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Short Communication: Structure and composition of mangrove vegetation in Lembar bay area, West Lombok District, Indonesia

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Abstract. *Sukuryadi, Harahab N, Primyastanto M, Hadi AP. 2021. Short Communication: Structure and composition of mangrove vegetation in Lembar bay area, West Lombok District, Indonesia. Biodiversitas 22: 5585-5592.* One of the potential natural resources of coastal areas in West Lombok District, West Nusa Tenggara Province, Indonesia is the 501.9-ha mangrove ecosystem. The purpose of this study was to analyze the structure and composition of mangroves in the Lembar bay area. The study used field observation methods based on predetermined plots. The results showed that the composition of mangroves in the Lembar Bay area consisted of *Avicennia alba* Bl, *Avicennia marina* (Forsk) Vierh, *Bruguiera cylindrica* (L) Bl, *Ceriop decandra* (Griff) Ding Hou, *Ceriop tagal* (Perr) C.B. Rob, *Lumnitzera littorea* (Jack) Voight, *Lumnitzera racemosa* Willd. Var, *Phemphis acidula, Rhizhopora stylosa* Griff, *Rhizophora apiculata* Bl, *Rhizophora mucronata* Lmk, and *Sonneratia alba* J.E. Smith. The mangrove vegetation at tree level was composed of 12 species dominated by *Rhizhopora stylosa* Griff and *Rhizophora mucronata* Lmk, with Importance Value Index (IVI) of 56.05 and 48.89, respectively, at sapling level 9 species dominated by *Rhizhopora stylosa* Griff, *Bruguiera cylindrica,* and *Rhizophora mucronata*, with IVI of 47.46, 33.33, and 31.07 respectively, and at the seedling level 7 species dominated by *Rhizhopora stylosa* Griff and *Rhizophora mucronata* Lmk, with IVI of 47.71 and 37.76, respectively.

Keywords: Composition, importance value index mangrove, structure, vegetation index

INTRODUCTION

Indonesia is a tropical country widely known to have high biodiversity, abundant natural wealth, widespread throughout the archipelago. According to Tuheteru and Mahfudz (2012), Indonesia has around 17,508 islands with a coastline of about 81,000 km. The beach is a border area between marine ecosystems and land ecosystems. Coastal forests are part of coastal and marine areas that can yield natural products. Mangrove forests have many ecological functions, namely as a nutrient provider, as a spawning ground, and as a place of enlargement for certain marine biota such as fish, shrimp, and crabs (Jesus 2012; Purwanti et al. 2018; Santos et al. 2014). Besides, it can reduce the impact of tsunami waves, prevent coastal abrasion, protect terrestrial ecosystems from wind and storms, prevent erosion and global warming, and produce raw materials for cosmetics, bioenergy, and pharmaceutical industries (Tuheteru and Mahfudz 2012).

The Food and Agriculture Organization (FAO) states that mangrove vegetation has socio-economic and environmental functions (Kustianti 2011). Typical mangrove vegetation shows a zoning pattern: closely related to soil type (mud, sand, or peat), exposure to wave action, salinity, and tidal influences (Serosero et al. 2020). Mangrove areas are fertile areas both in land and water because of the transportation of nutrients from the tides (Aminuddin et al. 2019; Hossain and Nuruddin 2016). Thus, mangroves are known as coastal area resources with high productivity (Nugraha et al. 2021; Yulianto et al. 2016). Therefore, the mangrove area has a strategic role ecologically and economically (Hidayatullah and Pujiono 2014). In Indonesia, mangrove areas that are constantly flooded even at low tide are generally dominated by *Avicennia alba* or *Sonneratia alba*, those inundated by moderate tides are dominated by *Rhizophora* sp, and those inundated only at high tide, more inland, are generally dominated by *Bruguiera* and *Xylocarpus granatum.*

Mangrove forest, as part of the coastal ecosystem, has decreased in area and function. According to Friess et al. (2019), there has been a global degradation of 5 million hectares (20%) of mangrove forests in the past 20 years. The decline in the quality and quantity of mangrove forests is caused by excessive forest exploitation, forest conversion into agricultural and fishery areas, settlements, industry, tourism, contamination, natural disasters, and sea-level rise due to global warming (Eddy et al. 2019; Mangaoang and Flores 2019; Nguyen et al. 2020; Rakhfid and Rochmady 2014; Rudianto et al. 2020).

Mangrove ecosystem in the coastal area and the small island of West Lombok with an area of 501.9 ha is one of the potential natural resources in West Lombok District. Spatially, the distribution of those mangroves can be grouped into three areas, namely the Bangko-Bangko and

Pelangan, Lembar and Sekotong, and Sepi bay areas. The area of mangrove forest in the Bangko-bangko and Pelangan areas is 178.4 ha which includes Bangko-Bangko, Labuhan Poh, Pelangan, Gili Gede and Gili Layar. The mangrove forest in the Lembar and Sekotong areas cover an area of 205.5 ha with a distribution covering Medang, Telaga Lupi, Empol, Buwur and Lembar Village. The mangrove forest in the Sepi bay area covers an area of 118.0 ha (DKP Lobar, 2016). Sukuryadi et al. (2020) and Sukuryadi et al. (2021) found the mangrove ecosystem in the Lembar Bay area was in poor condition: due to the conversion of mangroves into ports and ponds and the increasingly widespread logging of mangroves to meet the need for firewood which has reduced the area of mangrove forests. Syarifuddin and Zulharman (2012), Kusmana and Sukristijiono (2016), and Carugati et al. (2018) stated that many mangrove areas had been used as storage places for ships, ports, and settlement. If this happens continuously, it will cause damage to various growth strata, which will have a significant impact on the mangrove regeneration process in the future.

Analysis of vegetation is a way to study the species composition and structure of vegetation displayed quantitatively (Ali et al. 2018; Baderan et al. 2018; Frederika et al. 2021; Numbere 2018; Priosambodo et al. 2019). Vegetation analysis requires quantitative data to determine several indexes to know the structure, species abundance, distribution of vegetation in an ecosystem, and the relationship between the plants and environmental factors. Vegetation analysis in mangrove forests is one of the tools that can support conservation activities, especially in collecting data regarding the ecological characteristics of mangrove forests so that policies taken on mangrove forests can run well. This research will provide information on the composition of the species and the grouping of mangrove communities to be used in planning for the conservation of mangrove forest areas in Lembar Sub-district. The current condition of the mangrove vegetation structure can be used to determine the effect of ecosystem changes that occur as a result of the management actions taken (Avtar et al. 2021; Hanggara et al. 2021; Rajkaran 2011; Sukuryadi et al. 2020; Tetelepta et al. 2020). Therefore, the purpose of this study was to analyze the structure and composition of the mangrove vegetation in the Lembar bay area, West Lombok.

MATERIALS AND METHODS

Study area

The research was carried out in the mangrove ecosystem area of Lembar Bay, Lembar Sub-district, West Lombok District, West Nusa Tenggara Province, Indonesia, one of the sub-districts whose area is mainly in the coastal area (Figure 1). The area of the mangrove ecosystem that is used as the research location is 168.19 ha of the mangrove ecosystem in the Lembar and Sekotong areas. Based on the zoning plan for coastal areas and small islands of West Lombok District, the mangrove area in Lembar Sub-district is a mangrove ecosystem pilot area that has been divided based on a zoning system, namely core zones, buffer zones, and utilization zones. This is because, considering that the mangrove ecosystem has limitations and is vulnerable to pressures, both internal and external, that can reduce the quality and quantity of the ecosystem.

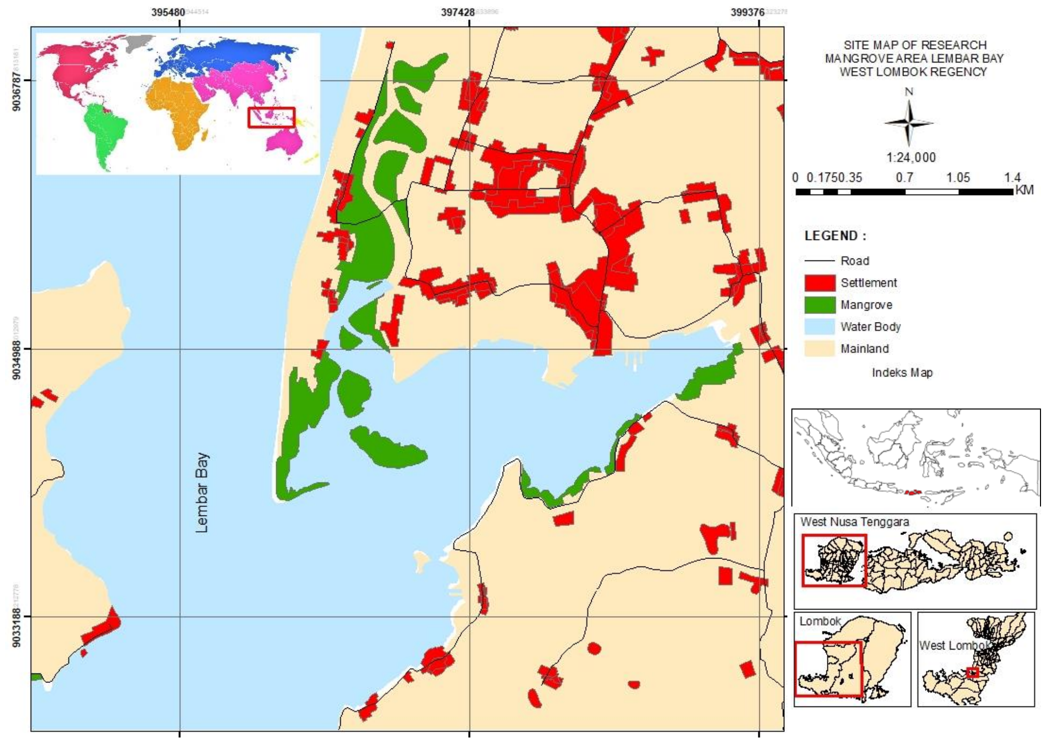

Figure 1. Site map of research in the mangrove ecosystem area of Lembar Bay, Lembar Sub-district, West Lombok District, West Nusa Tenggara Province, Indonesia

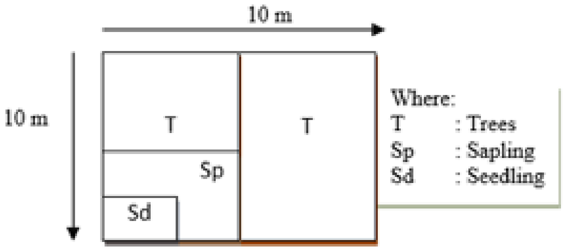

Figure 1. Schematic drawing of the Vegetation observation plot in the mangrove ecosystem area of Lembar Bay, Lembar Sub-district

Determination of plot sizes

Observations were made at all levels of growth of vegetation which was grouped into three levels, i.e., (1) the seedlings, namely small plants with a height of less than 1.5 meters, (2) saplings:, plants with a height of more than 1.5 meters and a diameter of smaller than 10 cm, and (3) trees: plants with a diameter of more than 10 cm and a height of more than 1.5 m. The method used was line plot sampling, with a plot size of 2 x 2m for seedlings, 5 x 5 m for saplings, and 10 x 10 m for trees (Kauffman and Donato 2012; Rosalina et al. 2014; Sofian et al. 2012). The total number of plots was 21. The species of each plant and the number of individuals within the plots were recorded. For trees, the diameter of each plant was measured. The unidentified plants were taken to the laboratory for identification.

Analysis of mangrove structure and composition

The collected vegetation data were then analyzed to determine the species importance value index using the formula 1-7 (Atsbha et al. 2019; Dodo & Hidayat (2020); Ismail et al. 2017; Kacholi 2014; Serosero et al. 2020; Tolangara et al. 2019).

$$\text{Species Density} = \frac{\text{Number of individuals}}{\text{Area of the measuring area}} \quad [1]$$

$$\text{Relative Density} = \frac{\text{Species Density}}{\text{Density of all species}} \text{ x } 100\% \quad [2]$$

$$\text{Species Dominance} = \frac{\text{Closing area of a species}}{\text{Area of measuring plots}} \quad [3]$$

$$\text{Relative Dominance} = \frac{\text{Species Dominance}}{\text{Dominance of all species}} \text{x} 100\% \quad [4]$$

$$\text{Species Frequency} = \frac{\text{The number of plots containing a species}}{\text{The sum of all plots}} \quad [5]$$

$$\text{Relative Frequency} = \frac{\text{Species Frequency}}{\text{Frequency of all species}} \text{ x } 100\% \quad [6]$$

$$\text{Important Value Index} = \text{Relative Density} + \text{Relative Frequency} + \text{Relative Dominance} \quad [7]$$

Importance value index (IVI) is the sum of the relative density, relative dominance, and relative frequency ranging from 0 to 300 for the tree level (Irwanto et al. 2020; Ismail et al. 2017; Kacholi 2014; Sofian et al. 2012; Yunus et al. 2020). For the seedlings and sapling, IVI is the sum of relative density with relative frequency, so the maximum importance value is 200.

RESULTS AND DISCUSSION

Importance Value Index (IVI) at tree level

As many as 12 mangrove species from 5 families at the tree level were found in the study site, namely *Avicennia alba* Bl, *Avicennia marina* (Forsk) Vierh, *Bruguiera cylindrica* (L) Bl, *Ceriop decandra* (Griff) Ding Hou, *Ceriop tagal* (Perr) CB Rob, *Lumnitzera littorea* (Jack) Voight, *Lumnitzera racemosa* Willd. Var, *Phemphis acidula, Rhizhopora stylosa* Griff, *Rhizophora apiculata* Bl, *Rhizophora mucronata* Lmk, *Sonneratia alba* J.E. Smith. According to Sandilyan and Kathiresan (2012), Baderan et al. (2018), Basyuni et al. (2018), and Onrizal et al. (2020) the diversity of mangrove species in an area can support the diversity of associated biota and become the main habitat for another biota.

Figure 2 shows that several species of mangroves, i.e., *B. cylindrica, C. tagal, R. stylosa, R. mucronata* dominated the mangrove vegetation in 2 plots, while several other species, namely *A. alba, A. marina, C. decandra, L. littorea, L. racemosa, P. acidula, R. apiculata, S. alba* were present only in some plots.

Figure 2 shows that *R. stylosa* and *R. mucronata* had the highest IVI, namely 56.05 and 48.98, respectively. Other dominant species were *B. cylindrica* with an IVI of 37.96 and *C. tagal*, 40.22. These four species are major mangrove plants that usually dominate the mangrove area and they are quite evenly distributed both in Eat Mayang area and Puyuhan area. *R. stylosa* and *R. mucronata* are commonly found in coastal mangrove forests in the Indo-Malesia region (Indonesia and Malaysia) which are the biogeographic centers of certain species such as *Rhizhopora, Bruguiera, Sonneratia, Avicennia, Ceriops,* and *Lumnitzera* (Analuddin et al. 2020; Dangan-Galon et al. 2016).

Importance Value Index at sapling level

At the sapling level, 9 mangrove species from 4 families were found, i.e., *A. alba, B. cylindrica, C. decandra, C. tagal, L. littorea, L. racemosa, R. stylosa, R. mucronata, S. alba* (Figure 3). *B. cylindrica, C. tagal, R. stylosa* and *R. mucronata* dominated the mangrove in all plots, while some other species, i.e., *A. alba, C. decandra, L. littorea, L. racemosa,* and *S. alba* were present only in a few plots. The IVI of each species of mangrove at the sapling level can be seen in Figure 3.

Figure 3 shows that *R. stylosa, B. cylindrica,* and *R. mucronata* had the highest IVI, i.e., 47.46, 33.33, and 31.07, respectively, while another species that had moderate IVI was *C. tagal* with an IVI of 27.68. These four species of mangrove plants at the sapling level were quite evenly distributed both in Eat Mayang and Puyuhan area.

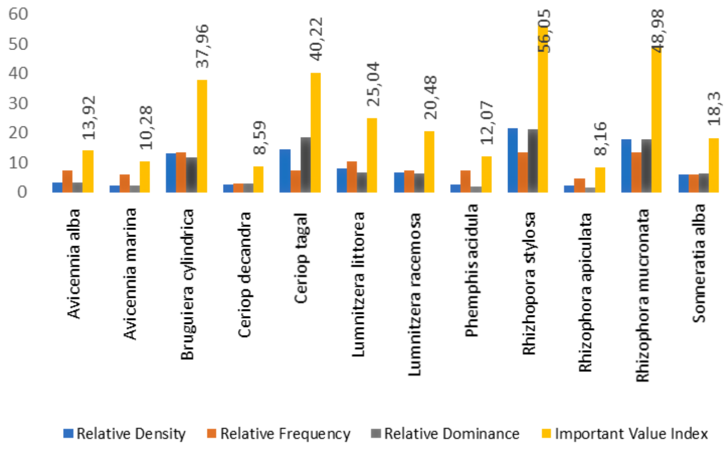

Figure 2. Importance Value Index (IVI) at tree level in the mangrove ecosystem area of Lembar Bay, Lembar Sub-district

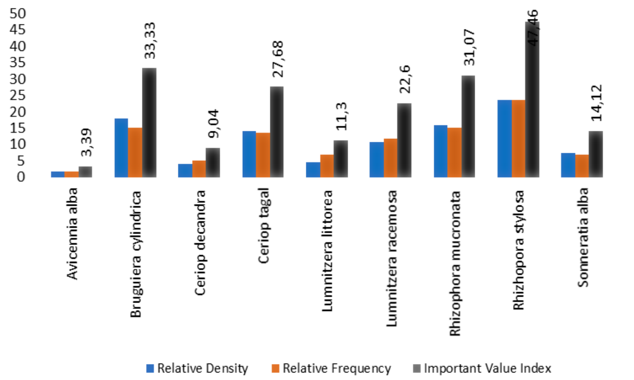

Figure 3. Importance Value Index at sapling level in the mangrove ecosystem area of Lembar Bay, Lembar Sub-district

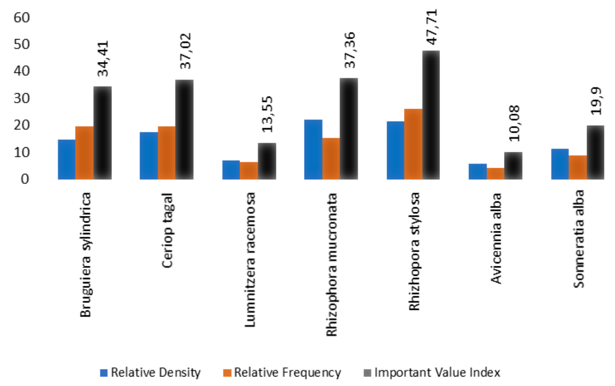

Figure 4. Importance Value Index (IVI) at seedling Level in the mangrove ecosystem area of Lembar Bay, Lembar Sub-district

Importance Value Index at seedling level

At seedling level, seven mangrove species from four families were found, i.e., *A. alba, B. cylindrica*, *C. tagal*, *L. racemosa*, *R. stylosa*, *R. mucronata*, *S. alba* as shown in Figure 4. Several species of mangroves, i.e., *B. cylindrica, C. tagal*, *R. stylosa* Griff, *R. mucronata* dominated the mangrove in all plots, while some other species, namely *A. alba*, *L. racemosa*, *S. alba* were present only in a few plots.

Species density is the number of individuals in a unit area. Figure 5 shows that the dominant mangrove species found at the tree, sapling, and seedling levels were *R. mucronata*, *R. stylosa*, *C. tagal*, and *B. cylindrica* which are members species of the Rhizhoporaceae family. The mangrove density was dominated by seedlings with 2530 individuals/ha (*R. mucronata*), followed by saplings with 800 individuals/ha (*R. stylosa*), and tree level with 276 individuals/ha (*R. stylosa*).

Discussion

Figures 2, 3 and 4 show IVI of each species at different growth level of mangrove plants. Importance value index integrates the relative density, relative frequency, and relative dominance of each species of vegetation (Araújo and Shideler 2019; Arbiastutie et al. 2021; Asadi et al. 2018; Ismail et al. 2017; Njana 2020; Scales and Friess 2019), so the difference in the IVI of each species reflects differences in the density, frequency, and dominance of each species in an area. Srikanth et al. (2015), Serosero et al. (2020), Hilmi et al. (2021), Numbere (2018), and Susi et al. (2018) say that differences in mangrove density are influenced by plant adaptation and human activities in the mangrove ecosystem. The highest level of mangrove vegetation density for each growth level of mangrove is located quite far from residential areas and ponds because the mangrove ecosystem in this area has a relatively low utilization rate by the local community.

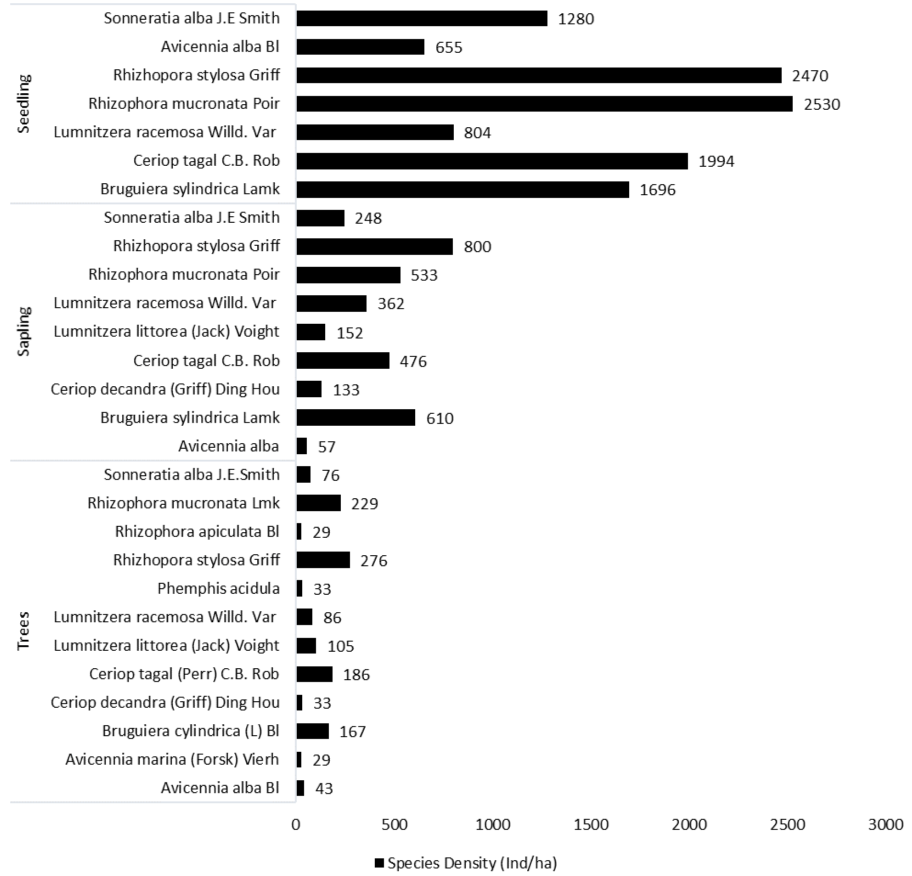

Figure 5. Density of mangrove species values (ind/ha) at seedling, sapling and trees level in the mangrove ecosystem area of Lembar Bay, Lembar Sub-district

According to Ismail et al. (2017), Bhadra and Pattanayak (2017), Tolangara et al. (2019), and Kacholi (2014), the dominant species in a plant community will have a high IVI, so the most dominant species will have the greatest IVI. Furthermore, Schaduw (2020), Romañach et al. (2018), and Scales and Friess (2019) added that species that have a higher IVI than the other species also have more control over their habitat than the other species. Figures 2, 3 and 4 show that *R. stylosa* was the most dominant species at all levels of plant growth. According to Galvani et al. (2016), the influence of a population on communities and ecosystems does not only depend on the species of the organization involved but also on the number or density of the population.

The highest IVI for each location and level of mangrove belonged to *Rhizophora* sp. Data from the Department of Marine Affairs and Fisheries of West Lombok District (2016), Syarifuddin and Zulharman (2012), and Imran and Ismail (2016) showed that the dominant species of mangrove in the Lembar bay area, West Lombok district was *Rizhophora sp* with an IVI that varied at various levels. The IVI in each of these locations shows the important role of a mangrove species on the marine biota community and the surrounding waters. Based on this, the species of mangrove that has a strategic role in ecology and the environment that stands out is *Rhizophora* sp. The high ecological role of the mangrove ecosystem in some of these locations can provide economic benefits for the local community, especially in the provision of crabs, shellfish, and shrimp. The dominance of *Rhizophora* sp. in this area is strongly influenced by the sandy and muddy habitat factors as described by Delvian et al. (2019), Setyawan et al. (2014), Usman et al. (2013), and Iswahyudi et al. (2019) that *Rhizophora* sp. is a species of mangrove tolerant to environmental conditions, especially on sandy and muddy substrates and has seeds that can germinate while still in the parent and have a large area to live so that they can survive. It grows well to the interior as long as it still gets a good supply of saltwater. Besides that, according to Sari et al. (2019), Srikanth et al. (2015), Utina et al. (2019), and Syarifuddin and Zulharman (2012) that mangrove plants have unique adaptability to the environment such as adaptation to low oxygen levels, adaptation to high salinity, adaptation to unstable soil.

The dominant mangrove species at each tree, sapling, and seedling level at the study site were *R. mucronata*, *R. stylosa*, *C. tagal*, and *B. cylindrica*. According to Utina et al. (2019), All of these dominant species are mangrove species in the Rhizhoporaceae family. This family was found more often than the other families in the study site. It means that the Rhizophoraceae family had a wide distribution area. Meanwhile, according to Priosambodo et al. (2019), Composition and structure of mangrove vegetation in Tamo rocky cliff beach Majene West Sulawesi dominated by monoculture stake of *R. stylosa* which is an important value index range between 182.90 - 300. Sari et al. (2021). The mangrove forests in Jakarta Bay have an average Important Value Index (IVI) for all levels of life stage 95.7 with the mangrove forests were dominated by *A. marina*, *Avicennia lanata*, *R. apiculata*, *Sonneratia caseolaris*, and *S. alba*. Based on the research results of Eddy et al. (2019), the dominant species of tree, sapling and seedling levels in the Air Telang Protected Forest, South Sumatra were *Nypa fruticans*, *R. apiculata* and *Acrostichum aureum*, respectively. Rumondang et al. (2021), The dominant species in Angke Kapuk Mangrove Protected Forest (AKMPF) DKI Jakarta were *A. marina* for a tree with its regenerations and *A. aureum* for groundcover. According to Ali et al. (2018), The *A. marina* and *R. mucronata* were two mangrove species with the highest important value index at each growth level in the Ujungpangkah coastal, region Gresik, East Java Province. The highest value index (71.73) was attributed to *A. marina* for the tree level, while *R. mucronata* was dominant at the sapling level (82.55). Ismail et al. (2021), the highest Importance Value Index (IVI) was at 221 for *R. apiculata* and at 220 for *S. caseolaris* in the Segara Anakan lagoon and its surrounding area, Cilacap District.

In conclusion, the mangrove composition consisted of 12 species and *Rhizhopora stylosa* Griff was the most dominant species at tree, sapling and seedling levels.

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