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Status of Mangrove Species Found in Purok Pag-Asa, Brgy. Dahican, Mati City, Davao Oriental

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ABSTRACT

The assessment of the status of mangrove species located in Purok Pag-asa, barangay. Dahican, Mati City, Davao Oriental was conducted. There were 4 transect lines made with 3 plots according to the zonation pattern from landward, midward to seaward. The data gathered were from December 2015 to February 2016. After 3 months of assessing and determining the different mangrove species, eight species of mangroves were found belonging to 4 families, specifically the families of *Rhizophoraceae, Avicenniaceae, Sonneratiaceae,* and *Aegiceriaceae.* The *Rhizophora* group mostly dominated the four stations established in the area. Most species were found in the landward zones except in station four. The status of anthesis was also recorded, and it has been found that the *Rhizophora* group, *Ceriops* species, *Bruguiera sexangula*, and *Sonneratia alba* were the most species found bearing flowers, seeds, and propagules. Environmental parameters like temperature, salinity, and substrate type highly affect mangroves' growth rate, reproduction, and survival. Human settlement was widespread, and places have been cut down for various reasons. Some were cut to make or widen the way to the sea. Some were cut to widen the spaces for their houses, and some were destroyed for firewood use. Mangrove species were highly dependent on some environmental factors, and with some intervening factors, mangrove species were highly affected. Mangrove species' survival rate, especially mangrove saplings and seedlings, depends mainly on their environment. Disturbances such as human intervention affect mangrove reproduction, growth, and survival rate.

Keywords: Human disturbance, mangrove, Rhizophora, salinity, anthropogenic factor

INTRODUCTION

Mangrove ecosystems, composed of mangrove forests, are among the most productive and biologically significant natural systems (Giri et al., 2011; Sandilyan and Kathiresan, 2012). They provide vital ecological benefits to human society and coastal and marine environments. Specifically, mangrove forests serve as breeding, shelter, and nursery grounds for aquatic species. As stated by Macusi et al. (2011), coastal watersheds and adjacent marine regions were among the world's most dynamic and productive ecosystems. Furthermore, this crucial area for food supply, trade, commerce, and tourism represents more than fifty percent of the overall service value obtained from global environmental benefits.

The global environment is undergoing rapid changes, with the rate of transformation accelerating. While increased awareness may contribute to the perception of these changes, measurable environmental shifts are occurring at alarming rates. The primary drivers of these alterations are human activities, which exert a far greater influence than natural geological or astronomical forces (Valiela, 2006).

In the Philippines, mangrove forests have drastically declined from 500,000 to 120,000 ha, while fish and shrimp culture ponds have expanded to 232,000 ha. Mangrove replanting programs have progressed from community-led efforts in the 1930s–1950s to large-scale government and internationally supported projects since the 1970s (Primavera & Esteban, 2008). However, threats such as eutrophication, unplanned coastal development, unsustainable resource exploitation, and aquaculture persist along tropical and subtropical coastlines. Globally, approximately 10,000 km^2 of mangrove forests are lost each year (Robertson and Alongi, 1992), highlighting the urgent need for effective conservation strategies.

At this present time, mangrove conversion into residential or fishponds is widespread here in Mati. Many marine organisms are being affected due to the activity. Some of the mangroves in Purok Pag-asa were cut for housing materials.

This study was conducted to gather information that will be used to support advocacy for protecting mangrove forests in Purok Pag-asa, Barangay Dahican, Mati City, and Davao Oriental. The study aimed to assess the status of mangrove species in Purok Pag-asa, Dahican, Mati City, Davao Oriental. The information gathered from this study will help the people managing the environmental resources of Mati, especially the Department of Environment and Natural Resources (DENR), as a baseline for planning and implementing programs that would enhance and preserve the mangrove forest in Dahican, Mati City, Davao Oriental. The study also provided information about the common and unique uses of mangroves in the economy as well as in the community. The study will also help the public be more responsible, cooperative, and participative in conserving our marine ecosystem, especially the mangrove species. The study results provide baseline information to the readers, students, and researchers for future ecological studies on the status of mangrove species and mangrove forests. The collection of species at different sites would increase the value of updating the distributional data of mangrove species.

MATERIALS AND METHODS

Sampling Site

The study area was in Purok Pag-asa, Brgy. Dahican, Mati City, Davao Oriental. The study area lies between 6º55'38.3556" North latitude and 126º15'12.5568" East longitude.

Establishment of the study area

Transect lines were established from the seaward margin to the edges of the mangrove forest. The transect lines were established 200m away from the following transect line. There was no definite number of transect lines; the transect lines accommodated at least the area according to the distances of each transect line.

In each transect line, 10m x 10m plots were established according to the mangrove zonation: the seaward, middle ward, and landward inside the plots 5m x 5m subplots that will be established for the saplings and seedlings.

Figure 1. The map shows the location of the study area where the mangroves in Purok Pag-asa grew naturally.

Landward Zone

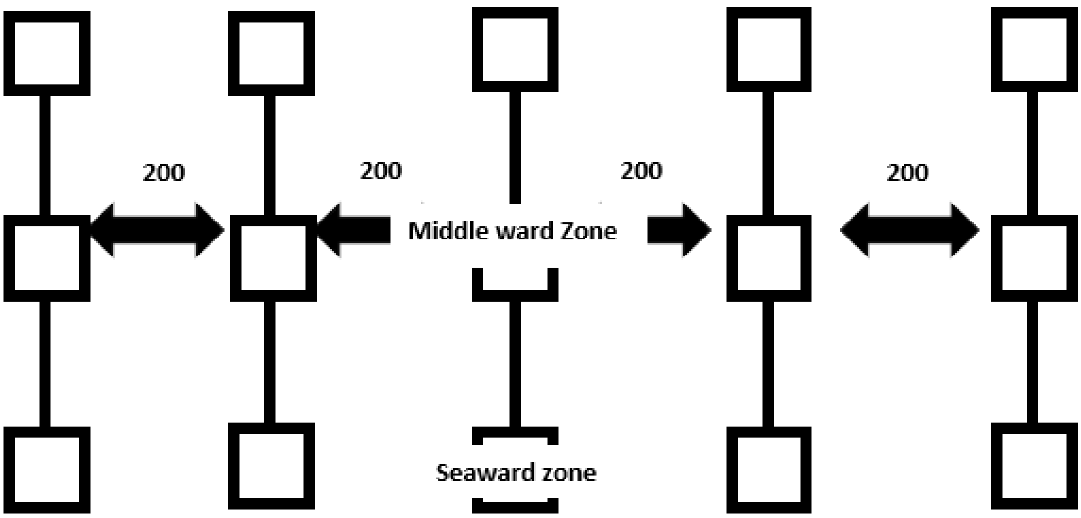


Figure 2. Transect lines with 200m distance away from weach other and 10m x 10m plots according to mangrove zonation.

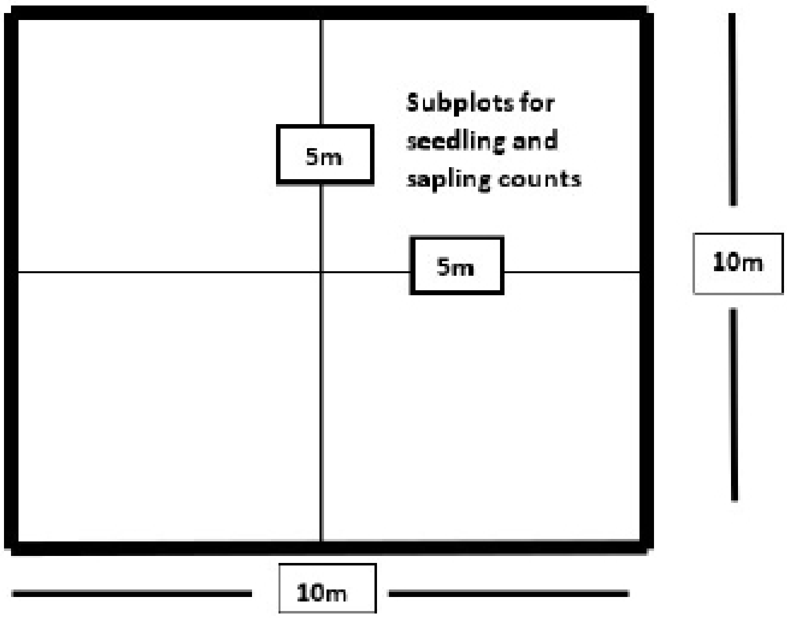


Figure 3. Plots and subplots in the study area.

Sampling Frequency

A one-shot sampling was conducted from December to February 2016 during low tide. The Transect line method was used during the sampling. The Transect line plot method was used because it quantitatively describes the species composition, community structure, and plant biomass of mangrove forests. It provides a convenient framework for relating forest structure and growth changes to soil, climatic, and hydrologic factors (English, Wilkins & Baker, 1994).

Data Gathering

Mangrove identification

Photo documentation was performed to identify the various species of mangroves. Photos of the samples of leaves, flowers, and tree structures were gathered to be easily identified compared to the existing reference method. The references used include the "Field Guide to the Common Mangrove, Seagrasses, and Algae of the Philippines" by Calumpong and Nuñez (1997) and Sealife Base by Palomares and Pauly (2009).

Mangrove abundance and distribution

In every transect plot established, the abundance and distribution of mangrove species were recorded and documented.

Seedlings

Seedlings must have a height of less than 1 m or below from their first branch, which was identified, and the number of each species was determined by actual count (English et al., 1994).

Sapling

The diameter of the saplings was less than 4 cm at breast height or 1.3 m above the ground, and a height greater than 1m was identified. The diameter was measured using the tree caliper, and the number of each species was determined by actual count (English et al., 1994).

Mature mangrove

Mature mangroves are larger than 4 cm in diameter at breast height (DBH) and girth at breast height (GBH).

Notes on anthesis

Flowering and seed/propagule bearing of mangroves were recorded through photo documentation and observation along the area. Those mangrove species that were not inside the plots were also recorded to make the data more accurate.

Environmental parameters

Temperature (^{0}C)

In measuring the temperature, calibrated alcohol temperature with a scale of 100ºC will be used. The temperature of each plot per zone was recorded during the sampling period. The thermometer was inserted into the core of sediment 10 cm below the top of the core (English et al., 1994).

Salinity (ppt)

The salinity of mangrove soils significantly affects the growth and zonation of mangrove forests. Most of the mangrove species grow best in low to moderate salinities (25 ppt). Samples of water on the surface from landward, midward, and seaward were gathered from the study area to analyze water salinity. A hand Refractometer was used during the collection. Soil was removed from the core at 10cm and 40cm along the core (English et al., 1994).

Substrate

The substrate type was recorded using ocular inspection and photo documentation.

Anthropogenic factors

Human activities such as bathing, fishing, and cutting affect mangroves' growth. Photo documentation using a digital camera was used to determine the status of the study area.

Data analysis

Species composition

Identified species were arranged into taxonomic categories, specifically at the family level. It was also compared with another study in terms of numbers.

Species abundance

$$Relative\ density = \frac{No.\, of\ individuals\ of\ a\ species}{Total\ of\ no.\, individuals\ (all\ species)}\, x\ 100$$

$$Relative\ frequency = \frac{Frequency\ of\ a\ species}{\sum Frequency\ of\ all\ species} x100$$

$$Relative\ dominance = \frac{Total\ basal\ area\ of\ species}{Basal\ area\ of\ all\ species} x100$$

Basal area (BA)

BA for each tree is the cross-sectional area at breast height. The basal area for the stand in m^2 per hectare (ha) was calculated using the formula:

$$BA = \frac{\pi DBH^2}{4} (\frac{m^2}{ha^2})$$

The BA is converted (cm^2 to m^2), and the ground area from m^2 to hectares (ha) where: $1m^2$= 1000 cm ^{2} and 1 ha= 10, 000 m^2

$$stand\ BA = \frac{\sum BA}{Area\ of\ the\ plot} (m^2 ha{-}^2)$$

Distribution

The distribution of mangrove species was determined using Elliot's (1971) variance (S2) to arithmetic mean (x) ratio test:

$$X^2 = \sum \left[\frac{(x - X)^2}{n} \right]$$

Where:

x= the number of individuals (per species) in each plot
n= the number of plots
X= the mean density

$$S^2 = \sum \frac{(x - X^2)}{n - 1}$$

When:

S2 = x, distribution is random
S2 = x, distribution is uniform/regular
S2 = x, distribution is clamp

Importance Value (IV)

The sum of the Relative density, Relative frequency and Relative dominance. This is mathematically expressed as:

IV = Rdent+RF+Rdom

RESULT AND DISCUSSION

Species composition

Eight species of true mangroves belonging to four families were encountered in the survey. *Rhizophora apiculata, Rhizophora stylosa* and *Ceriops tagal* were common in all stations. Station four has the greatest number of mangrove species found, with 7, while the other stations have only five to six mangrove species (Table 1).

Table 1. Mangrove species identified in the four stations in Purok Pag-asa.

Species	Common name	Stations											
		1			2			3			4		
		L	M	S	L	M	S	L	M	S	L	M	S
I. RHIZOPHORACEAE													
1. *Rhizophora mucronate*	Bakawan Babae	+	+	+			+						+
2. *Rhizophora apiculate*	Bakawan Lalake	+	+		+	+		+	+	+	+	+	+
3. *Rhizophora stylosa*	Bakawan Bato							+	+	+		+	+
4. *Ceriops tagal*	Tangal	+	+					+	+	+	+		+
5. *Bruguiera gymnorrhiza*	Pototan											+	
II. AVICENNIACEAE													
6. *Avicennia officinalis*	Piapi	+		+	+	+	+	+				+	
III. SONNERATIACEAE													
7. *Sonneratia alba*	Pagatpat	+	+	+	+				+	+			+
IV. AEGICERATACEAE													
8. *Aegiceras floridum*	Saging-saging		+		+	+	+						
Total		5	5	3	4	3	3	4	4	4	2	4	5

Legend: (+) = present, L= Landward, M= Midward, S=Seaward

Station 1 has the families of *Avicenniaceae, Rhizophoraceae, Aegicerataceae,* and *Sonneratiaceae. Avicennia officinalis* (Piapi) was found only in landward and seaward zones. Aegiceras floridum (Saging-saging) was found only in the middleward zone, specifically in Quadrats two and four. *Rhizophora mucronata* (Bakawan Babae), *Rhizophora apiculata* (Bakawan Lalake), *Ceriops tagal* (Tangal), and *Sonneratia alba* were primarily found in landward to seaward zones. Rhizophoraceae species were widespread in station 1 because the most common factor is that the Rhizophora species mostly grow on muddy surfaces.

Station 2 found that five mangrove species existed. *Avicennia officinalis* (Piapi), *Rhizophora mucronata* (Bakawan Babae), *Rhizophora apiculata* (Bakawan Lalake), *Soneratia alba* (Pagatpat), and *Aegiceras floridum* (Saging-saging) were the five mangrove species found in station two. Piapi and Saging-saging were found in landward, midward, and seaward zones. In contrast, Bakawan Lalake was found only in landward and midward zones, Pagatpat was found only in the landward zone, and Bakawan Babae was found only in the seaward zone.

Rhizophora apiculata (Bakawan Lalake), *Rhizophora stylosa* (Bakawan Bato), *Ceriops tagal* (Tangal), *Avicennia officinalis* (Piapi), and *Sonneratia alba* (Pagatpat) were the only mangrove species found in station 3. Tangal was mainly found in the landward to seaward zone and Bakawan Bato. Pagatpat and Bakawan Lalake were primarily found in the midward and landward zone. Rhizophora species mostly dominated station 4, where Bakawan Lalake was commonly found (Table 2).

Table 2. Abundance and distribution of mature mangrove.

Species	Common name	Stations												Total
		1			2			3			4			
		L	M	S	L	M	S	L	M	S	L	M	S	
I. RHIZOPHORACEAE														
1. *Rhizophora mucronate*	Bakawan Babae	30	42	48			66							186
2. *Rhizophora apiculate*	Bakawan Lalake	8	10		21	23			6	3	2	11	4	88

Species	Common name	Stations												Total
		1			2			3			4			
		L	M	S	L	M	S	L	M	S	L	M	S	
3. *Rhizophora stylosa*	Bakawan Bato							2	6	5		1	6	20
4. *Ceriops tagal*	Tangal	8	6					10	10	3	6	6		49
5. *Bruguiera gymnorrhiza*	Pototan											3		3
II. AVICENNIACEAE														
6. *Avicennia officinalis*	Piapi	10		6	29	48		4				2		99
III. SONNERATIACEAE														
7. *Sonneratia alba*	Pagatpat	8	4	2	3		6		1	3			3	30
IV. AEGICERATACEAE														
8. *Aegiceras floridum*	Saging-saging		12		14	9	9							35
Total		194			219			53			44			510

Rhizophoraceae species highly dominated all stations. Reforestation also occurred, and the seedlings of Bakawan Babae, Bakawan Lalake, and Tangal were abundant in the area, especially in stations 3 and 4. Bakawan Babae is the most common mangrove species in all stations. Stations 1 and 2 have the most vegetative mature mangroves from the landward to the seaward zone. Even though humans have intervened in the area, commonly with garbage dumping, it is still dense with mangrove species. As observed in the study, stations 3 and 4 received low-numbered species because human settlement occurred in the area, especially in landward zones (Table 3).

Table 3. Relative frequency, density, dominance and importance value of different mangroves species.

Species	Common name	*Frequency*	Relative			Importance value
			Frequency	Density	Dominance	
Rhizophora mucronata	Bakawan Babae	33.33	90.7	31.22	25.27	147.19
Sonneratia alba	Pagatpat	0.66	1.81	21.77	34.10	57.69
Avicennia officinalis	Piapi	0.5	1.36	6.81	14.73	22.90
Rhizophora apiculata	Bakawan Lalake	0.75	2.04	12.20	10.87	25.11
Ceriops tagal	Tangal	0.58	1.58	2.27	6.64	10.50
Aegiceras floridum	Saging-saging	0.33	0.90	1.43	5.26	7.60
Rhizophora stylosa	Bakawan Bato	0.41	1.13	23.44	2.43	27.00
Bruguiera gymnorrhiza	Pototan	0.16	0.45	0.83	0.65	1.94
Total		36.75	100	100	100	300

The highest importance value of the mangrove species is *Rhizophora mucronata* commonly known as Bakawan Babae, with 147.20, and *Sonneratia alba* known as Pagatpat with 57. 69. *Bruguiera gymnorrhiza*, known as Pototan, has the lowest importance value at 1.95 (Table 3).

The most vegetative mangrove saplings were recorded in station 4, with 94 stems per ha containing six species, which are *R. apiculata, R. mucronata, R. stylosa, C. tagal, B. gymnorrhiza,* and *S. alba.* The highest density of seedlings observed was also in station 4, with 319 stems per ha The data indicates that massive reforestation occurred. Reforestation was done by the local community and through the Department of Environment and Natural Resources (DENR) (Table 4).

Table 4. Density of saplings and seedlings in the 4 stations.

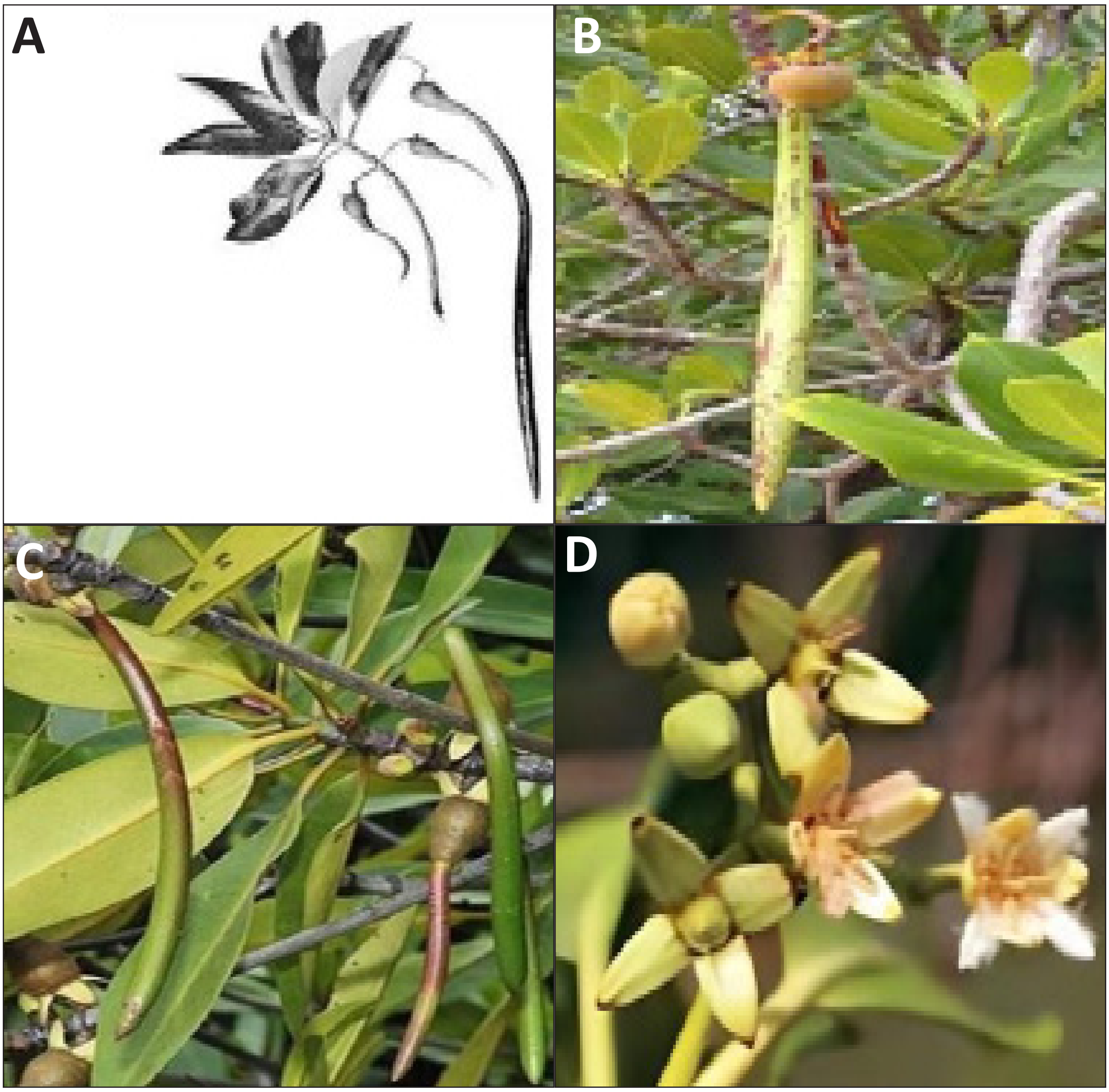
Stations	Species	Density	
		Saplings	Seedlings
1	*R. mucronata*	7	20
	R. apiculata	6	11
	C. tagal	3	
	A. corniculatum	2	
2	*A. marina*	1	3
	R. mucronata	5	12
	R. apiculata	4	11
	C. tagal	8	17
3	*A. marina*	4	2
	R. stylosa	8	80
	R. apiculata	21	204
	C. tagal	12	23
4	*R. apiculata*	22	273
	R.mucronata	2	12
	R. stylosa	38	12
	C. tagal	15	16
	B.sexangula	16	3
	S. alba	1	3
Total		168	682

Notes and Anthesis

Only four families of mangrove species bear flowers and propagules: *Rhizophoraceae, Avicenniaceae, Aegicerataceae,* and *Sonneratiaceae.* The most common species was the *Ceriops tagal*, *Rhizophora mucronata* and *Rhizophora apiculata.*

Rhizophora species

Seed development of Rhizophora species is long, covering a period of 36 weeks or 9 to 10 months (Calumpong & Nuñez, 1997).



Fig**ure 4.** *Rhizophora* species: Bakawan Babae (A, B), Bakawan Lalake (C), and Bakawan Bato (D) Flower and Propagule.

Bakawan Babae: Fruit is ovoid, 3.5 to 5cm long, pendulous, brown or olive in color. The persistent calyx-lobes are refluxed. The protruded radicle is green and cylindric, growing 20 to 40cm long before falling off the tree. Seeds often germinate while on the tree and crop as young plants into the mud above (Figure 4A and B).

Bakawan Lalake - fruit an ovoid or inversely pear-shaped berry, 2.0 to 3.5cm long and rough brown. Hypocotyl is cylindrical to club-shaped up to 40cm x 1.2cm before falling. One-seeded fruits start to germinate when still hanging on the tree. Mature propagules remain viable for 4 to 5 mos (Figure 4C).

Bakawan Bato - a flowering of stylosa varies by location. The first flowers, developed at about 5 years, develop propagules twice a year. Fresh propagule varies from dark to light green and develops little brown fruits about 3 to 5cm small. A propagule sprouts in the fruit while still on the mother tree. A viviparous propagule grows up to 65cm long (Figure 4D).

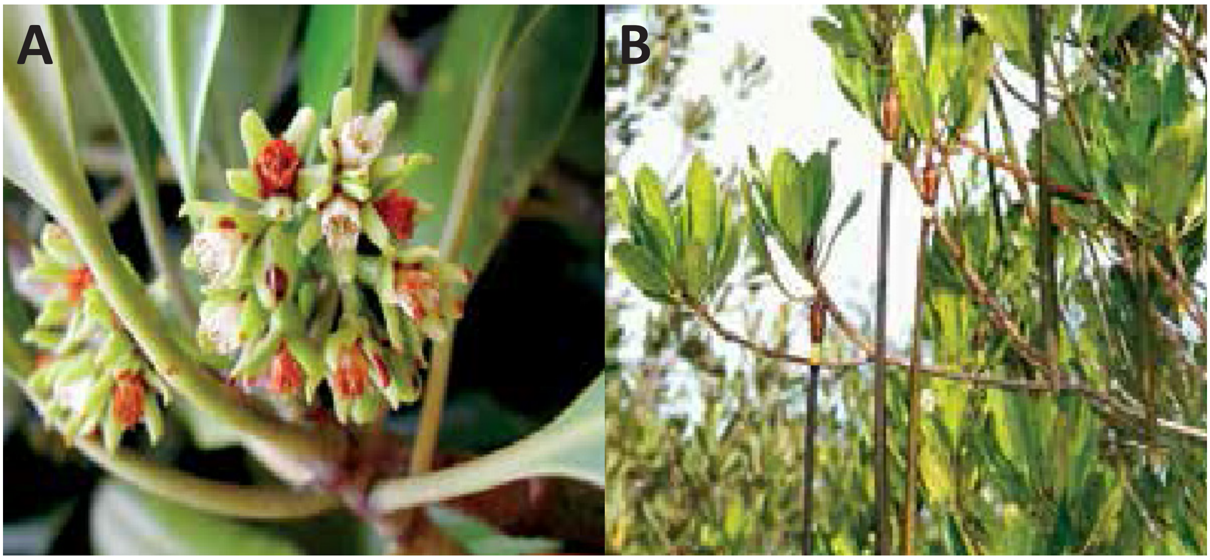


Figure 5. Tangal (*Ceriops tagal*) flower and propagule (A,B).

Tangal - flowers open mainly in the evening, the fruit is brown and smooth without any texture. Hypocotyl long pointed (15 to 25cm long) with fluted ridges along the length and a white collar when ready to drop off (Figure 5).

Figure 6. Pototan (*Bruguiera gymnorrhiza*) flower and propagule (A, B, C).

Pototan – large-leafed orange mangrove that grows flower and propagules during the whole year. Develops flower of about 5 years (Figure 6).

Avincenniaceae

Figure 7. Piapi (*Avicennia officinalis*) flower and fruit (A,B).

Piapi seeds have no dormancy, but they usually are sown with the fruit cover removed because they are highly susceptible to fungus attack. Fresh seeds often have very high germination, typically more than 95%. Seeds that have imbibed moisture usually have radicle formation within 3 days of sewing. Flowers form for 36 to 41 days, and the inflorescence produces 9 to 35 flowers over 16 to 25 days and 4 to 6 weeks to produce mature fruits (Figure 7).

Sonneratiaceae

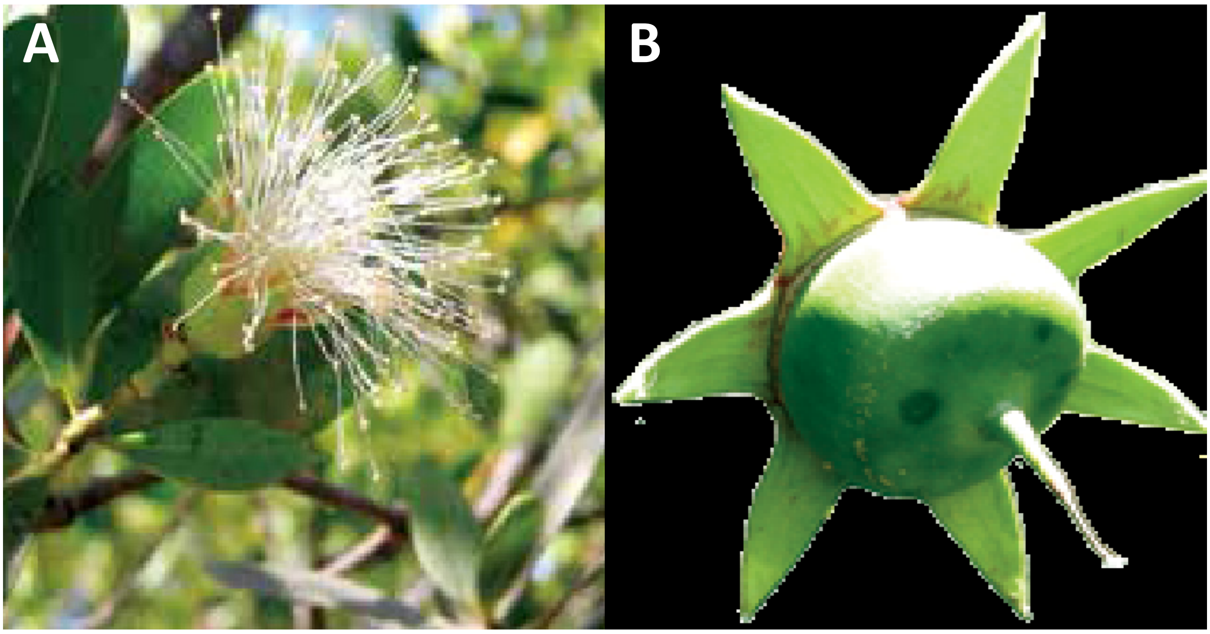


Figure 8. Pagatpat (*Sonneratia albe*) flower and fruit (A,B).

Pagatpat - also called mangrove apple. The flowers are white and pom-pom-like, and they open for one night. The fruit has 100 to 150 seeds. Flowers are borne in clusters of 5 to 8 and only bloom between dusk to dawn. Mature fruits are approximately 2 to 4.5cm across which ripens to green with a dull surface. The reproductive cycle takes approximately 4 to 5 months (Figure 8).

Aegicerataceae

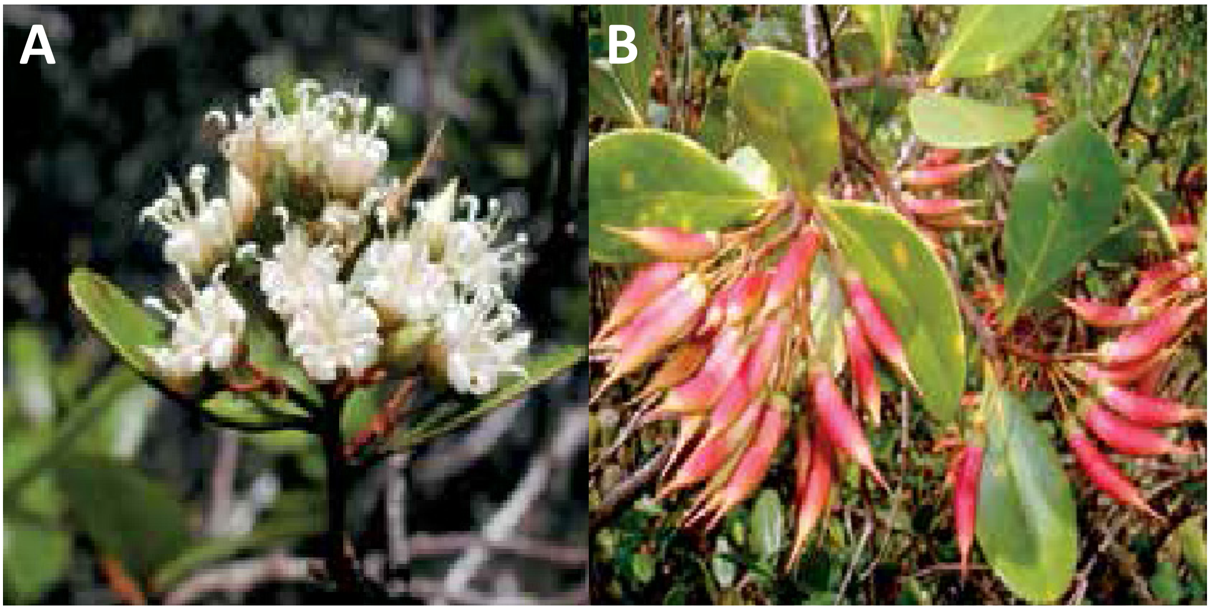


Figure 9. Saging-saging (*Aegiceras floridum*) flower and fruit (A,B).

Saging-saging - produces flower once a year from February to June. Completes flowering from 2 to 3 days and completes floral cycle in 21 days and 3 days from flowering to fruit setting. The fruit matures in 3 months (Figure 9).

Environmental parameters

Table 5. Environmental parameters in all stations.

Environmental Parameters	**Stations** 1	2	3	4
Landward				
Substrate type	Sandy Coraline	Muddy	Coraline and Muddy	Coraline
Salinity (ppt)	30	28	28	26
Temperature (^{0}C)	26	24	25	27
Midward				
Substrate Type	Muddy	Muddy	Muddy	Muddy and Coraline
Salinity (ppt)	30	29	27	30
Temperature (^{0}C)	24	26	24	28
Seaward				
Substrate Type	Muddy	Muddy	Coraline and Muddy	Coraline and Muddy
Salinity (ppt)	26	26	25	26
Temperature (^{0}C)	26	26	24	28

Temperature (^{0}C)

The temperature highly affects the growth and reproduction of the mangroves. Air temperature is appropriate for the mangroves because they are highly needed in growing (Tomlinson, 2016). During the sampling period, station 4 had the highest average temperature at 27.6°C. The temperature is one of the agents of seedling growth. *Ceriops* tagal was the most abundant mangrove species in station 4 because the temperature was high, causing its seedlings to survive and grow progressively. As shown in Table 5, station 4 has obtained the highest number of saplings and seedlings.

Substrate type

Dixon (1989) states that mangrove species grow in different soil types. Bakawan species grow mostly in muddy substrates, but they also survive or can grow in sandy areas. Ceriops and Bruguiera species grow and can be planted in clay areas, while Sonneratia species and *Avicennia marina* grow in sandy and muddy regions (Calumpong & Nuñez, 1997). This study observed different substrate types (muddy, sandy coralline, muddy coralline, and coralline). The Bakawan species mostly dominated the 4 stations being established from landward, midward to seaward zone since the area was covered by mostly muddy substrates (Table 5).

Salinity

The standard salinity of the marine ecosystem ranges from 25 to 35 parts per thousand (ppt) (Tomlinson, 2016). The values obtained from the sampling in stations 1 to 4 from landward and midward have a mean of 28ppt (26-30ppt). The results obtained in seaward zones from stations 1 to 4 show lower salinity because of freshwater runoff from the land, especially during rainy seasons (Tomlinson, 2016) (Table 5).

Anthropogenic factor

Human intervention

Cutting and garbage dumping significantly disrupt the growth and reproduction of mangrove species, causing stress to seedlings and slowing their growth rate. Human settlements in the study area have further contributed to mangrove degradation, with severe damage observed in Stations 3 and 4. Mangroves have been cut down to create more space for housing, establish pathways from land to the seaward zone, and make way for boat passages, often leading to the destruction of branches. Walking through mangrove areas damages their delicate root systems, causing tree decline and death. Some mangroves have also been removed to construct bridges and walkways for easier access, while others have been harvested for housing materials. These human activities continue to degrade mangrove ecosystems, weakening their ability to provide essential environmental and ecological benefits, which may have lasting consequences on coastal biodiversity and ecosystem stability.

CONCLUSION

In general, the abundance and distribution of mangroves were high except in stations 3 and 4 near the settlement area. Since anthropogenic activities in some areas were evident. This factor would lead to destruction and decrease the abundance in the area. The flowering of different mangrove species was not affected by the destruction. However, their propagules and the seedlings, which are more important for their reproduction, were highly affected and increasingly damaged due to these disturbances.

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