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The diversity of gastropoda in meru betiri national park

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TABLE OF CONTENT

Student worksheet based on inquiry with vee map to improve writing skills in physics learning
T R D Kusumawati, Supeno and A D Lesmono

Analysis metacognitive skills of junior high school students on nervous system material with different academic skills
E Jakiyah, Suratno and J Waluyo

Student worksheet based on inquiry with vee map to improve students' scientific reasoning ability in physics learning in senior high school
S N Indahsari, Supeno and Maryani

Design of assessment based on guided discovery to improve the quality of teachers' professionalism of mathematics
F A Hidajat and B I Hidajat

An analysis of students' written mathematical communication in learning limits of functions through dependent field and independent field cognitive style at the eleventh grade of SMAN 1 Surakarta
S N Hayati, P Sujatmiko and I Kurniawati

The development of ecosystem education game based on Baluran National Park for senior high school
D Alvionita, W Subchan and M Iqbal

Mathematics interactive CD media based on discovery learning on congruence material and its effect on the students' generalization thinking skills.
A Widiatsih, I Baehaqi and D Ariyanto

Shifting of perfective metacognitive activities in solve math problems
I D Hastuti, Surahmat, Sutarto and Dafik

The development of think together about science in society (TToSS) learning model to increase critical thinking skill in science lesson
O Yuwentin, I K Mahardika, Nuriman, A A I A R Sudiatmika and I W Sugiartana

The correlation regression equations between metacognitive skills and concept gaining of science and biology of Indonesian students
B H Siswati and A D Corebima

Students' creative thinking skills in solving mathematical logic problem with open-ended approaches
M Kholil

The analysis of metacognitive skills and creative thinking skills in STEM education at senior high school for biotechnology
Kustiana, Suratno and D Wahyuni

Integrating GeoGebra into geometry space learning: a lesson from traditional cultural festival *tumpeng sewu*
L N Safrida, T B Setiawan, Susanto, E Yudianto, R Ambarwati and I W S Putri

Analysis of students critical thinking skills in junior high school on natural sciences based on the difference of learning styles
M Aini, Suratno and I N Asyiah

The profile of students' mathematical representation in constructing line equation concept
O C F Mulyono, Sunardi and Slamin

Anxiety: how was the process of the undergraduate students who were in visualization level in constructing the definition?
R C Purnomo, Sunardi, N Yuliati, E Yudianto, M Mahfut and C Sa'dijah

Error analysis of undergraduate students in solving problems on ring theory
N Fatmiyati, Triyanto and L Fitriana

The analysis of metacognitive in biology lesson to senior high school students with different learning interest
R J Riftana, Suratno and D Wahyuni

The analysis of students metacognitive in science with different learning environments on junior high school
N N Musyafaah, Suratno and Nuriman

The anxiety of students on deduction level in proving the geometry theorem
K Ni'mah, Susanto, Sunardi and Hobri

Creative thinking level of visual-spatial students on geometry HOTS problems
A N Aini, M Mukhlis, A M Annizar, M H D Jakaria and D D Septiadi

Analyzing types of interaction in nuclear magnetic spectroscopy online discussion forums that affects student learning outcomes
I W A Terra, S Wonorahardjo and S Suharti

Teachers' belief toward science and local wisdom's integration in mathematics instruction
A A Jingga and I Sujadi

Validity of physical learning module based on multiple representation and higher order thinking skills
I K Mahardika, I G Rasagama, L Indrianto, A Doyan and Supeno

The analysis of students' critical problem solving on circle-related questions using pesantren-based scientific approach
A Kriswanto, Susanto and M Irvan

Students' error analysis in solving geometry problems based on the mathematical anxiety under the theory of van hiele
A K Dewi, Sunardi, M Irvan, Hobri and F N Rohmah

An analysis of the students' anxiety in solving creative thinking problem on geometry according to van hiele's theory
F N Rohmah, Sunardi, M Irvan, Hobri and A K Dewi

Student profile in constructing concept of exponential through the problem posing
H Cahyohadi, Sunardi and M Irfan

Deduction level of undergraduate students' imagination in solving geometrical problem
M Mahfut, Sunardi, E Yudianto, R C Purnomo and F F Firmansyah

The students' perception of the teacher's apperception and its influence on students' initial knowledge
P R Musthofa and I Sujadi

The profile of student's creative thinking skills in mathematics problem solving in terms of adversity quotient
Nahrowi, Susanto and Hobri

The analysis of learning materials implementation using inquiry based learning method to enhance student's critical thinking skills in solving two dimensional problem
A M Y Wijaya, Hobri, T D Prastiti, Dafik and Suratno

Students' combinatorial generalization thinking skills in solving tessellation coloring pattern problems and its enhancement through problem-based learning
M Anwarudin, Dafik and M I Farisi

Cognitive description of students in mathematics learning through lesson study
H A Susanto, D Hidajat, Hobri and D D H Jatmiko
Open abstract, Cognitive description of students in mathematics learning through lesson study View article, Cognitive description of students in mathematics learning through lesson study PDF, Cognitive description of students in mathematics learning through lesson study

The diversity of gastropoda in meru betiri national park

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Abstract: National Park plays important role in maintaining natural ecosystems such as freshwater ecosystems. Meru Betiri National Park is loacted in southern East Java, it covers two regencies, Banyuwangi and Jember. A recent survey was carried out in two resorts, Bandealit and Andongrejo, to study the diversity of freshwater gastropoda. We had collected 86 specimens which consisted of five families, seven genera, and nine species. Seven species were found from Andongrejo and four species were found from Bandealit. River in the Bandealit primary forest area had the highest diversity with four species. The relations between diversity and environmental conditions will be discussed briefly in this paper.

1. Introduction

Biodiversity covers all variety of ecosystems, species, and genes of plant, animal, and microorganism [1]. An ecosystem consists of biological communities and their associations with the physical environment. The diversity of ecosystems can be divided into two types, namely terrestrial ecosystems and aquatic ecosystems [2]. The Indonesian government set many national parks to protect and maintain its biodiversity.

Aquatic ecosystems are consist of three main categories, namely freshwater ecosystems, estuarine ecosystems, and marine ecosystems [3]. Litoral zones of the freshwater ecosystem are rich in benthic animal diversity. Benthic organisms are live on the substrate, have limited movement, and tend to experience pressure if their habitat is disturbed. Gastropoda is a benthic animal that can be found in the littoral zone [4].The first section in your paper.

Gastropoda is the largest class of Molluscan phyla [5]. The number of Gastropod species in the world is around 181,525, while in Indonesia is around 4,000 [6]. Molluscs are cosmopolite that have a wide distribution and highly adaptive to many varieties of habitats and environmental conditions [7]. Gastropods are found on every continent except Antarctica and almost all aquatic habitats including rivers, lakes, swamps, underground aquifers, and springs as well as ponds, drainages and seasonal waters [8]. Gastropods are live in the river by sticking, burying on the substrate and bottom waters that have sedentary properties [9].

Meru Betiri National Park is located in southern East Java covering Banyuwangi and Jember regencies. Many rivers or small streams are found inside this national park. The information about aquatic fauna is still scarce. Only 13 species of Perciformes fishes are known so far [10], while there is no available data on the diversity of aquatic Gastropods. We carried out a field trip to Meru Betiri National Park to study the diversity of freshwater Gastropoda as well as their population.

2. Sampling stations and methods

2.1 Sampling points

This study was conducted in Bandealit and Andongrejo Resort, Meru Betiri National Park in March 2019. The sampling was carried out from 07:00 until 16:00 WIB. The sampling locations are as follow:

- Location 1: River in the Andongrejo settlement area with rocky and sandy bottom.
- Location 2: River in the Andongrejo secondary forest area with rocky and muddy bottom.
- Location 3: River in the Andongrejo primary forest area with rocky and muddy bottom.
- Location 4: River in the Bandealit primary forest area with rocky, sandy, and muddy bottom.
- Location 5: River in the Bandealit secondary forest area with rocky, sandy, and muddy bottom.
- Location 6: River in the Bandealit settlement area with rocky, sandy, and muddy bottom.
- Location 7: River in the Bandealit monoculture forest area with rocky and muddy bottom.
- Location 8: River in the Bandealit coastal forest area 1 with muddy bottom.
- Location 9: River in the Bandealit coastal forest area 2 with leaf litter and muddy bottom.

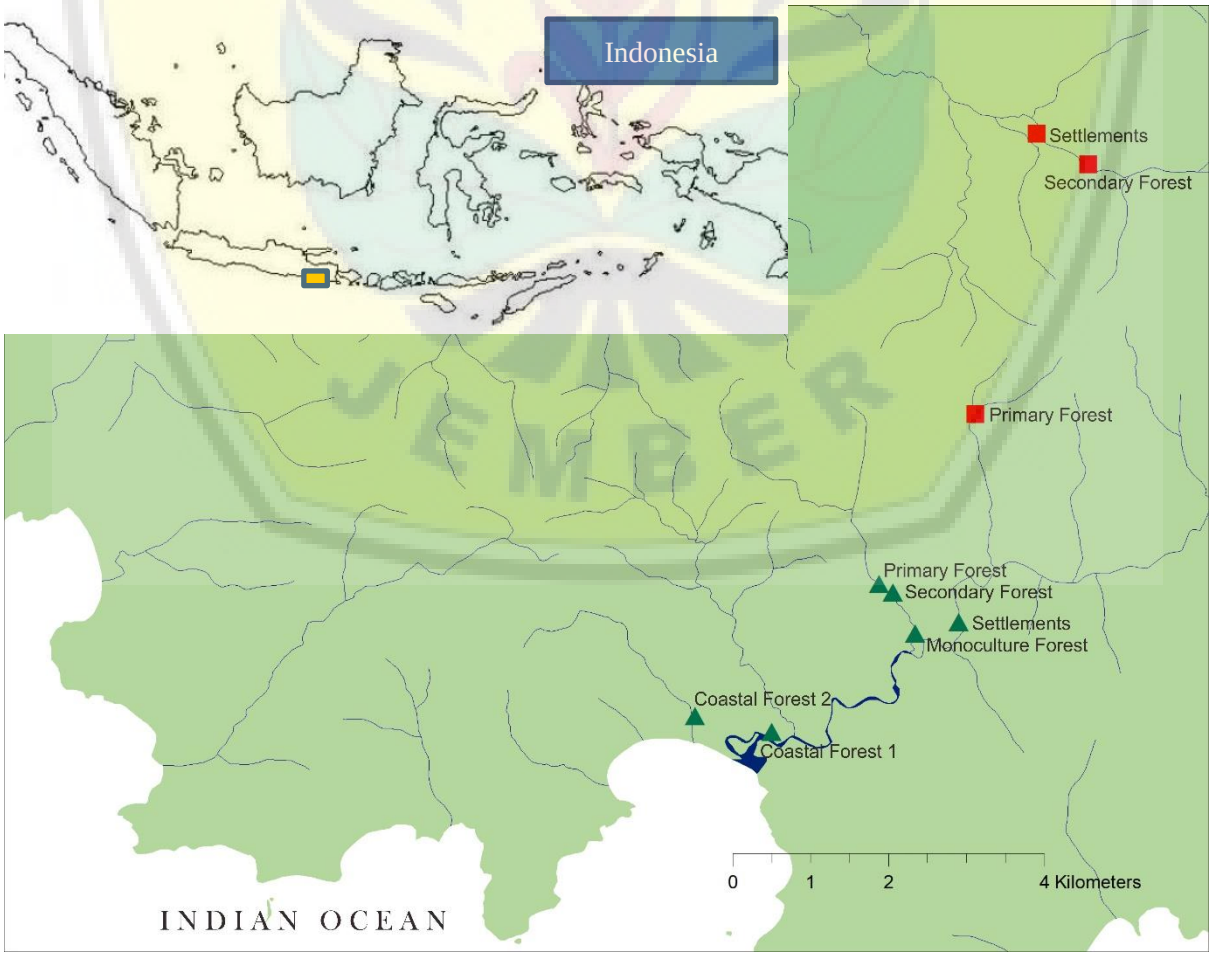

Figure 1. Sampling Points.

2.2 Sampling Techniques

We classified the rivers into five types based on their location and forest vegetation: rivers in settlement area, rivers in coastal forest, rivers in monoculture forest, rivers in primary forest, and rivers in secondary forest. 200 meters transect was set in each river's type to collect the Gastropod specimens [11]. Gastropods attached in the rocks were taken directly by hand, while gastropods buried in the substrate were collected with a small shovel by digging at 10 cm depth. Specimens were put in plastic bags and labeled using tracing paper.

2.3 Gastropod Identification

Gastropod specimens were photographed using DSLR camera. We sent the specimens to Museum Zoology Bogor (MZB) to be identified following Dharma, 1988 and 1992 [5].

2.4 Calculation of Diversity Index

Species diversity index were calculated using the Shannon-Wiener formula [12]. The formula was as follow:

$$H' = -\sum pi \ln pi \, , pi = \frac{ni}{N}$$

Note:

ni : The number of individuals for the species observed
N : Total number of individuals
H' : Shannon-Wiener diversity index

Criteria for diversity index (H ') are as follow:

H' < 1 : Low diversity
1 < H' ≤ 3 : Medium diversity
H' > 3 : High diversity

3. Result

We had collected 86 specimens of freshwater Gastropoda from Andongrejo and Bandealit resort in Meru Betiri National Park which consisted of five families, seven genera, and nine species. However, the species composition from both locations were not equal. Seven species were found from Andongrejo, while only four were found from Bandealit. Two species (*Neritina variegata* and *Sulcospira testudinaria*) were found from both locations (Table 1).

Table 1. Gastropod species identified from Andongrejo and Bandealit resorts

Family	Spesies	Andongrejo	Bandealit	Location
Neritidae	*Clithon bicolor* Récluz, 1843		+	6, 7
	Neritina variegata Lesson, 1831	+	+	3, 4, 9
	Neritina pulligera Linnaeus, 1767		+	4, 7
	Neritina turrita Gmelin, 1791		+	8
	Septaria cumingiana Récluz, 1843		+	4
Pachychilidae	*Sulcospira testudinaria* Von dem Busch, 1842	+	+	2, 4, 5, 8
Potamididae	*Cerithidea cingulata* Gmelin, 1791		+	8
Thiaridae	*Thiara scabra* O. F. Muller, 1774	+		2
Ampullariidae	*Pomacea canaliculata* Lamarck, 1822	+		1

The description of each Gastropod species found are as follows.

3.1 Clithon bicolor (Récluz, 1843)

The shell is thick and dextral with rounded aperture. Dorsal surface is black, while innerlip and outerlip are blackish brown. Apex is low and eroded. Shell length 2.2 cm and width 1.6 cm.

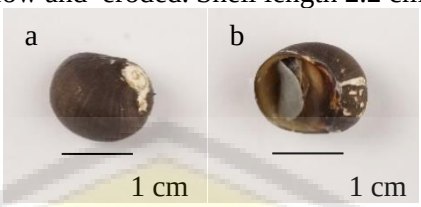

Figure 2. *Clithon bicolor* dorsal (a) ventral (b).

3.2 Neritina variegata (Lesson, 1831)

The shell is thick and dextral with rounded aperture. Dorsal surface with black patches, while innerlip and outerlip are white. Apex is conical and eroded. Shell length 1.6 cm and width 1.2 cm.

Figure 3. *Neritina variegata* dorsal (a) ventral (b).

3.3 Neritina pulligera (Linnaeus, 1767)

The shell is thick and dextral with rounded aperture. Dorsal surface is brownish black, innerlip is orange, and outerlip is shinny purple. Apex is low. Shell length 2.7 cm and width 2.1 cm.

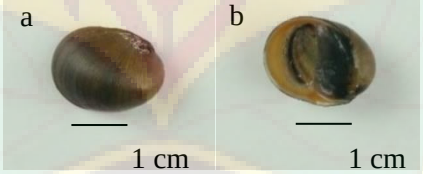

Figure 4. *Neritina pulligera dorsal* (a) *ventral* (b).

3.4 Neritina turrita (Gmelin, 1791)

The shell is thick and dextral with rounded aperture. Dorsal surface is yellowish brown with vertical black stripes. Innerlip is white and outerlip is orange. Apex is highly conical. Shell length 2.6 cm and width 1.6 cm.

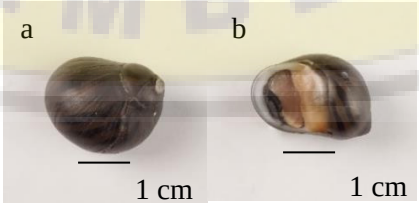

Figure 5. *Neritina turrita* dorsal (a) ventral (b).

3.5 Septaria cumingiana (Récluz, 1843)

The shell is thin with rounded aperture. Dorsal surface is yellowish-brown with numerous triangle pattern. Innerlip and outerlip are white. Apex is small, conical and eroded. Shell length 1.6 cm and width 1.4 cm.

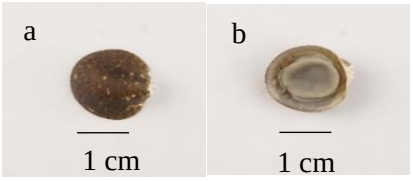

Figure 6. *Septaria cumingiana* dorsal (a) ventral (b).

3.6 Sulcospira testudinaria (Von dem Busch, 1842)
Sulcospira testudinaria is only found in Bandealit primary forests located in rivers with large rocky substrates, sandy, and landed, Bandealit secondary forests located in rivers with large, sandy, landed rocky substrates, 1 Bandealit coastal forests in rivers with muddy substrates, Andongrejo secondary forest which is in a river with a large rocky substrate, gravel and land. *Sulcospira testudinaria* has a thick, black shell surface on the dorsal and ventral parts. Has a white aperture and black outerlip. Apex in this type is hollow. This species has a shell length of about 6.4 cm and a shell width of about 1.7 cm.

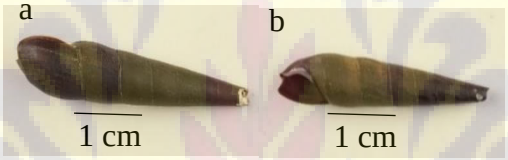

Figure 7. *Sulcospira testudinaria* dorsal (a) ventral (b).

3.7 Cerithidea cingulata (Gmelin, 1791)
Cerithidea cingulata is only found in 1 Bandealit coastal forest which is in a river with a muddy substrate. *Cerithidea cingulata* has a fluted rough shell surface, white in the dorsal region while in the ventral light brown. The innerlip and outerlip parts are yellow with brown stripes. Apex in this type is blunt. This species has a shell length of about 2.8 cm and a shell width of 1.2 cm

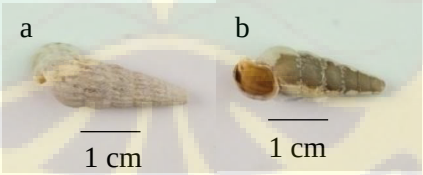

Figure 8. *Cerithidea cingulata* dorsal (a) ventral (b).

3.8 *Pomacea canaliculata* (Lamarck, 1822)
Pomacea canaliculata is only found in the Andongrejo settlement habitat which is in a river with a large rocky and sandy substrate. *Pomacea canaliculata* has a thin, brownish-yellow surface on the dorsal and ventral parts. Has a yellow aperture. The innerlip and outerlip parts are yellow. Apex in this type is pointed. Round dextral shell. This species has a shell length of about 2.9 cm and a shell width of about 2.2 cm.

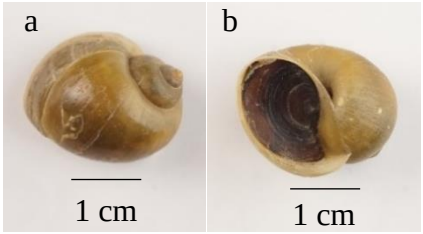

Figure 9. *Pomacea canaliculata* dorsal (a) ventral (b).

3.9 *Thiara scabra* (O. F. Muller, 1774)

Thiara scabra is only found in rivers Andongrejo secondary forest habitat which is in rivers with large rocky substrates, gravel, and land. *Thiara scabra* has a rough, thorny shell surface, blackish yellow on the dorsal part, while the ventral part is black. Has a black aperture. The innerlip and outerlip are brownish yellow. Apex in this type is pointed. Round dextral shell. This species has a shell length of about 1.8 cm and a shell width of about 0.75 cm.

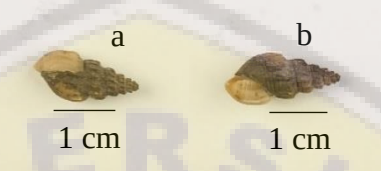

Figure 10. *Thiara scabra* dorsal (a) ventral (b).

3.10 Diversity of Gastropod

Based on calculation data, Gastropod diversity index values obtained at the Bandeali and Andongrejo Resort Meru Betiri National Park are classified as moderate. Diversity index values are calculated using the formula using the Shannon-Wiener diversity index (H '). Data from the calculation of Gastropod diversity in Bandealit can be seen in the following table.

Table 2. Calculation of gastropod diversity in Bandealit Resort

No	Species	Total	pi	n(n-1)/N(N-1)	ln pi	pilnpi	H'
1	*Clithon bicolor*	17	0,265	267,75	-1,325	-0,352	0,352
2	*Neritina variegata*	5	0,078	19,687	-2,549	-0,199	0,199
3	*Neritina pulligera*	10	0,156	88,593	-1,856	-0,290	0,290
4	*Neritina turrita*	4	0,062	11,812	-2,772	-0,173	0,173
5	*Septaria cumingiana*	5	0,078	19,687	-2,549	-0,199	0,199
6	*Sulcospira*	14	0,218	179,156	-1,519	-0,332	0,332
7	*testudinaria* *Cerithidea cigulata*	9	0,140	70,875	-1,961	-0,275	0,275
	Total	64	1	657,562	-14,534	-1,822	1,822

Based on Table 2, the results of the calculation of the diversity index (Shannon wiener) Gastropoda at the Bandealit Resort amounted to 1,822. Next, the calculation of Gastropod diversity in Andongrejo Resort can be seen in the following Table 3.

Table 3. Calculation of Gastropod diversity in Andongrejo Resort

No	Spesies	Total	pi	n(n-1)/N(N-1)	ln pi	pilnpi	H'
1	*Neritina variegata*	4	0,181	11,454	-1,704	-0,309	0,309
2	*Pomacea*	3	0,136	5,727	-1,992	-0,271	0,271
3	*canaliculata*	4	0,181	11,454	-1,704	-0,309	0,309
4	*Sulcospira* *testudinaria* *Thiara scabra*	11	0,5	105	-0,693	-0,346	0,346
	Total	22	1	133,636	-6,096	-1,238	1,238

Based on Table 3, the Gastropod diversity index (Shannon Wiener) calculation at Andongrejo Resort is 1,238. Then it can be said that the results of the Shannon Wiener diversity index analysis

found at the Bandealit and Andongrejo resorts have a moderate diversity index because of less than 2. Each sampling location has different abiotic conditions both in Bandealit and Andongrejo Resorts. The abiotic conditions of each location can be seen in Table 4 below.

3.11 Abiotic Condition of Sampling Location

The abiotic conditions of each location can be seen in Table 4 below.

Table 4. Abiotic conditions of sampling locations

Location	Water velocity (m/s)	Water Temp (ºC)	Water Ph	Depth (m)	Height (masl)	Substrat
1	0,24	27	7,5	0,25	61	Rocky, sandy
2	0,48	27	6,7	0,8	223	Rocky, Pebble, mud
3	0,87	26	7,2	1,2	102	Rocky, sandy, mud
4	0,93	26	7,4	1,3	14	Pebble, mud
5	0,37	26	6,8	0,4	30	Rocky, sandy, mud
6	1,1	25	6,9	1,2	57	Rocky, sandy, mud
7	0,41	26	6,7	1,3	77	Rocky, mud
8	0,79	27	6,9	0,5	18	Mud
9	0,73	26	7,1	1,4	27	Mud, leaf litter

4. Discussion

Measurement of species diversity was calculated using the Shannon-wienner index [12]. The calculation results of diversity index (H ') Gastropoda in Bandealit Resort amounted to 1,822 and in Bandealit Resort amounted to 1,238. Gastropod diversity in both resorts is classified as moderate. This is caused by several factors that support the life of Gastropoda. The high and low diversity index of Gastropods found in Bandealit and Andongrejo Resort rivers is influenced by the ability of Gastropods to adapt to environmental changes in the waters of Bandealit and Andongrejo rivers. Species diversity in an area is influenced by several factors, namely contaminated substrates, availability of food sources, inter and intra-species competition, interference and conditions of the surrounding environment so that species that have a high tolerance will increase while those that have a low tolerance will drop. High or low species diversity depends on the number of species and the evenness of the number of individuals in a community.

According to [11] a community is said to have high species diversity if the community is composed of many species with an abundance of the same or almost the same species. Conversely, if the community is composed of few species and if only a few species are dominant, the species diversity is low. While it is said that high diversity occurs when a community has a high type of interaction. So in a community that has a high diversity of species there will be a type of interaction that involves the transfer of energy (food webs), predation, complex and the division of niches which is theoretically more complex.

Resort Bandealit and Andongrejo Meru Betiri National Park have varying Water velocity of 0.24-1.1 m /s. The Water velocity is moderate to fast, this is because before observing floods occur in the river flow which results in relatively fast flowing currents. According to [13] said that the water velocity ranges from 0.3-0.39 m/s, including the medium category and is still below the threshold for the life of macrobenthos animals. Current velocity will also affect the distribution of sediments which in turn will form the basic substrate which will become a habitat for macrobentos in the waters.

Water temperatures in Resort Bandealit and Andongrejo rivers in each habitat have a range of 25 °C-27 °C. According to [14] water temperature greatly affects the distribution of a species and changes in water temperature can cause abundance, density, biomass, and diversity. The lowest water temperature with a value of 25 °C is in the secondary forest habitat of Bandealit, while the highest

temperature is in the habitat of the Andongrejo settlement, primary forest of Andongrejo, and Bandealit coastal forest 1. This shows that in this temperature range Gastropods are still able to live with water temperatures between 25 °C-27 °C.

Water pH in the Bandealit and Andongrejo Resort rivers has a range between 6.7-7.5. According to [15] said that the ideal pH of freshwater biota is between 6.80-8.50. Very low levels of acidity (pH) can lead to greater solubility of metals in water which is toxic to water orgasm. Data obtained from the study shows that in the Meru Betiri National Park River there are 2 research locations with a water pH of 6.7 in the habitat of the Bandealit monoculture forest and the Andongrejo primary forest. These conditions indicate that Gastropods are still tolerant of water pH 6.7.

Species composition found in all habitat types differ according to the characteristics of the environment including *Clithon bicolor* found in several habitats namely Bandealit Settlement has a water temperature of 26 ° C, river current velocity of 0.93% m/s with a depth of 1.3 meters, and Water pH of 7.4. The condition of substrate soil and small rocks (gravel). Bandealit Secondary Forest has a water temperature of 25 ° C, a river water velocity of 1.1 m/s with a depth of 1.2 meters, and a water pH of 6.9. Condition of large rocky substrates, sandy, and soil. *Clithon bicolor* is a type of snail that has the most extensive distribution, which can be found in 4 of 6 provinces in Java. Banten Province has the highest number of snail species, 10 species, then West Java has 9 species.

Neritina variegata is found in several habitats, namely Bandealit Primary Forest which has a water temperature of 26 ° C, river water velocity of 0.37 m/s with a depth of 0.4 meters, and a water pH of 6.8. Condition of large rocky substrates, sandy, and soil. Bandealit Coastal Forest has a water temperature of 26 °C, river water velocity of 0.73 m/ with a depth of 1.4 meters, and a water pH of 7.1. The condition of the substrate is muddy and hard. Andongrejo Primary Forest has a water temperature of 27 °C, river water flow velocity of 0.48 m/s with a depth of 0.8 meters, and a water pH of 6.7. The condition of large rocky substrates, gravel, and soil. According to [16] said that Gastropoda tends to choose sandy mud substrate because sand is easy to shift and move to other places,

Neritina pulligera is found in the habitat of Bandealit Monoculture Forest which has a water temperature of 26 °C, river water velocity of 0.41 m/s with a depth of 1.3 meters, and a pH meter of 6.7. Condition of large rocky substrates and soil. *Neritina turrita* is found in the habitat of Bandealit Coastal Forest 1 which has a water temperature of 27 °C, river water velocity of 0.79 m/s with a depth of 0.5 meters, water pH of 6.9. Muddy substrate conditions.

Septaria cumingiana was found in the Bandealit Primary Forest habitat having a water temperature of 26 °C, river water flow velocity of 0.37 m/s with a depth of 0.4 meters, and a water pH of 6.8. The condition of rocky, sandy, and soil substrates.

Sulcospira testudinaria was found in several habitats including Bandealit Primary Forest having a water temperature of 26 °C, river water velocity of 0.37 m/s with a depth of 0.4 meters, and a water pH of 6.8. Condition of rocky, sandy, and soil substrates, the Bandealit Secondary Forest has a water temperature of 25 °C, a river current velocity of 1.1 m/s with a depth of 1.2 meters, and a pH of water of 6.9. Condition of large rocky substrates, sandy, and soil. Bandealit Beach Forest has a water temperature of 27 °C, river water velocity of 0.79 m/s with a depth of 0.5 meters, water pH of 6.9. The condition of the mud substrate, Andongrejo Secondary Forest has a water temperature of 26 °C, a river water velocity of 0.87 m/s with a depth of 1.2 meters, and a water pH of 7.2. Condition of large rocky substrates, sandy, and soil.

Cerithidea cingulata found in the habitat of Bandealit Coastal Forest 1 has a water temperature of 27 ° C, river water velocity of 0.79 m/s with a depth of 0.5 meters, water pH of 6.9. Muddy substrate conditions. This is in accordance with the statement of [17] which states that the Genus Cerithidea is a type of Gastropoda which is found in muddy sand areas that have good adaptation to the type of sand substrate, mud, to muddy sand. *Cerithidea cingulata* is a gastropod that lives epipuana and is very fond of muddy substrates with higher organic content [18].

Pomacea canaliculata found in Andongrejo settlement has a water temperature of 27 °C, river water velocity of 0.24 m/s with a depth of 0.25 meters, water pH of 7.5. The condition of large rocky substrates and sand.
Thiara scabra found in Andongrejo Secondary Forest habitat has a water temperature of 26 °C, a river water flow rate of 0.87 m/s with a depth of 1.2 meters, and a water pH of 7.2. Condition of large rocky substrates, sandy, and soil. According to [17] the Thiaridae family has very good adaptability in various substrates and has a high ability to accumulate polluted materials without being killed because this species can hide itself in its shell.

5. Conclusion

Diversity index shows that the Bandealit and Andongrejo resorts have a medium level of Gastropod diversity with values of 1,822 and 1,238, respectively. Andongrejo Resort has a lower level of Gastropod diversity compared to Bandealit Resort. The abiotic conditions of the Meru Betiri National Park are ideal for Gastropod life. Water velocity ranges from 0.24-1.1%, water temperature ranges from 25-27 °C, pH of water ranges from 6.7 to 7.5%, and depth ranges from 0.25-1.4 meters.

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