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Ecological Study of Mangrove Forest in Mandeh Bay, West Sumatra, Indonesia: I. Structure and Composition of True Mangrove.

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ABSTRACT

The objectives of this research was to clarified mangrove forest structure and species composition in Mandeh Bay, West Sumatra Indonesia. This research was applied in two ecological view such as two plots in mainland and one plot in Island area. The sampling method used a 10 X 10-m quadrat for trees. A 5 X 5-m subplot and a 2 X 2 m subplot, for saplings and seedlings respectively, were made in each of the main plots at 25 m intervals. Species found at all stations for all growth category (tree, sapling and seedling) were *Rhizophora apiculata*. Each location showed their own characteristics such as for *Scyphiphora hydrophylacea* found only in Cubadak Island, *Bruigiera gymnorhiza* and *Sonneratia alba* were found only at Cacocok village. Important value index (IVI) obtained from mangrove vegetation analysis were used as indicators for determining mangrove forest structure. *R. apiculata* was found dominating with higher of IVI. In Cubadak Island we predict the next regeneration will be *S. hydrophylaceae*, in Mandeh Village will be *S. alba* an in Carocok will be *Ceriops tagal*. Based on the above result *R. apiculata* should be for future of mangrove forest development.

Keywords: composition, structure, mangrove, Mandeh Bay, West Sumatra

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INTRODUCTION

Indonesia as an archipelago state, consisting of more than 17.508 islands with a coastline of 81.000 km long, has a very extensive mangrove forests. The mangroves provide live supports for a diversity of marine biota, such as providing breeding sites, nursery grounds, feeding sites and protection [1]. The existing mangrove forest area in Indonesia of about 3,244,018 ha and that of those mangroves 30.7 % were in good condition, 27.4 % moderately destroyed and 41.9 % heavily destroyed. The extensive clearing of mangrove over the last 50 years has caused many area to vanish worldwide, or they are now degraded sites with secondary vegetation, or rehabilitated areas with modified species and community characteristics [2]. Therefore, mangrove ecosystems have received a great deal of scientific attention. The distribution of individuals within it, as well as factors which have molded this habitat have become a recurrent concern in studies on mangrove ecology.

Mangrove ecosystem has a role ecology, socioeconomic and socio-cultural importance. Functions include a mangrove forest ecological remediation of contaminants, maintaining the stability of coastal erosion, sea water intrusion and storm surge and keeping the naturalness of habitat [3]. The geographic distribution, species composition, and structural features of mangrove forests are primarily determined by the interactions among regional factors [4]. This environmental variability results in different mangrove community types with divergent structure and floristic composition distributed along environmental. The diverse plant and animal life associated with mangrove ecosystems can also provide opportunities for nature education, tourism and scientific study, thereby providing further social and economics values [3].

In the present study, therefore, our focus on floristic and structural aspects, which are important for establishing conservation areas and subsequent management and monitoring, in particular in view of the threat from increasing ecotourism development and conversion for economic and physical development in the regency. This study aimed to identify and analyze the composition and diversity of mangrove treespecies in the study site, and to determine the forest structure and current natural regeneration status of the mangrove tree species between island and mainlandarea. Knowledge of the exact species composition is a basic and important prerequisite, which can improve the understanding of the structure and present condition of the mangroves. This knowledge is essential for conservation and sustainable management of the mangroves along the Mandeh Bay. Therefore, the specific objectives of this study were: (1) to describe the species composition, forest structure and regeneration status (species, density, frequency and the importance value) of mangroves in the Mandeh Bay, West Sumatra, Indonesia; (2) to compare this structure andregeneration status between two ecological view of mangrove distribution.

MATERIALS AND METHODS

Study site



Figure 1. Location of the study area at Mandeh Bay, West Sumatra, Indonesia
I = Cubadak Island, II = Mandeh village, III = Carocok village

This study was carried out in the natural mangrove stand situated in the coast of Mandeh village, S 1° 13'18", E 100°23'24", which is located 50 km South of provincial capital, Padang city, West Sumatra, Indonesia (Fig. 1). Mandeh tourism area is combination among natural hills with beautiful bay which is decorated by clusters of small islands locating in the middle of Carocok Tarusan bay. This bay is quite flat and has no waves because in surrounding area there are some small islands, among others Traju, Setan Kecil, big and small Sironjong Island and Cubadak Island. This site was selected based on accessibility and safety in going to and from the natural mangrove stands.

Sampling procedure

Terraced line method was applied in this research. Three sites were selected considering the distance from the mouth of the bay. Each site consisted of two belt transects located close to each other. In each Station two transects were demarcated with distances of 25 m between them. Each plot measured 10 x 10 m for tree, 5 x 5 m for sapling and 2 x 2 m for seedling. In each plot, we measured diameter at breast height (DBH, 1.3 m above substrate). All data is recorded in tallysheet that have been made. As for species that have not been identified to be sampled for further identification in Herbarium, Department of Biology, University of Andalas and matched with herbaria existing mangrove plants.

Data analysis

The Importance Value Index (IVI) which indicates the structural importance of each species in the community was obtained by adding the percentage values of Relative Frequency (RF), Relative Dominance (RDom) and Relative Density (RD), where:

$$RF = (\text{Number of occurrence of the species} / \text{Number of occurrence of all the species}) \times 100 \%$$

$$Rdom = (\text{Total basal area of the species} / \text{Total area of all the species}) \times 100 \%$$

$$RD = (\text{Number of individuals of the species} / \text{Number of individuals the species}) \times 100 \%$$

RESULTS AND DISCUSSION

Species composition

Species found at all stations at Mandeh Bay for all growth category (tree, sapling and seedling) were *Rhizophora apiculata*. The detail of species composition is shown in Table 1. We found four species of true mangrove in Cubadak Island, five species in Mandeh village and eight species in Carocok village. Each Station of research was showed their own characteristics such as for *Scyphiphora hydrophyllacea* found only in Cubadak Island, *Bruguiera gymnorrhiza* and *Sonneratia alba* were found only at Carocok village. Genera such as *Sonneratia* which are regarded as light demanding taxa are found in more exposed areas while *Rhizophora apiculata* are found in deep muddy areas. Furthermore, all growth category of *Rhizophora apiculata* exist in Mandeh bay mangrove forest therefore it could be concluded that their regeneration process was complete. This phenomenon also indicated that future of mangrove forest development.

Table 1. Species composition of mangrove forest in Mandeh Bay

Family	Genus	Species	Cubadak Island			Mandeh village			Carocok village		
			T	Sp	Sd	T	Sp	Sd	T	Sp	Sd
Rhizophoraceae	Rhizophora	<i>R. apiculata</i>	o	o	o	o	o	o	o	o	o
		<i>R. mucronata</i>	-	-	-	-	o	-	o	o	o
	Ceriops	<i>C. tagal</i>	-	-	-	o	o	-	o	o	o
	Bruguiera	<i>B. gymnorrhiza</i>	-	-	-	-	-	-	o	o	o
Sonneratiaceae	Sonneratia	<i>S. alba</i>	-	-	-	-	-	-	o	o	o
Rubiaceae	Scyphiphora	<i>S. hydrophyllacea</i>	o	o	-	-	-	-	-	-	-
Combretaceae	Lumnitzera	<i>L. littorea</i>	o	o	-	o	o	-	o	o	-
Meliaceae	Xylocarpus	<i>X. granatum</i>	-	o	-	o	o	-	o	o	-
Pteridaceae	Acrostichum	<i>A. aureum</i>	-	-	-	-	-	-	-	-	o

Note : T = Tree, Sp = Sapling, Sd = Seedling, o = Found, - = Not found

Comparison of tree composition based on family, genus and species showed various characteristics. However, tree composition in Mandeh Bay was not so different compare to other mangrove forest ecosystem as shown in Table 2. Considering species number, our study was also not so different compare to other mangrove community except for Sematan, Serawak [3] which have higher tree species, genus dan family. This phenomenon indicated that condition of the physiographic coast is very diverse and biota in the mangrove forest has a range of ecological separate causes the formation of a wide range of community and zoning in species composition is different from place to place other.

Table 2. Comparison tree species composition of Mandeh Bay to other mangrove forest.

	Location	Family	Genus	Species	Sources
1	Mandeh forest Bay	6	8	9	
2	Karimunjawa National Park	3	4	5	Hartoko <i>et al</i> , 2015
3	Raja Ampat, Papua	7	10	11	Prawiroatmodjo and Kartawinata, 2014
4	Palawan, Philipines	3	4	5	Abino <i>et al</i> , 2014
5	Sematan, Serawak	9	12	18	Ashton and Machintosh, 2002
6	Kuala Selangor, Malaysia	6	6	8	Zhila <i>et al</i> , 2014

Structure

Important Value Index

The results of the analysis of vegetation plant species found in Region Mandeh can be seen the number and importance of each level of the tree, sapling and seedling. Of the nine species of plants at the level of the tree, sapling and seedling contained in the observation plot, the type most dominating on the location of the mainland and the island was *Rhizophora apiculata*. Among the species recorded in the mangrove stand, *R. apiculata* was found dominating the mangrove forest with various of IVI as shown in Table 3. Futhermore, It was followed by *Lumnitzera littorea* and *Xylocarpus granatum*. The type and amount of vegetation that is different from the location of the mainland and the island was strongly influenced by the surrounding environment so that the existence and the number of individuals were different. The difference is caused by physiographic beach each different location. The importance value of a species was determined based on the total contribution that a species made to the community in relation to the number of plants within the quadrats (relative abundance), its influence on the other species through its competition, shading, or aggressiveness (relative dominance), and its contribution to the community by means of distribution (relative frequency) in a study plot. *Rhizophora apiculata* and *Lumnitzera littorea* jointly dominated the forest at sapling and tree stages, confirming themselves that their dynamic good regeneration ensure the species will stay in the community unless severe perturbation interferes and stimulates the successional changes to set in. The above two species were complemented by less prevalent but important species.

Tabel 3. Important Value Index (IVI) of mangrove forest in Mandeh Bay

Species	Important Value Index (%)								
	Cubadak Island			Mandeh village			Carocok village		
	T	Sp	Sd	T	Sp	Sd	T	Sp	Sd
<i>Rhizophora apiculata</i>	250.16	225.71	200	166.11	125.92	200	48.44	67.66	86.17
<i>Lumnitzera littorea</i>	19.60	17.46	-	64.98	92.93	-	8.22	3.66	-
<i>Xylocarpus granatum</i>	-	13.30	-	38.18	7.15	-	9.78	6.33	-
<i>Rhizophora mucronata</i>	-	-	-	19.58	15.80	-	29.42	22.63	13.21
<i>Ceriops tagal</i>	-	-	-	11.14	58.20	-	52.89	64.43	20.13
<i>Schyphiphora hydrophyllacea</i>	30.24	43.54	-	-	-	-	-	35.45	8.38
<i>Sonneratia alba</i>	-	-	-	-	-	-	132.95	35.26	31.56
<i>Bruguiera gymnorhiza</i>	-	-	-	-	-	-	18.30	32.90	8.82
<i>Acrostichum aureum</i>	-	-	-	-	-	-	-	-	22.04

Note : T= Tree, Sp=Sapling, Sd=Seedling

In Cubadak Island we predict the next regeneration will be *Schyphiphora hydrophyllaceae*, in Mandeh Village will be *Sonneratia alba*. In Carocok village they have complete regeneration stage for *Ceriops tagal* included tree, sapling and seedling stage. They are various of dominant species in each mangrove ecosystem

as shown in Table 4. Mainly Rhizophoraceae was occupied mangrove ecosystem in Indonesia and other mangrove ecosystem. The mangrove forests in Region Mandeh have importance value index was low when compared to the mangrove forests in Karimunjawa. But higher when compared with Rajaampat (Indonesia)[1], Palawan (Philippines)[4] and Kuala Selangor (Malaysia)[5]. Our study indicated that the mangrove ecosystem was similar to Rajaampat and Karimunjawa [6]. The mangrove forests in the Mandeh Bay should, by any means, be conserved, managed and maintained as the green belts, whose width should satisfy the requirements and criteria that have been developed for ecotourism and conservation term. The relationship between tourist and conservation can be a symbiotic one. If tourism is properly controlled, it can create the conditions necessary to support the process of conservation through productivity planning and comprehensive management.

Tabel 4. Important Value Index (IVI) of Mandeh mangrove forest to other mangrove forest.

Species	IVI (%)			Location
	T	Sp	Sd	
<i>Rhizophora apiculata</i>	154.90	139.76	162.06	Mandeh forest area
<i>Sonneratia alba</i>	115	105	120	Raja Ampat, Papua
<i>Rhizophora mucronata</i>	217.39	-	-	Karimunjawa, National Park
<i>Rhizophora mucronata</i>	80.30	-	-	Palawan, Philippines
<i>Bruguiera parviflora</i>	70.96	-	-	Kuala Selangor, Malaysia

Note : T= Tree, Sp=Sapling, Sd=Seedling

CONCLUSION

The results of data analysis and discussion that has been done to the vegetation structure and the species composition in Mandeh Bay concluded that it was found nine species. Species found at all stations at Mandeh Bay for all growth category (tree, sapling and seedling) were *Rhizophora apiculata*. Four species of true mangrove was found in Cubadak Island, five species in Mandeh village and eight species in Carocok village. Among the species recorded in the mangrove stand, *R. apiculata* was found dominating the mangrove forest with various of IVI. The type and amount of vegetation that is different from the location of the mainland and the island was strongly influenced by the surrounding environment so that the existence and the number of individuals were different. Furthermore, all growth category of *Rhizophora apiculata* exist in Mandeh bay mangrove forest therefore it could be concluded that their regeneration process was complete. This phenomenon also indicated that future of mangrove forest development.

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