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ANATOMY OF SELECTED WOODY MANGROVES IN THE WEST COAST OF KERALA

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ABSTRACT

This investigation was carried out with the objectives of studying the anatomical features of wood of selected mangrove species seen in west coast of Kerala. Based on the results, it is observed that all the selected species have shown diffuse porous condition with indistinct growth rings. However, in *Sonneratia alba* and *Sonneratia caseolaris*, the growth rings are feebly distinct in some cases. In *Avicennia marina* and *Avicennia officinalis*, the presence of included phloem gives an impression of growth rings. In all the selected species studied, the vessels are small to very small. But in *Rhizophora mucronata* the vessels are large. In almost all the species studied, the parenchymatous cells are associated with the vessels. In *Kandelia candel*, the parenchyma cells are abundant. In both *Bruguiera* species, the parenchymatous cells are vasicentric and scanty whereas in *Sonneratia*, both species are characterized by the absence of parenchyma. The rays are present in all the species except *Avicennia marina* and *Avicennia officinalis* wherein the rays are heterogeneous. In *Kandelia candel*, the rays are multiseriate whereas *Rhizophora mucronata* showed both uniseriate and multiseriate conditions.

Keywords: Mangroves, Anatomy, Growth rings, Parenchyma, Vessels, Rays

INTRODUCTION

Mangroves are unique communities growing in intertidal silted up deltaic regions, estuarine mouths sheltered shallow coasts, edges of islands, back waters and saline mud flats in the tropical and sub tropical regions of the world. This ecosystem consists of a diverse collection of trees, shrubs and herbs that adapt best in the newly silted up clay loam or sandy beaches and salt marshes. Apart from such life forms, mangroves also supports a variety of other organisms like fishes, molluscs, crustaceans, reptiles, amphibians, birds and mammals among large number of epiphytes, parasites, and climbers among flora. In Kerala it is estimated that there were 700 sq. km of mangrove in the near past which has been reduced to less than 30 sq km in area that too as isolated patches. Today there are only vestiges of mangroves in Kerala, which represented a feeble fraction of Indian mangroves (Blasco, 1975).

Mangroves are unique vegetations that support microbes to human beings. They serve as breeding grounds for aquatic organisms like fishes and prawns. They protect the coasts from harsh sea waves. For human they provide with timber, firewood, charcoal, tannins etc. The wood of *Rhizophora mucronata* is a suitable timber for beams, joints and foundation piles where as timber of *Sonneratia alba* and *Sonneratia caseolaris* are best suited for packing cases, planks and scantlings (Rao and Purkayastha, 1972).

The xylem anatomy of the mangrove species is unique (Stern and Brizicky, 1957). Many mangrove species show distinctive features like exclusively scalariform perforated plates, scalariform inter vascular pitting, little vasicentric parenchyma and numerous fine celled multiseriate rays which are supporting them to resist from collapse when the vessels under tension.

The anomalous wood structures and alternative concentric ring of xylem and phloem of few species provide unusual strength to protect conductive tissues which are resisting split of the trunk (Gill, 1971). The anatomical, physical and mechanical properties of mangrove species are characterized by well identified growth layers and microscopically, a substantial proportion of parenchyma, confined phloem and silicon particles (Ubrig *et al.*, 1996). Anatomical modifications pertaining to specific site conditions

Research Article

are reported from various mangrove formations in the east coast of India and other regions of sub tropic. However no detailed studies have been reported from the estuaries and back water systems in the west coast of Kerala.

MATERIALS AND METHODS

The study was conducted for characterizing anatomical features of 10 mangrove species seen in Kerala. The species are: *Aegiceras corniculatum*, *Avicennia marina*, *Avicennia officianalis*, *Bruguiera cylindrical*, *Bruguiera gymnorhiza*, *Exoecaria agallocha*, *Kandelia candel*, *Rhizophora mucronata*, *Sonneratia alba* and *Sonneratia caseolaris*.

Collection of specimens: Wood samples were collected from the selected species which are distributed in the mangroves of various back water areas of Kerala. The girths of all the trees were measured for determining the mean tree and wood samples of 40 cm length were cut from the lower, middle and upper portions of the mean tree. This is to incorporate the variations in the anatomical features along longitudinal axis. The samples of above dimensions were collected using a billhook. Then the logs were labeled using tags. These samples were brought to college laboratory for preparing permanent sections.

Laboratory works: In laboratory, each logs were converted into discs of 5 cm thickness using a saw. Then one small block is cut from that section which measures 1 cm³ (from heartwood portion). Cross, radial and tangential sections were cut by using sledge microtone. Permanent slides were prepared by mounting it with 'DPX'. Anatomical features were studied by using permanent slides prepared for selected species.

RESULTS AND DISCUSSION

Anatomy of the selected species

Aegiceras corniculatum: The wood is white in colour with reddish tinge, turning yellow with age, and is straight grained with fine texture. Growth rings are indistinct therefore classified under diffuse porous wood. Vessels are small to medium sized, indistinct even under a hand lens, very numerous solitary and in radial multiples of 2 to 3, round to angular in outline. Vessel lines are indistinct. Parenchyma is sparse, indistinct under a hand lens, paratrachial and apotrachial. Rays are uniseriate, homogenous and moderately broad to fine.

Avicennia marina: The wood is light grey to pinkish brown, heartwood usually absent but rarely present. The grain is interlocked and coarse textured, often with a pleasant figure on longitudinal surface due to included phloem. Growth rings are indistinct. As a diffuse porous wood, it is characterized by presence of concentric type of included phloem which gives the appearance of growth rings. Vessels are small to very small distinct only under a hand lens, and are moderately few to numerous, evenly distributed in short radial multiples of 2 to 3. Parenchyma is paratrachial, distinct only under a hand lens, forms thin sheets around vessels or vessel groups. Rays are fine to extremely fine, closely spaced and uniformly distributed, multiseriate and heterogeneous. Presence of large cavities near the concentric type of included phloem.

Avicennia officianalis: The wood is light grey to pinkish brown, heartwood usually absent but rarely present. The grain is interlocked and coarse textured, often with a pleasant figure on the longitudinal surface due to included phloem. Growth rings are indistinct. The wood is diffuse porous with the presence of concentric type of included phloem which falsely gives the appearance of growth rings. Vessels are small, distinct under a hand lens. Rays are fine, closely spaced and uniformly distributed, multiseriate and heterogeneous. Presences of large cavities are present near to the concentric type of included phloem.

Bruguiera cylindrical: Wood shows grayish brown to reddish brown colour with interlocked grain and fine textured. Growth rings are indistinct. It is a diffuse porous wood. Vessels are small distinct under a hand lens, moderately numerous, evenly distributed, in short radial multiples of 2 to 3 and open with inconspicuous vessel line. Parenchyma is paratrachial, indistinct under hand lens, vasicentric and scanty. Rays are multiseriate (with 4-5 cells) and homogeneous.

Bruguiera gymnorhiza: Wood is grayish brown to reddish brown with fine textured and interlocked grain. Growth rings are indistinct. It is a diffuse porous wood. Sap wood and heartwood are indistinguishable. Vessels are small, distinct under a hand lens, moderately numerous to numerous, evenly distributed,

Research Article

solitary and in short radial multiples of 2 to 4, occasionally in small clusters of 3 to 4, open, vessel line inconspicuous. Parenchyma is vasicentric, scanty, paratrachial, homogenous. Rays are moderately broad, widely spaced and multiseriate (2 to 4 cells width).

Excoecaria agallocha: The wood is white in colour, turns yellow with age, straight grained, fine to medium fine and even textured. Growth rings are indistinct. It is a diffuse porous wood. Vessels are small to very small, less in number, fairly visible under hand lens, rarely solitary and uneven distribution. Parenchyma is paratrachial and metatrachial. Rays are uniseriate and homogenous.

Kandelia candel: The wood is light brown, soft, straight grained and medium fine textured. Growth rings are indistinct. It is a diffuse porous wood. Vessels are small to very small, distinct only under hand lens, moderately numerous to numerous, evenly distributed, solitary and in short radial multiples of 2 to 5, open, vessel lines inconspicuous. Parenchyma is square, paratrachial, abundant and in narrow bands. Rays are multiseriate (2 to 3 cell width) and homogenous.

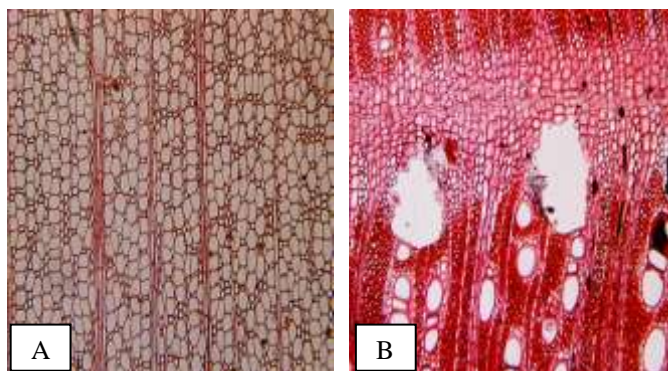
Rhizophora mucronata: Sapwood is light brown, heartwood reddish brown, darkening on exposure, rather dull, straight grained and fine textured. Growth rings are indistinct. It is a diffuse porous wood. Vessels are large; moderately numerous to numerous, evenly distributed, solitary and in short radial multiples of 2 to 3, round in outline, vessel line inconspicuous. Parenchyma is scanty, paratrachial, indistinct under hand lens. Rays are multiseriate (2 to 3 cells width), very few uniseriate, not distinctly visible to the naked eye.

Sonneratia alba: Sapwood is light grey, sharply demarcated from light brown to brown heartwood, straight to interlocked grain, even and fine textured. Growth rings are usually inconspicuous, but wood with conspicuous growth rings are also met with. It is a diffuse porous wood. Vessels are small to very small distinct only under hand lens, moderately numerous to numerous, more or less evenly distributed, solitary and in short radial multiples of 2 to 4, open, vessel lines indistinct. Parenchyma is absent. Rays are usually fine to very fine, uniseriate and homogenous.

Sonneratia caseolaris: Heartwood and sapwood are indistinguishable, straight to interlocked grain, even and fine textured. Growth rings are inconspicuous, slightly distinct growth rings are also seen. It is a diffuse porous wood. Vessels are small to very small; moderately numerous to numerous, evenly distributed, solitary and in short radial multiples of 2 to 3, open, and vessel lines inconspicuous. Parenchyma is absent. Rays are fine to very fine, uniseriate and homogenous.

Modification in anatomical features: In addition to the common anatomical features of the selected species, the members of the family Rhizophoraceae (*Rhizophora mucronata*, *Kandelia candel*, *Bruguiera cylindrica* and *Bruguiera gymnorhiza*) showed distinct variations in few anatomical features. Though they showed homogeneity in anatomical features such as large number of smaller vessels, scanty parenchyma, and fine to moderately fine rays. However, *Kandelia candel* differs from other genera by its distribution of abundant parenchyma in narrow bands. The samples of *Rhizophora mucronata* collected from Valapattanam of Kannur district showed distinctly larger vessels when compared to samples of the same species collected from other districts.

It is also observed that in the two species of Sonneratiaceae (*Sonneratia alba* and *Sonneratia caseolaris*) characterized by the absence of parenchyma cells in the wood. In Aviceniaceae, both *Avicennia marina* and *Avicennia officianalis*, showed concentric type of phloem cells in the wood which gave an impression of growth rings. In both of the species, large cavities are observed near the included phloem.



Research Article

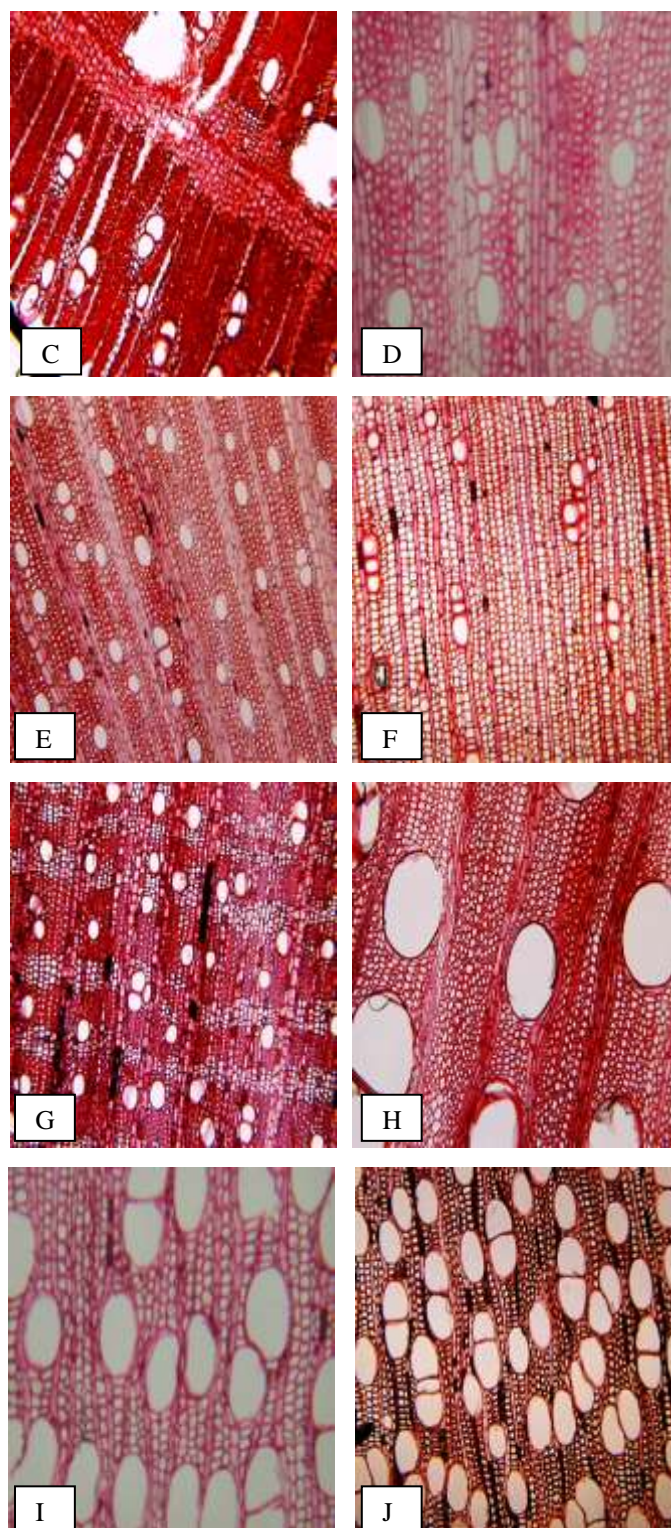


Figure 1: Wood anatomy of selected mangroves of the west coast Kerala

A. *Aegiceras corniculatum* B. *Avicennia marina* C. *Avicennia officinalis* D. *Bruguiera cylindrica* E. *Bruguiera gymnorrhiza* F. *Excoecaria aggalocha* G. *Kandelia candal* H. *Rhizophora mucronata* I. *Sonneratia alba* J. *Sonneratia caseolaris*

This investigation was carried out with the objectives of studying the anatomical features of wood of selected

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mangrove species seen in west coast of Kerala. Based on the results, it is observed that all the selected species have shown diffuse porous condition with indistinct growth rings. However, in *Sonneratia alba* and *Sonneratia caseolaris*, the growth rings are feebly distinct in some cases (Venketeswarlu and Rao, 1964). In *Avicennia marina* and *Avicennia officinalis*, the presence of included phloem gives an impression of growth rings. Santini *et al.*, (2012) reported that *Avicennia marina* can have large xylem vessel sizes and high growth rates while still maintaining high wood density because of the abundance and thickness of fibres in which vessels are found. The secondary xylem of both species of the above genus is indicated large shyzogenous cavities which is believed to be associated with deposits.

In all the selected species studied, the vessels are small to very small. But in *Rhizophora mucronata* the vessels are large. This is against the earlier studies in which *Rhizophora mucronata* has small vessels. Rao and Purkayastha (1972) reported that the vessels of *Rhizophora mucronata* are small. In all the species, the vessels are moderately numerous to numerous and evenly distributed. This is assumed to be a mechanism to give resistance to the flow of water (Jansonius, 1950), where as *Exoecaria agallocha*, the vessels are less in number and has an uneven distribution. In *Aegiceras corniculatum* the vessels are very numerous and they are distributed unevenly (Sun *et al.*, 1997). It has rounded to angular outlined vessels, where as in other species, the vessels are round or oval in outline. Lennz *et al.*, (2005) reported *Aegiceras corniculatum* differs from other species because it has short vessel elements that are storied, non-septate fibers, a combination of low uni- and multiseriate rays with exclusively procumbent body ray cells.

In almost all the species studied, the parenchymatous cells are associated with the vessels. In some cases such as *Aegiceras corniculatum* and *Exoecaria agallocha* showed apotrachial and metatrachial characters along with paratrachial character. In *Kandelia candel*, the parenchyma cells are abundant. In both *Bruguiera* species, the parenchymatous cells are vasicentric and scanty whereas in *Sonneratia*, both species are characterized by the absence of parenchyma as reported by Rao and Purkayastha (1972).

The rays are present in all species except *Avicennia marina* and *Avicennia officinalis* wherein the rays are heterogeneous i.e., rays are composed of different types of cells. In *Kandelia candel*, the rays are multi-seriate whereas *Rhizophora mucronata* showed both uniseriate and multiseriate conditions (Macro, 1935).

Conclusion

The anatomical structures along with functional modifications of mangrove species are very much distinct and different from a non-mangrove species. They have morphological modifications or adaptation with respect to their anatomical features in order to survive in the most difficult and harsh environment. Usually, the mangrove woods possess more number of vessels per mm² when compared to a non-mangrove species. The vessels are so modified that they impart more resistance to the flow of water. The presence and arrangement of pits and perforation plates in the vessels are unique so as to help the plant survive under saline and marshy soil.

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REFERENCES

- Blasco F (1975).** *The Mangroves in India*. Institut Francais de Pondicherry, Pondicherry, 1-175.
- Gill AM (1971).** Endogenous control of growth ring development in *Avicennia*. *Forest Science* **17** 462-65.
- Jansonius HH (1950).** The vessels in the wood of Javan mangrove trees. *Blumea* **6**(2) 465-469.
- MaCro HF (1935).** Systematic anatomy of the woods of the Rhizophoraceae. *Tropical Woods* **31** 1-26.
- Rao R and Purkayastha K (1972).** A general description of the wood of Rhizophoraceae. *Indian wood* **3** 163-75.
- Santini N S, Catherine N and Lovelock CE (2012).** Variation in wood density and anatomy in a widespread mangrove species. *Trees Structure and Function* **26**(5) 1555-1563.
- Stern WL and Brizicky GK (1957).** The woods and the flora of the Florida keys-introduction. *Tropical Wood* **107** 36-65.
- Sun QA, Lin P Wong YS and Tam NYF (1997).** Wood structure of *Aegiceras corniculatum* and its ecological adaptation to salinities. *Hydrobiologia* **352** 61-66.
- Venketeswarlu J and Rao RSP (1964).** The wood anatomy and Taxonomic position of Sonneratiaceae. *Current Science* **33** 6-9.