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2 messages

Jurnal Biosaintifika <biosaintifika@mail.unnes.ac.id>
To: sucipto-h@fst.unair.ac.id

Tue, Jun 12, 2018 at 10:47 AM


yth bpk Hariyanto, terima kasih naskah bpk masih banyak revisi silahkan direvisi sesuai pedoman dan saran reviewer terima kasih

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Biosaintifika: Journal of Biology & Biology Education [p-ISSN (Print) 2085-191X | e-ISSN (Online) 2338-7610] published scientific papers on the results of biological research and education covering the fields of biology including botany, zoology, environmental, and biotechnology. Editor accepts the article has not been published in other media with the writing format as listed on page manuscript writing guidelines. Manuscripts will be reviewed by an expert editor and managing editor. The journal has been indexed in **Google Scholar**, **DOAJ**, **DOI Crossref**, **EBSCO**, **CABI** and published three times a year, on April, August & December.

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sucipto hariyanto <sucipto-h@fst.unair.ac.id>
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Tue, Jun 12, 2018 at 12:13 PM

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

Salam hormat,
Sucipto Hariyanto
[Quoted text hidden]



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

Revisi Artikel A.n Sucipto Hariyanto

4 messages

sucipto hariyanto <sucipto-h@fst.unair.ac.id>
To: Jurnal Biosaintifika <biosaintifika@mail.unnes.ac.id>

Thu, Oct 25, 2018 at 9:08 PM

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

Salam,
Sucipto Hariyanto

2 attachments**hariyanto, 20 juni (Revised).docx**
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Jurnal Biosaintifika <biosaintifika@mail.unnes.ac.id>
To: sucipto-h@fst.unair.ac.id

Wed, Oct 31, 2018 at 6:08 AM

terima kasih pak Hariyanto, bersama ini kami krm hasil review silahkan disesuaikan terima kasih

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sucipto hariyanto <sucipto-h@fst.unair.ac.id>
To: Jurnal Biosaintifika <biosaintifika@mail.unnes.ac.id>

Wed, Oct 31, 2018 at 7:48 PM

Chief Editor Jurnal Biosaintifika Yth.

Terimakasih atas perhatiannya, akan saya sesuaikan secepatnya

Salam,
Sucipto Hariyanto

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

Thu, Nov 22, 2018 at 5:21 AM

To: Jurnal Biosaintifika <biosaintifika@mail.unnes.ac.id>

Kepada Yth.
Chief Editor Journal Biosaintifika

Berikut saya kirimkan perbaikan dari revidi, mohon dapat diterima
Sesuai dengan saran perevidi sudah saya tambahkan:

1. Background pada Abstract
2. Implication pada akhir Abstract
3. Novelty

Terimakasih atas perhatiannya

Salam,
Sucipto Hariyanto

On Wed, Oct 31, 2018 at 6:09 AM Jurnal Biosaintifika <biosaintifika@mail.unnes.ac.id> wrote:

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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>

Kepada Yth.
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.

Terimakasih

Salam,
Sucipto Hariyanto

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 disesuaikan dengan saran lalu kirim kembali terima kasih

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

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

To: Jurnal Biosaintifika <biosaintifika@mail.unnes.ac.id>, Biosaintifika Unnes <biosaintifika@gmail.com>

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

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


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

To: Jurnal Biosaintifika <biosaintifika@mail.unnes.ac.id>

Baik, akan saya perbaiki dan akan segera saya kirimkan kembali

Terimakasih
Sucipto Hariyanto
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1 message

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 disesuaikan. 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**

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

3
4 *Sucipto Hariyanto, Akhmad Kharish Fahmi, Thin Soedarti

5 Department of Biology, Faculty of Science and Technology, Universitas Airlangga

6 Email: sucipto-h@fst.unair.ac.id

7
8
9 **ABSTRACT maks 250 words**

10
11 **The Background (2-3 lines).....**

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

31 **Implication/Benefit for science development/society.....**

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

2

3

4

5 **INTRODUCTION**

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

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

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

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

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

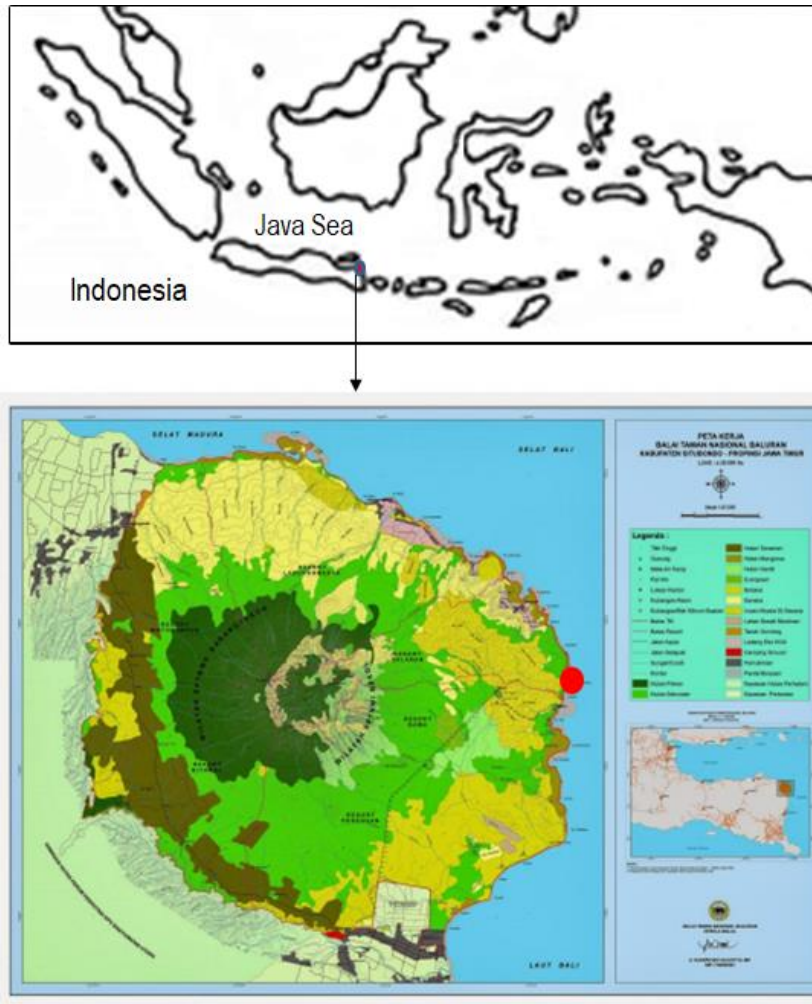
3 The ecotourism development program in Bama Beach area requires data of mangrove
4 ecosystem structure in Bama Beach Baluran National Park. This research aimed to know the
5 community structure of mangrove ecosystem that includes mangrove species, diversity,
6 domination, and zonation pattern in Bama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

9

10 **METHODS**

11 **The study area**

12 The research was conducted in January-May 2014 at Bama Beach Baluran National Park.
13 Baluran National Park is located at Situbondo District East Java Province (Figure 1)
14 geographically lies between 7°50'44.48' S- 114°27'39.65'' E and 7°51'04.11'' S -114°27'32.32''
15 E. Mapping transects and plots in sampling area was obtained through Global Positioning
16 System (GPS) by the use of an online mapping (Figure 2).



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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

1

2 **Establishment of sampling plots and measurement**

3 We used quadrat transect methods with ten transects belt that perpendicular to the
4 mainland, each sub-plot (100 m²) for sapling (dbh: 2cm-9.99cm) and trees (dbh: ≥ 10cm), and a
5 5 x 5-meter plot was laid inside the main plot for seedling (dbh: < 2.0cm) study. Mangroves trees
6 inside the sampling plots were counted and identified respectively. The data collected of this
7 research were mangrove species, number of stem to determine the value of density, tree diameter
8 at breast height (dbh), stem height, substrate type (fraction), and physical-chemical condition
9 such as pH, temperature, salinity, and light intensity.

10

11 **Vegetation analysis**

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

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

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

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

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

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

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

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

24

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

26 $H' = -\sum P_i \ln P_i$

27 H = Shannon diversity index

1 P_i = Fraction of the entire population made up of species i (proportion of a species i
 2 relative to total number of species present)

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

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

5
$$C = \sum \left(\frac{n_i}{N} \right)^2$$

6 C = dominance index

7 n_i = importance value for each species

8 N = total of importance value

9 **Water Analysis**

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

12 **Light Intensity**

13 Light intensity on each plots was measured using lux meter

14 **Substrat Analysis**

15 The determination of texture of mangrove substrate was done ex situ in the laboratory.
 16 Soils in all plots were collected using a stainless steel corer (7 cm inside diameter) to a depth of
 17 20 cm. Soils samples each plot were taken twice. The steps in substrate texture analysis are based
 18 on the USDA triangle.

19

20 **RESULTS AND DISCUSSION**

21 **Overview of the Research Site**

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

26

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

No	Species	Family	Stage		
			Seedlings	Saplings	Trees
1	<i>Rhizophora stylosa</i>	<i>Rhizophorazeae</i>	0	48	50

2	<i>Rhizophora mucronata</i>	<i>Rhizophoraceae</i>	0	5	3
3	<i>Rhizophora apiculata</i>	<i>Rhizophoraceae</i>	13	81	221
4	<i>Bruguiera gymnorrhiza</i>	<i>Rhizophoraceae</i>	2	16	11
5	<i>Ceriops tagal</i>	<i>Rhizophoraceae</i>	0	2	0
6	<i>Nypa fructicans</i>	<i>Araceae</i>	0	26	3
		Total	15	178	288

1
2 All of these mangroves are mayor mangrove or true mangrove. *Rhizophora apiculata* was the
3 most abundant tree with 221 trees followed by *Rhizophora stylosa* (50 trees), *Bruguiera*
4 *gymnorrhiza* (11 trees), *Rhizophora mucronata* (3 trees) and *Nypa fructicans* (3 trees). Moreover
5 *Rhizophora apiculata* sapling showed the highest dispersal followed by *Rhizophora stylosa*,
6 *Nypa fructicans*, *Bruguiera gymnorrhiza*, *Rhizophora mucronata*, and *Ceriops tagal*. When
7 considering the seedlings, *Rhizophora apiculata* was the highest dispersal (13 trees), followed by
8 *Bruguiera gymnorrhiza* (2 trees). The success of *Rhizophora apiculata* regeneration at the sea
9 edge due in part to differences inflooding tolerance of these species (Sukardjo et al, 2014). It's
10 also could be due to *Rhizophora apiculata* has the highest tolerance limit of the extreme
11 conditions such as high salinity and muddy substrate. That highest tolerance limit is supported by
12 the root system of *Rhizophora apiculata* which is aerial root (pneumatophore) in the form of
13 long roots and branches arise from the base of stem. This root is known as the prop root and will
14 eventually become still root if the stem is held up so that it no longer touches the ground. The
15 root helps the upright of the tree because it has a broad base to support in soft and unstable mud.
16 It also helps the aeration when exposed at low tide (Ng dan Sivatoshi, 2001; Hogarth, 2015).

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

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

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

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

21 **Table 2.** Analysis of mangroves trees

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

22
 23 Diversity is the total range of plant species in an area Diversity index or Shannon
 24 diversity index is used to determine the species diversity in a community. Species evenness is a
 25 measure of biodiversity which quantifies how equal the populations are numerically (Kasawani

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

9 **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

10

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

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

19

20 **Table 4.** Dominancy index of mangrove vegetations

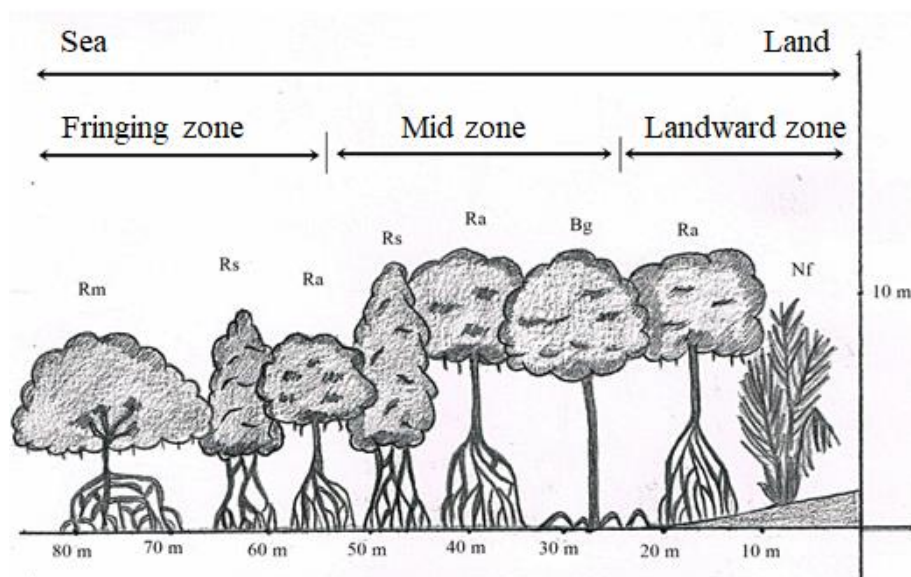
No	Species	Dominance Index
1	<i>Rhizophora stylosa</i>	0.029
2	<i>Rhizophora mucronata</i>	0.000
3	<i>Rhizophora apiculata</i>	0.487
4	<i>Bruguiera gymnorhiza</i>	0.004
5	<i>Ceriops tagal</i>	0.000

6	<i>Nypa fruticans</i>	0.001
Total		0.521

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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.



18
19

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

- 1 Rm : *Rhizophora mucronata* Rs : *Rhizophora stylosa*
2 Ra : *Rhizophora apiculata* Bg : *Bruguiera gymnorrhiza*
3 Nf : *Nypa fruticans*
4

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

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

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| <ul style="list-style-type: none">• The benefits and contribution of research for the science/ society |

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24 CONCLUSIONS

25 A total of six mangrove species (*Rhizophora stylosa*, *Rhizophora mucronata*, *Rhizophora*
26 *apiculata*, *Bruguiera gymnorrhiza*, *Ceriops tagal*, and *Nypa fruticans*) from two families
27 (*Rhizophoraceae* and *Araceae*) were identified in Bama Resort. Analysis in vegetation in Bama
28 Resort showed that species with highest importance value was *R. apiculata* (229.80%) followed
29 by *R. stylosa* (47.78%), *B. gymnorrhiza* (15.57%), *N. fruticans* (3.42%), and *R. mucronata*
30 (3.34%). The greatest mangrove diversity (1.37) in terms of diameter category is sapling and the

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

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

3
4 Sucipto Hariyanto¹⁾, Akhmad Kharish Fahmi¹⁾, Thin Soedarti¹⁾, Emy Endah Suwarni²⁾

5 1. Department of Biology, Faculty of Science and Technology, Universitas Airlangga

6 2. Baluran National Park

7 Corresponding author Email: sucipto-h@fst.unair.ac.id

8 ☒ Campus C Universitas Airlangga, Mulyorejo, Surabaya 60115

9
10 **ABSTRACT**

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

30
31 **Keywords:** Bama, community, diversity, mangrove, zonation.

1 **INTRODUCTION**

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

10 The mangrove ecosystem in Indonesia holds 75% of total mangroves in South East Asia
11 or around 27% of total mangroves in the world. Besides that, mangrove ecosystem in Indonesia
12 has the highest diversity in the world (Sukardjo & Alongi, 2012). The distribution of mangroves
13 in Indonesia is located on the coast of Sumatra, Kalimantan, and Papua. The extent of mangroves
14 distribution continued to decline from 4.25 million hectares in 1982 to approximately 3.24 million
15 hectares in 1987 and remaining of 2.79 hectares in 2000 (Richards & Friess, 2016). Between 2000
16 -2012, the percentage of mangroves loss were 1.72% (Richards & Friess, 2016). The declining
17 trend indicates that there were 61.000 hectares of mangrove forests deforestation and mangrove
18 habitat loss of 48.000 hectares over 12 years (Richards & Friess, 2016). It is caused by the
19 conversion of land used into aquaculture/farming, agriculture, tourism, urban development, and
20 overexploitation (Dahuri, 2002; Giri *et al.*, 2008; Richards & Friess, 2016).

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

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

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

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

5

6 METHODS

7 The study area

8 The research was conducted in January-May 2014 at Bama Beach Baluran National Park.
9 Baluran National Park is located at Situbondo District East Java Province (Figure 1)
10 geographically lies between 7°50'44.48' S- 114°27'39.65" E and 7°51'04.11" S -114°27'32.32"
11 E. Mapping transects and plots in sampling area was obtained through Global Positioning System
12 (GPS) by the use of an online mapping (Figure 2).

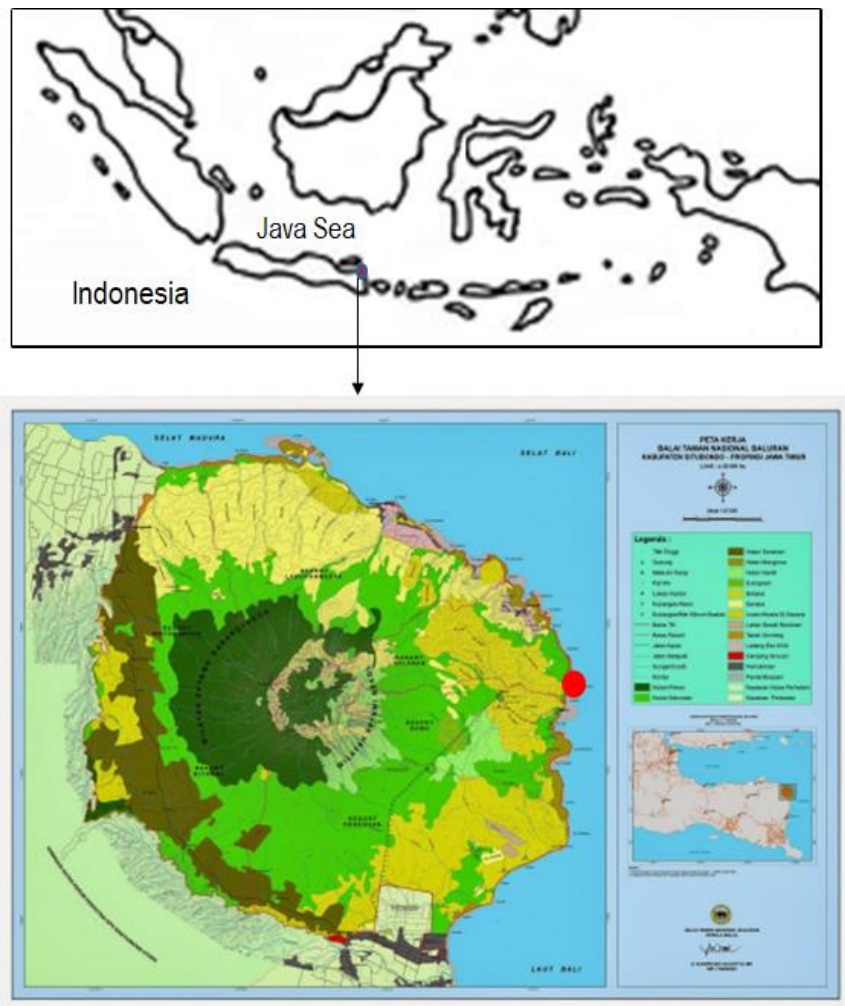


Figure 1. The research site

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



4
5 **Figure 2.** Sampling transects in Bama Beach
6

7 **Establishment of sampling plots and measurement**

8 We used quadrat transect methods with ten transects belt that perpendicular to the
9 mainland, each sub-plot (100 m²) for sapling (dbh: 2cm-9.99cm) and trees (dbh: ≥ 10cm), and a 5
10 x 5-meter plot was laid inside the main plot for seedling (dbh: < 2.0cm) study. Mangroves trees
11 inside the sampling plots were counted and identified respectively. The data collected of this
12 research were mangrove species, number of stem to determine the value of density, tree diameter
13 at breast height (dbh), stem height, substrate type (fraction), and physical-chemical condition such
14 as pH, temperature, salinity, and light intensity.

16 **Vegetation analysis**

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

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

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

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

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

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

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

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

6

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

8 $H' = -\sum P_i \ln P_i$

9 H = Shannon diversity index

10 P_i = Fraction of the entire population made up of species i (proportion of a species i relative
11 to total number of species present)

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

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

14 $C = \sum \left(\frac{n_i}{N}\right)^2$

15 C = dominance index

16 n_i = importance value for each species

17 N = total of importance value

18 **Water Analysis**

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

21 **Light Intensity**

22 Light intensity on each plots was measured using lux meter

23 **Substrat Analysis**

24 The determination of texture of mangrove substrate was done ex situ in the laboratory.
25 Soils in all plots were collected using a stainless steel corer (7 cm inside diameter) to a depth of
26 20 cm. Soils samples each plot were taken twice. The steps in substrate texture analysis are based
27 on the USDA triangle.

28

1 RESULTS AND DISCUSSION

2 Overview of the Research Site

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

7

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

No	Species	Family	Stage		
			Seedlings	Saplings	Trees
1	<i>Rhizophora stylosa</i>	<i>Rhizophoraceae</i>	0	48	50
2	<i>Rhizophora mucronata</i>	<i>Rhizophoraceae</i>	0	5	3
3	<i>Rhizophora apiculata</i>	<i>Rhizophoraceae</i>	13	81	221
4	<i>Bruguiera gymnorhiza</i>	<i>Rhizophoraceae</i>	2	16	11
5	<i>Ceriops tagal</i>	<i>Rhizophoraceae</i>	0	2	0
6	<i>Nypa fruticans</i>	<i>Araceae</i>	0	26	3
		Total	15	178	288

10

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

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

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

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

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

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

26

27

28

29

30

1 **Table 2.** Analysis of mangroves trees

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

2
3 Diversity is the total range of plant species in an area Diversity index or Shannon diversity
4 index is used to determine the species diversity in a community. Species evenness is a measure of
5 biodiversity which quantifies how equal the populations are numerically (Kasawani et al., 2007).
6 Evenness index (J) which is the relative abundance with each mangrove species is represented in
7 an area. In this research, the value of diversity index is 0.39 for seedling, which is low as shown
8 in Table 3. Although the diversity index is relatively low, there were 6 species mangroves
9 belonging to mayor mangrove or true mangrove, so it is important to maintain the mangroves.
10 Bama Resort area has a low diversity because there was *Rhizophora apiculata* which has the sub-
11 dominant or dominant but not a whole characteristic. This occurs because the ecosystem conditions
12 that strongly support the growth of *Rhizophora apiculata* which is the type of substrate (mud).

13 **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

14
15 Species diversity and mangrove growth are influenced by the supply of the fresh water
16 from the river that empties into the sea and the suitability of habitat of each species towards the
17 climate and geographical condition (Duke et al., 1998). Setyawan (2005) added that the extent of
18 the mangroves area greatly determines the diversity of plant species. The extent of area also allows
19 sufficient space to grow and reduce competition among species in the fight for space, nutrition,
20 and space.

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

3
4 **Table 4.** Dominancy index of mangrove vegetations

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

5
6 Based on this results, it is known that there were sub-dominant mangrove or non-dominant.
7 *Rhizophora apiculata* has the highest dominance value (0.487), which also has the sub-dominant
8 characteristic (Table 4).

9 The mangrove zonation pattern in the research site from the coastal line to the mainland
10 was *Rhizophora stylosa*, *Rhizophora mucronata*, and *Rhizophora apiculata* in the outer zone,
11 respectively (zone directly adjacent to the sea); *Bruguiera gymnorrhiza* and *Ceriops tagal* in the
12 middle zone; and *Nypa fruticans* in the zone that adjacent to the mainland or landward zone. The
13 three zones of mangroves in Bama resort are not similar to those found throughout the Sirondo
14 and Batu Sampang Baluran National Park (Sudarmadji, 2003), the Cimanuk Delta (Sukardjo et al.,
15 2014). The principal drivers of zonation are complex, dependent on the interrelationships between
16 and among factors, including soil nutrients, frequency of tidal inundation or different positions
17 along some physical gradient, ecological interactions between species in the community (Hogarth,
18 2015). The percentage of the most dominant substrate fraction is mud with total percentage of 10
19 transects at 48.76%. This result indicated that the type of the research site was coastal akressif.

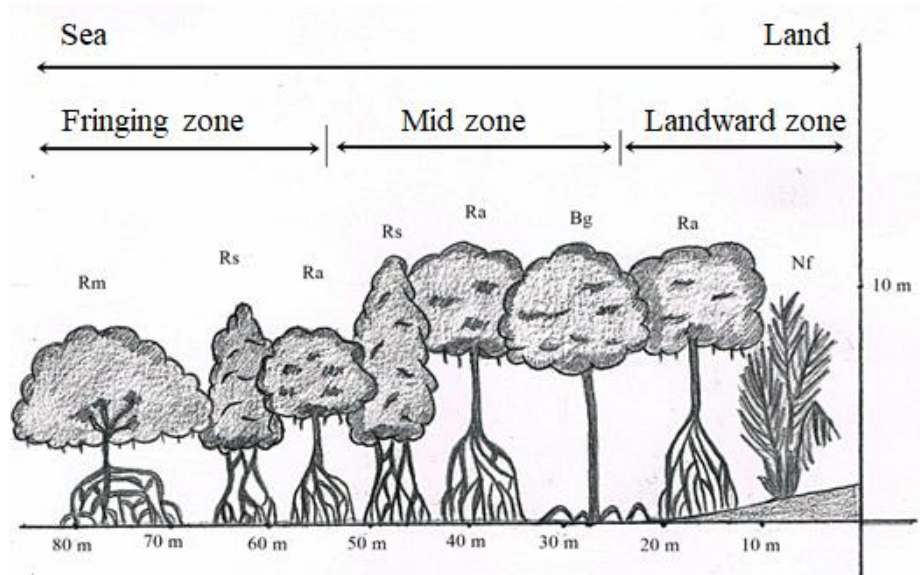


Figure 3. [U1] The mangrove zonation pattern at the research site

- | | | | |
|----|-------------------------------|----|--------------------------------|
| Rm | : <i>Rhizophora mucronata</i> | Rs | : <i>Rhizophora stylosa</i> |
| Ra | : <i>Rhizophora apiculata</i> | Bg | : <i>Bruguiera gymnorrhiza</i> |
| Nf | : <i>Nypa fruticans</i> | | |

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 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* (*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

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

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

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

8

9 **CONCLUSIONS**

10 A total of six mangrove species (*Rhizophora stylosa*, *Rhizophora mucronata*, *Rhizophora*
11 *apiculata*, *Bruguiera gymnorrhiza*, *Ceriops tagal*, and *Nypa fruticans*) from two families
12 (*Rhizophoraceae* and *Araceae*) were identified in Bama Resort. Analysis in vegetation in Bama
13 Resort showed that species with highest importance value was *R. apiculata* (229.80%) followed
14 by *R. stylosa* (47.78%), *B. gymnorrhiza* (15.57%), *N. fruticans* (3.42%), and *R. mucronata*
15 (3.34%). The greatest mangrove diversity (1.37) in terms of diameter category is sapling and the
16 lowest mangrove diversity (0.39) was belongs to seedling. The mangrove zonation patterns from
17 the coastline to the mainland are *Rhizophora stylosa*, *Rhizophora mucronata*, and *Rhizophora*
18 *apiculata* in the outermost zone (the zone adjacent to the sea), *Bruguiera gymnorrhiza* and *Ceriop*
19 *tagal* in the middle zone. *Nypa fructicans* in the zone bordering on land mangrove.

20

21 **ACKNOWLEDGEMENT**

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

24

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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	

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

3
4 Sucipto Hariyanto¹⁾, Akhmad Kharish Fahmi¹⁾, Thin Soedarti¹⁾, Emy Endah Suwarni²⁾

5 ¹⁾ Department of Biology, Faculty of Science and Technology, Universitas Airlangga

6 ²⁾ Baluran National Park, Situbondo East Java

7 Corresponding author Email: sucipto-h@fst.unair.ac.id

8 ☒ Campus C Universitas Airlangga, Mulyorejo, Surabaya 60115

9
10 **ABSTRACT**

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

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

16
17 Ten belt-transects were laid perpendicular to the shoreline, using standard methods. Vegetation
18 structure was determined using data collected on plant species diversity, density, basal area, and
19 the number of each species of mangroves. Shannon Wiener index to calculated diversity,
20 evennes and Simpson to calculated dominance index. The results show there are 2 families and 6
21 mangrove species occurring in the study areas that is Rhizophoraceae (*Rhizophora stylosa*,
22 *Rhizophora mucronata*, *Rhizophora apiculata*, *Bruguiera gymnorrhiza*, and *Ceriops tagal*) and
23 Araceae (*Nypa fruticans*). The highest importance value was *R. apiculata* (229.90%) for trees, *R.*
24 *apiculata* (148.69%) for the sapling, and *R. apiculata* (244.83%) for the seedling. The diversity
25 (H) and dominance index (C) values were moderate (1.79) and 0.521. The most dominant
26 species was *R. apiculata* (C=0.487). The mangrove zonation pattern from coastline to the
27 mainland was *R. stylosa*, *R. mucronata*, and *R. apiculata*, in the outer zone, respectively (zone
28 directly adjacent to the sea); *B. gymnorrhiza* and *C. tagal* in the middle zone; and *N. fruticans* in
29 the zone that adjacent to the mainland.
30

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

3
4 Keywords: Bama, community, diversity, mangrove, zonation.

5 **INTRODUCTION**

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

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

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

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

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

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

9

10 **METHODS**

11 **The study area**

12 The research was conducted in January-May 2014 at Bama Beach Baluran National Park.
13 Baluran National Park is located at Situbondo District East Java Province (Figure 1)
14 geographically lies between 7°50'44.48' S- 114°27'39.65'' E and 7°51'04.11'' S -114°27'32.32''
15 E. Mapping transects and plots in sampling area was obtained through Global Positioning
16 System (GPS) by the use of an online mapping (Figure 2).

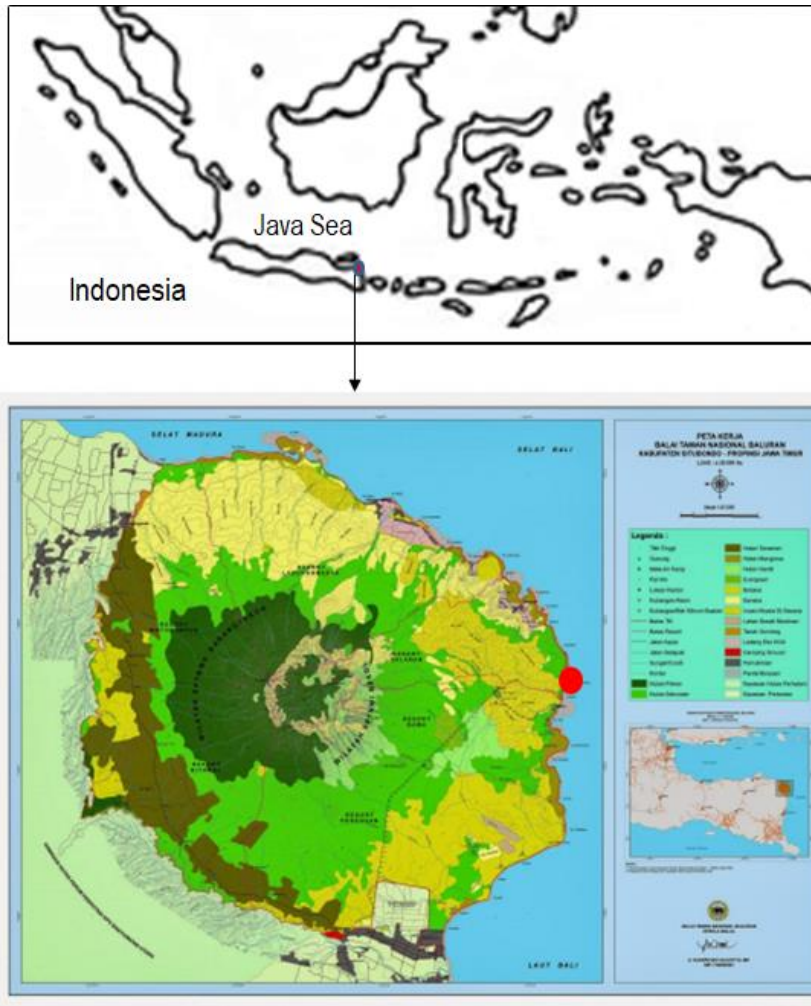


Figure 1. The research site

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

1

2 **Establishment of sampling plots and measurement**

3 We used quadrat transect methods with ten transects belt that perpendicular to the
4 mainland, each sub-plot (100 m²) for sapling (dbh: 2cm-9.99cm) and trees (dbh: ≥ 10cm), and a
5 5 x 5-meter plot was laid inside the main plot for seedling (dbh: < 2.0cm) study. Mangroves trees
6 inside the sampling plots were counted and identified respectively. The data collected of this
7 research were mangrove species, number of stem to determine the value of density, tree diameter
8 at breast height (dbh), stem height, substrate type (fraction), and physical-chemical condition
9 such as pH, temperature, salinity, and light intensity.

10

11 **Vegetation analysis**

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

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

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

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

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

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

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

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

23

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

25 $H' = -\sum P_i \ln P_i$

26 H = Shannon diversity index

1 P_i = Fraction of the entire population made up of species i (proportion of a species i
 2 relative to total number of species present)

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

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

5
$$C = \sum \left(\frac{n_i}{N} \right)^2$$

6 C = dominance index

7 n_i = importance value for each species

8 N = total of importance value

9 **Water Analysis**

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

12 **Light Intensity**

13 Light intensity on each plots was measured using lux meter

14 **Substrat Analysis**

15 The determination of texture of mangrove substrate was done ex situ in the laboratory.
 16 Soils in all plots were collected using a stainless steel corer (7 cm inside diameter) to a depth of
 17 20 cm. Soils samples each plot were taken twice. The steps in substrate texture analysis are based
 18 on the USDA triangle.

19

20 **RESULTS AND DISCUSSION**

21 **Overview of the Research Site**

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

26

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

No	Species	Family	Stage		
			Seedlings	Saplings	Trees
1	<i>R. stylosa</i>	Rhizophoraceae	0	48	50

2	<i>R. mucronata</i>	Rhizophoraceae	0	5	3
3	<i>R. apiculata</i>	Rhizophoraceae	13	81	221
4	<i>B. gymnorrhiza</i>	Rhizophoraceae	2	16	11
5	<i>C. tagal</i>	Rhizophoraceae	0	2	0
6	<i>N. fructicans</i>	Araceae	0	26	3
		Total	15	178	288

1
2 All of these mangroves are mayor mangrove or true mangrove. *R. apiculata* was the most
3 abundant tree with 221 trees followed by *R. stylosa* (50 trees), *B. gymnorrhiza* (11 trees), *R.*
4 *mucronata* (3 trees) and *N. fructicans* (3 trees). Moreover *R. apiculata* sapling showed the
5 highest dispersal followed by *R. stylosa*, *N. fructicans*, *B. gymnorrhiza*, *R. mucronata*, and *C.*
6 *tagal*. When considering the seedlings, *R. apiculata* was the highest dispersal (13 trees),
7 followed by *B. gymnorrhiza* (2 trees).The success of *R. apiculata* regeneration at the sea edge
8 due in part to differences infloading tolerance of these species (Sukardjo et al, 2014). It's also
9 could be due to *R. apiculata* has the highest tolerance limit of the extreme conditions such as
10 high salinity and muddy substrate. That highest tolerance limit is supported by the root system of
11 *R. apiculata* which is aerial root (pneumatophore) in the form of long roots and branches arise
12 from the base of stem. This root is known as the prop root and will eventually become still root if
13 the stem is held up so that it no longer touches the ground. The root helps the upright of the tree
14 because it has a broad base to support in soft and unstable mud. It also helps the aeration when
15 exposed at low tide (Ng and Sivatoshi, 2001; Hogarth, 2015).
16

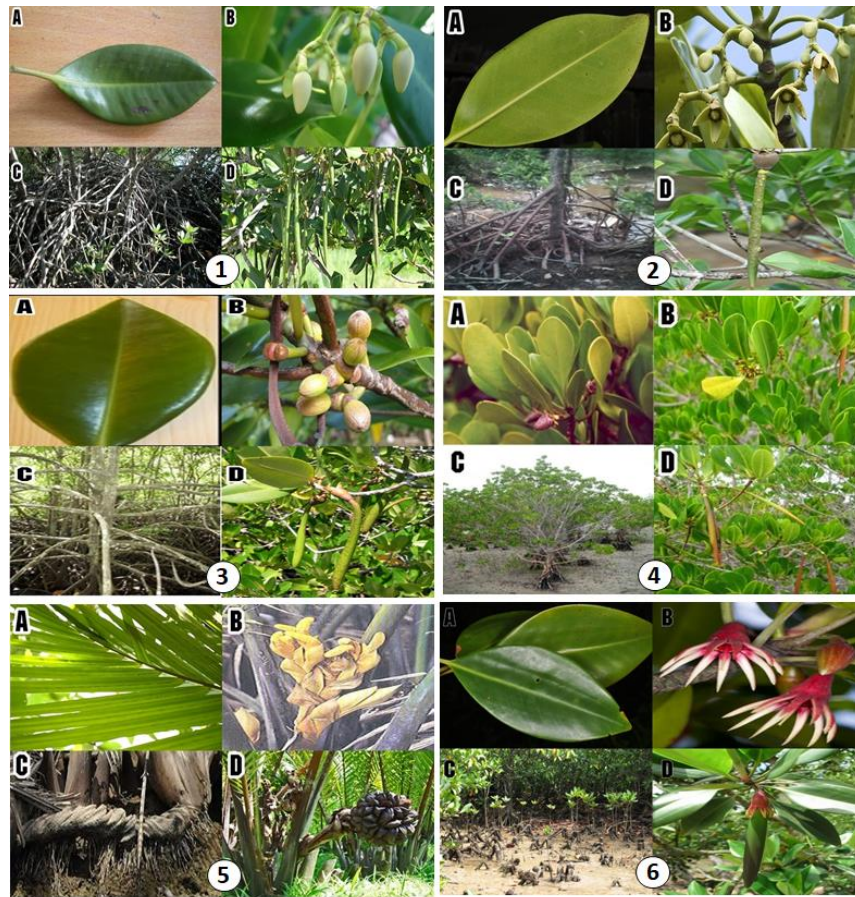


Figure 3. Mangrove species recorded in Bama Resort: 1. *R. stylosa*. 2. *R. mucronata*. 3. *R. apiculata*. 4. *C. tagal*. 5. *N. fruticans*. 6. *B. gymnorrhiza*. A. leaf. B. flower arrangement. C. rooting system. D. propagul.

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°C -29°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

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

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

13

14 **Table 2.** Analysis of mangroves trees

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

15

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

1

2 **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

3

4 Species diversity and mangrove growth are influenced by salinity (Ball, 2002),
5 competition and other physical factor (Hogarth, 2015, Hossain and Nuruddin, 2016). Setyawan
6 (2005) added that the extent of the mangroves area greatly determines the diversity of plant
7 species. The extent of area also allows sufficient space to grow and reduce competition among
8 species in the fight for space, nutrition, and space.

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

11

12 **Table 4.** Dominancy index of mangrove vegetations

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

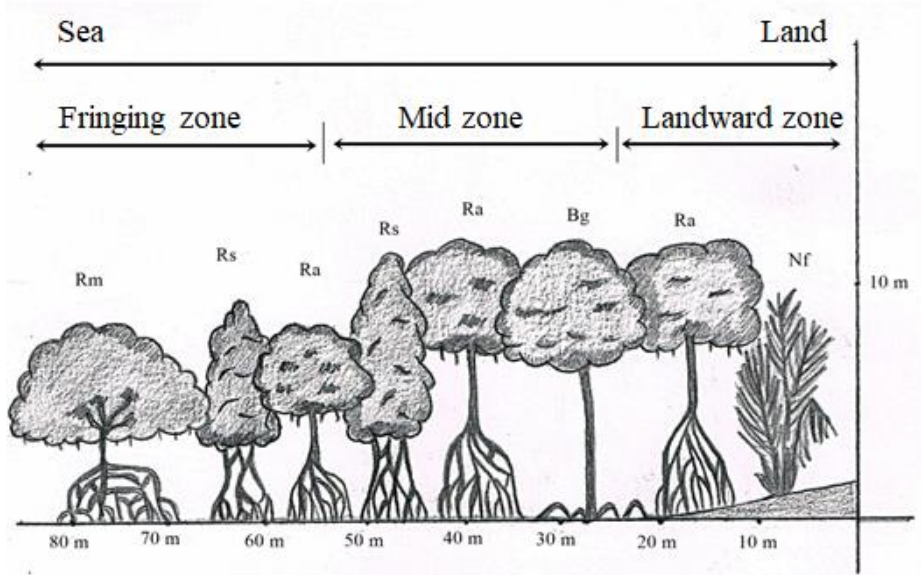
13

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

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

1 adjacent to the sea); *B. gymnorrhiza* and *C. tagal* in the middle zone; and *N. fruticans* in the zone
 2 that adjacent to the mainland or landward zone (Figure 4). The three zones of mangroves in
 3 Bama resort are not similar to those found throughout the Sirondo and Batu Sampang Baluran
 4 National Park (Sudarmadji, 2003), the Cimanuk Delta (Sukardjo et al., 2014). The principal
 5 drivers of zonation are complex, dependent on the interrelationships between and among factors,
 6 including soil nutrients, frequency of tidal inundation or different positions along some physical
 7 gradient, ecological interactions between species in the community (Hogarth, 2015). The
 8 percentage of the most dominant substrate fraction is mud with total percentage of 10 transects at
 9 48.76%. This result indicated that the type of the research site was coastal akressif.

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

13

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

14

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

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Nf : *N. fruticans*



1
2 **Figure 5.** The rooting appearance of *R.apiculata* located in the middle zone
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4 Zoning is almost entirely dominated by *R. apiculata* from the coastal line to the mainland
5 (Figure 5), except at transect 5 which is only found saplings of *N. fruticans* at the coral sand
6 substrate. This condition is more influenced by the adaptability of *R. apiculata* which is fairly
7 high. Besides that, its shorter and slender hypocotyl than the *Rhizophoraceae* group allow to be
8 carried by the sea water (Hogarth, 2015).

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

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

22 The present study will aid in the conduct and preservation planning of mangrove forest
23 especially at Bama coast and generally in the coastal areas of Indonesia.
24

1 **CONCLUSIONS**^[u2]

2 A total of six mangrove species (*R. stylosa*, *R. mucronata*, *R. apiculata*, *B. gymnorrhiza*,
3 *C. tagal*, and *N. fruticans*) from two families (*Rhizophoraceae* and *Araceae*) were identified in
4 Bama Resort. Analysis in vegetation in Bama Resort showed that species with highest
5 importance value was *R. apiculata* (229.80%) followed by *R. stylosa* (47.78%), *B. gymnorrhiza*
6 (15.57%), *N. fruticans* (3.42%), and *R. mucronata* (3.34%). The greatest mangrove diversity
7 (1.37) in terms of diameter category is sapling and the lowest mangrove diversity (0.39) was
8 belongs to seedling. The mangrove zonation patterns from the coastline to the mainland are *R.*
9 *stylosa*, *R. mucronata*, and *R. apiculata* in the outermost zone (the zone adjacent to the sea), *B.*
10 *gymnorrhiza* and *C. tagal* in the middle zone. *N. fruticans* in the zone bordering on land
11 mangrove.

13 **ACKNOWLEDGEMENT**

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15 research and Arif Pratiwi, S.T. Manager of Bama Resort, Baluran National Park for facilitating
16 this study.

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

3
4 Sucipto Hariyanto¹⁾, Akhmad Kharish Fahmi¹⁾, Thin Soedarti¹⁾, Emy Endah Suwarni²⁾

5 ¹⁾ Department of Biology, Faculty of Science and Technology, Universitas Airlangga

6 ²⁾ Baluran National Park, Situbondo East Java

7 Corresponding author Email: sucipto-h@fst.unair.ac.id

8 ✉ Campus C Universitas Airlangga, Mulyorejo, Surabaya 60115

9
10 **ABSTRACT**

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

29
30 Keywords: Bama, community, diversity, mangrove, zonation.

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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).

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

8 **METHODS**

9 **The study area**

10 The research was conducted in January-May 2014 at Bama Beach Baluran National Park.
11 Baluran National Park is located at Situbondo District East Java Province (Figure 1)
12 geographically lies between 7°50'44.48' S- 114°27'39.65" E and 7°51'04.11" S -114°27'32.32"
13 E. Mapping transects and plots in sampling area was obtained through Global Positioning System
14 (GPS) by the use of an online mapping (Figure 2).

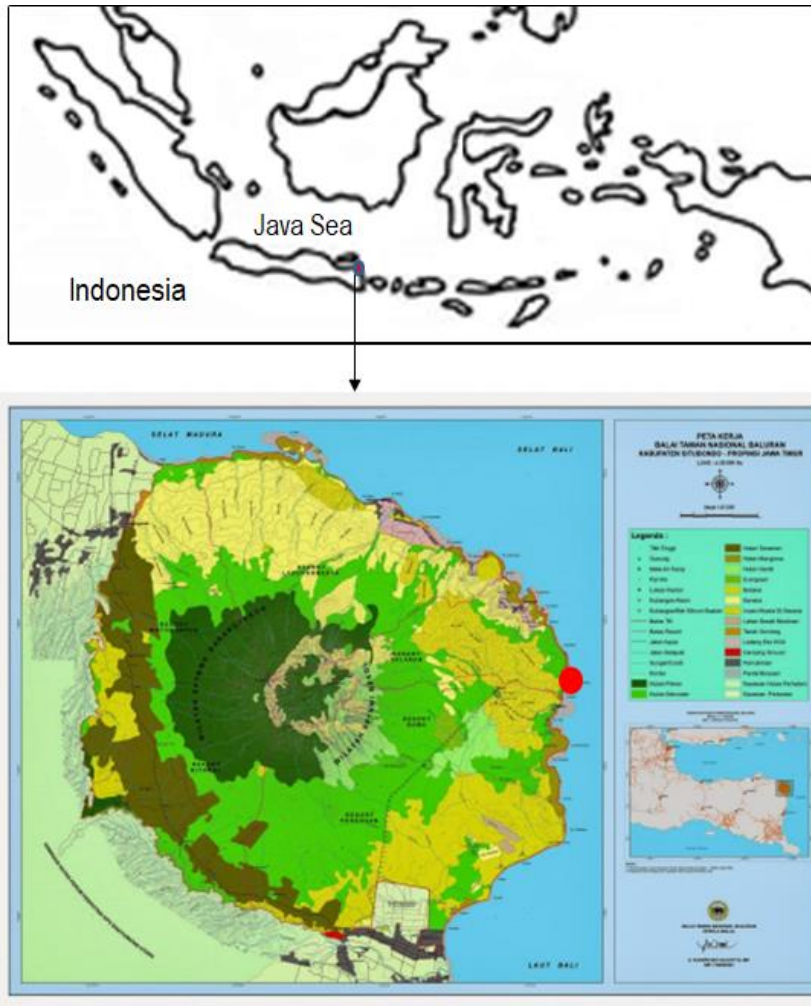


Figure 1. The research site

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

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Establishment of sampling plots and measurement

We used quadrat transect methods with ten transects belt that perpendicular to the mainland, each sub-plot (100 m²) 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 & Baret, 2005). This analysis can better inform of species function in its habitat. It also gives order for appropriate species within the mangrove community.

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

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

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

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

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

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

$$\text{Importance value (IV)} = \text{Relative density} + \text{Relative frequency} + \text{Relative dominance}$$

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

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

H = Shannon diversity index

1 P_i = Fraction of the entire population made up of species i (proportion of a species i relative
 2 to total number of species present)

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

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

5
$$C = \sum \left(\frac{n_i}{N}\right)^2$$

6 C = dominance index

7 n_i = importance value for each species

8 N = total of importance value

9 **Water Analysis**

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

12 **Light Intensity**

13 Light intensity on each plots was measured using lux meter

14 **Substrat Analysis**

15 The determination of texture of mangrove substrate was done ex situ in the laboratory.
 16 Soils in all plots were collected using a stainless steel corer (7 cm inside diameter) to a depth of
 17 20 cm. Soils samples each plot were taken twice. The steps in substrate texture analysis are based
 18 on the USDA triangle.

19

20 **RESULTS AND DISCUSSION**

21 **Overview of the Research Site**

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

26

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

No	Species	Family	Stage		
			Seedlings	Saplings	Trees
1	<i>R. stylosa</i>	Rhizophorazeae	0	48	50

2	<i>R. mucronata</i>	Rhizophoraceae	0	5	3
3	<i>R. apiculata</i>	Rhizophoraceae	13	81	221
4	<i>B. gymnorrhiza</i>	Rhizophoraceae	2	16	11
5	<i>C. tagal</i>	Rhizophoraceae	0	2	0
6	<i>N. fruticans</i>	Araceae	0	26	3
		Total	15	178	288

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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. fruticans* (3 trees). Moreover *R. apiculata* sapling showed the highest dispersal followed by *R. stylosa*, *N. fruticans*, *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 in flooding 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).

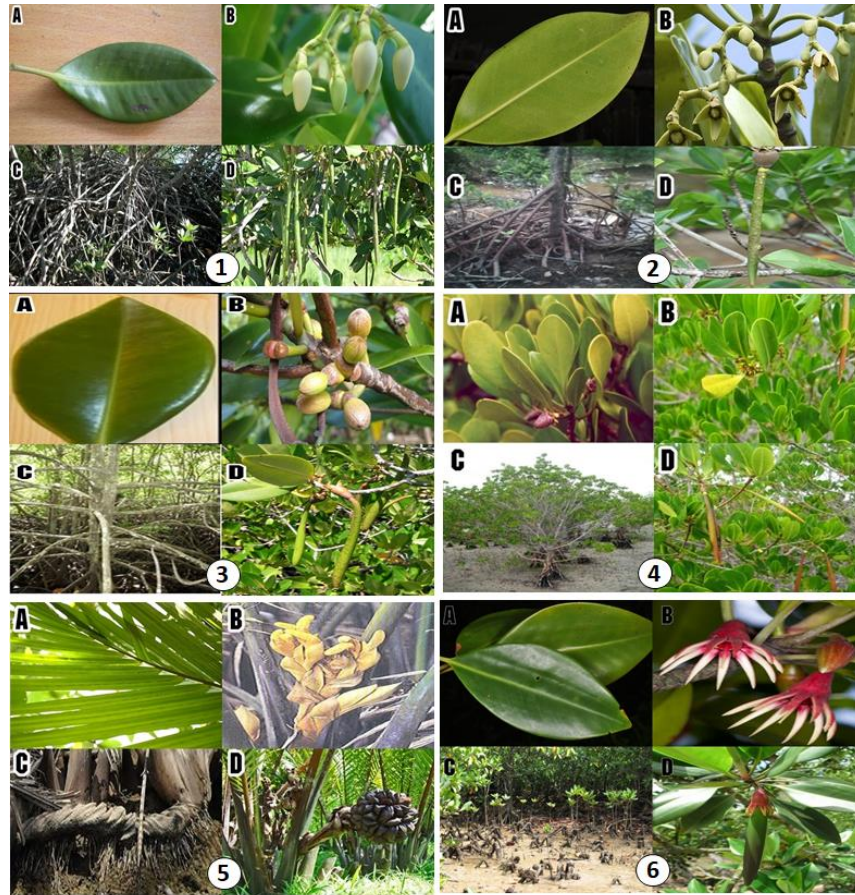


Figure 3. Mangrove species recorded in Bama Resort: 1. *R. stylosa*. 2. *R. mucronata*. 3. *R. apiculata*. 4. *C. tagal*. 5. *N. fruticans*. 6. *B. gymnorrhiza*. A. leaf. B. flower arrangement. C. rooting system. D. propagul.

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°C -29°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,

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

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

12

13 **Table 2.** Analysis of mangroves trees

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

14

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

25

1 **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

2

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

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

10

11 **Table 4.** Dominancy index of mangrove vegetations

No	Species	Dominance Index
1	<i>R. stylosa</i>	0.029
2	<i>R. mucronata</i>	0.000
3	<i>R. apiculata</i>	0.487
4	<i>B. gymnorhiza</i>	0.004
5	<i>C. tagal</i>	0.000
6	<i>N. fruticans</i>	0.001
Total		0.521

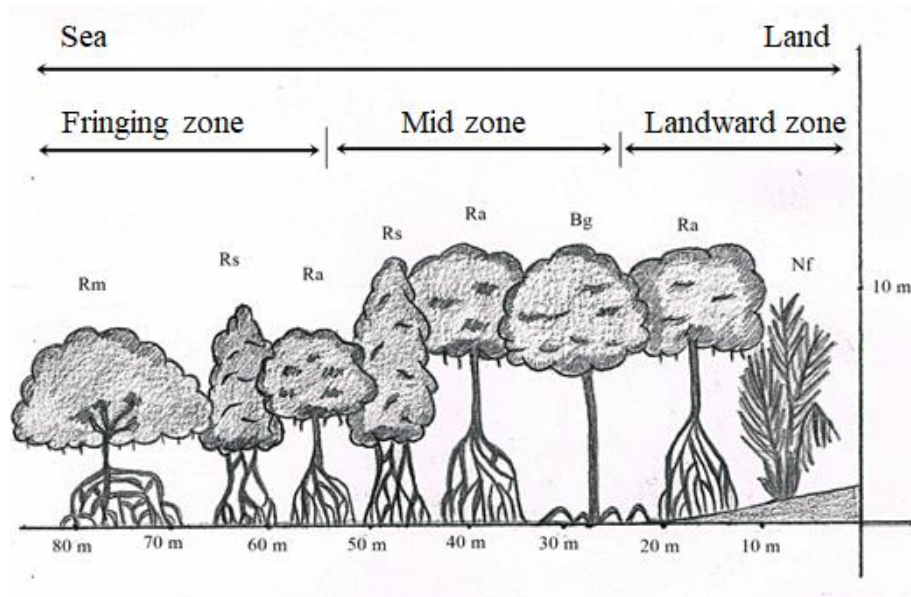
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13 Based on this results, it is known that there were sub-dominant mangrove or non-dominant. *R.*
 14 *apiculata* has the highest dominance value (0.487), which also has the sub-dominant characteristic
 15 (Table 4).

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

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

9



10

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

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

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

14 Nf : *N. fruticans*



1
2 **Figure 5.** The rooting appearance of *R.apiculata* located in the middle zone
3

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

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

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

22 The present study will aid in the conduct and preservation planning of mangrove forest
23 especially at Bama coast and generally in the coastal areas of Indonesia.
24

1 **CONCLUSIONS**^[u2]

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

11

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15

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1 **Vegetation and Community Structure of Mangrove in Bama Resort**
2 **Baluran National Park Situbondo, East Java**

3
4 Sucipto Hariyanto¹⁾, Akhmad Kharish Fahmi¹⁾, Thin Soedarti¹⁾, Emy Endah Suwarni²⁾

5 ¹⁾ Department of Biology, Faculty of Science and Technology, Universitas Airlangga

6 ²⁾ Baluran National Park, Situbondo East Java

7 Corresponding author Email: sucipto-h@fst.unair.ac.id

8 ✉ Campus C Universitas Airlangga, Mulyorejo, Surabaya 60115

9
10 **ABSTRACT**

11 Ecotourism development program at Bama beaches area requires baseline data of mangrove
12 structure at Bama Resort. The aims of this study ~~was~~ were to find the structure, composition,
13 distribution and zonation patterns of mangroves at Bama Resort Baluran Nasional Park. Ten belt-
14 transects were laid perpendicular to the shoreline, using standard methods. Vegetation structure
15 was determined ~~using data collected onby~~ collecting the data of plant species diversity, density,
16 basal area, and the number of each species of mangroves. Shannon Wiener index was used to
17 calculate the diversity, evenness and Simpson to calculated dominance index. ^[Mi1] ~~The results~~
18 ~~show there~~ There were are 2 families and 6 mangrove species from 2 families ~~occurring appeared~~
19 in the study areas ~~that is~~ i.e. Rhizophoraceae (*Rhizophora stylosa*, *Rhizophora mucronata*,
20 *Rhizophora apiculata*, *Bruguiera gymnorhiza*, and *Ceriops tagal*) and Araceae (*Nypa fruticans*).
21 The highest importance value of tree, sapling and seedling stages was shown by *R. apiculata*
22 with the value of (229.90%) for trees, R. apiculata (148.69%) for the sapling, and R. apiculata
23 and (244.83%) respectively for the seedling. The diversity (H) and dominance index (C) values
24 were moderate (1.79) and 0.521. ~~The most dominant species was R. apiculata~~ was also became
25 the most dominant species with (C=0.487). The mangrove zonation pattern from coastline to the
26 mainland was *R. stylosa*, *R. mucronata*, and *R. apiculata*, in the outer zone (zone directly
27 adjacent to the sea), respectively ~~(zone directly adjacent to the sea)~~; *B. gymnorhiza* and *C. tagal*
28 in the middle zone; and *N. fruticans* in the zone that adjacent to the mainland. The present study
29 provides the information that can be used as a basis in planning and conducting the preservation
30 efforts of mangrove forest especially at Bama coast and generally in the coastal areas of
31 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

Mangroves ~~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 million 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.

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

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

12 13 **METHODS**

14 **The study area**

15 The research was conducted in January-May 2014 at Bama Beach Baluran National Park.
16 Baluran National Park is located at Situbondo District East Java Province (Figure 1)
17 geographically lies between 7°50'44.48' S- 114°27'39.65" E and 7°51'04.11" S -114°27'32.32"
18 E. Mapping transects and plots in sampling area was obtained through Global Positioning
19 System (GPS) by the use of an online mapping (Figure 2).

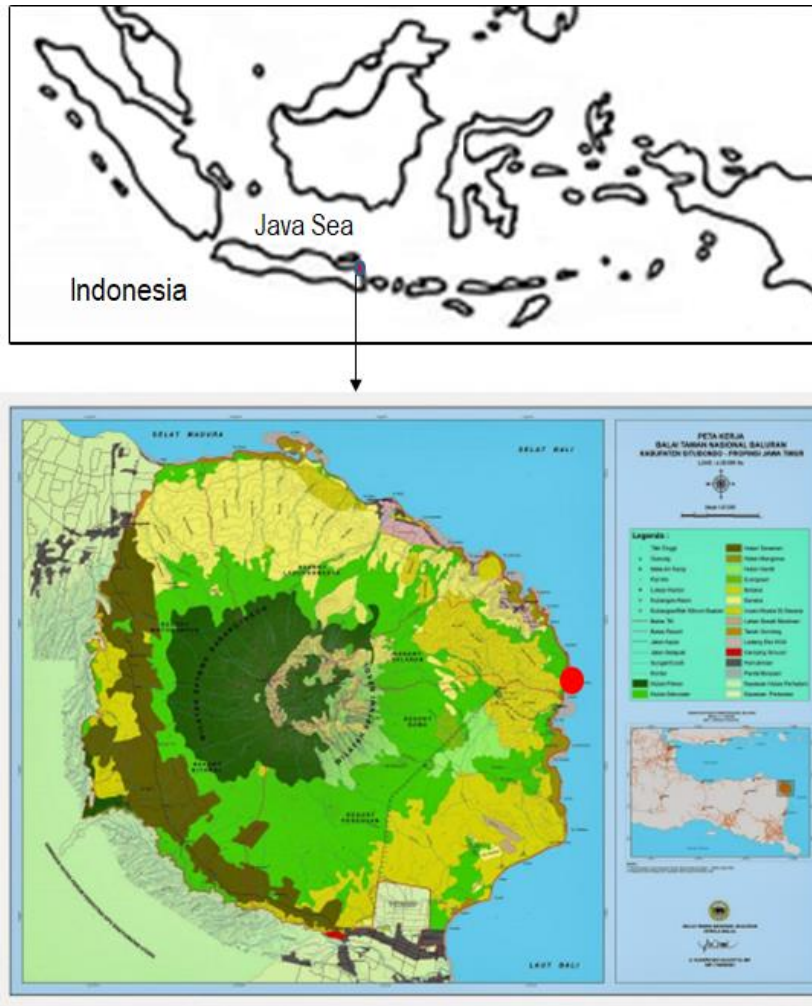


Figure 1. The research site

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

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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 methods ~~was used~~ with ten ~~transects~~ **belt transects** that perpendicular to the mainland, each sub-plot (100 m²) 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 & Barrett, 2005). **This analysis can better inform of species function in its habitat. It also gives order for appropriate species within the mangrove community.** [Mi7]

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

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

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

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

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

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

$$\text{Importance value (IV)} = \text{Relative density} + \text{Relative frequency} + \text{Relative dominance}$$

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

1 $H' = -\sum P_i \ln P_i$
 2 H = Shannon diversity index
 3 P_i = Fraction of the entire population made up of species i (proportion of a species i
 4 relative to total number of species present)

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

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

7
$$C = \frac{\sum n_i^2}{N^2}$$

8 C = dominance index
 9 n_i = importance value for each species
 10 N = total of importance value

11 **Water Analysis**

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

14 **Light Intensity**

15 Light intensity on each plots was measured using lux meter

16 ~~Substrat~~Substrate Analysis

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

21

22 **RESULTS AND DISCUSSION**

23 **Overview of the Research Site**

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

28

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

No	Species	Family	Stage
----	---------	--------	-------

			Seedlings	Saplings	Trees
1	<i>R. stylosa</i>	Rhizophoraceae	0	48	50
2	<i>R. mucronata</i>	Rhizophoraceae	0	5	3
3	<i>R. apiculata</i>	Rhizophoraceae	13	81	221
4	<i>B. gymnorrhiza</i>	Rhizophoraceae	2	16	11
5	<i>C. tagal</i>	Rhizophoraceae	0	2	0
6	<i>N. fruticans</i>	Araceae	0	26	3
		Total	15	178	288

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All of these mangroves are ~~major 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. fruticans* (3 trees). Moreover, *R. apiculata* sapling showed the highest dispersal followed by *R. stylosa*, *N. fruticans*, *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 flooding tolerance of these species ^[M19](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 stilt root if the stem is held up so that it no longer touches the ground. ^[M10]The root helps the upright of the tree because it has a broad base to support in soft and unstable mud. ^[M11]It also helps the aeration when exposed ~~at to~~ low tide (Ng ~~and &~~ Sivasotesthi, 2001; Hogarth, 2015).

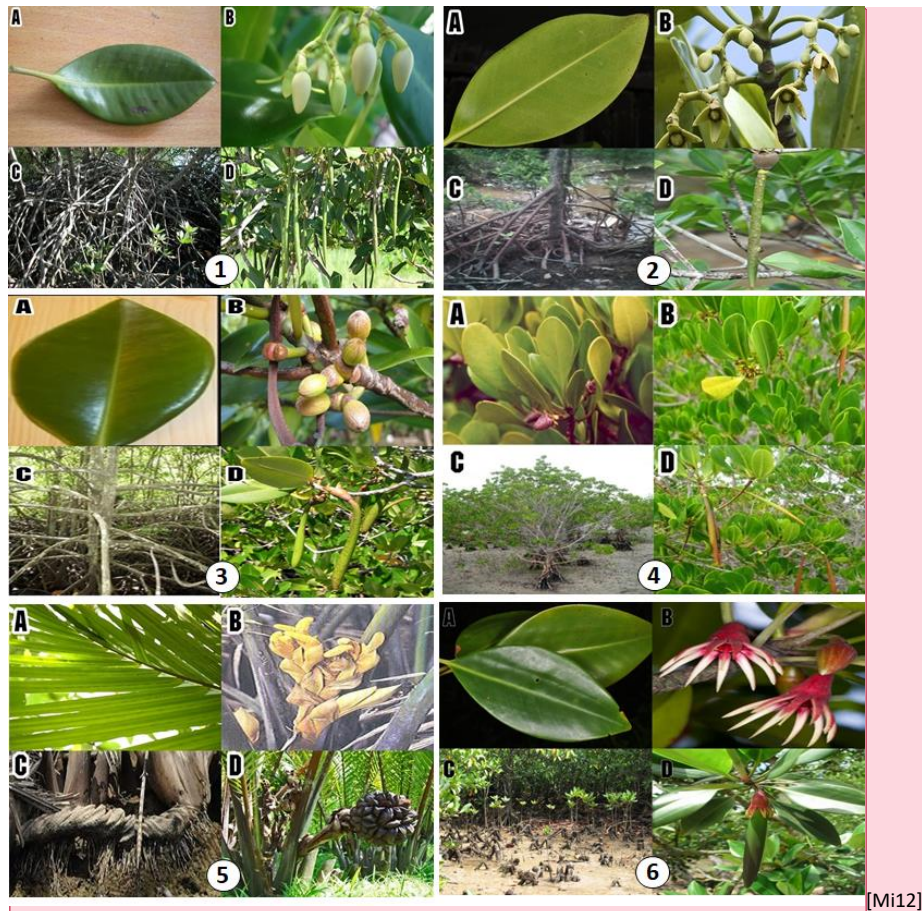


Figure 3. Mangrove species recorded in Bama Resort: 1. *R. stylosa*. 2. *R. mucronata*. 3. *R. apiculata*. 4. *C. tagal*. 5. *N. fruticans*. 6. *B. gymnorrhiza*. A. leaf. B. flower arrangement. C. rooting system. D. propagule.

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°C -29°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 indicates ~~sd~~ the result of quantitative analysis for tree ~~_level-stage~~ based on importance value index. Its 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	<i>R. apiculata</i>	75.00	62.29	82.74	229.80
2	<i>R. stylosa</i>	17.31	20.27	10.63	47.78
3	<i>B. gymnorrhiza</i>	3.85	10.14	5.75	15.57
4	<i>N. fruticans</i>	1.92	4.38	0.44	3.42
5	<i>R. mucronata</i>	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 ~~major 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

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

3

4 **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

5

6 Species diversity and mangrove growth are influenced by salinity (Ball, 2002),
7 competition and other physical factors (Hogarth, 2015, Hossain and Nuruddin, 2016-). Setyawan
8 (2005) added that the extent of the mangroves area greatly determines the diversity of plant
9 species. The extent of area also allows sufficient space to grow and reduce competition among
10 species in the fight for space and nutrition, and space.

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

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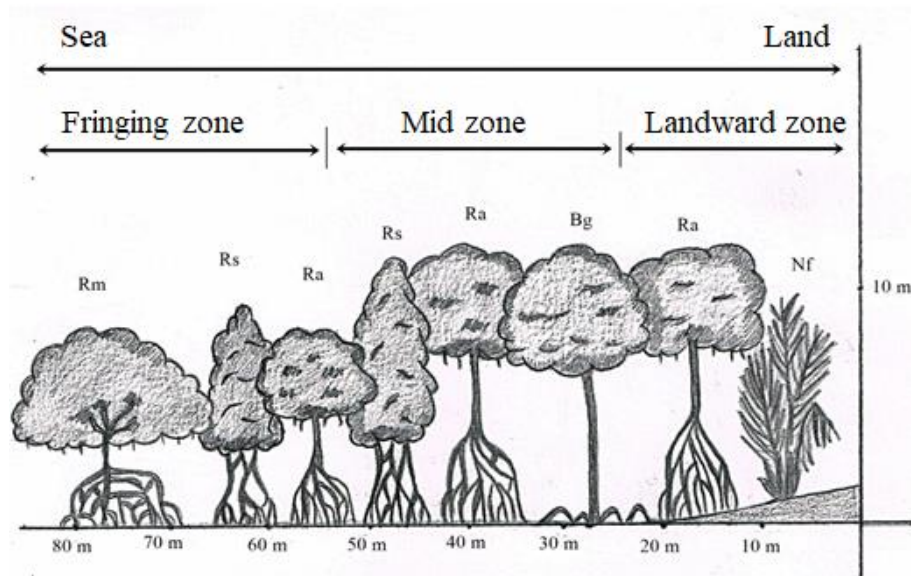
15 **Table 4.** Dominancy index of mangrove vegetations

No	Species	Dominance Index
1	<i>R. stylosa</i>	0.029
2	<i>R. mucronata</i>	0.000
3	<i>R. apiculata</i>	0.487
4	<i>B. gymnorhiza</i>	0.004
5	<i>C. tagal</i>	0.000
6	<i>N. fruticans</i>	0.001
Total		0.521

16

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

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



17
 18 **Figure 4.** The mangrove zonation pattern at the research site

- 19 *Rm* : *R. mucronata* *Rs* : *R. stylosa*
 20 *Ra* : *R. apiculata* *Bg* : *B. gymnorhiza*
 21 *Nf* : *N. fruticans*



1
2 **Figure 5.** The rooting appearance of *R. apiculata* located in the middle zone
3

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

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

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

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

4 5 CONCLUSIONS

6 A total of six mangrove species (*R. stylosa*, *R. mucronata*, *R. apiculata*, *B. gymnorrhiza*,
7 *C. tagal*, and *N. fruticans*) from two families (*Rhizophoraceae* and *Araceae*) were identified in
8 Bama Resort. Analysis in vegetation in Bama Resort showed that species with highest
9 importance value was *R. apiculata* (229.80%) followed by *R. stylosa* (47.78%), *B. gymnorrhiza*
10 (15.57%), *N. fruticans* (3.42%), and *R. mucronata* (3.34%). The greatest mangrove diversity
11 (1.37) in terms of diameter category is sapling and the lowest mangrove diversity (0.39) was
12 belongs to seedling. The mangrove zonation patterns from the coastline to the mainland are *R.*
13 *stylosa*, *R. mucronata*, and *R. apiculata* in the outermost zone (the zone adjacent to the sea), *B.*
14 *gymnorrhiza* and *C. tagal* in the middle zone ~~and~~ *N. fruticans* in the zone bordering on land
15 mangrove.

16 17 ACKNOWLEDGEMENT

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19 ~~giving the~~ permission for this research and Arif Pratiwi, S.T. Manager of Bama Resort, Baluran
20 National Park for facilitating this study.

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BIOSAINTEFIKA

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	✓
6	Key words	• Implication/Benefit for science development/society	✓
		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	✓
8	Methods (± ½-1 page, 1.5 spacing)	• The benefits to the science / society	✓
		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	✓

		<ul style="list-style-type: none"> • Explain the novelty of your research 	✓
		<ul style="list-style-type: none"> • The benefits and contribution of research for the science/ society 	✓
10	Conclusion	<ul style="list-style-type: none"> • It is written in one paragraph without numbering 	✓
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11	Suggestion (Optional)	<ul style="list-style-type: none"> • 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	✓
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		<ul style="list-style-type: none"> • 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
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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.

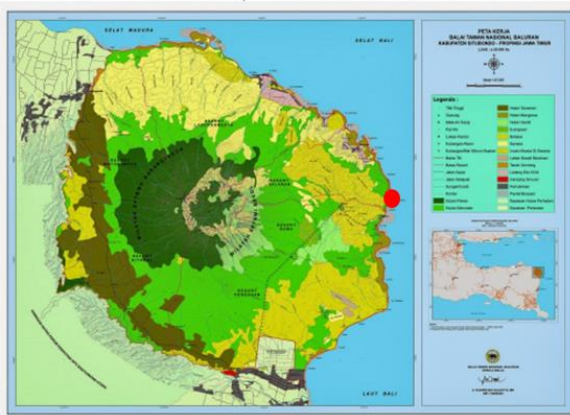
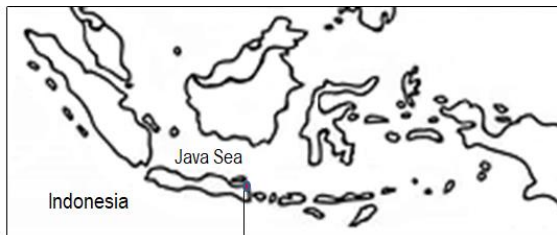
The growth of each plant will adjust to surrounding environment so that the morphology that occurs will vary from one place to another (Gratani, 2014). Therefore, the morphology of mangroves in Baluran National Park is typical, considering that the different environmental conditions have different morphological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

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

8 METHODS

9 The study area

10 The research was conducted in January-May 2014 at Bama Beach Baluran National Park.
11 Baluran National Park is located at Situbondo District East Java Province (Figure 1)
12 geographically lies between $7^{\circ}50'44.48''$ S- $114^{\circ}27'39.65''$ E and $7^{\circ}51'04.11''$ S - $114^{\circ}27'32.32''$
13 E. Mapping transects and plots in sampling area was obtained through Global Positioning System
14 (GPS) by the use of an online mapping (Figure 2).



15 **Figure 1.** The research site

16 **Figure 2.** Sampling transects in Bama Beach

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

4 5 **Establishment of sampling plots and measurement**

6 We used quadrat transect methods with ten transects belt that perpendicular to the
7 mainland, each sub-plot (100 m²) for sapling (dbh: 2cm-9.99cm) and trees (dbh: ≥ 10cm), and a 5
8 x 5-meter plot was laid inside the main plot for seedling (dbh: < 2.0cm) study. Mangroves trees
9 inside the sampling plots were counted and identified respectively. The data collected of this
10 research were mangrove species, number of stem to determine the value of density, tree diameter
11 at breast height (dbh), stem height, substrate type (fraction), and physical-chemical condition such
12 as pH, temperature, salinity, and light intensity.

13 14 **Vegetation analysis**

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

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

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

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

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

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

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

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

26

1 Diversity index of mangroves was calculated by Shannon-Wiener index (Legendre & Legendre,
2 2012).

$$3 \quad H' = -\sum P_i \ln P_i$$

4 H = Shannon diversity index

5 P_i = Fraction of the entire population made up of species i (proportion of a species i relative
6 to total number of species present)

$$7 \quad \text{Evenness index (J)} = \frac{H'}{H_{max}}$$

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

$$9 \quad D = \frac{1}{\sum \left(\frac{n_i}{N}\right)^2}$$

10 D = dominance index

11 n_i = importance value for each species

12 N = total of importance value

13 Water Analysis

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

16 Light Intensity

17

18 **Substrat Analysis**

19 The determination of texture of mangrove substrate was done ex situ in the laboratory.
20 Soils in all plots were collected using a stainless steel corer (7 cm inside diameter) to a depth of
21 20 cm. Soils samples each plot were taken twice. The steps in substrate texture analysis are based
22 on the USDA triangle.

23

24 **RESULTS AND DISCUSSION**

25 **Overview of the Research Site**

26 The research site was located at Bama Resort which include in Baluran National Park area
27 with 6.126 ha [05]. 6 species mangroves from 2 families were recorded in this research, that is family
28 Rhizophoraceae (*R. stylosa*, *R. mucronata*, *R. apiculata*, *B. gymnorrhiza*, and *C. tagal*) and family
29 Araceae (*N. fruticans*) (Table 1) and (Figure 4).

30

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

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

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

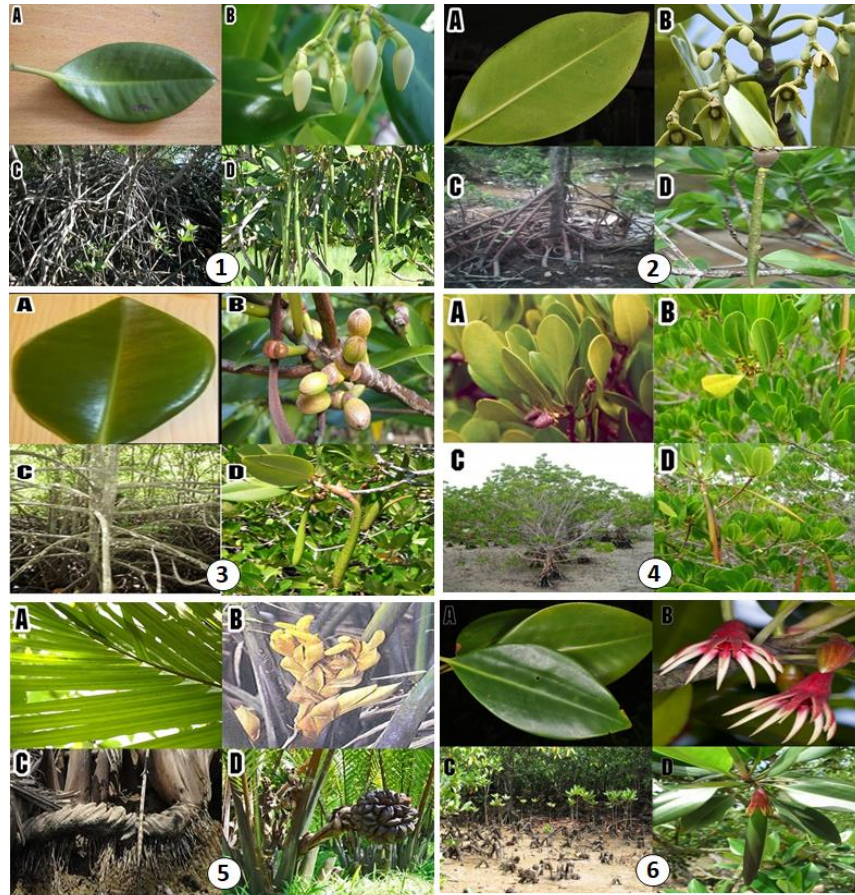


Figure 3. Mangrove species recorded in Bama Resort: 1. *R. stylosa*. 2. *R. mucronata*. 3. *R. apiculata*. 4. *C. tagal*. 5. *N. fruticans*. 6. *B. gymnorhiza*. A. leaf. B. flower arrangement. C. rooting system. D. propagul.

From this data, total number of seedling all plots showed a pure regeneration potential, only *R. apiculata* and *B. gymnorhiza*. 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°C -29°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,

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

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

12

13 **Table 2.** Analysis of mangroves trees

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

14

15 Diversity is the total range of plant species in an area Diversity index or Shannon diversity
 16 index is used to determine the species diversity in a community. Species evenness is a measure of
 17 biodiversity which quantifies how equal the populations are numerically (Legendre & Legendre,
 18 2012). Evenness index (J) which is the relative abundance with each mangrove species is
 19 represented in an area. In this research, the value of diversity index is 0.39 for seedling, which is
 20 low as shown in Table 3. Although the diversity index is relatively low, there were 6 species
 21 mangroves belonging to mayor mangrove or true mangrove, so it is important to maintain the
 22 mangroves. Bama Resort area has a low diversity because there was *R. apiculata* which has the
 23 sub-dominant or dominant but not a whole characteristic. This occurs because the ecosystem
 24 conditions that strongly support the growth of *R. apiculata* which is the type of substrate (mud).

25

1 **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

2

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

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

10

11 **Table 4.** Dominancy index of mangrove vegetations

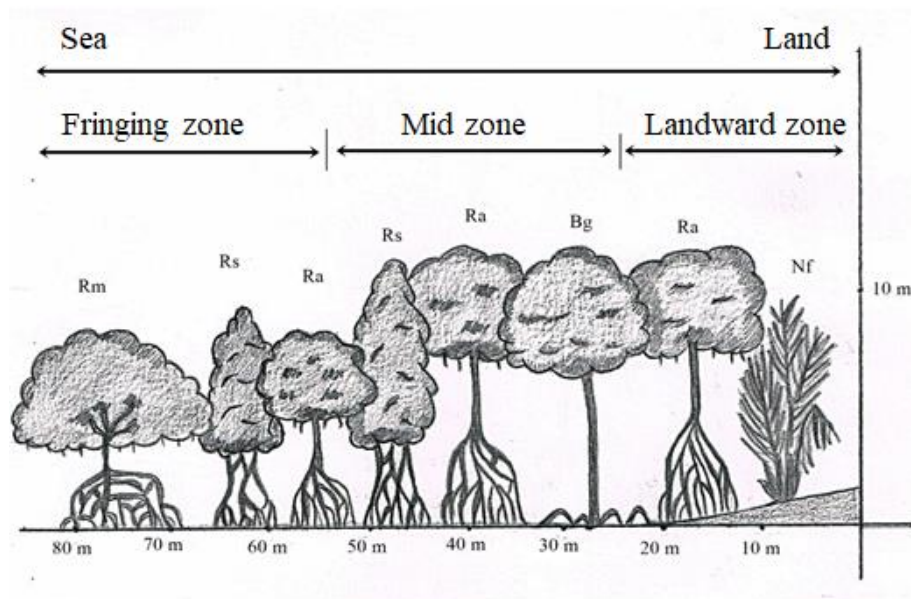
No	Species	Dominance Index
1	<i>R. stylosa</i>	0.029
2	<i>R. mucronata</i>	0.000
3	<i>R. apiculata</i>	0.487
4	<i>B. gymnorhiza</i>	0.004
5	<i>C. tagal</i>	0.000
6	<i>N. fruticans</i>	0.001
Total		0.521

12

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

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

1 that adjacent to the mainland or landward zone (Figure 4). The three zones of mangroves in Bama
 2 resort are not similar to those found throughout the Sironde and Batu Sampang Baluran National
 3 Park (Sudarmadji, 2003), the Cimanuk Delta (Sukardjo et al., 2014). The principal drivers of
 4 zonation are complex (Alongi, 2002), dependent on the interrelationships between and among
 5 factors, including soil nutrients, frequency of tidal inundation or different positions along some
 6 physical gradient, ecological interactions between species in the community (Hogarth, 2015). The
 7 percentage of the most dominant substrate fraction is mud with total percentage of 10 transects at
 8 48.76%. This result indicated that the type of the research site was coastal akressif.
 9



10

11

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

12

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

13

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

14

Nf : *N. fruticans*



1
2 **Figure 5.** The rooting appearance of *R.apiculata* located in the middle zone
3

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

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

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

22 The present study will aid in the conduct and preservation planning of mangrove forest
23 especially at Bama coast and generally in the coastal areas of Indonesia.
24

1 **CONCLUSIONS**^[u8]

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

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BIOSAINTEFIKA

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)	✓
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6	Key words	• Implication/Benefit for science development/society	✓
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		Methods Include:	
		• Explanation of how / step of research in a systematic way and detailed step by step written in the section.	
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		• Figure and table should be clear and the description must be concise and clear	✓
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		<ul style="list-style-type: none"> • The benefits and contribution of research for the science/ society 	✓
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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	✓
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