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Jurnal Biosaintifika <biosaintifika@mail.unnes.ac.id> Tue, Jun 12, 2018 at 10:47 AM
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yth bpk Hariyanto, terima kasih naskah bpk masih banyak revisi silahkan direvisi sesui pedoman dan saran reviwer terima kasih

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Terimakasih
Naskah akan segera saya revisi dan saya perbaiki sesuai dengan saran reviwer

Salam hormat,
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Revisi Artikel A.n Sucipto Hariyanto

4 messages

sucipto hariyanto <sucipto-h@fst.unair.ac.id> Thu, Oct 25, 2018 at 9:08 PM
To: Jurnal Biosaintifika <biosaintifika@mail.unnes.ac.id>

Kepada Yth.
Editorial Office
Jurnal Biosaintifika

Berikut saya kirimkan Artikel yang telah kami revisi kami dan sudah di proofread dan isian guideline (attach)
Mohon maaf agak terlalu lama, Mohon dapat diterima.

Terimakasih

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Jurnal Biosaintifika <biosaintifika@mail.unnes.ac.id> Wed, Oct 31, 2018 at 6:08 AM
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sucipto hariyanto <sucipto-h@fst.unair.ac.id> Thu, Nov 22, 2018 at 5:21 AM

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Chief Editor Journal Biosaintifika

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Sesuai dengan saran pereviu sudah saya tambahkan:
1. Background pada Abstract
2. Implication pada akhir Abstract
3. Novelty

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sucipto hariyanto <sucipto-h@fst.unair.ac.id>

Tindak lanjut tentang Artikel A.n. Sucipto Hariyanto

2 messages

sucipto hariyanto <sucipto-h@fst.unair.ac.id> Fri, Mar 1, 2019 at 9:00 AM
To: Jurnal Biosaintifika <biosaintifika@mail.unnes.ac.id>, Biosaintifika Unnes <biosaintifika@gmail.com>

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Chief Editor Jurnal Biosaintifika

Pada tanggal 22 Nopember 2018, saya telah mengirim revisi ke-2, tetapi sampai saat ini kami belum menerima pemberitahuan tentang kelanjutan artikel tersebut.
Mohon dengan hormat tindaklanjutnya.

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Salam,
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Jurnal Biosaintifika <biosaintifika@mail.unnes.ac.id> Tue, Mar 5, 2019 at 11:16 PM
To: sucipto hariyanto <sucipto-h@fst.unair.ac.id>

terima kasih pak Sucipto, bersama ini km krm hasil review silahkan disesuikan dengan saran lalu kirim kembali terima kasih

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Artikel A.n. Sucipto Hariyanto: revisi ke-3

3 messages

sucipto hariyanto <sucipto-h@fst.unair.ac.id> Sat, Mar 9, 2019 at 11:08 AM
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Kepada Yth.
Dr. Ir. Dyah Rini Indriyanti
Chief editor Jurnal Biosaintifika

Salam hormat,
Berikut saya kirimkan artikel revisi ke-3, mohon dapat diterima dan dicek
Saya mengucapkan banyak terimakasih atas segala perhatian dan bantuannya

Wassallam,
Sucipto Hariyanto

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Jurnal Biosaintifika <biosaintifika@mail.unnes.ac.id> Sat, Mar 9, 2019 at 5:20 PM
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terima kasih pak Hariyanto, masih ada sedikit perbaikan silahkan dilengkapi, lalu kirim kembali terima kasih

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sucipto hariyanto <sucipto-h@fst.unair.ac.id> Mon, Mar 11, 2019 at 4:12 PM
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Baik, akan saya perbaiki dan akan segera saya kirimkan kembali

Terimakasih
Sucipto Hariyanto
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sucipto hariyanto <sucipto-h@fst.unair.ac.id>

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Jurnal Biosaintifika <biosaintifika@mail.unnes.ac.id> Sat, Apr 6, 2019 at 8:54 AM
To: sucipto hariyanto <sucipto-h@fst.unair.ac.id>

yth bpk Sucipto Hariyanto, bersama ini km kirim hasil review silahkan disesuikan. apabila naskah bpk dpt segera direvisi maka akan kami ikutkan edisi april 2019. terima kasih

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REVIEWER RECOMMENDATIONS AND COMMENTS & RESPONSES TO REVIEWER COMMENTS

Vegetation and Community Structure of Mangrove in Bama Resort Baluran National Park Situbondo East Java

*Sucipto Hariyanto, Akhmad Kharish Fahmi, Thin Soedarti
Department of Biology, Faculty of Science and Technology, Universitas Airlangga
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ABSTRACT maks 250 words

The Background (2-3 lines)…….

This research aimed to reveal the mangrove community and vegetation of mangrove forest and zonation pattern of mangrove in Bama Resort Baluran National Park Situbondo East Java. Due to the important and strategic roles of mangrove in protection, ecological function, and ecotourism development at Bama beach region. Therefore, it is needed to know scientific information about mangrove population dynamic and the findings could be used in decision making for management purposes. Ten belt-transects were laid perpendicular to the shoreline, using standard methods. Vegetation structure was determined using data collected on plant species diversity, density, basal area, and the number of each species of mangroves. Shannon Wiener index to calculated diversity, evennes and Simpson to calculated dominance index. The results show there are 2 families and 6 mangrove species occurring in the study areas that is Rhizophoraceae (*Rhizophora stylosa*, *Rhizophora mucronata*, *Rhizophora apiculata*, *Bruguiera gymnorrhiza*, and *Ceriops tagal*) and Araceae (*Nypa fruticans*). The highest importance value was *Rhizophora apiculata* (229.90%) for trees, *Rhizophora apiculata* (148.69%) for the sapling, and *Rhizophora apiculata* (244.83%) for the seedling. The diversity (H) and dominance index (C) values were moderate (1.79) and 0.521. The most dominant species was *Rhizophora apiculata* (C=0.487). The mangrove zonation pattern from coastline to the mainland was *Rhizophora stylosa*, *Rhizophora mucronata*, and *Rhizophora apiculata*, in the outer zone, respectively (zone directly adjacent to the sea); *Bruguiera gymnorrhiza* and *Ceriops tagal* in the middle zone; and *Nypa fruticans* in the zone that adjacent to the mainland.

Implication/Benefit for science development/society……..

Keywords: Bama, community, diversity, mangrove, zonation.

INTRODUCTION

Mangroves are one of forests ecosystem that unique and special. The mangrove ecosystem exists in tidal coastal areas, beaches, and some small islands. Mangrove forests harbor a valuable natural resource with high intrinsic natural productivity. Mangrove are woody plants, which grow in loose wet soils of brackish-to-saline estuaries and shorelines in the tropics and sub-tropics (Joshi & Ghose, 2003). Mangrove forests provide many valuable ecosystem services, such as assimilating excess atmospheric carbon, protecting coastlines from hurricanes, increasing vertical land development, and providing nursery habitat for fish (Alongi D. M., 2002; Nagelkerkin, et al., 2008; Lee, et al., 2014).

The mangrove ecosystem in Indonesia holds 75% of total mangroves in South East Asia or around 27% of total mangroves in the world. Besides that, mangrove ecosystem in Indonesia has the highest diversity in the world (Sukardjo & Alongi, 2012). The distribution of mangroves in Indonesia is located on the coast of Sumatra, Kalimantan, and Papua. The extent of mangroves distribution continued to decline from 4.25 million hectares in 1982 to approximately 3.24 million hectares in 1987 and remaining of 2.79 hectares in 2000 (Richards & Friess, 2016). Between 2000 -2012, the percentage of mangroves loss were 1.72% (Richards & Friess, 2016). The declining trend indicates that there were 61.000 hectares of mangrove forests deforestation and mangrove habitat loss of 48.000 hectares over 12 years (Richards & Friess, 2016). It is caused by the conversion of land used into aquaculture/farming, agriculture, tourism, urban development, and overexploitation (Dahuri, 2002; Giri *et al*., 2008; Richards & Friess, 2016).

One result of various human activities in the coastal areas that affect the sustainability of natural resources is the destruction of mangrove ecosystem. The existence of mangrove ecosystems play an important role for the continuity of ecological and hydrological processes. Bengen (2001) added that damage and disturbance to the growth state could be a problem for the regeneration of mangroves in the future.

The growth of each plant will adjust to surrounding environment so that the morphology that occurs will vary from one place to another (Gratani, 2014). Therefore, the morphology of

mangroves in Baluran National Park is typical, considering that the different environmental conditions have different morphological descriptions (Sudarmadji, 2003).

The ecotourism development program in Bama Beach area requires data of mangrove ecosystem structure in Bama Beach Baluran National Park. This research aimed to know the community structure of mangrove ecosystem that includes mangrove species, diversity, domination, and zonation pattern in Bama Resort Baluran National Park, which can be used in the management and conversation of mangroves especially in Baluran National Park and generally in East Java.

METHODS

The study area

The research was conducted in January-May 2014 at Bama Beach Baluran National Park. Baluran National Park is located at Situbondo District East Java Province (Figure 1) geographically lies between 7º50'44.48' S- 114º27'39.65" E and 7º51'04.11" S -114º27'32.32" E. Mapping transects and plots in sampling area was obtained through Global Positioning System (GPS) by the use of an online mapping (Figure 2).

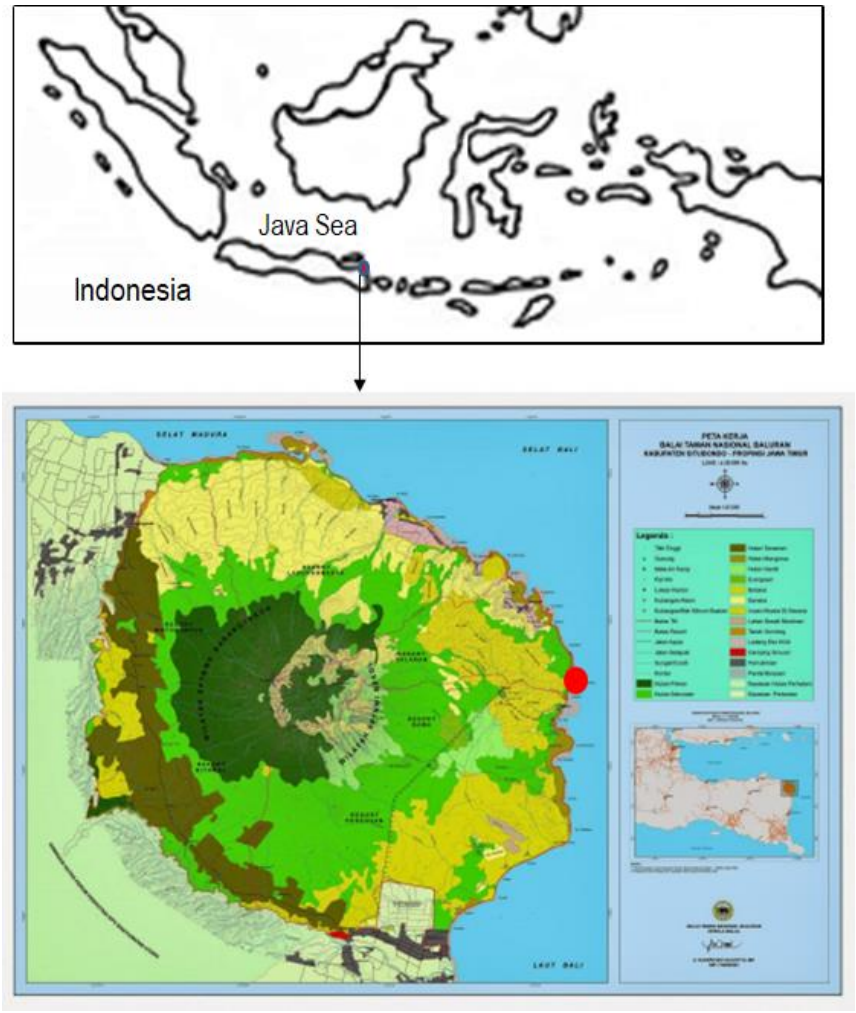

Figure 1. The research site

The research procedures were by conducting survey and imaging via Google Earth which allegedly representing and depicting mangrove zonation pattern then determined ten transects with length adjusting the mangrove thickness.

Figure 2. Sampling transects in Bama Beach

Establishment of sampling plots and measurement

We used quadrat transect methods with ten transects belt that perpendicular to the mainland, each sub-plot (100 m^2) for sapling (dbh: 2cm-9.99cm) and trees (dbh: ≥ 10cm), and a 5 x 5-meter plot was laid inside the main plot for seedling (dbh: < 2.0cm) study. Mangroves trees inside the sampling plots were counted and identified respectively. The data collected of this research were mangrove species, number of stem to determine the value of density, tree diameter at breast height (dbh), stem height, substrate type (fraction), and physical-chemical condition such as pH, temperature, salinity, and light intensity.

Vegetation analysis

The data were analyzed using several parameters: population density, frequency, dominance, relative density, relative frequency, relative dominance, and the importance value (*IV*) (Odum & Barett, 2005; Krebs, 1985; Mueller-Dumbois & Ellenberg, 1974). This analysis can better inform of species function in its habitat. It also gives order for appropriate species within the mangrove community.

Population density = $\frac{Number\ of\ individuals}{Total\ area\ sampled}$

Frequency = $\frac{Number\ of\ plots\ in\ which\ a\ species\ ocurs}{Total\ number\ of\ plots\ sampled}$

Dominance = $\frac{Total\ of\ basal\ area\ of\ each\ tree\ of\ a\ species\ from\ all\ plots}{Total\ area\ of\ all\ measured\ plots}$

Relative density = $\frac{Number\ of\ individual\ of\ a\ species}{Total\ number\ of\ individuals\ all\ of\ species}$ x 100

Relative dominance = $\frac{Total\ basal\ area\ of\ \ a\ species}{Basal\ area\ of\ all\ species}$ x 100

Relative frequency = $\frac{Frequency\ of\ species}{Total\ frequency\ of\ all\ species\ in\ different\ plots}$ x 100

Importance value (*IV*) = Relative density + Relative frequency + Relative dominance

Diversity index of mangroves was calculated by Shannon-Wiener index (Odum, 1993).

$H' = -\sum Pi \ln Pi$

H = Shannon diversity index

*P*i = Fraction of the entire population made up of species *i* (proportion of a species *i* relative to total number of species present)

Evennes index (J) = $\frac{H'}{H\ max}$

Dominance index was calculated by Simpson (Odum, 1993).

$$C = \Sigma(\frac{ni}{N})^2$$

C = dominance index

ni = importance value for each species

N = total of importance value

Water Analysis

Water in all plots were measured pH, salinity, and temperature. The measurement have been carried out in situ.

Light Intensity

Light intensity on each plots was measured using lux meter

Substrat Analysis

The determination of texture of mangrove substrate was done ex situ in the laboratory. Soils in all plots were collected using a stainless steel corer (7 cm inside diameter) to a depth of 20 cm. Soils samples each plot were taken twice. The steps in substrate texture analysis are based on the USDA triangle.

RESULTS AND DISCUSSION

Overview of the Research Site

The research site was located at Bama Resort which include in Baluran National Park area with 6.126 ha. 6 species mangroves from 2 families were recorded in this research, that is family Rhizoporaceae (*Rhizophora stylosa*, *Rhizophora mucronata*, *Rhizophora apiculata*, *Bruguiera gymnorrhiza*, and *Ceriops tagal)* and family Araceae (*Nypa fruticans*) (Table 1).

Table 1. The total number of seedlings, saplings, and trees of all mangrove in a 0.3 h at Bama resort

No	Species	Family	Stage		
			Seedlings	Saplings	Trees
1	*Rhizophora stylosa*	*Rhizophorazeae*	0	48	50

2	*Rhizophora mucronata*	*Rhizophorazeae*	0	5	3
3	*Rhizophora apiculata*	*Rhizophorazeae*	13	81	221
4	*Bruguiera gymnorrhiza*	*Rhizophorazeae*	2	16	11
5	*Ceriops tagal*	*Rhizophorazeae*	0	2	0
6	*Nypa fructicans*	*Araceae*	0	26	3
		Total	15	178	288

All of these mangroves are mayor mangrove or true mangrove. *Rhizophora apiculata* was the most abundant tree with 221 trees followed by *Rhizophora stylosa* (50 trees), *Bruguiera gymnorrhiza* (11 trees), *Rhizophora mucronata* (3 trees) and *Nypa fructicans* (3 trees). Moreover *Rhizophora apiculata* sapling showed the highest dispersal followed by *Rhizophora stylosa, Nypa fructicans, Bruguiera gymnorrhiza, Rhizophora mucronata,* and *Ceriops tagal*. When considering the seedlings, *Rhizophora apiculata* was the highest dispersal (13 trees), followed by *Bruguiera gymnorrhiza* (2 trees).The success of *Rhizophora apiculata* regeneration at the sea edge due in part to differences infloading tolerance of these species (Sukardjo et al, 2014). It's also could be due to *Rhizophora apiculata* has the highest tolerance limit of the extreme conditions such as high salinity and muddy substrate. That highest tolerance limit is supported by the root system of *Rhizophora apiculata* which is aerial root (pneumatophore) in the form of long roots and branches arise from the base of stem. This root is known as the prop root and will eventually become still root if the stem is held up so that it no longer touches the ground. The root helps the upright of the tree because it has a broad base to support in soft and unstable mud. It also helps the aeration when exposed at low tide (Ng dan Sivatoshi, 2001; Hogarth, 2015).

From this data, total number of seedling all plots showed a pure regeneration potential, only *Rhizophora apiculata* and *Bruguiera gymnorrhiza*. Hastuti & Budihastuti (2016) has indicated that environment parameters including temperature, turbidity, pH, DO and its changes had significant effect on the growth of mangrove seedling especially *Rhizophora mucronata*.

The water temperature is still classified as a normal range between 28^{o}C -29^{o}C, salinity is quite good for the growth of mangrove that range 29ppt -31ppt, and the water pH is normal in the range 6.8-7.5. Soil in all plots consisted of a mixture of dark gray silt-clay (71-74%) with lesser amounts of sand (19-26%).

The intensity of the light is in the range of 900 lux until more than 3000 lux, the light intensity of the different areas of the outside and the inside of the mangrove forests. The outer area got more sunlight compared to other areas in the central part of or inside of the mangrove forests, so the value is also different, although there are some parts in the area of mangrove forests also got sunshine that's a lot, this caused the existence of an open canopy or the presence of uprooted trees caused the sunlight may enter among the vegetation. Areas with more sunlight supports the process of the growth of mangroves or other organism is better compared to the darker areas and dense.

Table 2 indicated the result of quantitative analysis for tree-level based on importance value index. Its shows that there were 5 tree level mangrove species in the research site. The most important species was *Rhizophora apiculata* with the importance value at 229.80% and the least important species was *Rhizophora mucronata* with the importance value at 3.34%. In this study did not found *Avicenia marina* such mangrove species as is common to other mangrove forest bordering the Java Sea. Hogarth, 2015 has been reported Avicenia marina can grow where the soil salinity is greater than 65‰**.**

Table 2. Analysis of mangroves trees

No	Species	Relative density (%)	Relative frequency (%)	Relative dominance (%)	*IV* (%)
1	*Rhizophora apiculata*	75.00	62.29	82.74	229.80
2	*Rhizophora stylosa*	17.31	20.27	10.63	47.78
3	*Bruguiera gymnorrhiza*	3.85	10.14	5.75	15.57
4	*Nypa fruticans*	1.92	4.38	0.44	3.42
5	*Rhizophora mucronata*	1.92	2.92	0.44	3.34
	Total	100.00	100.00	100.00	300.00

Diversity is the total range of plant species in an area Diversity index or Shannon diversity index is used to determine the species diversity in a community. Species evenness is a measure of biodiversity which quantifies how equal the populations are numerically (Kasawani

et al., 2007). Evenness index (J) which is the relative abundance with each mangrove species is represented in an area. In this research, the value of diversity index is 0.39 for seedling, which is low as shown in Table 3. Although the diversity index is relatively low, there were 6 species mangroves belonging to mayor mangrove or true mangrove, so it is important to maintain the mangroves. Bama Resort area has a low diversity because there was *Rhizophora apiculata* which has the sub-dominant or dominant but not a whole characteristic. This occurs because the ecosystem conditions that strongly support the growth of *Rhizophora apiculata* which is the type of substrate (mud).

Table 3. Shannon diversity (H') and Evenness (J)

Category	Shannon Diversity (H')	Evenness (J)
Seedlings	0.39	0.22
Saplings	1.37	0.76
Trees	0.73	0.41
All species	1.79	0.49

Species diversity and mangrove growth are influenced by the supply of the fresh water from the river that empties into the sea and the suitability of habitat of each species towards the climate and geographical condition (Duke *et al*., 1998). Setyawan (2005) added that the extent of the mangroves area greatly determines the diversity of plant species. The extent of area also allows sufficient space to grow and reduce competition among species in the fight for space, nutrition, and space.

Table 4 shows that research plot with the Simpson dominance index (C) at 0.521, which classified as sub-dominant because the C value is in between 0.5 and 0.75 (Wibisono, 2005).

Table 4. Dominancy index of mangrove vegetations

No	Species	Dominance Index
1	*Rhizophora stylosa*	0.029
2	*Rhizophora mucronata*	0.000
3	*Rhizophora apiculata*	0.487
4	*Bruguiera gymnorrhiza*	0.004
5	*Ceriops tagal*	0.000

6	*Nypa fruticans*	0.001
	Total	0.521

Based on this results, it is known that there were sub-dominant mangrove or non-dominant. *Rhizophora apiculata* has the highest dominance value (0.487), which also has the sub-dominant characteristic (Table 4).

The mangrove zonation pattern in the research site from the coastal line to the mainland was *Rhizophora stylosa*, *Rhizophora mucronata*, and *Rhizophora apiculata* in the outer zone, respectively (zone directly adjacent to the sea); *Bruguiera gymnorrhiza* and *Ceriops tagal* in the middle zone; and *Nypa fruticans* in the zone that adjacent to the mainland or landward zone. The three zones of mangroves in Bama resort are not similar to those found throughout the Sirondo and Batu Sampang Baluran National Park (Sudarmadji, 2003), the Cimanuk Delta (Sukardjo et al., 2014). The principal drivers of zonation are complex, dependent on the interrelationships between and among factors, including soil nutrients, frequency of tidal inundation or different positions along some physical gradient, ecological interactions between species in the community (Hogarth, 2015). The percentage of the most dominant substrate fraction is mud with total percentage of 10 transects at 48.76%. This result indicated that the type of the research site was coastal akressif.

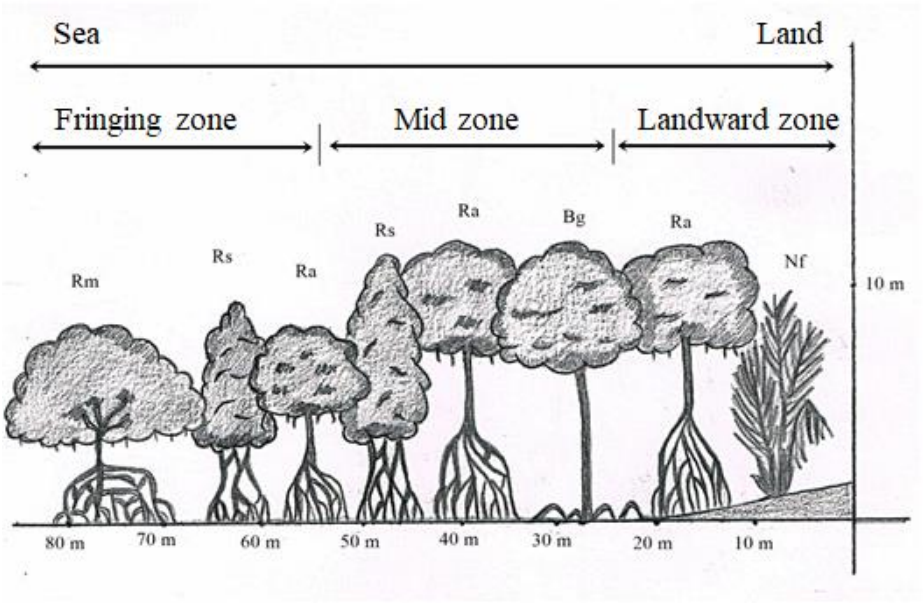

Figure 3. [U1]The mangrove zonation pattern at the research site

Rm	: *Rhizophora mucronata*	Rs	: *Rhizophora stylosa*
Ra	: *Rhizophora apiculata*	Bg	: *Bruguiera gymnorrhiza*
Nf	: *Nypa fruticans*		

Zoning is almost entirely dominated by *Rhizophora apiculata* from the coastal line to the mainland, except at transect 5 which is only found saplings of *Nypa fruticans* at the coral sand substrate. This condition is more influenced by the adaptability of *Rhizophora apiculate* which is fairly high. Besides that, its shorter and slender hypocotyl than the *Rhizophoraceae* group allow to be carried by the sea water (Hogarth, 2015).

Based on the results, it can be concluded that there were 6 species mangroves from 2 families in Bama Resort Baluran National Park, that is family *Rhizophoraceae* (*Rhizophora stylosa*, *Rhizophora mucronata*, *Rhizophora apiculata*, *Bruguiera gymnorrhiza*, and *Ceriops tagal*) and family Araceae (*Nypa fruticans*). The diversity of mangroves in Bama Resort Baluran National Park was classified as good (1.79). There is not mangrove which classified as dominant in Bama Resort Baluran National Park area. But, *Rhizophora apiculata* has sub-dominant characteristic with the dominance value at 0.487. The mangrove zonation pattern from the coastal line to the mainland was *Rhizophora stylosa*, *Rhizophora mucronata*, and *Rhizophora apiculata*, in the outer zone, respectively (zone directly adjacent to the sea); *Bruguiera gymnorrhiza* and *Ceriops tagal* in the middle zone; and *Nypa fruticans* in the zone that adjacent to the mainland or landward zone.

- Explain the novelty of your research
- The benefits and contribution of research for the science/ society

CONCLUSIONS

A total of six mangrove species (*Rhizophora stylosa*, *Rhizophora mucronata*, *Rhizophora apiculata*, *Bruguiera gymnorrhiza*, *Ceriops tagal*, and *Nypha fruticans*) from two families (*Rhizophoraceae* and *Araceae*) were identified in Bama Resort. Analysis in vegetation in Bama Resort showed that species with highest importance value was *R. apiculata* (229.80%) followed by *R. stylosa* (47.78%), *B. gymnorrhiza* (15.57%), *N. fruticans* (3.42%), and *R. mucronata* (3.34%). The greatest mangrove diversity (1.37) in terms of diameter category is sapling and the

lowest mangrove diversity (0.39) was belongs to seedling. The mangrove zonation patterns from the coastline to the mainland are *Rhizophora stylosa*, *Rhizophora mucronata*, and *Rhizophora apiculata* in the outermost zone (the zone adjacent to the sea), *Bruguiera gymnorrhiza* and *Ceriop tagal* in the middle zone. *Nypha fructicans* in the zone bordering on land mangrove.

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Vegetation and Community Structure of Mangrove in Bama Resort Baluran National Park Situbondo East Java

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ABSTRACT

Ecotourism development program at Bama beaches area require baseline data of mangrove structure at Bama Resort and in the past two decades has been lost about 35% area of mangrove forest in Indonesia and in the world. It is needed to know scientific information about mangrove population dynamic. Ten belt-transects were laid perpendicular to the shoreline, using standard methods. Vegetation structure was determined using data collected on plant species diversity, density, basal area, and the number of each species of mangroves. Shannon Wiener index to calculated diversity, evennes and Simpson to calculated dominance index. The results show there are 2 families and 6 mangrove species occurring in the study areas that is Rhizophoraceae (*Rhizophora stylosa*, *Rhizophora mucronata*, *Rhizophora apiculata*, *Bruguiera gymnorrhiza,* and *Ceriops tagal*) and Araceae (*Nypa fruticans*). The highest importance value was *Rhizophora apiculata* (229.90%) for trees, *Rhizophora apiculata* (148.69%) for the sapling, and *Rhizophora apiculata* (244.83%) for the seedling. The diversity (H) and dominance index (C) values were moderate (1.79) and 0.521. The most dominant species was *Rhizophora apiculata* (C=0.487). The mangrove zonation pattern from coastline to the mainland was *Rhizophora stylosa*, *Rhizophora mucronata*, and *Rhizophora apiculata*, in the outer zone, respectively (zone directly adjacent to the sea); *Bruguiera gymnorrhiza* and *Ceriops tagal* in the middle zone; and *Nypa fruticans* in the zone that adjacent to the mainland. The present study will aid in the conduct and preservation planning of mangrove forest especially at Bama coast and generally in the coastal areas of Indonesia.

Keywords: Bama, community, diversity, mangrove, zonation.

INTRODUCTION

Mangroves are one of forests ecosystem that unique and special. The mangrove ecosystem exists in tidal coastal areas, beaches, and some small islands. Mangrove forests harbor a valuable natural resource with high intrinsic natural productivity. Mangrove are woody plants, which grow in loose wet soils of brackish-to-saline estuaries and shorelines in the tropics and sub-tropics (Joshi & Ghose, 2003). Mangrove forests provide many valuable ecosystem services, such as assimilating excess atmospheric carbon, protecting coastlines from hurricanes, increasing vertical land development, and providing nursery habitat for fish (Alongi D. M., 2002; Nagelkerkin, et al., 2008; Lee, et al., 2014).

The mangrove ecosystem in Indonesia holds 75% of total mangroves in South East Asia or around 27% of total mangroves in the world. Besides that, mangrove ecosystem in Indonesia has the highest diversity in the world (Sukardjo & Alongi, 2012). The distribution of mangroves in Indonesia is located on the coast of Sumatra, Kalimantan, and Papua. The extent of mangroves distribution continued to decline from 4.25 million hectares in 1982 to approximately 3.24 million hectares in 1987 and remaining of 2.79 hectares in 2000 (Richards & Friess, 2016). Between 2000 -2012, the percentage of mangroves loss were 1.72% (Richards & Friess, 2016). The declining trend indicates that there were 61.000 hectares of mangrove forests deforestation and mangrove habitat loss of 48.000 hectares over 12 years (Richards & Friess, 2016). It is caused by the conversion of land used into aquaculture/farming, agriculture, tourism, urban development, and overexploitation (Dahuri, 2002; Giri *et al*., 2008; Richards & Friess, 2016).

One result of various human activities in the coastal areas that affect the sustainability of natural resources is the destruction of mangrove ecosystem. The existence of mangrove ecosystems play an important role for the continuity of ecological and hydrological processes. Bengen (2001) added that damage and disturbance to the growth state could be a problem for the regeneration of mangroves in the future.

The growth of each plant will adjust to surrounding environment so that the morphology that occurs will vary from one place to another (Gratani, 2014). Therefore, the morphology of mangroves in Baluran National Park is typical, considering that the different environmental conditions have different morphological descriptions (Sudarmadji, 2003).

The ecotourism development program in Bama Beach area requires data of mangrove ecosystem structure in Bama Beach Baluran National Park. This research aimed to know the

community structure of mangrove ecosystem that includes mangrove species, diversity, domination, and zonation pattern in Bama Resort Baluran National Park, which can be used in the management and conversation of mangroves especially in Baluran National Park and generally in East Java.

METHODS

The study area

The research was conducted in January-May 2014 at Bama Beach Baluran National Park. Baluran National Park is located at Situbondo District East Java Province (Figure 1) geographically lies between 7º50'44.48' S- 114º27'39.65" E and 7º51'04.11" S -114º27'32.32" E. Mapping transects and plots in sampling area was obtained through Global Positioning System (GPS) by the use of an online mapping (Figure 2).

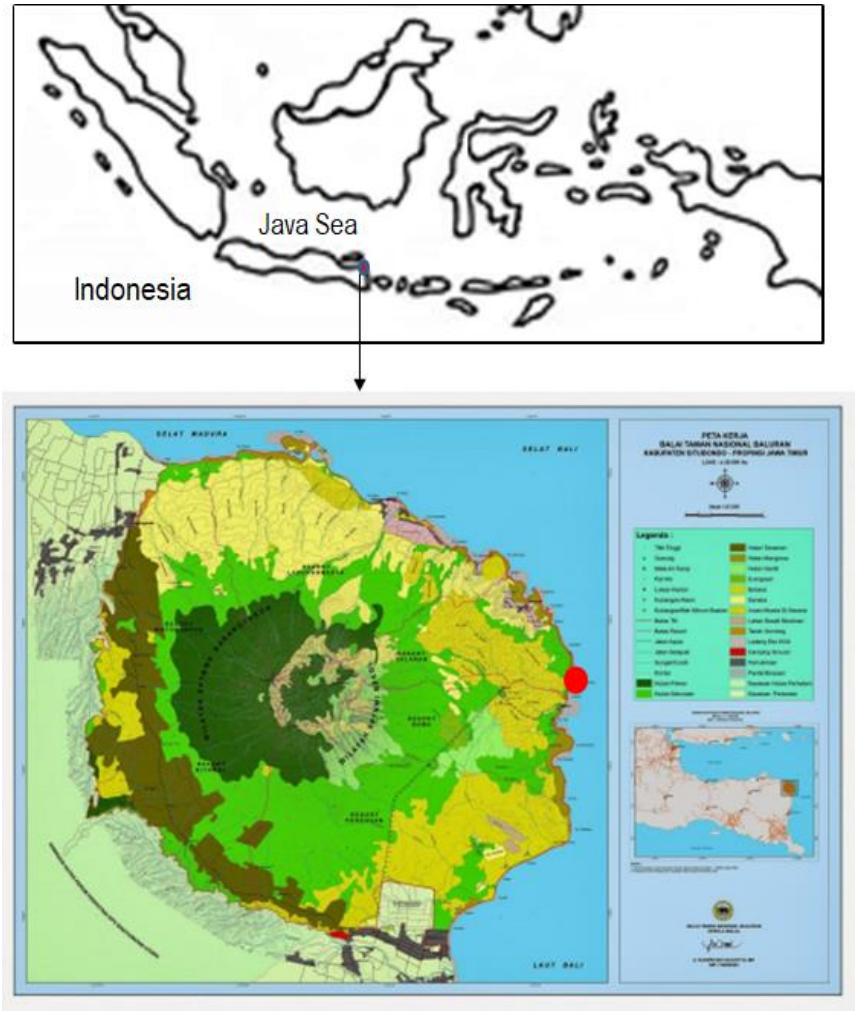

Figure 1. The research site

The research procedures were by conducting survey and imaging via Google Earth which allegedly representing and depicting mangrove zonation pattern then determined ten transects with length adjusting the mangrove thickness.

Figure 2. Sampling transects in Bama Beach

Establishment of sampling plots and measurement

We used quadrat transect methods with ten transects belt that perpendicular to the mainland, each sub-plot (100 m^2) for sapling (dbh: 2cm-9.99cm) and trees (dbh: ≥ 10cm), and a 5 x 5-meter plot was laid inside the main plot for seedling (dbh: < 2.0cm) study. Mangroves trees inside the sampling plots were counted and identified respectively. The data collected of this research were mangrove species, number of stem to determine the value of density, tree diameter at breast height (dbh), stem height, substrate type (fraction), and physical-chemical condition such as pH, temperature, salinity, and light intensity.

Vegetation analysis

The data were analyzed using several parameters: population density, frequency, dominance, relative density, relative frequency, relative dominance, and the importance value (*IV*) (Odum & Barett, 2005; Krebs, 1985; Mueller-Dumbois & Ellenberg, 1974). This analysis can better inform of species function in its habitat. It also gives order for appropriate species within the mangrove community.

$$\text{Population density} = \frac{Number\ of\ individuals}{Total\ area\ sampled}$$

$$\text{Frequency} = \frac{Number\ of\ plots\ in\ which\ a\ species\ ocurs}{Total\ number\ of\ plots\ sampled}$$

Dominance = $\frac{Total\ of\ basal\ area\ of\ each\ tree\ of\ a\ species\ from\ all\ plots}{Total\ area\ of\ all\ measured\ plots}$

Relative density = $\frac{Number\ of\ individual\ of\ a\ species}{Total\ number\ of\ individuals\ all\ of\ species}$ x 100

Relative dominance = $\frac{Total\ basal\ area\ of\ \ a\ species}{Basal\ area\ of\ all\ species}$ x 100

Relative frequency = $\frac{Frequency\ of\ species}{Total\ frequency\ of\ all\ species\ in\ different\ plots}$ x 100

Importance value (*IV*) = Relative density + Relative frequency + Relative dominance

Diversity index of mangroves was calculated by Shannon-Wiener index (Odum, 1993).

$H' = -\sum Pi \ln Pi$

H = Shannon diversity index

*P*i = Fraction of the entire population made up of species *i* (proportion of a species *i* relative to total number of species present)

Evennes index (J) = $\frac{H'}{H\ max}$

Dominance index was calculated by Simpson (Odum, 1993).

$$C = \Sigma(\frac{ni}{N})^2$$

C = dominance index

ni = importance value for each species

N = total of importance value

Water Analysis

Water in all plots were measured pH, salinity, and temperature. The measurement have been carried out in situ.

Light Intensity

Light intensity on each plots was measured using lux meter

Substrat Analysis

The determination of texture of mangrove substrate was done ex situ in the laboratory. Soils in all plots were collected using a stainless steel corer (7 cm inside diameter) to a depth of 20 cm. Soils samples each plot were taken twice. The steps in substrate texture analysis are based on the USDA triangle.

RESULTS AND DISCUSSION

Overview of the Research Site

The research site was located at Bama Resort which include in Baluran National Park area with 6.126 ha. 6 species mangroves from 2 families were recorded in this research, that is family Rhizoporaceae (*Rhizophora stylosa*, *Rhizophora mucronata*, *Rhizophora apiculata*, *Bruguiera gymnorrhiza,* and *Ceriops tagal)* and family Araceae (*Nypa fruticans*) (Table 1).

Table 1. The total number of seedlings, saplings, and trees of all mangrove in a 0.3 h at Bama resort

No	Species	Family	Stage		
			Seedlings	Saplings	Trees
1	*Rhizophora stylosa*	*Rhizophorazeae*	0	48	50
2	*Rhizophora mucronata*	*Rhizophorazeae*	0	5	3
3	*Rhizophora apiculata*	*Rhizophorazeae*	13	81	221
4	*Bruguiera gymnorrhiza*	*Rhizophorazeae*	2	16	11
5	*Ceriops tagal*	*Rhizophorazeae*	0	2	0
6	*Nypa fructicans*	*Araceae*	0	26	3
		Total	15	178	288

All of these mangroves are mayor mangrove or true mangrove. *Rhizophora apiculata* was the most abundant tree with 221 trees followed by *Rhizophora stylosa* (50 trees), *Bruguiera gymnorrhiza* (11 trees), *Rhizophora mucronata* (3 trees) and *Nypa fructicans* (3 trees). Moreover *Rhizophora apiculata* sapling showed the highest dispersal followed by *Rhizophora stylosa, Nypa fructicans, Bruguiera gymnorrhiza, Rhizophora mucronata*, and *Ceriops tagal*. When considering the seedlings, *Rhizophora apiculata* was the highest dispersal (13 trees), followed by *Bruguiera gymnorrhiza* (2 trees).The success of *Rhizophora apiculata* regeneration at the sea edge due in part to differences infloading tolerance of these species (Sukardjo et al, 2014). It's also could be due to *Rhizophora apiculata* has the highest tolerance limit of the extreme conditions such as high salinity and muddy substrate. That highest tolerance limit is supported by the root system of *Rhizophora apiculata* which is aerial root (pneumatophore) in the form of long roots and branches arise from the base of stem. This root is known as the prop root and will eventually become still root if the stem is held up so that it no longer touches the ground. The root helps the upright of the tree

because it has a broad base to support in soft and unstable mud. It also helps the aeration when exposed at low tide (Ng dan Sivatoshi, 2001; Hogarth, 2015).

From this data, total number of seedling all plots showed a pure regeneration potential, only *Rhizophora apiculata* and *Bruguiera gymnorrhiza*. Hastuti & Budihastuti (2016) has indicated that environment parameters including temperature, turbidity, pH, DO and its changes had significant effect on the growth of mangrove seedling especially *Rhizophora mucronata*.

The water temperature is still classified as a normal range between 28^{o}C -29^{o}C, salinity is quite good for the growth of mangrove that range 29ppt -31ppt, and the water pH is normal in the range 6.8-7.5. Soil in all plots consisted of a mixture of dark gray silt-clay (71-74%) with lesser amounts of sand (19-26%).

The intensity of the light is in the range of 900 lux until more than 3000 lux, the light intensity of the different areas of the outside and the inside of the mangrove forests. The outer area got more sunlight compared to other areas in the central part of or inside of the mangrove forests, so the value is also different, although there are some parts in the area of mangrove forests also got sunshine that's a lot, this caused the existence of an open canopy or the presence of uprooted trees caused the sunlight may enter among the vegetation. Areas with more sunlight supports the process of the growth of mangroves or other organism is better compared to the darker areas and dense.

Table 2 indicated the result of quantitative analysis for tree-level based on importance value index. Its shows that there were 5 tree level mangrove species in the research site. The most important species was *Rhizophora apiculata* with the importance value at 229.80% and the least important species was *Rhizophora mucronata* with the importance value at 3.34%. In this study did not found *Avicenia marina* such mangrove species as is common to other mangrove forest bordering the Java Sea. Hogarth, 2015 has been reported Avicenia marina can grow where the soil salinity is greater than 65‰.

Table 2. Analysis of mangroves trees

No	Species	Relative density (%)	Relative frequency (%)	Relative dominance (%)	*IV* (%)
1	*Rhizophora apiculata*	75.00	62.29	82.74	229.80
2	*Rhizophora stylosa*	17.31	20.27	10.63	47.78
3	*Bruguiera gymnorrhiza*	3.85	10.14	5.75	15.57
4	*Nypa fruticans*	1.92	4.38	0.44	3.42
5	*Rhizophora mucronata*	1.92	2.92	0.44	3.34
	Total	100.00	100.00	100.00	300.00

Diversity is the total range of plant species in an area Diversity index or Shannon diversity index is used to determine the species diversity in a community. Species evenness is a measure of biodiversity which quantifies how equal the populations are numerically (Kasawani et al., 2007). Evenness index (J) which is the relative abundance with each mangrove species is represented in an area. In this research, the value of diversity index is 0.39 for seedling, which is low as shown in Table 3. Although the diversity index is relatively low, there were 6 species mangroves belonging to mayor mangrove or true mangrove, so it is important to maintain the mangroves. Bama Resort area has a low diversity because there was *Rhizophora apiculata* which has the sub-dominant or dominant but not a whole characteristic. This occurs because the ecosystem conditions that strongly support the growth of *Rhizophora apiculata* which is the type of substrate (mud).

Table 3. Shannon diversity (H') and Evenness (J)

Category	Shannon Diversity (H')	Evenness (J)
Seedlings	0.39	0.22
Saplings	1.37	0.76
Trees	0.73	0.41
All species	1.79	0.49

Species diversity and mangrove growth are influenced by the supply of the fresh water from the river that empties into the sea and the suitability of habitat of each species towards the climate and geographical condition (Duke *et al*., 1998). Setyawan (2005) added that the extent of the mangroves area greatly determines the diversity of plant species. The extent of area also allows sufficient space to grow and reduce competition among species in the fight for space, nutrition, and space.

Table 4 shows that research plot with the Simpson dominance index (C) at 0.521, which classified as sub-dominant because the C value is in between 0.5 and 0.75 (Wibisono, 2005).

Table 4. Dominancy index of mangrove vegetations

No	Species	Dominance Index
1	*Rhizophora stylosa*	0.029
2	*Rhizophora mucronata*	0.000
3	*Rhizophora apiculata*	0.487
4	*Bruguiera gymnorrhiza*	0.004
5	*Ceriops tagal*	0.000
6	*Nypa fruticans*	0.001
	Total	0.521

Based on this results, it is known that there were sub-dominant mangrove or non-dominant. *Rhizophora apiculata* has the highest dominance value (0.487), which also has the sub-dominant characteristic (Table 4).

The mangrove zonation pattern in the research site from the coastal line to the mainland was *Rhizophora stylosa*, *Rhizophora mucronata*, and *Rhizophora apiculata* in the outer zone, respectively (zone directly adjacent to the sea); *Bruguiera gymnorrhiza* and *Ceriops tagal* in the middle zone; and *Nypa fruticans* in the zone that adjacent to the mainland or landward zone. The three zones of mangroves in Bama resort are not similar to those found throughout the Sirondo and Batu Sampang Baluran National Park (Sudarmadji, 2003), the Cimanuk Delta (Sukardjo et al., 2014). The principal drivers of zonation are complex, dependent on the interrelationships between and among factors, including soil nutrients, frequency of tidal inundation or different positions along some physical gradient, ecological interactions between species in the community (Hogarth, 2015). The percentage of the most dominant substrate fraction is mud with total percentage of 10 transects at 48.76%. This result indicated that the type of the research site was coastal akressif.

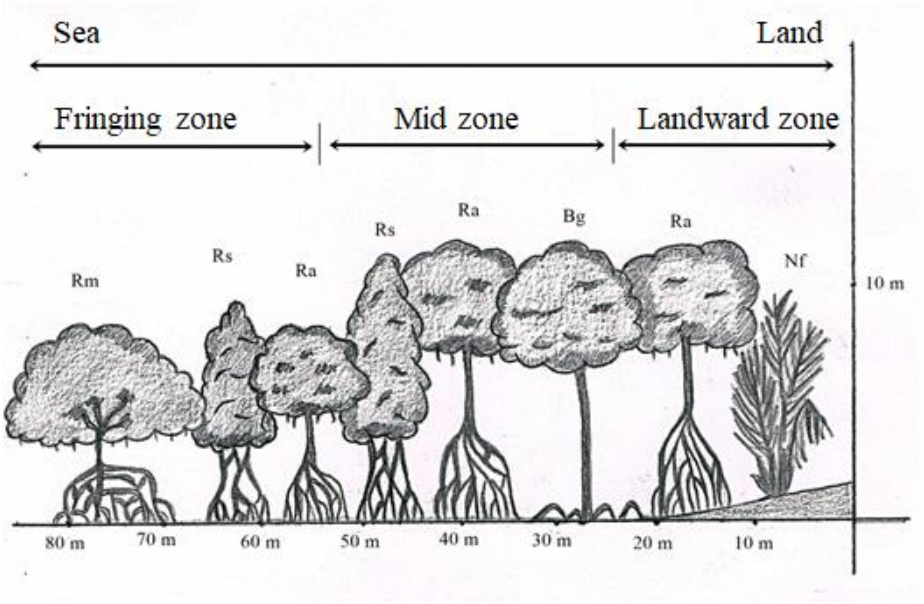

Figure 3. [U1]The mangrove zonation pattern at the research site

Rm : *Rhizophora mucronata* Rs : *Rhizophora stylosa*

Ra : *Rhizophora apiculata* Bg : *Bruguiera gymnorrhiza*

Nf : *Nypa fruticans*

Zoning is almost entirely dominated by *Rhizophora apiculata* from the coastal line to the mainland, except at transect 5 which is only found saplings of *Nypa fruticans* at the coral sand substrate. This condition is more influenced by the adaptability of *Rhizophora apiculate* which is fairly high. Besides that, its shorter and slender hypocotyl than the *Rhizophoraceae* group allow to be carried by the sea water (Hogarth, 2015).

Based on the results, it can be concluded that there were 6 species mangroves from 2 families in Bama Resort Baluran National Park, that is family *Rhizophoraceae* (*Rhizophora stylosa*, *Rhizophora mucronata*, *Rhizophora apiculata*, *Bruguiera gymnorrhiza*, and *Ceriops tagal*) and family Araceae (*Nypa fruticans*). The diversity of mangroves in Bama Resort Baluran National Park was classified as good (1.79). There is not mangrove which classified as dominant in Bama Resort Baluran National Park area. But, *Rhizophora apiculata* has sub-dominant characteristic with the dominance value at 0.487. The mangrove zonation pattern from the coastal line to the mainland was *Rhizophora stylosa*, *Rhizophora mucronata*, and *Rhizophora apiculata*, in the outer zone, respectively (zone directly adjacent to the sea); *Bruguiera gymnorrhiza* and

Ceriops tagal in the middle zone; and *Nypa fruticans* in the zone that adjacent to the mainland or landward zone.

This study identified that arrangement of mangroves in Bama resort is slightly different from the type of zoning compiler in general, there is not found of *Avicenniaceae* or *Verbenaceae* family, and the mangroves of Bama resort did not have dominant species.

The present study will aid in the conduct and preservation planning of mangrove forest especially at Bama coast and generally in the coastal areas of Indonesia.

CONCLUSIONS

A total of six mangrove species (*Rhizophora stylosa*, *Rhizophora mucronata*, *Rhizophora apiculata*, *Bruguiera gymnorrhiza*, *Ceriops tagal*, and *Nypha fruticans*) from two families (*Rhizophoraceae* and *Araceae*) were identified in Bama Resort. Analysis in vegetation in Bama Resort showed that species with highest importance value was *R. apiculata* (229.80%) followed by *R. stylosa* (47.78%), *B. gymnorrhiza* (15.57%), *N. fruticans* (3.42%), and *R. mucronata* (3.34%). The greatest mangrove diversity (1.37) in terms of diameter category is sapling and the lowest mangrove diversity (0.39) was belongs to seedling. The mangrove zonation patterns from the coastline to the mainland are *Rhizophora stylosa*, *Rhizophora mucronata*, and *Rhizophora apiculata* in the outermost zone (the zone adjacent to the sea), *Bruguiera gymnorrhiza* and *Ceriop tagal* in the middle zone. *Nypha fructicans* in the zone bordering on land mangrove.

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We are thankful to Director of Baluran National Park for gave permission for this research and Arif Pratiwi, S.T. Manager of Bama Resort, Baluran National Park for facilitating this study.

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List of Response for reviewer (2nd Revision)

No	Reviewer comments	Response of Author	Page/Line
1	Abstract mak 250 word	I have rewrite < 250 word	
2	The Background (2-3 lines)…….	I have addition the background	
3	Implication/Benefit for science development/society……..	I have added the implication or benefit	
4	Explain the novelty of your research	I have explain the novelty of our research	
5	The benefits and contribution of research for the science/ society	I have added the benefit and contribution of research	

Vegetation and Community Structure of Mangrove in Bama Resort Baluran National Park Situbondo East Java

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ABSTRACT

Ecotourism development program at Bama beaches area require baseline data of mangrove structure at Bama Resort. ~~and in the past two decades has been lost about 35% area of mangrove forest in Indonesia and in the world~~. ~~It is needed to know scientific information about mangrove population dynamic.~~

Explain the Aims/objectives of the research (2-3 lines)

Ten belt-transects were laid perpendicular to the shoreline, using standard methods. Vegetation structure was determined using data collected on plant species diversity, density, basal area, and the number of each species of mangroves. Shannon Wiener index to calculated diversity, evennes and Simpson to calculated dominance index. The results show there are 2 families and 6 mangrove species occurring in the study areas that is Rhizophoraceae (*Rhizophora stylosa*, *Rhizophora mucronata*, *Rhizophora apiculata*, *Bruguiera gymnorrhiza*, and *Ceriops tagal*) and Araceae (*Nypa fruticans*). The highest importance value was *R. apiculata* (229.90%) for trees, *R. apiculata* (148.69%) for the sapling, and *R. apiculata* (244.83%) for the seedling. The diversity (H) and dominance index (C) values were moderate (1.79) and 0.521. The most dominant species was *R. apiculata* (C=0.487). The mangrove zonation pattern from coastline to the mainland was *R. stylosa*, *R. mucronata*, and *R. apiculata*, in the outer zone, respectively (zone directly adjacent to the sea); *B. gymnorrhiza* and *C. tagal* in the middle zone; and *N. fruticans* in the zone that adjacent to the mainland.

The present study will aid in the conduct and preservation planning of mangrove forest especially at Bama coast and generally in the coastal areas of Indonesia.

Keywords: Bama, community, diversity, mangrove, zonation.

INTRODUCTION

Mangroves are one of forests ecosystem that unique and special. The mangrove ecosystem exists in tidal coastal areas, beaches, and some small islands. Mangrove forests harbor a valuable natural resource with high intrinsic natural productivity. Mangrove are woody plants, which grow in loose wet soils of brackish-to-saline estuaries and shorelines in the tropics and sub-tropics (Joshi & Ghose, 2003). Mangrove forests provide many valuable ecosystem services, such as assimilating excess atmospheric carbon, protecting coastlines from hurricanes, increasing vertical land development, and providing nursery habitat for fish (Alongi D. M., 2002; Nagelkerkin, et al., 2008; Lee, et al., 2014).

The mangrove ecosystem in Indonesia holds 75% of total mangroves in South East Asia or around 27% of total mangroves in the world. Besides that, mangrove ecosystem in Indonesia has the highest diversity in the world (Sukardjo & Alongi, 2012). The distribution of mangroves in Indonesia is located on the coast of Sumatra, Kalimantan, and Papua. The extent of mangroves distribution continued to decline from 4.25 million hectares in 1982 to approximately 3.24 million hectares in 1987 and remaining of 2.79 hectares in 2000 (Richards & Friess, 2016). Between 2000 -2012, the percentage of mangroves loss were 1.72% (Richards & Friess, 2016). The declining trend indicates that there were 61.000 hectares of mangrove forests deforestation and mangrove habitat loss of 48.000 hectares over 12 years (Richards & Friess, 2016). It is caused by the conversion of land used into aquaculture/farming, agriculture, tourism, urban development, and overexploitation (Giri *et al*., 2008; Richards & Friess, 2016).

One result of various human activities in the coastal areas that affect the sustainability of natural resources is the destruction of mangrove ecosystem. The existence of mangrove ecosystems play an important role for the continuity of ecological and hydrological processes. Bengen (2001) added that damage and disturbance to the growth state could be a problem for the regeneration of mangroves in the future.

The growth of each plant will adjust to surrounding environment so that the morphology that occurs will vary from one place to another (Gratani, 2014). Therefore, the morphology of

mangroves in Baluran National Park is typical, considering that the different environmental conditions have different morphological descriptions (Sudarmadji, 2003).

The ecotourism development program in Bama Beach area requires data of mangrove ecosystem structure in Bama Beach Baluran National Park. This research aimed to know the community structure of mangrove ecosystem that includes mangrove species, diversity, domination, and zonation pattern in Bama Resort Baluran National Park, which can be used in the management and conversation of mangroves especially in Baluran National Park and generally in East Java.

METHODS

The study area

The research was conducted in January-May 2014 at Bama Beach Baluran National Park. Baluran National Park is located at Situbondo District East Java Province (Figure 1) geographically lies between 7º50'44.48' S- 114º27'39.65" E and 7º51'04.11" S -114º27'32.32" E. Mapping transects and plots in sampling area was obtained through Global Positioning System (GPS) by the use of an online mapping (Figure 2).

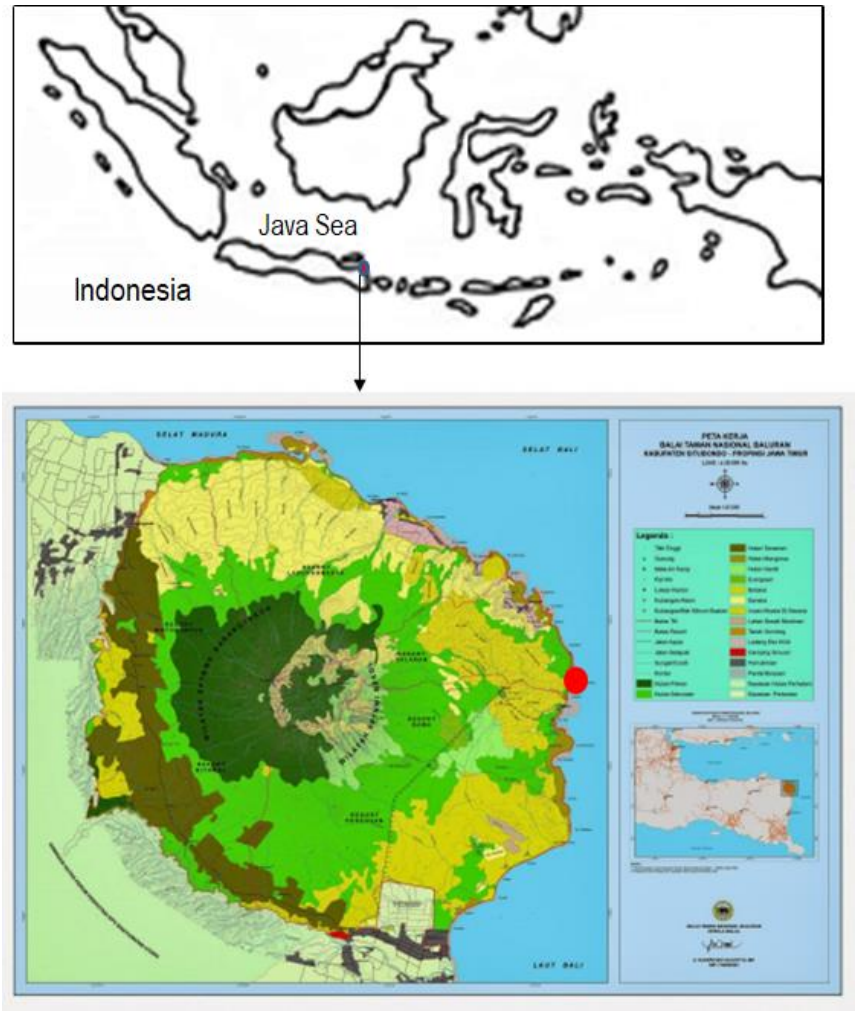

Figure 1. The research site

The research procedures were by conducting survey and imaging via Google Earth which allegedly representing and depicting mangrove zonation pattern then determined ten transects with length adjusting the mangrove thickness.

Figure 2. Sampling transects in Bama Beach

Establishment of sampling plots and measurement

We used quadrat transect methods with ten transects belt that perpendicular to the mainland, each sub-plot (100 m^2) for sapling (dbh: 2cm-9.99cm) and trees (dbh: ≥ 10cm), and a 5 x 5-meter plot was laid inside the main plot for seedling (dbh: < 2.0cm) study. Mangroves trees inside the sampling plots were counted and identified respectively. The data collected of this research were mangrove species, number of stem to determine the value of density, tree diameter at breast height (dbh), stem height, substrate type (fraction), and physical-chemical condition such as pH, temperature, salinity, and light intensity.

Vegetation analysis

The data were analyzed using several parameters: population density, frequency, dominance, relative density, relative frequency, relative dominance, and the importance value (*IV*) (Odum & Barett, 2005). This analysis can better inform of species function in its habitat. It also gives order for appropriate species within the mangrove community.

Population density = $\frac{Number\ of\ individuals}{Total\ area\ sampled}$

Frequency = $\frac{Number\ of\ plots\ in\ which\ a\ species\ ocurs}{Total\ number\ of\ plots\ sampled}$

Dominance = $\frac{Total\ of\ basal\ area\ of\ each\ tree\ of\ a\ species\ from\ all\ plots}{Total\ area\ of\ all\ measured\ plots}$

Relative density = $\frac{Number\ of\ individual\ of\ a\ species}{Total\ number\ of\ individuals\ all\ of\ species}$ x 100

Relative dominance = $\frac{Total\ basal\ area\ of\ \ a\ species}{Basal\ area\ of\ all\ species}$ x 100

Relative frequency = $\frac{Frequency\ of\ species}{Total\ frequency\ of\ all\ species\ in\ different\ plots}$ x 100

Importance value (*IV*) = Relative density + Relative frequency + Relative dominance

Diversity index of mangroves was calculated by Shannon-Wiener index (Odum & Barett, 2005).

$H' = -\sum Pi \ln Pi$

H = Shannon diversity index

*P*i = Fraction of the entire population made up of species *i* (proportion of a species *i* relative to total number of species present)

Evennes index (J) = $\frac{H'}{H\ max}$

Dominance index was calculated by Simpson (Odum & Barett, 2005).

$$C = \Sigma(\frac{ni}{N})^2$$

C = dominance index

ni = importance value for each species

N = total of importance value

Water Analysis

Water in all plots were measured pH, salinity, and temperature. The measurement have been carried out in situ.

Light Intensity

Light intensity on each plots was measured using lux meter

Substrat Analysis

The determination of texture of mangrove substrate was done ex situ in the laboratory. Soils in all plots were collected using a stainless steel corer (7 cm inside diameter) to a depth of 20 cm. Soils samples each plot were taken twice. The steps in substrate texture analysis are based on the USDA triangle.

RESULTS AND DISCUSSION

Overview of the Research Site

The research site was located at Bama Resort which include in Baluran National Park area with 6.126 ha. 6 species mangroves from 2 families were recorded in this research, that is family Rhizoporaceae (*R. stylosa*, *R. mucronata*, *R. apiculata*, *B. gymnorrhiza,* and *C. tagal)* and family Araceae (*N. fruticans*) (Table 1) and (Figure 4).

Table 1. The total number of seedlings, saplings, and trees of all mangrove in a 0.3 h at Bama resort

No	Species	Family	Stage		
			Seedlings	Saplings	Trees
1	*R. stylosa*	Rhizophorazeae	0	48	50

2	*R. mucronata*	Rhizophorazeae	0	5	3
3	*R. apiculata*	Rhizophorazeae	13	81	221
4	*B. gymnorrhiza*	Rhizophorazeae	2	16	11
5	*C. tagal*	Rhizophorazeae	0	2	0
6	*N. fructicans*	Araceae	0	26	3
		Total	15	178	288

All of these mangroves are mayor mangrove or true mangrove. *R. apiculata* was the most abundant tree with 221 trees followed by *R. stylosa* (50 trees), *B. gymnorrhiza* (11 trees), *R. mucronata* (3 trees) and *N. fructicans* (3 trees). Moreover *R. apiculata* sapling showed the highest dispersal followed by *R. stylosa, N. fructicans, B. gymnorrhiza, R. mucronata,* and *C. tagal*. When considering the seedlings, *R. apiculata* was the highest dispersal (13 trees), followed by *B. gymnorrhiza* (2 trees).The success of *R. apiculata* regeneration at the sea edge due in part to differences infloading tolerance of these species (Sukardjo et al, 2014). It's also could be due to *R. apiculata* has the highest tolerance limit of the extreme conditions such as high salinity and muddy substrate. That highest tolerance limit is supported by the root system of *R. apiculata* which is aerial root (pneumatophore) in the form of long roots and branches arise from the base of stem. This root is known as the prop root and will eventually become still root if the stem is held up so that it no longer touches the ground. The root helps the upright of the tree because it has a broad base to support in soft and unstable mud. It also helps the aeration when exposed at low tide (Ng and Sivatoshi, 2001; Hogarth, 2015).

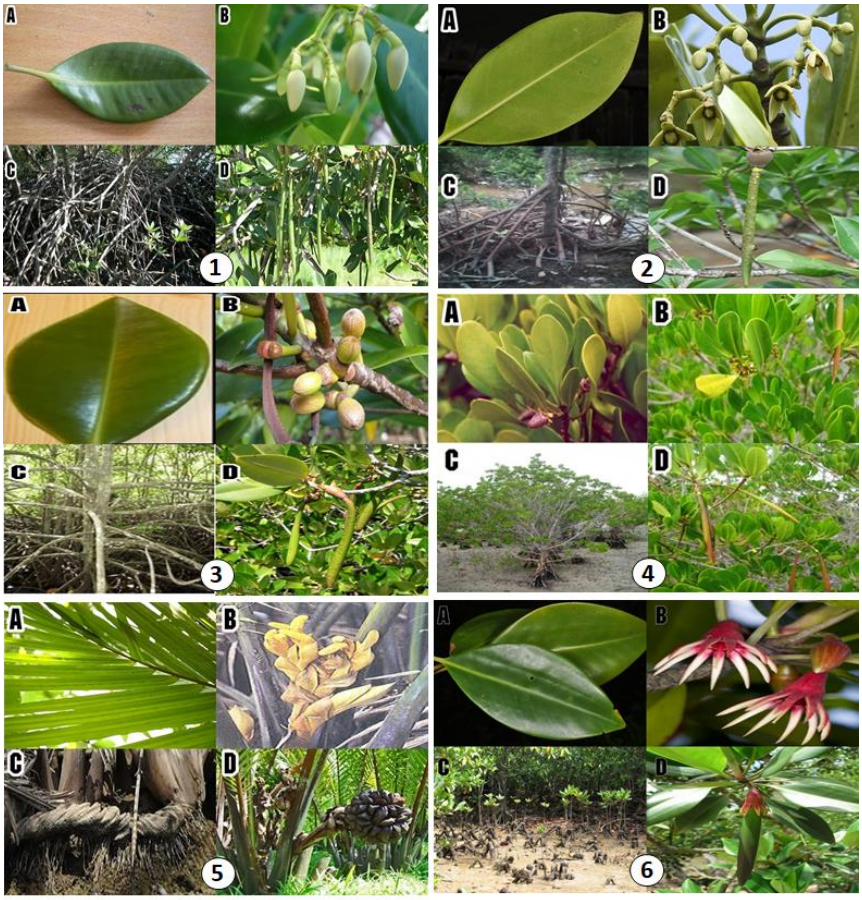

Figure 3. Mangrove species recorded in Bama Resort: 1. *R. stylosa*. 2. *R. mucronata*. 3. *R. apiculata*. 4. *C.tagal*. 5. *N. fruticans.* 6. *B. gymnorrhiza*. A. leaf. B. flower arrangement. C. rooting system. D. propagul.

From this data, total number of seedling all plots showed a pure regeneration potential, only *R. apiculata* and *B. gymnorrhiza*. Hastuti & Budihastuti (2016) has indicated that environment parameters including temperature, turbidity, pH, DO and its changes had significant effect on the growth of mangrove seedling especially *R. mucronata*.

The water temperature is still classified as a normal range between 28^{o}C -29^{o}C, salinity is quite good for the growth of mangrove that range 29ppt -31ppt, and the water pH is normal in the range 6.8-7.5. Soil in all plots consisted of a mixture of dark gray silt-clay (71-74%) with lesser amounts of sand (19-26%).

The intensity of the light is in the range of 900 lux until more than 3000 lux, the light intensity of the different areas of the outside and the inside of the mangrove forests. The outer area got more sunlight compared to other areas in the central part of or inside of the mangrove

forests, so the value is also different, although there are some parts in the area of mangrove forests also got sunshine that's a lot, this caused the existence of an open canopy or the presence of uprooted trees caused the sunlight may enter among the vegetation. Areas with more sunlight supports the process of the growth of mangroves or other organism is better compared to the darker areas and dense.

Table 2 indicated the result of quantitative analysis for tree-level based on importance value index. Its shows that there were 5 tree level mangrove species in the research site. The most important species was *R. apiculata* with the importance value at 229.80% and the least important species was *R. mucronata* with the importance value at 3.34%. In this study did not found *Avicenia marina* such mangrove species as is common to other mangrove forest bordering the Java Sea. Hogarth (2015) has been reported *A. marina* can grow where the soil salinity is greater than 65‰**.**

Table 2. Analysis of mangroves trees

No	Species	Relative density (%)	Relative frequency (%)	Relative dominance (%)	*IV* (%)
1	*R. apiculata*	75.00	62.29	82.74	229.80
2	*R. stylosa*	17.31	20.27	10.63	47.78
3	*B. gymnorrhiza*	3.85	10.14	5.75	15.57
4	*N. fruticans*	1.92	4.38	0.44	3.42
5	*R. mucronata*	1.92	2.92	0.44	3.34
	Total	100.00	100.00	100.00	300.00

Diversity is the total range of plant species in an area Diversity index or Shannon diversity index is used to determine the species diversity in a community. Species evenness is a measure of biodiversity which quantifies how equal the populations are numerically (Kasawani et al., 2007). Evenness index (J) which is the relative abundance with each mangrove species is represented in an area. In this research, the value of diversity index is 0.39 for seedling, which is low as shown in Table 3. Although the diversity index is relatively low, there were 6 species mangroves belonging to mayor mangrove or true mangrove, so it is important to maintain the mangroves. Bama Resort area has a low diversity because there was *R. apiculata* which has the sub-dominant or dominant but not a whole characteristic. This occurs because the ecosystem conditions that strongly support the growth of *R. apiculata* which is the type of substrate (mud).

Table 3. Shannon diversity (H') and Evenness (J)

Category	Shannon Diversity (H')	Evenness (J)
Seedlings	0.39	0.22
Saplings	1.37	0.76
Trees	0.73	0.41
All species	1.79	0.49

Species diversity and mangrove growth are influenced by salinity (Ball, 2002), competition and other physical factor (Hogarth, 2015, Hossain and Nuruddin, 2016). Setyawan (2005) added that the extent of the mangroves area greatly determines the diversity of plant species. The extent of area also allows sufficient space to grow and reduce competition among species in the fight for space, nutrition, and space.

Table 4 shows that research plot with the Simpson dominance index (C) at 0.521, which classified as sub-dominant because the C value is in between 0.5 and 0.75 (Wibisono, 2005).

Table 4. Dominancy index of mangrove vegetations

No	Species	Dominance Index
1	*R. stylosa*	0.029
2	*R. mucronata*	0.000
3	*R. apiculata*	0.487
4	*B. gymnorrhiza*	0.004
5	*C. tagal*	0.000
6	*N. fruticans*	0.001
	Total	0.521

Based on this results, it is known that there were sub-dominant mangrove or non-dominant. *R. apiculata* has the highest dominance value (0.487), which also has the sub-dominant characteristic (Table 4).

The mangrove zonation pattern in the research site from the coastal line to the mainland was *R. stylosa*, *R. mucronata*, and *R. apiculata* in the outer zone, respectively (zone directly

adjacent to the sea); *B. gymnorrhiza* and *C. tagal* in the middle zone; and *N. fruticans* in the zone that adjacent to the mainland or landward zone (Figure 4). The three zones of mangroves in Bama resort are not similar to those found throughout the Sirondo and Batu Sampang Baluran National Park (Sudarmadji, 2003), the Cimanuk Delta (Sukardjo et al., 2014). The principal drivers of zonation are complex, dependent on the interrelationships between and among factors, including soil nutrients, frequency of tidal inundation or different positions along some physical gradient, ecological interactions between species in the community (Hogarth, 2015). The percentage of the most dominant substrate fraction is mud with total percentage of 10 transects at 48.76%. This result indicated that the type of the research site was coastal akressif.

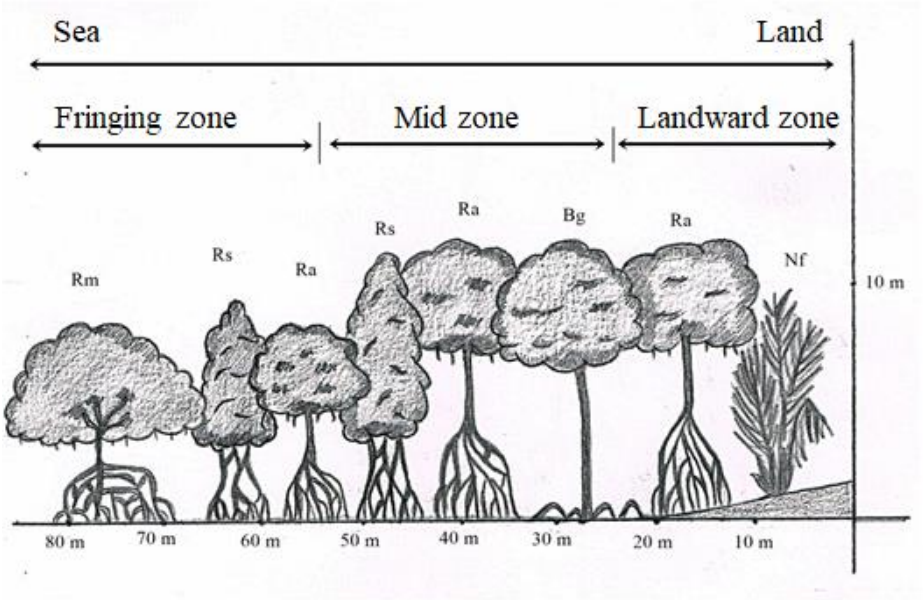

Figure 4. [U1]The mangrove zonation pattern at the research site

Rm : *R. mucronata* Rs : *R. stylosa*

Ra : *R. apiculata* Bg : *B. gymnorrhiza*

Nf : *N. fruticans*

Figure 5. The rooting appearance of *R.apiculata* located in the middle zone

Zoning is almost entirely dominated by *R. apiculata* from the coastal line to the mainland (Figure 5), except at transect 5 which is only found saplings of *N. fruticans* at the coral sand substrate. This condition is more influenced by the adaptability of *R. apiculata* which is fairly high. Besides that, its shorter and slender hypocotyl than the *Rhizophoraceae* group allow to be carried by the sea water (Hogarth, 2015).

Based on the results, it can be concluded that there were 6 species mangroves from 2 families in Bama Resort Baluran National Park, that is family *Rhizophoraceae* (*R. stylosa*, *R. mucronata*, *R. apiculata*, *B. gymnorrhiza*, and *C. tagal*) and family Araceae (*N. fruticans*). The diversity of mangroves in Bama Resort Baluran National Park was classified as good (1.79). There is not mangrove which classified as dominant in Bama Resort Baluran National Park area. But, *R. apiculata* has sub-dominant characteristic with the dominance value at 0.487. The mangrove zonation pattern from the coastal line to the mainland was *R. stylosa*, *R. mucronata*, and *R. apiculata*, in the outer zone, respectively (zone directly adjacent to the sea); *B. gymnorrhiza* and *C. tagal* in the middle zone; and *N. fruticans* in the zone that adjacent to the mainland or landward zone.

This study identified that arrangement of mangroves in Bama resort is slightly different from the type of zoning compiler in general. There is not found of *Avicenniaceae* or *Verbenaceae* family, and the mangroves of Bama resort did not have dominant species.

The present study will aid in the conduct and preservation planning of mangrove forest especially at Bama coast and generally in the coastal areas of Indonesia.

CONCLUSIONS[U2]

A total of six mangrove species (*R. stylosa*, *R. mucronata*, *R. apiculata*, *B. gymnorrhiza*, *C. tagal*, and *N. fruticans*) from two families (*Rhizophoraceae* and *Araceae*) were identified in Bama Resort. Analysis in vegetation in Bama Resort showed that species with highest importance value was *R. apiculata* (229.80%) followed by *R. stylosa* (47.78%), *B. gymnorrhiza* (15.57%), *N. fruticans* (3.42%), and *R. mucronata* (3.34%). The greatest mangrove diversity (1.37) in terms of diameter category is sapling and the lowest mangrove diversity (0.39) was belongs to seedling. The mangrove zonation patterns from the coastline to the mainland are *R. stylosa*, *R. mucronata*, and *R. apiculata* in the outermost zone (the zone adjacent to the sea), *B. gymnorrhiza* and *C. tagal* in the middle zone. *N. fructicans* in the zone bordering on land mangrove.

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Vegetation and Community Structure of Mangrove in Bama Resort Baluran National Park Situbondo East Java

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ABSTRACT

Ecotourism development program at Bama beaches area require baseline data of mangrove structure at Bama Resort. ~~and in the past two decades has been lost about 35% area of mangrove forest in Indonesia and in the world~~The aims of this study was to find structure, composition, distribution and zonation patterns of mangroves at Bama Resort Baluran Nasional Park.Ten belt-transects were laid perpendicular to the shoreline, using standard methods. Vegetation structure was determined using data collected on plant species diversity, density, basal area, and the number of each species of mangroves. Shannon Wiener index to calculated diversity, evennes and Simpson to calculated dominance index. The results show there are 2 families and 6 mangrove species occurring in the study areas that is Rhizophoraceae (*Rhizophora stylosa*, *Rhizophora mucronata*, *Rhizophora apiculata*, *Bruguiera gymnorrhiza*, and *Ceriops tagal*) and Araceae (*Nypa fruticans*). The highest importance value was *R. apiculata* (229.90%) for trees, *R. apiculata* (148.69%) for the sapling, and *R. apiculata* (244.83%) for the seedling. The diversity (H) and dominance index (C) values were moderate (1.79) and 0.521. The most dominant species was *R. apiculata* (C=0.487). The mangrove zonation pattern from coastline to the mainland was *R. stylosa*, *R. mucronata*, and *R. apiculata*, in the outer zone, respectively (zone directly adjacent to the sea); *B. gymnorrhiza* and *C. tagal* in the middle zone; and *N. fruticans* in the zone that adjacent to the mainland. The present study will aid in the conduct and preservation planning of mangrove forest especially at Bama coast and generally in the coastal areas of Indonesia.

Keywords: Bama, community, diversity, mangrove, zonation.

INTRODUCTION

Mangroves are one of forests ecosystem that unique and special. The mangrove ecosystem exists in tidal coastal areas, beaches, and some small islands. Mangrove forests harbor a valuable natural resource with high intrinsic natural productivity. Mangrove are woody plants, which grow in loose wet soils of brackish-to-saline estuaries and shorelines in the tropics and sub-tropics (Joshi & Ghose, 2003). Mangrove forests provide many valuable ecosystem services, such as assimilating excess atmospheric carbon, protecting coastlines from hurricanes, increasing vertical land development, and providing nursery habitat for fish (Alongi D. M., 2002; Nagelkerkin, et al., 2008; Lee, et al., 2014).

The mangrove ecosystem in Indonesia holds 75% of total mangroves in South East Asia or around 27% of total mangroves in the world. Besides that, mangrove ecosystem in Indonesia has the highest diversity in the world (Sukardjo & Alongi, 2012). The distribution of mangroves in Indonesia is located on the coast of Sumatra, Kalimantan, and Papua. The extent of mangroves distribution continued to decline from 4.25 million hectares in 1982 to approximately 3.24 million hectares in 1987 and remaining of 2.79 hectares in 2000 (Richards & Friess, 2016). Between 2000 -2012, the percentage of mangroves loss were 1.72% (Richards & Friess, 2016). The declining trend indicates that there were 61.000 hectares of mangrove forests deforestation and mangrove habitat loss of 48.000 hectares over 12 years (Richards & Friess, 2016). It is caused by the conversion of land used into aquaculture/farming, agriculture, tourism, urban development, and overexploitation (Giri *et al*., 2008; Richards & Friess, 2016).

One result of various human activities in the coastal areas that affect the sustainability of natural resources is the destruction of mangrove ecosystem. The existence of mangrove ecosystems play an important role for the continuity of ecological and hydrological processes. Bengen (2001) added that damage and disturbance to the growth state could be a problem for the regeneration of mangroves in the future.

The growth of each plant will adjust to surrounding environment so that the morphology that occurs will vary from one place to another (Gratani, 2014). Therefore, the morphology of mangroves in Baluran National Park is typical, considering that the different environmental conditions have different morphological descriptions (Sudarmadji, 2003).

The ecotourism development program in Bama Beach area requires data of mangrove ecosystem structure in Bama Beach Baluran National Park. This research aimed to know the community structure of mangrove ecosystem that includes mangrove species, diversity, domination, and zonation pattern in Bama Resort Baluran National Park, which can be used in the management and conversation of mangroves especially in Baluran National Park and generally in East Java.

METHODS

The study area

The research was conducted in January-May 2014 at Bama Beach Baluran National Park. Baluran National Park is located at Situbondo District East Java Province (Figure 1) geographically lies between 7º50'44.48' S- 114º27'39.65" E and 7º51'04.11" S -114º27'32.32" E. Mapping transects and plots in sampling area was obtained through Global Positioning System (GPS) by the use of an online mapping (Figure 2).

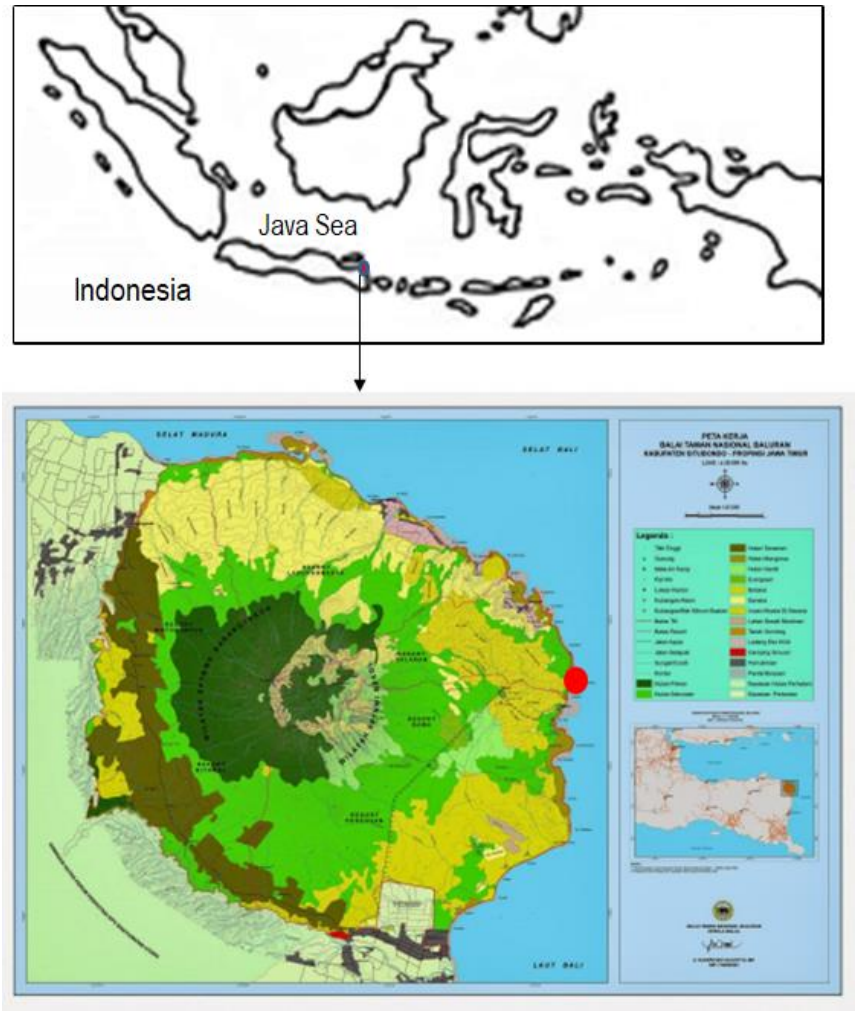

Figure 1. The research site

The research procedures were by conducting survey and imaging via Google Earth which allegedly representing and depicting mangrove zonation pattern then determined ten transects with length adjusting the mangrove thickness.

Figure 2. Sampling transects in Bama Beach

Establishment of sampling plots and measurement

We used quadrat transect methods with ten transects belt that perpendicular to the mainland, each sub-plot (100 m^2) for sapling (dbh: 2cm-9.99cm) and trees (dbh: ≥ 10cm), and a 5 x 5-meter plot was laid inside the main plot for seedling (dbh: < 2.0cm) study. Mangroves trees inside the sampling plots were counted and identified respectively. The data collected of this research were mangrove species, number of stem to determine the value of density, tree diameter at breast height (dbh), stem height, substrate type (fraction), and physical-chemical condition such as pH, temperature, salinity, and light intensity.

Vegetation analysis

The data were analyzed using several parameters: population density, frequency, dominance, relative density, relative frequency, relative dominance, and the importance value (*IV*) (Odum & Barett, 2005). This analysis can better inform of species function in its habitat. It also gives order for appropriate species within the mangrove community.

Population density = $\frac{Number\ of\ individuals}{Total\ area\ sampled}$

Frequency = $\frac{Number\ of\ plots\ in\ which\ a\ species\ ocurs}{Total\ number\ of\ plots\ sampled}$

Dominance = $\frac{Total\ of\ basal\ area\ of\ each\ tree\ of\ a\ species\ from\ all\ plots}{Total\ area\ of\ all\ measured\ plots}$

Relative density = $\frac{Number\ of\ individual\ of\ a\ species}{Total\ number\ of\ individuals\ all\ of\ species}$ x 100

Relative dominance = $\frac{Total\ basal\ area\ of\ \ a\ species}{Basal\ area\ of\ all\ species}$ x 100

Relative frequency = $\frac{Frequency\ of\ species}{Total\ frequency\ of\ all\ species\ in\ different\ plots}$ x 100

Importance value (*IV*) = Relative density + Relative frequency + Relative dominance

Diversity index of mangroves was calculated by Shannon-Wiener index (Odum & Barett, 2005).

$H' = -\sum Pi \ln Pi$

H = Shannon diversity index

*P*i = Fraction of the entire population made up of species *i* (proportion of a species *i* relative to total number of species present)

Evennes index (J) = $\frac{H'}{H\ max}$

Dominance index was calculated by Simpson (Odum & Barett, 2005).

$$C = \Sigma(\frac{ni}{N})^2$$

C = dominance index

ni = importance value for each species

N = total of importance value

Water Analysis

Water in all plots were measured pH, salinity, and temperature. The measurement have been carried out in situ.

Light Intensity

Light intensity on each plots was measured using lux meter

Substrat Analysis

The determination of texture of mangrove substrate was done ex situ in the laboratory. Soils in all plots were collected using a stainless steel corer (7 cm inside diameter) to a depth of 20 cm. Soils samples each plot were taken twice. The steps in substrate texture analysis are based on the USDA triangle.

RESULTS AND DISCUSSION

Overview of the Research Site

The research site was located at Bama Resort which include in Baluran National Park area with 6.126 ha. 6 species mangroves from 2 families were recorded in this research, that is family Rhizoporaceae (*R. stylosa*, *R. mucronata*, *R. apiculata*, *B. gymnorrhiza*, and *C. tagal)* and family Araceae (*N. fruticans*) (Table 1) and (Figure 4).

Table 1. The total number of seedlings, saplings, and trees of all mangrove in a 0.3 h at Bama resort

No	Species	Family	Stage		
			Seedlings	Saplings	Trees
1	*R. stylosa*	Rhizophorazeae	0	48	50

2	*R. mucronata*	Rhizophorazeae	0	5	3
3	*R. apiculata*	Rhizophorazeae	13	81	221
4	*B. gymnorrhiza*	Rhizophorazeae	2	16	11
5	*C. tagal*	Rhizophorazeae	0	2	0
6	*N. fructicans*	Araceae	0	26	3
		Total	15	178	288

All of these mangroves are mayor mangrove or true mangrove. *R. apiculata* was the most abundant tree with 221 trees followed by *R. stylosa* (50 trees), *B. gymnorrhiza* (11 trees), *R. mucronata* (3 trees) and *N. fructicans* (3 trees). Moreover *R. apiculata* sapling showed the highest dispersal followed by *R. stylosa, N. fructicans, B. gymnorrhiza, R. mucronata,* and *C. tagal*. When considering the seedlings, *R. apiculata* was the highest dispersal (13 trees), followed by *B. gymnorrhiza* (2 trees).The success of *R. apiculata* regeneration at the sea edge due in part to differences infloading tolerance of these species (Sukardjo et al, 2014). It's also could be due to *R. apiculata* has the highest tolerance limit of the extreme conditions such as high salinity and muddy substrate. That highest tolerance limit is supported by the root system of *R. apiculata* which is aerial root (pneumatophore) in the form of long roots and branches arise from the base of stem. This root is known as the prop root and will eventually become still root if the stem is held up so that it no longer touches the ground. The root helps the upright of the tree because it has a broad base to support in soft and unstable mud. It also helps the aeration when exposed at low tide (Ng and Sivatoshi, 2001; Hogarth, 2015).

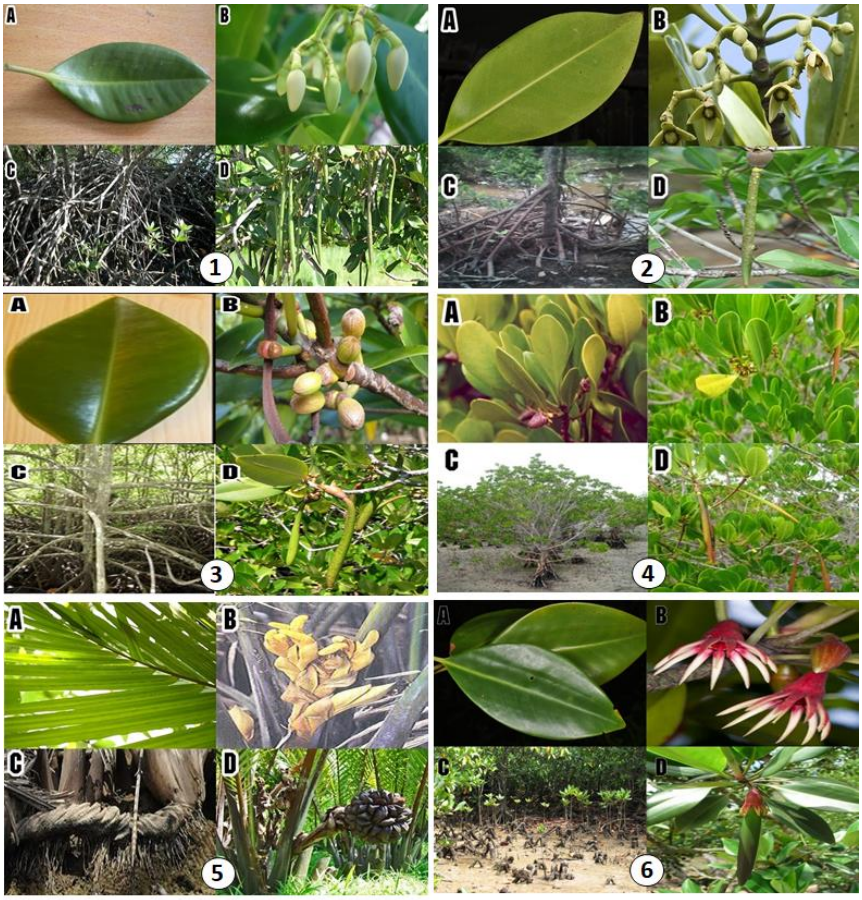

Figure 3. Mangrove species recorded in Bama Resort: 1. *R. stylosa*. 2. *R. mucronata*. 3. *R. apiculata*. 4. *C.tagal*. 5. *N. fruticans.* 6. *B. gymnorrhiza*. A. leaf. B. flower arrangement. C. rooting system. D. propagul.

From this data, total number of seedling all plots showed a pure regeneration potential, only *R. apiculata* and *B. gymnorrhiza*. Hastuti & Budihastuti (2016) has indicated that environment parameters including temperature, turbidity, pH, DO and its changes had significant effect on the growth of mangrove seedling especially *R. mucronata*.

The water temperature is still classified as a normal range between 28^{o}C -29^{o}C, salinity is quite good for the growth of mangrove that range 29ppt -31ppt, and the water pH is normal in the range 6.8-7.5. Soil in all plots consisted of a mixture of dark gray silt-clay (71-74%) with lesser amounts of sand (19-26%).

The intensity of the light is in the range of 900 lux until more than 3000 lux, the light intensity of the different areas of the outside and the inside of the mangrove forests. The outer area got more sunlight compared to other areas in the central part of or inside of the mangrove forests,

so the value is also different, although there are some parts in the area of mangrove forests also got sunshine that's a lot, this caused the existence of an open canopy or the presence of uprooted trees caused the sunlight may enter among the vegetation. Areas with more sunlight supports the process of the growth of mangroves or other organism is better compared to the darker areas and dense.

Table 2 indicated the result of quantitative analysis for tree-level based on importance value index. Its shows that there were 5 tree level mangrove species in the research site. The most important species was *R. apiculata* with the importance value at 229.80% and the least important species was *R. mucronata* with the importance value at 3.34%. In this study did not found *Avicenia marina* such mangrove species as is common to other mangrove forest bordering the Java Sea. Hogarth (2015) has been reported *A. marina* can grow where the soil salinity is greater than 65‰**.**

Table 2. Analysis of mangroves trees

No	Species	Relative density (%)	Relative frequency (%)	Relative dominance (%)	*IV* (%)
1	*R. apiculata*	75.00	62.29	82.74	229.80
2	*R. stylosa*	17.31	20.27	10.63	47.78
3	*B. gymnorrhiza*	3.85	10.14	5.75	15.57
4	*N. fruticans*	1.92	4.38	0.44	3.42
5	*R. mucronata*	1.92	2.92	0.44	3.34
	Total	100.00	100.00	100.00	300.00

Diversity is the total range of plant species in an area Diversity index or Shannon diversity index is used to determine the species diversity in a community. Species evenness is a measure of biodiversity which quantifies how equal the populations are numerically (Kasawani et al., 2007). Evenness index (J) which is the relative abundance with each mangrove species is represented in an area. In this research, the value of diversity index is 0.39 for seedling, which is low as shown in Table 3. Although the diversity index is relatively low, there were 6 species mangroves belonging to mayor mangrove or true mangrove, so it is important to maintain the mangroves. Bama Resort area has a low diversity because there was *R. apiculata* which has the sub-dominant or dominant but not a whole characteristic. This occurs because the ecosystem conditions that strongly support the growth of *R. apiculata* which is the type of substrate (mud).

Table 3. Shannon diversity (H') and Evenness (J)

Category	Shannon Diversity (H')	Evenness (J)
Seedlings	0.39	0.22
Saplings	1.37	0.76
Trees	0.73	0.41
All species	1.79	0.49

Species diversity and mangrove growth are influenced by salinity (Ball, 2002), competition and other physical factor (Hogarth, 2015, Hossain and Nuruddin, 2016). Setyawan (2005) added that the extent of the mangroves area greatly determines the diversity of plant species. The extent of area also allows sufficient space to grow and reduce competition among species in the fight for space, nutrition, and space.

Table 4 shows that research plot with the Simpson dominance index (C) at 0.521, which classified as sub-dominant because the C value is in between 0.5 and 0.75 (Wibisono, 2005).

Table 4. Dominancy index of mangrove vegetations

No	Species	Dominance Index
1	*R. stylosa*	0.029
2	*R. mucronata*	0.000
3	*R. apiculata*	0.487
4	*B. gymnorrhiza*	0.004
5	*C. tagal*	0.000
6	*N. fruticans*	0.001
	Total	0.521

Based on this results, it is known that there were sub-dominant mangrove or non-dominant. *R. apiculata* has the highest dominance value (0.487), which also has the sub-dominant characteristic (Table 4).

The mangrove zonation pattern in the research site from the coastal line to the mainland was *R. stylosa*, *R. mucronata*, and *R. apiculata* in the outer zone, respectively (zone directly adjacent to the sea); *B. gymnorrhiza* and *C. tagal* in the middle zone; and *N. fruticans* in the zone

that adjacent to the mainland or landward zone (Figure 4). The three zones of mangroves in Bama resort are not similar to those found throughout the Sirondo and Batu Sampang Baluran National Park (Sudarmadji, 2003), the Cimanuk Delta (Sukardjo et al., 2014). The principal drivers of zonation are complex, dependent on the interrelationships between and among factors, including soil nutrients, frequency of tidal inundation or different positions along some physical gradient, ecological interactions between species in the community (Hogarth, 2015). The percentage of the most dominant substrate fraction is mud with total percentage of 10 transects at 48.76%. This result indicated that the type of the research site was coastal akressif.

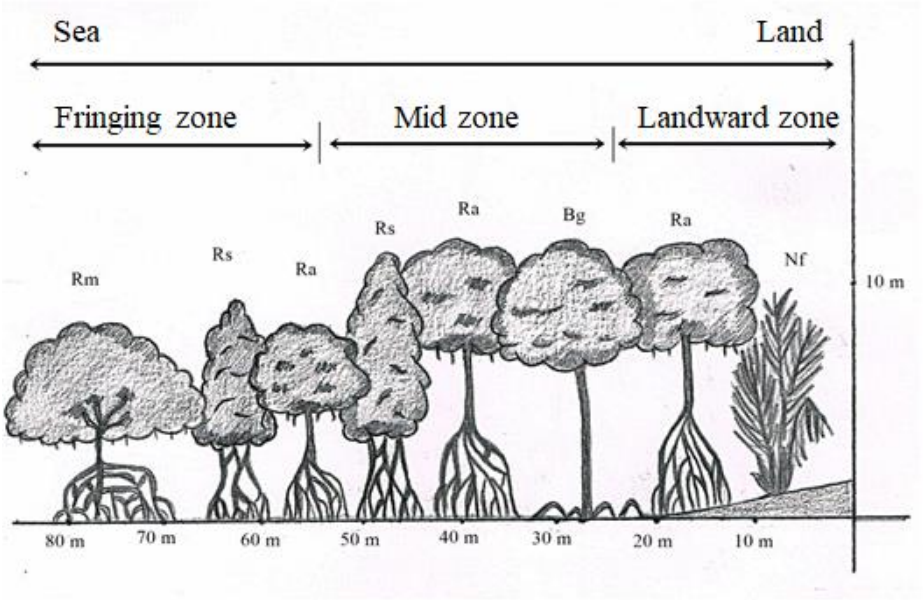

Figure 4. [U1]The mangrove zonation pattern at the research site

Rm : *R. mucronata* Rs : *R. stylosa*

Ra : *R. apiculata* Bg : *B. gymnorrhiza*

Nf : *N. fruticans*

Figure 5. The rooting appearance of *R.apiculata* located in the middle zone

Zoning is almost entirely dominated by *R. apiculata* from the coastal line to the mainland (Figure 5), except at transect 5 which is only found saplings of *N. fruticans* at the coral sand substrate. This condition is more influenced by the adaptability of *R. apiculata* which is fairly high. Besides that, its shorter and slender hypocotyl than the *Rhizophoraceae* group allow to be carried by the sea water (Hogarth, 2015).

Based on the results, it can be concluded that there were 6 species mangroves from 2 families in Bama Resort Baluran National Park, that is family *Rhizophoraceae* (*R. stylosa*, *R. mucronata*, *R. apiculata*, *B. gymnorrhiza*, and *C. tagal*) and family Araceae (*N. fruticans*). The diversity of mangroves in Bama Resort Baluran National Park was classified as good (1.79). There is not mangrove which classified as dominant in Bama Resort Baluran National Park area. But, *R. apiculata* has sub-dominant characteristic with the dominance value at 0.487. The mangrove zonation pattern from the coastal line to the mainland was *R. stylosa*, *R. mucronata*, and *R. apiculata*, in the outer zone, respectively (zone directly adjacent to the sea); *B. gymnorrhiza* and *C. tagal* in the middle zone; and *N. fruticans* in the zone that adjacent to the mainland or landward zone.

This study identified that arrangement of mangroves in Bama resort is slightly different from the type of zoning compiler in general. There is not found of *Avicenniaceae* or *Verbenaceae* family, and the mangroves of Bama resort did not have dominant species.

The present study will aid in the conduct and preservation planning of mangrove forest especially at Bama coast and generally in the coastal areas of Indonesia.

CONCLUSIONS[U2]

A total of six mangrove species (*R. stylosa*, *R. mucronata*, *R. apiculata*, *B. gymnorrhiza*, *C. tagal*, and *N. fruticans*) from two families (*Rhizophoraceae* and *Araceae*) were identified in Bama Resort. Analysis in vegetation in Bama Resort showed that species with highest importance value was *R. apiculata* (229.80%) followed by *R. stylosa* (47.78%), *B. gymnorrhiza* (15.57%), *N. fruticans* (3.42%), and *R. mucronata* (3.34%). The greatest mangrove diversity (1.37) in terms of diameter category is sapling and the lowest mangrove diversity (0.39) was belongs to seedling. The mangrove zonation patterns from the coastline to the mainland are *R. stylosa*, *R. mucronata*, and *R. apiculata* in the outermost zone (the zone adjacent to the sea), *B. gymnorrhiza* and *C. tagal* in the middle zone. *N. fructicans* in the zone bordering on land mangrove.

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ABSTRACT

Ecotourism development program at Bama beaches area requires baseline data of mangrove structure at Bama Resort. The aims of this study ~~was~~ were to find the structure, composition, distribution and zonation patterns of mangroves at Bama Resort Baluran Nasional Park. Ten belt-transects were laid perpendicular to the shoreline, using standard methods. Vegetation structure was determined ~~using data collected on~~by collecting the data of plant species diversity, density, basal area, and the number of each species of mangroves. Shannon Wiener index was used to calculate the~~d~~ diversity, evennes and Simpson to calculated dominance index. [Mi1]~~The results show there~~There were ~~are 2 families and~~ 6 mangrove species from 2 families ~~occurring~~ appeared in the study areas ~~that is~~i.e. Rhizophoraceae (*Rhizophora stylosa*, *Rhizophora mucronata*, *Rhizophora apiculata*, *Bruguiera gymnorrhiza*, and *Ceriops tagal*) and Araceae (*Nypa fruticans*). The highest importance value of tree, sapling and seedling stages was shown by *R. apiculata* with the value of ~~(~~ 229.90%~~) for trees~~, ~~*R. apiculata* (~~148.69%~~) for the sapling, and *R. apiculata*~~ and ~~(~~244.83%~~)~~ respectively~~for the seedling~~. The diversity (H) and dominance index (C) values were moderate (1.79) and 0.521. ~~The most dominant species was~~ *R. apiculata* was also became the most dominant species with ~~(~~C=0.487~~)~~. The mangrove zonation pattern from coastline to the mainland was *R. stylosa*, *R. mucronata*, and *R. apiculata*, in the outer zone (zone directly adjacent to the sea), respectively ~~(zone directly adjacent to the sea)~~; *B. gymnorrhiza* and *C. tagal* in the middle zone; and *N. fruticans* in the zone that adjacent to the mainland. The present study provides the information that can be used as a basis in planning and conducting the preservation efforts of mangrove forest especially at Bama coast and generally in the coastal areas of Indonesia.

~~The present study will aid in the conduct and preservation planning of mangrove forest especially at Bama coast and generally in the coastal areas of Indonesia.~~

Keywords: Bama[Mi2], community, diversity, mangrove, zonation[Mi3].

INTRODUCTION

Mangrove~~s~~ ~~are~~ is one of forests ecosystem that is unique and special. The mangrove ecosystem exists in tidal coastal areas, beaches, and some small islands. Mangrove forests harbor a valuable natural resource with high intrinsic natural productivity. Mangrove are woody plants, which grow in loose wet soils of brackish-to-saline estuaries and shorelines in the tropics and sub-tropics (Joshi & Ghose, 2003). Mangrove forests provide many valuable ecosystem services, such as assimilating excess atmospheric carbon, protecting coastlines from hurricanes, increasing vertical land development, and providing nursery habitat for fish (Alongi ~~D. M.~~, 2002; Nagelkerkin, et al., 2008; Lee, et al., 2014).

The mangrove ecosystem in Indonesia holds 75% of total mangroves in South East Asia or around 27% of total mangroves in the world. Besides that, mangrove ecosystem in Indonesia has the highest diversity in the world (Sukardjo & Alongi, 2012). [Mi4]The distribution of mangroves in Indonesia is located on the coast of Sumatra, Kalimantan, and Papua. The extent of mangroves distribution continued to decline from 4.25 million hectares in 1982 to approximately 3.24 million hectares in 1987 and remaining ~~of~~ 2.79 hectares in 2000 (Richards & Friess, 2016). Between 2000 -2012, the percentage of mangroves loss ~~were~~ was 1.72% (Richards & Friess, 2016). The declining trend was ~~indicates~~ indicated by ~~that there were~~ 61.000 hectares of mangrove forests deforestation and 48.000 hectares of mangrove habitat loss ~~of 48.000 hectares~~ over 12 years (Richards & Friess, 2016). It is caused by the conversion of land used into aquaculture/farming, agriculture, tourism, urban development, ~~and~~ as well as its overexploitation (Giri et al., 2008; Richards & Friess, 2016).

One result of various human activities in the coastal areas that affect the sustainability of natural resources is the destruction of mangrove ecosystem. The existence of mangrove ecosystems play an important role for the continuity of ecological and hydrological processes. Bengen (2001) added that the damage and disturbance to the growth state could be a problem for the regeneration of mangroves in the future.

The growth of each plant will adjust to surrounding environment so that the morphology that ~~occurs~~ appears will vary from one place to another (Gratani, 2014). ~~–~~Therefore, the morphology of mangroves in Baluran National Park is typical, considering that the different environmental conditions have different morphological descriptions (Sudarmadji, 2003).

The ecotourism [Mi5]development program in Bama Beach area requires data of mangrove ecosystem structure in Bama Beach Baluran National Park. This research aimed to ~~know~~ determine the community structure of mangrove ecosystem that includes mangrove species, diversity, domination, and zonation pattern in Bama Resort Baluran National Park. Information obtained from this study was expected to~~, which can~~ be used in the management and ~~conversation~~ conservation efforts of mangroves especially in Baluran National Park and generally in East Java.

METHODS

The study area

The research was conducted in January-May 2014 at Bama Beach Baluran National Park. Baluran National Park is located at Situbondo District East Java Province (Figure 1) geographically lies between 7º50'44.48' S- 114º27'39.65" E and 7º51'04.11" S -114º27'32.32" E. Mapping transects and plots in sampling area was obtained through Global Positioning System (GPS) by the use of an online mapping (Figure 2).

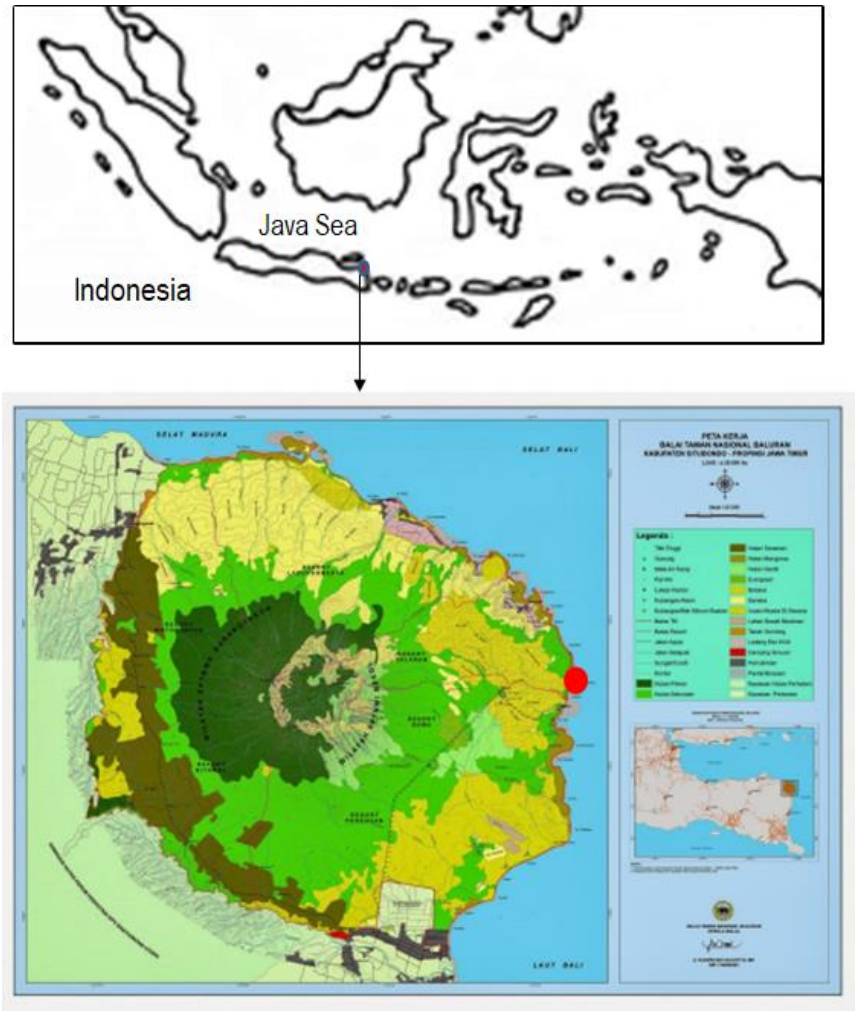


Figure 1. The research site

The research procedures were by conducting survey and imaging via Google Earth which allegedly representing and depicting mangrove zonation pattern, then determined ten transcects with length adjusting the mangrove thickness.

Figure 2. Sampling transects in Bama Beach

Establishment of sampling plots and measurement

The data collected of this research were mangrove species, number of stems to determine the value of density, tree diameter at breast height (dbh), stem height, substrate type (fraction), and physical-chemical condition such as pH, temperature, salinity, and light intensity.

~~We used quadrat~~Quadrat transect method~~s~~ was used with ten ~~transects~~ belt transects that perpendicular to the mainland, each sub-plot (100 m^2) for sapling (dbh: 2cm-9.99cm) and trees (dbh: ≥ 10cm), and a 5 x 5-meter plot was laid inside the main plot for seedling (dbh: < 2.0cm) study. [Mi6]Mangroves trees inside the sampling plots were counted and identified respectively. ~~The data collected of this research were mangrove species, number of stem to determine the value of density, tree diameter at breast height (dbh), stem height, substrate type (fraction), and physical-chemical condition such as pH, temperature, salinity, and light intensity.~~

Vegetation analysis

The data were analyzed using several parameters: population density, frequency, dominance, relative density, relative frequency, relative dominance, and the importance value (*IV*) (Odum & Barett, 2005). This analysis can better inform of species function in its habitat. It also gives order for appropriate species within the mangrove community.[Mi7]

Population density = $\frac{Number\ of\ individuals}{Total\ area\ sampled}$

Frequency = $\frac{Number\ of\ plots\ in\ which\ a\ species\ ocurs}{Total\ number\ of\ plots\ sampled}$

Dominance = $\frac{Total\ of\ basal\ area\ of\ each\ tree\ of\ a\ species\ from\ all\ plots}{Total\ area\ of\ all\ measured\ plots}$

Relative density = $\frac{Number\ of\ individual\ of\ a\ species}{Total\ number\ of\ individuals\ all\ of\ species}$ x 100

Relative dominance = $\frac{Total\ basal\ area\ of\ \ a\ species}{Basal\ area\ of\ all\ species}$ x 100

Relative frequency = $\frac{Frequency\ of\ species}{Total\ frequency\ of\ all\ species\ in\ different\ plots}$ x 100

Importance value (*IV*) = Relative density + Relative frequency + Relative dominance

Diversity index of mangroves was calculated by Shannon-Wiener index (Odum & Barett, 2005).

$H' = -\sum Pi \ln Pi$

H = Shannon diversity index

*P*i = Fraction of the entire population made up of species *i* (proportion of a species *i* relative to total number of species present)

Evenness index (J) = $\frac{H'}{H\ max}$

Dominance index was calculated by Simpson (Odum & Barett, 2005).

$$C = \Sigma(\frac{ni}{N})^2$$

C = dominance index

ni = importance value for each species

N = total of importance value

Water Analysis

Water analysis was conducted by measuring ~~W~~water ~~in all plots were measured~~ pH, salinity, and temperature in all plots. The measurement ~~have been~~was carried out *in situ*.

Light Intensity

Light intensity on each plot~~s~~ was measured using lux meter

~~Substrat~~**Substrate Analysis**

The determination of texture of mangrove substrate was done *ex situ* in the laboratory. Soils in all plots were collected using a stainless steel soil core~~r~~ (7 cm ~~inside~~ in diameter) to a depth of 20 cm. Soils samples from each plot were taken twice. The steps in substrate texture analysis ~~are~~ were based on the USDA triangle.

RESULTS AND DISCUSSION

Overview of the Research Site

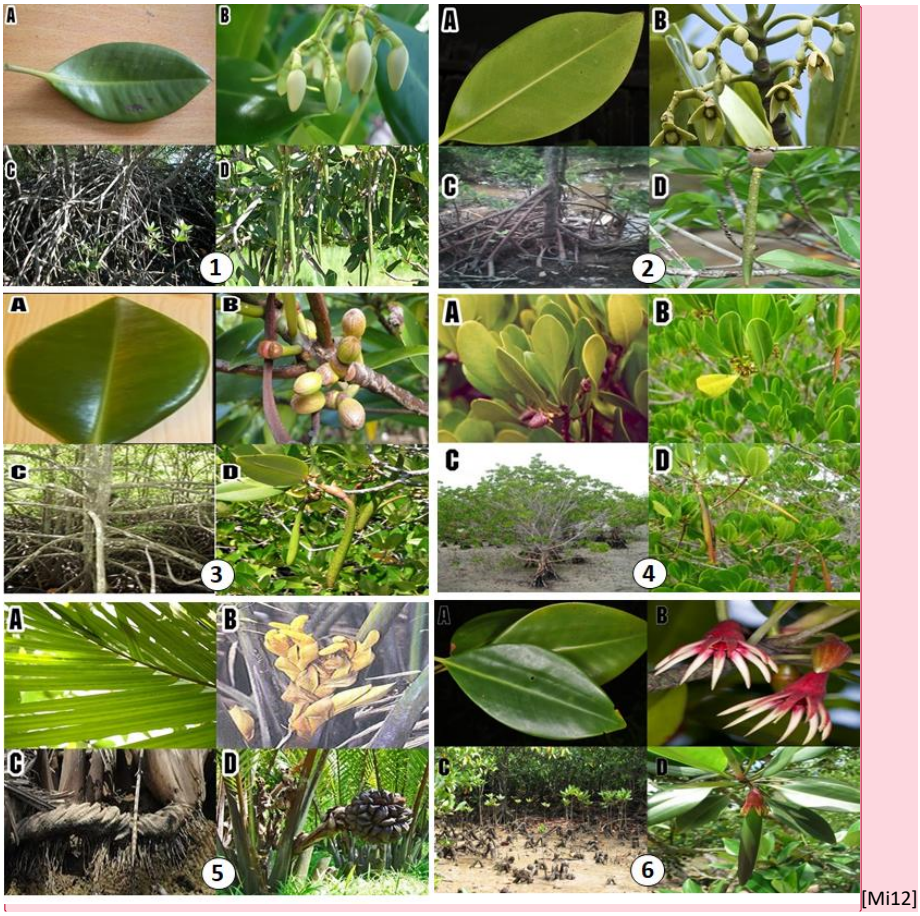
The research site was located at Bama Resort ~~which~~ included in Baluran National Park area with 6.126 ha. ~~6~~ Six species mangroves from 2 families that were recorded in this research i.e., ~~that is~~ family of Rhizophoraceae (*R.*[Mi8] *stylosa*, *R. mucronata*, *R. apiculata*, *B. gymnorrhiza*, and *C. tagal)* and family of Araceae (*N. fruticans*) (Table 1) and (Figure 4).

Table 1. The total number of seedlings, saplings, and trees of all mangrove in a 0.3 h at Bama resort

No	Species	Family	Stage

			Seedlings	Saplings	Trees
1	*R. stylosa*	Rhizophorazeae	0	48	50
2	*R. mucronata*	Rhizophorazeae	0	5	3
3	*R. apiculata*	Rhizophorazeae	13	81	221
4	*B. gymnorrhiza*	Rhizophorazeae	2	16	11
5	*C. tagal*	Rhizophorazeae	0	2	0
6	*N. fructicans*	Araceae	0	26	3
		Total	15	178	288

All of these mangroves are ~~mayor mangrove or~~ true mangrove. *R. apiculata* was the most abundant tree with 221 trees followed by *R. stylosa* (50 trees), *B. gymnorrhiza* (11 trees), *R. mucronata* (3 trees) and *N. fructicans* (3 trees). Moreover, *R. apiculata* sapling showed the highest dispersal followed by *R. stylosa*, *N. fructicans*, *B. gymnorrhiza*, *R. mucronata*, and *C. tagal*. When considering the seedlings, *R. apiculata* ~~was~~ had the highest dispersal (13 trees), followed by *B. gymnorrhiza* (2 trees). The success of *R. apiculata* regeneration at the sea edge due in part to differences in floading tolerance of these species [Mi9](Sukardjo et al., 2014). It was~~'s~~ also ~~could be~~ due to *R. apiculata* has the highest tolerance limit of the extreme conditions such as high salinity and muddy substrate. That highest tolerance limit is supported by the root system of *R. apiculata* which is an aerial root (pneumatophore) in the form of long roots and branches arise from the base of stem. This root is known as the prop root and will eventually become stil~~l~~t root if the stem is held up so that it no longer touches the ground. [Mi10]The root helps the upright of the tree because it has a broad base to support in soft and unstable mud. [Mi11]It also helps the aeration when exposed ~~at~~ to low tide (Ng ~~and~~ & Siva~~s~~o~~tost~~hi, 2001; Hogarth, 2015).



[Mi12]

Figure 3. Mangrove species recorded in Bama Resort: 1. *R. stylosa*. 2. *R. mucronata*. 3. *R. apiculata*. 4. *C. tagal*. 5. *N. fruticans*. 6. *B. gymnorrhiza*. A. leaf. B. flower arrangement. C. rooting system. D. propagule.

From this data, total number of seedlings in all plots showed a pure regeneration potential, only *R. apiculata* and *B. gymnorrhiza*. [Mi13]Hastuti & Budihastuti (2016) ~~has~~ had indicated that environment parameters including temperature, turbidity, pH, DO [Mi14]and ~~its~~ their changes had significant effect on the growth of mangrove seedling especially *R. mucronata*.

The water temperature ~~is~~ was still classified as a normal range ~~between (~~28^{o}C -29^{o}C~~)~~, salinity ~~is~~ was quite good for the growth of mangrove ~~that range(~~ 29ppt -31ppt~~)~~, and the water pH ~~is~~ was normal ~~in the range(~~ 6.8-7.5~~)~~. Soil in all plots consisted of a mixture of dark gray silt-clay (71-74%) with lesser amounts of sand (19-26%).

The intensity of the light is in the range of 900 lux ~~until~~ to more than 3000 lux, the light intensity of the different areas of the outside and the inside of the mangrove forests. [Mi15]The outer area got more sunlight compared to other areas in the central part of or inside of the

mangrove forests, so the value ~~is~~ was also different, although there are some parts in the area of mangrove forests also got sunshine that's a lot, this caused the existence of an open canopy or the presence of uprooted trees caused the sunlight may enter among the vegetation. [Mi16]~~Areas with more sunlight supports the process of the growth of mangroves or other organism is better compared to the darker areas and dense.~~Sunlight supports the growth of mangroves, so that, the mangroves grow better in area with more sunlight.

Table 2 indicate~~d~~ the result of quantitative analysis for tree ~~level~~ stage based on importance value index. It~~s~~ shows that there were 5 ~~tree level~~ mangrove species in tree stage in the research site. The most important species was *R. apiculata* with the importance value at 229.80% and the least important species was *R. mucronata* with the importance value at 3.34%. In this study, ~~did not found~~ *Avicenia marina* was not found even though such mangrove species ~~as~~ is common to other mangrove forest bordering the Java Sea. Hogarth (2015) ~~has~~ had ~~been~~ reported that *A. marina* can grow where the soil salinity is greater than 65‰.

Table 2. Analysis of mangroves trees

No	Species	Relative density (%)	Relative frequency (%)	Relative dominance (%)	*IV* (%)
1	*R. apiculata*	75.00	62.29	82.74	229.80
2	*R. stylosa*	17.31	20.27	10.63	47.78
3	*B. gymnorrhiza*	3.85	10.14	5.75	15.57
4	*N. fruticans*	1.92	4.38	0.44	3.42
5	*R. mucronata*	1.92	2.92	0.44	3.34
	Total	100.00	100.00	100.00	300.00

Diversity is the total range of plant species in an area. ~~Diversity index or~~ Shannon diversity index is used to determine the species diversity in a community. Species evenness is a measure of biodiversity which quantifies how equal the populations are numerically (Kasawani et al., 2007). Evenness index (J) which is the relative abundance with each mangrove species is represented in an area[Mi17]. In this research, the value of diversity index is low ~~0.39~~ for seedling ~~(0.39), which is low~~ as shown in Table 3. Although the diversity index is relatively low, there were 6 species of mangroves belonging to ~~mayor mangrove or~~ true mangrove, so it is important to maintain the mangroves. Bama Resort area has a low diversity because there was *R. apiculata* which has the sub-dominant or dominant but not a whole characteristic.[Mi18] [Mi19]This occurs

because the ecosystem conditions that strongly support the growth of *R. apiculata* which is the type of substrate (mud). [Mi20]

Table 3. Shannon diversity (H') and Evenness (J)

Category	Shannon Diversity (H')	Evenness (J)
Seedlings	0.39	0.22
Saplings	1.37	0.76
Trees	0.73	0.41
All species	1.79	0.49

Species diversity and mangrove growth are influenced by salinity (Ball, 2002), competition and other physical factors (Hogarth, 2015, Hossain and Nuruddin, 2016~~-~~). Setyawan (2005) added that the extent of the mangroves area greatly determines the diversity of plant species. The extent of area also allows sufficient space to grow and reduce competition among species in the fight for space and~~,~~ nutrition.~~, and space.~~

Table 4 shows that Simpson dominance index (C) of research plots ~~with the Simpson dominance index (C) at~~is 0.521, which classified as sub-dominant because the C value is ~~in~~ between 0.5 and 0.75 (Wibisono, 2005).

Table 4. Dominancy index of mangrove vegetations

No	Species	Dominance Index
1	*R. stylosa*	0.029
2	*R. mucronata*	0.000
3	*R. apiculata*	0.487
4	*B. gymnorrhiza*	0.004
5	*C. tagal*	0.000
6	*N. fruticans*	0.001
	Total	0.521

Based on theseis results, it is known that there were sub-dominant mangrove or non-dominant. *R. apiculata* has the highest dominance value (0.487), which also has the sub-dominant characteristic (Table 4).[Mi21]

The mangrove zonation pattern in the research site from the coastal line to the mainland was *R. stylosa*, *R. mucronata*, and *R. apiculata* in the outer zone, respectively (zone directly adjacent to the sea); *B. gymnorrhiza* and *C. tagal* in the middle zone; and *N. fruticans* in the zone that adjacent to the mainland or landward zone (Figure 4). The three zones of mangroves in Bama resort are not similar to those found throughout the Sirondo and Batu Sampang Baluran National Park (Sudarmadji, 2003) and in, the Cimanuk Delta (Sukardjo et al., 2014). The principal drivers of zonation are complex, dependent depend on the interrelationships between and among factors, including soil nutrients, frequency of tidal inundation or different positions along some physical gradient as well as, ecological interactions between species in the community (Hogarth, 2015). The percentage of the most dominant substrate fraction is mud with total percentage of 10 transects byat 48.76%. This result indicated that the type of the research site was coastal akressif[Mi22].

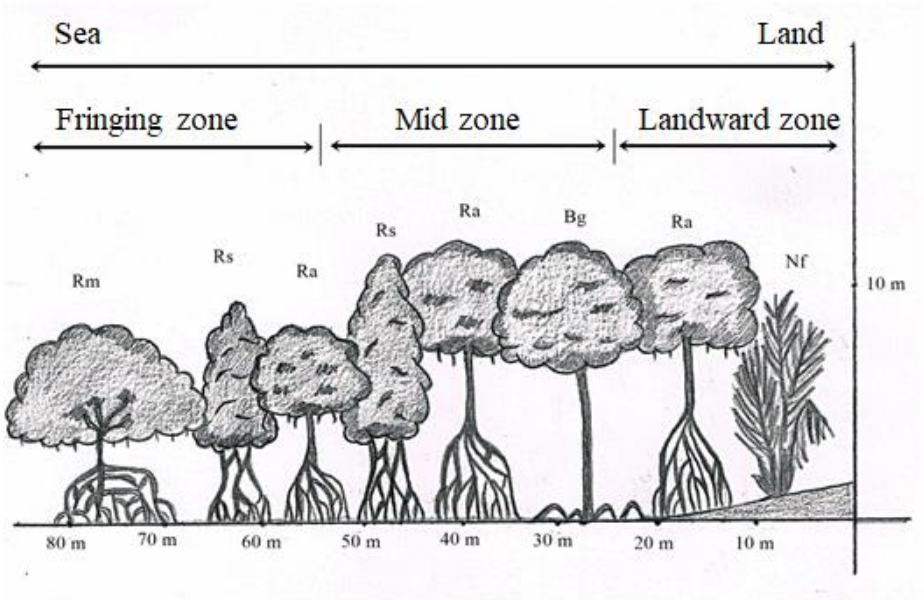


Figure 4. The mangrove zonation pattern at the research site

Rm : *R. mucronata* Rs : *R. stylosa*

Ra : *R. apiculata* Bg : *B. gymnorrhiza*

Nf : *N. fruticans*

Figure 5. The rooting appearance of *R.apiculata* located in the middle zone

~~Zoning~~ All zones ~~is~~ are almost entirely dominated by *R. apiculata* from the coastal line to the mainland (Figure 5), except at transect 5 which ~~is~~ was only found saplings of *N. fruticans* at the coral sand substrate. This condition is more influenced by the adaptability of *R. apiculata* which is fairly high. Besides that, ~~its~~ their shorter and slender hypocotyl ~~than~~ compared to the *Rhizophoraceae* group allow them to be carried by the sea water (Hogarth, 2015).

Based on the results, it can be concluded that there were 6 species mangroves from 2 families in Bama Resort Baluran National Park, ~~that is~~i.e. family of *Rhizophoraceae* (*R. stylosa*, *R. mucronata*, *R. apiculata*, *B. gymnorrhiza*, and *C. tagal*) and family of *Araceae* (*N. fruticans*). The diversity of mangroves in Bama Resort Baluran National Park was classified as good (1.79). There is not mangrove which classified as dominant mangrove in Bama Resort Baluran National Park area. ~~But~~However, *R. apiculata* ~~has~~ was determined as sub-dominant ~~characteristic~~ mangrove with the dominance value ~~at~~ of 0.487. The mangrove zonation pattern from the coastal line to the mainland was *R. stylosa*, *R. mucronata*, and *R. apiculata*, in the outer zone, respectively (zone directly adjacent to the sea); *B. gymnorrhiza* and *C. tagal* in the middle zone; and *N. fruticans* in the zone that adjacent to the mainland or landward zone.

This study identified that arrangement of mangroves in Bama resort is slightly different from the type of zoning compiler in general. There is not found of *Avicenniaceae* or *Verbenaceae* family, and[Mi23] ~~the mangroves of~~ Bama resort did not have any dominant mangrove species.

The present study provides the information that can be used as a basis in ~~will aid in the conduct and~~planning and conducting the preservation ~~planning~~ efforts of mangrove forest especially at Bama coast and generally in the coastal areas of Indonesia.[Mi24]

CONCLUSIONS

A total of six mangrove species (*R. stylosa*, *R. mucronata*, *R. apiculata*, *B. gymnorrhiza*, *C. tagal*, and *N. fruticans*) from two families (*Rhizophoraceae* and *Araceae*) were identified in Bama Resort. Analysis in vegetation in Bama Resort showed that species with highest importance value was *R. apiculata* (229.80%) followed by *R. stylosa* (47.78%), *B. gymnorrhiza* (15.57%), *N. fruticans* (3.42%), and *R. mucronata* (3.34%). The greatest mangrove diversity (1.37) in terms of diameter category is sapling and the lowest mangrove diversity (0.39) was belongs to seedling. The mangrove zonation patterns from the coastline to the mainland are *R. stylosa*, *R. mucronata*, and *R. apiculata* in the outermost zone (the zone adjacent to the sea), *B. gymnorrhiza* and *C. tagal* in the middle zone and~~.~~ *N. fructicans* in the zone bordering on land mangrove.

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We ~~are thankful to~~would like to thank the Director of Baluran National Park for ~~gave~~ giving the permission for this research and Arif Pratiwi, S.T. Manager of Bama Resort, Baluran National Park for facilitating this study.

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BIOSAINTIFIKA
EVALUATION GUIDELINES OF MANUSCRIPT

Sucipto Hariyanto, Akhmad Kharish Fahmi, Thin Soedarti, Emy Endah Suwarni

No	Manuscript parts	Description	Answer
1	Manuscript	Total words should be 3500 – 5000 words or the pages should not exceed than 15 pages including figures, tables and bibliographical references, 1.5 line spacing, Times New Roman 12, numbered pages and lines, in MS-Word, or compatible.	✓
2	Title	The title consists of 12 up to 15 words, must be to the point.	✓
3	Name of authors	The full name(s) of the author(s) (at least 2 authors/ not a single author)	✓
4	Affiliation	All of the authors' institutional address(es) and the e-mails of the author for correspondence should be inserted	✓
5	Abstract	Abstracts 150-250 words, contain brief information on:	✓
		• The Background (2-3 lines)	✓
		• Aims/objectives of the research (2-3 lines)	✓
		• Methods employed	✓
		• Results and conclusion	✓
		• The novelty of the research	✓
		• Implication/Benefit for science development/society	✓
6	Key words	Key words, 3-5 words or phrases, it represents the article content and should include words found in research database.	Provide the keywords that are unique and represent the article content
7	Introduction (± 1 page, 1.5 line spacing)	Introduction Include:	
		• The important issues in general and specifically encountered	✓
		• Research that has been done as the references and what has not been done (research gap)	✓
		• The solution offered, the importance of research conducted	✓
		• The research purposes	✓
		• The benefits to the science / society	✓
8	Methods (± ½-1 page, 1.5 spacing)	Methods Include: • Explanation of how / step of research in a systematic way and detailed step by step written in the section. • The method does not contain any theory, but rather emphasize what has been done in research to obtain results in line with the objectives.	✓
9	Results and Discussion	Results and discussion are combined in one part. It contains:	✓
		• The results of the findings to answer the research objectives	✓
		• Figure and table should be clear and the description must be concise and clear	✓
		• Discussion must reveal the in depth analysis of the obtained results it is critically and in-depth synthesis accompanied by proof of evidence related latest references	✓

		• Explain the novelty of your research	✓
		• The benefits and contribution of research for the science/ society	✓
10	Conclusion	• It is written in one paragraph without numbering	✓
		• Answering the research objectives	✓
11	Suggestion (*Optional*)	• It is optional	-
12	Acknowledgement (if any)	Addressed to the person /organization that has been contributed in the research, e.g. funders of certain agencies or research assistance or language and paper editors	✓
13	References	• Written alphabetically, using the "APA" style	Correct the incorrect reference style
		• References contain at least 80% refers to the primary references / research journals and the latest sources (at least at last 10 years)	Add more reference from journals or proceedings. 80% of reference must be from those two sources. It is also suggested to use the source from the last 10 years
		• Citing the related journal article/s in Biosaintifika which have been published, at least 1 article. Please open: http://journal.unnes.ac.id/nju/index.php/biosaintifika/issue/archive	✓
14	Manuscript content	Please use the proofreading service in English language expert/native before submission	Minor modification is needed.

Vegetation and Community Structure of Mangrove in Bama Resort Baluran National Park Situbondo East Java

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ABSTRACT

Ecotourism development program at Bama beaches area require baseline data of mangrove structure at Bama Resort. ~~and in the past two decades has been lost about 35% area of mangrove forest in Indonesia and in the world~~The aims of this study was to find structure, composition, distribution and zonation patterns of mangroves at Bama Resort Baluran Nasional Park. Ten belt-transects were laid perpendicular to the shoreline, using standard methods. Vegetation structure was determined using data collected on plant species diversity, density, basal area, and the number of each species of mangroves. Shannon Wiener index to calculated diversity, evennes and Simpson to calculated dominance index. The results show there are 2 families and 6 mangrove species occurring in the study areas that is Rhizophoraceae (*Rhizophora stylosa*, *Rhizophora mucronata*, *Rhizophora apiculata*, *Bruguiera gymnorrhiza*, and *Ceriops tagal*) and Araceae (*Nypa fruticans*). The highest importance value was *R. apiculata* (229.90%) for trees, *R. apiculata* (148.69%) for the sapling, and *R. apiculata* (244.83%) for the seedling. The diversity (H) and dominance index (C) values were moderate (1.79) and 0.521. The most dominant species was *R. apiculata* (C=0.487). The mangrove zonation pattern from coastline to the mainland was *R. stylosa*, *R. mucronata*, and *R. apiculata*, in the outer zone, respectively (zone directly adjacent to the sea); *B. gymnorrhiza* and *C. tagal* in the middle zone; and *N. fruticans* in the zone that adjacent to the mainland. The present study will aid in the conduct and preservation planning of mangrove forest especially at Bama coast and generally in the coastal areas of Indonesia.

Keywords: Bama resort, mangrove community[U1], mangrove diversity~~,~~, mangrove zonation[U2].

INTRODUCTION

Mangroves are one of forests ecosystem that unique and special. The mangrove ecosystem exists in tidal coastal areas, beaches, and some small islands. Mangrove forests harbor a valuable natural resource with high intrinsic natural productivity. Mangrove are woody plants, which grow in loose wet soils of brackish-to-saline estuaries and shorelines in the tropics and sub-tropics (Joshi & Ghose, 2003; Giri, et al., 2010). Mangrove forests provide many valuable ecosystem services, such as assimilating excess atmospheric carbon, protecting coastlines from hurricanes, increasing vertical land development, and providing nursery habitat for fish (Nagelkerkin, et al., 2008; Lee, et al., 2014).

The mangrove ecosystem in Indonesia holds 75% of total mangroves in South East Asia or around 27% of total mangroves in the world. Besides that, mangrove ecosystem in Indonesia has the highest diversity in the world (Spalding, et al., 2010; Giri, et al., 2010; Sukardjo & Alongi, 2012). The distribution of mangroves in Indonesia is located on the coast of Sumatra, Kalimantan, and Papua. The extent of mangroves distribution continued to decline from 4.25 million hectares in 1982 to approximately 3.24 million hectares in 1987 and remaining of 2.79 hectares in 2000 (Richards & Friess, 2016). Between 2000-2012, the percentage of mangroves loss were 1.72% (Giri, et al., 2008; Richards & Friess, 2016). The declining trend indicates that there were 61,000 [PDIPWM3]hectares of mangrove forests deforestation and mangrove habitat loss of 48,000 [U4]hectares over 12 years (Richards & Friess, 2016). It is caused by the conversion of land used into aquaculture/farming, agriculture, tourism, urban development, and overexploitation (Giri et al., 2008; UNEP, 2014; Richards & Friess, 2016).

One result of various human activities in the coastal areas that affect the sustainability of natural resources is the destruction of mangrove ecosystem (Alongi, 2009; Van Oudenhoven, et.al., 2012). The existence of mangrove ecosystems play an important role for the continuity of ecological and hydrological processes. Damage and disturbance to the growth state could be a problem for the regeneration of mangroves in the future.

The growth of each plant will adjust to surrounding environment so that the morphology that occurs will vary from one place to another (Gratani, 2014). Therefore, the morphology of mangroves in Baluran National Park is typical, considering that the different environmental conditions have different morphological descriptions (Sudarmadji, 2003).

The ecotourism development program in Bama Beach area requires data of mangrove ecosystem structure in Bama Beach Baluran National Park. This research aimed to know the community structure of mangrove ecosystem that includes mangrove species, diversity, domination, and zonation pattern in Bama Resort Baluran National Park, which can be used in the management and conversation of mangroves especially in Baluran National Park and generally in East Java.

METHODS

The study area

The research was conducted in January-May 2014 at Bama Beach Baluran National Park. Baluran National Park is located at Situbondo District East Java Province (Figure 1) geographically lies between 7º50'44.48' S- 114º27'39.65" E and 7º51'04.11" S -114º27'32.32" E. Mapping transects and plots in sampling area was obtained through Global Positioning System (GPS) by the use of an online mapping (Figure 2).

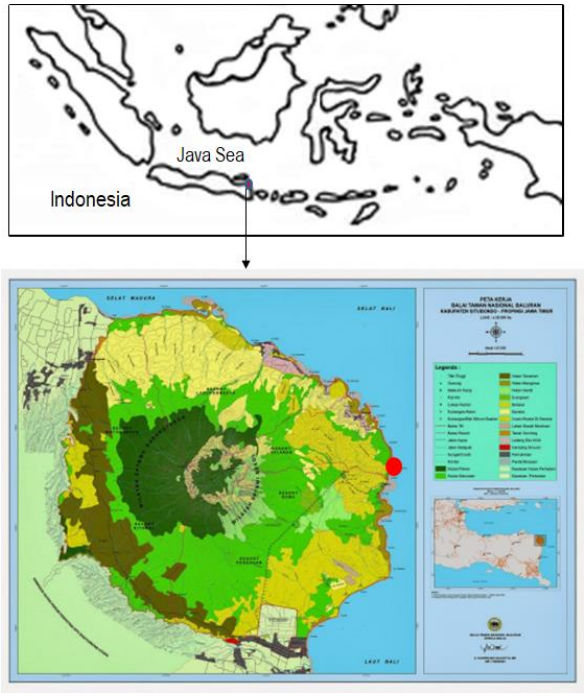

Figure 1. The research site

Figure 2. Sampling transects in Bama Beach

The research procedures were by conducting survey and imaging via Google Earth which allegedly representing and depicting mangrove zonation pattern then determined ten transects with length adjusting the mangrove thickness.

Establishment of sampling plots and measurement

We used quadrat transect methods with ten transects belt that perpendicular to the mainland, each sub-plot (100 m^2) for sapling (dbh: 2cm-9.99cm) and trees (dbh: ≥ 10cm), and a 5 x 5-meter plot was laid inside the main plot for seedling (dbh: < 2.0cm) study. Mangroves trees inside the sampling plots were counted and identified respectively. The data collected of this research were mangrove species, number of stem to determine the value of density, tree diameter at breast height (dbh), stem height, substrate type (fraction), and physical-chemical condition such as pH, temperature, salinity, and light intensity.

Vegetation analysis

The data were analyzed using several parameters: population density, frequency, dominance, relative density, relative frequency, relative dominance, and the importance value (Legendre & Legendre, 2012). This analysis can better inform of species function in its habitat. It also gives order for appropriate species within the mangrove community.

Population density = $\frac{Number\ of\ individuals}{Total\ area\ sampled}$

Frequency = $\frac{Number\ of\ plots\ in\ which\ a\ species\ ocurs}{Total\ number\ of\ plots\ sampled}$

Dominance = $\frac{Total\ of\ basal\ area\ of\ each\ tree\ of\ a\ species\ from\ all\ plots}{Total\ area\ of\ all\ measured\ plots}$

Relative density = $\frac{Number\ of\ individual\ of\ a\ species}{Total\ number\ of\ individuals\ all\ of\ species}$ x 100

Relative dominance = $\frac{Total\ basal\ area\ of\ \ a\ species}{Basal\ area\ of\ all\ species}$ x 100

Relative frequency = $\frac{Frequency\ of\ species}{Total\ frequency\ of\ all\ species\ in\ different\ plots}$ x 100

Importance value (*IV*) = Relative density + Relative frequency + Relative dominance

Diversity index of mangroves was calculated by Shannon-Wiener index (Legendre & Legendre, 2012).

$H' = -\sum Pi \ln Pi$

H = Shannon diversity index

*P*i = Fraction of the entire population made up of species *i* (proportion of a species *i* relative to total number of species present)

Evennes index (J) = $\frac{H'}{H\ max}$

Dominance index was calculated by Simpson (Legendre & Legendre, 2012).

$$D = \Sigma(\frac{ni}{N})^2$$

D = dominance index

ni = importance value for each species

N = total of importance value

~~**Water Analysis**~~

Water in all plots were measured pH, salinity, and temperature. The measurement have been carried out in situ. Light intensity on each plots was measured using lux meter

~~**Light Intensity**~~

Substrat Analysis

The determination of texture of mangrove substrate was done ex situ in the laboratory. Soils in all plots were collected using a stainless steel corer (7 cm inside diameter) to a depth of 20 cm. Soils samples each plot were taken twice. The steps in substrate texture analysis are based on the USDA triangle.

RESULTS AND DISCUSSION

Overview of the Research Site

The research site was located at Bama Resort which include in Baluran National Park area with 6.126 ha[U5]. 6 species mangroves from 2 families were recorded in this research, that is family Rhizoporaceae (*R. stylosa*, *R. mucronata*, *R. apiculata*, *B. gymnorrhiza*, and *C. tagal)* and family Araceae (*N. fruticans*) (Table 1) and ~~(~~Figure 4~~)~~.

Table 1. The total number of seedlings, saplings, and trees of all mangrove in a 0.3 h at Bama resort

No	Species	Family	Stage		
			Seedlings	Saplings	Trees
1	*R. stylosa*	Rhizophorazeae	0	48	50
2	*R. mucronata*	Rhizophorazeae	0	5	3
3	*R. apiculata*	Rhizophorazeae	13	81	221
4	*B. gymnorrhiza*	Rhizophorazeae	2	16	11
5	*C. tagal*	Rhizophorazeae	0	2	0
6	*N. fructicans*	Araceae	0	26	3
		Total	15	178	288

All of these mangroves are mayor mangrove or true mangrove. *R. apiculata* was the most abundant tree with 221 trees followed by *R. stylosa* (50 trees), *B. gymnorrhiza* (11 trees), *R. mucronata* (3 trees) and *N. fructicans* (3 trees). Moreover *R. apiculata* sapling showed the highest dispersal followed by *R. stylosa, N. fructicans, B. gymnorrhiza, R. mucronata,* and *C. tagal*. When considering the seedlings, *R. apiculata* was the highest dispersal (13 trees), followed by *B. gymnorrhiza* (2 trees).The success of *R. apiculata* regeneration at the sea edge due in part to differences infloading tolerance of these species (Sukardjo et al., 2014). It's also could be due to *R. apiculata* has the highest tolerance limit of the extreme conditions such as high salinity and muddy substrate. That highest tolerance limit is supported by the root system of *R. apiculata* which is aerial root (pneumatophore) in the form of long roots and branches arise from the base of stem. This root is known as the prop root and will eventually become still root if the stem is held up so that it no longer touches the ground. The root helps the upright of the tree because it has a broad base to support in soft and unstable mud. It also helps the aeration when exposed at low tide (Ng & Sivatoshi, 2001; Hogarth, 2015).

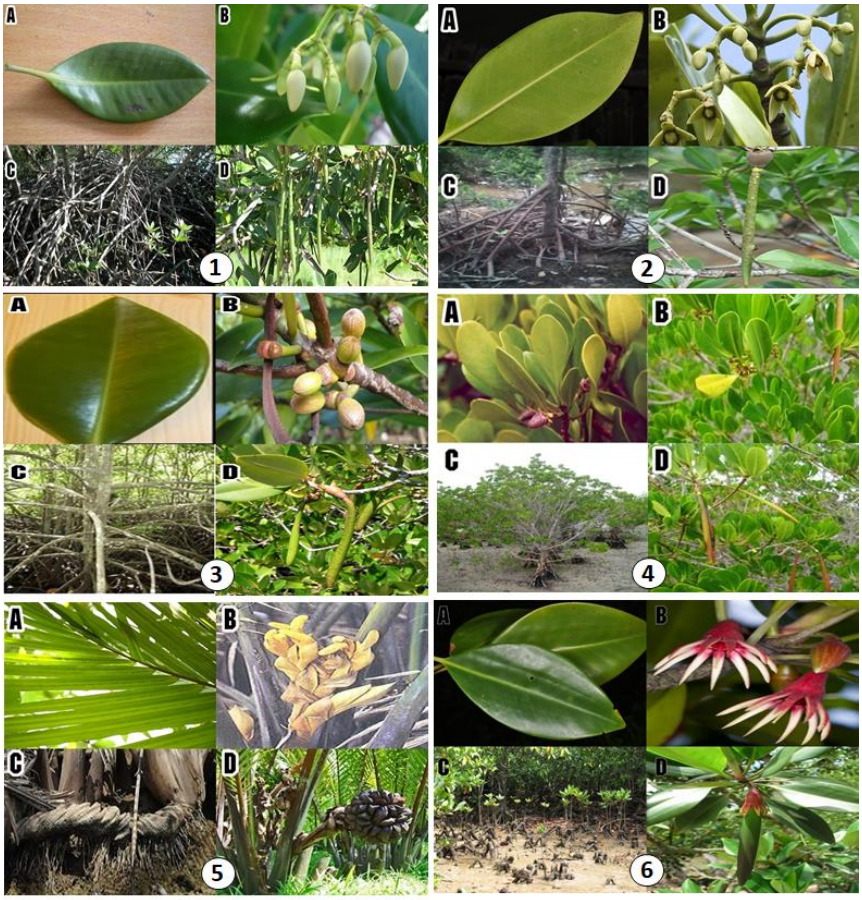

Figure 3. Mangrove species recorded in Bama Resort: 1. *R. stylosa*. 2. *R. mucronata*. 3. *R. apiculata*. 4. *C.tagal*. 5. *N. fruticans.* 6. *B. gymnorrhiza*. A. leaf. B. flower arrangement. C. rooting system. D. propagul.

From this data, total number of seedling all plots showed a pure regeneration potential, only *R. apiculata* and *B. gymnorrhiza*. Hastuti & Budihastuti (2016) has indicated that environment parameters including temperature, turbidity, pH, DO and its changes had significant effect on the growth of mangrove seedling especially *R. mucronata*.

The water temperature is still classified as a normal range between 28ºC -29ºC, salinity is quite good for the growth of mangrove that range 29ppt -31ppt, and the water pH is normal in the range 6.8-7.5. Soil in all plots consisted of a mixture of dark gray silt-clay (71-74%) with lesser amounts of sand (19-26%).

The intensity of the light is in the range of 900 lux until more than 3000 lux, the light intensity of the different areas of the outside and the inside of the mangrove forests. The outer area got more sunlight compared to other areas in the central part of or inside of the mangrove forests,

so the value is also different, although there are some parts in the area of mangrove forests also got sunshine that's a lot, this caused the existence of an open canopy or the presence of uprooted trees caused the sunlight may enter among the vegetation. Areas with more sunlight supports the process of the growth of mangroves or other organism is better compared to the darker areas and dense.

Table 2 indicated the result of quantitative analysis for tree-level based on importance value index. Its shows that there were 5 tree level mangrove species in the research site. The most important species was *R. apiculata* with the importance value at 229.80% and the least important species was *R. mucronata* with the importance value at 3.34%. In this study did not found *Avicenia marina* such mangrove species as is common to other mangrove forest bordering the Java Sea. Hogarth (2015) has been reported *A. marina* can grow where the soil salinity is greater than 65‰**.**

Table 2. Analysis of mangroves trees

No	Species	Relative density (%)	Relative frequency (%)	Relative dominance (%)	Importance value (%) [PDIPWM6]
1	*R. apiculata*	75.00	62.29	82.74	229.80
2	*R. stylosa*	17.31	20.27	10.63	47.78
3	*B. gymnorrhiza*	3.85	10.14	5.75	15.57
4	*N. fruticans*	1.92	4.38	0.44	3.42
5	*R. mucronata*	1.92	2.92	0.44	3.34
	Total	100.00	100.00	100.00	300.00

Diversity is the total range of plant species in an area Diversity index or Shannon diversity index is used to determine the species diversity in a community. Species evenness is a measure of biodiversity which quantifies how equal the populations are numerically (Legendre & Legendre, 2012). Evenness index (J) which is the relative abundance with each mangrove species is represented in an area. In this research, the value of diversity index is 0.39 for seedling, which is low as shown in Table 3. Although the diversity index is relatively low, there were 6 species mangroves belonging to mayor mangrove or true mangrove, so it is important to maintain the mangroves. Bama Resort area has a low diversity because there was *R. apiculata* which has the sub-dominant or dominant but not a whole characteristic. This occurs because the ecosystem conditions that strongly support the growth of *R. apiculata* which is the type of substrate (mud).

Table 3. Shannon diversity (H') and Evenness (J)

Category	Shannon Diversity (H')	Evenness (J)
Seedlings	0.39	0.22
Saplings	1.37	0.76
Trees	0.73	0.41
All species	1.79	0.49

Species diversity and mangrove growth are influenced by salinity (Ball, 2002; Friess, et al., 2012; Atwell, et al., 2016), competition and other physical factor (Hogarth, 2015, Hossain & Nuruddin, 2016). Setyawan, et al. (2008) added that the extent of the mangroves area greatly determines the diversity of plant species. The extent of area also allows sufficient space to grow and reduce competition among species in the fight for space, nutrition, and space.

Table 4 shows that research plot with the Simpson dominance index (D) at 0.521, which classified as sub-dominant because the D value is in between 0.5 and 0.75.

Table 4. Dominancy index of mangrove vegetations

No	Species	Dominance Index
1	*R. stylosa*	0.029
2	*R. mucronata*	0.000
3	*R. apiculata*	0.487
4	*B. gymnorrhiza*	0.004
5	*C. tagal*	0.000
6	*N. fruticans*	0.001
	Total	0.521

Based on this results, it is known that there were sub-dominant mangrove or non-dominant. *R. apiculata* has the highest dominance value (0.487), which also has the sub-dominant characteristic (Table 4).

The mangrove zonation pattern in the research site from the coastal line to the mainland was *R. stylosa*, *R. mucronata*, and *R. apiculata* in the outer zone, respectively (zone directly adjacent to the sea); *B. gymnorrhiza* and *C. tagal* in the middle zone; and *N. fruticans* in the zone

that adjacent to the mainland or landward zone (Figure 4). The three zones of mangroves in Bama resort are not similar to those found throughout the Sirondo and Batu Sampang Baluran National Park (Sudarmadji, 2003), the Cimanuk Delta (Sukardjo et al., 2014). The principal drivers of zonation are complex (Alongi, 2002), dependent on the interrelationships between and among factors, including soil nutrients, frequency of tidal inundation or different positions along some physical gradient, ecological interactions between species in the community (Hogarth, 2015). The percentage of the most dominant substrate fraction is mud with total percentage of 10 transects at 48.76%. This result indicated that the type of the research site was coastal akressif.

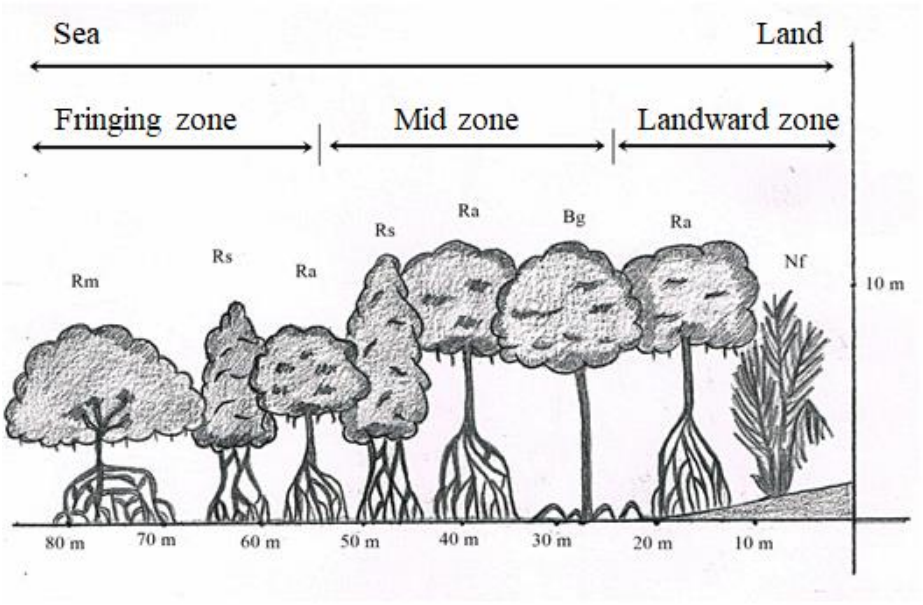

Figure 4. [U7]The mangrove zonation pattern at the research site

Rm : *R. mucronata* Rs : *R. stylosa*

Ra : *R. apiculata* Bg : *B. gymnorrhiza*

Nf : *N. fruticans*

Figure 5. The rooting appearance of *R.apiculata* located in the middle zone

Zoning is almost entirely dominated by *R. apiculata* from the coastal line to the mainland (Figure 5), except at transect 5 which is only found saplings of *N. fruticans* at the coral sand substrate. This condition is more influenced by the adaptability of *R. apiculata* which is fairly high. Besides that, its shorter and slender hypocotyl than the *Rhizophoraceae* group allow to be carried by the sea water (Hogarth, 2015).

Based on the results, it can be concluded that there were 6 species mangroves from 2 families in Bama Resort Baluran National Park, that is family *Rhizophoraceae* (*R. stylosa*, *R. mucronata*, *R. apiculata*, *B. gymnorrhiza*, and *C. tagal*) and family Araceae (*N. fruticans*). The diversity of mangroves in Bama Resort Baluran National Park was classified as good (1.79). There is not mangrove which classified as dominant in Bama Resort Baluran National Park area. But, *R. apiculata* has sub-dominant characteristic with the dominance value at 0.487. The mangrove zonation pattern from the coastal line to the mainland was *R. stylosa*, *R. mucronata*, and *R. apiculata*, in the outer zone, respectively (zone directly adjacent to the sea); *B. gymnorrhiza* and *C. tagal* in the middle zone; and *N. fruticans* in the zone that adjacent to the mainland or landward zone.

This study identified that arrangement of mangroves in Bama resort is slightly different from the type of zoning compiler in general. There is not found of *Avicenniaceae* or *Verbenaceae* family, and the mangroves of Bama resort did not have dominant species.

The present study will aid in the conduct and preservation planning of mangrove forest especially at Bama coast and generally in the coastal areas of Indonesia.

CONCLUSIONS[U8]

A total of six mangrove species (*R. stylosa, R. mucronata, R. apiculata, B. gymnorrhiza, C. tagal*, and *N. fruticans*) from two families (*Rhizophoraceae* and *Araceae*) were identified in Bama Resort. Analysis in vegetation in Bama Resort showed that species with highest importance value was *R. apiculata* (229.80%) followed by *R. stylosa* (47.78%), *B. gymnorrhiza* (15.57%), *N. fruticans* (3.42%), and *R. mucronata* (3.34%). The greatest mangrove diversity (1.37) in terms of diameter category is sapling and the lowest mangrove diversity (0.39) was belongs to seedling. The mangrove zonation patterns from the coastline to the mainland are *R. stylosa*, *R. mucronata*, and *R. apiculata* in the outermost zone (the zone adjacent to the sea), *B. gymnorrhiza* and *C. tagal* in the middle zone. *N. fructicans* in the zone bordering on land mangrove.

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BIOSAINTIFIKA
EVALUATION GUIDELINES OF MANUSCRIPT

Sucipto Hariyanto, Akhmad Kharish Fahmi, Thin Soedarti, Emy Endah Suwarni

No	Manuscript parts	Description	Answer
1	Manuscript	Total words should be 3500 – 5000 words or the pages should not exceed than 15 pages including figures, tables and bibliographical references, 1.5 line spacing, Times New Roman 12, numbered pages and lines, in MS-Word, or compatible.	✓
2	Title	The title consists of 12 up to 15 words, must be to the point.	✓
3	Name of authors	The full name(s) of the author(s) (at least 2 authors/ not a single author)	✓
4	Affiliation	All of the authors' institutional address(es) and the e-mails of the author for correspondence should be inserted	✓
5	Abstract	Abstracts 150-250 words, contain brief information on:	✓
		• The Background (2-3 lines)	✓
		• Aims/objectives of the research (2-3 lines)	✓
		• Methods employed	✓
		• Results and conclusion	✓
		• The novelty of the research	✓
		• Implication/Benefit for science development/society	✓
6	Key words	Key words, 3-5 words or phrases, it represents the article content and should include words found in research database.	✓
7	Introduction (± 1 page, 1.5 line spacing)	Introduction Include:	
		• The important issues in general and specifically encountered	✓
		• Research that has been done as the references and what has not been done (research gap)	✓
		• The solution offered, the importance of research conducted	✓
		• The research purposes	✓
		• The benefits to the science / society	✓
8	Methods (± ½-1 page, 1.5 spacing)	Methods Include: • Explanation of how / step of research in a systematic way and detailed step by step written in the section. • The method does not contain any theory, but rather emphasize what has been done in research to obtain results in line with the objectives.	✓
9	Results and Discussion	Results and discussion are combined in one part. It contains:	✓
		• The results of the findings to answer the research objectives	✓
		• Figure and table should be clear and the description must be concise and clear	✓
		• Discussion must reveal the in depth analysis of the obtained results it is critically and in-depth synthesis accompanied by proof of evidence related latest references	✓
		• Explain the novelty of your research	✓

		• The benefits and contribution of research for the science/ society	✓
10	Conclusion	• It is written in one paragraph without numbering	✓
		• Answering the research objectives	✓
11	Suggestion (*Optional*)	• It is optional	-
12	Acknowledgement (if any)	Addressed to the person /organization that has been contributed in the research, e.g. funders of certain agencies or research assistance or language and paper editors	✓
13	References	• Written alphabetically, using the "APA" style	✓
		• References contain at least 80% refers to the primary references / research journals and the latest sources (at least at last 10 years)	✓
		• Citing the related journal article/s in Biosaintifika which have been published, at least 1 article. Please open: http://journal.unnes.ac.id/nju/index.php/biosaintifika/issue/archive	✓
14	Manuscript content	Please use the proofreading service in English language expert/native before submission	✓