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Short Communication: Species composition and density of mangrove forest in Kedawang Village, Pasuruan, East Java, Indonesia

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Abstract. *Isroni W, Islamy RA, Musa M, Wijanarko P. 2019. Short Communication: Species composition and density of mangrove forest in Kedawang Village, Pasuruan, East Java. Biodiversitas 20: 1688-1692.* Mangrove is one of ecosystems located in estuary and shallow coastal waters and its existence has a significant role for life. The aim of this study was to identify species composition and density of mangrove forest in Kedawang village, Nguling Sub-district, Pasuruan District, East Java, Indonesia. Survey method using belt transects was carried at three sampling points. Results of this study showed that mangrove vegetation in Kedawang includes five species from three families, namely Avicenniaceae (*Avicennia alba* and *Avicennia marina*), Rhizophoraceae (*Rhizophora apiculata* and *Rhizophora mucronata*), and Sonneratiace (*Sonneratia alba*). At sampling point 1, *A. alba* dominated with a density of 37 individuals/ha at tree level, 380 individuals/ha at pole level and 3100 individuals/ha at stake level. At sampling point 2, the tree level was dominated by *A. alba* with 142 individuals/ha, while *R. mucronata* dominated the pole and stake level with 1300 and 1467individuals/ha, respectively. At sampling point 3, the pole and stake level was dominated by *A. alba* with 167 and 933 individuals/ha respectively, while *A. marina* dominated the sapling level with 800 individuals/ha. At all stations, the density at stake level is greater than that tree level. Therefore, it is necessary to carry out conservation efforts in the form of protection combined with restoration by enrichment planting at all study locations to increase the diversity and density of mangrove vegetation.

Keywords: *Avicennia marina,* forest, mangrove, *Rhizopora apiculata, Sonneratia alba*

INTRODUCTION

Mangrove is one of ecosystems located in estuary and shallow coastal waters. In the tropics, mangrove forest is the dominant ecosystem type in estuarine area. The existence of mangroves has a significant role for life since in mangrove ecosystem there are various types of biological resources that can be utilized for human welfare (Tuwo 2011). Ecosystem of mangrove is ecologically and economically importance (Shing et al. 2014). Mangrove forest, which is in between land and sea interface, provides food, breeding grounds and nursery sites for a variety of terrestrial and marine organisms (Igulu et al. 2014). Mangrove forest is highly productive ecosystem with rates of primary production are equal to those of tropical humid evergreen forests, accumulating carbon in tree biomass and most of this carbon is lost by decomposition and exported to adjacent ecosystems (Alongi 2002). Mangroves also play a key role in human livelihoods, being heavily used for food, timber, fuel and medicinal purposes (Saenger et al. 2002). They serve as protection from catastrophic events, such as tsunami, tropical cyclones, and tidal bores and can dampen shoreline erosion (Alongi 2008). While the socio-economic functions of mangrove ecosystem include as a source of building materials, wood, medicines, food, and beverage ingredients as well as areas for agriculture, fisheries and tourism (Anwar and Gunawan 2006).

Nowadays, in addition to intense local and regional impacts on mangroves, global climate change is putting pressure on the dynamics of mangrove ecosystems and their communities with scale and intensity are still uncertain (FAO 2007). Changes in temperature, rainfall, and elevations of sea level have the potential to change existing hydrological and biogeochemical characteristics, threatening the biodiversity and ecological balance of mangroves (Gilman et al. 2008; Soares 2009). These dynamics also occur in coastal mangrove forest in Pasuruan District, East Java Province which has been degraded in both the extent of area and biological diversity. The main causes of the disturbances in the area are economic factors and the lack of understanding of the people in Pasuruan, especially in Kedawang village, about the ecological functions of mangrove forests, leading to increased illegal logging and the conversion of mangrove forests into ponds (Chatarina et al. 2011).

The structure and composition of mangrove species directly influence the conditions and functioning of mangrove forests, and its alteration may affect the distribution and abundance of fauna (Soares 1999; Cavalcanti et al. 2009). Therefore, characterization of mangrove forest constitutes an important tool in understanding how this ecosystem responds to existing environmental conditions, aiding in studies to preserve its existence. As an example, extracting or cutting mangrove trees for land conversion will reduce the energy available within the ecosystem, decreasing productivity and leading to smaller structural vigor of forest, especially in term of average height, diameter, basal area and density of mangrove trees (Peria et al. 1990; Souza and Sampaio 2001; Atheull et al. 2009). The aim of this study was to identify species composition and density of mangrove forest in Kedawang village, Pasuruan District, East Java Province, Indonesia.

MATERIALS AND METHODS

Study location

This research was conducted at mangrove forest in Kedawang village, Nguling Sub-district, Pasuruan District, East Java Province, Indonesia from January to February 2018 (Figure 1). Point and sampling locations were determined based on differences in land use. Determination of stations was done by purposive sampling, which is a method of determining the location of data collection carried out based on the consideration of individuals or researchers at the location of the study (Fachrul 2006). The research station was determined subjectively based on the representativeness of the location according to topographical condition as well as the characteristics of the region (Juwita et al. 2015). Sampling locations were divided into three locations: (i) *Sampling point 1:* near the boat port and close to the residential area; (ii) *Sampling point 2:* within the mangrove forest area and located 200 meters to the east from sampling point 1. This location is an area near the coast and there is a river flow; (iii) *Sampling point 3*: within the mangrove forest area and located 500 meters to the east from sampling point 2. This location is near the beach in which there is an area of aquaculture.

Sampling procedures

The method used for mangroves sampling was belt transect with three replications for each station. The choice of belt transect was based on the richness and diversity of mangrove species in the study location with consideration to the general appearance of the stand, so that the profile diagram created can represent the mangrove vegetation in that location. The belt size of the transect was 60x10 m^2. Six squared plots with size of 10x10 m^2 were created for data collection. The direction of transects from sea/estuary to land was expressed as the x axis, while the width of the transect as the y axis and the vertical direction as the z axis. There was obtained x axis with 60 m length, y axis with 10 m width, and z axis with 20 m height. The z axis determination of only 20 m was based on the fact that mangrove trees in the research location were <20 m high. Similar method of belt transect also was used in the analysis of vegetation composition and structure by Setyawan et al. (2005). All tree, sapling and shrub species within the plots were sampled and identified.

Species identification referred to published method (Backer and Bakhuizen van den Brink 1963; Tomlison 1986; Kitamura et al. 1997; Ng and Sivasothi 2001a,b). Furthermore, all trees, saplings and shrubs were numbered and their positions were determined against the x and y axis, then were measured of the total height, height of the first branch, width and length of the canopy, and diameter at breast height (diameter at breast high/DBH: 130 cm), and were drawn vertically on graph paper. Fallen trees were recorded of their length, diameter, and position on the x and y axes, and drawn on graph paper. The data was then tabulated followed by projecting the canopy onto the surface of forest floor to create vertical profile diagram of the vegetation. Based on this forest profile, several tree strata were determined (Aumeeruddy 1994; Baker and Wilson 2000). The determination of tree strata depended on personal decision of the researcher (Grubb et al. 1963).

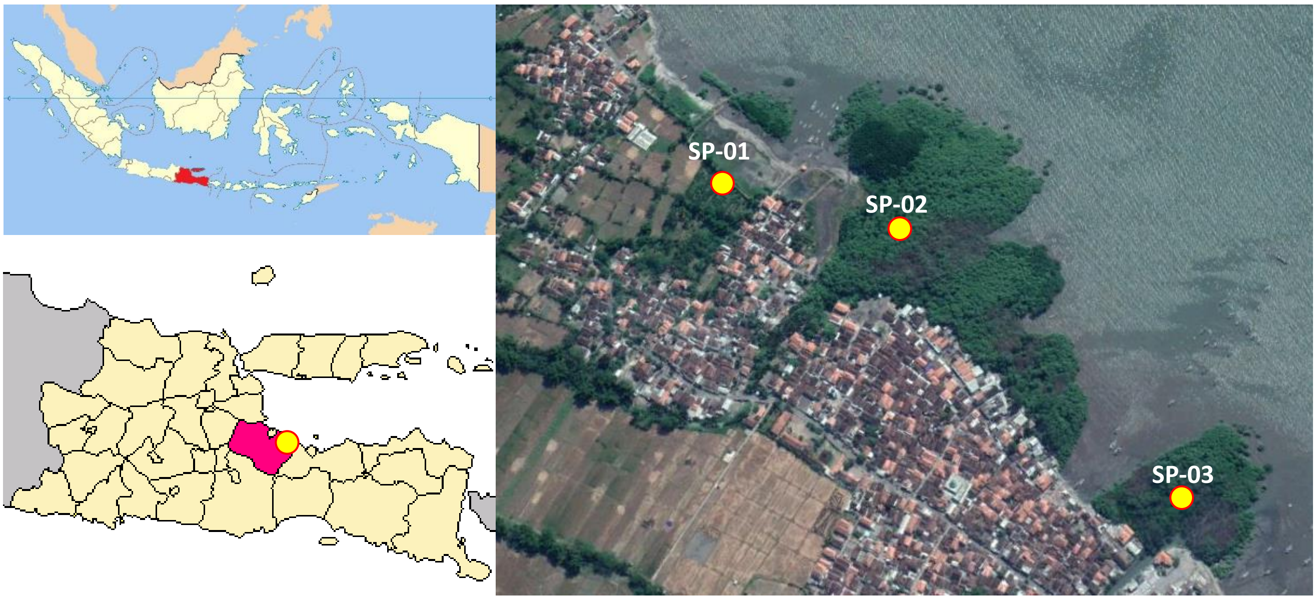

Figure 1. Sampling point location at mangrove forest in Kedawang village, Nguling Sub-district, Pasuruan District, East Java Province, Indonesia. SP-01: Sampling Point 1, SP-02: Sampling Point 2, SP-03: Sampling Point 3

RESULTS AND DISCUSSION

Mangrove vegetation

There were five species from three families found at the studied area of mangrove forest in Kedawang village, Nguling Sub-district, Pasuruan District, namely *Avicennia alba* and *Avicennia marina* (Avicenniaceae), *Rhizophora apiculata* and *Rhizophora mucronata* (Rhizophoraceae), and *Sonneratia alba* (Sonneratiaceae). The distribution of mangrove species in each sampling point is shown in Table 1. Based on Table 1, *A. alba* was found at each plot of all sampling points, describing the condition of mangrove vegetation in Kedawang village. While *S. alba*, *R. apiculata*, and *A. marina* were rarely found.

Sampling point 1

There were only one species of mangrove found at sampling point 1, i.e., *A. alba* from Avicenniaceae family with density of 37 trees/ha, 380 poles/ha and 3100 stakes/ha (Figure 5). Sampling point 1 only had *A. alba* which is presumably because the state of the mangrove vegetation in this area is still natural and is located directly opposite to the sea with soil composed by sandy substrate. Avicenniaceae zone is located at the farthest or closest to sea where the condition of the soil is rather soft (shallow) muddy (Pramudji 2001). *Avicennia* spp. is a genus that has the ability to tolerate a wide range of salinity, even this species grow in coastline areas that have high salinity (Pramudji 2000). Based on Figure 5, the density of *A. alba* at stake level is greater than of trees and saplings.

Sampling point 2

At sampling point 2, there were three species of mangrove, i.e. *A. alba* (Avicenniaceae), *R. mucronata* (Rizhophoraceae) and *S. alba* (Sonneratiaceae) (Figure 6). At tree level, *A. alba* had the highest density with 142 individuals/ha while *R. mucronata* and *S. alba* consist of 17 individuals/ha for each species. The high density of *A. alba* species at sampling point 2 is likely because this station is natural mangrove vegetation where the dominance of *A. alba* is common.

At pole level, mangrove species with the highest density was *R. mucronata* with 1300 individuals/ha while *A. alba* had density of 833 individuals/ha. The high density of *R. mucronata* is understandable as this area had been the location of planting of *R. mucronata*.

At stake level, *R. mucronata* was also the species with the highest density with 1467 individuals/ha, while *S. alba* was the lowest with 13 individuals/ha. This is likely because the sandy clay substrate at this station which is not suitable for the life of *S. alba* as according to Noor et al. (1999) *S. alba* commonly grows on sandy beaches or even rocky beaches.

Based on density, species that dominates sampling point 2 at tree level was *A. alba* while at the levels of pole and stake was *R. mucronata*. The density of *R. mucronata* at stake level is greater than its density at tree level because *R. mucronata* have been planted at this location. Therefore, conservation effort in the form of protection is necessary to maintain the planted species grow well until they reach maturity.

Sampling point 3

There were three species of mangrove at sampling point 3, including *A. alba* and *A. marina* (Avicenniaceae) and *R. mucronata* (Rizhophoraceae). The mangrove vegetation at tree level in sampling point 3 was dominated by *A. alba* with density of 167 individuals/ha. Similarly, at pole level, mangrove species with the highest density was *A. alba* (933 individuals/ha). In agreement with other sampling units, the high density of *A. alba* at tree and pole level is because these species have been naturally grown in mangrove forest in Kedawang village. Different composition is shown at stake level in which *A. marina* dominated the area with 800 individuals/ha followed by A. alba and R. apiculata with density of 666 and 133 individuals/ha, respectively.

Figure 2. Sampling point 1

Figure 3. Sampling point 2

Figure 4. Sampling point 3

Table 1. Vegetation and distribution of mangrove at the studied areas in mangrove forest of Kedawang village, Nguling Sub-district, Pasuruan District, East Java Province, Indonesia

Family	Species	Sampling point 1			Sampling point 2			Sampling point 3		
		1	2	3	1	2	3	1	2	3
Avicenniaceae	*Avicennia alba*	+	+	+	+	+	+	+	+	+
	Avicennia marina	-	-	-	-	-	-	+	-	-
Sonneratiaceae	*Sonneratia alba*	-	-	-	+	+	-	-	-	-
Rhizophoraceae	*Rhizopora mucronata*	-	-	-	+	+	+	-	-	-
	Rhizophora apiculata	-	-	-	-	-	-	+	-	-

Note: 1, 2 and 3 refers to replication of sampling. (+): found; (-): not found

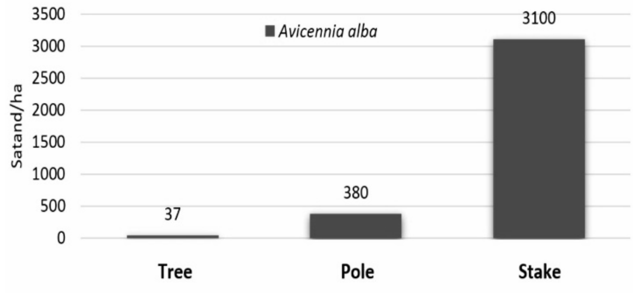

Figure 5. The density of mangrove species at sampling point 1

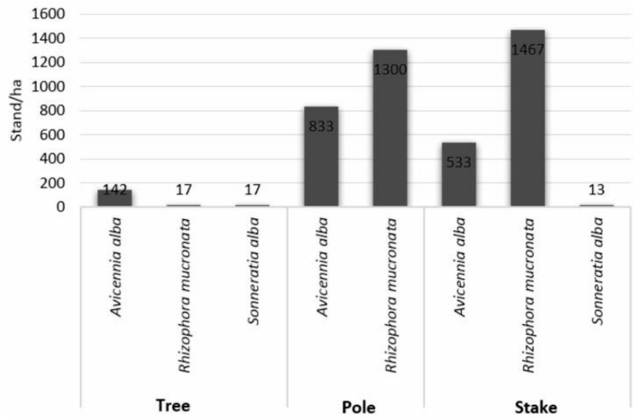

Figure 6. The density of mangrove species at sampling point 2

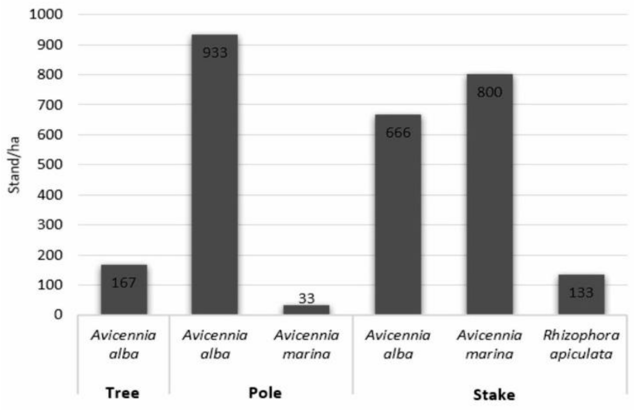

Figure 7. The density of mangrove species at sampling point 3

The value of biological diversity of a community depends on the number of species and the number of individuals contained in the community. The diversity of a community will be high if it is composed by many species with no species dominates. Conversely, a community has a low value of biodiversity if the community is composed by few species with dominance of particular species (Indriyanto 2006)

In sampling points 1, 2 and 3, species which most commonly found was *Avicennia*. This is because *Avicennia* mangroves have generally large stem and broad canopy so that it tends to dominate other species. The dominance of *Avicennia* also reflects the ability to tolerate environmental conditions (Nasution 2005). In addition, this species can adapt to extreme conditions so that they can compete to obtain more nutrients than other species (Fadli et al. 2015). The high density of mangrove vegetation indicates that the vegetation community is in a condition that has no disturbance (Erwin 2005).

In conclusion, the mangrove vegetation in Kedawang village includes five species from three families, namely Avicenniaceae (*A. alba* and *A. marina*), Rhizophoraceae (*R. apiculata* and *R. mucronata*), and Sonneratiaceae (*S. alba*). At sampling point 1, *A. alba* was found with density of 37 individuals/ha at tree level, 380 individuals/ha at pole level and 3100 individuals/ha at stake level. At sampling point 2, the highest density was *A. alba* with 142 individuals/ha at tree level, *R. mucronata* with 1300 individuals/ha at pole level and 1467 individuals/ha at stake level. At sampling point 3, the pole and stake level were dominated by *A. alba* with 167 individuals/ha and 933 individuals/ha, respectively, while at sapling level the highest density was *A. marina* with 800 individuals/ha. At all sampling points, the density at stake level is greater than that at tree level. For this reason, it is necessary to carry out conservation efforts in the form of protection combined with restoration by enrichment planting at all study locations because the occurrence of some species is not evenly distributed.

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