Inventory of Mangrove in Molugan, El Salvador City, Misamis Oriental

LIBERTY E. TANEO

ABSTRACT

The inventory of mangroves in Molugan, El Salvador City was assessed for species composition, diversity, and dominance using the quadrat method. The vegetation in the area consisted of eight species: *Avicennia marina*, *Avicennia rumphiana*, *Rhizophora apiculata*, *Rhizophora mucromata*, *Sonneratia alba*, *Rhizophora styloza*, *Lumnitzera racemosa* and the mangrove associate *Nypa Fruticans*. Rhizophoraceae species dominated *the seaward zone* while Nypa fruticans is a mangrove found only in landward zone. This was attributed to the mangrove's typical zonation pattern based on inundation and the common seedlings of *Rhizophora species* used in replanting activities in the area. The mangrove area in Molugan is relatively unstable, with high human disturbance. The relatively low species diversity of the mangrove at Molugan, El Salvador City, is recommended to increase species richness, which is significant for achieving an ecologically-stable mangrove flora that provides economic benefits to the community and to enhance the biodiversity of the forest.

Keywords*: species composition, diversity, zonation pattern*

INTRODUCTION

Mangrove forests presently cover an area of 20 million hectares worldwide. They are the main vegetation type in protected intertidal areas along the subtropical coastline. Within this broad geographic range, mangroves grow in environments ranging from highly humid to extremely and conditions and on soils, ranging from pure clay to peat, sand, or coral rubble. Therefore, it is not surprising that the mangrove ecosystem displays extreme variations in plant composition, forest structure, and growth rate.

The Philippines is one of the countries with many true mangrove species, having about 42 species representing 18 families (Samson and Rollon 2011). According to the estimate of (Long & Giri 2011), using remotely sensed satellite observations for the year 2000, 66 out of the 82 provinces in the country contain mangroves with a total covered area of 256,185 ha. It is also considered as one of the top 15 most mangrove-rich countries in the world according to Long and Giri (2011). The biodiversity of mangroves and mangroves as an ecosystem has been increasingly attracting greater interest because it is a highly productive but also extremely sensitive and fragile

environment (Donoso 2018). However, because of their accessibility, these coastal forests have a very high risk of being subjected to numerous pressures related to developmental activities and are often over-exploited. Vast areas of mangroves in this country have been cleared and converted to aquaculture ponds (Lawrence 2012). Mangrove forests are continuously

subjected to unsustainable anthropogenic activities, which, aside from their vulnerability to the impacts of climate change such as sea-level rise, inevitably lead to the degradation of these ecosystems. (Abino, Castillo, and Lee, 2014).

Mangrove reforestation programs have been popular, from international development assistance programs, government-sponsored projects to community initiatives. Consequently, a mangrove reforestation effort exists in the Province of Misamis Oriental in Mindanao, Philippines. This is specifically located in the coastal Barangay Molugan, El Salvador City.

A long time ago, during the Spanish time, the municipality was named "Tagnipa" because of the abundance of Nipa mangroves in the locality. This place endowed with abundant natural resources like vast farmlands, and Macajalar Bay bound it. As El Salvador becomes an industrial place with the presence of Asia Brewery, Universal Robina (URC), Tanduay, and other 15 companies, the mangrove area becomes critical. Barangay Molugan in cooperation with the Department of Environment and Natural Resources (DENR) has developed mangrove restoration and conservation programs to protect the area. This mangrove forest covers at least 6.5 hectares.

In 2000, a joint project was established involving the Department of Environment and Natural Resources (DENR), Bureau of Fisheries and Aquatic Resources (BFAR), Philippine Coast Guard (PCG), Misamis Oriental Provincial Government, the Local Government Unit of the Municipality of El Salvador and Xavier University. The involvement of the different stakeholders intensified the said project and has made it a continuous endeavor for the nature activists. In support of coastal rehabilitation, these stakeholders conduct mangrove planting and coastal cleanup in the said place.

The mangrove area in Barangay Molugan was selected as the study area because of its diverse mangrove trees, which is the focus of this study. Hence, this paper explores the species diversity and composition of mangrove in Molugan, El Salvador City. This guide was designed for field use by researchers, government agencies, NGOs, academicians, and students who are actively involved in mangrove research.

Objectives of the Study

The study aims to determine the inventory of Mangrove in the coastal area of Molugan, El Salvador City. Specifically to:

1. Identify and document the mangroves species based on its taxonomic characters.
2. Assess the ecological status of mangrove species distributed across the area. 3. Determine mangrove species composition and diversity.

Significance of the study

The study on the inventory of mangroves in Molugan, El Salvador City can provide information on the status of mangroves in the area before it will be extinct due to coastal development. Determination of taxonomic characters, dominance, and conservation status of species can provide information that would be useful for the conservation and rehabilitation efforts in the area.

Limitation of the study

The sampling area covered only the mangrove forest areas of Molugan, El Salvador City. Species richness density was determined. Three quadrats were established. The counting of trees were limited within the perimeter of the quadrant found in the area. Measurements of physicochemical properties were not included.

REVIEW OF RELATED LITERATURE AND STUDIES

Several works have been concluded on the determination of the mangrove community structure in the country and elsewhere. In Mindanao, Canizares, and Seronay (2016) conducted a study on the mangrove in Barangay Imelda, Dinagat Island. They reported ten (10) species found in the area dominated by Family Rhizophoracea with five mangrove species these were: Rhizophora mucromata, *Rhizophora stylosa, Rhizophora apiculata, Bruguiera gymnorrhiza,* and *Bruguiera sexangula.* The true mangroves recorded of having the highest population density, relative frequency, relative dominance, and importance value while *Heritiera littoralis* have the lowest value. Mangaong and Flores (2019) conducted an inventory of mangroves in Katunggan Coastal Eco-Park, Sultan Kudarat Province. They identified 29 species of mangroves and 16 genera, representing 14 families, including Acanthaceae, Pteridaceae, Myrsinaceae, Avicenniaceae, Bignonia Bombacaceae, Rhizophoraceae, Euphorbiaceae, Combretaceae, Arecaceae, Lythraceae, Sonneratiaceae, Rubiaceae, and Meliaceae. Among the documented mangrove families, Rhizophoraceae had the most species with 8 under 3 genera while the least number of species was in Arecaceae, Bombacaceae, Bignoniaceae, Euphorbiaceae, Lythraceae, Myrsinaceae, and Rubiaceae with only one species per family. The area also harbors some threatened mangrove species which at least 3.45% species are considered as Near Threatened (*Ceriops zippelliana),* 3.45 % species is vulnerable (*Avicennia rumphiana)* and an endangered species *Camptostemon philippinensis* is also 3.45% (Figure 2). The remaining 89.65% is considered Least Concern.

In the study of Mapping the Philippines' Mangrove Forests Using Landsat Imagery conducted by Long and Jiri in 2011, notably, 19% (49,363 ha) of the Philippines' total mangrove area is located within existing protected area networks (International Union for Conservation of Nature (IUCN) protected areas categories, I-VI), with the greatest area of protected mangroves located on

Palawan. The IUCN declares a protected area as "A clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values. Although this

study provides a detailed analysis of the areal extent and distribution of the Philippines' mangrove forests, more qualitative and quantitative information concerning the quality and condition of mangrove forests is needed for scientific planning and conservation efforts in the Philippines.

Chilika Development Authority, Govt. of Odisha, India. et al., 2017 recorded a total of 29 true mangrove species and 72 associate species from various regions of Bhitarkanika National Park. The reported true mangroves belong to 11 families and 15 genera and the associates recorded from 39 families and 56 genera. Among the studied true mangrove families, Rhizophoraceae showed maximum richness both at species and generic level with 10 true mangrove species.

Malaysia has about 575,000 ha of mangrove forest, reduced from 695,000 in the 1970s; that is, reduced by 17%, due to land conversion/ reclamation for agriculture, aquaculture, urbanization, infrastructure development, and natural causes mainly from coastal erosion. (Romañach et al, 2018).

The total mangrove forest area of the world in 2000 was 137,760 km2 in 118 countries and territories. The total mangrove area accounts for 0.7% of the total tropical forests of the world. The largest extent of mangroves is found in Asia (42%) followed by Africa (20%), North and Central America (15%), Oceania (12%), and South America (11%). Approximately 75% of mangroves are concentrated in just 15 countries. Worldwide, species diversity, height, and biomass are the lowest in the northern and southern extremes and increase toward the tropics. The best-developed mangroves can be found in the Sundarbans, Mekong Delta, Amazon, Madagascar, Papua New Guinea, and Southeast Asia. Although the exact reasons for species diversity can be debated, the conservation and sustainable management of this diversity are critical (Giri et al., 2011).

Ecological Importance of Mangroves

The mangrove ecosystem is highly productive and plays a critical role in economic and social development. Mangroves not only have environmental benefits like purifying water, but they also act as a buffer zone between land and sea and protect the land from erosion and play an invaluable role as nature's shield against cyclones, ecological disasters, and a protector of shorelines. Mangroves also provide indirect benefits through their impact on the up-gradation of coastal and marine eco-system. It is well known that the coastal population succumbs to disasters of cyclones and Tsunamis', incurring heavy losses to their properties and livestock. Mangrove plantation along the coast serves as a barrier to cyclones and Tsunamis and protects the people living in Coastal areas. The endangered mangrove ecosystem has been accepted as a unique biological setup that needs protection and conservation. Mangroves harbor a variety of life forms and economically. Mangroves are a good source of timber, fuel, and fodder and are the main source of income generation for shoreline communities like fisherfolk (Patel et al., 2014).

In addition, mangroves form the foundation of a highly productive and biologically rich ecosystem that provides a home and feeding ground for a wide range of species, many of which

are endangered. Although mangroves make up less than one percent of all tropical forests worldwide, they are highly valuable ecosystems, providing an array of essential goods and services that contribute significantly to coastal communities' livelihoods, well-being, and security (UNEP, 2014). Thus, mangrove forests are extremely important

coastal resources, which are vital to our socio-economic development. Much of the ecological service of mangroves lies in protecting the coast from solar UV-B radiation, "greenhouse" effects, and fury of cyclones, floods, sea-level rise, wave action, and coastal erosion. Mangroves contribute significantly to the global carbon cycle and produce large amounts of litter in the form of falling leaves, branches, and other debris. Besides, mangrove habitats contribute to complex food webs and energy transfers (Kathiresan 2012). However, the value of intact mangrove ecosystems in supporting local economic production could be substantial and could contribute significantly towards achieving better development outcomes for these communities while maintaining global values.

MATERIALS AND METHODS

Entry Protocol

In order to conduct the study, a letter requesting for the permission to conduct the study and to comply for gratuitous permit were forwarded to the Office of the Punong Baranggay of Molugan, El Salvador City, Office of the City Mayor of El Salvador, Office of The City ENRO in El Salvador, Office of the CENRO, Initao, and the DENR Regional Office 10. All necessary environmental and health protocol were deliberated and taken in place in conducting the study.

Research locale

The study was conducted at the Mangrove Area in Molugan, El Salvador City, Philippine. The collection of data was accomplished from September to December 2020 (Figure 1). Division of the study site included the landward zone, middle zone and the seaward zone. The Station 1 was the landward zone, Station 2 was the middle zone and the seaward zone was Station 3.

Establishment of the Study Site

The selection of the study sites or stations determined based on the zonation pattern of the mangrove. The landward zone of the original mangrove area in Barangay Molugan was assigned as the first station. The middle zone as part of the original mangrove is assigned as the second station and the seaward zone, which is part of mangrove rehabilitation area assigned as the third station. The identified study sites or stations were properly documented.

Sampling Procedure

Three (3) different stations on the mangrove area in Molugan, El Salvador City were selected as sampling sites. The inventory of mangrove species in Molugan, El Salvador City was done through the Quadrat method (BMB 2017) three quadrats measuring 10mx10m were laid out to represent the seaward zone, middle zone and landward zone. Each station is 10 meter away from each other. Several field trips were made to select the field stations. The mangrove area includes the original mangrove area where the landward and middle zone is located while the seaward zone is the area of mangrove rehabilitation (Table 1).

Table 1: Selected sampling stations with coordinates

Quadrat	Zone	Status/ Mangrove area type	Latitude	Longitude
1	Landward zone	Degraded/ Original Mangrove area	8.5354011°	124.5572936°
2.	Middle zone	Degraded/ Original Mangrove Area	8.5355867°	124.5573917°
3	Seaward zone	Intact/ Rehabilitation Area	8.5344938°	124.5608747°

Morphology and Habitat Description

Each specimen collected was described in terms of the leaf, flowers and propagules. Those parts were represented in the herbarium preparations. The gathered plants was numbered and record in the filed notes regarding the collector, date of collection, locality, common name, habitat, diameter breast height and height of the mangrove.

Ex Situ Conservation

Two live representative specimens of each species were collected during sampling

Documentation

Photographs were made from actual observation in the field site as to the mangrove species natural habitat using camera.

Preparation of herbarium specimen

Field notes were taken and preliminary identification of mangrove species and habitat description will be conducted. Morphological characteristics of leaf, flowers, and propagules

were noted and used in the identification of species. Key guides such as the Field guide to Philippine Mangroves by Primavera 2006 and other published work were used.

Photographs were made from actual observation in the field site to the mangrove species natural habitat using high-resolution camera. Species diversity was determined using the Shannon index of diversity, with the formula for the computation based on Magurran (1988):
Shannon index H+ =-∑[n1/N)[ln(n1/N)]
where:

H' = Shannon index of diversity

n1 = frequency of occurrence of species within the plots n = the total number of occurrences of all species in all plots **Ethical Considerations**

The researcher ensured that the study was guided by ethical principles. The ethical principle emphasized in this study is informed consent. A gratuitous permit was secured, approved letter from the Barangay Captain, Mayor, City ENRO and DENR Region 10 as requirements to obtain the gratuitous permit.

RESULTS AND DISCUSSION

Taxonomy and Morphology of Mangroves at Molugan, El Salvador City

There were eight (8) species of mangroves were collected in the study site and pre-identified until species level and confirm by the expert. The collected mangroves belong to five (5) families, namely Avicenniaceae, Combretaceae, Rhizophoraceae, Lythraceae and Arecaceae.

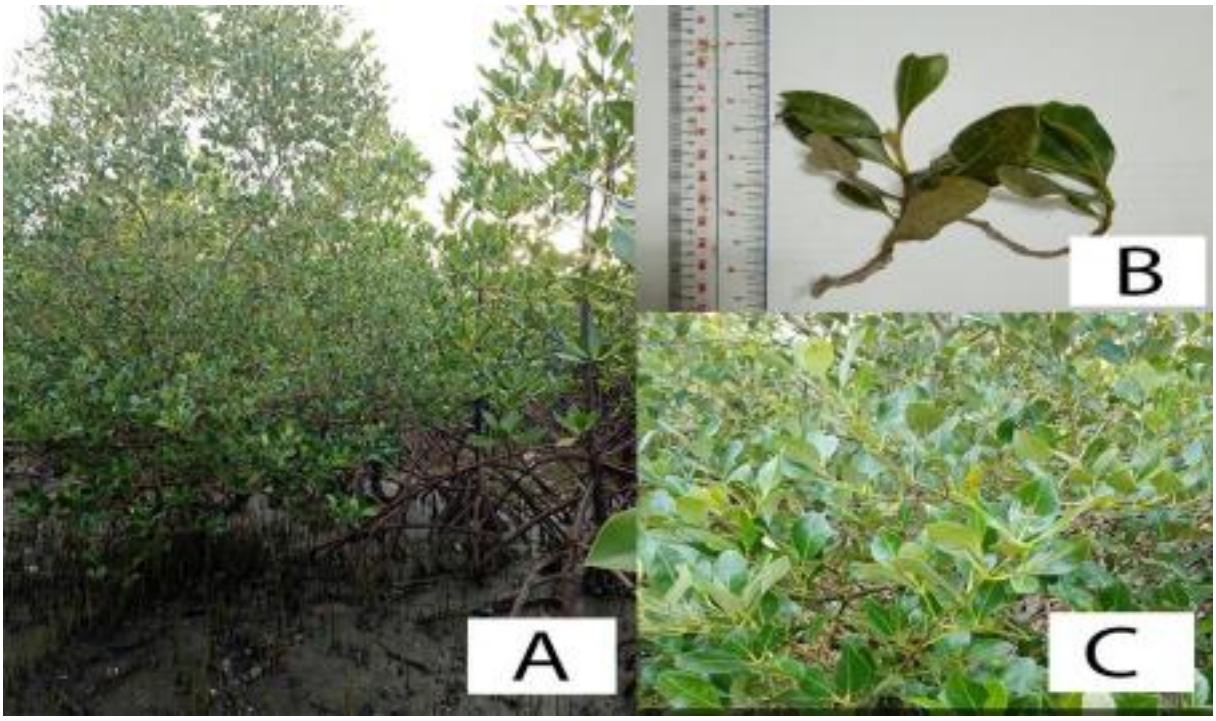

Figure 2: A. Pneumatophore of Avicennia marina, B. Leaves, C. Actual photograph of the leaves

Family: Avicenniaceae
Scientific Name: *Avicennia marina*
Common Name: Bungalon, Api Api, Miapi
Distribution: It is found in the locality of Molugan, El Salvador City in coordinates Latitude: 8.5344938° and Longitude: 124.5608747° **Ecology:** The species is found in mangrove swamp in Molugan, EL Salvador City.
Taxonomic treatment:

Small to the medium-sized tree (3-11 m), main trunk straight, up to 76 cm in diameter, with a much-branched, rounded crown. Leaves opposite, 30-100 x 12-40 mm, thick, leathery, shiny olive-green above, with dense grey hairs beneath, margin entire with sharply or bluntly pointed tip, base narrowing, petiole short (5 mm long). Bark pale yellowish-green, with raised dots, flaking. Extensive underground root system with 'pencil roots' (pneumatophores or breathing roots) up to 90 mm long, sticking up out of the mud in dense stands spreading out from the tree.

Flowers creamy yellow, small, dense round heads in leaf axils or terminally, on short, square stalks, sweetly scented. Fruit a green, oval, two-valved capsule 20-25 mm diam.; seed developing on the tree, fruit usually splitting after falling; water-dispersed.

Figure 3: Mangrove tree of Avicennia rumphiana, B. Leaves C. Actual Photograph of Leaves

Family: Avicenniaceae
Scientific Name: *Avicennia rumphiana*
Common Name: Bungalon, Api Api, Miapi
Conservation Status: Threatened
Distribution: It is found in the locality of Molugan, El Salvador City in coordinates Latitude: 8.53538° and Longitude: 124.5572783° **Ecology:** The species is found in coastal swamp in Molugan, EL Salvador City. **Taxonomic treatment:** Height of 3 to 10 m (9.8 to 32.8 ft), or up to 14 m in tropical regions. The habit is a gnarled arrangement of multiple branches. It has smooth light-grey bark made up of thin, stiff, brittle flakes. The leaves are thick, 5 to 8 cm (2.0 to 3.1 in) long, a bright, glossy green on the upper surface, and silvery-white, or grey, with very small matted hairs on the surface.

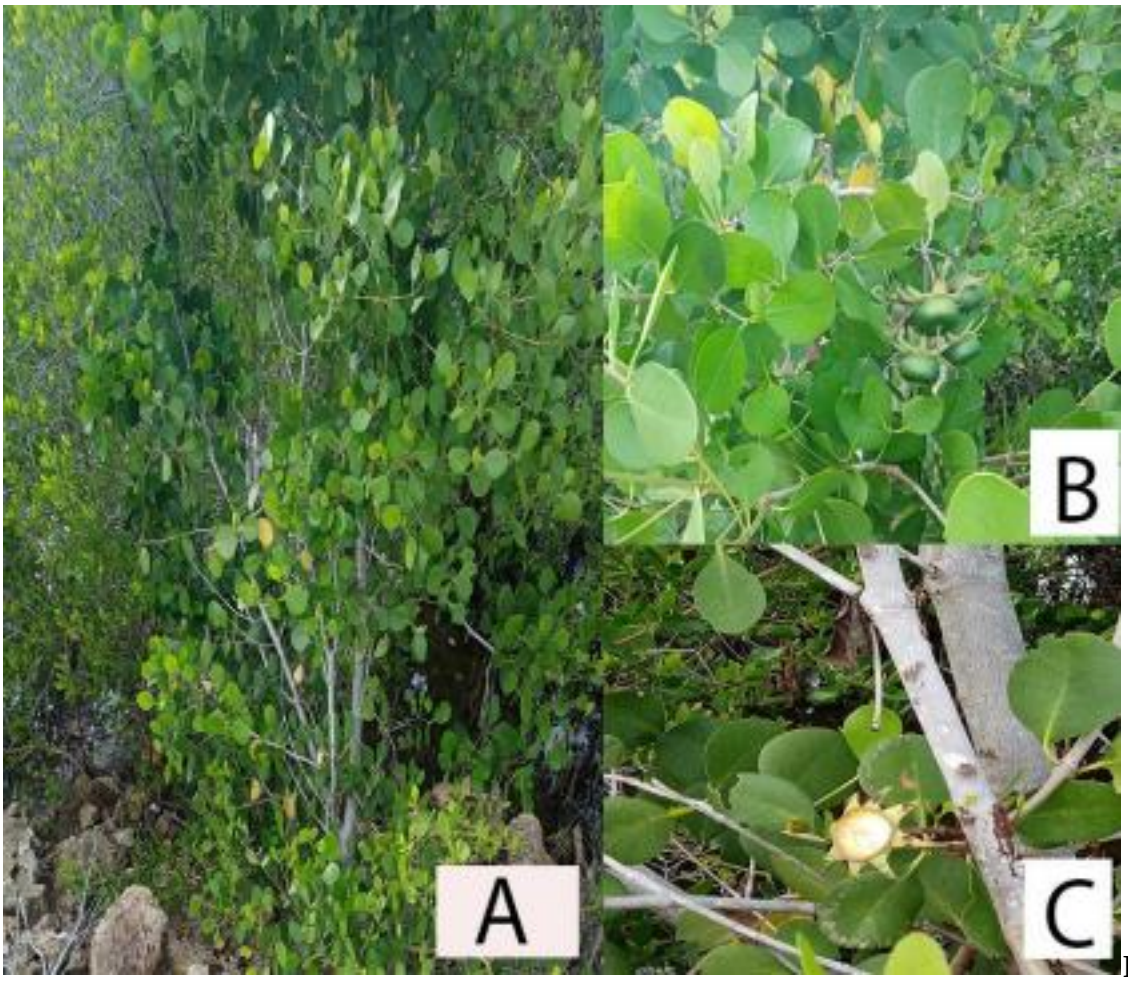

Figure 4: A. Mangrove tree of *Sonneratia alba*, B. Fruit of *Sonneratia alba*, C. Stem of *Sonneratia alba*

Family: Combretaceae
Scientific Name: *Sonneratia alba*
Common Name: Pagatpat
Conservation Status: Threatened
Distribution: It is found in the locality of Molugan, El Salvador City in coordinates Latitude: 8.5355867° and Longitude: 124.5573917° **Ecology:** Grow inland side of coastal swamp in Molugan, El Salvador City. **Taxonomic Treatment:** grows up to 40 metres (130 ft) tall with a trunk diameter of up to 70 centimetres (30 in). The cracked to fissured bark is brownish, turning grey below the tidal mark. The flowers are white, pink at their base. The dark green fruits measure up to 5 cm (2 in) long.

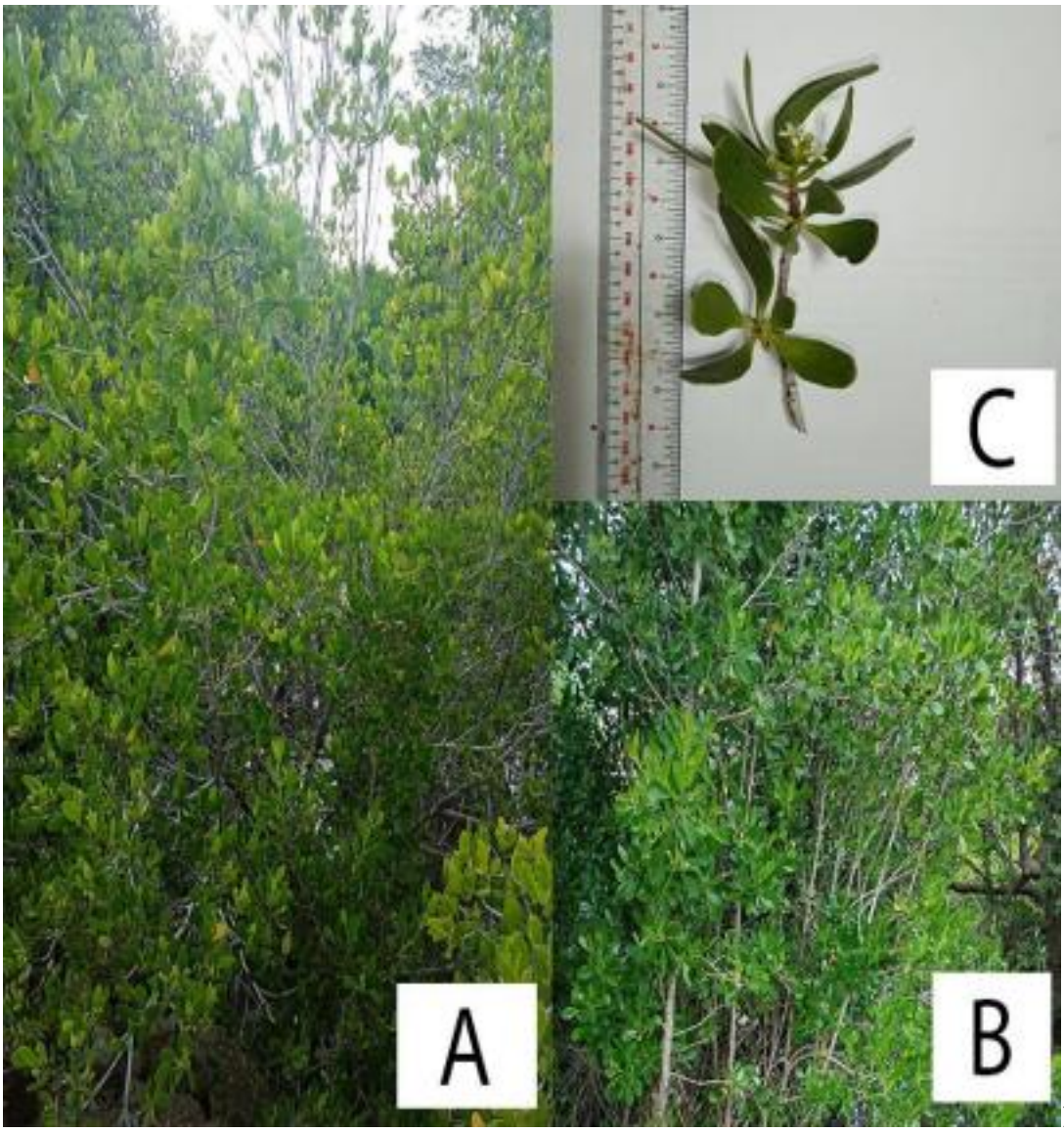

Figure 5: Mangrove tree of *Lumnitzera racemosa,* B. Leaves and Flowers, *C.* Actual Photograph of leaves

Family: Combretaceae
Scientific Name: *Lumnitzera racemosa*
Common Name: Tabao, Culasi
Conservation Status: Threatened
Distribution: It is found in the locality of Molugan, El Salvador City in coordinates Latitude: 8.5354107° and Longitude:124.5572481° **Ecology:** The species is found in mangrove swamp in Molugan, EL Salvador City.
Taxonomic Treatment: small to medium-sized evergreen tree, growing to a maximum height of 37 m (121 ft). It develops pneumatophores and often has stilt roots. The leaves are arranged spirally at the tips of the shoots; they are simple and obovate, with slightly toothed margins.

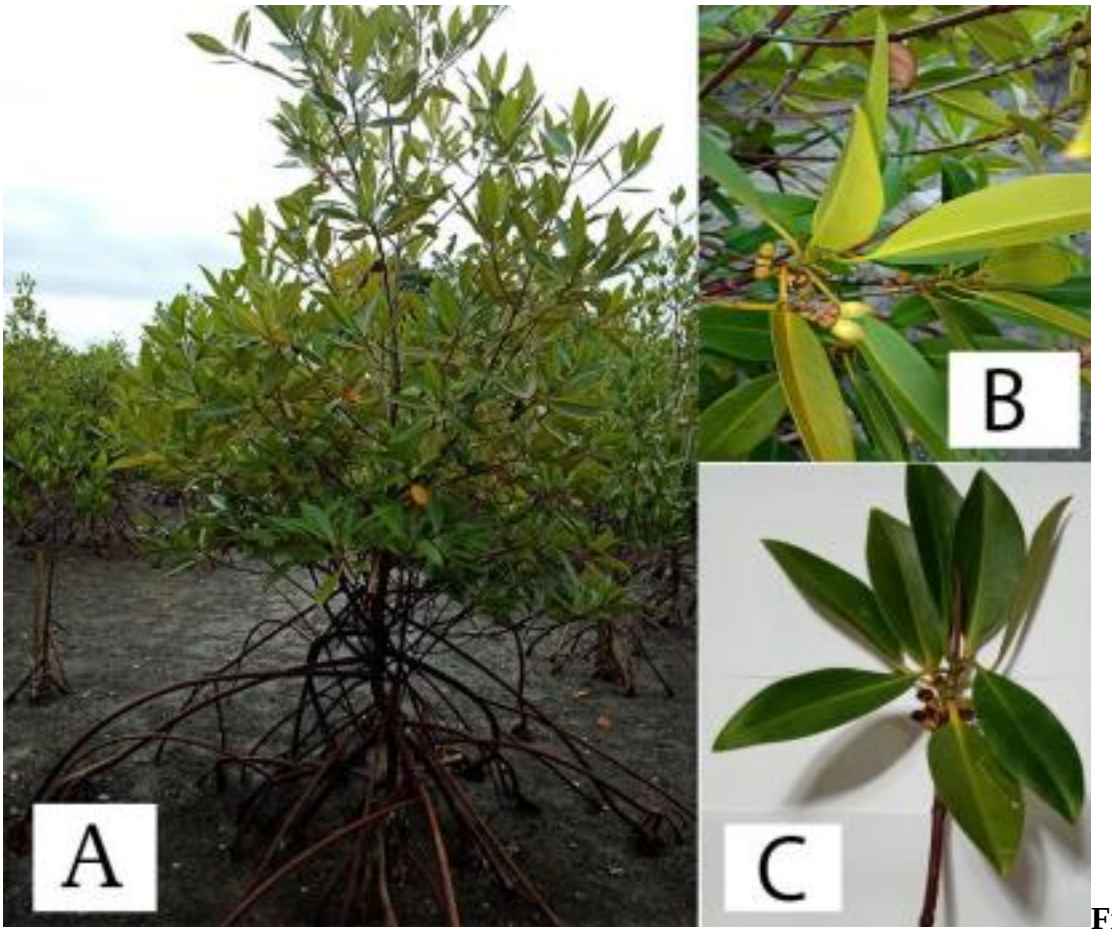

Figure 6: Mangrove tree of *Rhizophora apiculata* B. Flower C. Leaves

Family: Rhizophoraceae
Scientific Name: *Rhizophora apiculata*
Common Name: Bakhaw Lalaki
Conservation Status: Least Concern (Population Decreasing) **Distribution:** It is found in the locality of Molugan, El Salvador City in coordinates Latitude: 8.5369785° and Longitude:124.5574896° **Ecology:** The species is found in sandy coastal areas in Molugan, El Salvador City.
Taxonomic Treatment: Tree 20-30m tall. Bark dark grey and chequered. It is conspicuously arching stilt roots that can extend 5m up of the stem. Often also with lots of aerial roots emerging from the branches so that the tree appears to have a skirt of roots under the leave. Leaves eye shaped (8-15cm long), glossy green and stiff, with tiny evenly distributed black spots on the underside. A stipule is usually (but not always) red. Flowers (1-2cm) in pairs on very short stalks so they appear to be stuck directly onto the branch. Calyx globular hard thick, brown on the outside yellow inside.

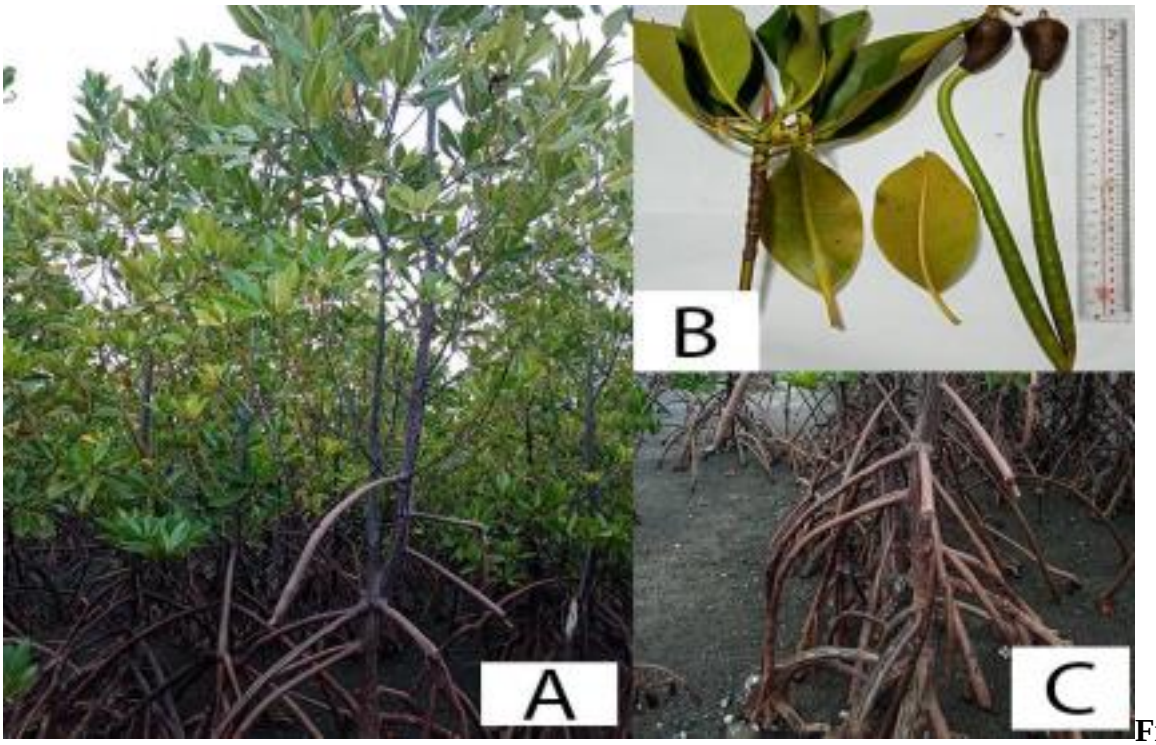

Figure 7: A. Mangrove tree of *Rhizophora mucromata, B. Leaves, Flowers and Propagules, C. Stilt roots*

Family: Rhizophoraceae
Scientific Name: *Rhizophora mucromata*
Common Name: Bakhaw babae
Conservation Status: It is declining due to harvesting and habitat degradation; it is not threatened with extinction but should be monitored.
Distribution: It is found in the locality of Molugan, El Salvador City in coordinates Latitude: 8.5369785° and Longitude: 124.5574896 **Ecology:** The species is found in sandy coastal areas in Molugan, El Salvador City.
Taxonomic Treatment: The tree's size is from small to medium, and it measured 2–5 m, even up to 10 m tall, with strong apical dominance. Stem up to 400 mm in diameter, straight, with distinctive aerial roots or what is also referred to as knee-roots (breathing roots), with rough reddish, brown to almost black bark and extending, bristled, light grey branches. Leaves compact, simple, oppositely arranged, broadly elliptic to oblong-elliptic, leathery, hairless, glossy, dark green to yellowish
green, crowded towards the end of branches; margins smooth with pointed apex and distinctive hair-like tip of up to 5 mm long; tapering at both ends; main vein prominent and with distinguishing black dots underneath the leaves. Creamy white flowers, few arranged in axillary heads, leathery with short thick stalks; calyx persistent. The fruit is
single-seeded, up to 70 mm long, germinating while still on the tree (viviparous). It is said that its seeds do not last long in

storage.

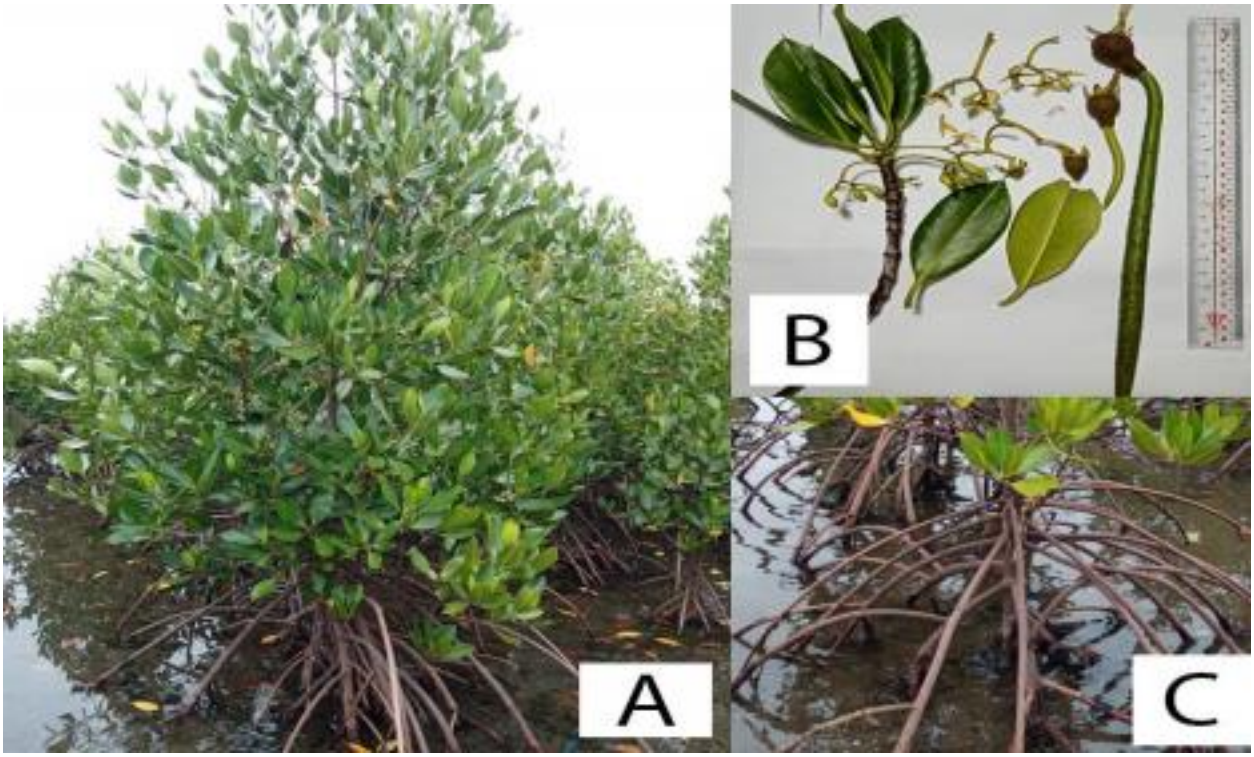

Figure 8: Mangrove tree of *Rhizophora styloza B. Leaves, Flower and Propagules, C. Stilt root*

Family: Rhizophoraceae
Scientific Name: *Rhizophora styloza*
Common Name: Bakhaw bato
Conservation Status: It is declining due to harvesting and habitat degradation; it is not threatened with extinction but should be monitored.
Distribution: It is found in the locality of Molugan, El Salvador City in coordinates Latitude: 8.5344938° and Longitude:124.5608747° **Ecology:** The species is found in sandy coastal areas in Molugan, El Salvador City.
Taxonomic Treatment: Height of 3 to 5 meters, and the propagules grow 20 to 30cm in length. Rhizophora species-typical stilt roots or prop roots. Stilt roots arise from the trunk or branches of the mangrove and grow toward the soil where the stilt root will develop an underground root system. The leaves are generally opposite and have an elliptic shape. The upper side is smooth and dark green; the bottom is waxy and light green to yellowish. The Stilted Mangrove has thick and leathery leaves, which are up to 14cm, most of the time between 6 to 12cm and about 4 to 8cm wide. The blossoms of Rhizophora stylosa are small and inconspicuous
as all blossoms of all Rhizophora species. The colors of the blooms are usually white and yellow, which can vary from pale yellow to dark yellow.

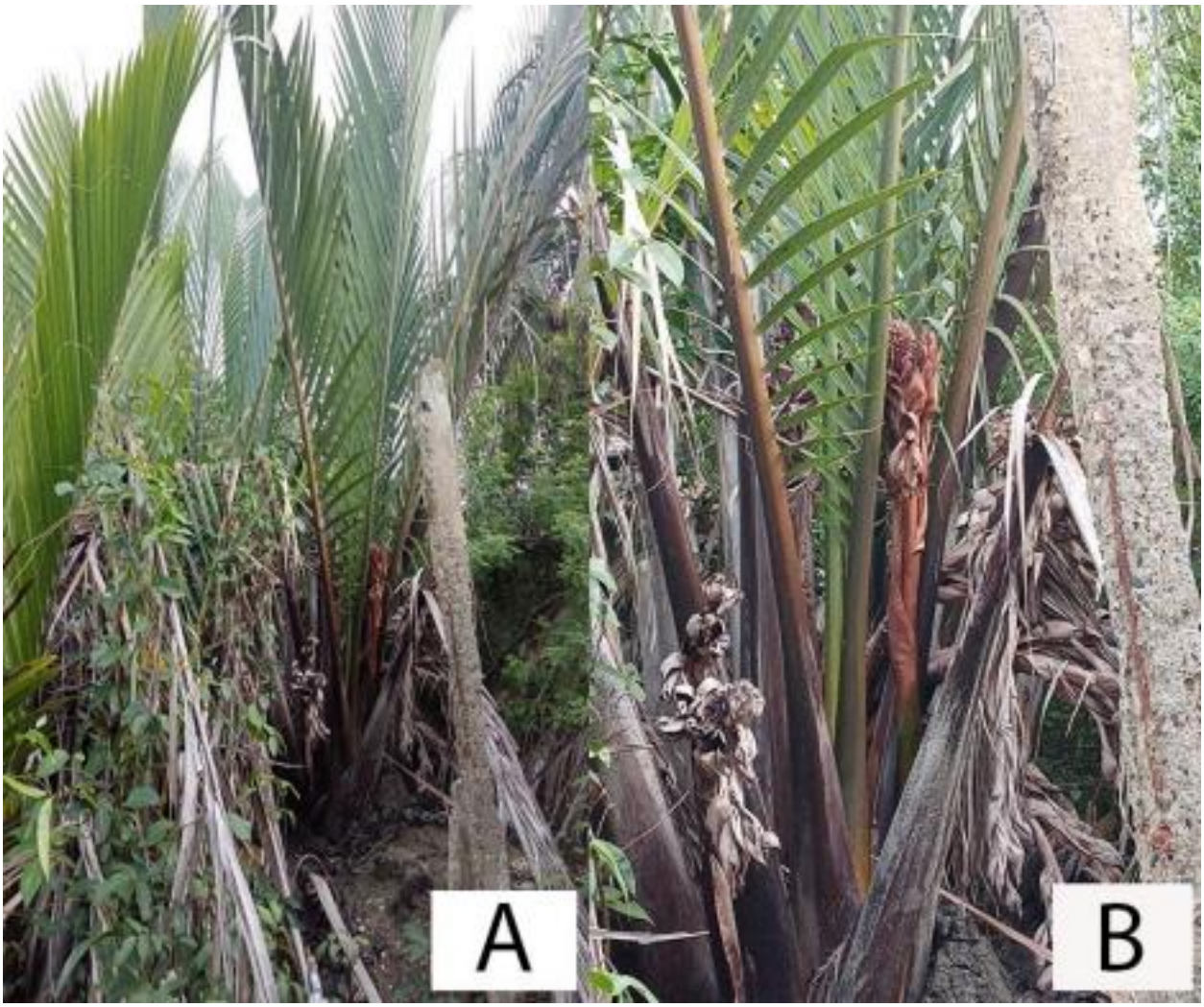

Figure 9: A. Mangrove tree of *Nypa fruiticans*, B. Flower

Family: Palmae
Scientific Name: Nypa fruticans
Common Name: Nipa
Conservation Status: Least Concern (Population Decreasing) **Distribution:** It is found in the locality of Molugan, El Salvador City in coordinates Latitude: 8.535375° and Longitude:124.5567783° **Ecology:** The species is found in mangrove swamp in Molugan, El Salvador City.
Taxonomic treatment: The nipa palm's trunk grows beneath the ground, and only the leaves and flower stalk grow upwards above the surface. Thus, it is an unusual palm tree, and the leaves can extend up to 9 m (30 ft) in height. The flowers are a globular inflorescence of female flowers at the tip with catkin-like red or yellow male flowers on the lower branches. The flower produces woody nuts arranged in a globular cluster up to 25 cm (10 in) across on a single stalk. The ripe nuts separate from the ball and are floated away on the tide, occasionally germinating while still water borne.

Species Composition, Abundance and Distribution

A total of eight (8) mangrove species were recorded in Molugan, El Salvador City (Table 2). These species belong to five (5) families. Rhizophoraceae is the most represented family with 3 species, followed by Acanthaceae with two (2) species. Species belonging to *Rhizophoraceae* include *Rhizophora apiculata*, *Rhizophora mucronata* and *Rhizophora styloza, while those of Acantacheae include Avicennia marina* and *Avicenna rumphiana.*

Overall total of 205 individuals of mangroves were recorded from the sampling sites (Table 2). *R. stylosa* (Quadrat 3) is the most abundant, having the highest number of individuals (33). R. mucromata (Quadrat 3) is the second most abundant with 29 individuals. The next most abundant are *A. marina, S. alba* and *R. apiculata,* while the least abundant are *L. racemosa* and *N. fruticans.*

Three species (R. *apiculata, R. mucromata* and *A. marina*) were observed to occur in all sampling sites. Three species (*R. stylosa, A. rumphiana, L. racemosa and S. alba)* occurred in two sites. While one species (*N. fruticans*) and occurred in a single site only. The results shows that the abundant species are also widely distributed species, while the less abundant species are those with limited distribution.

R. stylosa dominated the seaward zone because of its high adaptability and tolerance to climate and soil. It also grows in muddy, sandy, stony soil as well as in the corals. *R. mucromata* is generally widespread throughout the mangrove forest, usually occurs along tidal streams and river banks with soil rich in humus. It can also tolerate hypersaline conditions. *R. apiculata* usually occur in mangrove swamps although it prefers soft mud normally flooded with tidal waters. *A. marina* is abundant in exposed areas facing the sea and has high tolerance to hypesaline conditions. *A. rumphiana* occurs on river banks on firm mud and rare on the seaward zone. *S. alba* usually occurs in newly formed sandy mud falls in estuaries and tidal streams and can tolerate salinity (Melana & Gonzales, 2000).

Species richness of mangrove in Molugan, El Salvador City is very low compared to those recorded in other parts of Mindanao such as in Panguil Bay which mangroves consisted of a total of 11, Davao Gulf with eight (Lumasag et al., 1991, 1996) and Pangasinan in Gingoog Bay which mangroves consisted of eighteen species (Dalogdog, 2006). However, this observation should be taken with caution since these mangrove forests have been reforested. There are several factors attributed to it, such as the size of the mangrove area and the number of trees present and mangrove planting activity provided only particular species of mangrove to plant which are suitable to the condition of the area such as *Rhizophoraceae sp*. is the most common and often used in replanting activities. Most of the seedlings of Rhizophora (Bakawan) are planted and cannot be attributed to natural regeneration. At the same time, *S. alba* (Pagatpat) tress is probably from natural recruitment.

However, in 2016, Shah, Kamal, Rosli, Hakeem, and Hoque identified nine mangrove tree species from eight families at the Sibuti mangrove forest. Sarawak was the dominant mangrove

species in the forest and also *Rhizophora apiculata*. Like *R. apiculata*, *Xylocarpus granatum* was also found in all three transects, and Nypa fruticans was observed on the river bank.

Table 2. Species composition of mangroves in Molugan, El Salvador City.

Family	Common Name Species		Local Name	Quadrat			
				Q1	Q2	Q3	Total
Acanthaceae	Black mangrove	*Avicennia marina*	Bungalon, Apiapi, Miapi	14	13	1	28
		Avicennia rumphiana	Bungalon, Apiapi, Miapi	12	10	0	22
Combretaceae	White mangrove	*Lumnitzera racemosa*	Tabao, Culasi	8	9	0	17
Rhizophorace ae	Red Mangrove	*Rhizophora apiculata*	Bakhaw laki	2	3	20	25
		Rhizophora mucronata	Bakhaw Babae	2	2	25	29
		Rhizophora styloza	Bakhaw Bato	0	1	32	33
Lythraceae	Apple Mangrove	*Sonneratia alba*	Pagatpat	15	12	0	27
Arecaceae	Mangrove Palm	*Nypa fruticans*	Nipa, Sasa	10	0	0	10
Total No. of Species				7	7	4	
Total No. of Individuals				70	57	78	205

Species diversity

Estimates of Shannon- Wiener Diversity Index (Table 3) shows that the species diversity of the mangrove communities in the three quadrats within the mangrove forest of Molugan, El Salvador City is relatively weak with H' values ranging from 0.71- 1.65. Middle zone obtained the highest diversity with 1.65, which indicates that it has the most diverse mangrove composition, followed by landward with 1.62. In contrast, quadrat 3 with 0.71, which was located at the seaside of the forest, showed the least different quadrat in terms of mangrove composition because *Rhizophoracea* species are dominated this quadrat.

The index is used to measure the diversity that accounts for the number of species present in the area and the relative abundance of each species. Hence, if the species richness increases, the diversity increases (Barcelona Field Study Centre, 2015). The seaward has the lowest index of evenness due to the least number of species richness and the predominance of *Rhizophoracea* species. Aggregating the data from the three quadrats indicates an overall mean diversity index of H' 1.33, which indicates low diversity. The mangrove community of Molugan is relatively high in terms of species diversity, due to high species richness and abundance of most species. Another factor affecting the diversity measure of Molugan mangroves is the dominance in the number of a few species, notably *Rhizophora sp*., while other species are rare.

The current study is similar to the study of Cañizares and Seronay (2016). They conducted a survey of the diversity and species composition of mangroves in Barangay Imelda, Dinagat Island, and the Philippines. They concluded that Barangay Imelda, Dinagat Island, falls under very low Diversity (H category) with ten true mangrove species, belongs to six families. Additionally, according to Sambu, Rahmi, and Khaeriyah (2014), the species composition of mangrove vegetation in their three study sites shows that heterogeneity or biodiversity is very low since they only found four (4) mangrove vegetation. The above authors further claimed that based on their findings, the adaptability of mangrove vegetation differs either in versatility to zonation or resilience level. Species Rhizophora is more adaptive to zonation, and it can be restored fast compared to other vegetation.

Table 3: Shannon- wiener index of the three quadrats within mangrove forest in Molugan, El Salvador City.

	Seaward	Middle	Landward	Mean
Index of Diversity (H')	0.71	1.65	1.62	1.33

Interpretation: Typical values are generally between 1.5 and 3.5 in most ecological studies, and the index is rarely greater than 4.The Shannon Index increases as both the richness and the evenness of the community increase

CONCLUSIONS AND RECOMMENDATIONS

As for the study results, it can be concluded that the mangrove area is conducive to the growth of several mangroves. It was mostly dominated by mature mangrove trees but some parts are degraded indicating that it had human disturbance and was relatively unstable.

Mangrove reforestation and rehabilitation project located in the seaward coastal zone in Barangay Molugan was a very important project to the residents to replace those former mangrove areas located in the middle and landwards zone of mangrove forest that will soon be extinct because of coastal development. Other positive impacts on mangrove conservation in the area include the control of dynamite fishing partly attributed to the organization's visibility; involvement of fishermen who are now protecting the mangrove. The community headed by the organization also keep the cleanliness of the area by conducting "pahina," a communal cleanup drive regularly. To sustain the program, they make a follow-up to check if the planting is in place. Despite efforts to protect the area, there is still another individual who cut newly planted mangroves unnoticed. To address this problem, they always remind the group to be more vigilant and cited the role of caretakers. This effort of conservation highly shows a significant part of the people's organization in mangrove rehabilitation in Barangay Molugan. Today, the mangrove forest serves as a sanctuary of fishes and eggs and a tourist spot of the City.

Recommendations

Based on the study's findings, it is recommended to sustain the effort by strengthening the organization through training related to reforestation by the DENR. The local community should be encouraged to participate in these activities actively. Furthermore, regular monitoring of the mangrove status should be conducted at regular periods, e.g., annually, to determine improvements from any rehabilitation activities. It is also recommended that residents in the area participate in reforestation programs and planting another species. Strict implementation of laws should be done to minimize if not stop the cutting of mangroves in the area to allow trees and seedlings to grow. The increase in species richness is significant for achieving ecologically stable mangrove flora associates that may provide economic benefits to the community.

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