

Distribution and Morphological Adaptations of *Avicennia Marina* in the Sundarbans

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Many factors contribute to the morphological variations in the members of a species of the plants grown in different areas and ecosystems. In such a way, *Avicennia* is woody trees or shrubs which grow near the coastal areas. Scientists Moldenke 1975 & Tomlinson 1986 recorded the considerable morphological differences in the leaves and flowers of Mangroves. The objective of the present work is to find out the complete morphological variations among the members of *Avicennia* grown in inland and marine systems.

Keywords: Morphological variation, Ecosystem, Sundarbans.

The word “*mangrove*” was usually believed as chief compound of Portuguese word “*mangue*” and English word “*grove*.” Mostly used words in French were “*manglier*” and “*paletuvier*”¹. In Spanish the term is coined as “*manglar*”. The term “*vloedbosschen*” is used by the Dutch for the mangrove community and when they talk about the single or individual trees they called it “*mangrove*”. Basically the term “*mangro*” is considered to be common name for *Rhizophora*.

“*manggi*” word being originated from the Malaysian word, which means above soil. But the use of the word is stopped in Malaysia and it is believed to be used in eastern Indonesia more than the origin. In Indonesia it refers to *Avicennia* species.

Mangroves were quite old and it might have possibly arisen. About 125 million years ago after the first angiosperm there were basically *Avicennia* and *Rhizophora*³ that evolve around the

end of cretaceous period.⁴ Some vital information can be extracted from the pollen records which is useful about the subsequent radiation. It is suggested and understood from the studies of fossil pollen from sediments in Leizhou Peninsula and China there might be possibility of expanding of mangroves from south to north. When they reach their farther end or we should call it a northern limit that is Changjiang Delta in the middle of Holocene, it suggests mangroves were established before 3000 years or more and gradually the sea level decrease with every passing century⁵

According to the recent estimate of Dr. Spalding of over 18 million hectares with 49.5% in south and south eastern parts of Asia. If Indonesia is considered as an addition it is 39.4%. In India Mangroves are mostly found or restricted to 25.N and 25.S mostly in reference to the studies. The limit of the northern extension occurs in Japan 31.N and towards south it is believed to be in Australia 38.45 S.

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Main Factors which can strongly affect the distribution of mangroves is temperature and moisture⁷. High tides and currents may also limit the distributions by stopping propagates distribution to other areas⁸. Individual mangrove species differ in length along with their ecological success, rate of

growth and their power of tolerance. All the above factors, are quite consistent throughout the world, which in return produces characteristic distribution in ranges in almost all the species as illustrated in Table.1.

Table 1. Taxonomy and global distribution of *Avicennia*

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



A study from different part of world of pollen were recorded from the Antilles in mexico, the, the northern South America and Central America⁸ indicates the neotropical environments were firstly occupied by *Nypa*, *Pelliceria*, *Acrostichum*, and *Brevitricolpites variabilis*. About 50 million years. In Miocene *Avicennia* appeared late in this part (10 million years ago). In the Middle Pliocene six mangrove species



Normal Short Root



Long Adapted Roots

were present along with three associated genera. (3.5 million years ago) and during the Quaternary period fifteen plant genera were present. In present-day assemblage of about 27 genera of associated plants and mangroves twelve additional species were added⁹

In near times there had been a geological phenomenon that had produce a mixture and dispersal of genes widely. This change showed the increase in evolutionary process. As it is found that *Avicennia marina* is found in temperate latitude and it is mostly found in southern hemisphere

Thus mangroves were evolved in the tropic when tectonic is dispersed because of continental fragment it is said that western Gondwana origin with subsequent radiation¹¹. Fossils of Mangroves had provided valuable information about the pre historical evolution of mangrove and its dispersal. However, cautions of Burnham regarding reconstructions in organic sector may be substantially different, found in studies of different mangrove parts (e.g., fruits and seedlings vs. leaflets).

Distribution of mangrove according to the old times or historical changes can reveal detail about Paleo Climate and Sea level changes. We can take the examples of Pacific Ocean in equatorial region especially changing the mangrove fossils and the reef in the lower Pliocene deposits and in the upper Miocene¹³. Clear Indication shows that mangrove peat had filled the lagoon before 4800 Holocene sediments from Maya wetland of Belize prove this¹⁴. When we study farther we can notice the change in large-scale climatic shifts and disturbance in the sea levels. In Poverty Bay, New Zealand, the presence of *Avicennia marina*

indicates that this area was a frost-free climate¹⁵. The mangrove fossil record is clearly an area where a continued research has the potential for providing significant information about the history of these unique plants.

MATERIALS AND METHODS

A survey has been conducted recently to study the mangrove vegetation in the Sundarbans with great diversity. We studied the morphology and anatomy of few mangroves species in relation to their adaptation to saline habitat. Leaves, stems, roots from different families of mangrove, materials were collected from those areas during 2016 and they were placed in a polythene bag containing water. Thin sections and cross sections were cut by using a sharp razor blade. The sections were immersed in water to avoid the formation of air bubbles. Sections were stained with Safranin. Excess of stain was washed with water. Then, the sections were stained with fast green solution and the excess dye was washed. Thereafter, small cuttings were mounted in Glycerol and covered with cover slip and observed under microscope.

RESULTS AND DISCUSSION

Genetic Variation

There were a significant amount of and internal and external specific differences among variants of mangroves. These Differences can be morphological differences had been noticed between western atlantic species and west african species of *Avicennia germinans*¹⁶ and *A. germinans* and *Rhizophora* have been identified as distinct chemo



More spores for oxygen absorption



type¹⁷. Local environments may have resulted in differences of genotypic or phenotypic responses. *Rhizophora mangle* of Mexico shows mean leaf area rightly correlated with annual precipitation and negatively correlated with latitude. Photosynthetic efficiency is enhanced through the morphological response to local conditions of the trees¹⁸. Same case in southeast Florida, leaf area indices can be used to differentiate *Rhizophora mangle* from basin and dwarf forest types. *Rhizophora mangle* flower indicates contrast variation in morphology which appears to be genetically based.

Genetic differentiation can be led by the fluctuations in genetic frequency such as those species produced by crossbreeding. Conjugation or inbreeding is accustomed than a mangrove forest can be mono specific with equality of genetic diversity in small number. Bee's pollination produces geitonogamous selfing in *Kandelia candel*. Whereas, a little genetic differentiation is seen among thirteen populations in the coastlines of Hong Kong, indicate the fact that the dispersion of propagates is sufficient to maintain high levels

of gene flow in this species¹⁹. In contrast, the concept of genotypic differentiation, has led to sub speciation in *Avicennia marina*²⁰. It has been considered that propagates of *Avicennia* commonly travel far distances. but, allozyme findings suggest that *Avicennia* species in the indo-west pacific and eastern North America have limited gene flow. This suggests that true dispersal distances are much shorter than commonly believed²¹.

Tissue Culture

To pass on the tolerance towards salinity from mangrove to the plants which are non-salt tolerant a technique is used named "Cell Prolopast". Obtaining and preparing method from tissues culture of *Bruguiera gymnorrhiza* believed to be created by Eghudhi .et.al. Study have shown the familiar work has been done by Sasamota el with aspects of *A. lanata* and *Avicennia marina*. Unique characteristics of mangroves such as salt tolerant can be utilized by researchers to do some creative tissue culture work which may allow the researchers to better understanding the uniqueness of Mangroves.

Table 2. Leaf Characteristics of Avicenniaceae

Avicenniaceae	<i>Avicennia officinalis</i>	Leaves are leathery, shiny, and medium size; Opposite and deccasate orientation; Ovate shape; Lamina elliptic and oblong; Rounded apex; Upper surface is glabrous; Midrib and viens are prominent; Small petiole with semi terrate and Exstipulate.
	<i>Avicennia alba</i>	Dark green leaves. Leaves are somewhat leathery. Oblong linear shape. Opposite leaves. Lamina linear. Acute apex, Mid rib somewhat swollen. Small petiole and exstipulate.
	<i>Avicennia marina</i>	Leaves are leathery, Medium size leaves. Opposite. Ovate shape, Lamina. Elliptic oblong. Somewhat rounded apex. Upper surface is glabrous. Midrib is prominent. Small petiole with exstipulate



Healthy leaves

Root Anatomy

Mangroves are usually found on Coastal area so that's the reason there adaptation is high on coastal environment. It has the breathing roots and farther supportive roots which are exposed. Live Bearing or Viviparous water dispersed porpagukes and same is done by the salt excreting leaves. The adaptation differentiate from genus to genus with respect to this physicochemical nature of the habitat²⁰. The most unique adaptations of mangroves were seen at the pneumatophores of *Avicennia*, *Sonneratia* and *Lumnitzera*, and the stilt roots of *Rhizophora*, the root knees of *Bruguiera*, *Ceriops* and *Xylocarpus* and the buttress roots of *Xylocarpus* and *Heritiera*. Many mangroves roots do not penetrate far into the anaerobic substrata, but, the trees produce profuse lateral roots for their strength. Their strength is well demonstrated by the tallest mangrove trees, present in Ecuador, are of heights of more than 60 m and aged above 100 years²³.

Gas exchange for living in anaerobic substrata the specialized roots of mangroves were important sites. There are numerous lenticels to the exposed surfaces³. In *Avicennia* there are pneumatophores possesses lenticel in upward direction of roots, through which passive diffusion of oxygen is carried out⁵. These lenticels may be opened or partially closed or fully closed depending on the environmental factors⁶. These pneumatophores are generally spongy and short (< 30 cm), instead they are much larger and become more numerous in *Avicennia marina* in anaerobic and oil affected conditions. These morphologic responses were increased in surface area for gas exchange⁷.

Wood Anatomy

Unique anatomical feature of mangrove wood is discussed and summarized by Tomilson (1986). On the basis of nodal number in leaf scar the easiest way to know or to estimate age of seedling belong to *Rhizophora*. The effect of temperature causes osmotic potential of sea water and the transpiration the mangrove wood have the best survival feature. There are several thin vascular bundles running through the stem which have density. The range of density is from 32 mm⁻² in *Excoecaria* to 270 mm⁻² in *Aegiceras*⁸. High tensions created by vessels in the xylem is due to a reduced diameter in the vessel to

produce a disproportionately high increase in flow resistance⁹⁻¹¹. The vascular bundles usually have basic small plates of perforation. Except the *Kandelia* candle from the family of mangroves *Rhizophoraceae* bearing scalar form perforation plates.

Seed coat and Seed anatomy

In the early embryonic histo differentiation in *Avicennia marina* forms an endosperm haustoria. In the initial growth phase, extra-ovular subsequent embryonic development takes place. Once mature, the seed, furthermore is enclosed by a pericarp, originates entirely from the wall of ovary. The mature seeds are abscised from the end of histo differentiation, the cotyledon cells contain large amounts of soluble sugars, they are highly vacuolated, and they act as the important food reserves of the mature seed²³.

Leaf (Table.2) thickness differs from species to species within the members of *Avicenniaceae* and the range is 327.83 $\frac{1}{4}$ m to 666.60 $\frac{1}{4}$ m. Mostly stomata are preset on lower surface, but in case of *Sonneratiaceae*, stomata were seen on both surfaces of the lamina. The average number of stomata per given area and the average leaf area was differs from species to species.

CONCLUSION

Mangrove ecosystems are receiving an increasing attention in the recent times but still we lack a much more amount of structural and functional information. There are still opening in different basic aspects in the study of reproductive biology among mangroves, there evolution and it is not properly understood. Still there is lack of knowledge and understanding in the level of energy involved among the food web in mangrove environment and their connection inside the ecosystem. There is a great need to understand the environmental changes and pollution on the ecosphere of mangrove. Still, studies are required to understand the organisms that are totally dependent on mangroves, especially with respect to their recruitment and larval supply.

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