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Taxonomic Diversity of Mangroves: Analysis of Morphological Characteristics in Different Ecological Niches

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Taxonomic diversity and morphological diversity are interrelated. The diverse mangrove systems can grow in wide range of geographical, climatic, soil and hydrological conditions.The main aim of this work is to record different morphological features (such as size of stem, leaves, flowers etc. in different species of Mangroves found in deferent ecological niches (like swamps, fresh water bodies, salt water, plainsand mountains etc).

Keywords: Mangroves, Ecological niches, Diversity.

The term "*mangrove*" was considered as chief component in Portuguese term "*mangue*" and the English term "*grove*." The corresponding terms in French were "*manglier*" & "*paletuvier*" [1]. In Spanish the term is coined as "*manglar*". In case of Dutch the term "*vloedbosschen*" describes the mangrovian community and the term "*mangrove*" refers the individual trees. Usage in German follows English. In Surinam, "*mangro*" refers *Rhizophora*[2]. It was believed that most of these terms were originated from Malaysian word, "*manggi-manggi*" which means "above the soil." At present, this term is not used in Malaysia but it is addressed in eastern part of Indonesia to refer *Avicennia* species.

Mangroves were quite old and it might have possibly arised after the evolution of first angiosperms before 114 million years[3]. *Avicennia* and *Rhizophora* were the first genera to evolve at the end of Cretaceous period[4]. Records of Pollen had provided vital information about the subsequent radiation. Fossil sediments in China and Leizhou Peninsula suggest that the mangroves were expanded their range from south to north. After reaching their limit on the northern region in the delta region of Changjiang by the mid-Holocene, a similar case study was conducted from the latent regions of Holocene. The samples found in Bermuda suggest the fact that the mangroves were established before 3000 years and the level of sea rise were gradually decreased from 26 cm to 7 cm per century[5].

Dr. Spalding gave a rough estimate of 18 million in hectares, with 41.4% in the south and southeast Asia along with an additional range of 23.5% in Indonesia. Mangroves were restricted to latitudes between 30°N and 30°S. Extension in north for this limit occurs in Bermuda (32°20'N) and Japan (31°22'N).In case of extension in south, Australia

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(38°45'S) and New Zealand (38°03'S) were highlighted.

Mangroves were distributed within their ranges and they were strongly affected by temperature[6] and moisture[7]. Currents in large-scale may also influence the level of distribution by the process of preventing propagates from reaching certain low areas[8]. Individual mangrove species differ in length along with their establishment in tolerance and growth rate. These factors were consistent around the world to produce a distributional range for most of the species, as illustrated in Table.1.

Taxonomy

Tomlinson (1986) had categorized mangroves as Major, Minor and associates. Major species were the strict mangroves and they were recognized by most of the following features like (1) Their occurrence in mangal. (2) Their role in community in forming pure stands. (3) They have aerial roots to perform the mechanism for gas exchange. (4) Their physiological mechanisms to exclude & excrete salt. (5) Their viviparous structure for reproduction and (6) Species isolation from their terrestrial relatives with respect to taxonomy.

The minor species of mangroves were rarely form pure stands. According to Tomlinson (1986), mangroves include 34 Species for 9 Generalization in 5 Families. The minor contribute to an additional of 20 species[9-11] in 11 Families and 11 Genera for a total of 54 species in mangrove for 20 Genera for 16 Families.

Duke (1992) had identified 69 species of mangrove that belong to 26 Genera for 20 Families. One family falls in Fern division (Polypodiophyta). The remainders were present in Magnoliophyta (angiosperms). Families that contain only mangroves belong to Aegialitidaceae, Avicenniaceae, Pellicieraceae and Nypaceae. Two orders (Rhizophorales & Myrtales) contain 25% of family members in Mangrove. By reconciling the common features from experts like Tomlinson (1986) and Duke (1992), it was estimated that 65 mangrove species were found in 22 Genera of 16 Families.

The problems associated with mangrove taxonomy were based on the nature of hybridization between the species. For instance, the difference between the *R. stylosa* in Australia and *Rhizophora mucronata* in the eastern Africa were still unclear. *Rhizophora lamarckii* were found in New Caledonia. *Rhizophora x annamalayana* was found in the mangrove forest of south India [12-16]. Initially it was identified as *R. lamarckii* but it has been re identified as a new hybrid between *R. apiculata* and *R. mucronata*. Some hybrids like *Rhizophora x harrissoni* were not confirmed by the principle of wax chemistry. Molecular analyses may eventually help us to resolve the problems associated with taxonomy. For example, the data were obtained from the DNA sequence of **rbcL (**chloroplast gene**)** indicate the fact that the Rhizophoraceae belongs to Myrtales family that includes the families Humiriaceae, Malphighiaceae and Euphorbiaceae.

Ecological condition: Salt regulation

Mangroves were tolerant to high level of salt content and have a mechanism for obtaining fresh water due to strong potential of osmosis for sediments (Ball, 1996). They avoid the load of salt through a combination of, salt excretion and accumulation. For example, *Bruguiera*, *Rhizophora* and *Ceriops* possess ultrafilters in their root systems. These filters exclude salt while extracting water from the soil. Other genus (e.g., Acanthus, Avicennia, and Aegiceras) takes the content of salt but excrete it through the specialized glands for salts in their leaves (Dschida *et al.*, 1992; Fitzgerald *et al.*, 1992).

The species which excretes salt allows the accumulation of salt into xylem than the non-excretors but it still excludes about 90% of salinity. The process of excretion of salt is always an active process and it was evidenced on the activity of ATPase in the plasmalemma of excretory cells[24]. The process is regulated by hypodermal cells in leaf to store water and salt.

Excoecaria and *Lumnitzera* species accumulate their salts in leaf vacuoles to become succulent. Concentrations of salt can be reduced by transferring them into senescent leaves or storing them in the bark or the wood. As the salinity of water increases, some species become conservative in usage of water and hence it has achieved greater tolerance[25]. In case of south Florida, *Rhizophora mangle* decreases the stress of salt by the utilization of surface water as its primary source of water. In wet season, the biomass of fine root increase in response to decrease in salinity of surface water and thus an enhanced uptake was observed with respect to low-salinity of water.

Most of the species in mangrove regulates their salt directly. However, they may also synthesize and accumulate solutes other than salts for regulating their osmotic balance. For example, *Aegialitis annulata*, *Aegiceras corniculatum* and *Laguncularia racemosa* can accumulate proline and mannitol. *Avicennia marina* accumulate glycine betaine, asparagine and stachyose. *Sonneratia alba* synthesizes the purine base of nucleotides and it helps the species to adapt a salt load of 100 mM of NaCl. In order to facilitate water flow from root to leaves, the potential of water at leaves were held lower (-2.5 to -6 MPa) than roots (-2.5 MPa).

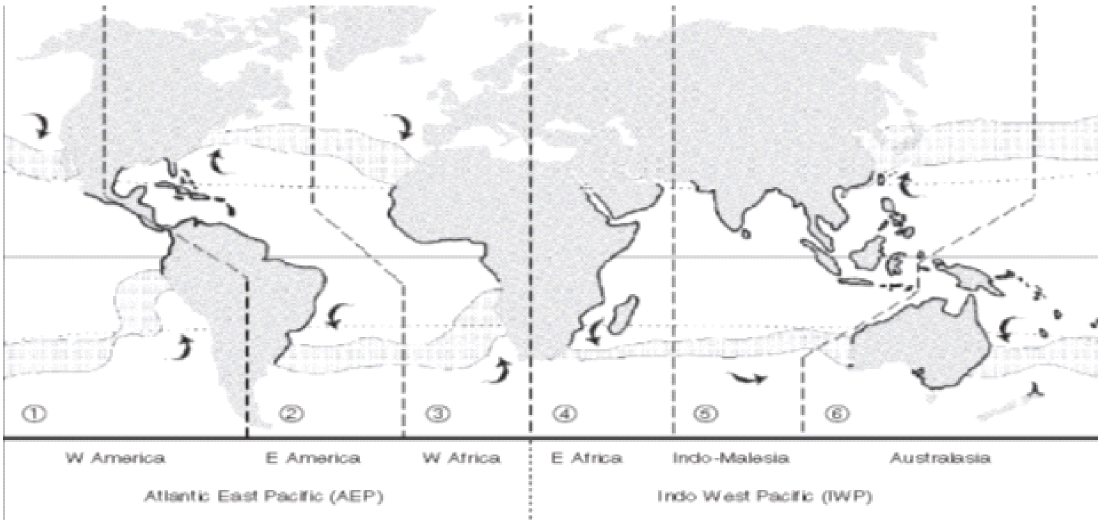
Mangroves conserve water and regulate the internal concentrations of salt. Slow water uptake and low transpiration and were not the character of all species in mangrove. High transpiration rates in *Rhizophora apiculata* and *Avicennia alba* and were measured by Becker *et al.*. In case of *Bruguiera cylindrical* the transpiration rates vary with season and the change is corresponded to stomatal movement. The oscillatory behavior of stomata in *Avicennia germinans* were affected by factors that trigger a change in hydraulic flow throughout plant. This includes an increase in the deficit of osmotic potential and vapor pressure of the substrata. Fukushima *et al.* (1997) had studied the effects of salinity on sugar catabolism with respect to the leaves and roots of *Avicennia marina* and it was observed the pathway was significantly affected by salinity.

Ecological condition: Photosynthesis

Mangroves were characteristic with respect to the photosynthesis of C^{3+}. Basak *et al.* (1996) found a significant variation with respect to inter- and intraspecific aspects in photosynthetic activity of 14 species in mangrove and it suggest that the rate of photosynthesis might have a base in genetics. This possibility was continuously supported on the basis of observations with respect to rate of photosynthesis of *Bruguiera*. In contrast, other researchers have shown that the rate of photosynthesis in some species and it was strongly affected by the environmental conditions. For example, the conditions favoring lower content of salinity can reduce the loss of carbon in *Avicennia germinans* and *Aegialitis annulata*. Fluctuating soil salinities can lead to a significant decrease in lowering the intercellular level of CO_2 concentration and reducing the level of photosynthesis in the scrub forests of south Florida.

The stunted mangroves have lower canopies than mangroves in fringe forests which experiences less variability in salinity. Steinkem and Naidoo had demonstrated the fact that the temperature can affect the photosynthetic rate of *Avicennia marina* and it has an influence with respect to the overall rate in growth.

Strong sunlight can also play an important role in reducing photosynthesis through



the inhibition of mangrove. The photosynthetic rates can get saturated at a relatively low level, despite of their presence in the tropical environments with high sunlight[26]. The lower rate of photosynthetic efficiency may also be related to the pigment concentration present in the leaves of zeaxanthin. Inorder to prevent the damage of photo system, the mangroves converts the excess light energy by the xanthophyll cycle for the conversion of O2 to phenolics and peroxidases.

Kathiresan *et al* had demonstrated the fact that the application of aliphatic alcohols can have a stimulatory effect on the photosynthesis of mangrove. Treatment with alchohal like triacontanol (a long-chain aliphatic alcohol) had increased the photosynthetic rate of *Rhizophora apiculata* by 25%. A similar treatment with methanol (a short-chain aliphatic alcohol) had increased photosynthesis of *R. mucronata* by 61%.

Fig.1. Morphology of normal and adapted sections

MATERIALS AND METHODS

Studies were carried out on the interspecific differences was based on the taxa which includes A. marina, A. macroneta. Collections from include samples from to the south-eastern and western regions of the Sundarbans's. The specimens were partitioned into two categories on the basis of specimens with flowers and specimens with mature 'fruit'. Partitioning was necessary because the mutually exclusive nature of species.

RESULTS AND DISCUSSION

Mangroves had evolved and they had flourished their dynamic setting. Collectively mangroves were specialized their morphology and physiology. These attributes contribute for the limited variability of the individual species. The range of distribution for each mangrove species had reflected their response to the dominant influencing factors at the regional, local and global scales. Mangroves inhabit the tropical regions of world and their presence in latitudes is generally constrained by 20°C in winter in the isotherm of the respective hemispheres (Fig. 1). Exceptions to this pattern correspond to the path of oceanic currents for circulation where mangrove distributions are broader on the eastern margins of continental regions and they were more constrained on the west. Distribution patterns in current day depend on the specialized water-

Table 1. Taxonomy and global distribution of Avicennia

Species	Distribution
Avicennia alba Blume	Southeast Asia, South Asia, East Asia & Archipeligo.
Moldenke ex Molodenke and *Avicennia balanophora* Stapf	Australia
Avicennia bicolor Standley	Central / South America
Avicennia eucalyptifolia (Zipp. ex Miq.) Moldenke	Australia
Avicennia germinans (L.) Stearn	Southeast USA & Central/SouthAmerica
Avicennia lanata Ridley	Malay Archipeligo
Avicennia marina (Forsk.). Vierh.	Southeast Asia, Malay Archipeligo, Africa, South Asia, Southwest Pacific, Australia & East Asia
Avicennia officinalis L.	Southeast Asia, Malay Archipeligo, East Asia & Australia.
Leechman ex Moldenke and *Avicennia schaueriana* Stapf	Central / South America
Avicennia africana Palisot de Beauvois	Africa

buoyant propagules in mangroves. Their dispersal is constrained by the wide coverage of water and the land in continental areas. Four major barriers that restrict the dispersal of coastal marine organisms (including mangroves) around the world today, namely: the continents of (1) Africa and Euro-Asia; plus (2) North and South American continents; and the oceans of (3) the North and South Atlantic; plus (4) the eastern Pacific. The relative effectiveness of each of these barriers differs, depending on its geological history, dispersal ability and the evolutionary appearance of respective species.

Figure 1 Worldwide distribution of mangroves (dark line in coastal margins) shows global regions and sub regions with limits for ocean zone at the seasonal 20°C isotherm (source: Duke et al., 1998).

Species and community distribution were widely used techniques for evaluating the potential impacts on biodiversity. The work involves the application of species and community response of mangrove distributions. The SDMs and CDMs provide the approximation of mangroves studies in which researchers across the world can collaborate to provide a consistent data on biotic and social drivers of mangrove distributions.

CONCLUSION

There is a need for wide propaganda to promote understanding and knowledge by gathering detailed observations and appropriate data. The answers lie in studies by taking one or all of three different approaches, namely:-

(1) Assessments of chemical, genetic and morphological variation among the related taxa to develop an evolutionary understanding of the individual taxa across the entire range of distribution;

(2) Comprehensive compilations of the distributional records for the revised genetic and morphological assessments of the extant groups of related-taxa (e.g. multi-specific genera) across their range of distribution;

(3) A complete review regarding the synthesis of fossil records to identify the gaps in time and space to demonstrate continuity between fossil and extant taxa. In addition, questions were raised about global distributions and genetic discrepancy still remains unanswered. There were solid reasons for the many gaps but still there are no answers for the fundamental questions regarding the early dispersal and evolution of modern mangrove communities.

Challenges remain pertinent in the systematics and botanical taxonomy, where the extant of mangrovian taxa is still incomplete. This aspect continues to be somewhat surprising by considering the fact that, there are only 70-80 taxa of mangroves in the world. Furthermore, those unresolved taxonomic questions can still be applied equally to restrict the rare taxa to identify the common ones. In addition, our understanding of relationships within and among mangroves were not been assisted by the recent advances in molecular techniques. Our limited progress is due to lack of coordination between field observations and laboratory analyses –regarding the comparison of morphological and genetic and data analyses.

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