Omni-Akuatika, 15 (1): 12–18, 2019
ISSN: 1858-3873 print / 2476-9347 online

Research Article

journal homepage: http://ojs.omniakuatika.net

Plankton Diversity in Karst River, Masigit - Pawon Cave, West Java, Indonesia

Muhammad Wahyudin Lewaru[1,2*], Fifi Dwi Pratiwi[2], Sunardi[2,3]

[1]Department of Marine Science, Faculty of Fisheries and Marine Sciences, Padjadjaran University, Indonesia
[2]Center for Environment and Sustainability Science (CESS), Padjadjaran University, Indonesia
[3]Department of Biology, Faculty of Mathematics and Natural Sciences, Padjadjaran University, Indonesia

[*]Correspondence Author: m.w.lewaru@unpad.ac.id

Received 12 September 2018; Accepted 1 May 2019; Available online 10 May 2019

ABSTRACT

Karst of Citatah region has been known strategies economic value of biotic and abiotic resources in West Java. Karst river belongs to Karst of Citatah region is important freshwater ecosystem such as plankton community structure. This study investigated plankton diversity as community structure in Cibukur and Cibodas river, which is part of karst river particularly on Masigit-Pawon cave. The result of four stations showed that karst river was high species richness of plankton community structure with diversity index nearly 1. The numbers of plankton identified were of 24 species of phytoplankton consist of 9 class and 16 species of zooplankton consists of 8 class. The high abundance of phytoplankton was *Navicula sp and Synedra sp*, while high abundance of zooplankton was *Cyclops sp*.

Keywords: *Karst of Citatah, plankton, diversity index*

1. Introduction

Karst of Citatah region has been known strategic economic value related to its existence as biotic and abiotic resources, which can be used for community welfare such as limestone mining. Based on data from *Badan Pengelolaan Lingkungan Hidu*p (BPLHD) of West Java (2009), the Karst of Citatah region has important strategic values including: (1) One of several the oldest karst region on the island of Java; (2) The existence of archaeological sites in the Pawon Cave; (3) Scientific value relates to the development of science; (4) Having high economic value; and (5) Having humanitarian values related to the socio-cultural.

The high potential of resources from the karst of Citatah region has caused many communities to make limestone mining as their livelihood. However, rock mining in the area has caused a very worrying damage to ecosystems and the environment. Based on BPLHD of West Java records in 2009, the Citatah Karst region experienced a fairly high damage rate. Brahmantyo (2008) states that around 80%-90% of the entire Citatah Karst region which extends from Tagog Apu to Padalarang is no longer intact except Pasir Pawon.

The increasingly high damage of ecosystems in Karst of Citatah need for rehabilitation efforts to restore and develop ecological functions from the region, such as manage the rivers in surrounding Karst ecosystems. The intial step of river management conducted to know the potential diversity and community structure of plankton in the ecosystem.

In the aquatic ecosystems, plankton plays a very important role because these organisms occupy the lowest tropic level. Plankton are important indicators in freshwater ecosystems as a source of primary production (phytoplankton) and natural food (zooplankton) for the other trophic level such as fish. Aside from being a food source for aquatic organisms, plankton can also be an indicator for the quality of an aquatic ecosystem (Farashi et al. 2014). The higher level of plankton diversity, indicate better of the ecosystem, on the contrary if the plankton diversity is lower it means that the aquatic ecosystem conditions are disturbed or damaged (Farashi et al. 2014).

http://dx.doi.org/10.20884/1.oa.2019.15.1.573

The availability of plankton in the aquatic ecosystems can be used as natural food for many aquatic species in the karst river such as zooplankton and fish. Therefore the strategy to rehabilitate the Karst region through the identification of potential biological resources, especially aquatic such as plankton, can be used as an indicator of the management of the Karst ecosystem in the future. The purpose of this study was identify the potential for plankton diversity in the Karst river in the Citatah Karst region, especially in the Masigit – Pawon which is location sampling site. The benefit of this research can be used to development of Karst management zone related aquatic ecosystems using indentification of plankton diversity as quatic resources.

2. Materials and Methods

2.1. Determination of sampling location

This research was carried out at an early stage is a preliminary study conducted to determine the location of research (location of sampling). Based on the results of preliminary studies, sampling was carried out on two rivers, namely Cibukur and Cibodas River. Both rivers are located in Masigit mountain Village, Cipatat District, West Bandung Regency. The selection of the two rivers is because they come from wellspring in the karst and the water flow that is part of the Citatah Karst ecosystem. In addition, the two rivers also meet the criteria to be used as sampling sites, because the river flow is close to karst rock and passes through settlements area.

The next stage is taking samples covering Cibukur and Cibodas rivers. Based on criteria of the location, the sampling point was divided into four stations, the first station sampled was the upstream area of the Cibukur (CHu) river flow (Figure 1a) which is close to the Masigit-Pawon Karst region. The second station was taken close to the Karst (MA) wellspring (Figure 1b), which is around the Pawon Cave. The third station is on the lower Cibukur River (CHi) (Figure 1c), which is close to settlements and agricultural areas. The fourth station is taken on the Cibodas (CB) river flow (Figure 1d), where the river is still connected to the Cibukur river so the source of water is mixed.

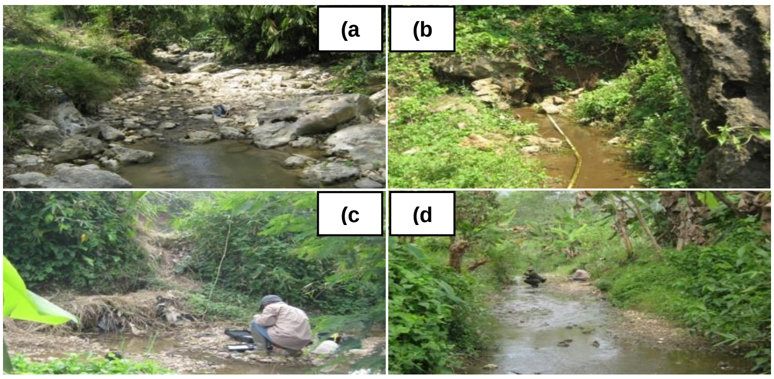

Figure 1. Sampling location in Masigit-Pawon Karst area, a) Cibukur River upstream, b) Masigit-Pawon Karst wellspring around Pawon Cave, c) Stream downstream of Cibukur River, and d) Cibodas river flow.

2.2. Sampling and data analysis

Sampling is carried out in the morning period until noon. Plankton samples were taken using plankton-net then stored in polyethylene based plastic containers, then given preservatives in the form of 4% formalin solution. Bottles containing samples are stored in a storage box and then taken to the laboratory for identification. To evaluate the community structure of phytoplankton, three parameters were counted: species richness, diversity index, and abundance (N) of phytoplankton. Species richness of the phytoplankton was obtained by calculate the total number of species in each of the water sample. As for diversity index, it was calculated using Shanon-Wiener equation:

$$H' = -\sum_{i-1}^{s} \left(\frac{ni}{N}\right) ln\left(\frac{ni}{N}\right)$$

Where H'= Shanon-Wiener Diversity Index, ni= total number of plankton and species identified, and N= total number of plankton. Diversity index (H') was categorized as “low” if the result below 1 (<1), and “middle” if the number laid between 1 and 3 (1<H’<3), or “high” when above 3 (>3).

While the abundance of phytoplankton was calculated using formula:

$$N = \left(\frac{Vk}{Vp}\right)\ x\ \left(\frac{1}{Vs}\right)\ x\ (n)$$

Where N= total number of plankton per liter (Ind/L),
Vs= total volume of filtered water,
Vk = total volume of concentrated water,
Vp= total volume of analyzed of water, and n= number of species identified.

3. Results and Discussion

3.1. Species richness

Based on results of the study, river water bodies in Masigit-Pawon Karst Region have high potential biological resources. This was indicated by the results of identification of plankton samples taken from the four sampling stations, which showed that in the study locations there were 24 types of phytoplankton and 16 types of zooplankton.

The classification results of each type found using the key of determination (systema naturae 2000), all types of phytoplankton found were divided into nine classes, which is *Chlorophyceae, Cyano-bacteria, Trebouxio-phyceae,Charophyceae, Bacillariophyceae, Fragilariophyceae, Eugleno-phyceae, Florideo-phyceae,* and *Ulvophyceae*. Type of phytoplankton that identified in this research is more larger than the research conducted by Radifa (2015) in Karst Cileungsi waters, which consists of five classes consisting of *Dinophyceae, Euglenophyceae, Cyano-phyceae, Bacillariophyceae,* and *Chlorophyceae*.

As for zooplankton, nine species are divided into eight class in total, which is *Tubulinea*, *Monogononta*, *Multicrustacea*, *Ostracoda*, *Eutardigrada*, *Branchiophoda*, *Oligohymenophorea and one class was identified unknown class.* The composition of plankton at the study location can be seen in Table 1.

Based on the data in Table 1, it is known that the most phytoplankton species in the study area from *Bacillariophyceae* classes while the most zooplankton species were classified as *Tubulinea* and *Monogononta* classes. The most abundant types of phytoplankton are *Navicula sp* as many as 5,280 individuals (Figure 2) and for zooplankton, *Cyclops sp* is the species with the highest abundance, reaching 2,904 ind. (Figure 3).

Most abundance plankton are species that have the best adaptability to the condition of the aquatic environment located in the karst region, because the karst area has very specific environmental characteristics. There are two types of plankton consits of *Navicula sp* and *Cyclops sp* that most able to adapt with environmental conditions, perhaps in karst waters.

Table 1. Class composition of plankton in sampling site

No	Phytoplankton		No	Zooplankton	
	Class	Species Count		Class	Species Count
1.	Bacillariophyceae	7	1.	Tubulinea	2
2.	Charophyceae	3	2.	Monogononta	2
3.	Chlorophyceae	1	3.	Multicrustacea	1
4.	Cyanobacteria	4	4.	Ostracoda	1
5.	Euglenoidea	1	5.	Eutardigrada	1
6.	Florideophyceae	1	6.	Branchiophoda	1
7.	Fragilariophyceae	5	7.	Oligohymenophorea	1
8.	Trebouxiophyceae	1	8.	Unidentified	7
9.	Ulvophyceae	1			
Total		24	Total		16

Phytoplankton from the *Bacillariophyceae* class are the most common phytoplankton found in karst waters (Udovic et al. 2016 and Kupe et al. 2010) because karst waters have a high hardness level due to the lime content in their waters (Udovic et al. 2016). *Navicula sp*. is the most common species from *Bacillariophycea* class, this is due to *Navicula sp*. has a very high tolerance for extreme or vulnerable environmental conditions (Lai et al. 2016). *Navicula sp.* has ability to live in a very wide range of temperature, salinity and depth (Table 2). *Navicula sp.* is the best feed for *Vannamei* shrimp compared to 28 other types of phytoplankton (Ferreira-Marinho et al. 2014). This shows that in region of Masigit - Pawon Karst waters it has potential to develop *Vanname*i shrimp culture.

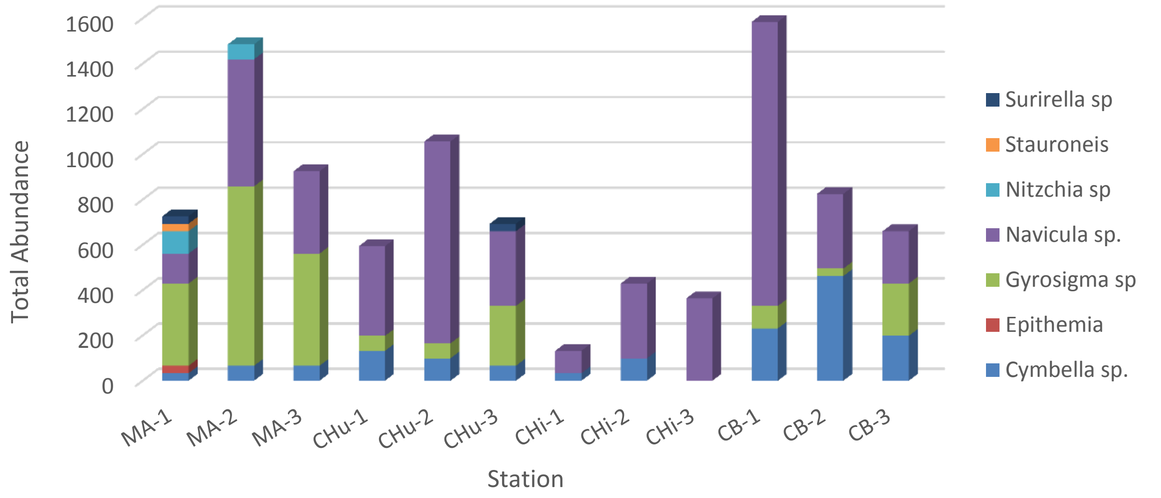

Figure 2. Total species of Phytoplankton from each station

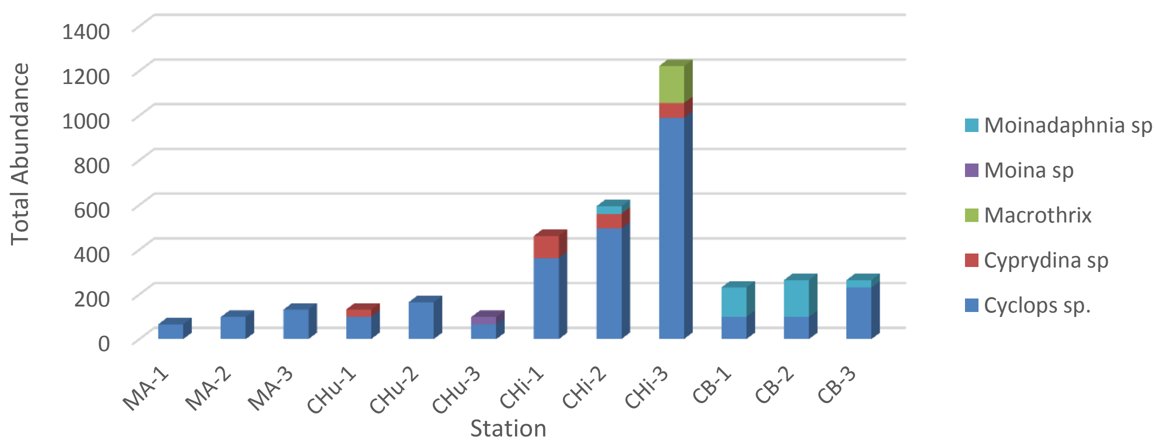

Figure 3. Total species of Zooplankton from each station

Cyclops sp. is one of the most commonly found zooplankton species in freshwater such as lakes and rivers (Johnsons et al. 2007). *Cyclops sp* has a fairly high tolerance level and can live in water conditions that lack oxygen (Johnsons et al. 2007). Research conducted by Jersabek and Schabetsberger (1996) on Lake Alpine Karst found that *Cyclops sp.* was the most abundant zooplankton in the area. *Cyclops sp.* is the most preferred food for milkfish (Diani 2016). *Cyclops sp*. often used for natural fish feed because it has a high protein content of 4.2 % of body biomass.

3.2 Community structure of plankton

Calculation of the Diversity Index or Diversity Index, according to McNaughton (1998) in Soedarti et al. (2006), has two functions, (1) shows the number of species or abundance of species, and (2) shows the balance of the community. While the calculation of the Dominance Index value can provide an overview of the pressure from the environment on organisms that cause organisms to experience stress, so that the organism community is only dominated by one particular type that can survive and thrive in these environmental conditions (Lamshead, et al., 1983 in Magurran , 1988; Soedarti et al., 2006). If the Diversity Index value approaches 1, it indicates that the community has a good community balance and abundant species diversity. Conversely, if the Dominance Index value approaches 1, it means that the community has been dominated by one particular type and indicates that the aquatic environment is under pressure.

In general, the condition of plankton community in all four study locations is in balanced condition and not dominated by one

The high index value of phytoplankton diversity in Karst waters of Citatah due to agricultural activities so that phosphorus and nitrogen content in waters increase (Baloly et. al. 2016). In addition, phytoplankton especially from Bacillariophyceae class, need more nitrates than the other classes (Kamp et al. 2011). If the nutrient content in waters increases due to agricultural activities can cause eutrophication.

Different trends are shown by the zooplankton community, where the value of Diversity Index is lower than the index values of phytoplankton. Zooplankton Diversity Index values at the study locations ranged from 0.588 to 0.739. Station 1 gets least Diversity Index value (0.588), this is because the diversity of species and abundance of zooplankton at the station is at least compared to other stations. The low variety of zooplankton species and abundance at Station 1, due to high conductivity in waters of the karst spring. High content of calcium and sulfate derived from lime also affects the low value of the zooplankton diversity index (Stanković et al. 2011).

This is influenced by differences environmental conditions in three stations, which makes environmental conditions at Station 1, 2 and 4 suitable for phytoplankton growth, and Station 3 is suitable for zooplankton growth. At Station 3, plants that shade river water bodies are more dense than other stations, making penetration of light into water more difficult than other stations. Lack of light penetration into water, making phytoplankton growth at Station 3 not optimal. This is because light is an important factor for phytoplankton growth (Smith & Thomas, 2000).

Table 2. Simpson diversity and dominance index of plankton community from each station.

Organism	***Station**			
	MA	**CHu**	**CHi**	**CB**
Phytoplankton				
Abundance of Phytoplankton	2684	1320	649	1716
Simpson Diversity Index	0.792	0.724	0.733	0.712
Simpson Dominance Index	0.208	0.276	0.267	0.288
Zooplankton				
Abundance of Zooplankton	209	319	1320	462
Simpson Diversity Index	0.588	0.739	0.693	0.752
Simpson Dominance Index	0.412	0.261	0.307	0.248
Total Plankton				
Total Plankton	2893	1639	1969	2178
Simpson Diversity Index	0.820	0.809	0.831	0.808
Simpson Dominance Index	0.180	0.191	0.169	0.192

*MA : Karst
Chu : Cibukur River (upper)
Chi : Cibukur River (lower)
CB : Cibodas River

3.3. Water Quality

Water quality which includes temperature, pH, and dissolved oxygen content (DO) in study sites is generally in a good range to support plankton productivity (Table 4). The constraints that must be anticipated are the value of transparency can change due to activities of surrounding population, plus shallow river flow due to the dry season with flowrate values ranging between 0.9-2 L / s. The debit value also tends to fluctuate in rainy season.

Table 4. Water quality at study site

No	Location	Temperature (^oC)	pH	DO (mg /L)	Conductivity	Tranparency	Flowrate (L/s)
1	MA	26.2	6.8	5.2	0.531	Shallow	0.9
2	CHu	26.3	7.59	6.2	0.471	Shallow	0.9
3	CHi	30.6	7.48	4.2	0.465	Shallow	0.9
4	CB	31.4	7.69	6.7	0.427	Shallow	2

4. Conclusion

The water body (river) located in the Masigit-Pawon Karst Region has a high potential for plankton biological resources. A total of 24 types of phytoplankton are divided into 9 class, and 16 types of zooplankton divided into 8 class has been identified from water samples taken from four observation stations. The most abundant types of plankton are Navicula sp (5,280 individuals), *Synedra* sp (4,092 individuals), and *Cyclops* sp (2,904 individuals).

In general, the value of Diversity at four observation stations is close to 1 (maximum score), which indicates that the plankton community (including phytoplankton and zooplankton communities) in study sites has a high diversity. Whereas, the dominance index value close to 0. This condition indicates that the community is in a balanced condition, and there is no dominance by one particular type. Except for Station 1, the Diversity Index of Zooplankton value only 0.588. The highest abundance of phytoplankton is in Station 1, while zooplankton is the most abundant in Station 3. Low abundance of phytoplankton at Station 3 affected by the density of plant covering area around the water body cause decrease light penetration to water.

Acknowledgements

This research have funded by Directorate of Research and Community Development (DRPMI), Padjadjaran University for young researcher and also supported by Center for Environment and Sustainability Science, Padjadjaran University.

References

Baloly A.B. 2016. Phytoplankton composition and diversity in response to abiotic factors in Lake Buhi, Camarines Sur, Philippines. *Algological 150*. P.21-38.

Brahmantyo, B. 2008. Save for Pawon cave and *the hills of Karst Citatah Rajamandala. BPLHD of Bandung Barat.*

Farashi, A. Kaboli, M. Rezaei, H.R., Naghavi, M.R., Rahimian, H. 2014. Plankton composition and environmental parameters in the habitat of the Iranian cave barb (*Iranian typhlops*) in Iran. *Animal Biodiversity an Conservation* 37-1.

Ferreira-Marinho, Y., Otavio-Brito, L., da Silva, C.V.F., Sobral, I.G., Olivera-Gálvez, A. 2014. *Latin American Journal of Aquatic Research.* 42(3): 427-437.

Howarth, F.G. 1980. The Zoogeography of Spcialized Cave Animals: A Bioclimati c Models. Evolution 34 (2) : 394-406.

Jersabek, C.D., Chabetsberger, R. 1996. Limnological aspects of Alpine Karst Lake with Extreme Changes in Water Level. *Limnologica*. 26(1): 1-13.

Johnson, C.R., O'Brien W.J., Macintyre, S. 2007. Vertical and temporal distribution of two copepod species, *Cyclops scutifer* and *Diaptomus pribilofensis,* in 24 h arctic daylight. *Journal of Plankton Research*. Volume 29: Page 275-289.

Kupe, L., Poci, A., Miho, A.,Hübener. 2010. Microscopic algae from karst lakes of Dumre Region (Central Albania). *Botanica Serbica*. 34(2): 87 – 98.

Magurran, A. E. 1988. *Ecological Biodiversity and Measurement*. London: Chapman and Hall.

Radifa, M. 2015. *Struktur Komunitas Plankton di Perairan Cekungan Karst Cileungsi, Kabupaten Bogor, Jawa Barat*. [Skripsi]. Institut Pertanian Bogor.

Rahmadi, C., Y.R. Suhardjono, J. Subagja. 2002. Komunitas Collembola Guano Kelelawar Gua Lawa Nuskambangan, Jawa Tengah. Biologi 2(14): pp. 861-875.

Smith, R. L., Thomas M. Smith, 2000. *Elements of Ecology*. San Fransisco: Benjamin/Cummings Science Publishing.

Soedarti, T., Jayanti Aristiana., Agoes Soegianto. 2006. ”Diversitas Fitoplankton pada Ekosistem Perairan Waduk Sutami, Malang”. *Berk. Penel. Hayati* 11:97-103.

Stanković, I., Ternjej, I., Mihaljević, Z., Furač, L., Kerovec M. 2011. Crustacean plankton community (Crustacea: Copepoda and Cladocera) in gypsum lakes and their rellation to abiotic parameters. *Hydrobiologia*. 666: 145-153.

Udovic, M.G. 2017. Defining centric diatoms of most relevant phytoplankton functional groups in deep karst lakes. *Hydrobiologia*. 788: 169 – 191.