

KORESPONDENSI PAPER

Judul : Mangrove Species and Their Conservation Status In Mantehage Island, Bunaken National Park, North Sulawesi, Indonesia

Jurnal : Biodiversitas

No.	Aktivitas/Status	Tanggal	Keterangan
1.	Submission	25 April 2022	Covering Letter of Submission
2.	First Decision	26 April 2023	Decision on manuscript and Reviewer 1's Comments
3.	Revision 1	30 April 2023	Authors' Comments/Revision 1
4.	Second Decision	11 Mei 2023	Decision on manuscript and Reviewer 2's Comments
5.	Revision 2	20 Mei 2023	Authors' Comments (Revision 2), Revised Version of the manuscript
6.	Uncorrected Proof	23 Mei 2023	Copyedited File (Uncorrected Proof)
7.	Final Corrections	30 Mei 2023	Corrections
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Covering Letter of Submission

Comments for the Editor



Participants [Edit](#)

Smujo Editors (editors)

Rignolda Djamaluddin (rignolda_djamaluddin)

Messages

Note

From

Dear, Editor

rignolda_djamaluddin
2022-04-25 03:09 PM

I am happy to finalise the manuscript titled "the mangrove flora and their conservation status in Mantehage Island, Bunaken National Park, North Sulawesi, Indonesia. This manuscript is of importance as this provides new information regarding to mangrove flora in the island system of the northern part of Sulawesi Island. I hope this manuscript will be considered to be published in the Biodiversitas Journal.

Best wishes,

Dr. Rignolda Djamaluddin

Decision on manuscript and Reviewer 1's Comments

Notifications

undefined

[biodiv] Editor Decision

2022-04-26 02:02 AM

Rignolda Djamaluddin, Brama Djabar:

We have reached a decision regarding your submission to Biodiversitas Journal of Biological Diversity, "Mangrove Species and Their Conservation Status In Mantehage Island, Bunaken National Park, North Sulawesi, Indonesia".

Our decision is: Revisions Required

Reviewer 1:

Dear author,

The paper entitled 'Mangrove species and their conservation status in Mantehage Island, Bunaken National Park, North Sulawesi, Indonesia' has outdated references to be published in Biodiversitas Journal. References list should consist of at least 20 citations which 80% of international scientific journals published in the last 10 years (2012-2022), and a maximum of 10% references from national publication.

Best regards

Recommendation: Revisions Required

[Biodiversitas Journal of Biological Diversity](#)

Authors' Comments/Revision 1

Revised version of the manuscript

[Close Panel](#)

Participants [Edit](#)

- Rignolda Djamaluddin (rignolda_djamaluddin)
- Nor Liza (nliza)

Messages

Note

From

Dear, Nor Liza

Revisions have been made to meet 80% the latest references (2012-2022).

Old citations that are still relevant and irreplaceable are maintained considering that the taxonomy aspect of this manuscript is very important.

Best wishes,

Rignolda Djamaluddin [rignolda_djamaluddin](#), Mantehage Mangrove

[Paper.docx](#)

rignolda_djamaluddin

2022-04-30 01:44 PM

Decision on manuscript and Reviewer 2's Comments

Notifications

undefined

[biodiv] Editor Decision

2022-05-11 02:38 AM

Rignolda Djamaluddin, Brama Djabar:

We have reached a decision regarding your submission to Biodiversitas Journal of Biological Diversity, "Mangrove Species and Their Conservation Status In Mantehage Island, Bunaken National Park, North Sulawesi, Indonesia".

Our decision is: Revisions Required

Reviewer 2:

Dear Editor and Author,

Please find attached is the reviews and suggested edits for the manuscript entitled "Mangrove Species and Their Conservation Status In Mantehage Island, Bunaken National Park, North Sulawesi, Indonesia".

Despite the simple methodology, this paper presents a complete data regarding mangrove species in Mantehage Island which might serve as basic information of biological diversity of Bunaken National Park. In particular, I am impressed with the total number of locations surveyed which deemed adequate to claim that all areas of the island are covered. The manuscript is also considerably well-written with proper English. Several suggestions to improve the paper as follow:

1. Title, In this paper, I did not see deep elaboration regarding conservation concern of the mangrove species. Thus, I would suggest to remove words concerning conservation status from the Title to avoid overclaiming.
2. Introduction, I would suggest to merge paragraph 2 with the previous one since it has similar idea (i.e. the general definition of mangrove).

3. Introduction, Please check again regarding the total extent of mangrove in Indonesia. To my knowledge, it is around 3.3 million hectares.

4. Method, What is the extent of Mantehage Island?

5. Method, It is not clear from here whether you collect primary (new) data for this paper or you collate secondary data from previous surveys. Please make it explicit.

6. Results, Figure 2, I note there is no *C. philippinense* in Figure 1. Is there any photo of the species to put here?

7. Results, Please be consistent when presenting decimals vs thousands either using dot point or comma. I would suggest to use dot point when expressing decimals to follow common standard in international journal.

8. Results, For the rest of text explaining the description of species, please separate each part by (;) so that readers can note, for example, which description refers to leaf, and which one to fruit. An example on how to edit is provided in the attached file.

9. Please be clear and consistent when you put abbreviation, in some cases you said BNP but in other cases you mentioned TNB.

More detailed comments are in the attached file.

Best regards,

Reviewer

Recommendation: Revisions Required

[Biodiversitas Journal of Biological Diversity](#)

Authors' Comments/Revision 2

Second revised version of the manuscript

[Close Panel](#)

Participants [Edit](#)

- Smujo Editors (editors)
- Rignolda Djamaluddin (rignolda_djamaluddin)
- Nor Liza (nliza)

Messages

Note	From
<p>Dear, Editor</p> <p>We have revised the manuscript (attached file) based on reviewer's notes. There is still one note about photo of <i>C. philippinense</i> that is missing from figure 2, and regarding it, we are currently trying to recollect better photos of the species to be included in figure 2. We thank very much to the reviewer for any helpful comments.</p> <p>Best wishes</p>	<p>rignolda_djamaluddin 2022-05-20 01:00 AM</p>

Revised Version of The Manuscript

Mangrove species of Mantehage Island, Bunaken National Park, North Sulawesi, Indonesia

Abstract. Study on mangrove species in Mantehage Island, Bunaken National Park, North Sulawesi, Indonesia is important due to the extension of mangrove forest, geographical position and geomorphological characteristics of the island. Many mangrove species are expected to occur on this island. This study was conducted to explore biological diversity of mangrove species and to evaluate biogeography and conservation status of certain species occurring in this island. Extensive surveys had been conducted throughout the island on the areas covered with mangroves with a total of 58 locations surveyed using spot check and quadrat-transect methods, and species identification was based on morphological characteristics. Results showed that in Mantehage Island there were 20 species of true mangrove belonging to 13 genera and 11 families including *Acanthus ilicifolius* L., *Acrostichum spesiosum* Willd., *Aegiceras corniculatum* (L.) Blanco, *Avicennia marina* (Forsk.) Vierh., *Bruguiera gymnorrhiza* (L.) Lamk., *Bruguiera parvilora* Weight & Arnold ex Griffith, *Ceriops tagal* (Perr.) C.B. Rob, *Excoecaria agallocha* L., *Heritiera littoralis* Dryand, *Nypa fruticans* (Thunb.) Wurm., *Rhizophora apiculata* Bl., *Rhizophora mucronata* Lamk., *Rhizophora stylosa* Griff., *Scyphiphora hydrophyllacea* Gaertn., *Sonneratia alba* J. Smith, *Sonneratia ovata* Blake., *Xylocarpus granatum* Koenig. Three rare species in the mangrove of Bunaken National Park, *Camptostemon philippinense* (Vidal) Becc., *Bruguiera cylindrica* (L.) Bl. and *Lumnitzera racemosa* Willd. were also recorded. The presence of *C. philippinense* could explain its distribution limit in the northern coast of North Sulawesi. Indication of putative hybrids in the genera of *Rhizophora* was found, but these need further investigation. Two species of conservation concern, *C. philippinense* and *S. ovata*, are categorised as endangered and near-threatened species, respectively.

Keywords: Bunaken, *Camptostemon philippinense*, mangrove, Mantehage Island

Running title: mangrove species in Mantehage Island

INTRODUCTION

The terminology of 'mangrove' from West Africa, Senegal, Gambia, and Guinea is believed to be the origin of the word mangrove (Vannuci 1998). Previously, the word 'mangrove' was used to describe the plant forming a dense forest community in tropical intertidal waters (Tomlinson, 1986). Recently, mangrove refers to a small group of plants or the entire communities of plants exclusively occurring on intertidal habitats (Djamaluddin 2018b; Duke 1992; Maxwell 2015). According to Krauss and Ball (2013) mangrove species are facultative halophyte, meaning that they have the ability to survive in a salty environment (Kodikara et al. 2018; Noor et al. 2015; Reef and Lovelock, 2015) because of its morphological, anatomical, physiological, and molecular adaptations (Srikanth et al. 2016). Naturally, mangrove plant can be in the form of tree, shrub, palm, and fern (Duke and Schmitt 2015).

An approximately 33.8% of the world mangrove occurs in Southeast Asia (Thomas et al. 2017) with Indonesia alone has 60% of the total mangrove extent in this region (Giesen et al. 2006). The latest data on Indonesia's mangrove area is 3,364,076 ha (Ministry of Environment and Forestry 2022). Most of Indonesia's mangroves are found in Papua (56%), Sumatra (19%), Kalimantan (16%) with the rest in Sulawesi, Maluku, and Java (Hanum et al. 2014). Factors that support the occurrences of the large extent of mangroves in Indonesia include the ideal

Commented [AR1]: I would suggest to merge this paragraph with the previous one since it has similar idea (i.e. the general definition of mangrove).

Commented [RD2R1]: I agree

Commented [AR3]: Please check again regarding the total extent of mangrove in Indonesia. To my knowledge, it is around 3.3 million hectares.

Commented [RD4R3]: It was checked and revised as in the text

position of the country in equatorial line which receives high rainfall and sun exposure, geological history and oceanography (Djamaluddin 2018a).

Through the study of biogeography, the present and past distribution patterns of biodiversity and the environment underlying their presence and historical causes can be explained (Saenger et al. 2019; Sanmartín 2012). In general, Indonesian mangroves can be divided into two major biogeographic regions: the Indo-Malesia region (including Sumatra, Java, Kalimantan, Nusa Tenggara), and the Australasia region (including Papua) (Duke 1992). Duke et al. (1998) recorded a total of 57 species of mangroves in Indonesia, where 37 species occurred in both regions, meanwhile several of them occurred only in one region, either Indo-Malesia or Australasia. Tomlinson (1986) suggested the possible presence of 32 true mangrove species in biogeographical region between longitude 120° E and 135° E, including Bunaken National Park in North Sulawesi, in which 27 species were confirmed (Djamaluddin 2018b).

Mantehage Island represents an interesting mangrove site to investigate due to its extension (1,383.21 ha). Its geographical position results in a complex series of factors shaping their distribution and diversity, such as under the influence of different seawater masses and its geomorphological characteristics. The marine environment of Mantehage Island includes the Sulawesi Sea that connects to Makasar Strait in the southwest, to the Pacific Ocean in the east and the South China Sea in the north. Geomorphologically, there are three distinct mangrove ecosystems: mangrove habitat formed by wind and wave and physically stable, habitat with diminished tidal inundation, and habitat with fine and poorly drained sediments and has been considerably changed as the mangrove developed (Djamaluddin et al. 2004).

The combination of geographic position and geomorphological characteristics of Mantehage Island provides a unique opportunity to study mangrove species on the island. Several previous studies have indicated this (Djamaluddin 2018b; Djamaluddin et al. 2004). However, no study has been specifically carried out to fully reveal the biological diversity of mangroves on the island, along with the morphological characteristics of each species, stand structure, and local distribution of the species. The analysis of the possible presence of several species that have never been reported and important in terms of biogeographic distribution and biological conservation has also not been reported in detail. Therefore, this study is important to complete the various information that has been mentioned.

This study reports in full the biological diversity of true mangroves on Mantehage Island, biogeographic analysis of several important species and the conservation value of certain species. The results of this study are useful for completing information about the biogeography of true mangrove species, biological diversity of true mangrove species and the development of strategies for conservation and management of mangroves in Bunaken National Park (BNP).

MATERIALS AND METHOD

Study area

Mantehage Island is part of the northern section of Bunaken National Park, which is located on the north coast of North Sulawesi. Geographically, it is located between 1°45'13" and 1°41'32" N; 124°43'51" and 124°46'50" E. The total extent of mangrove on this island was 1383.21 ha (Sapsuha et al. 2018), compared to 700 ha of land area (Medea et al 2015).

Geomorphologically, the two elements of Mantehage Island are elevated ancient limestone reefs. Its current elevation of about 15 m is believed to result from quarternary volcanic uplift.

Commented [AR5]: Where is it? Information regarding the geographical context will provide introductory perspective for readers where it is about.

Commented [RD6R5]: The information is included in the method section of study area

Commented [AR7]: What is the extent of Mantehage Island?

Commented [RD8R7]: 700 ha & already included in the text

On this island mangroves grow on coralline sands and low intertidal habitat dominated by clay sediment from adjacent terrigenous islets (Djamaluddin et al. 2004).

Data collection procedure

The first mangrove survey was started in late 1995, followed by several surveys in 1998, 2000, 2002, and several others during 2012 – 2018. A representative forest area had been observed, and 58 locations were investigated in detail (Figure 1) using spot check and quadrat-transect methods (Djamaluddin 2018a). True mangrove species were easily identified using morphological characteristics directly in the field. At the same time, where it was not possible to conduct the precise identification, the specimens were collected for further morphological identification process in the lab. Systematic references used for species determination included: Mabberley et al. (1995), Ragavan et al. 2014; Tomlinson (1986). To confirm the specimen of *Camptostemon philippinense*, the specimen of similar species stored in Herbarium Bogoriensis was investigated in 2001. Additionally, during surveys, local villagers were interviewed to reveal local knowledge about the local naming system, habitats or specific locations where a specific mangrove species grew and mangrove uses.

Commented [AR9]: It is not clear from here whether you collect primary (new) data for this paper or you collate secondary data from previous surveys. Please make it explicit.

Commented [RD10R9]: All mangrove flora specimens are primary data collected from different dates of survey during 1995 to 2018, corrections were made if necessary based on herbariums of collected mangrove specimens

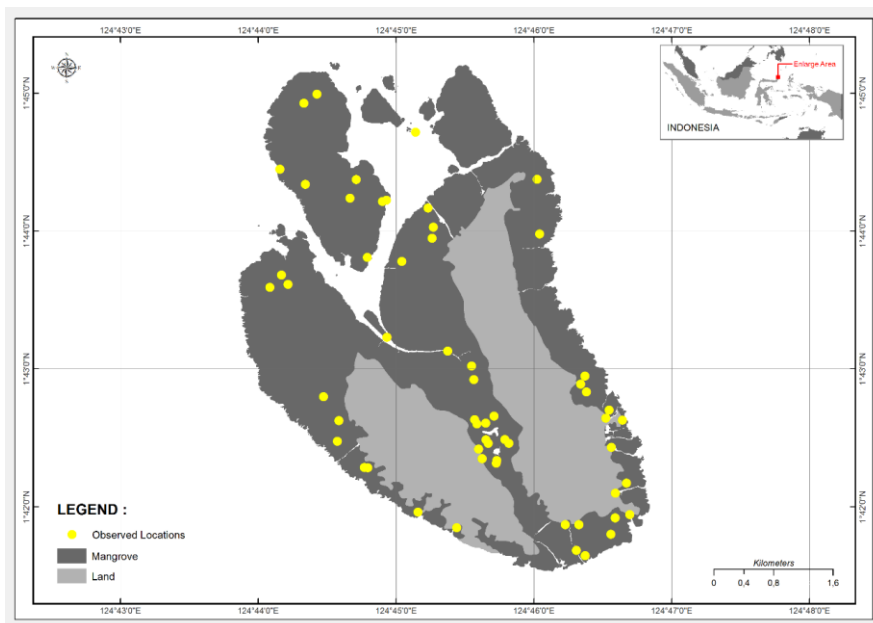


Figure 1. Map of Mantehage Island and observed locations using spot check and quadrat-transect methods.

RESULT AND DISCUSSION

Species diversity

In total, 20 species belonging to 13 genera and 11 families were found in Mantehage Island (Figure 2). Three uncommon species (i.e. *Camptostemon philippinense*, *Bruguiera cylindrica*, and *Lumnitzera racemosa*) occurred on this Island. With specific concern to *C. philippinense*,

its occurrence in this island could be a new record because it had never been reported to occur on the northern coast of North Sulawesi. Compared to the total 27 species in BNP (Djamaluddin 2018b), there were only seven species absent in Mantehage Island.

Commented [AR11]: What is BNP?

Commented [RD12R11]: BNP stands for Bunaken National Park, and I have added this abbreviation at the end sentence of the last paragraph in introduction section

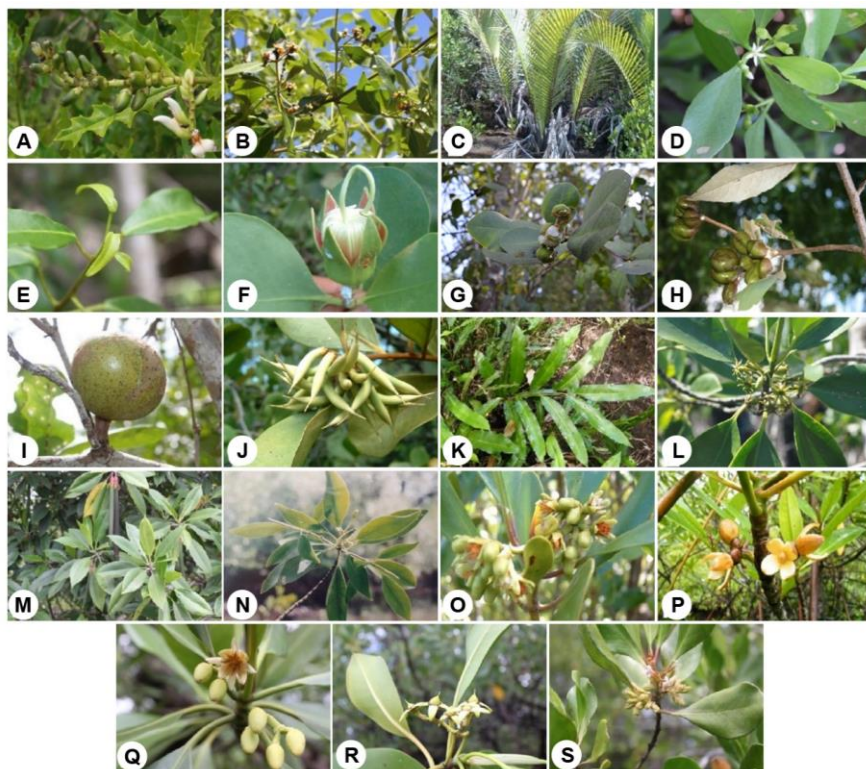


Figure 2. Mangrove species in Mantehage Island: (A) *Acanthus ilicifolius* L., (B) *Avicennia marina* (Forsk.) Vierh., (C) *Nypa fruticans* (Thunb.) Wurm., (D) *Lumnitzera racemosa* Willd., (E) *Excoecaria agallocha* L., (F) *Sonneratia alba* J.E. Smith, (G) *Sonneratia ovata* Back., (H) *Heritiera littoralis* Dryand, (I) *Xylocarpus granatum* Koenig., (J) *Aegiceras corniculatum* L. Blanco, (K) *Acrostichum spesiosum* Willd., (L) *Bruguiera cylindrica* (L.) Bl., (M) *Bruguiera gymnorhiza* (L.) Lamk., (N) *Bruguiera parviflora* Weight & Arnold ex Griffith, (O) *Ceriops tagal* (Perr.) C.B. Rob, (P) *Rhizophora apiculata* Bl., (Q) *Rhizophora mucronata* Lamk., (R) *Rhizophora stylosa* Griff., (S) *Scyphiphora hydrophyllacea* Gaertn.

Commented [AR13]: I note there is no *C. philippinense* in Figure 1. Is there any photo of the species to put here?

Commented [RD14R13]: The available photo of the species is in low quality, so it was not included in the figure 2. We are currently trying to recollect better quality of the specimen to include in the figure.

It is important to note that the estuary habitat located between two islets in Mantehage Island had high diversity. Only three species (*R. mucronata*, *R. stylosa*, dan *S. alba*) were not found in this habitat. This fact might relate to variability in environmental gradients, and mangrove species have different responses to these conditions (Cisneros-de la Cruz et al. 2022). Djamaluddin (2018b) described that this habitat had relatively high surface soil pore water salinity (21.7 ± 7.4 ppt), poor drainage soil with sediments dominated by clay and silt,

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Commented [RD16R15]: Corrected

inundated by freshwater during the rainy season and dry during the dry season, and only reached by tidal water at high tide.

Several species reported to occur in BNP but absent in Mantehage Island included *Acrosticum aureum* L., *Avicennia alba* Blume, *Bruguiera sexangula* (Lour.) Poir., *Lumnitzera littorea* (Jack) Voigt., *Sonneratia caseolaris* (L.) Engler, *Xylocarpus molucensis* Pierre. One species *Ceriops decandra* (Griff.) Ding Hou that was revised to be *Ceriops zippeliana* Blume (Sheue et al. 2009; Duke et al. 2010) was not found on this Island. Two species expected to occur in this biogeographical region, i.e. *Aegiceras floridum* Roemer & Schultes and *Osbornia octodonta* F. Muell. (Tomlinson 1986), were not found on this Island. These two species were reported to occur in the south coast of North Sulawesi, bordering directly to the Maluku Sea (Damanik and Djamaluddin 2012; Djamaluddin 2015; Djamaluddin et al. 2019).

In addition, there were several specimens to indicate differences in morphological characteristics comparing to three common species of *Rhizophora*. These specimens were possibly putative hybrid species. According to Setyawan et al. (2014), there are two putative hybrid species in the Indo-Malayan region, namely *Rhizophora x lamarckii* (*R. apiculata* and *R. stylosa*) and *Rhizophora x annamalayana* (*R. apiculata* and *R. mucronata*). The occurrence of two sterile natural hybrids in *Rhizophora* has been discussed in various reports (Ng et al. 2020; Ng et al. 2013; Ng and Szmids 2014; Ragavan et al. 2015).

Acanthaceae

Acanthus ilicifolius L. (Figure 2A) was a common species found in the estuary habitat between two islets in Mantehage Island, especially in locations influenced by freshwater. It is locally known as *gahana* or *kamunte*, probably because of thorns similar to those in an orange tree. Species height is generally less than 2 m. Morphological characteristics of this species include: branch is generally upright, not much and appearing from an older section; stilt root arises from the lower surface of the horizontal stem; leaf is light to dark green, broadly serrated, narrowly pointed with or without spiny edge, simple, opposite; flower is light blue to purple and sometimes white, located at the end with a grain formation; fruit is bright green, like *melinjo - Gnetum gnemon*. This species is widely distributed throughout Southeast Asia (Giesen et al. 2006) and is also found in Solomon Islands (Duke et al. 2012), Africa, and the western Pacific (Tomlinson 1986).

Avicennia marina (Forsk.) Vierh. (Figure 2B) was found in the estuary habitat in less than 10 m in height. It is locally known as *api-api*. Morphological characteristics of this species include root spreads horizontally, pencil-shaped, upright pneumatophore with lenticels; bark is green to grey, finely peeling off; leaf is covered with glandular spots, greyish-white at the bottom, elliptic, simple, opposite; flower often appears in clusters at the end of the branch, strong scent, a lot of nectars, 2 to 12 grains each bunch, four pale yellow to dark orange petals, five sepals, four filaments; fruit is slightly rounded with a beak sharpened tip, green slightly grey with a fine hairy surface. This species is widely distributed from East Africa and the Red Sea to tropical coasts of the Indian Ocean and the South China Sea and Fiji, Australia, and New Zealand (Tomlinson 1986).

Areceaceae

Nypa fruticans (Thunb.) Wurmb. (Figure 2C) was rare in Mantehage Island, probably due to limitation in freshwater supply. One location where stands of this species were found was in estuary habitat. This species is locally known as *bobo*. The life form of this species is the palm, without stems and clumps. Morphological characteristics of this species include: trunk is

Commented [AR17]: What is this? What differs with BNP?

Commented [RD18R17]: corrected

Commented [AR19]: For the rest of text explaining the description of species, please separate each part by (;) so that readers can note, for example, which description refers to leaf, and which one to fruit. An example on how to edit is provided here.

Commented [RD20R19]: Have checked and followed the suggestion

underground with fine roots; flower is bisexual and appears near the top of the trunk (female flower with circular head, bright yellow male flower); fruit is wavy round, bright brown, hard with an egg-shaped seed inside. This species is widely distributed in Southeast Asia (Giesen et al. 2006). In the Pacific Ocean, this species was found occurring in Solomon Islands (Duke et al. 2012). According to (Tomlinson 1986), this species is widely distributed up to the north to Ryuku Island in Japan and to the south to the northern Queensland in Australia. It was also found in the Bengal Delta in Bangladesh and West Indian Bengal.

Bombacaceae

Camptostemon philippinense (Vidal) Becc. was found only in Mantehage specific location around 1°42'59.4" N; 124°45'31.2" E. It is locally known as *kayu polompong* (buoy wood), probably because wood pieces of this species are used for a buoy in the fishnet. The stands of this species have less than 7 m in height. Morphological characteristics of this species include: root is elongated on the ground with prominent aerial roots; bark is grey with longitudinal cracks; leaf has a scaly surface, simple, opposite, obovate, obtuse; flower has white petals covered with short hairs, located at axillary, grain formation, five filaments; fruit is round like capsule with sepals.

Reports on the geographical distribution of *C. philippinense* are very limited (Tomlinson, 1986). Its presence in Mantehage Island could represent the distribution limit of this species in Sulawesi and its biogeographical in the western Pacific. Several records on its distribution included: in the Philippine (Dangan-Galon et al. 2016; Mangaoang and Flores 2019; Patidol and Casas Jr 2019), in Berau East Kalimantan (Mukhlisi and Sidiyasa 2014), and in Donggala of Central Sulawesi (Wahyuningsih and Suleman 2012). In contrast, this species was absent in the southern coast of North Sulawesi, bordering directly to Maluku Sea (Damanik and Djamaluddin 2012; Djamaluddin 2015; Djamaluddin et al. 2019). It was also absent in Western Papua (Prawiroatmodjo and Kartawinata 2014). Since 2014 this species was categorised as endangered by IUCN (*The International Union for Conservation of Nature and Resources*) because of its decreased population.

Combretaceae

Lumnitzera racemosa Willd. (Figure 2D) was found in the estuary habitat. This species is locally known as *lolang* (wooden boat peg), probably because the wood of this species is usually used as pegs in traditional boat making. In general, the stands of this species were still young, with a height of less than 5 m. Morphological characteristics of this species include: root is without pneumatophore; bark is reddish-brown with longitudinal cracks in old stems; leaf is dark green, clustered at the end of the branch, narrowed obovate, simple, cross over; flower is bisexual, without pedicel, filled by nectars, located at the end of the base, grain, five white petals, five green sepals, less than ten filaments; fruit has an ellipse shape, yellowish-green, fibrous and dense. This species is widely distributed in Southeast Asia (Giesen et al. 2006) and found in east Africa, west Pacific, and tropical Australia (Tomlinson 1986).

Euphorbiaceae

Excoecaria agallocha L. (Figure 2E) grew individually near land at a height of up to 10 m. It was locally known as *buta-but*a (blindness), probably because its sap can cause blindness if exposed to the eye. Morphological characteristics of this species include root is creeping on the ground; bark is grey, smooth with freckles; leaf is dark green, fine jagged at the edges, two glands at the base, elliptic, acute, simple, cross over; flower is located at axillary, spread along

the bunch, male or female-only (male flowers without peduncles and smaller than female), fragrant male flowers, located at axillary, grain formation, green and white petals, yellowish-green sepal, yellow filament. This species is widely distributed in Southeast Asia (Giesen et al. 2006). In the Pacific, it is found in Solomon Islands, Vanuatu, Fiji, and Tonga (Duke et al. 2012), eastern Africa, Sri Lanka, Hainan, Ryuku Island, and tropical Australia (Tomlinson 1986).

Lythraceae

Sonneratia alba J.E. Smith (Figure 2F) were commonly distributed along seaward edges or dead coral reefs with a height of up to 20. It was locally known as *posi-posi*. Before Mantehage Island was included in the Bunaken National Park in 1991, big trees of this species were cut by local villagers for boat material and pillars for the Bajo community house on Nain Island, which is located near Mantehage Island. Morphological characteristics of this species include: root is vertical conical pneumatophore; bark is grey to light brown, roughly cracked and peeled off, a leaf that is green, obovate, obtuse, simple, opposite, the flower being bisexual, solitary in 1 to 3 per group, white petals, 6 to 8 sepals, many yellow-stemmed stamens and white tips); fruit is round slightly flattened, steamed at the end, wrapped by sepals at the base. This species is widely distributed in Southeast Asia (Giesen et al., 2006), and is also found in the Solomon Islands and Vanuatu (Duke et al. 2012), and East Africa and tropical Australia (Tomlinson 1986).

Sonneratia ovata Back. (Figure 2G) were found in October 2018 at one location in an estuary habitat in the form of a mature tree and some saplings and young trees. Morphological characteristics of this species include root is conical vertical pneumatophore; bark is grey to light brown, coarsely cracked and peeled off, the leaf that is green, ovate, obtuse, simple, opposite, generally smaller than *S. alba*; flower is bisexual, solitary in groups of 1 to 3 per group, without petal, a lot of filaments and easily fall off; fruit is round slightly flattened, the base covered by calyx, generally smaller than *S. alba*. This species is found in China, Malaysia, Thailand, Vietnam, New Guinea, and Indonesia (Haining et al. 2007). In Indonesia, it is found in Riau Kepulauan, Jawa, Kalimantan, Sulawesi, Maluku, and Papua (Giesen et al. 2006). In BNP, it is found only in several locations near the land under the influence of freshwater (Djamaluddin 2018b). IUCN categorised this species into near threatened species (Polidoro et al. 2010).

Malvaceae

Heritiera littoralis Dryand (Figure 2H) grew individually in a location near land that was rarely inundated by tidal water. Trees of this species were growing with more than one branches and a height of up to 12 m. It is locally known as *kolot kambing* (goat's ball), probably because it's fruit like goat's ball. Morphological characteristics of this species include: bark is grey, light brown to dark brown, cracked; leaf is pale green on top, greyish white on low part, simple unit and cross, broadly acuminate, cluster at the end; flower is located at the end or armpit, male or female only, more male flowers but smaller than female, hairy bunches, clustered freely, purple and brown petal, 4 to 5 like bowl redness and hairy petals; fruit is green to bright brown, one seed. This species is widely distributed in Southeast Asia (Giesen et al. 2006). In the Pacific, it is found in Solomon Islands (Duke et al. 2012), from east Africa to Madagascar and to the north to Hong Kong, and to the south to north, south, east and west Australia (Tomlinson 1986).

Meliaceae

Xylocarpus granatum Koenig. (Figure 2I) was found not common in locations near land that was rarely inundated by tidal water. It is locally known *kira-kira* which means not easy. This term may come from the traditional game of coastal communities in which they compete to reassemble a fruit from separated seeds. The stands were less than 10 m in height. Morphological characteristics of this species include: root is like a plank extending sideways near the base in an old individual but often absent in young; bark is light brown, thin and peeled off; leaf is rather thick, green, obovate, obtuse; flower arises from the base of the axillary, male and female or female only, randomly clustered with 8 to 20 flower per group, 4 greenish-white petals, 4 light yellow sepals, creamy white filaments and coalesce in the tube; fruit is like a cannon ball, skinned, brownish-green, 6 – 16 woody tetrahedral seeds. This species is widely distributed in Southeast Asia (Giesen et al. 2006), found in Solomon Islands, Vanuatu, Fiji, Tonga, and Samoa (Duke et al. 2012), and East Africa (Tomlinson 1986).

Myrcinaceae

Aegiceras corniculatum (L.) Blanco (Figure 2J) was found in locations near land with a hard substrate. It is a shrub species, growing alone or in a group with less than 3 m in height. It is locally known as *rica-rica* or *anting-anting*, probably because of its fruit is alike chilli or half-round earing. Morphological characteristics of this species include: roots creep on the ground; bark is grey to brown, cracked, with several lenticels, the leaf that is dark green, bright, salt gland on the surface and on the leaf stalks, obovate to elliptic, simple, opposite, obtuse; flower has many flowers in one bunch hanging like lanterns, umbrella formation, five hairy white petals, white to green sepals; fruit is green to red, bent like a crescent, one seed. This species is widely distributed in Southeast Asia (Giesen et al. 2006). It is found in Solomon Islands (Duke et al. 2012), India, Sri Lanka, south China, and tropical Australia (Tomlinson 1986).

Pteridaceae

Acrostichum spesiosum Willd. (Figure 2K) was found in an estuary habitat that was reached by tidal water in high tide. It is a fern species with a height of up to 1 m. Morphological characteristics of this species include: leaf is brownish-green, rush coloured at the end, smaller and narrower tip on the sterile leaf, covered uniformly with large sporangia, fertile leaf covered with sporangia and dark brown underside, large tetrahedral spore. Distribution of this species is restricted to the Indo-West Pacific region (Kimura et al. 2017).

Rhizophoraceae

Bruguiera cylindrica (L.) Bl. (Figure 2L) was commonly found in estuary habitat. Big stands of this species were dying-back, and young stands with less than 7 m in height remained healthy in certain locations. It is locally known as *ting Putih* (white *Ceriops*) to differentiate it from *Ceriops tagal*. Trees of this species used to be cut for firewood and sold to the Manado Market. Morphological characteristics of this species include: root with knee root and plank root widening to the side; bark is grey with small lenticel, leaf with a bright green top surface and slightly yellowish green bottom, simple, opposite, elliptic, broadly acute; flower appears in a cluster at the end of the bunch, usually with white hair at the outer side, at the end or armpit of the stalk, petals – white and brown when aged, eight yellowish-green sepals; fruit with cylindrical hypocotyl, green near the base and purplish-green at the end, attached to the calyx. This species is widely distributed in Southeast Asia (Giesen et al. 2006), is also found in Solomon Islands (Duke et al. 2012) and North Queensland (Tomlinson 1986).

Bruguiera gymnorhiza (L.) Lamk. (Figure 2M) was commonly found in the middle area of a mangrove belt together with species of *Rhizophora apiculata*. It is locally known *makurung*. Trees of this species used to be cut for wood material in house construction. Morphological characteristics of this species include: root with knee root widening to the side; bark is grey to dark grey with lenticel; leaf is bright to dark green, elliptic to the elliptic lancet, simple, opposite, broadly acute; flower is hanging, attached to axillary, solitary, 10 to 14 petals - white and brown when aged, 10 – 14 sepals – pink to red; fruit is in spiral circle, transverse circle, straight blunt hypocotyl - green to purplish. This species is widely distributed in Southeast Asia (Giesen et al. 2006), is found in Solomon Islands, Vanuatu, Fiji, Tonga, and Samoa (Duke et al. 2012), and globally found in east Africa, including Madagascar, Sri Lanka, and spreading up to the north to Ryukyu Islands, to the south to tropical Australia (Tomlinson 1986).

Bruguiera parviflora Weight & Arnold ex Griffith (Figure 2N) was found only in estuary habitat with a height of less than 7 m. Morphological characteristics of this species include: bark is grey to dark brown with small knee root; leaf is slightly yellowish-green, simple, opposite, elliptic with a taper tip; flower is in a cluster at the end of the bunch, located in the axillary of the leaves, eight greenish white petals, hairy on edge, eight yellowish-green sepals; fruit is circular spiral, slightly curved and yellowish-green hypocotyl. This species is widely distributed in Southeast Asia (Giesen et al. 2006), is found in the Solomon Islands and Vanuatu (Duke et al. 2012), and tropical Australia (Tomlinson 1986).

Ceriops tagal (Perr.) C.B. Rob (Figure 2O) was commonly found in a location near land in the form of a shrub with less than 4 m in height. It is locally known as *ting* or *ting merah* (red *Ceriops*). Trees of this species used to be cut for household firewood or sold to the Manado market. It was believed that firewood of this species gave a specific taste to smoked fish. Morphological characteristics of this species include: roots are piled up at the base of the tree, a short taproot; bark is grey to dark with shallow crack; leaf is shiny green, obovate, simple, opposite, obtuse; flower is attached to the axillary or the tip of the branch, group in 5 to 10, 5 sepals - white and becoming brownish when old, stamen with longer filament and blunt anther; fruit is hypocotyl with freckles, smooth and darker brown when aged, yellow cotyledon neck when ripe. This species is widely distributed in Southeast Asia (Giesen et al. 2006), is found in the Solomon Islands and Vanuatu (Duke et al. 2012), and in east Africa to Madagascar, Micronesia to Hongkong, and Queensland (Tomlinson 1986).

Rhizophora apiculata Bl. (Figure 2P) was widely distributed from seaward edge to near land with a height of up to 15 m. It is locally known as *lolaro merah* to differentiate it from *R. mucronata* and *R. stylosa*. Trees of this species used to be cut for house construction material, house pole in the Bajo community, firewood, and stakes in the traditional fish trap (*sero*). Morphological characteristics of this species include: roots are tap and stilt roots; bark is grey to dark grey, rather clean and slippery than others *Rhizophora* species; leaf is green to dark green with speckles underside, narrowly acute, simple unit and opposite; flower is bisexual, yellowish flower head, attached to axillary, two flowers in the group, four yellowish petals without hair, four brownish sepals, 11 to 12 filaments without stem; fruit is like a pear, brown with one fertile seed, orange – green cylindrical hypocotyl with freckles, cotyledon neck – brownish-green when young and reddish when ripe. This species is widely distributed in Southeast Asia (Giesen et al. 2006), is found in the Solomon Islands and Vanuatu (Duke et al. 2012), and in Andaman Island, Queensland, southwest Pacific (New Caledonia), and Penelope Island in the Central Pacific (Tomlinson 1986).

Rhizophora mucronata Lamk. (Figure 2Q) was found only in seaward margins and along the tidal creek in the middle between two islets. The stands of this species reached a height of up to 15 m. It is locally known as *lolaro putih* to differentiate it from *R. apiculata*. Trees of this species used to be cut for the same purposes as trees of *R. apiculata*. Morphological characteristics of this species include: roots are tap and stilt roots; bark is dark to black with horizontal cracks; leaf is green with speckles underside, elliptic, simple, opposite; flower is bisexual, attached to the axillary, 4 to 8 flowers in the group, 4 to 8 white hairy petals, 4 -8 pale yellow sepals, eight filaments without stem; fruit is oval long to round egg, one seed, rough cylindrical hypocotyl with freckles. This species is widely distributed in Southeast Asia (Giesen et al. 2006), is found in Solomon Islands (Duke et al. 2012) and in east Africa, north Australia to Queensland (Tomlinson 1986).

Rhizophora stylosa Griff. (Figure 2R) was found in the same habitat as *R. mucronata*. Trees used to be cut for similar purposes as trees of the other two species of *Rhizophora*. The stands of this species reached a height of up to 15 m. Morphological characteristics of this species include: roots are tap and stilt roots; bark is grey to black with cracks; leaf is bright green with freckles underside, the elliptic, simple, opposite; flower is bisexual, attached to the axillary, 8 to 16 flowers in the group, white hairy petals, four yellowish sepals, eight filaments with one elongated stipe; fruit is like a pear, brown, one fertile seed, cylindrical hypocotyl, cotyledon neck – greenish-yellow when ripe. The distribution of this species in Southeast Asia was restricted to Malaysia, Indonesia, Philippines, Singapore, Papua New Guinea, Timor-Leste, and Vietnam (Giesen et al. 2006). In the Pacific, it is found in Solomon Islands, Vanuatu, Fiji, and Tonga (Duke et al. 2012). Other distribution areas included southern India, New South Wales in Australia, and China (Tomlinson 1986).

Rubiaceae

Scyphiphora hydrophyllacea Gaertn. (Figure 2S) was found in shrub form at the landward margin with rather a hard substrate type, but not common. The stands composed by this species were generally less than 3 m in height. It is locally known as *lemong pece*, probably because its leaf shape like a lemon's leaf. Morphological characteristics of this species include: branches come out directly from the base of the tree; bark is rough, brown; leaf is skinned, bright green, obovate, simple, opposite, obtuse; flower is white, nearly stemless, attached to axillary, 4 to 5 reddish-white petals, four bowl-shaped sepals, 4 to 5 filaments; fruit is cylindrical, round elongated, green to brown, leftover sepal that does not open when ripe, four cylindrical seeds. In Southeast Asia, this species is not found in Myanmar dan Timor-Leste (Giesen et al. 2006). In the Pacific, it is found in Solomon Islands (Duke et al. 2012). This species is also found in southern Indian, south China and Hainan, and tropical Australia (Tomlinson 1986).

Overall, mangroves in Mantehage Island were floristically rich with 20 species or about 74% of the total species in BNP. Most of them (17 species) were found in estuary habitat in the middle of the two islets. Three uncommon mangrove species of BNP found in Mantehage Island were *C. philippinense*, *B. cylindrica* and *L. racemosa*. *C. philippinense* in this Island could explain its distribution limit in the northern coast of North Sulawesi. It was important to notice that *C. philippinense* and *S. ovata* were important in the context of conservation because these two species were categorised as endangered and near-threatened species. Two other species, i.e., *B. Cylindrica* and *L. racemosa*, were locally important due to their rare presence in BNP. In addition, there was a need for further investigation into the indication of putative hybrids in *Rhizophora*.

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