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Assessing The Role Of Mangrove Vegetation Structure In Shaping Potamids Gastropod (Telescopium Sp.) Distribution

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Abstract—Mangrove ecosystems have been proven to have a rich diversity of gastropods in coastal areas [1, 2]. They have a wide variety of gastropod families, such as Potamididae, Ellobiidae, Neritidae, and Assimineidae. In conjunction with mangrove trees, gastropods play a particularly important role in nutrient cycling within the mangrove ecosystem [10]. Besides playing a significant ecological role in the decomposition of organic matter and nutrient cycling within the mangrove floor, its presence also serves as a bioindicator of mangrove ecosystem health, making it a valuable species for monitoring environmental changes and assessing the success of conservation and restoration efforts. In this study, we aim to assess the current status of T.telescopium populations in relation to mangrove cover canopy, with a focus on understanding how habitat alteration affects their abundance, distribution, and ecological function. The results demonstrate consistently high canopy coverage in Teluk Awur Bay, with average values ranging from 71.952% to 78.966%, categorizing all stations under the "High" canopy cover class as defined by the Ministry of Environment standard. The total number of individuals recorded across four stations (St 1, 2, 3, and 5) is 191 individuals, with the highest abundance at Station 2 (65 individuals) and the lowest at Station 5 (29 individuals). The relatively high abundance of T. telescopium supports the interpretation of a healthy mangrove environment.

Keywords—Mangrove, Canopy Cover, Gastropods, Telescopium Telescopium,

I. INTRODUCTION

Mangrove ecosystems have been proven to have a rich diversity of gastropods in coastal areas [1, 2]. They have a wide variety of gastropod families, such as Potamididae, Ellobiidae, Neritidae, and Assimineidae [3]. Potamididae, one of the most abundant families of gastropods in mangrove ecosystems, is widely distributed across tropical and subtropical regions [3, 4]. Several species, such as Telescopium telescopium and Terebralia palustris, are commonly encountered in large numbers within mangrove habitats [3, 5]. The distribution of gastropods is related to the conditions in which the organisms live, for example, physical, chemical, and biological factors [6]. The structure of gastropod communities may be influenced by many factors related to water and soil quality, the presence of macrophytes, and the shading provided by riparian areas [7, 8]. Environmental factors are the key factor in the life of gastropods because the ability of gastropods to migrate is low, especially in mangrove ecosystems [6]. Sediment texture factors, temperature, salinity, pH, organic matter content, and oxygen influence the presence of gastropods [9].

In conjunction with mangrove trees, gastropods play a particularly important role in nutrient cycling within the mangrove ecosystem [10]. Gastropods contribute significantly to the organic detritus available, which is essential for the energy needs of surrounding aquatic biota [11]. Their interactions with mangrove trees further enhance nutrient cycling processes within these ecosystems and support the overall health and resilience of coastal environments. Gastropods also play a role in controlling seedling

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dispersal and reducing competition from mangrove species through selective predation on seedlings [12]. Understanding these processes is essential for gaining a better knowledge of how efficient ecosystems work.

The density of mangrove forests in Indonesia, estimated at 3.2 million hectares, is vital for coastal communities and ecological health [13]. Despite facing many ecological pressures on Java Island, the mangrove trees were still important as they provide essential services such as coastal protection and habitat for various marine species [14]. One such species is *Telescopium telescopium*, a gastropod that is closely associated with mangrove environments. Besides playing a significant ecological role in the decomposition of organic matter and nutrient cycling within the mangrove floor, its presence also serves as a bioindicator of mangrove ecosystem health, making it a valuable species for monitoring environmental changes and assessing the success of conservation and restoration efforts [12]. In 2013, Teluk Awur, the bay, which is located in Jepara City, Central Java, had a high diversity of gastropods with a medium density of mangrove forests [15]. Unfortunately, several areas have since been converted into aquaculture ponds, replacing rehabilitated mangrove zones and disrupting the ecological balance. In this study, we aim to assess the current status of *Telescopium telescopium* populations in relation to mangrove cover canopy, with a focus on understanding how habitat alteration affects their abundance, distribution, and ecological function. This research is expected to provide insights into the role of *T. telescopium* as an indicator species for mangrove ecosystem health and to support future conservation and management strategies in Teluk Awur.

II. RESEARCH METHODS

A. Site Location

This research was conducted in December 2024 at Teluk Awur Bay, Jepara, Central Java, Indonesia. Site location was determined using purposive sampling methods and divided into 4 stations at the rehabilitated mangrove area. Gastropod sample collection was taken using five square transects, sized 1m x 1m, placed inside a 10m x 10m transect of mangrove plot.

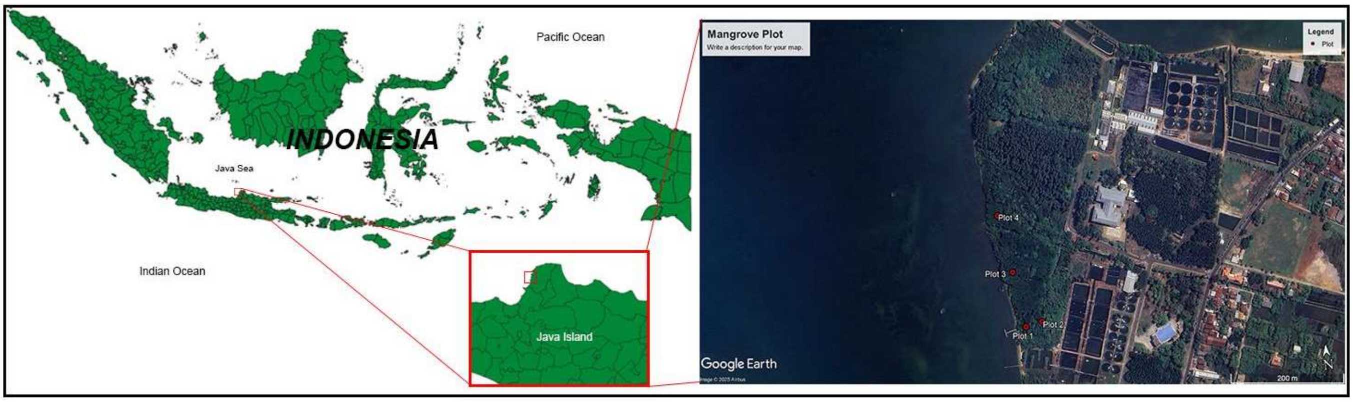

Figure 1. Mangrove Plot Location

B. Mangrove

Mangrove data collection refers to the research of Dharmawan and Pramudji (2017) which uses the plot method. Mangrove data collection using a 10m x 10m quadrant transect that is stretched on rehabilitated mangroves. Then measurements were taken including species type and stem diameter. Data collection of tree diameter is done at breast height (Diameter at Breast Height) (DBH) or ± 1.3 m. The measured tree categories have DBH (diameter ≥ 4 cm or trunk circumference ≥ 16 cm) tree diameter and species in the plot. Afterwards, the data was analyzed for mangrove density index using equation 1. [16]

$$K = I / A \quad \textbf{(1)}$$

Where :

K : Mangrove Density Index

I : number of individual, species

A : plot area (m^2)

C. Hemispherical Photography

Hemispherical photography data was collected using a smartphone camera. The cell phone was placed at chest level or 1/3 the height of the mangrove tree. The number of photos taken was determined based on the density of mangrove trees. This study was conducted 4 times, taking photos on one research plot. Photographs should not have grainy images, flares, or other objects. Image data processing into canopy cover is done with ImageJ software and equation 2 [17].

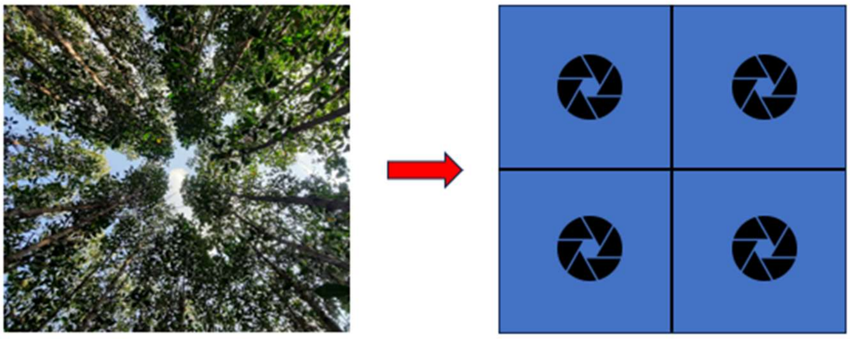

Figure 2. Illustration of a mangrove hemisphere picture collection

$$.C = \frac{P_{255}}{P_{tot}} x\, 100\ \% \quad \textbf{(2)}$$

Where :

C : Canopy cover percentage (%)

P_{255} : Number of pixels with value 255, canopy

P_{tot} : Number of pixels with value 0, sky

D. Gastropod

Sampling of gastropods was conducted using 1m x 1m quadrant transects placed on a 10m x 10m mangrove transects.. Gastropods were picked with hand picking method and identified based on physical traits such as shell form, breadth, and length [18]

1. Abundance

Abundance is defined by the number of species of type-i found per unit area (m^2)

$$A = \frac{xi}{ni} \quad \textbf{(3)}$$

Where :

A : abundance (ind/m^2)

xi : number of species type-i

ni : plot area (m^2)

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The Shannon-Wiener diversity index is classified into three levels: low (H'<2); moderate (<2H'<4), high (H'>4)

2. Morphometric

Morphometric measurements were performed using a caliper, including the length (A) and width (B) of the shell of gastropods [19].

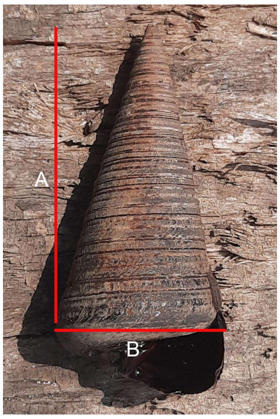

Figure 3. Illustration of Telescopium sp. measurement

III. RESULT AND DISCUSSION

3.1 Mangrove

3.1.1 Density

Based on the observation of mangrove vegetation, two types of mangrove species were discovered: *Rhizophora apiculata* and *Avicennia marina*. These two types of mangroves are commonly found in mangrove rehabilitation areas as they have high adaptability and protection against abrasion and sea waves [6]. These species are often used as rehabilitation plants in various regions because seeds are abundant, easy to grow, and have a high distribution level [20]. In addition, *Rhizophora apiculata* is one of the species that offers substantial economic benefits [21].

The data showed, station 4 has a high density among all the stations. This result could be attributed to several ecological factors, such as abundant food resources, optimal substrate type, suitable water quality parameters (e.g., temperature, salinity, dissolved oxygen), or reduced levels of predation and competition in the area. Another parameter to consider is the organic matter source, due to station 4, which lies adjacent to the river's entrance with fed by the culture pond outflow.

Figure 4. Mangrove species. *Rizhopora apiculata* (left) and *Avicennia marina* (right).

Table 1. Density of Mangrove

Mangrove Species	Density mangrove per station (ind/ha)			
	1	**2**	**3**	**4**
Rhizophora apiculata	1600	1675	1525	1850
Avicennia marina	50	-	-	-
Total	1650	1675	1525	1850

The results in Table 1 indicate that the mangrove density of the Teluk Awur is high. This is based on the decision of the Minister of Environment No 201 year 2004 divides mangrove density into 3 categories, namely high (> 1500 ind/ha), medium (>1000 - >1500), and low (< 1000). The average mangrove density ranged from 5950 to 484 ind/ha with the density of *Rhizophora apiculata* species ranging from 5900 ind/ha and *Avicennia marina* 50 ind/ha, respectively. This wide range in density suggests spatial variation in mangrove distribution across the observed plots. The predominance of *R. apiculata* indicates its adaptability and possible preference for the prevailing environmental conditions, such as salinity, tidal influence, and substrate type [22]. In contrast, the limited presence of *A. marina* may reflect its lower tolerance or competition with other species, or perhaps anthropogenic pressures in this area, such as the outflow of culture pond. This pressure could affect salinity fluctuation since *A.marina* shows better growth performance under high salinity conditions compared to Rhizophora [23].

3.1.2 Canopy Cover of Mangrove

Table 2. Canopy cover

Station	1				2				3				4			
Plot	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Coverage (%)	69,653	75,162	77,091	83,541	68,922	82,959	86,426	77,557	78,160	75,911	69,441	64,296	75,534	76,626	76,335	81,034
Average	76,362				78,966				71,952				77,382			
Categories	High				High				High				High			

The cover of the Awur Bay mangrove ecosystem has a canopy cover that falls into the high category. Ranging from 71.952% to 78.966%. This high mangrove canopy cover is one measure of the success of mangrove rehabilitation in Awur Bay. The dense canopy cover can play a role in the microclimate in the ecosystem and is directly related to the accumulation of organic matter in the area derived from mangrove litter. Furthermore, the canopy is crucial to the buildup of organic materials. The mangrove litter, which consists of fallen leaves, twigs, flowers, and fruit, is the principal source of detritus in the mangrove ecosystem. This organic material decomposes, enriching the sediment with nutrients, promoting microbial activity, and contributing to the production of peat. This, in turn, increases soil fertility and boosts the production of benthic and aquatic species.

3.2 Density of Gastropod

Gastropods	Station				Total
	St 1	St 2	St 3	St 5	
Telescopium telescopium	54	65	43	29	191

The results showed that there were a total of 191 individuals of T. telescopium found in the mangrove forest ecosystem of Awur Bay. The highest abundance of gastropods was found at station 2 which had an abundance of 65 ind/m2. Gastropod abundance is strongly influenced by environmental conditions. *T. telescopium* as a deposit feeder gastropod (using an extensible snout to swallow mud and detritus from the mud surface) will be abundant in areas with high organic matter, dissolved oxygen, and fine muddy substrate types [24].

3.3 Morphometric

3.3.1 Shell Length Measure

The results of sample measurements showed that T. telescopium varied in size between 2.5 cm - 11.04 cm. Gastropods were then categorized into 3 size groups, namely small, medium, and large as shown in the following graph. Based on the graph, station 2 was the location with the most large gastropods, while at station 5 the gastropod sample had the smallest average size of all stations.

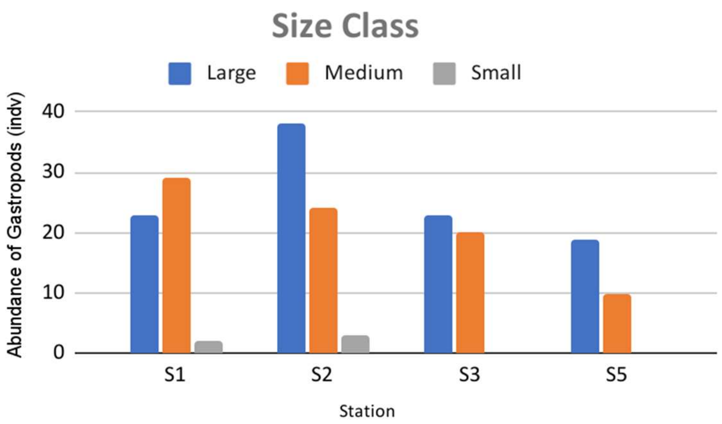

Figure 5. Size Class of *T.telescopium*

3.4 Relationship between Gastropods and Mangrove Ecosystems

Telescopium telescopium is a typical large gastropod that lives in coastal ecosystems, especially mangrove ecosystems. The mangrove ecosystem of Awur Bay is dominated by R. apiculata mangroves, making it a suitable habitat for gastropods. According to Kurniawati, *T. telescopium* was only found in abundance in several types of mangroves such as Rhizophoran [24], avicennia, and Soneratia. This is one indicator that these types of mangroves are suitable habitats for telescopium. According to Bengen, mangroves have the potential to be the main food source for biota in coastal ecosystems through their litter [25]. Organic matter from the litter is the main food of *T. telescopium*. Based on hemispherical data, the mangrove ecosystem of awur bay has a high mangrove density. Rhizophora species are mangroves that have the characteristics to live and grow on muddy substrates,

The high density of mangroves and muddy substrates is a characteristic that the area has a high concentration of organic material [26]. Mangrove density will produce more litter which is then decomposed by microorganisms into minerals, so that organic matter becomes increasingly. Gastropods tend to inhabit different microhabitats based on sediment size, canopy cover, tides and salinity [27]. Canopy cover can regulate microbenthic-scale primary productivity through feeding and crawling activities [28]. According spearman correlation, the results do not show a p-value significantly lower than 0.05, which means that the correlation between canopy cover and gastropod abundance is not statistically significant. This implies that, based on the available data, we cannot confidently conclude that a strong or consistent relationship exists between these two variables across the studied stations.

IV. CONCLUSION

In conclusion, the high canopy cover in Awur Bay not only reflects successful rehabilitation but also plays a fundamental role in maintaining ecological balance, supporting biodiversity, and providing ecosystem services crucial for both the environment and surrounding communities. The results demonstrate consistently high canopy coverage, with average values ranging from 71.952% to 78.966%, categorizing all stations under the “High” canopy cover class as defined by the Ministry of Environment standard. The total number of individuals recorded across four stations (St 1, 2, 3, and 5) is 191 individuals, with the highest abundance at Station 2 (65 individuals) and the lowest at Station 5 (29 individuals). The relatively high abundance of *T. telescopium* supports the interpretation of a healthy mangrove environment, as these organisms are bioindicators of ecosystem productivity and sediment quality. Statistically, the results do not show a *p*-value significantly greater than 0.05, which means that the correlation is not statistically significant.

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