Evaluation of Restored Mangrove Ecosystem using Community Structure of Gastropod as an Associated Bio-indicators

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ABSTRACT

The mangrove restoration program, however, will modify the ecosystem, including its resources and ecosystem services. Changes in the condition of the mangrove ecosystem will affect the vegetation structure as well as the associated organisms such as gastropods. The aims of this study were 1) to determine changes in the mangrove vegetation community structure at Segara Anakan Cilacap and Logending Kebumen, 2) to determine the structure of the gastropod community and its changes, 3) to determine the relationship between vegetation and gastropods and their environmental factors. The material that will be used in this research is the mangrove vegetation community and the gastropod community. The method used is survey method with purposive sampling technique. To determine changes in mangrove and gastropod vegetation communities, the data obtained will be analyzed in a multivariate manner which includes biodiversity analysis, cluster analysis, multi-dimensional sclae (MDS), and Bio-env using the PRIMER-E program. This study showed that gastropod at Segara Anakan mangrove Cilacap consists of 12 species from 3 families and dominated by family Potamididae and Neritidae. In comparison, at Logending beach mangrove Kebumen consists of 10 species from 5 families and dominated by Cassidula nucleus family Ellobidae. Gastropod community structure between these two mangrove ecosystems was high significance difference with the value of dissimilarity 83.93%. Increased mangroves age shows a more stable in gastropod community structure, therefore it can be used as an indicator of mangrove restoration.

Keywords: mangrove, gastropod, community structure

1. INTRODUCTION

Gastropods are mollusks that primarily have a calcium carbonate-dominated shell made of organic and inorganic materials. Up to a certain level of classification, the shell's characteristic of a twisted spiral that is turned to the left and right can be utilized to determine the identity. Shell traits can be used to distinguish up to (Karyanto et al., 2004). The mangrove ecosystem's decomposer, the gastropod, is crucial to the decomposition and mineralization of trash (Cappenberg, 2006). Mangrove vegetation and environmental factors affect gastropod density. The abundance of mangrove species is directly inversely correlated with the abundance of gastropod species. In the area with more mangrove species, there are numerous different species of gastropods (Susetya *et al*., 2013).

Mangroves are a type of coastal community found along tropical coasts that are dominated by special tree or shrub species that can tolerate in saline water and are more common near estuaries and in tide-dependent habitats throughout tropical and subtropical regions. Mangrove is important to the life cycle of aquatic organisms, especially as a spawning, nursery, and feeding area (Pramudji, 2001). Crustaceans and mollusks are the predominant macrofauna in the mangrove ecosystem, which supports the habitat complexity and diversity of the macrofauna linked with it (Saenger & Hutchings, 1987; Sasekumar, 1974; Yulianti & Ariastita, 2013).

The mangrove habitat in Segara Anakan Cilacap is one of the mangrove ecosystems that are prominent of Java. Around the lagoon, there are around 12,230 Ha of mangrove forests with multiple levels of disturbance. *Rhizophora apiculata, Rhizophora mucronata, Avicennia marina, Sonneratia caseolaris, Ceriops tagal, Aegiceras corniculatum*, and *Nypa fruticans* are currently the dominant species in mangrove systems (Hinrichs et al., 2009). According to (Darmawati, 2016), a total of 21 species from 8 families, including Ampulariidae, Assiminidae, Nassariidae, Muricidae, Littorinidae, Ellobidae, and Neritidae, were discovered at the Segara Anakan mangrove Cilacap.

Geographically, Logending Beach Mangrove Kebumen is situated between 109°22'45" and 109°23'30" Eastern Longitude and 7°42'00" and 7°43'00" Southern Latitude (US Army Map Service, 1963; 1964). The mangrove ecology in this region is distinct from the naturally occurring Segara Anakan mangrove Cilacap and the planted Logending beach mangrove Kebumen. The objectives of this research are to understand the gastropod community structure in the mangroves in Segara Anakan Cilacap and Logending Beach in Kebumen and to compare it.

2. METHODS

The equipment utilized in this study include a roll meter, plastic clip, bottle sample, icebox, mangrove shoes, machete, markers, measuring tape, and tweezer. Labels, ice blocks, and 70% alcohol are the materials used. This study was carried out in the mangroves of Segara Anakan Cilacap on August 26 and Logending Beach Kebumen on August 3 2019. Purposive random sample was used in the survey method in this study. Three stations were obtained from

Logending Beach in Kebumen and four stations were acquired from the Segara Anakan mangrove in Cilacap.

The community structure of gastropods, which includes species composition, variety, density, dominance, and resemblance, serves as the study's main independent variable. The Shannon-Wienner diversity index (H') is derived using the following formulas: D=N/A for density (Brower & Zar, 1977), Simpson dominance index C=(n/N)2, and Bray-Curtis similarity index IS=2c/(a+b) x 100% for similarity (Odum, 1993). The parameters in this study include the quantity and species of gastropods, the quantity and species of flora, and environmental factors such soil salinity, air temperature, and water temperature.

With the use of a roll meter measuring 1 m x 1 m, three repetitions of each plot are made at each station. Each plot's gastropod samples are collected and put into a plastic clip that has been previously labeled. The samples are then cleaned with water and put into the icebox. In order to determine the initial shell color of the gastropod, a photo from the preserved gastropod samples was taken immediately. Identification was carried out at the International Tropical Marine and Earth Laboratory (ITMEL), Jenderal Soedirman University, Purwokerto by identifying the gastropod morphology characters, such as shell type (Table 1), shell color, and shell ornament, with the identification key from the FAO Species Identification Guide for Fishery Purpose (Carpenter & Niem, 1998), source from http://www.gastropods.com/index.shtml, and verifying the validity to the World Register of Marine Species (WoRMS).

Table 1 Table of Morphology Characteristic (Karyanto, et al., 2004)

Family	Characteristics					
	Body Whorl	Whorl	Shell Type	Modification character	Siphon	Spire
Neritidae	Big body whorl	Short and curl up	Neritiform	No modification	No siphon	Convex shape
Muricidae	-	-	Fusiform	Have Spine	Have a long siphon	Big and jagged spire
Ellobidae	Smooth	Pyramid shape	Pupiform	No modification	Short siphon	Flat and straight
Littorinidae		Convex	Trochiform	No modification	No siphon	Conical shape
Potamididae	Not clearly seen	Dominant	Turretet	No modification	No siphon	Long, slim, and pointy

Data from this study were examined using both univariate and multivariate methods. The Shannon-Wienner diversity index is used to determine species diversity (Krebs, 1989):

$$H' = pi \ln Pi$$

Notes:
Shannon-Wienner diversity index is H'.
N = Number of all species
Pi = ni/N
ni = Number of species-i

Density Formula for calculating the total population per unit area (Brower & Zar, 1977):
D=N/A
D refers for gastropod density (ind.m-2)
N = Number of Species
Sample Layout Area = A (m^2)
The formula for the Simpson Dominance Index is $C=(n/N)^2$ (Krebs, 1989).

C stands for the Simpson Dominance Index.
ni = All species / total
N = Number of species, I = 1, 2, 3. I
Based on biological criteria, the Bray-Curtis Similarity Index (Odum, 1993) compares the similarity of stations: IS=2c/(a+b) x 100% (3.4)
IS stands for the Index of Similarity.
A = Number of species present at the site B = Number of species The number of individuals that is less than or equal to pairs of kinds is compared at two places. on location a = Total species on location b = On location c = Total species.

Community Structure and Environmental Variables The Bray-Curtis Similarity Index (Odum, 1993) compares the biological parameters of stations to determine how similar they are:
IS = c / (a + b) x 100%
Notes:
Index of Similarity (IS)
The number of individuals that is lower or equal than pairs of kinds is compared at two locations with a = total species on location and b = total species on location.
Community structure and environmental factors correlation analyzed using the software Primer 5, environmental parameters that affected community structure were calculated using BIO-ENV Simper.

3. RESULT AND DISCUSSION

Ten gastropod species from Logending Beach Mangrove in Kebumen and 12 gastropod species from Segara Anakan Mangrove were obtained in this research (Table 2).

Table 2. Species Comparison at Logending Beach Mangrove Kebumen and Segara Anakan Mangrove Cilacap.

Species	Location	
	Segara Anakan	Logending Beach
Pirenella cingulata	✓	-
Cerithidea quoyii	✓	✓
Cerithidea obtusa	✓	✓
Cerithidea djajariensis	✓	-
Telescopium telescopium	✓	-
Neripteron violaceum	✓	✓
Nerita pica	✓	-

Species	Location	
	Segara Anakan	Logending Beach
Nerita balteata	✓	✓
Nerita indera	-	✓
Clithon aspersum	-	✓
Vittina turrita	✓	-
Vittina natalensis	✓	-
Littoraria angulifera	-	✓
Cassidula nucleus	✓	✓
Cassidula aurisfelis	✓	-
Optediceros breviculum	-	✓

Table 3. Table of Total Gastropods (ind/m^2) at Segara Anakan Mangrove Cilacap (SA) and Logending Beach Mangrove Kebumen (LK)

Species	Station				Station			Total
	SA 16	SA 40	SA 02	SA 03	LK 01	LK 02	LK 03	
Pirenella cingulata	14	2	-	4	-	-	-	20
Cerithidea quoyii	9	-	8	2	6	18	2	45
Cerithidea obtusa	4	2	7	1	41	57	17	129
Cerithidea djajariensis	-	12	0	5	-	-	-	17
Telescopium Telescopium	9	-	2	-	-	-	-	11
Neripteron violaceum	6	73	1	39	1	6	6	132
Vittina turrita	-	-	33	2	-	1	-	36
Nerita picea	-	-	23	2	-	-	-	25
Vittina natalensis	-	6	6	2	-	-	-	14
Nerita balteata	3	-	22	-	3	3	1	32
Cassidula nucleus	12	2	8	1	72	36	53	184
Cassidula aurisfelis	15	4	2	-	-	-	-	21
Nerita incerta	-	-	-	-	1	6	6	13
Clithon aspersum	-	-	-	-	8	7	7	22
Littoraria angulifera	-	-	-	-	6	21	4	31
Optediceros breviculum	-	-	-	-	-	5	-	5

According to data from this study (Table 3), the Logending Beach Mangrove Kebumen is home to ten species that belong to five families. *C. quoyii* and *C. obtusa* are two species from the Potamididae family, and *N. balteata, N. incerta, C. aspersum, N. violaceum*, and *V. turrita* are five species from the Neritidae family. *L. angulifera, C. nucleus*, and *O. breviculum* are all species from the family Littorinidae, family Ellobidae, and family Assiminidae, respectively. According to the data, there are 161 species of Kebumen in the family Ellobidae, which dominates the mangroves near Logending Beach. *Cassidula nucleus*, with a total value of

species density of 17.88 ind.m^2, is the most prevalent species at Logending Mangrove Kebumen, followed by *Cerithidea obtusa* (12.78 ind. m^2) and *Littoraria angulifera* (3.44 ind.m^2).

Table 4. Results of Gastropod Community Structure Analysis

Station	S	N	H'	C	D
SA 16	8	72	1,9638	0,85994	8
SA 40	7	101	1,0163	0,46178	11,222
SA 02	10	112	1,8978	0,82207	12,556
SA 03	9	58	1,2671	0,53962	6,444
LK 01	8	138	1,2924	0,63641	15,333
LK 02	10	160	1,8134	0,79143	17,778
LK 03	8	58	1,4326	0,65526	10,667
Segara Anakan	12	343	2,1805	0,83951	9,527
Logending	10	394	1,633	0,73337	14,592

Notes :
S = Number of species
N = Number of individu
H' = Species diversity index
C = Species dominance index
D = Species density
SA = Segara Anakan
LK = Logending Kebumen

According to the data (Table 4), Kebumen founded ten species with a total of 394 individuals at Logending Beach Mangrove whereas 12 species were founded at Segara Anakan. With 10 species, Segara Anakan Mangrove SA 02 has the most species overall; only the species *P. cingulata* and *C. djajariensis* were missing from this station. With 10 species, Logending mangrove Kebumen station LK 02 has the most species by contrast; this indicates that all gastropod species discovered at Logending beach mangrove Kebumen were first discovered at station LK 02. The station with the most individuals, SA 02, has a total of 112 individuals (Table 4); the station with the most species, V. turrita, has a total of 33 species.

Results of the SIMPER analysis revealed that Cilacap had a similarity of 26.42% across 4 stations at the Segara Anakan mangrove. *Neripteron violaceum* contributed 43.17% of the total, followed by *Cassidula nucleus* (10.64%), *Cerithidea quoyii* (8.91%), and *Cerithidea obtusa* (7.89%), with a cumulative total of 70.61% from all of those species. Three stations at the Logending Mangrove in Kebumen are comparable by 67.67%. The *Cassidula nucleus* contributed 48,07% to this similarity, followed by *Cerithidea obtusa* (27.25%), with a cumulative total from all those species of 75.32%.

The difference between the gastropod community structure in the Logending beach mangrove in Kebumen and the Segara Anakan mangrove in Cilacap is 83.93 percent. The results of the SIMPER study revealed that the gastropod community structure between the Logending Beach Mangrove in Kebumen and the Segara Anakan Mangrove in Cilacap differs significantly. Different gastropod species have different community structures, which we can see. Segara Anakan founded 12 species with a total of 343 individuals, whereas Kebumen founded 10 species at Logending Beach Mangrove with a total of 394 individuals. *Neripteron violaceum*, a

species of Cilacap, predominated in the mangroves in Segara Anakan, while *Cassidula nucleus*, a species of Kebumen, predominated at Logending Beach.

4. CONCLUSION

The following conclusions can be drawn from the research's findings: a) The gastropod community structure at Segara Anakan mangrove Cilacap consists of 12 species from three families, with family Potamididae and Neritidae dominating the group, b) In Logending Beach Mangrove Kebumen, the gastropod community structure consists of 10 species from 5 families, with species *Cassidula nucleus* from family Ellobidae dominating, c) There is a substantial difference in the gastropod community structure between the Segara Anakan mangrove in Cilacap and the Logending beach mangrove in Kebumen, with a dissimilarity score of 83.93%. *Cassidula nucleus* contributed 27.32%, followed by *Cerithidea obtusa* (18.52%), Neripteron violaceum (15.13%), Littoraria angulifera (5.38%), and Vittina turrita (4.41%), for a cumulative total of 70.76% from all of those species.

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