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DIVERSITY OF GASTROPODA IN THE PEPE RIVER PARANGTRITIS, BANTUL, D.I. YOGYAKARTA

Abstract. Gastropods are quite abundant in nature and their role in river ecosystems is very important. The Pepe River empties in the middle of Parangtritis Beach so it will be affected by tourism developed in the area. This research aims to identify the types of gastropods in the Pepe Parangtritis River, analyze their level of diversity, and also examine each type of gastropod in their environment. Analysis of environmental parameters was also carried out including DO, dissolved CO2, pH, water salinity and also the type of substrate where the gastropods found lived. The research method used was purposive sampling method. Three research stations were determined. Data collection on gastropod samples at the three stations was carried out using the transect method. Data on gastropod types were then analyzed for the level of gastropod diversity. From the research results, 31 species of Gastropod members were found. The gastropods with the highest abundance are from the genus Tarebia. The Shannon-Wiener diversity index is 2.4, which means the level of gastropod diversity in the Pepe Parangtritis River is moderate. The substrate is mud and a little sand at the end of the Pepe River estuary. Environmental parameters are good in supporting gastropod life.

1 Introduction

Data collection and measurement of the level of animal diversity in order to maintain or conserve their existence in the environment is absolutely necessary. Gastropods as one of the benthic fauna that make up or act as biotic factors in aquatic ecosystems, their existence is the key to the existence of other fauna. Gastropods can function as food for other animals, limit the growth of algae/moss, and can also be a bioindicator of the level of river cleanliness. The distribution of Gastropods is related to the conditions in which the organisms live, for example physical, chemical and biological factors. Sediment texture factors, temperature, salinity, pH, organic matter content and oxygen influence the presence of gastropods. Environmental factors are the main factor in the life of gastropods because the ability of gastropods to migrate is low [1][2].

The Pepe Parangtritis River empties on the south coast of Bantul, precisely at Parangtritis Beach. The presence of gastropods on the coast is very important in maintaining the ecological balance of the region because gastropods are one of the initial decomposers for breaking down leaf litter in coastal areas[3]. Parangtritis Beach as the estuary of the Pepe River is a tourist spot that is very busy with tourists. Development around the Pepe River is quite massive, although currently there are still a few rice fields at the mouth of the Pepe River, household waste thrown from houses or stalls on Parangtritis Beach can affect the presence of gastropods in that place. Environmental pressures and changes can affect the existence, number of types and structure of gastropods[2]. Freshwater gastropods can be found in several types of water, both flowing and stagnant. Some species are able to survive in poor or polluted water conditions due to various types of waste[4]. Research on the diversity of gastropod species in the Pepe Parangtritis River has never been carried out. It is hoped that the results of this research will become the basis

for the local government in developing the Parangtritis tourist area without disturbing the existing river ecosystem. It is hoped that the participation of all parties can maintain the environmental conditions of the Pepe River so that there is no loss of gastropod species due to waste or rubbish entering the river.

Gastropods are mollusks with around 1,500 species spread across land, river, brackish and marine ecosystems. The Gastropod class is known as snails or snails. Gastropods have very varied body shapes and sizes. Gastropods generally have shells, indeed there are several types that are without shells (naked), for example slugs. Shelled gastropods, some have a single threaded shell, a well-developed head, equipped with tentacles and eyes. Gastropods can have important value, both economically because their shells can be used for various expensive decorations and their flesh as a source of food as well as important value in the health sector because some types of gastropods can be intermediate hosts for several types of trematode worms[5].

Biodiversity or diversity has a positive relationship with habitat complexity in the ecological concept. Species diversity and richness will increase in accordance with increasing variations in the habitat structure that exists in an ecosystem [6]. Rivers can be breeding, living and foraging places for aquatic biota including gastropods. The food source for gastropods is organic material that comes from upstream, fallen leaves or rubbish from land that will rot. Gastropods have an important role for the survival of life in an aquatic ecosystem. This is because gastropods play a role in the recycling and circulation mechanism of nutrients from the biological content of waters. The role of other gastropods from a scientific perspective is as a source of knowledge about the diversity of aquatic biota that is easily found. The role of gastropods from an economic perspective has selling value as a source of additional food and also for their shells which can be used as decoration. The existence of gastropods needs to be preserved so that the diversity and abundance of gastropod species can be well maintained by supported by properly maintained gastropod habitat [7].

Research in the Logawa River, Banyumas found eight species of gastropods with the dominance of the species Sulcospira testudinaria [8]. The results of this study are far below the number of gastropod species. Estimated number of freshwater snail species is 66 species4. In the mangrove ecosystem in Ujung Pangkah-Gresik, 2,171 gastropod specimens were found belonging to 15 species, 5 families and 5 orders [6]. Research on the diversity of other types of gastropods, namely at the mouth of the Empayang-Kasap River, found 8 species of gastropods (*Melanoides granifera*, *Elimia acuta*, *Brotia tetidinaria*, *Lymnae stagnalist*, *Lymnae rubiginosa*, *Pomacea canaliculata*, *Pila polita* and *Menetus sp*) with 7 genus [9]. Research in the Nogosari River, Pacitan found 10 species of gastropods with a moderate level of diversity category [4].

Another study at the mouth of the Segoro Ananakan River, Cilacap, found 17 species with a high dominance of *Melanoides tuberculata* snails [8]. The Pepe Parangtritis River has a diverse habitat, upstream in the karst mountains of southern Bantul and also Gunungkidul and downstream at Parangtritis Beach which is a sand dune. It is hoped that many species will be discovered in the research that will be carried out. This reseach is accordance with one of the 17 sustainable development goal (SDGs) for 2030 declared by both developed and developing countries at the UN General Assembly in September 2015, namely point (15) terrestrial ecosystem.

2 Material and Methods

2.1. Study Site

The research was conducted from June 2023 to February 2024 which included an initial survey, sampling, sample identification, and data analysis. The research was located at -8.026314, 110.335743, Pepe River in Parangtritis Beach, Bantul, D.I Yogyakarta, Indonesia. Abiotic data sampling that was measured were substrate, temperature, pH, and also salinity.

2.2. Procedures

The method used was purposive sampling in three research station areas. Station 1 is in the upstream area, station 2 is in the middle area, and station 3 is in the estuary or downstream area at Parangtritis Beach, Bantul. This section should provide a clear description of the experimental procedure. The method section for the research paper may contain the design of steps (experimental setup) or procedures carried out in data collection and data analysis.

2.2.1. *Sample collections*

This study used ten plot transects (1mx1m) each station. The tools used include a meter to measure the distance between transects, a GPS to mark the location of the sampling site, a book to record activities and results, a ruler/millimeter block of paper to measure the length of the sample, stationery, plastic sample holders, a bucket for tools, an ice box to transport sample to the lab. Petri dishes for sample identification. Tissue to wipe the water so it doesn't get wet. Microscope to help with the identification process, and identification book. Camera to photograph samples. Thermometer to measure temperature, DO meter to measure dissolved oxygen content, pH meter to measure acidity levels, CO_2 kits to measure dissolved carbon dioxide, salinometer as a tool for measuring environmental salinity.

The research material is all types of gastropods found in the Pepe River. Gastropods were preserved in 70% alcohol. The type of gastropods that found in the plot, both attached to trees, roots and leaves and on the substrate, were recorded, counted and sampled to match with previous identification. Environmental parameters were measured in each transect which included; DO, dissolved CO2, water pH, salinity and also recording the type of substrate where the gastropods were found. Samples that have been identified counted and diversity index analyzed.

2.3 Data Analysis

2.3.1. The density of marine gastropods was determined as a number of individuals/m2.

2.3.2. The diversity was calculated using the Shannon-Wiener index, its' formula is:

$$H' = -\sum P_i \ln P_i$$

In the above, *H'* is the value of the Shannon-Wiener diversity index, *Pi* is the proportion of the i^{th} species (ni/N), *ni* is the number of individuals of the i^{th} species, *N* = the total number of individuals of all types. The Shannon-Wiener diversity index is classified into three levels: low (H'<2); moderate (2<H'<4); and high (H'>4) [5] [9] [10]

3 Results and Discussion

Total 31 species was described in this research. Some are still identified at genus level because the species is not yet certain.

Table 1. Density of Gastropods in Pepe River

No	Species	Density Station 1/m2	Density Station 2/m2	Density Station 3/m^2	Average Density /m2
1	*Melanoides Trubeculata*	5.60	0.00	3.7	3.10
2	*Stenomelania Crenulata*	7.30	0.00	1.1	2.80
3	*Tarebia* sp1.	18.90	16.00	175.1	70.00
4	*Clithon* sp.	5.00	24.70	9.90	13.20
5	*Neritina* sp1.	0.00	0.00	0.80	0.27
6	*Pomaceae canaliculata*	0.00	0.10	0.10	0.07
7	*Stenomelania aspirans*	3.10	12,80	1.80	5.90
8	*Stenomelania* sp2.	4.20	51.20	18.20	24.53
9	*Stenomelania* sp3.	12.40	80.80	16.40	36.53
10	*Stenomelania* sp.	6.10	16.20	11.00	11.10
11	*Neretina* Sp8.	0.00	0.00	0.10	0.03
12	*Mionepletia* sp1.	5.40	51.80	3.30	20.17
13	*Melanoides* sp.	0.00	0.00	7.40	2.47
14	*Clithon diadema*	0.80	0.00	1.20	0.67
15	*Stenomelania crenata*	2.80	6.20	12.60	7.20
16	*Neritina* sp6.	1.10	0.00	0.10	0.40
17	*Neritina* sp3.	0.30	0.00	0.50	0.27
18	*Thiara scabra.*	0.00	6.80	0.00	2.27
19	*Cliton corona*	1.00	0.30	0.00	0.43
20	*Neritina* sp5.	0.00	0.10	0.00	0.03
21	*Thiara* sp2.	0.00	33.10	0.00	11.03
22	*Thiara* sp1.	0.00	5.80	0.00	1.93
23	*Thiara* sp3.	0.00	2.10	0.00	0.70
24	*Tarebia granifera*	9.50	83.10	0.00	30.87
25	*Tarebia* sp2.	0.00	88,2	0.00	29.40
26	*Achatina* sp.	0.60	0	0.00	0.20
27	*Neritina natalensis*	0.10	0	0.00	0.03
28	*Neritina variegate*	2.80	0	0.00	0.93
29	*Neritina* sp5.	0.50	0	0.00	0.17
30	*Neritina* Sp7.	1.00	0	0.00	0.33
31	*Neritina* sp9.	1.30	0	0.00	0.43
	Total of Density	89.90	479.3	263.4	277.53

From the table above, it can be seen that the Tarebia genus has the highest density. In total, the specific density can reach 130/m2 or close to 50% of the total density (277.53/m2)

of the mollusks found. Terebia (Fig 1.a) is a species distributed in Indonesia with the main character being a rough shell (Genus Tarebia). The special character is that there are round spots surrounding the shell. In nature, this species functions as food in the form of algae and moss that grow on the surface of the roots or branches of mangrove trees [11].

a. Genus Tarebia

b. Genus Stenomelania

Fig. 1. Mollucs of Genera Tarebia and Stenomelania

Sumpil Snails, Genus Stenomelania (Fig 1.b) is the second genus that dominates the Pepe River. Sumpil snails are typical fauna that inhabit rivers in Bantul. This snail has a sharp cone morphology. This genus is found widely distributed, even in the coastal regions of the Indian Ocean and the Pacific Ocean [12]. Species of this genus have the potential to be intermediate hosts for trematode worms [13]. Not only in river and estuary ecosystems, the member species Stenomelania is found in the Lake Lanao ecosystem in the Philippines [14]. Tarebia and Stenolenamia are the two genera most commonly found in the Pepe Parangtritis river (Table 1.). They are found in abundance due to the suitability of the habitat, namely the muddy bottom of the waters which are often inhabited by micro mosses which are their main food. Tarebia has a widespread distribution in the Indo-Malayan and Oceania realms [15].

The least common species found in the Pepe River is *Neretenia natalensis*. These snails live in forest streams as they are freshwater habitats because the dissolved oxygen is high so in this study they were only found in the upper reaches of the Pepe River. Although rarely found, this snail can live up to 5 years [16]

Several other genera occupy medium and low density levels. These genera are: Clithon; Melanoides; Neritina; Pomacea; Melanoides; Tiara; and Achatina. Clithon and Neretina are herbivores that eat algae on rock surfaces, substrates and aquatic plants. By controlling algae growth, they help maintain the cleanliness and balance of aquatic ecosystems, reducing the risk of eutrophication which can lead to decreased water quality. The Pepe River is a small river which is a dumping ground for household waste water, making it vulnerable to eutrification. Cliton abundance was significantly influenced by stone coverage, water condition and time of year [17]. Clithons (Fig 2.a) are found in low

densities in the Pepe River because the bottom of the waters is muddy, small rocks as clithon habitat are few found in the riverbed.

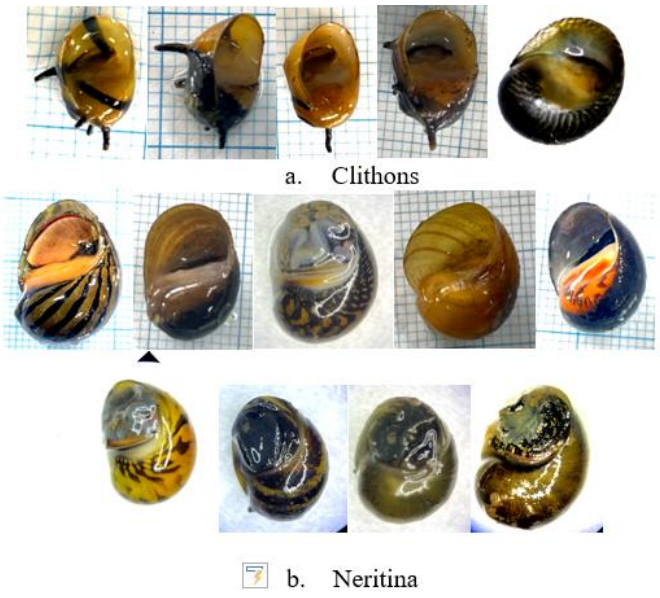
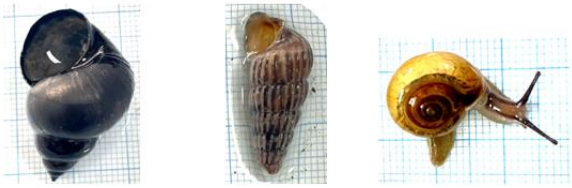


Fig 2. Genera of Clithons (a.) dan Neritina (b.) found at Pepe River

The Neritina genera (Fig 2.b.) are found in many color variations in the Pepe River, so not all have been identified to species. Whether color variations are the same or different species needs to be further identified through molecular identification of their DNA. Neritina can be found in both freshwater and marine ecosystems, they have varied body anatomy [18]. In this study, Neritina with different colors was still separated into different species because if they were grouped into one genus there might still be species differences. what is important is their ecological function as eaters of moss attached to rocks. Limiting the amount of moss in these waters is important so that they do not become too abundant and disrupt the ecological balance. The upstream movement of Neritina can be explained by the snails avoiding increased predation in downstream areas these rivers of fish, crustaceans, and birds [19]. Some members of the gastropod genus have low densities. Most likely due to the environment being more muddy than rocky, because the genus with the lowest density found is a gastropod that is often found living in rocky river beds. The muddy bottom type with few rocks is the reason they are rarely found in the Pepe River. They are: Pomaceae; Melanoides; and Achatina. There were even species that were found during the survey but were not caught during sampling (Fig 3.), are; *Filopaludina javanica, Pirenella* sp. and *Oxychilus alliarius.*



a.Filopaludina javanica *b. Pirenella* sp. c. O*xychilus alliarius.*

Fig 3. Several species were found at survey

From data on the types and number of species found, the level of diversity is analyzed.

Table 2. Gastropods diversity in the Pepe River

No	Name	Diversity index
1	*Melanoides Trubeculata*	-0.050203
2	*Stenomelania Crenulata*	-0.046372
3	*Terebia* sp1.	-0.347422
4	*Clithon* sp1.	-0.14486
5	*Neretina* sp1.	-0.006676
6	*Pomacea canaliculata*	-0.002002
7	*Stenomelania aspirans*	-0,081867
8	*Stenomelania* sp2	-0.214445
9	*Stenomelania* sp3	-0.26692
10	*Stenomelania* sp	-0.128744
11	*Neretina* Sp8.	-0.190518
12	*Melanoides trebeculata*	-0.041978
13	*Pomaceae canaliculata*	-0.002002
14	*Clithon diadema*	-0.014488
15	*Stenomelania crenata*	-0.09474
16	*Neritina sp6*	-0.009429
17	*Neritina sp3*	-0.006676
18	*Thiara scabra*	-0.039265
19	*Cliton corona*	-0.01009
20	*Neritina sp5*	-0.001084
21	*Taenia sp 2*	-0.128211
22	*Taenia sp1*	-0.034599
23	*Taenia sp3*	-0.015089
24	*Terebia granifera*	-0.244264
25	*Tarebia sp2*	-0.237814
26	*Achantina sp*	-0.005214
27	*Neritina natalensis*	-0.001084
28	*Neritina variegata*	-0.019152
29	*Neritina sp5*	-0.004455
30	*Neritina Sp.7*	-0.008077
31	*Neritina sp9*	-0.01009
H'		***2.408913***

From the results of the Shannon Wiener diversity index analysis, a value of 2.4 was obtained, which means that the level of diversity of gastropod species in the Pepe River is moderate. Even though the Pepe River is a small river, it does not flow into a large river, but it goes straight to Parangtritis Beach, it turns out it has a moderate level of diversity in mollusk species.

H'= Shannon-Wiener Diversity Index. The criteria for the value of the Shannon-Wiener diversity index (H') are as follows:

H'<1= low diversity.

1<H'<3= medium diversity. (In this research, Gastropod's index is = 2.40)

H'>1= high diversity [20] [21].

The moderate level of diversity of gastropods in river ecosystems indicates there are a fairly diverse number of gastropod species, although not extraordinarily high. This moderate diversity has several important implications for river ecosystems [22]. A moderate level of diversity in Pepe River indicates that the river ecosystem has a fairly good balance. Its' mean that no species dominates excessively, so that interactions between species in the food chain remain balanced [21]. Pepe River ecosystems are able to support the life of various species of gastropods, which require certain conditions to survive, such as good water quality and adequate food availability. If one species declines in the Pepe River ecosystem then another similar species can take over its function, thereby reducing the negative impact on the ecosystem as a whole. On the other hand, moderate diversity may indicate the presence of some environmental pressure (such as pollution or habitat change), but the pressure has not yet reached a level that threatens the survival of many species. The Pepe River is a small river that is vulnerable to pollution from households and food stalls around the coast.

The Pepe River ecosystem with its moderate diversity has good potential for recovery if disturbance occurs. However, continuous monitoring needs to be carried out so that the disturbances that arise in this river are not too big. If major disturbances occur, there could be a decrease in the number of gastropod species. Habitat change is a serious threat to the Pepe River. Habitat structure and complexity play an important role in the formation of fauna communities in ecosystems [23]. The Pepe River Ecosystem is an ecosystem that is easily influenced by surrounding conditions because the river is small and does not flow into a large river. This is unique because there are no large rivers connected to the Pepe River. Tourism development at Parangtritis Beach must still be environmentally friendly, especially protecting the Pepe River ecosystem from the treat. River water contaminated with pesticides, metals, EDCs, drugs, pathogens, etc. may not be suitable for human consumption [24] and is also not good for the fauna in it. For this reason, the physical and chemical parameters of the Pepe River were also measured in this research.

Table 2. Environmental Parameters

Parameters	**Upstream**	**Middle**	**Downstream**
DO (ppm)	6.7	3.5	7.2
pH	7.34	7.67	7.4
Salinity (ppt)	0.0	0.0	0.0
Temperature (^{0}C).	29.6	31.0	30.0
Substrate	Muddy rock	Muddy rock	Muddy

From the table 2, dissolved oxygen in the upstream part is quite good (6.7 ppm), but in the middle part it decreases drastically (3.5.ppm). This is because in the middle river it is close to food stalls that throw organic waste into the water. The dissolved oxygen content in

the downstream section rose again, indicating that the Pepe River is well in the process of self-purification in the Pepe River. The Pepe River is indicated to have a healthy ecosystem, this self-purification process works effectively to control and reduce the impact of organic material pollution originating from its aquatic environment. This self-purification capacity has limitations in that if the amount of organic material entering the waters is too large, then this process may not be able to deal with pollution effectively. If this happens it can cause a decrease in water quality and cause disruption to the aquatic ecosystem. The process of self-purification of water bodies is a process that involves biological, chemical and physical processes that act simultaneously on biological pollutants, oxidizing them and increasing the amount of dissolved oxygen [25].

The pH parameter is relatively stable even though DO in the middle decreases. This shows that the self-purification process in Pepe River has no effect on environmental pH. The water temperature in the middle river shows higher than the upstream and downstream. This also allows for a greater decrease in dissolved oxygen. for every 1 °C RWT increase, there will be about 2.3% decrease in DO saturation level concentrations [26]. Types of gastropods that prefer muddy substrates are most commonly found and have high densities (Tarebia and Stenomelania). The salinity at the three research stations is the same. Even though the downstream one is close to the beach. In general, the condition of the aquatic environment is still good in supporting the life of gastropods.

Conclusion

From the research carried out, 31 types of gastropods were found in the Pepe River with the most abundant species being from the genera Tarebia and Stenomelania. The level of diversity of gastropod species is moderate, so it is necessary to protect the ecosystem so that the existence of mollusk species is maintained. Environmental conditions are still good in supporting gastropod life.

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