thermometer, Secchi disk, camera, dipper, dropper, microscope, counting camber, periphyton identification book, cover glass, volume pipette, spectrophotometer, water bath, Erlenmeyer, burette, spatula, filter paper. While the materials used during the study are: Lugol's 1%, ice cubes, $MnSO_4$, H_2SO_4, Sodium thiosulfate, O_2 reagent, $K_2Cr_2O_7$, Ag_2SO_4 H_2SO_4, $HgSO_4$, sulfuric acid, standard solution of Potassium Hydrogen Phthalate ($HOOCC_6H_4COOK$, KHP), NHO 10%, Signets Solution, Nessler Reducing Solution $SnCl_2$, NH_4-molybdate and distilled water.

Research methods using survey methods and sampling is done by purposive sampling, which is a method of taking data that is tailored to the needs of research. There are 4 stations that are determined based on differences in anthropogenic activities and river zoning as sampling locations and are carried out 5 times with a span of taking 7 days.

2.1 Observation Parameters

2.1.1 Abundance

Periphyton abundance uses a modified formula [6]:

$$K = \frac{\mathrm{N\ x\ At\ x\ Vt}}{\mathrm{Ac\ x\ Vs\ x\ As}}$$

Information:

K = Periphyton abundance (ind/cm^2)
N = Number of observed periphytons (cells)
As = Area of scraped substrate (cm^2)
At= Cover glass area (mm^2)
Ac = Wipe area (mm^2)
Vt = Volume of concentration in the sample bottle (ml)
Vs = Concentration volume in the glass cover (ml)

2.1.2 Dominance index

To see the dominance of certain types, use the Simpson dominance index formula [7] as follows:

$$C = \sum[ni/N]^2$$

Information:

C = Dominance Index
Ni = Number of individual genus i
N = Total number of individuals from all genera

The criteria for dominance index are:

$0 < C \leq 0.5$ = there is no dominant genus
$0.5 < C < 1$ = there is a dominant genus

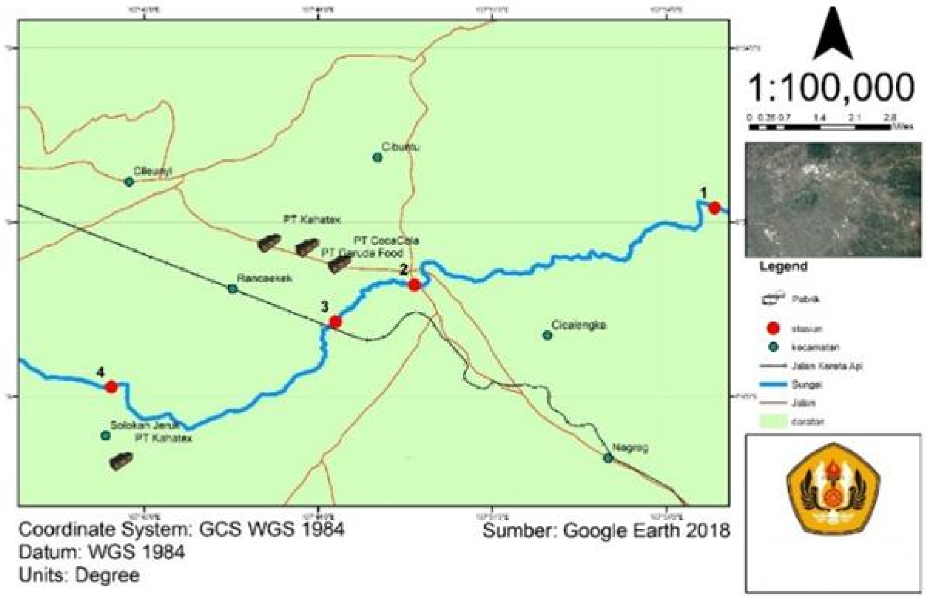

Fig. 1. Research location map

2.1.3 Diversity index

The diversity index is calculated using the Simpson equation [7] as follows:

Diversity Index = 1 - C

Information:

C = Index of dominance

The Simpsons diversity index value ranges from 0-1, if the index value is close to 1, the distribution of individuals is uneven, and the stability of the ecosystem is said to be good if it has a Simpsons diversity index between 0.6-0.8 [7].

2.1.4 Species deficit

Comparison of periphyton abundance by looking at the genus abundance at the downstream station with the upstream station using a species deficit comparison. The formula of species deficit [8] as follows:

$$I = \frac{Su - Sd}{Su} x\ 10$$

Information:

I = Species deficit
Su = Number of genus upstream
Sd = Number of genera downstream

3. RESULTS AND DISCUSSION

3.1 Water Quality Parameters

The results of measurements of water quality parameters during the study in the Citarik River is shown in Table 1.

3.1.1 Temperature

The average temperature in the Citarik River at the time of observation the average temperature of the Citarik River during the study was 19°C - 26.6°C. The temperature of the Citarik River at each station is normal for the life of aquatic organisms [9], if the optimum temperature for periphyton growth in waters is 20 – 30°C. The lowest temperature is at Station I which is an upstream section that has a vegetation density around the river flow high enough, so that the intensity of sunlight entering the river body is low. While the highest temperature is at Station IV because it is a fairly open location with high intensity of sunlight.

3.1.2 Light transparency

The highest light transparency is found in station I with a range of 48 - 58 m. While transparency began to decrease at station II, station III and station IV because the station had been influenced by the accumulation of particles from the upstream and the burden of contamination that entered the body of water so as to prevent the penetration of sunlight into the body of water.

3.1.3 Current

The highest current speed is found in station I with a range of 0.5 - 1.49 m/s. While the lowest is in station II with a range of 0.20 to 0.63 m/s. The amount of current can affect the type of substrate per water [4]. This causes Station I to have a rocky and sandy substrate type. While stations II, III and IV have muddy substrates because the current at the station is slow.

3.1.4 Acidity (pH)

The pH value at station I upstream was the most acidic during the study, which was pH 6.35. Changes in pH values at stations II, III and IV become more alkaline because of the presence of domestic waste inputs such as alkaline detergents. The highest pH value is at station IV that is 8.8, the pH value has exceeded the quality standard according to Government Regulation of the Republic of Indonesia Number 82 of 2001, good water has a pH between 6.5 and 8.5.

3.1.5 DO (Dissolved Oxygen)

Dissolved oxygen at station I ranged between 6 - 8 m/L, indicating that the waters at station I were still classified as good. In accordance with the statement [10], which states that waters with DO concentrations of more than 5 mg/L indicate low levels of pollution. Decline in DO values at stations II, III and IV dues to the presence of organic materials from industrial waste containing reduced and other materials [4].

3.1.6 BOD (Biochemical Oxygen Demand)

BOD value at station I ranged from 0.32 to 0.96 mg/l, which is classified as unpolluted waters. Station II and III ranged from 0.96 to 5.12 mg/l and 1.6 - 5.12 mg/L have entered the mildly polluted waters. Whereas station IV with 1,92 - 8,64 mg/L is classified as medium polluted waters. Natural waters have a BOD value between 0.5 - 7.0 mg/l while waters with a BOD value of more than 10 mg/L are considered to have contaminated [9].

3.1.7 COD (Chemical Oxygen Demand)

Citarik River COD value at the time of the study ranged between 6.5 - 36 mg/l. The highest COD value is at station IV, which ranges from 19 - 36 mg/l, station IV is an area that has anthropogenic activity, namely industry, especially the textile industry which discharges waste in river bodies. While the lowest COD found at station I ranged from 8 - 16 mg/L. The low COD value for Station I is because Station I has not been influenced by waste input from anthropogenic activities.

Table 1. Water quality parameters

Physical parameters		**Site**				**Class III Quality Standards (PPRI No.82 of 2001)**
		I	**II**	**III**	**IV**	
Temperature (^{o}C)	R	19 - 21,2	22 - 25	21,8 - 25	24,1 - 26,6	Deviasi 3
	A	20,3±1	23,5±1,3	24±1,5	25,4±1,1	
Transparency (cm)	R	48 - 58	19 - 24	24 - 27	19 - 23	-
	A	52,8±4,3	21,4±2,5	25,3±1,3	21,±1,8	
Stream flow (m/s)	R	0,71 - 1,49	0,23 - 0,47	0,20 - 0,63	0,25 - 0,45	-
	A	1,05±0,33	0,36±0,11	0,40±0,22	0,35±0,08	
pH	R	6,4 - 7,4	6,8 - 7,8	6,6 – 7	6,6 - 8,8	6,5 - 8,5
	A	6,8±0,5	7,2±0,4	6,9±0,2	7,9±1	
Dissolved Oxygen	R	8 – 9	5,7 - 7,4	3 - 6,8	2,4 - 6,5	3
(mg/l)	A	8,4±0,4	56,3±0,8	5,5±1,7	3,9±1,8	
BOD (mg/l)	R	0,32 - 0,96	1,28 - 5,12	2,88 - 5,12	4,46 – 8,64	6
	A	0,72±0,31	2,32±1,87	3,68±0,99	6,48±1,70	
COD (mg/l)	R	9 - 16	15 - 17	12 - 21	19 - 30	50
	A	12,5±4,9	16,5±6,4	16,5±6,4	24,5±7,8	
Nitrate (mg/l)	R	0,233-0,292	0,200-0,259	0,176-0,294	0,207-0,365	20
	A	0,260±0,026	0,235±0,025	0,222±0,051	0,268±0,070	
Phosphate (mg/l)	R	0,117-0,149	0,119-0,162	0,119-0,192	0,129-0,295	1
	A	0,136±0,014	0,147±0,020	0,158±0,033	0,166±0,039	

3.1.8 Nitrate

The results of measurements of Citarik River nitrate levels during the study ranged from 0.171 to 0.365 mg/L. The lowest level of nitrate is found in station I, which is around 0.171 - 0.292 mg/l, this is because at station I there has not been much anthropogenic pollution. Whereas the highest is in Station II with levels ranging from 0.232 to 0.365 mg/L, the high levels of nitrate at Station IV are caused by the large amount of pollution load input from anthropogenic activities, especially water runoff from agricultural areas around Station IV.

3.1.9 Phosphate

Phosphate at each observation station tended to increase, station I ranged from 0.117 to 0.115 mg/l, station II ranged from 0.119 to 0.162 mg/L, station III ranged from 0.119 to 0.192 mg/L, and station IV ranged from 0.129 to 0.295 mg/L. The increase in phosphate levels is caused by the more downstream of the river more and more anthropogenic activities that contribute waste to the river, especially domestic and industrial waste which causes an increase in phosphate levels.

3.2 Periphyton Observation Parameters

3.2.1 Periphyton abundance

The results of the analysis of the periphyton abundance of each station at the time of the research showed varied results for each station.

Periphyton abundance found at each station varies. The highest abundance was at Station I with an abundance of 18278 ind/cm^2 while the lowest abundance was at Station IV with an abundance of 22 ind/cm^2. The high abundance at Station I because it is still not polluted, so that it is still supportive for peripheral life. At station I, the species *Nitzschia* sp. and *Navicula* sp. (*Bacillariophyta*) were the most abundant group. The cause of the high abundance of these two genera can survive the current at station 1 which is quite high and has a rocky substrate. Bacillariophyceae class is a group of algae that can live in all types well [11]. The Bacillariophyceae class, namely species *Nitzschia* sp. and *Navicula* sp. are able to adapt to currents that increase to heavy because it has a strong attachment to the substrate that contains gelatinous stems [12].

Periphyton abundance at stations II, III and IV Periphyton abundance decreased. This relates to the quality conditions at stations II, III and IV that have been affected by the influx of anthropogenic waste from households, agriculture or industry. Shown by the results of measurements of low DO and high BOD (Table 1) in accordance with the statement of Ali et al. [13] polluted water has a low oxygen content, the more organic waste material in the water the less residual dissolved oxygen content in water.

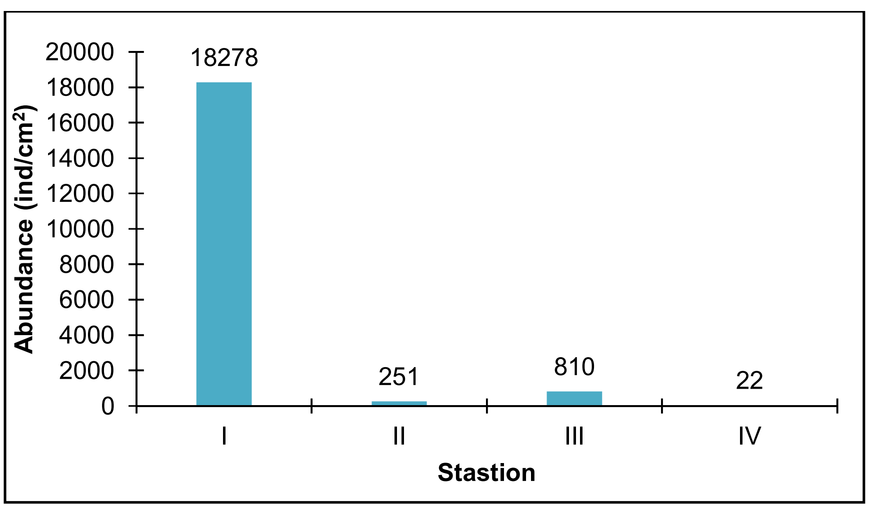

Fig. 2. Abundance of Citarik River Periphyte during Research

3.2.2 Dominance index

Dominance index is used to determine the extent to which a species or genus dominates other groups. At this time the calculation method uses the Simpson dominance index. The dominance index criterion is $0 < C \leq 0.5$ meaning that there is no genus dominating. Whereas $0.5 < C < 1$ means that there is a dominant genus. Periphyton dominance index results in Fig. 3.

At station I the dominance index ranges from 0.17 to 0.68, which means that there are several genera that dominate at station I, namely the genus *Nitzschia* and *Navicula*. Both of these genera have the ability to attach to strong substrates so that they are not carried by currents because at Station I the waters have strong currents and have rocky substrates.

Station II has an average dominance index of 0.35 and a range of dominance index of 0.13 - 0.81. There is a high degree of dominance at station II that is because station II there is an ecological pressure from water quality which causes dominance at station II. And the genus that dominates at the station is the genus *Nitzschia*. Which has more individuals than other genera with only 1 individual.

Stations III and IV have almost the same dominance index value, with an average of station III of 0.26 and station IV of 0.20. The index range of station III is 0.19 - 0.32 and station IV ranges from 0.14 to 0.29. Dominance index values at stations III and IV indicate no dominance at both stations.

From all observation stations, there are genera that always dominate, namely the genus *Navicula* and *Nitzschia* (*Bacillariophyta*). The two genera are cosmopolitan in that they are found throughout the observation station and are better able to adapt to the existing environmental conditions.

3.2.3 Diversity index

Diversity Index is used to see the stability of a community or show the condition of the community structure of the diversity of organisms that are in an area. Citarik River periphyton diversity index as follows.

The average Simpson diversity index during the study ranged from 0.64 to 0.74. The lowest diversity index is 0.18 the lowest and 0.86 the highest. The Simpson diversity index value is said to be good if it has a value of 0.6 to 0.8 [8]. Simpson periphyton diversity index shows fluctuations in the range of 0.18 - 0.86, this is because the number of periphyton found has a different abundance value. In addition, bad environmental and weather conditions also affect the number of periphytons found.

If a community is said to have a high diversity of species, if the community is composed of many species which have a large abundance and are the same or almost the same. Conversely, a community is only composed by a number of abundant species, so the diversity of species is low [14].

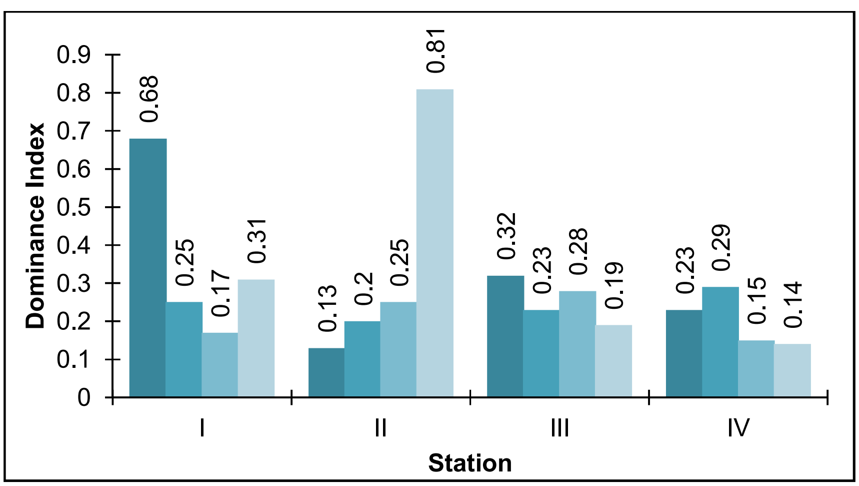

Fig. 3. Dominance index of Citarik River Periphyton during Research

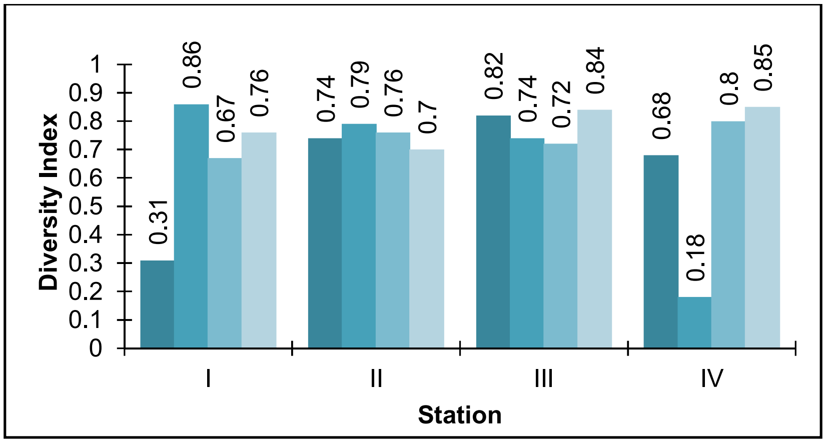

Fig. 4. Citarik River Periphyton diversity index during the study

Table 2. Species deficits

Stations	**Sampling**				**Average**
	I	**II**	**III**	**IV**	
1 and 2	-23 %	50 %	47 %	43 %	29 %
1 and 3	0 %	58 %	53 %	57 %	42 %
1 and 4	-8 %	50 %	33 %	29 %	26 %

3.2.4 Species deficit

Decreasing the number of species in water can be caused by the presence of input load pollution that causes some species can't survive certain conditions.

Species deficits are a comparison of the abundance of organisms at upstream and downstream stations. Calculation of species deficits obtained during observations is presented in Table 2.

The species deficit value in the Citarik River ranges from 0 - 58%. The observations showed that there were differences in the number of species deficits during the four observations. The difference in species deficit values is influenced by physical and chemical parameters of the waters. Comparison of species deficits is done by comparing the number of periphytons found at station I with station II, station I with station III and station I with station IV. The results obtained show if there is a reduction in the number of periphyton from station I to station IV. That is because the water conditions at stations II, III and IV are less supportive for periphyton growth as seen from the low transparency of light and DO and high BOD values (Table 1) while increasing abundance. The abundance of periphyton in water always changes along with changes that occur in the surrounding environment [4].

From the results of periphyton biological index exposure showed that the status of Citarik River pollution is classified into mild pollution, it is seen in the dominance index that on average does not show any dominance in each station. Likewise, the diversity index shows that the periphyton community in the Citarik River still has quite high diversity.

4. CONCLUSION

Based on the research shows that the status of Citarik River pollution at the time of the research was classified as mild pollution. This is shown in the dominance index and diversity index which are still classified as normal. As for the deficit species, there was a reduction in periphyton species in the Citarik River from upstream to downstream.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Apandi T. Study of rainfall characteristics in the Citarik river, Citarum river basin in

West Java. Thesis. Faculty of Agriculture. Universitas Padjadjaran. Jatinangor; 2003.
2. Zomrodi. Citarik river management policy strategy (upper Citarum river). Graduate School. Universitas Padjadjaran. Bandung; 2016.
3. Kastolani W. Land degradation of upper Citarik sub-watershed sub watershed in Kab. Bandung and Sumedang. Gea Journal. 2009;3(1):2-3. Indonesia
4. Wijaya HK. Periphyton and phytoplankton communities and water quality parameters in the upper Cisadane river, West Java. Thesis. IPB Press. Bogor; 2009.
5. Watanabe MM, Mayama S, Hiroki M, Hiyashoyi N. Biomass, species composition and diversity of ephipelagic algae in mire pools. Hidrobiologia. 2000;421(1):91-102.
6. Eaton AD, Clesceri LS, Greenberg AE. APHA (American Public Health Association): Standard method for the examination of water and wastewater 19th Ed., AWWA (American Water Works Association), and WPCF (Water Pollution Control Federation). Washington DC; 1995.
7. Odum EP. Fundamental of ecology. W.B. Sounders Company Philadelphia; 2003.
8. Hellawel JM. Pollution monitoring series: Biological indicators of freshwater pollution and environmental management; 1977.
9. Effendi H. Water quality study: For resource and environmental management periods. Kanisius. Yogyakarta; 2003.
10. Hutabarat SP, Soedarsono I. Cahyaningtyas. Study of plankton analysis to determine the level of pollution in the Babon river estuary in Semarang. Journal of Management of Aquatic Resources. 2013;2(3):74-84. Indonesia
11. Adjie SS, Subagdja. Plankton abundance and diversity in Lake Arang-Arang, Jambi. Indonesian Research and Fisheries Journal: Resource and Arrest Edition. 2003;9(7):1-7. Indonesia
12. Nengsi AS, Tengku D, Madju S. Types and abundance of periphyton in natural substrate (stone) in the river Tapung around the village of Bencah Kelubi, Tapung District, Kampar Regency, Riau Province. Faculty of Fisheries and Maritime Affairs, Riau University; 2018. (In press).
13. Ali A, Soemarno, Mangku P. Water quality and status of Metro river water quality in Sukun District, Malang City. Bumi Lestari Journal. 2013;13(2):265-274. Indonesia
14. Soegianto A. Methods for estimating waters pollution with biological indicators. Airlangga University Press. Surabaya; 2004.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/54784