Relationship Between Macroinvertebrate Diversity With Elements C and N in The Mangrove Forest of Wonorejo Surabaya

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Abstract. Conservation of mangrove forests can be supported by constantly analyzing the interactions of organisms in these habitats. Mangrove plants require C and N nutrients in high concentrations. Based on these nutrient requirements, it is hypothesized that there is also a correlation between the species and diversity of macroinvertebrates in mangrove forests with C and N nutrients. In this study, randomized purposive sampling was conducted to obtain macroinvertebrate species. The physical and chemical properties of soil and water were also measured in this study. The specimens obtained were then identified. In addition, an analysis of the content of C and N in soil and water samples was also carried out. Dominance and diversity analysis as well as statistical analysis were carried out to determine certain species that were resistant to a high concentration of C and N. In this current study 32 species were identified. The highest species diversity index was at station 1 (2.868) and the highest dominance index was at station 2 (0.182). Based on the test results for the highest C nutrient at station 3 (2.055) and N at station 4 (0.129). The relationship between macroinvertebrate diversity with elements C dan N is inversely propostional. The higher the diversity of macroinvertebrate, the lower the elements C and N.

Keywords: Macroinvertebrate species, diversity, C and N, mangrove forest

1 Introduction

Mangrove ecosystems are coastal ecosystems that are the link between land and ocean ecosystems (Tidore et al., 2018). In the life of aquatic biota, the mangrove ecosystem serves as spawning ground, feeding ground, and nursery ground (Paruntu et al., 2017). From a physical point of view, the mangrove ecosystem functions in preventing coastal abrasion, reducing infiltration rates, maintaining shoreline stability, holding back seawater construction to the coast and maintaining biodiversity (Baderan, 2017). From an ecological point of view, mangrove forests are the best carbon sinks compared to all other forest types on earth (Verisandria et al., 2018).

Mangrove ecosystems are referred to as productive areas because they are rich in organic matter which is a food source for macroinvertebrates (Sani et al., 2020). In the mangrove leaf litter there are nutrients such as carbon, nitrogen, phosphorus, potassium, calcium, and magnesium that can fertilize the waters (Ramdani, 2015). The level of primary productivity in mangrove areas is relatively high due to litter (Komalasari et al., 2022). Primary productivity greatly affects the growth of mangroves. One indicator of mangrove growth is influenced by the sediment in which it lives which contains macro and micronutrients such as carbon (C) and nitrogen (N) elements (Chrisyariati et al., 2014).

In Surabaya, there is the Wonorejo Mangrove Area which is part of a conservation area located in the East Coast of Surabaya (Pamurbaya). This area is located east of the city of Surabaya and is directly connected to the Madura Strait with an area of approximately 200 hectares (Akhadah et al., 2019). Administratively, it is included in Wonorejo Village, Rungkut District, Surabaya City (Wijaya and Sanjaya, 2021). This mangrove area holds a variety of potential diversity of flora and fauna, one of them is macroinvertebrates.

Macroinvertebrates are a group of animals that are not equipped with a vertebral column which is the main characteristic of the vertebrate group. This macroinvertebrates live in all marine waters, including in the mangrove ecosystem (Azwir et al., 2019). The invertebrate phylum includes sponges, coelenterates, platyhelminthes, nemathelminthes, annelids, molluscs, arthropods and echinoderms (Candri et al., 2018). The body size of macroinvertebrates as one part of the macrofauna ranges from 2 – 20 mm (Hanafiah et al., 2013).

The high demand for C and N for mangrove life is predicted to cause interactions with macroinvertebrates in the mangrove ecosystem. Therefore, the purpose of this study was 1) to determine the diversity of

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https://doi.org/10.1051/matecconf/202237203002

macroinvertebrates in the mangrove area of Wonorejo, Surabaya 2) to determine which macroinvertebrate species were resistant to high C and N content.

2 Materials and Method

2.1 Stage 1: Sampling of Makroinvertebrata

This research was conducted in the Wonorejo Mangrove Forest Area, Surabaya. Determination of stations is done by using a purposive random sampling method. For each station, 3 points were sampled. Macroinvertebrata that can be identified at the site will be identified immediately, whereas if cannot be identified directly, then the sample is taken to the Taxonomy Laboratory for examination for further analysis and to known the structure of the macroinvertebrate community in each station. Macroinvertebrate diversity index can be calculated using the Shannon-Wiener diversity index formula as follows (Odum, 1993).

$$\mathbf{H}' = -(\sum \mathbf{pi\ In\ pi})$$

Description:
H′ = Species diversity index
Pi = ni/N ni = Number of individuals of each species
N = Total number of individuals

The results of the calculation of H' are between 1-3. H' is smaller than 1, it means that the diversity is low, H' in the range of 1 and 3 means that the diversity is moderate, and H' is greater than 3 which means that the diversity is high (Marian and Oka, 2018).

The dominance index (C) is used to determine the extent to which a group of biota dominates another group. A large enough dominance will lead to an unstable or depressed community. The greater the value of the dominance index (C), the greater the tendency certain species dominate. This dominance is obtained from the formula:

$$\mathbf{C} = \sum (\mathbf{ni}/\mathbf{N})^2)$$

Description:
C = Species dominace index
ni = Number of individuals of each species
N = Total number of individuals

2.2 Stage 2: Sample Analysis

2.2.1 Analysis of C levels

Testing the C nutrient content in soil samples was divided into 3 stages, namely sample preparation, calibration curve creation, and sample analysis using the Atomic Absorption Spectrophotometer (AAS) method at a wavelength of 561 nm. The formula for calculating organic C content is as follows:

C-organic (%) = ((abs sample-blank value) x sample vol)/(sample weight) x 10^{-4}

2.2.2 Analysis of N levels

Testing the total nitrogen nutrient content using the Kjeldahl method. First, sample preparation was carried out, then after going through a long process to obtain a suitable solution, then the solution is titrated until it turns pink. The titration volume of the sample (Vs) and the blank (Vb) was recorded, and calculated using the following formula:

N-total (%) = ((Vs-Vb) x N H_2SO_4 x Nitrogen atomic weight)/(sample weight (mg)) x 100%

2.3 Measurement Physicochemical Environmental Factor

Measurement of physicochemical factors was carried out in situ to determine the suspected abiotic factors have a significant effect on the biodiversity of mangrove forests, such as water temperature and air temperature measured using a thermometer, DO using a DO meter, pH and soil moisture using a soil tester, air humidity using hygrometer, salinity using refractometer, light intensity use lux meter, and CO_2.

2.4 Data Analysis

Data analysis was carried out in qualitative descriptions through tables and quantitatively, using an ecological index (species diversity index and dominance index), as well as nutrient tests for elements C and N to determine the relationship between the two.

3 Result and Discussion

The results of the research on macroinvertebrates in the Wonorejo Mangrve Forest Area that have been identified are 34 species belonging to 24 families (table 1).

Table 1. Number of individuals macroinvertebrate.

No.	Famili	Species	Station				sum
			1	2	3	4	
1	Grapsidae	Metopograpsus frontalis	1	1	-	-	2
2	Portunidae	Scylla paramamosain	-	2	3	-	5
3	Sesarmidae	Pseudosesarma moeschii	-	1	1	2	4
4	Sesarmidae	Episesarma singaporense	5	2	5	-	12
5	Camptandriidae	Ilyogynnis microcherium	1	1	-	-	2
6	Ocypodidae	*Tubuca bellator*	6	8	2	-	16

7	Ocypodidae	*Ocypode mortoni*	-	-	2	-	2
8	Ocypodidae	*Tubuca rosea*	5	7	1	-	13
9	Ocypodidae	*Tubuca coarctata*	3	3	1	-	7
10	Ocypodidae	*Ocypode ryderi*	12	1	-	-	13
11	Ocypodidae	*Austruca triangularis*	3	3	-	-	6
12	Lycaenidae	*Zizina otis*	4	-	-	5	9
13	Nymphalidae	*Acraea violae*	2	-	-	6	8
14	Libellulidae	*Crocothemis selvilia*	5	-	-	4	9
15	Araneidae	*Argiope sp*	1	2	-	2	5
16	Araneidae	*Leucauge sp*	-	2	-	1	3
17	Oxyopidae	*Oxyopes javanus*	-	-	2	-	2
18	Chrysomelidae	*Aspidomorpha deusta*	-	2	-	1	3
19	Apidae	*Apis sp*	1	2	-	1	4
20	Vespidae	*Polistes sp*	-	1	-	1	2
21	Erebidae	*Amata huebneri*	-		-	1	1
22	Pentatomoidae	*Euthyrhynchus sp*	-	1	-	2	3
23	Dinidoridae	*Cyclopelta obscura*	-	1	-	2	3
24	Mantidae	*Mantis religiosa*	2	2	-	2	6
25	Ellobiidae	*Ellobium sp1*	4	-	-	-	4
26	Ellobiidae	*Ellobium sp2*	4	-	-	-	4
27	Onchidiidae	*Paraonchidium sp1*	1	-	-	-	1
28	Onchidiidae	*Paraonchidium sp2*	5	-	-	-	5
29	Potamididae	*Telescopium telescopium*	4	3	-	-	7
30	Potamididae	*Cerithidea obtusa*	-	5	-	-	5
31	Potamididae	*Cerithidea sp*	-	-	-	10	10
32	Littorinidae	*Echinolittorina sp.*	-	-	1	-	1
33	Assimineidae	*Assiminea sp.*	3	32		-	35
34	Mytilidae	*Perna sp*	-	-	2	-	2
sum			72	82	20	40	214

Based on the results of macroinvertebrate research in the Wonorejo Mangrove Forest Area, the species diversity index and dominance index were calculated. The results of the calculation of the diversity index and dominance index are presented in the following table (table 2). The highest species diversity index was at station 1 and the highest dominance index was at station 2.

Table 2. Diversity index and dominance index macroinvertebarate.

Station	Diversity index	Dominance index
1	2,868	0,078
2	2,070	0,182
3	2,151	0,135
4	2,277	0,114
Average	2,342	0,128

This study also conducted tests on nutrients, namely C and N, the results of which are presented in the following table (table 3). Based on the test results for the highest C nutrient at station 3 and N at station 4.

Table 3. Number of individuals macroinvertebrate.

Station	C (g/100g)	Standart Deviasi	N (g/100g)	Standart Deviasi
1	0,925	0,105	0,071	0,003
2	1,240	0,093	0,079	0,002
3	2,055	0,084	0,115	0,006

4	1,988	0,021	0,129	0,008

In (Table 1), there were 214 individuals belonging to 34 species consisting of 24 families and 5 classes. Based on table 2, it is known that the diversity index at station 1 is 2.868; station 2 which is 2,070; station 3 which is 2,151; and station 4 which is 2,277. This shows that the highest species diversity index is at station 1. The dominance index at station 1 is 0.078; station 2 is 0.182; station 3 which is 0.135; station 4 is 0.114 and the highest dominance index is at station 2.

The highest diversity index at station 1 was 2.868, 20 species of microinvertebrates were found with a total of 72 individuals. Ocypode ryderi species were found at most in station 1, which was 12 individuals. Meanwhile, the highest dominance index at station 2, 0.182, found 21 species with a total of 82 microinvertebrate individuals. Assiminea sp. found the most at the station 2 that is 32 individuals.

Table 3 shows the results of C and N nutrient tests on samples in the Region. At station 1 the C element is 0.925 and the N element is 0.071. At station 2, element C is 1.240 and element is 0.079. At station 3 the C element is 2.055 and the N element is 0.115. And at station 4 the C element is 1.988 and the N element is 0.129.

The highest C nutrient content at station 3 was 2,055, 10 species of microinvertebrates were found with a total of 20 individuals. Episesarma singaporense species were found at most in station 3, namely 5 individuals. Meanwhile, the highest N nutrient at station 4, namely 0.129, was found 14 species with a total of 40 microinvertebrate individuals. Cerithidea sp species were found at most at station 4, which was 10 individuals.

Nutrients in the mangrove area containing C and N can support the growth process and the diversity of species of macroinvertebrates in it. In this study, it was shown that the C and N nutrients at station 1 which had the lowest levels were located at station 1 which had the highest diversity index among all stations. This shows that there is an inverse relationship between the levels of C and N nutrients with macroinvertebrates in the Wonorejo Mangrve Forest Area.

Mangrove forests can also take in and release nutrients C and N that have been suspended by sediment and organic debris (Adame et al. 2009). Mangrove forest roots can also absorb pollutants so that they become a place for birds, reptiles and also microinvertebrates to live.

The difficulty in identifying the relationship between macroinvertebrate diversity and nutrients C and N is because microinvertebrate communities are influenced by physical habitat (Poff and Ward, 1990), geomorphology (Richards et al. 1996), and land use (Richards et al. 1993).

Understanding of mangrove forests as importers and exporters of nutrients is useful directly for the ecosystem around the mangrove forest. For example, if it is dominated by the export of nutrients, then the mangrove forest plays an important role in the coastal ecosystem. On the other hand, if it is dominated by imports of nutrients throughout the year, then the mangrove forest plays a role in improving the quality of the surrounding ecosystem.

4 Conclusion

In this current study 32 species were identified In this current study 32 species were identified. The highest species diversity index was at station 1 (2.868) and the highest dominance index was at station 2 (0.182). Based on the test results for the highest C nutrient at station 3 (2.055) and N at station 4 (0.129). the relationship between macroinvertebrate diversity with elements C dan N is inversely propostional. The higher the diversity of macroinvertebrate, the lower the elements C and N.

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