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

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Abstract. *Djamaluddin R, Djabar B. 2022. Mangrove species of Mantehage Island, Bunaken National Park, North Sulawesi, Indonesia. Biodiversitas 23: 2845-2852.* A study on mangrove species in Mantehage Island, Bunaken National Park, North Sulawesi, Indonesia, is important due to the large extent 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 the biological diversity of mangrove species and to evaluate the biogeography and conservation status of certain species occurring on this island. Extensive surveys were 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 speciosum* 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.) Wurmb., *Rhizophora apiculata* Bl., *Rhizophora mucronata* Lamk., *Rhizophora stylosa* Griff., *Scyphiphora hydrophyllacea* Gaertn., *Sonneratia alba* J. Smith, *Sonneratia ovata* Blake., *Xylocarpus granatum* Köenig. 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 on the northern coast of North Sulawesi. Indication of putative hybrids in the genera of Rhizophora was found, but this needs further investigation. Two species of conservation concern, *C. philippinense* and *S. ovata*, are categorized as endangered and near-threatened species, respectively.

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

INTRODUCTION

The terminology of '*mangue*' 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 in intertidal habitats (Djamaluddin 2018b; Duke 1992; Maxwell 2015; Warui et al. 2020). According to Krauss and Ball (2013) mangrove species are facultative halophytes, 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 their morphological, anatomical, physiological, and molecular adaptations (Srikanth et al. 2016). Naturally, mangrove plants can be in the form of trees, shrubs, palms, and ferns (Duke and Schmitt 2015).

Approximately 33.8% of the world's mangrove occurs in Southeast Asia (Thomas et al. 2017), with Indonesia alone having 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 position of the country in the 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 the 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 is within Bunaken National Park and represents an interesting mangrove site to investigate due to its extent (1,383.21 ha). Its geographical position results in

a complex series of factors shaping its distribution and diversity, such as the influence of different seawater masses and its geomorphological characteristics. The marine environment of Mantehage Island includes the Sulawesi Sea that connects Makasar Strait in the southwest, 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 waves, which is physically stable, habitat with diminished tidal inundation, and habitat with fine and poorly drained sediments, which 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 are 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 comprehensively reports 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, the 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 mangroves on this island is 1383.21 ha (Sapsuha et al. 2018) which is much larger 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. On this island mangroves grow on coralline sands and low intertidal habitats dominated by clay sediment from adjacent terrigenous islets (Djamaluddin et al. 2004).

Data collection procedure

We collected primary data by conducting a series of surveys. 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 was 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. When 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.

RESULT AND DISCUSSION

Species diversity

In total, 20 species belonging to 13 genera and 11 families were found on 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 on 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 on Mantehage Island.

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 sediment dominated by clay and silt, inundated by fresh water 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 which was revised to be *Ceriops zippeliana* Blume (Sheue et al. 2009; Duke et al. 2010) was not found on this Island. Two species are 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 on the south coast of North Sulawesi, bordering directly the Maluku Sea (Damanik and Djamaluddin 2012; Djamaluddin 2015; Djamaluddin et al. 2019).

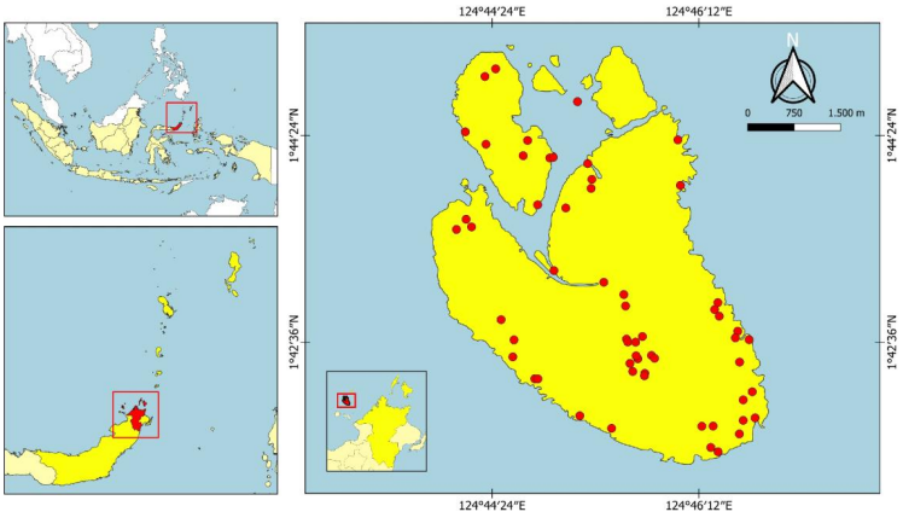

Figure 1. Map of Mantehage Island and observed locations using spot check and quadrat-transect methods

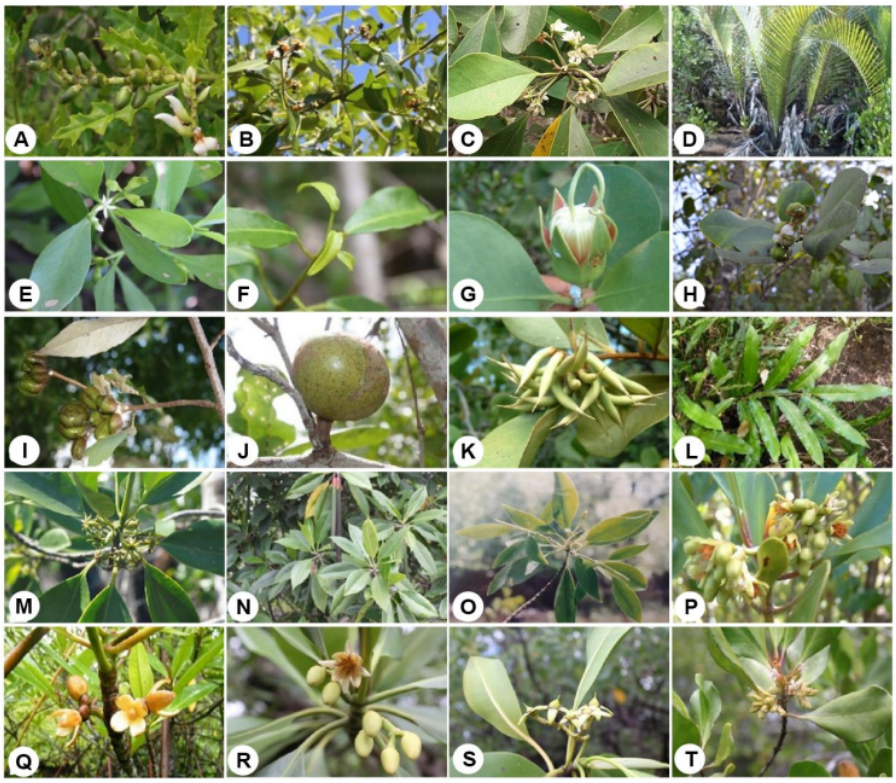

Figure 2. Mangrove species in Mantehage Island: (A) *Acanthus ilicifolius* L., (B) *Avicennia marina* (Forsk.) Vierh., (C) *Camptostemon philippinense* (Vidal) Becc., (D) *Nypa fruticans* (Thunb.) Wurmb., (E) *Lumnitzera racemosa* Willd., (F) *Excoecaria agallocha* L., (G) *Sonneratia alba* J.E. Smith,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

In addition, there were several specimens to indicate differences in morphological characteristics compared 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 harrisonii* (*R. apiculata* and *R. stylosa*) and *Rhizophora x lamarckii* (*R. apiculata* and *R. mucronata*). The occurrence of two sterile natural hybrids in *Rhizophora* has been discussed in various reports (Ng et al. 2013, 2020; Ng and Szmidt 2014; Setyawan et al. 2014; Ragavan et al. 2015).

Acanthaceae

Acanthus ilicifolius L. (Figure 2.A) was a common species found in the estuary habitat between two islets on 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; the leaf is light to dark green, broadly serrated, narrowly pointed with or without spiny edge, simple, opposite; the 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 at 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; the 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).

Arecaceae

Nypa fruticans (Thunb.) Wurmb. (Figure 2C) was rare in Mantehage Island, probably due to limitations in freshwater supply. One location where stands of this species were found was in the 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: the trunk is underground with fine roots; the 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; the leaf has a scaly surface, simple, opposite, obovate, obtuse; the 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 biogeography 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 on 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 has been categorized as endangered by IUCN (*The International Union for Conservation of Nature and Resources*) because of its decreased population.

Combretaceae

Lumnitzera racemosa Willd. (Figure 2.D) 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; the leaf is dark green, clustered at the end of the branch, narrowed obovate, simple, cross over; the 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, the west Pacific, and tropical Australia (Tomlinson 1986).

Euphorbiaceae

Excoecaria agallocha L. (Figure 2E) grew individually near land at the height of up to 10 m. It was locally known as *buta-buta* (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; the leaf is dark green, fine jagged at the edges, two glands at the base, elliptic, acute, simple, cross over; the 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, and 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*; the 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 categorized 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 branch 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; the leaf is pale green on top, greyish white on low part, simple unit and cross, broadly acuminate, cluster at the end; the 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 Köenig. (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 21mpete 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; the 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 cannonball, 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 its fruit is like chili 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; the 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 at high tide. It is a fern species with a height of up to 1 m. Morphological characteristics of this species include: the leaf is brownish-green, rush colored 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 tetrahe[23] spore. The 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 habitats. 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), and is also found in Solomon Islands (Duke et al. 2012) and North Queensland (Tomlinson 1986).

Bruguiera gymnorrhiza (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; the leaf is bright to dark green, elliptic to the elliptic lancet, simple, opposite, broadly acute; the 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 a spiral circle, transverse circle, st[31]ht blunt hypocotyl - green to purplish. This species is widely distri[28]ed in Southeast Asia (Giesen et al. 2006), is found in Solomon Islands, Vanuatu, Fiji, Tonga, and Samoa (Duke et al. 2012), and is 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 habitats with a height of less than 7 m. Morphological characteristics of this species include: bark is grey to dark brown with small knee root; the leaf is slightly yellowish-green, simple, opposite, elliptic with a tapper tip; the 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-g[3]en 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 [3]opical 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; the leaf is shiny green, obovate, simple, opposite, obtuse; the 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, smoot and darker brown when aged, yellow co[3]edon 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. [32]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 poles 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 other *Rhizophora* species; the leaf is green to dark green with speckles underside, narrowly acute, simple unit and opposite; the 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 the stem; fruit is like a pear, brown with one fertile seed, orange - green cylindrical hypocotyl with freckles, cotyledon neck - brownish-green when young and [3]eddish 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; the leaf is green with speckles

underside, elliptic, simple, opposite; the 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 the 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; the leaf is bright green with freckles underside, the elliptic, simple, opposite; the 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 stile; 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 is 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; the leaf is skinned, bright green, obovate, simple, opposite, obtuse; the 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 habitats 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 on 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 categorized 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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