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Analysis of Gastropod Diversity as a Bioindicator of Waters in Situ Ciburuy Padalarang, West Bandung Regency, West Java, Indonesia

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Authors' contributions

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

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ABSTRACT

This study conducted to determine the water quality of Situ Ciburuy based on the structure of the gastropod community as a bioindicator. The survey method used in this study based on collecting data directly at the research area (purpose sampling method). For instance, species and density of gastropods were descriptively analyzed, using diversity index and evenes index. For instance, The findings showed that level of water quality in Situ Ciburuy based on gastropods bioindicators was lightly polluted. That is indicated by the low to moderate diversity of gastropods, which ranges from 1.31-1.98. The Shannon evenness index (0,73-0.95) revealed low gastropod species diversity in Situ Ciburuy, indicating low evenness of gastropod in Situ Ciburuy.

Keywords: Water quality; Situ Ciburuy; gastropods.

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1. INTRODUCTION

Situ Ciburuy is inland water in Padalarang, West Java. Situ Ciburuy is used to irrigate rice fields, water storage during the dry season, and education and research.

Aquatic organisms live in the lake ecosystem, one of which is Mollusks. Mollusks are a phylum of invertebrates that have a soft and unsegmented body. Most of the species are protected by a shell. Mollusc species are widely distributed inland, marine, and brackish waters. Phylum Molluscs that exist in the waters are Gastropods, Bivalves, and Cephalopods. Gastropods and bivalves are found in fresh and marine waters.

In comparison, cephalopods are found in the sea and brackish waters. Gastropods are often found in a profundal zone; some immerse themselves in sediments, some can be found attached to rocks. Gastropod habitat varies, from very close to the water's surface to far from the surface of the water. The distribution of animals is based on two factors. First, the food factor is that animals that tend to live in an area of gastropods can quickly get food. The second factor is the barrier factor. Barriers significantly affect the distribution of a population because these barriers will hinder the survival of individuals or even the population [1].

Gastropods are widely studied as water bioindicators. The bioindicator can determine the quality of water in the lake. Information about the quality of water is vital to know the pollution that occurs in water bodies. Therefore it will be essential to research gastropods in Situ Ciburuy to determine the level of corruption in the area to make plans to overcome pollution.

2. METHODOLOGY

2.1 Research Sites

This research was conducted from January 28 to March 2, 2021, at Situ Ciburuy Kabupaten, Bandung Barat, West Java. Gastropod identification and water quality parameters were tested at the Laboratory of Aquatic Resources Management, Faculty of Fisheries and Marine iences, Padjadjaran University.

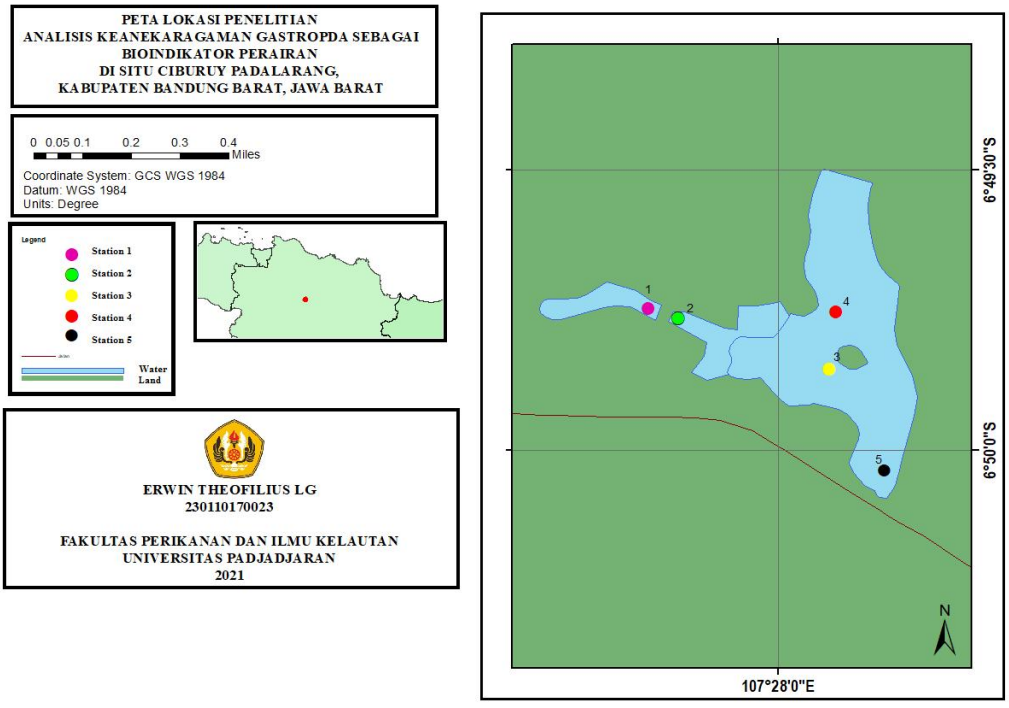

Fig. 1. Map of research location

3. MATERIALS AND METHODS

The research method conducted in this study is to use the survey method by sampling in situ Ciburuy in the form of purposive sampling. Selection is made at 5 points of the station as many as four times repetition. The data needed is primary data in gastropods community structure and water quality, including physical parameters, namely temperature, turbidity while chemical parameters include pH, DO, and BOD. Materials (gastropods samples, water samples, formaldehyde 4%, substrate samples, $MnSO_4$, H_2SO_4, Sodium thiosulfate, and O2 reagent) and tools (Ekman grab, net surber, sieve, cool box, magnifying glass, plastic container, 500 ml sample bottle, pH meter, Dissolved Oxygonometer, rowing boat.

3.1 Methods and Data Analysis

The parameters measured include the main parameters, namely gastropods and supporting parameters, namely physical parameters in the form of temperature, turbidity, and chemical parameters pH, DO, and BOD.

3.1.1 Density

To calculate the density of species, take samples in the field and count the number of stands.

Calculation of density using the formula [2] :

$$K = \frac{a}{b \times n}$$

Information:
K = Density of species (number of individuals/m^2);
a = Number of individual stands of the ith species
b = Area of sampling area (m2)
n = total number of sampling

3.1.2 Divesity

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

H' = species diversity index
Pi = ni/N
Ni = number of individuals for each type i
N = total number of individuals

The diversity of an aquatic biota can be determined using the Shannon – Wiener (H') information theory [2]. The primary purpose of this theory is to measure the level of order and disorder in a system.

Table 1. Categories of diversity

Diversity Indeks	Criteria
H' ≤ 1,0	Low
1,0 < H' ≤ 3,0	Medium
H' ≥ 3,0	High

3.1.3 Evenness

$$E = H' / Hmax$$

E = evennes index
H' = diversity index
Hmax = log 2 x (S)
S = number of types

H'max will occur when found in an atmosphere where all species are abundant. Meanwhile, the value of E ranges between 0 and 1. The value of 1 describes a situation where all species are relatively plentiful.

Table 2. Categories of evenness index values

Evenness Index	Criteria
0,0 < E ≤ 0,50	Stressed
0,50 < E ≤ 0,75	Less Stable
0,75 < E ≤ 1,00	Stable

4. RESULTS AND DISCUSSION

Analysis of chemical and physical data to determine the level of water pollution in Situ Ciburuy is quantitative descriptive data analysis. Quantitative data is data related to numbers, either obtained from the results of measurements or calculations. In contrast, quantitative descriptive data is data obtained from a sample of the research population analyzed using the Diversity and Evenness Index formulas and then interpreted.

4.1 Water Physical and Chemical Parameters

4.1.1 Temperature

At the sampling location, the temperature ranged from 25.7-26.2 °C. At stations 2-5, it had a temperature value of 26.2 °C, while at station one, it was around 25.7 °C., at station one, the temperature is slightly lower because it has the deepest depth.

4.1.2 Turbidity

Turbidity will measure the number of particles in the water with the help of light. The relationship between turbidity and gastropods is that gastropods are filter feeders Low turbidity at station 1 is influenced by depth. The deepest depth at station 1 causes sedimentation and waste carried into the waters at the bottom of the water so that there is less sedimentation on the surface Turbidity is influenced by suspended particles that enter the water. These particles can be caused by sedimentation and waste carried into the waters.

4.1.3 Dissolved Oxygen (DO)

Dissolved Oxygen DO oxygen contained in the waters, gastropods need oxygen to carry out respiration in the body, so oxygen in the waters needs to be measured. Fig 4 shows that DO ranges from 6.3-70, the highest DO value is at station 4, and the lowest is at station 4. The DO value at each station does not have a very significant difference. According to Sastrawijaya (1991), gastropod life can survive with minimum dissolved oxygen of 5 mg/l. Low oxygen will make it difficult for gastropods to breathe.

4.1.4 Biochemical Oxygen Demand (*BOD*)

In the measurement results, the highest BOD value is at station 1, and the lowest is at station 5. According to the statement [3] the DO value will be negatively correlated with the BOD value. As shown in the graph, when the DO value is low, the BOD value will be high.

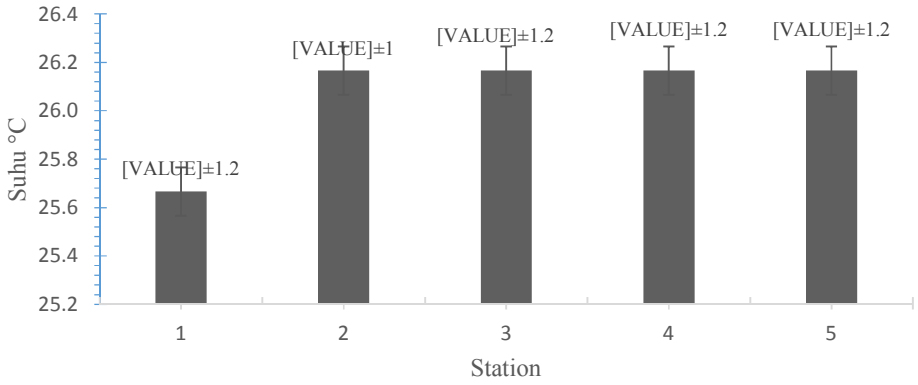

Fig. 2. Average temperatures in Situ Ciburuy

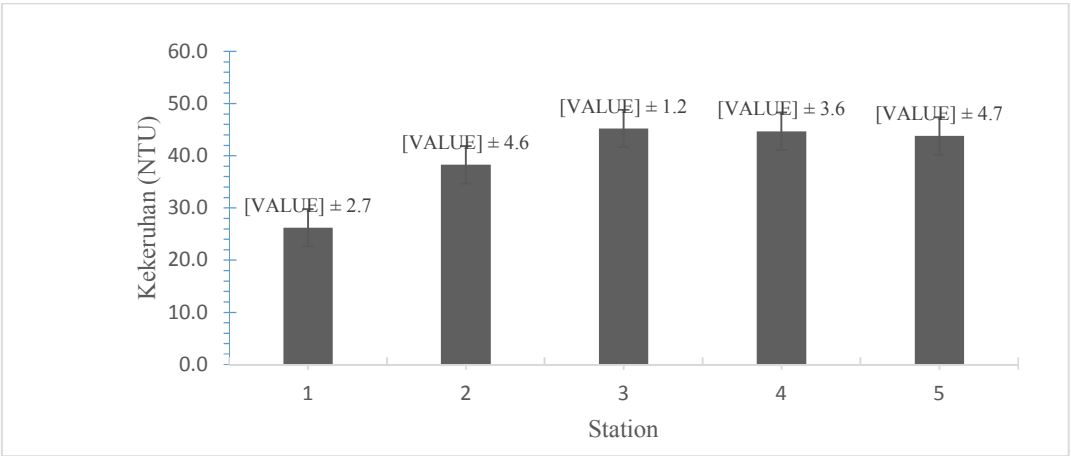

Fig. 3. Turbidity in Ciburuy Situ

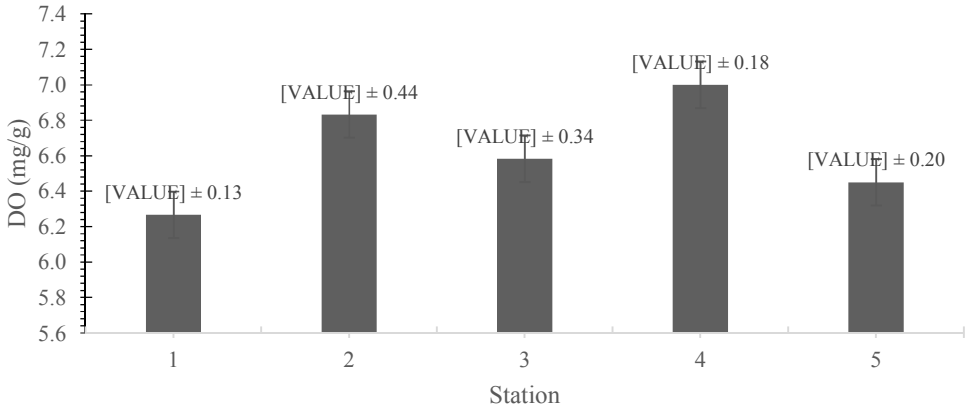

Fig. 4. DO in Situ Ciburuy

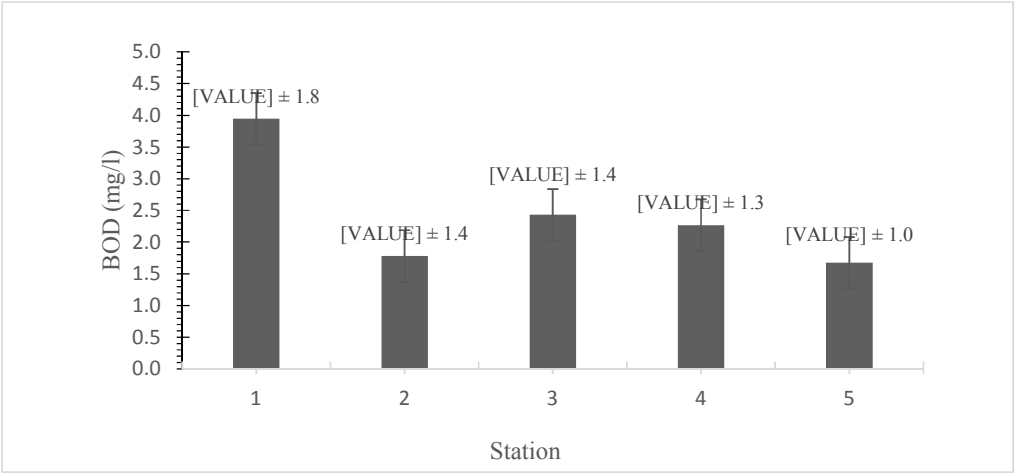

Fig. 5. BOD in Situ Ciburuy

4.1.5 Acidity

The degree of acidity or pH can be a limiting factor for gastropod life [4]. pH can affect the type and availability of nutrients and the toxicity of trace elements that can affect the life of gastropods.

The lowest pH value is at station 1 and the highest is at station 3. The pH value at Situ Ciburuy shows the normal range at stations 2-5 and follows the statement of Odum [2] that the pH value is between 6.5 - 8.0 as a safe limit for the pH of the waters for the life of the biota in it. The cause of the low pH at station 1 is influenced by several factors, including the photosynthetic activity of aquatic organisms. Oxygen consumption in the waters.

Purnomo et al. [5] mention that every aquatic organism has a different tolerance to pH values. In general, gastropods live in the pH range of 5-8.

4.2 Substrate Physical and Chemical Parameters

The base substrate is one of the significant environmental factors affecting the structure of the gastropod community [6]. The primary substrate is a vital component for the life of an organism. According to Yunita et al. [7] Substrate characteristics can affect the structure of the gastropod community.

Gastropods are animals from the mollusk species that live in the type of substrate from

coarse to fine. If the substrate changes, the structure of the gastropod community will change. Sediment's physical condition (type of substrate) and chemical (C-organic content, N-total) concerning the gastropod community's structure is fundamental because sediment is a habitat for these gastropod.

There are 3 different types of substrate texture at each station. Stations I and 5 have a dusty clay texture. At station 2, it is clay, and at stations 3 and 4, it is clay. The number of individual gastropods in Situ Ciburuy mostly live on clay substrate types. According to Riniatsih & Kushartono [8] gastropods are more commonly found in waters with a clay bottom substrate. This type of clay substrate has few barriers that gastropods can move easily.

The pH value of the substrate tends to be neutral, ranging from 7.06 to 7.45. The pH value is not significantly different. In general, gastropods can live in the pH range of 5-8. The highest organic C-value was at station 2 of 4.55% and the lowest was at station 3 of 0.75%. The value of C-organic is the determining factor of growth in the substrate. The value of C-Organic is low because <5% [9].

The highest N-Total value is at station 2 of 0.6% and the lowest is at stations 3 and 4 of 0.11%. The N-Total score of station 2 according to Anjani et al. [9] N-Total 0.5-0.75%, including the high category.

The most significant C/N ratio at station 1 was 17, and the lowest at station 2 was 7. The C/N ratio at station 1 had a higher value than other stations, indicating bacteria's low decomposition of organic matter. According to Purnomo et al. [5], the decomposition process of organic compounds indicates the fertility of the waters. It is related to natural food, which is a source of food for gastropods.

Changes in the total N content will affect the C/N ratio. At the same time, the total N-level will increase so that the C/N ratio will decrease. The higher the total N content formed, the lower the C/N ratio [10].

4.3 Gastropod Composition and Density

Gastropod organisms were collected at each station using an Eckman grab. Table 4 shows that the most gastropod species is found at station 2, and the lowest was at station 3. In the gastropod collection, there were 7 species, and the highest species divesity was *Pomacea* canaliculata. High quantity show that it can tolerate the environment to survive.

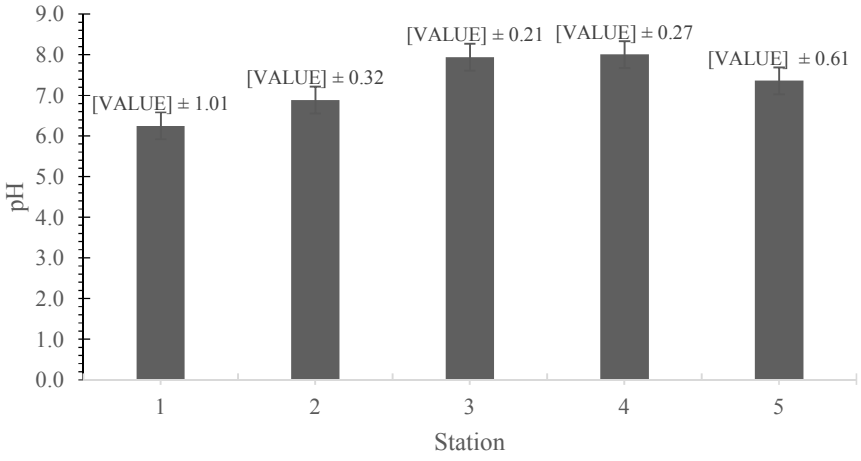

Fig. 6. pH in Situ Ciburuy

Table 3. Measurement of substrate physical and chemical parameters in Ciburuy Situ

No.	Parameter	Unit	Station				
			1	2	3	4	5
1.	Texture	-	Dusty clay	Clay clay	clay	clay	Clay clay dusty
2.	substrate pH	-	7.44	7.24	7.45	7.36	7.06
3.	C-Organic	%	2.97	0.75	4.55	1.57	3.28
4.	N-total	%	0.17	0.11	0.60	0.11	0.22
5.	C/N ratio	-	17	7	8	14	15

Table 4. The composition and divesity of gastropods in Ciburuy Situ

Type	Divesity of Each Station (ind/m2)				
	1	2	3	4	5
Pomacea canaliculata	7	17	25	29	20
Pila ampullacea	1	8	11	5	4
Terebiagranifera	1	6	0	0	1
Thiarascabra	0	18	0	2	4
Thiaragranifera	0	13	1	0	0
Filopaludinajavanicus	4	8	33	16	43
Melanoidestuberculata	0	21	10	8	12
Melanoidesplicaria	0	7	0	7	0
Lymnearubiginosa	0	0	1	3	0
Total	13	98	81	70	84

Table 5. Diversity and evenness index value

Index	Station				
	1	2	3	4	5
Diversity (H')	0.79	1.39	1.17	1.00	1.06
Evenness (E)	0.67	0.78	0.74	0.65	0.69

Table 5 shows the highest divesity at station 2 and the lowest at station 1. The small distribution at station 1 can be influenced by physical and chemical factors that are less tolerant of gastropods. Intense water conditions at station 1 have an effect because gastropods tend to live in shallow waters, then high C/N values so that the decomposition process of organic matter is low so that little natural feed is produced. The temperature value of 25.2°C at station 1 shows that gastropods are still within tolerance to survive.

Fig. 7 is the percentage of gastropod composition in Situ Ciburuy.

4.4 Gastropod Diversity and Evenness

Calculating the value of gastropod diversity in Situ Ciburuy using the Shanon-Weiner diversity index in Table 5 Diversity.

The highest diversity is at station 2, with an H' value of 1.98. The lowest is at station 5, with a value of 1.31. Station 5 has the highest abundance value, but the most species are Pomacea canaliculata and Filopaludina javanicus. At station 2, the one with the highest H' value has a more diverse composition compared to other stations so that many gastropod species at station 2 are tolerant of these environmental conditions.

In Fig. 10, evenness values range from 0.72 to 0.95, and the most stable evenness values in station 2 show that species evenness is not dominant of one species compared to another. According to Odum [2], the greater value of E is equal or almost the same. Conversely, the smaller the value of E, the less evenness population, meaning that the spread of the number of individuals of each species is not the same, and there is a tendency for a species to dominate the population. As in station 5, which has the lowest evenness of 0.73 when viewed from the composition and abundance of Pomacea canaliculata, Filopaludina javanicus dominates the region [11-12].

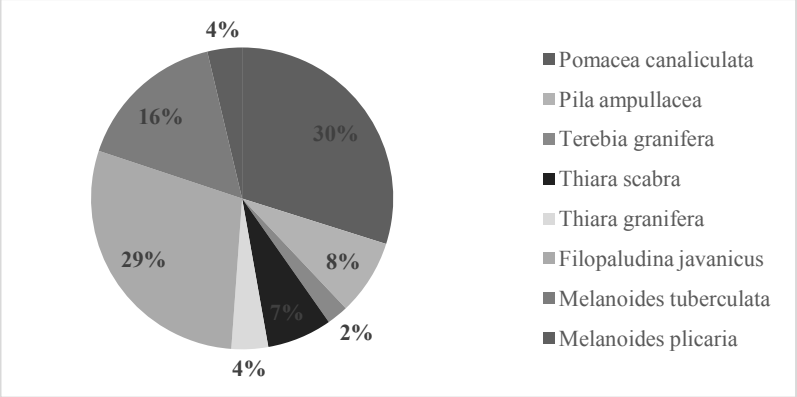

Fig. 7. Gastropod composition in Ciburuy Situ

Fig. 8. Gastropods found in Ciburuy Lake

Description: (a) Pila ampullaceal (b)Tarebia granifera (c) Pomacea canaliculata (d) Filopaludina javanica, (e) Melanoidesplicaria, (f) Thiara granifera, (g) Lymnea rubiginosa (h) Melanoides tuberculata (i) Thiara scabra

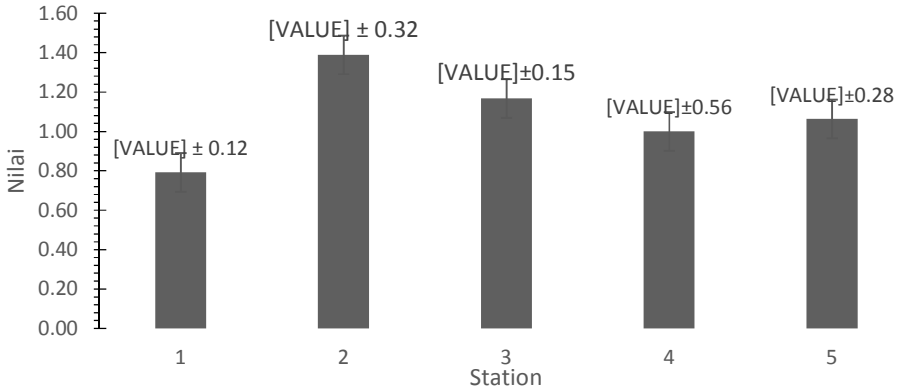

Fig. 9. Diversity chart in Ciburuy Situ

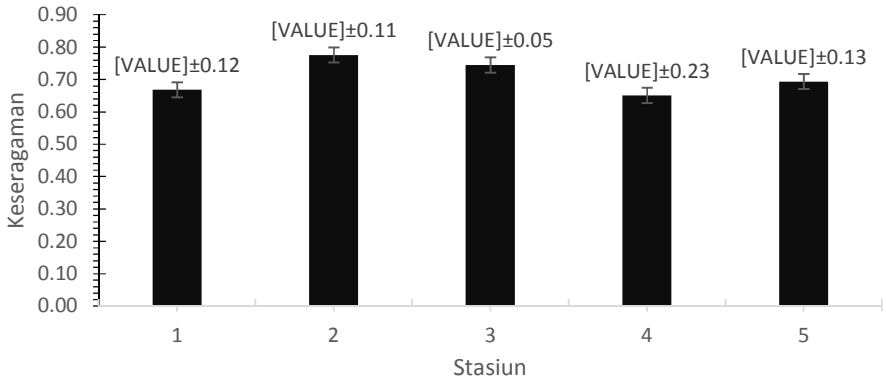

Fig. 10. Evennes graphics in Ciburuy situ

The diversity index and evenness index results showed that the species Pomacea canaliculata, Filopaludina javanicus and Lymnea rubiginosa are bioindicators of pollution. Pomacea canaliculata, Filopaludina javanicus has the highest abundance at each station, citing that the species can be found in a temperate environment, while Lymnea rubiginosa can only adapt at some stations indicating less tolerance with the environment [13-14].

5. CONCLUSION

The level of water pollution situ Ciburuy based on the value of the diversity index, uniformity index, and composition of Pomacea canaliculata and Filopaludina javanicus has the highest abundance then Situ Ciburuy is included in the category of moderately polluted waters.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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