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Species composition and diversity in a natural and reforested mangrove forests in Panguil Bay, Mindanao, Philippines

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Abstract

Mangroves are recognized as one of the richest ecosystems worldwide. Despite their importance and the efforts to preserve and protect these ecosystems, threats are still prevalent. Thus, in order to contribute in the preservation and protection of the remaining mangrove ecosystems, this study was conducted with the aim of determining the species composition and diversity of the natural mangrove forest in Barangay Matampay Bucana and the reforested mangrove forest in Barangay Mukas in Panguil Bay. This inventory is a benchmark study to determine the biodiversity of the mangrove species in both sites. It is then implied that any change in species composition and diversity may be attributed to human intervention. Transect-quadrat method was employed in gathering the data. A 100% inventory of mangrove species inside each 10x10m quadrat was done. Species composition data revealed ten true mangrove species and three mangrove associates. It was found that the natural forest hosts eight true mangrove species while the reforested forest have only five true mangrove species but it also host three mangrove associates. There are three species common to the two forests namely; *Avicennia alba*, *Bruguiera parviflora* and *Rhizophora mucronata*. The study also revealed that the reforested forests has slightly higher diversity index than of the natural forests. However, the two forests are classified as very low in diversity index according to categories classified by Fernando (1998). The differences in composition and diversity of each forest were attributed to the type of forests- natural and reforested, and to their geographical location.

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Introduction

Mangrove ecosystems play crucial roles in their ecological integrity and provide valuable ecosystem services. It is recognized as one of the world's richest ecosystem. They serve as habitat for many aquatic and terrestrial organisms and provide direct economic contribution in forms of timber, firewood, fiber and other products which can be harvested (Kathiresan & Bingham, 2001). However, despite their ecological and economic importance, mangroves are becoming vulnerable to degradation and loss worldwide. They have become ideal areas for conversion to commercial and industrial activities because of their accessibility.

Globally, already half of the mangrove forests have been lost since the mid-twentieth century (Spalding, Blasco & Field, 1997). Over the last 50 years, one-third of the world's mangroves were already lost (McLEod & Salm, 2006). According to Valiela *et al.* (2001), maricultural activities accounts to about 52% of the destruction of mangrove forests. Other activities such as coastal development, aquaculture, pollution and overharvesting had also led to loss of mangrove forests.

In the Philippines, continuous decline of mangrove forests is also noticeable (Gevaña & Pampolina, 2009). Brown and Fischer (1920) noted that in 1918 the mangrove forest in the country was estimated to occupy between 400,000 and 500,000 Hectares while the recent data of 247,362 hectares (Forest Management Bureau, 2007 as cited by Garcia *et al.,* 2013) indicates that already half of the estimated mangrove cover was already lost. It is quite alarming that with the existing loss of mangrove cover, it still continues to face threats. Among their major threats is the conversion to fishponds for commercial fishing and shrimp farming (Spalding *et al.*, 1997).

Despite the threats and drastic decrease in the mangrove areas, the country is still noted as one of the countries which support a high number of true mangrove species, having about 39 species belonging to 16 families (Sinfuego & Buot, 2008). This fact implies that the Philippines still holds high diversity of mangrove species. According to McKee *et al.* (2007) species diversity and abundance within mangrove forests determine how well the system can function and provide services. Thus, the more diverse forests offer higher delivery of ecosystem goods and services. Nevertheless, only about 35% of the remaining mangrove forests in the country are protected by national laws (Cudiamat & Rodriguez, 2017).

Albeit, greater conservation and localized replanting efforts, mangrove degradation is still anticipated in the Philippines (Samson & Rollon 2008). The importance of mangroves seemed to be undervalued by many. Massive conversion and overexploitation have been noted as one of the main threats to the existence of these ecosystems. However, these activities are still active today. Panguil Bay, in particular, was included in the critical list of Fisheries Sector Program due to observed environmental degradation (Philippine Journal of Development, 2004). Thus, to preserve and protect the remaining mangrove forest in the area, their assessment is greatly needed (Kauffman *et al.*, 2011).

Hence, this study generally aimed to provide an inventory of mangrove species and species diversity of natural and reforested mangrove forests in Panguil Bay. Specifically, it sought to determine the species composition, taxonomic classification, morphological characteristics, and conservation status of the determined mangrove species and the similarities and differences of mangrove species present in the two mangrove forests. This inventory is a benchmark study to determine the biodiversity of the mangrove species in both sites. It is then implied that any change in species composition and diversity may be attributed to human intervention.

Materials and methods

The Study Site

The study was conducted in the natural mangrove forest of Barangay Matampay Bucana of the Municipality of Lala and the reforested mangrove forest of Barangay Mukas of the Municipality of Kolambugan (see Fig. 1). These mangrove forests extend in the coastal areas of the Province of Lanao del Norte in Northern Mindanao.

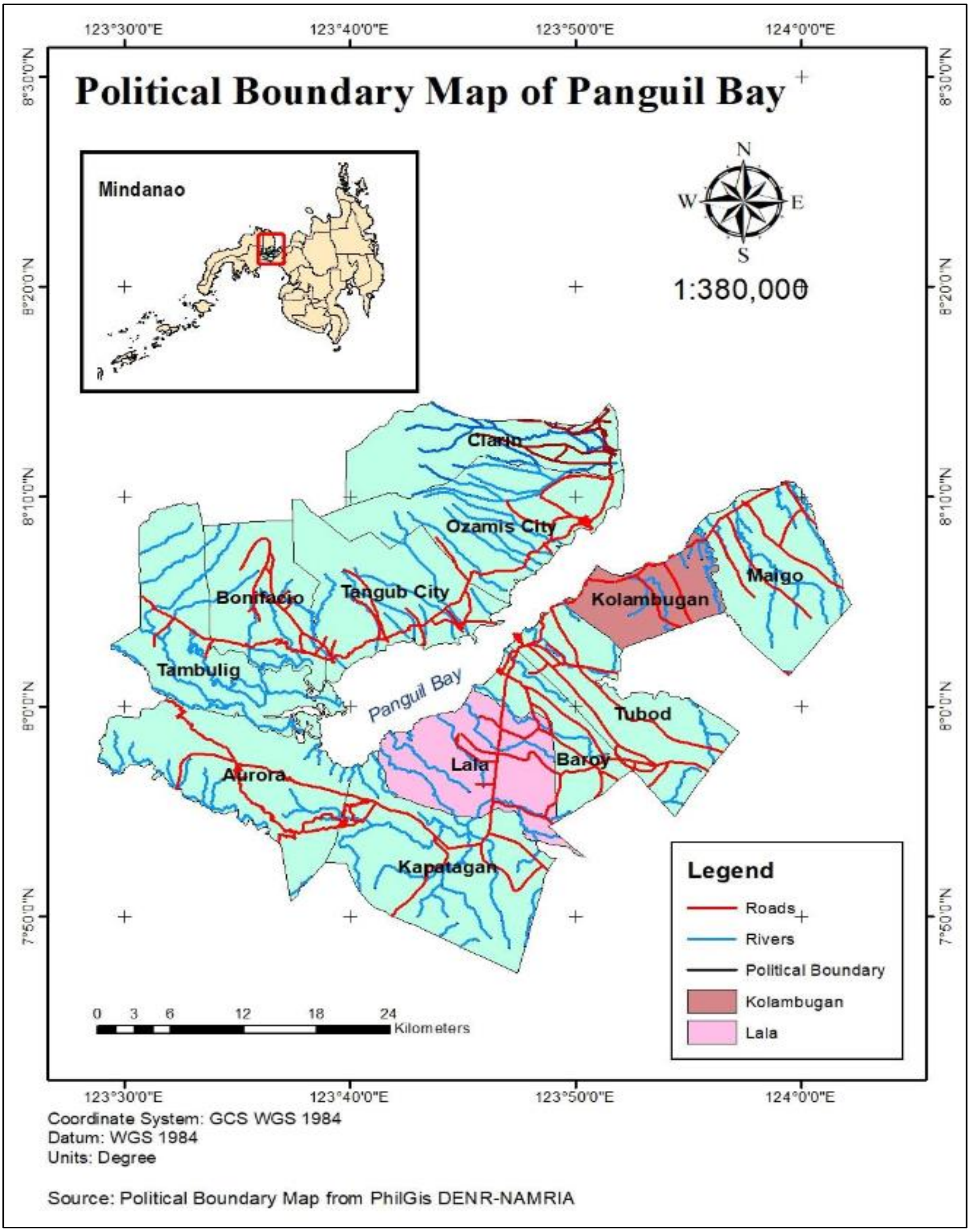

Fig. 1. Geographic map showing the location of the two municipalities involved in the study.

Barangay Matampay Bucana is the sixth largest barangay among the ten (10) coastal barangays of the Municipality of Lala with a total land area of 322 hectares. It is one the two migratory bird monitoring sites in Lanao del Norte. Fishponds are notably operated in the area.

The loss of original vegetation in the coast of Barangay Matampay Bucana was attributed to this activity. At present, it has an estimated mangrove cover of 181.16 hectares (LiDAR, 2015). The Key Informant Interview revealed that the natural growth mangrove forest in Bonbonon, the study site in Brgy.

Matampay Bucana where the study was conducted has been in existence for about 15 years.

Barangay Mukas has the largest land area of 696 hectares among the 12 coastal barangays of the Municipality of Kolambugan. The barangay has an approximate total mangrove cover of 71.48 hectares (LiDAR, 2015). Barangay Mukas together with Barangay Matampay Bucana are listed as migratory bird monitoring sites in the province.

Similar to Barangay Matampay Bucana, fishponds also caused the destruction of the natural vegetation of its mangrove ecosystem. Reclamation of mangrove areas for residential and other infrastructures is also apparent. Fortunately, according to the locals, non-government organizations had initiated the reforestation of the mangrove forest in the area. Among the areas reforested by an NGO is Sitio Pasil where the study was conducted.

Sampling Design

A non-destructive transect-quadrat sampling technique was employed to determine the mangrove species composition and diversity of the natural and reforested mangrove forests. With an aid of a compass, a 100-meter transect line was established parallel to the shoreline which served as the baseline. From the baseline three (3) 150-meters transect were established (perpendicular to the shoreline) with 50 meters distance between transects. In every line transect, five (5) 100 square meter quadrats were established for species diversity.

Species Composition

A 100% inventory of mangrove species inside each plot was conducted. Identification of the mangrove species were done *in situ* with an aid of a field guide to Philippine mangroves by Primavera (2004). Plant growth form, leaves, inflorescence, fruits, buttresses and bark were photographed for description of morphological features of each mangrove species.

Species Diversity Determination

Individual species inside each quadrat was quantified and recorded. The mangrove species diversity indices were calculated using the Shannon-Wiener's Diversity Index (Shannon & Weaver, 1963).

Shannon-Weiner Diversity (H'): $H' = -\sum_{i=1}^{s}(pi \; x \ln pi)$,

Where S as the total number of species, pi as the proportion of individuals to the ith species expressed as a portion of the total cover and ln as the log base of n.

The diversity values for Shannon-Weiner classified based on a scale developed by Fernando (1998) is presented in Table 1.

Table 1. Classification of Diversity Values.

Relative Values	H' Values
Very High	> 3.50
High	3.00 – 3.49
Moderate	2.50 – 2.99
Low	2.00 – 2.49
Very Low	< 1.99

Data Analyses

Descriptive statistics and graphs were computed and plotted using Microsoft Excel 2010.

Results and discussion

Species Composition

Mangrove species are categorized as exclusive and nonexclusive species. Exclusive species refer to plants unique to the inter-tidal mangrove habitats commonly called as true mangrove species while nonexclusive species are mainly distributed in terrestrial or aquatic habitat but also occur in the mangrove ecosystem and are usually referred as mangrove associates (Parani *et al.,* 1998; Lacerda *et al.,* 2002). Ten (10) true mangrove species and three (3) mangrove associates were observed in the natural and reforested mangrove forests in Panguil Bay (Table 2).

Sinfuego & Buot (2008) cited that there are about 39 true mangrove species known present in the Philippines. About 25.64% (10 out of 39) of these species exist in the mangrove forests in the two sampling sites. Compared to the study conducted by Rivera *et al.* (2016) in the three (3) barangays of Tangub City which hold eight (8) true mangrove species while in this study, Barangay Matampay Bucana and Barangay Mukas, respectively, of the

Province of Lanao del Norte, host more true mangrove species than in Tangub City. Tangub City is one of the two coastal cities in Misamis Occidental also along Panguil Bay.

Table 2. Inventory of mangrove species present in natural and reforested mangrove forests in Panguil Bay.

Category	Scientific Name	Local Name
True Mangrove Species	*Acanthus ebracteatus*	Lagiwliw
	Nypa fruticans	Nipa
	Avicennia alba	Miapi
	Lumnitzera littorea	Saging-saging
	Excoecaria agallocha	Lipata
	Sonneratia alba	Pagatpat
	Xylocarpus granatum	Tabigi
	Rhizophora mucronata	Bakhaw babae
	Rhizophora apiculata	Bakhaw lalaki
	Bruguiera parviflora	Lapis-lapis
Mangrove Associate Species	*Dolichandrone spathacea*	Tiwi
	Talipariti tiliaceum	Malabago
	Terminalia catappa	Talisay

Taxonomic Classification and Morphological Characteristics of Mangrove Species

The recorded true mangrove species belong to eight (8) families namely; Acanthaceae, Arecaceae, Avicenniaceae, Combretaceae, Euphorbiaceae, Meliaceae, Rhizophoraceae and Lythraceae while the mangrove associate species belong to three (3) families namely; Bignoniaceae, Combretaceae and Malvaceae. Among these 13 mangrove species, one (1) is palm (*Nypa fruticans),* one (1) is shrub (*Acanthus ebracteatus)* and the remaining species are trees. Figs. 2-14 exhibit the morphological features of the recorded species in natural and reforested mangrove forests in Panguil Bay.

Taxonomic Classification

Phylum: Tracheophyta

Class: Magnoliopsida

Order: Scrophulariales

Family: Acanthaceae

Genus: *Acanthus*

Species: *Acanthus ebracteatus* (see Fig. 2)

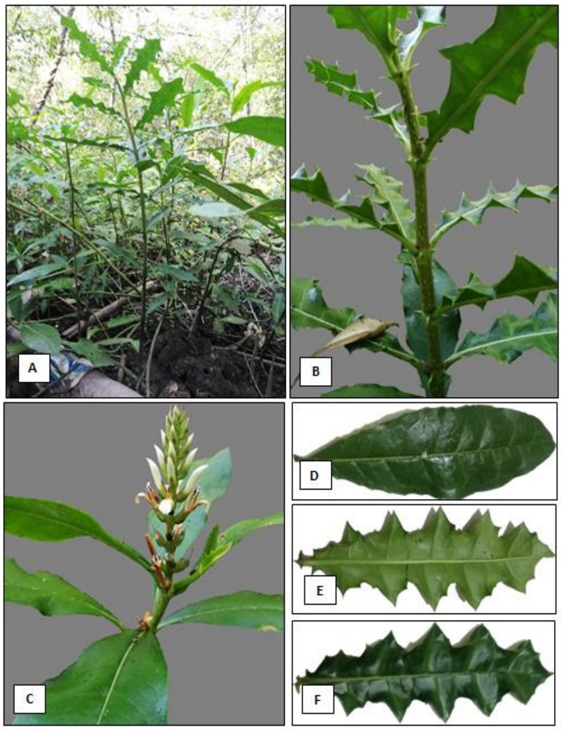

Fig. 2. Morphological characteristics of *Acanthus ebracteatus:* A. Growth form, B. Leaf arrangement and stem with axial spines, C. Inflorescence, D. Leaf margin (smooth), E. Leaf abaxial surface (serrated), F. Leaf adaxial surface.

Plant Morphology

Acanthus ebracteatus or Sea Holly is a shrub with decumbent stems. Its opposite, stalked leaves have blades that are oblong elliptic in shape, its apices are acute with or without spiny edge. Its leaf margin has variation, from entire to spiny and dentate. Its leaf's adaxial surface appears darker green than its abaxial surface. The species' inflorescence is a spike with white petals. The inflorescence of *Acanthus ebracteatus* and *Acanthus volubilis* are white compared to *Acanthus ilicifolius* that is is mostly purple, blue or dark blue (Ragavan *et al.*, 2015).

Taxonomic Classification

Phylum: Tracheophyta

Class: Liliopsida

Order: Arecales

Family: Arecaceae

Genus: *Nypa*

Species: *Nypa fruticans* (see Fig. 3)

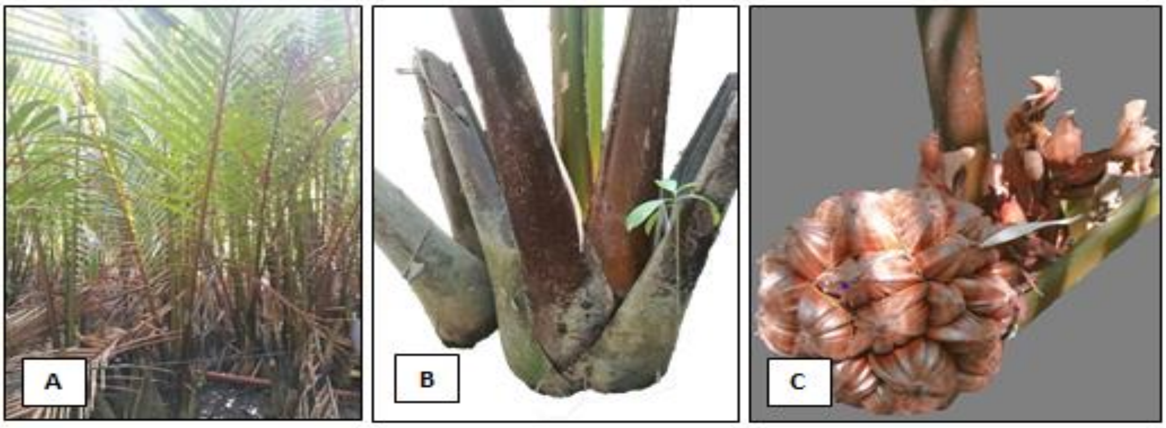

Fig. 3. Morphological characteristics of *Nypa fruticans:* A. Growth form, B. Bulbous base, C. Mature fruit.

Plant Morphology

Nypa fruticans or Nipa is a palm with large and erect leaf fronds. Its fronds possess stout leaf stalks that are bulbous at the base and are arranged alternately. Its lanceolate leaflets are arranged oppositely on each side of its rachis. Its fruits vary from brown to dark brown depending on its maturity. Young fruit appears lighter brown while mature fruit appears darker.

Taxonomic Classification

Phylum: Tracheophyta
Class: Magnoliopsida
Order: Lamiales
Family: Avicenniaceae
Genus: *Avicennia*
Species: *Avicennia alba* (see Fig. 4)

Plant Morphology

Avicennia alba or Miapi is a tree with numerous pneumatophores extending around its main trunk. Its trunk appears pale brown to darkish brown. Among the distinguishing feature of this species from other *Avicennia* spp. is the burnt-like feature of its bark. Its alternate, petioled and broadly elliptical leaves appear glossy dark green in its adaxial surface and pale green in its abaxial surface. This pale green appearance of its leaf abaxial surface is also a distinguishing feature of this tree. Its inflorescence is a panicle with individual flowers appears yellow to orange.

Taxonomic Classification

Phylum: Tracheophyta
Class: Magnoliopsida
Order: Myrtales
Family: Combretaceae
Genus: *Lumnitzera*
Species: *Lumnitzera littorea* (see Fig. 5)

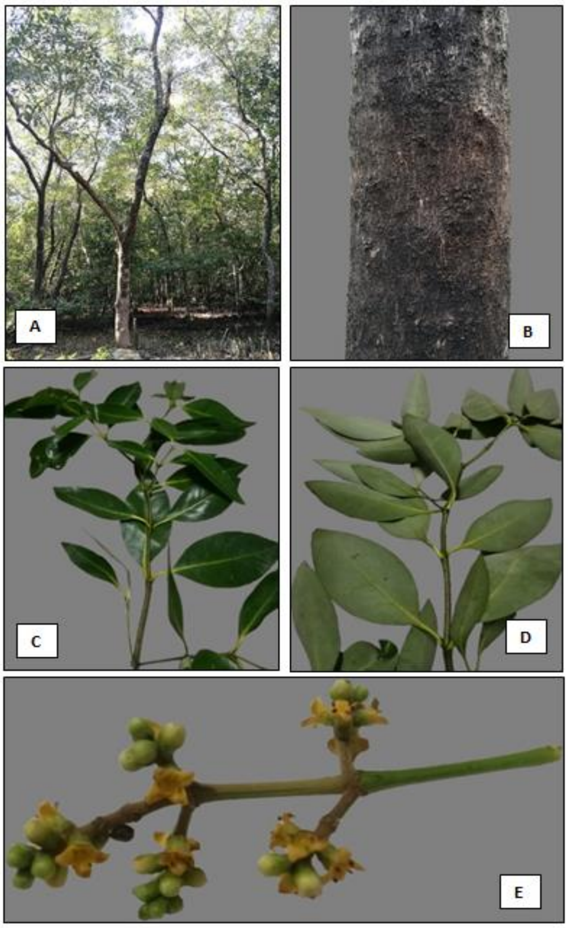

Fig. 4. Morphological characteristics of *Avicennia alba:* A. Growth form and its pneumatophores, B. Trunk, C. Leaf arrangement (adaxial surface), D. Leaf arrangement (abaxial surface), E. Inflorescence.

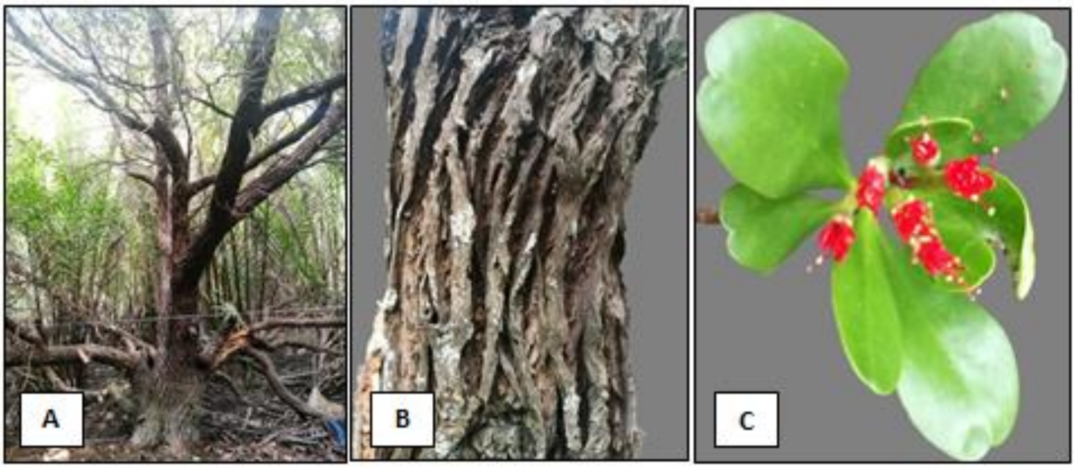

Fig. 5. Morphological characteristics of *Lumnitzera littorea:* A. Growth form, B. Trunk, C. Leaf arrangement and inflorescence.

Plant Morphology

Lumnitzera littorea or Red-flowered black mangrove is a tree with slightly spiral fissures. Its bark is dark brown to black. Its obovate shaped leaves have short petioles and are arranged alternately. Its inflorescence is a spike. Its individual flowers have fused green sepals and vibrant red petals.

Taxonomic Classification

Phylum: Tracheophyta
Class: Magnoliopsida
Order: Malpighiales
Family: Euphorbiaceae
Genus: *Excoecaria*
Species: *Excoecaria agallocha* (see Fig. 6)

Plant Morphology

Excoecaria agallocha or Milky Mangrove is a tree with linearly-arranged brown lenticels on its bark. Its alternate and spirally arranged, petioled, and ovate shaped leaves appear dark green on its adaxial surface and lighter green on its abaxial surface. Both barks and leaves exude latex when cut.

Taxonomic Classification

Phylum: Tracheophyta
Class: Magnoliopsida
Order: Sapindales
Family: Meliaceae
Genus: *Xylocarpus*
Species: *Xylocarpus granatum* (see Fig. 7)

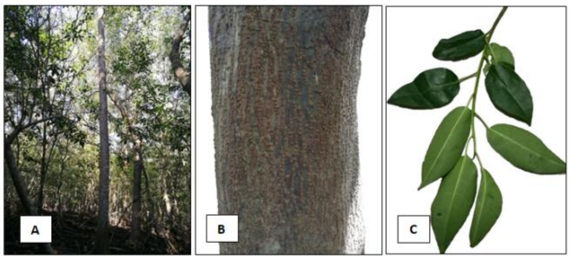

Fig. 6. Morphological characteristics of *Excoecaria agallocha:* A. Growth form, B. Trunk with lenticels, C. Leaf arrangement (abaxial and adaxial surface).

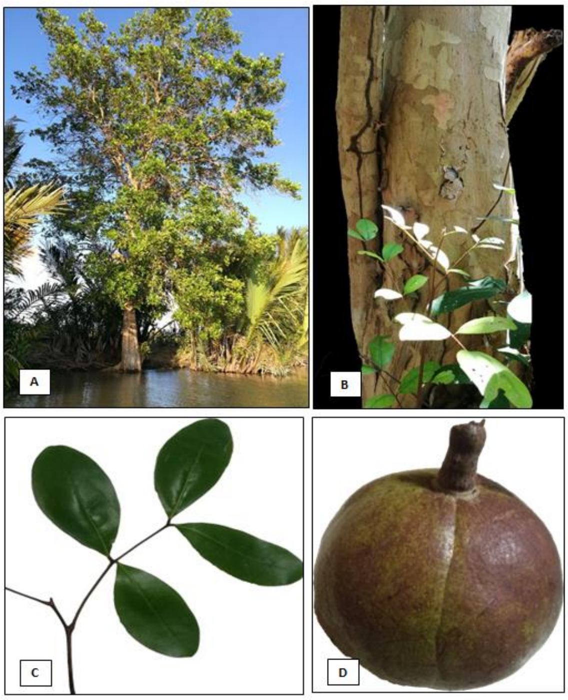

Fig. 7. Morphological characteristics of *Xylocarpus granatum:* A. Growth form, B. Trunk, C. Leaf arrangement (adaxial surface), D. Fruit.

Plant Morphology

Xylocarpus granatum or Cannonball Mangrove is a tree with long buttresses that extends laterally. Its smooth bark appears flaky with light brown to yellowish or greenish colour. Its brown fruit is a woody capsule. Its pinnate leaves are petioled and arranged alternately. The shortly petioled leaflets are arranged oppositely and are oval in shape.

Taxonomic Classification

Phylum: Tracheophyta
Class: Magnoliopsida
Order: Rhizophorales
Family: Rhizophoraceae
Genus: *Rhizophora*
Species: *Rhizophora mucronata* (see Fig. 8)

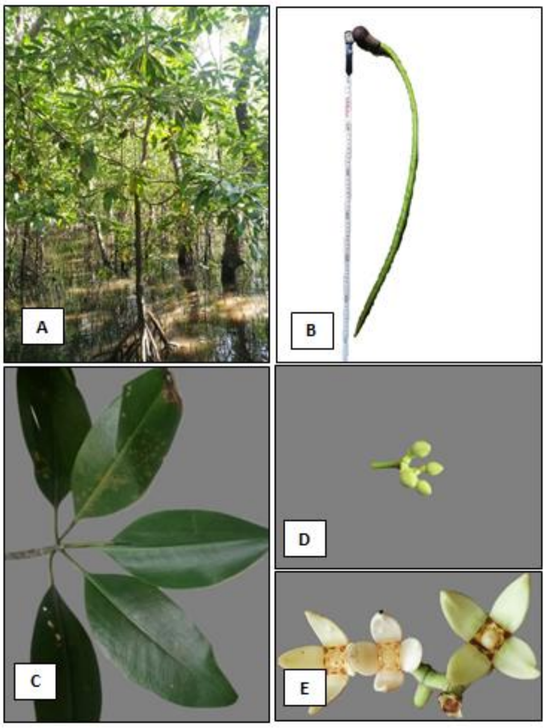

Fig. 8. Morphological characteristics of *Rhizophora mucronata:* A. Growth form (young tree), B. Propagule (70cm), C. Leaf arrangement (adaxial surface), D. Inflorescence bud, E. Inflorescence.

Plant Morphology

Rhizophora mucronata or Red Mangrove is a tree with both aerial and stilt roots. Its bark appears light brown to dark brown. Its oval-shaped, petioled and leathery dark-green leaves are arranged oppositely. Its terminal bud appears dark red. The propagule of this plant is brownish-green.

Taxonomic Classification

Phylum: Tracheophyta
Class: Magnoliopsida
Order: Rhizophorales
Family: Rhizophoraceae
Genus: R*hizophora*
Species: *Rhizophora apiculata* (see Fig. 9)

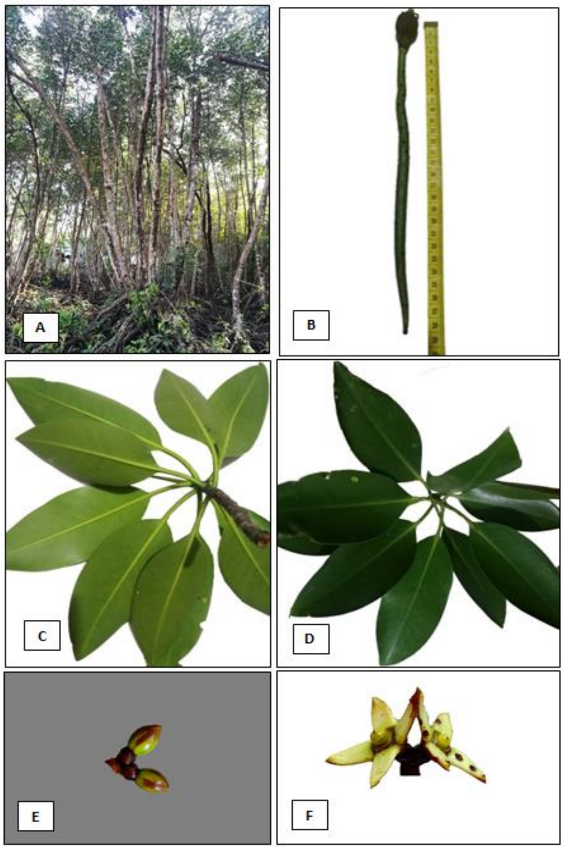

Fig. 9. Morphological characteristics of *Rhizophora apiculata:* A. Growth form (mature trees), B. Propagule (28.5cm), C. Leaf adaxial surface, D. Leaf abaxial surface, E. Inflorescence bud, F. Inflorescence.

Plant Morphology

Rhizophora apiculata or Bakhaw lalaki is a tree with stilt roots. Its bark is light brown to grey. Its petioled, elliptic shaped, entire margined leaves appear leathery and dark green in its adaxial surface while yellowish-green on its abaxial surface. Its brownish-green propagules are shorter than the propagules of *Rhizophora mucronata*.

Taxonomic Classification
Phylum: Tracheophyta
Class: Magnoliopsida
Order: Rhizophorales
Family: Rhizophoraceae
Genus: *Bruguiera*
Species: *Bruguiera parviflora* (see Fig. 10)

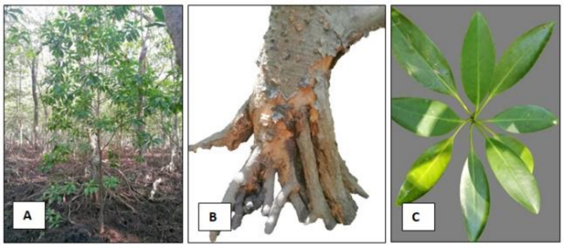

Fig. 10. Morphological characteristics of *Bruguiera parviflora:* A. Growth form (young tree), *B. Buttress* roots (mature tree), C. Leaf arrangement (adaxial surface).

Plant Morphology
Bruguiera parviflora or Smallflower Bruguiera is a tree with brownish-grey trunk. Part of its lateral roots can be observed above the muddy surface. These protruding roots are called knee roots and it appears grey and flaky. Its leaves are elliptic and yellowish-green.

Taxonomic Classification
Phylum: Tracheophyta
Class: Magnoliopsida
Order: Myrtales
Family: Lythraceae
Genus: *Sonneratia*
Species: *Sonneratia alba* (see Fig. 11)

Plant Morphology
Sonneratia alba or Mangrove Apple is a tree surrounded by thick and numerous pneumatophores. Its inflorescence is simple umbel. Its berry fruit is hard, round and flattened and has calyx at the base. Its petioled and oppositely arranged leaves are orbicular in shape with rounded apex.

Taxonomic Classification
Phylum: Tracheophyta
Class: Magnoliopsida
Order: Scrophulariales
Family: Bignoniaceae
Genus: *Dolichandrone*
Species: *Dolichandrone spathacea* (see Fig. 12)

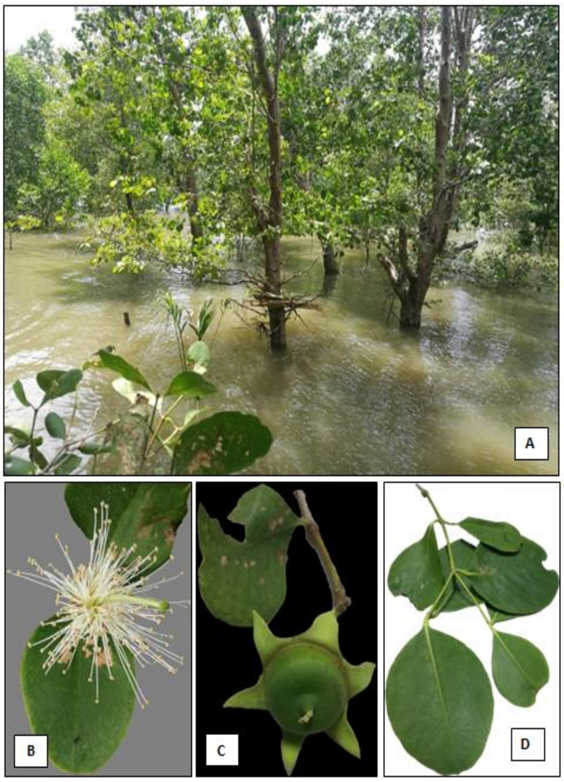

Fig. 11. Morphological characteristics of *Sonneratia alba:* A. Growth form, B. Flower, C. Fruit, D. Leaf arrangement (abaxial leaf surface).

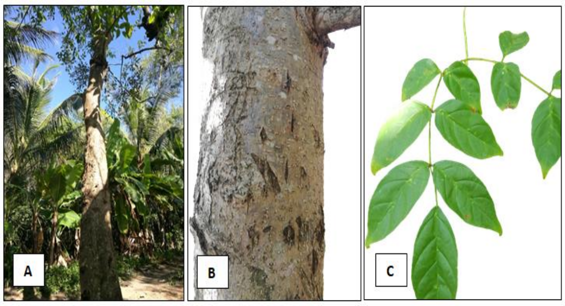

Fig. 12. Morphological characteristics of *Dolichandrone spathacea:* A. Growth form, B. Trunk, C. Leaf arrangement (adaxial surface).

Plant Morphology
Dolichandrone spathacea or Mangrove Trumpet is a tree with yellowish brown to grey trunk. Its pinnate leaves are petioled and arranged oppositely. Its elliptic leaflets are also stalked and arranged oppositely.

Taxonomic Classification
Phylum: Tracheophyta
Class: Magnoliopsida
Order: Myrtales
Family: Combretaceae
Genus: *Terminalia*
Species: *Terminalia catappa* (see Fig. 13)

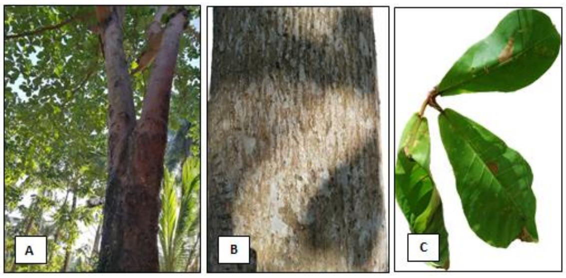

Fig. 13. Morphological characteristics of *Terminalia catappa:* A. Growth form, B. Leaf adaxial surface, C. Leaf abaxial surface.

Plant Morphology
Terminalia catappa or Tropical Almond is a tree with lightly fissured light brown to grey bark. It has spiral, stalked leaves that are papery to thinly leathery, dark green on its adaxial surface and light green on its abaxial surface. Its leaves are clustered at the end of the twigs.

Taxonomic Classification
Phylum: Tracheophyta
Class: Magnoliopsida
Order: Malvales
Family: Malvaceae
Genus: *Talipariti*
Species: *Talipariti tiliaceum* (see Fig. 14)

Plant Morphology
Talipariti tiliaceum or Beach Hibiscus is a tree. Its trunk is yellowish-brown with white pigmentation when in mature stage while smooth dark green when in younger stage. Its leaves are reniform in shape with acuminate apex and finely-serrated margins, appear dark green on its adaxial surface and with fine hairs on its abaxial surface and are spirally arranged along stem.

Conservation Status of Mangrove Species
According to Oldfield (2018), the conservation status of plant species is essential to planning and monitoring resource management program especially that it pertains to the number of existing individuals for each species. It could also serve as guide to conservation actions and its monitoring.

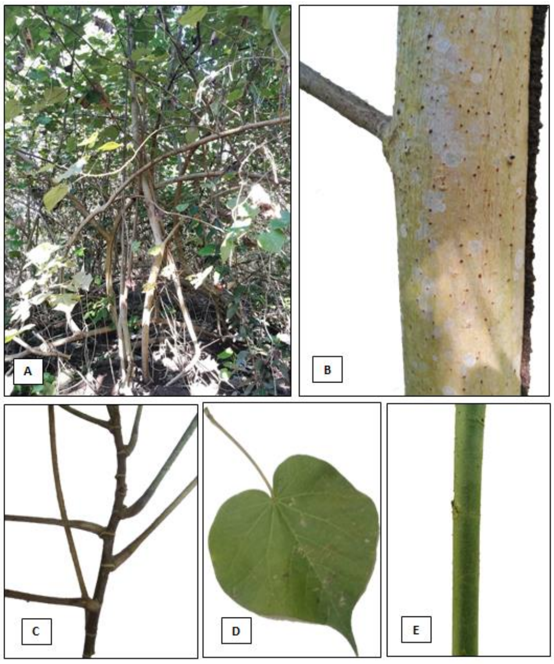

Fig. 14. Morphological characteristics of *Talipariti tiliaceum:* A. Growth form, B. Trunk (*mature tree*), C. Leaf arrangement, D. Leaf adaxial surface**,** E. Trunk (young tree)

Of the total recorded mangrove species in this study, about 85% (see Fig. 15) are noted to be of least concern conservation status based on the account of the International Union for Conservation of Nature. This implies that there are still no major threats to these mangrove species. Among this species with least concern status are *Acanthus ebracteatus*, *Nypa fruticans*, *Avicennia alba*, *Lumnitzera littorea*, *Excoecaria agallocha, Sonneratia alba, Xylocarpus granatum, Rhizophora mucronata, Rhizophora apiculata, Bruguiera parviflora,* and *Dolichandrone spathacea*. Though major threats such as habitat destruction and removal of mangrove areas have been reduced due to conservation efforts, these mangrove species are still facing threats from pollution which includes sewage effluent, solid waste, siltation, oils and grease, and agricultural and urban runoff (Ellison *et al*., 2010). Furthermore, there are about (2/13) or 15% of the 13 recorded mangrove species in the study that are not yet evaluated for their conservation status namely; *Talipariti tiliaceum* and *Terminalia catappa*. There is therefore a need to study the importance and economic value of these species to know how their utilization by the local community affects their number.

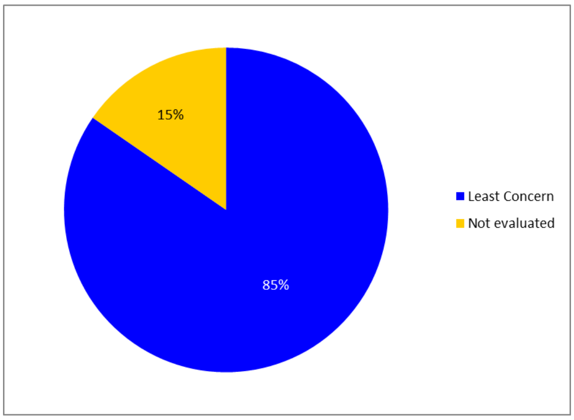

Fig. 15. Conservation (IUCN) status of mangrove species in a natural and reforested mangrove forests in Panguil Bay.

Species Diversity

The computed Shannon-Weiner Diversity Index revealed that the reforested mangrove forest of Barangay Mukas has higher diversity index of 1.481 than of the natural mangrove forest of Barangay Matampay Bucana with 1.176 diversity index (Fig. 16). However, both forests are classified with very low diversity based on the scale developed by Fernando (1998). This is primarily due to the lack of species variation in the mangrove stands. A number of studies also concluded that mangrove forests had very low diversity indices due to their unique stand formation compared to other tropical forest ecosystems (Gevaña and Pampolina, 2009; Kovacs *et al.,* 2013).

Moreover, according to Ellison and Farnsworth (1996) human activities have significantly modified the mangrove vegetation in various parts of the world on a scale at least equivalent to some of the natural changes. Many of the human activities led to modification of these ecosystems and eventually cause changes in the species composition through secondary succession. In the case of the reforested mangrove forest in Barangay Mukas, major stressors such as accumulated solid waste, oils and grease and residential areas situated in the intertidal zones are apparent. In particular, accumulation of solid waste generally of sawdust from Findlay Miller and plastics had created a natural dike in the area which stretches to about 70 meters parallel to the shoreline and with a distance of about 50-60 meters from the seaward front zone. This dike now caters both true mangrove and mangrove associate species but more of mangrove associate species. This mangrove associate species namely; *Acanthus ebracteatus*, *Dolichandrone spathacea* and *Terminalia catappa* perhaps grow favorably in the seasonally inundated dike; thus, contributing to the diversity of the reforested mangrove forest.

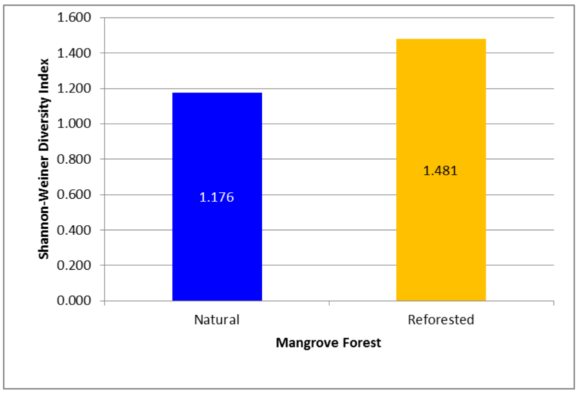

Fig. 16. Species diversity index of a natural and reforested mangrove forests in Panguil Bay, Mindanao.

Similarities and differences of species composition in natural and reforested mangrove forest

Of the total 13 mangrove species, about eight (8) true mangrove species were found in a natural mangrove forest of Barangay Matampay Bucana while only five (5) true mangrove species and three (3) mangrove associates were found in the reforested mangrove forest of Barangay Mukas. A seriation analysis was used to evaluate the similarities and differences of mangrove species present in naturally grown and reforested mangrove forests (Fig. 17). Apparently, there are only three (3) species common to the two (2) forests namely; *Avicennia alba, Bruguiera parviflora* and *Rhizophora mucronata*. There are five (5) species unique to Barangay Matampay Bucana namely; *Excoecaria agallocha, Lumnitzera littorea, Nypa fruticans, Xylocarpus granatum* and *Sonneratia* *alba* while Barangay Mukas also hosts five (5) unique species namely; *Rhizophora apiculata, Acanthus ebracteatus, Dolichandrone spathacea, Talipariti tiliaceum* and *Terminalia catappa*.

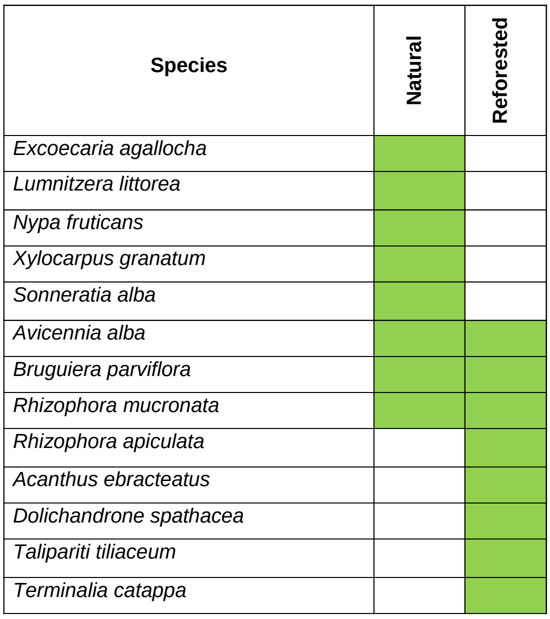

Fig. 17. Seriation analysis of mangrove species present in the natural and reforested mangrove forests in Panguil Bay.

The differences in the composition and diversity of mangrove stand in Barangay Matampay Bucana and Barangay Mukas are generally related to the type of stand namely; natural and reforested mangrove forests. It could also be further attributed to the geographic location of these barangays. Barangay Matampay Bucana covers an estuary of where its name is derived from ("Bucana"- mouth of a river). Given that the sampling area is situated near the estuary, salinity could be one of the factors affecting its species composition. Lower water salinity promotes growth of *Nypa fruticans*. Robertson and Alongi as cited by Duke (1992) noted that this species is fast growing, especially in estuaries and body of water with salinity ranges from 1-10ppt, and is a competitive species. Barangay Matampay Bucana has an average salinity of 21ppt which is comparable to the salinity of Barangay Mukas with an average value of 27ppt (data not shown). This may imply that *Nypa fruticans* can only tolerate and compete in areas with water salinity not far from 21ppt. It further implies that the growth of other mangrove species in Barangay Matampay Bucana, where *Nypa fruticans* is abundant, could be impeded thus, affecting the diversity of species in the area. Furthermore, in the unpublished report of Middeljans (2015) in the managed and unmanaged *Nypa fruticans* stands in Bohol, Philippines revealed that the unmanaged stand has lower species diversity than the managed stand. This could additionally imply that the unmanaged *Nypa fruticans* in the natural forest of Matampay Bucana has affected the diversity in the area. Another factor which could also help explain is the location of Barangay Matampay Bucana from the inlet or entrance of Panguil Bay as well as the age of its mangrove stand. Barangay Mukas is situated near the inlet of Panguil Bay and has much older mangrove stand, suggesting that natural introduction of new species was and is more likely to occur than of Barangay Matampay Bucana. Dethier *et al.* (2003) also hypothesized that the difference in the species present and diversity in an area could be due to its potential exposure to natural recruitment of propagules via advection current and land based flow.

Conclusion

Mangroves species found in the natural and reforested mangrove forests in Panguil Bay vary in composition and diversity. The 15-year old natural mangrove forest hosts eight (8) true mangrove species while the 30-year old reforested mangrove forest holds only five (5) true mangrove species and three (3) mangrove associates. There are three (3) species common to the two (2) forests, namely; *Avicennia alba, Rhizophora mucronata* and *Bruguiera parviflora*. The identification of these species was *in situ* with an aid of Primavera's field guide to Philippine mangroves (2004). Thus, it is recommended to conduct biomolecular analysis of the recorded species to verify taxonomic classification and for future reference. Moreover, it was also found that the reforested mangrove forest of Brgy. Mukas has higher species diversity than the natural mangrove forest of Brgy. Matampay Bucana of which was attributed to the areas' geographical location, salinity and age of the stand. However, both mangrove forests are classified as having very low species diversity according to the classification of Fernando (1998). Correlational studies of the factors affecting the composition and diversity of species in natural and mangrove forest is therefore recommended.

Furthermore, the least concern conservation status of the majority of observed mangrove species implies that there was no significant decrease in the population of this species worldwide. However, this should be a challenge to the local community, local government units, concerned government agencies and the academe to work collaboratively to maintain, if not improve, on their conservation status through proper management programs, monitoring and evaluation of these mangrove forests.

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