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ECOLOGICAL CHARACTERISATION OF TRUE MANGROVE SPECIES IN KERALA

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Abstract

Vessels and tracheids represent the most important xylem cells with respect to long distance water transport in plants. Wood anatomical studies frequently provide several quantitative details of these cells, such a vessel diameter, vessel density, vessel element length, tracheid length, vulnerability and mesomorphy provide a rough indication of the plant to withstand drought or frost induced cavitation. By generating information on vessel mesomorphy and vulnerability indices of the mangrove species, it will be possible to characterize each species as belonging to mesophytic or xerophytic site. Mangrove species arranged according to values of vessel vulnerability and vessel mesomorphy related to its salinity tolerance: *Rhizophora apiculata* < *Rhizophora mucronata*< *Excoecaria agallocha*< *Sonneratia alba* < *Sonneratia caseolaris*< *Bruguiera gymnorrhiza* <*Lumintzera recemosa* <*Kandelia candel* < *Bruguiera cylindrica*< *Aegiceras corniculatum*< *Bruguiera sexangula* < *Acanthus ilicifolius* < *Acanthus ebracteatus*< *Avicennia marina* < *Avicennia officinalis.*

Keywords: Vessel density, vulnerability, mesomorphy, vessel diameter.

INTRODUCTION

Vessel elements and tracheids play a crucial role in the trans- port of water from roots to leaves. Both cell types, also called tracheary elements or simply conduits, show wide anatomical diversity with respect to their size, shape, arrangement, and grouping.[1] Fiber-tracheids and libriform fibers are interpreted as non-water conducting cells.[2]Tracheary elements have been studied by plant anatomists for many years and provide valuable information to a wide range of wood related study fields, ranging from wood identification and palaeobotany to plant ecology and physiology[1,3,4,5,6,7]

Only few textbooks on wood anatomy include precise and clear instructions on technical details of conduits and the wide range of methods applied to measure vessels, vessel elements, and tracheids is found in a large number of diverse papers.[8] While there are various techniques available for quantifying xylem conduits, each one has its own advantages and drawbacks. Conduit parameters may not only provide additional structural information, but also valuable insight into hydraulic functionality and ecological traits. Because water conducting xylem cells are extremely variable, a method that may work perfectly well for diffuse-porous angiosperms may not be applicable to ring-porous woods. Moreover, collection of various samples and sufficient repetition is frequently required in order to deal with intra-tree, intraspecific, and interspecific variation.[9,10]

A low value of vulnerability indicates a greater redundancy of vessels and mesomorphy value expresses the conductive safety of a wood. Because of saline environmental conditions prevailing in mangrove ecosystem, the xylem sap is at negative absolute pressures. This increase in xylem sap tension induces cavitation, which results in the formation of gas bubbles (embolism). Embolism reduces hydraulic transport efficiency and finally leads to the death of the plant. Mangrove woods have been found to have specialized eco anatomical features to overcome stressful environment.[11,12,13]

MATERIALS AND METHODS

Stem samples were collected from the intertidal zones of Kerala. The plants were identified by Botanical survey of India, Coimbatore. One of the healthy plants was selected and stem were taken for anatomical studies stained with Toluidine blue 0 and mounted in 50% glycerin. The slides analyzed by trilocular compound microscope model number 10093409 and imaged by using the camera Olympus E-PL3. A minimum of five sections were prepared from each plant, for measuring the vessel diameter and vessel frequency and vessel length. The images were captured from the prepared slides for measurement and analysis using Magnus Pro.
Wood specimens of following species *viz*., *Acanthus ebracteatus*, *Acanthuus ilicifolius*, *Aegiceras corniculatum*, *Avicennia marina*, *Avicennia officinalis*, *Bruguiera gymnorrhiza*, *Bruguiera cylindrica*, *Bruguiera sexangula*, *Excoecaria agallocha*, *Kandelia candel*, *Rhizophora mucronata*, *Rhizophora apiculata*, *Sonneratia caseolaris*, *Sonneratia alba* and *Lumnitzera recemosa* for conducting anatomical studies were collected from the mangrove areas belonging to different

districts of Kerala. The vessel vulnerability and mesomorphy was worked out by using the following formula:

Vessel vulnerability = Vessel diameter/Vessel frequency per mm2

Vessel mesomorphy = Vessel vulnerability x Vessel element length

The data obtained was subject to Analysis of Variance (ANOVA) and comparison of means was done using Duncan's Multiple Range Test (DMRT) using MSTATC software package.

RESULT AND DISCUSSION

The 'vulnerability' is the ratio of vessel frequency and vessel diameter. A low value for this ratio could indicate safety of vessels. The vulnerability value of xeric species would be in the range 1.0 to 2.5. Mesomorphy is obtained when vulnerability ratio is multiplied with vessel length. Mesomorphy is said to be the measure of water availability of the species with high values being typically for the species related to mesic ecology. The xerophytes would have mesomorphic value near to 75.[1,14]

In Avicennia species the vessel morphology study of *A. marina* has low values of vessel vulnerability (1.90) and vessel mesomorphy (97) when compared to *A.officinalis* which has vessel vulnerability (2.26) and vessel mesomorphy (81). The *A. marina* is found more towards the marine zone where as *A. officinalis* spreads more towards the fresh water zone influenced by the estuarine water. The adaptation of *A. marina* to grow in highly saline habitat can be interpreted from their low vessel vulnerability and vessel mesomorphy values.[15]

Increase in vessel diameter and decrease in vessel frequency seems to be related to the improvement of conductive efficiency. This indicates that *A. officinalis* cannot tolerate stress imposed by high salinity and thus they were seen away from the seaside and towards the land fringes where salinity is very low.[16]

The features of small vessel diameter and high vessel frequency in *A. corniculatum* and *S. caseolaris* ensure the safety of water transportation inside the plant. The greater the number of vessels per mm^2 the lesser is the chance for air embolism under water stress.[17] The short and narrow vessels are valuable because they localize air embolism to a greater extent than long ones because of constrictions formed by perforation plates.[18]In Ratnagiri district of Maharashtra in India, zonation is found starting either with Sonneratia species or *A. marina* as one goes from seaward side to inland.[19]

Among the three species of Bruguiera studied, *B. cylindrica* had the lowest vessel vulnerability (0.62) and vessel mesomorphy (28) where as *B. sexangula* had the maximum vessel vulnerability (1.15) and vessel mesomorphy (19) value. The values of vessel vulnerability (0.38) and vessel mesomorphy (15) for *B. gymnorrhiza* lies in between the above two species of Bruguiera.

The value of vessel vulnerability (0.67) and vessel mesomorphy (28) for *K. candel* is higher than Rhizophora species and near Bruguiera species. This shows that the species are seen in between Bruguiera species and Rhizophora species in terms of zonation and can adapt only to medium range of salinity.

In dry season the study showed that *R. apiculata* and *R. mucronata* showed lowest vessel vulnerability and mesomorphy . This species has the lowest diameter and highest vessel frequency that indicate xeromorphy. In Pichavaram in north Tamil Nadu, the mangrove community is dominated by *R. apiculata* and *R. mucronata* along the fringes and *A. marina* behind.

The zonation pattern of Andamans as *R.mucronata* and *R. apiculata* from the seaward fringes of the swamp, Sonneratia and Avicennia species occurring independently in mangrove swamps and expanding among inland mangals. These observations show that Rhizophora are seen towards the land side having low range of salinity.[20,21] In Acanthus species shows the highest vessel vulnerability (2.26) and vessel mesomorphy (81). This indicates that Acanthus cannot tolerate stress by high salinity and thus they were seen away from the seaside. (Table-1, Fig-1,2,3,4,5).

By using the values obtained for vessel vulnerability and vessel mesomorphy from the present study we can categorize the mangrove species according to their tolerance to salinity and water stress. The data can also be used to find out the zonation pattern of mangrove species. Mangrove species arranged according to values of vessel vulnerability and vessel mesomorphy from Mangrove species arranged according to values of vessel vulnerability and vessel mesomorphy related to its salinity tolerance: *Rhizophora apiculata < Rhizophora mucronata< Excoecaria agallocha< Sonneratia alba < Sonneratia caseolaris< Bruguiera gymnorrhiza <Lumintzera recemosa <Kandelia candel < Bruguiera cylindrica< Aegiceras corniculatum< Bruguiera sexangula < Acanthus ilicifolius < Acanthus ebracteatus< Avicennia marina < Avicennia officinalis.*

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TABLE 1
VESSEL DIAMETER, DENSITY, LENGTH, VULNERABILITY AND MESOMORPHY OF SELECTED SPECIES OF MANGROVES

No	Plants	Average Vessel diameter (µm)	Average Vessel density (mm^2)	Average Vessel vulnerabiliy(µm)	Average Vessel length (µm)	Average Vessel mesomorphy (µm)
1	*L. recemosa*	3.01	16	0.50	29.68	9
2	*S. alba*	3.10	11	0.27	26.47	7
3	*S. caseolaris*	3.25	12	0.28	27.49	7
4	*B. cylindrica*	3.72	6	0.62	46.75	28
5	*B.gymnorhiza*	2.66	7	0.38	40.74	15
6	*B. sexangula*	3.47	4	1.15	17.45	19
7	*K. candel*	3.05	6	0.67	18.10	28
8	*R. apiculata*	3.10	13	0.18	24.60	5
9	*R. mucronata*	3.01	14	0.21	24.51	5
10	*E. agallocha*	2.68	4	0.26	42.31	6
11	*A. corniculata*	3.15	3	1.05	56.01	58
12	*A.ebracteatus*	2.56	2	1.43	39.52	40
13	*A. ilicifolius*	2.86	2	1.28	28.62	50
14	*A. marina*	3.81	2	1.90	51.37	97
15	*A. officinalis*	3.72	2	2.26	31.68	81

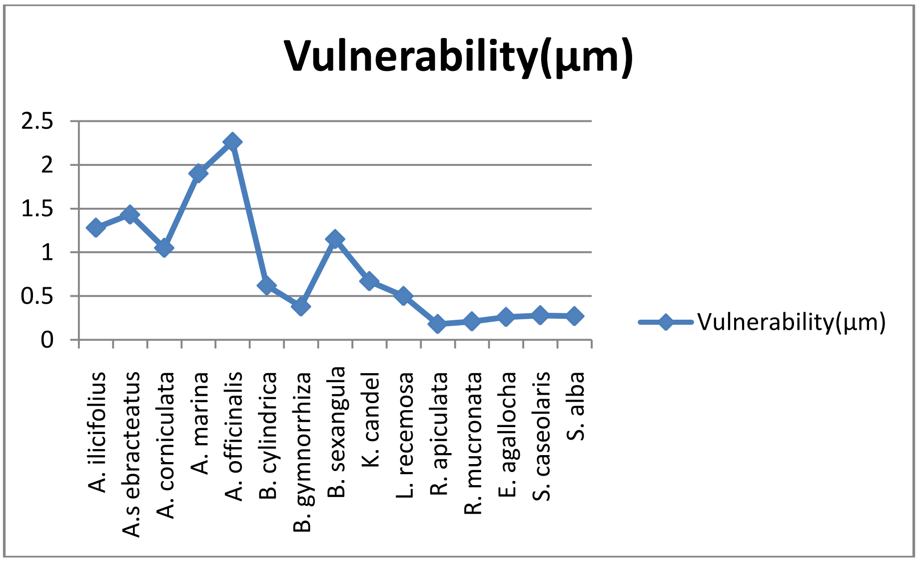

FIGURE 1
VESSEL VULNERABILITY OF THE SELECTED MANGROVE SPECIES

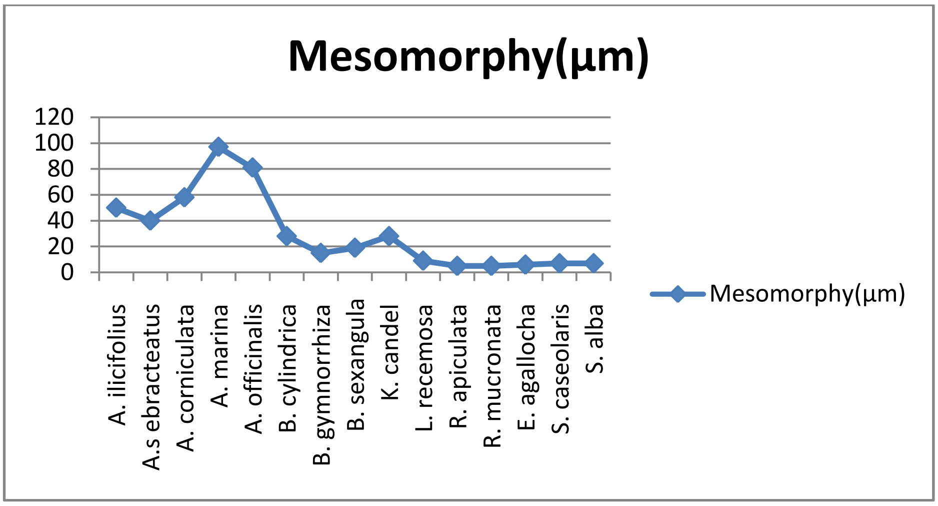

FIGURE 2
VESSEL MESOMORPHY OF THE SELECTED MANGROVE SPECIES

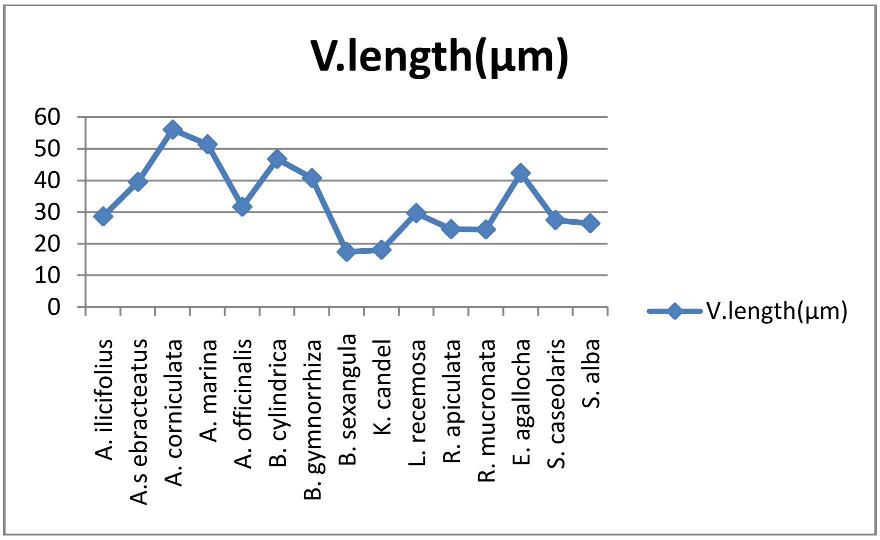

FIGURE 3
VESSEL LENGTH OF THE SELECTED MANGROVE SPECIES

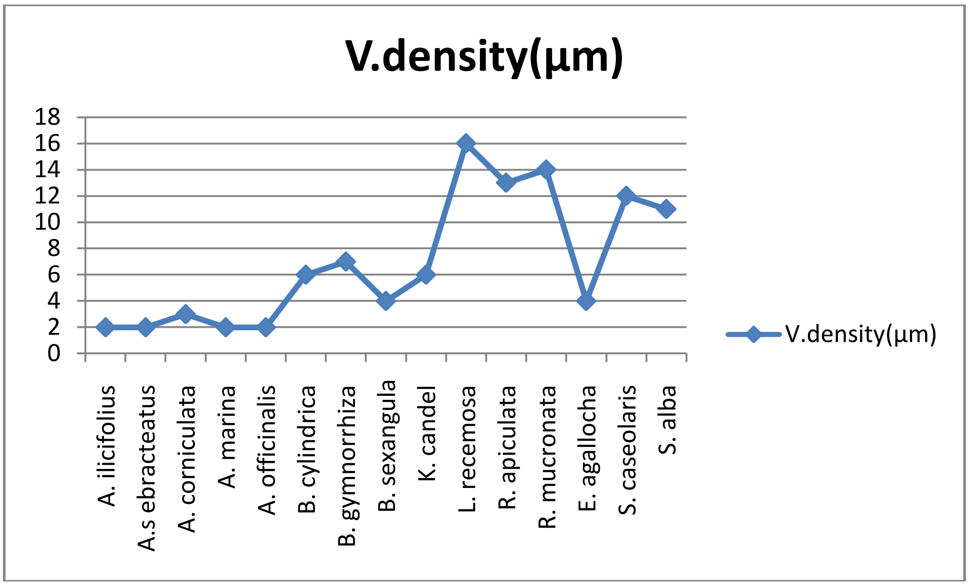

FIGURE 4
VESSEL DENSITY OF THE SELECTED MANGROVE SPECIES

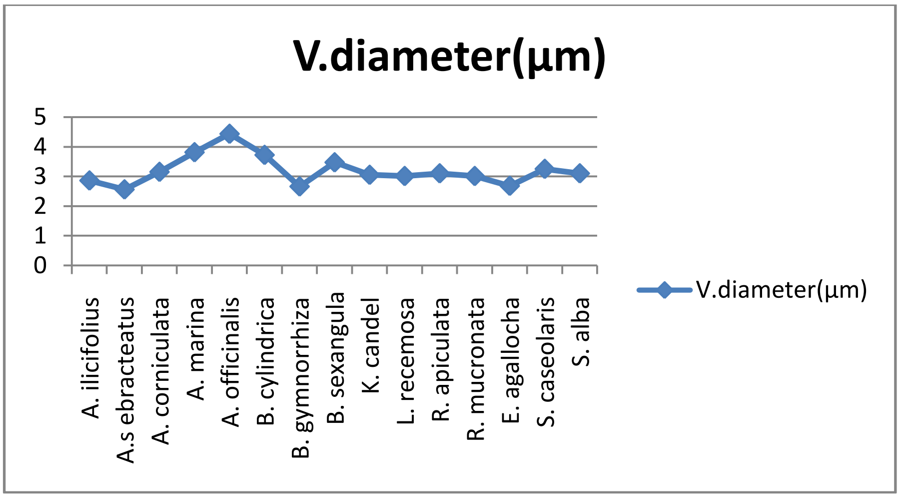

FIGURE 5
VESSEL DIAMETER OF THE SELECTED MANGROVE SPECIES