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FLORAL DISTRIBUTION, ABUNDANCE AND DIVERSITY OF MANGROVES IN SANGUPIDDY, KILINOCHCHI, THE NORTHERN COAST OF SRI LANKA

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Abstract: Sri Lanka, a precious little tropical island in the Indian Ocean harbors a remarkable amount of mangrove habitats scattered along the coastal zone of the country, yet confined to narrow strips since the country has a low tidal amplitude. However, most of the researches have given importance to the mangroves of wet zone of the country. Although neglected, Northern province shares about 16% of the total mangrove extent of the country. The research aimed to identify the floral distribution of mangroves in Sangupiddyof the Northern province, Sri Lanka. Mangrove vegetation was surveyed with 5m belt transects laid perpendicular to the shoreline and across the water – land gradient. True mangrove species in each transect were identified and counted. The quantitative data has been used to compute Shannon diversity index (H), Simpson Index (D) and Shannon Evenness (E), which were used to compare the diversity of the sites, sampled.Two true mangrove species of two families were identified at the site. Highest Shannon diversity index (H = 0.27) and the lowest Simpson index value (D = 0.72) was observed in 2nd transect. Since the place is used for fishing and tourism, pollution and human interaction can degrade the environmental quality of the mangrove habitats. Actions should be taken for conservation of existing patch and replenishment of new mangroves.

Key words: *Mangroves, Diversity, Zonation, Pollution, Replenishment*

I. INTRODUCTION

The term “mangrove” used to define both the plants that occur in tidal forest, and to describe the community itself. Generally, mangroves can be broadly defined as woody halophytes occurring in marine and brackish environments, restricted to the intertidal zone; which could be visible in the tropical and sub-tropical coastlines. Mangroves are true ecotones, occupying a margin between land and sea, composed of several genetically unrelated faunal and floral assemblages [3]. They could be either large trees or dense shrubs, specifically called ‘mangrove swamps’.

Mangroves are architecturally simple ecosystems, but also have developed unique adaptations; such as viviparous embryos, physiological mechanisms and aerial roots to survive through the high salinity [1].

Exclusivity of mangrove lies with their ability to grow optimally while tolerating salt, lack of freshwater and a stable substratum, and hypoxia when inundated and unfavorable conditions for seed germination and establishment that is commonplace in the inter-tidal zone. [3].

Mangroves provide a wide array of services to the humankind and to the bionetwork. They provide essential food and fuel services, nursery grounds for aquatic fauna, coastal protection (against pollution, Tsunami, and storms), sequesters carbon and other sediments [1], primary production, pollution abatement and recreation [8]. It has been recognized as a highly productive wetland system. They are also being emphasized in sustaining the adjoining intertidal ecosystems. In terms of climate change mitigation, they play an important role in maintain a balance of the atmospheric carbon dioxide via noteworthy quantities of carbon cycling and photosynthesis. Hence, these are unique and highly productive ecosystems, which deliver immense ecological and economical services. They are important in sustaining related faunal, floral as well as human lives.

Mangroves in most of the lagoons are highly productive, but extremely vulnerable habitats confined to intertidal zones of coastal environments including specially lagoons. They have special adaptations to harsh environmental conditions and mangrove habitats are considered as biodiversity hotspots [7].

Sri Lanka described as “The pearl of the Indian Ocean”, is located between latitudes 5.55’ and 9.51’

North and longitude 79.41' and 81.54 East in the Indian Ocean. It is found to the South of the Indian Subcontinent. The island spans about 65,610 sq. km and is astonishingly varied and with a continental shelf of 44,250 sq. km. The coastline is approximately 1600 km in length with a cover of 158,016 ha [8] of brackish water area. Thus, Sri Lanka enjoys wide array of coastal ecosystems such as coral reefs, mangrove forests, lagoons and estuaries, mudflats, sand dunes and beaches.

Since the tidal range of Sri Lanka is small, ranging from mean low water spring -37 cm to mean high water spring +40 cm [7] in relation to the mean sea level, the mangroves in are limited to narrow belts bordering the lagoons and estuaries [6], [8], thus showing a patchy distribution. Edirisinghe *et al.,* 2012 stated that the extent of mangroves in Sri Lanka is about 15, 670 ha [6], [8] which is less than the 0.03% of the total area and 0.2% of the total forest area.

Depending on the distribution, mangroves are divided as true and mangrove associates. True mangrove species are absolutely bound to brackish water areas while mangrove associates can grow in similar as well in aquatic environments and coastal backwaters with saline soil [10]. According to IUCN,twenty-one true mangrove species and approximately twenty-three mangrove associate species have been recorded in Sri Lanka [8]. But the species richness of the mangrove species is being notably decreasing with time due todestruction of mangrove forests and exposure to various anthropogenic pressures. Efforts should be carried out to minimize the deforestation and to promote reforestation of mangroves.

Jaffna Peninsula is an area in the Northern Province, Sri Lanka and is home to the capital city of the province, Jaffna. The northern part of the country has a shoreline of 403 km and comprises of 17 lagoons that cover nearly 804 sq. km [7]. Here the mangrove ecosystems have been distributed discontinuously along the shoreline. This area comprises of a mangrove patch of about 2505 ha covering areas of Thondamanar, Chundikulam and Jaffna lagoon. Sangupiddy Bridge is a road bridge across the Jaffna lagoon connecting Sangupiddy in Kilinochchi district to Karaitivu in Jaffna District. It is one of only two road bridges connecting the densely populated Jaffna Peninsula with the mainland.

The northern part of the island tends to be hot and dry in the dry season (February to September) and moderately cool and moist in the wet season (October to January). The area experiences average temperature of about 28^{O} to 30^{O} all around the year and an annual rainfall of less than 1250 mm. relative humidity varies from 70% during the day to 90% at night. Due to these reasons, the mangrove diversity is not that rich as in the other parts of the island but they have a wide distribution throughout the province. They generally have scarce numbers of lagoons. Since the fresh water flush is low or poor, the brackish water in here is tend to be highly saline.

The objective of this study was to determine the distribution, abundance and the diversity of true mangrove species and mangrove associates in Sangupiddy area of the Northern Province of Sri Lanka.

II. METHODOLOGY

Study Sites

Five points were located in the coastal stretch of Sangupiddy Bridge, which runs along the Navatkuli – Karaitivu - Mannar Highway, which connects Sangupiddy, Kilinochchi with Karaitivu via Jaffna. The bridge runs across the Jaffna lagoon. The mangrove ecosystems were scattered near the bridge and are located in the Northern coastal belt of the country. All the study sites are located in the dry zone of Sri Lanka (Figure 1).

Vegetation sampling

Mangrove vegetation was sampled using transect method. Species richness and density data were collected from 10m wide belt transects. Transects were randomly laid in the mangrove vegetation perpendicular to the shoreline (five transects) (Table 1) across the water-land gradient. Length of the transects varied depending on the density of the mangrove patches. About 10% of the area of each point was sampled. Each transect was divided into 5m x 5m sub plots for convenience of sampling. Within each transect true mangrove species were identified and counted.

Data Analysis

Quantitative data were used to calculate diversity indices based on species richness (Margalef Index, D_{Mg}), and proportional abundance (Shannon Index H'). Species dominance was estimated using Simpson index (D) and Shannon Evenness (E) was computed. The indices were used to explain the distribution and abundance of mangroves in the selected site. All the data analysis were done with MS Excel 2010 version and SPSS 17.0

III. RESULTS

Species distribution

Surprisingly only two true mangrove species,*Avicennia marina*and *Bruguiercylindrica* were identified in the study site (Figure 2). *Brugueira cylindrica* was common and seen in higher numbers at all the points that have been sampled. Other than that, *Avicennia marina*was the least abundant to be recorded at the sites sampled.

It was observed that *Avicennia marina*occupied the insides of the shores while *Brugueira cylindrica* has been found throughout the region, from the shoreline towards the estuary fringe (Figure 3).

Further, it was observed that the mangroves were relatively shorter, more like mangrove shrubs, than those tall trees found in the wet zones of the island.

Diversity indices

As from the results of the 2t- test the Shannon diversity values of the study site significantly vary from each other (p=0.016). Highest Shannon diversity index (H = 0.27) and the lowest Simpson index value (D = 0.72) was observed in point 2(Table 3). This point tended to show highest mangrove diversity and species distribution over all the other points. In contrast least Shannon diversity index (H = 0.00) and highest Simpson index value (D=1.00) was observed in point 3, where only one species of mangrove was recorded. Highest evenness value (E = 0.90) and highest dominance value (D_{Mg}= 0.73) were observed in point 2 while the lowest evenness value (E = 0.00) and lowest dominance value (D_{Mg}= 0.00) were observed in point 3.

Figure 1: Location of the study sites

Table 1: Study locations and number of quadrats studied in each location

Sampling point	GPS Location	No. of quadrats
Point 1	$9^0$34’55.07 N, $80^0$12’1.30 E	3
Point 2	$9^0$34’54.31 N, $80^0$12’1.18 E	5
Point 3	$9^0$34’53.33 N, $80^0$12’1.02 E	6
Point 4	$9^0$34’52.27 N, $80^0$12’1.07 E	5
Point 5	$9^0$34’51.09 N, $80^0$12’0.92 E	4

Table 2: Abundance and distribution of mangrove in selected sites

Family	**Species**	**Point 1**	**Point 2**	**Point 3**	**Point 4**	**Point 5**
Avicenniaceae	*Avicinnia marina*	+	+	-	+	+
Rhizophoraceae	*Brugueira cylindrica*	++	++	++	++	++
Total no. of sp.	2	2	2	1	2	2

Absent = -, Very rare = +, Very common = ++

Table 3: Diversity indices obtained for studies mangrove ecosystems

	Point 1	**Point 2**	**Point 3**	**Point 4**	**Point 5**
No. of species	2	2	1	2	2
No. of individuals	24	23	21	30	30
Shannon diversity index (H)	0.12	0.27	0.00	0.14	0.17
Simpson Index (D)	0.80	0.72	1.00	0.79	0.77
Evenness, E	0.40	0.90	0.00	0.47	0.56
Margalef's index(D_{Mg})	0.72	0.73	0.00	0.68	0.68

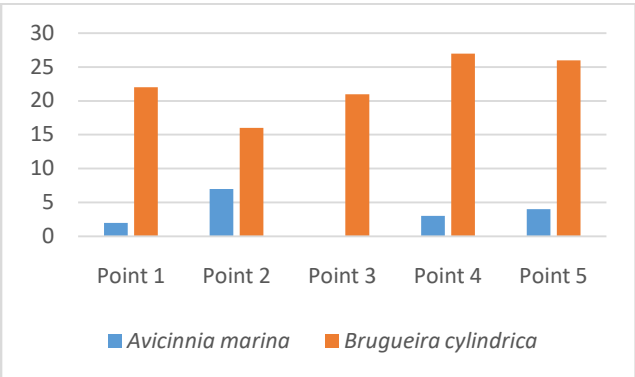

Figure 2: Distribution of the mangroves at the study site

As explained the Shannon diversity index was in the range of 0.00 – 0.30, whereas the Simpson index was observed in the range of 0.00 – 1.00. The number of total individuals recorded at point 4 and 5 were same. Still they have relatively different Shannon and Simpson index (H = 0.14 and 0.17 and D = 0.79 and 0.77 respectively).The least Shannon diversity index and evenness was recorded in point 3 at 0.00 and 0.00 respectively. This was because of the prevalence of only one species.

IV. Discussion

The study site consisted of two true mangrove species namely *Avicennia marina*and *Bruguiercylindrica* from the families Avicenniaceae and Rhizophoraceae respectively (Figure 4). The sampling site is located in the dry zone of the country, which is with average temperature between

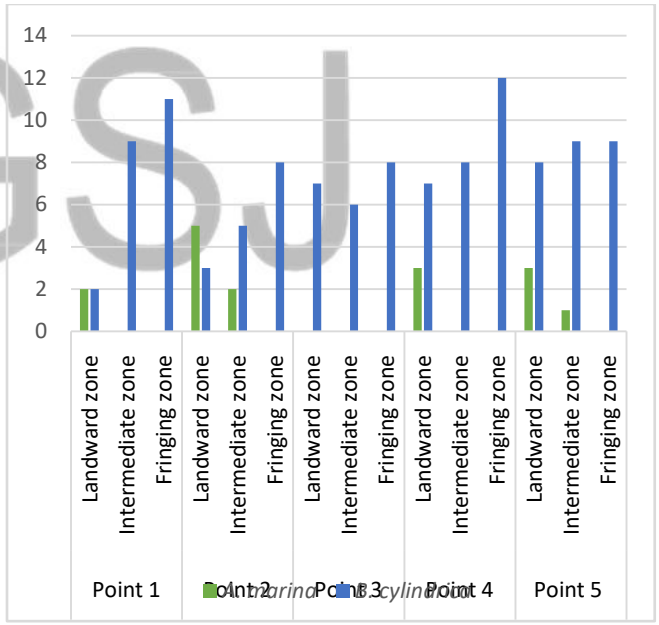

Figure 3: Zonation of the mangroves in the study site

28^{o} and 30^{o} and a mean rainfall less than 1250mm. The areas face extreme hot temperatures and low rainfall; thus,
the marshlands are highly saline. Further they, experience high flows of dry winds. Due to such reasons, the mangroves observed here are mostly shrubs rather than taller woody trees observed in the wet zones of the island.

Also, this may be attributed to differences with respect to their hydrology, soli salinity variations and other edaphic factors soil nutrition, texture, bulk density etc.).

It was observed that the soil in this area was with saline white patches (Figure 5) which could be due to either excessive evaporation or intrusion of salt water. Also, it should be noted that, since there lesser number of freshwater lagoons in the northern province of Sri Lanka, the fresh water inflow is fairly less. This could also raise up the salinity around the estuarine areas.

Figure 4: The mangrove distribution at the site

Species abundance and richness significantly varied from each other points sampled, as explained by the Shannon diversity index. However according to the survey undertaken, point 3 was lacking *Avicinnia marina*from the land ward fringe. Thus, the diversity observed was null at the specific point.

Figure 5: Soil structure of the study area

Avicinnia marina, unlike the other parts of the mangrove swamps in the country, was occupying the landward fringe in this site. In addition, it was found in few numbers, where as they are abundantly found in other parts specially the wet zones of the island. This could be explained by their inability to withstand dry conditions of the environment. *Brugueira cylindrica*, with their abundance in this area have proven its capability to endure extreme environmental conditions.

According to IUCN, mangrove species present in Sri Lanka can be categorized into most common, common and rare. The most common species of Sri Lankan mangroves are *Avicennia marina*, *Bruguiera gymnorrhiza*, *Excoecaria agallocha*, *Lumnitzera racemosa*, *Rhizophora mucronata*, *R. apiculata* and *Sonneratia caseolaris*. They can grow under a wide range of soil and hydrological conditions and are widely distributed in Sri Lanka. The common category of mangrove species include *Aegiceras corniculatum*, *A. officinalis*, *B. cylindrica*, *B. sexangula*, *Ceriops tagal*, *Heritiera littoralis*, *Pemphis acidula*, *Sonneratia alba*, and *Nypa fruticans*. Although these species are widely distributed in Sri Lanka, they are low in abundance. Rare species of mangroves that are few in numbers restricted to a few locations in Sri Lanka include *L. littorea*, *Xylocarpus granatum* and *Scyphiphora hydrophyllacea*[10]. It could be noted that the mangrove species spotted in this study site are commonly seen species throughout the coastal line of Sri Lanka. Also, there were no past studies or surveys done in this area way before.

This mangrove patch is located near to the Sangupiddy Bridge in Kilinochchi, Sri Lanka. Even though they never hold a diversified mangrove patch, these places are well known for the fishing activities. The fishermen use the mangrove patch as a harbor area, for fishing. However, the places seem subjected to various kinds of anthropogenic pressure. Fishermen using the mangrove poles and sticks to build fish baits and fishing rods can destroy the small patch spontaneously. Tourists littering the areas was also observed at the site. Plastic wrappers, foil, glass bottles and aluminum tins were observed at the site. They could be a hindrance to the fauna living or visiting the mangrove patch for their survival or migration. There weren't any large industries or aquaculture ponds near the mangrove patch, so there won't be any pollution via the effluents. Yet conservatory actions should be taken for the restoration and protection of this mangrove patch. Since the mangroves in the northern coastline are decreasing, care should be taken in replanting mangroves and conserving the existing patches.

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