

## *International Journal of Scientific Research and Reviews*

### **Fruit Morphology and Anatomy of Some Kerala Mangroves with its Taxonomic Relevance**

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#### **ABSTRACT**

Fruit morphology and anatomy of 15 true mangrove species comprise of seven families of Kerala, was investigated based on taxonomic relevance. Fruits are predominantly one seeded in the investigated taxa, except in *Acanthus* spp, *Excoecaria agallocha*, and *Sonneratia* spp. Seeds are indivisible from fruits in *Aegiceras corniculatum*, *Avicennia* spp., *Lumnitzera recemosa* and the species of Rhizophoraceae. Viviparous germination occurs in all members of Rhizophoraceae, the embryo grows through the seed coat, still attached to the parent plant In *Aegiceras corniculatum*, *Lumnitzera recemosa* and *Avicennia* spp. germination occurs as crypto-viviparous nature. Fruit anatomy showed presence of outer thick cuticle, multi layered hypodermis, sclereids, crystalliferous cells, terminal tracheids are halophytic adaptations of true mangroves.

**KEY WORDS:** Fruit, anatomy, mangrove, vivipary.

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## INTRODUCTION

Mangroves occupy less than 1% of the world's surface Saenger (2002)<sup>1</sup> and are mainly found between the Tropic of Cancer and the Tropic of Capricorn on all continents, covering an estimated 75 percent of the tropical coastline worldwide. Mangrove forests are distributed in the intertidal region between the sea and the land in the tropical and subtropical regions of the world approximately between 30° N and 30° S latitude (Alongi, 2009)<sup>2</sup>. The largest extent of mangroves is found in Asia (42%) followed by Africa (20%), North and Central America (15%), Oceania (12%) and South America (11%) (FAO, 2007)<sup>3</sup>.

Mangroves in India spread over an area of 4,639 sq. km, occupying only 0.14% of the geographical area of the country but represent about 3% of the global and 8% of Asian mangrove coverage (FAO, 2007)<sup>3</sup>.

It is obvious, that dispersal and establishment of propagules are critical in mangroves owing to tidal influence, high salinity of water and soil and dynamic nature of the land formation. In addition, as there is no seed dormancy period and buried seed bank of these plants, detailed study on seed morphology, dispersal and germination patterns is essential to pave in the recent efforts for replenishment of this mangrove forest (Das & Ghose, 2003)<sup>4</sup>. Apart from other biotic factors, establishment of mangrove propagules solely depend on the morphology of the dispersed units, which provide some useful clues for taxonomic identification of propagules (Martin & Barkley, 1968)<sup>5</sup>. In this work, detail documentation has been done on fruit morphology and anatomy of some true mangroves of Kerala.

## MATERIALS AND METHODS

Fruits of 15 mangrove taxa resides to seven families were collected from the plants intertidal zones of Kerala. Morphology of the fruits was observed by stereo microscope. Study of fruit anatomy of fifteen species was carried out. Thin transverse section of fruit was taken and temporary slides were prepared. They were analyzed by trilocular compound microscope (Model No. 10093409) and imaged using the camera Olympus E-PL3. The sections were stained with Toluidine blue O.

## RESULT AND DISCUSSION

***Lumnitzera recemosa* Willd.:** The fruit is a drupe, ellipsoid with persistent calyx lobes, laterally compressed and glabrous. The average length and diameter of the fruit was 1.5 cm X 0.9 cm.

Anatomy showed outer epidermis covered by thick cuticle. Epidermal cells rectangular and uniseriate followed by outer cortex consists of 7-8 layered polygonal shaped parenchyma. Inner portion comprise of vascular bundles and enormous sclereids. (Plate -1).

***Sonneratia alba* Sm.:** The fruit is a drupe, green, flattened with persistent calyx and a depression around the stylar base. The average length and diameter of the fruit was 5 cm X 7cm.

Anatomy showed outer epidermis covered by thick cuticle. Outer cortex consists of thin polygonal shaped parenchyma cells. Inner portion composed of numerous sclereids and terminal tracheids (Plate -2).

***Sonneratia caseolaris* (L.) Engl.:** The fruit is a drupe, globose, slightly flattened. The calyx lobes glabrous and horizontal. The average length and diameter of the fruit was 5 cm X 7cm.

Anatomy showed outer thick cuticle followed by epidermis. Outer cortex consists of thin polygonal shaped parenchyma cells. Inner portion composed of numerous sclereids and terminal tracheids (Plate -3).

***Bruguiera cylindrica* (L.) Blume.:** The fruit is single seeded drupe, long, reddish-green with persistent reflexed calyx. The average length and diameter of the fruit was 3.1 cm X 1 cm.

Anatomy showed the epidermis uniseriate covered by thick cuticle followed by chlorophyllated 9-10 layer of hypodermis. Inner cortex composed of polygonal shaped parenchyma cells. Vascular bundles 7-8 in number. Crystalliferous cells present in hypodermis and cortex (Plate -4).

***Bruguiera gymnorhiza* (L.) Lam.:** The fruit is a single seeded drupe, reddish-green, conoid with a persistent erect calyx. The average length and diameter of the fruit were 7 cm X 3 cm.

Anatomy showed the epidermis uniseriate covered by thick cuticle followed by chlorophyllated 9-10 layer of hypodermis. Inner cortex composed of polygonal shaped parenchyma cells. Vascular bundles 7-8 in number. Crystalliferous cells present in hypodermis and cortex (Plate -5).

***Bruguiera sexangula* (Lour.) Poir.:** The fruit is a single seeded drupe with persistent erect calyx and is reddish-green in colour with a conical shape. The average length and diameter of the fruit was 22 cm X 1.5 cm.

Anatomy showed the epidermis uniseriate covered by thick cuticle followed by chlorophyllated 9-10 layer of hypodermis. Inner cortex composed of polygonal shaped parenchyma cells. Vascular bundles 7-8 in number. Crystalliferous cells present in hypodermis and cortex (Plate -6).

***Kandelia candel* (L.) Druce.:** The fruit is a single seeded drupe with persistent reflexed calyx, green in colour, leathery, cylindrical, thick surface, blunt apexed and slightly curved. The average length and diameter of the fruit was 20.16 cm X 0.9 cm.

Anatomy showed the epidermis uniseriate covered by thick cuticle followed by chlorophyllated 9-10 layer of hypodermis. Inner cortex composed of polygonal shaped parenchyma cells. Vascular bundles 7-8 in number. Crystalliferous cells present in hypodermis and inner cortex (Plate -7).

***Rhizophora apiculata* Blume.:** The fruit is single seeded drupe with a persistent reflexed calyx, reddish-green in colour, leathery, cylindrical, thick surfaced, blunt apexed and slightly curved. The average length and diameter of the fruit was 19.16 cm X 0.9 cm.

Anatomy showed the epidermis uniseriate covered by thick cuticle followed by polygonal shaped 9-10 layer of cortex. It consists of plenty of sclereids. Vascular bundles 7-8 in number. Crystalliferous cells are present (Plate -8).

***Rhizophora mucronata* Lam.:** The fruit one seeded drupe, long, thick, conoid, pericarp glabrous and leathery with a persistent reflexed calyx. The average length and diameter of the fruit was 19 cm X 2.1 cm.

Anatomy showed the epidermis uniseriate covered by thick cuticle followed by hypodermis. Inner cortex composed of polygonal shaped parenchyma cells. Vascular bundles 14-18 in number. Crystalliferous cells present in hypodermis and cortex (Plate -9).

***Excoecaria agallocha* L.:** The fruit is a capsule, depressed, globose, crustaceous and 3-celled. Green in colour and a smooth surface. The average length and diameter of fruit was 0.8 cm X 1 cm

Anatomy showed outer epidermal cells consists of polygonal shaped parenchyma cells with stomata. Central portion has a vascular trace and terminal tracheids radiating from all directions. Inner portion consists of branched sclereids (Plate -10).

***Aegiceras corniculatum* (L.) Blanco.:** The fruit is a curved capsule, acute to acuminate, falcate, reddish-brown surrounded at the base by persistent calyx. The average length and diameter of the fruit was 4.4 cm X 0.9 cm.

Anatomy showed outer epidermis covered with cuticle followed by cortex consists of patches of sclereids with 7-8 layered polygonal parenchyma cells with inter cellular spaces. Middle and inner cortex comprise of compactly arranged parenchyma. Vascular bundles present inner region. Pith is wide. Cellular depositions present inner cortex (Plate -11).

***Acanthus ebracteatus* Vahl.**: The fruit is a capsule, compressed, coriaceous, green in colour. The average length and diameter of the fruit was 1.2 cm X 1.7 cm.

Anatomy showed the outer cuticle outer cortex consists of sclereids followed by chlorophyllated polygonal shaped parenchyma cells. Inner portion consists of sclereids with a groove was present in centre. Tracheids present in inner cortex (Plate -12).

***Acanthus ilicifolius* L.**: The fruit is a capsule, ovoid-oblong, apiculate and compressed, greenish in colour and coriaceous. The average length and diameter of the fruit was 1.4 cm X 1.5 cm.

Anatomy showed the outer cortex consists of sclerieds and aerenchyma cells followed by polygonal shaped parenchyma cells. Inner portion consists of sclereids with a groove was present in centre (Plate -13).

***Avicennia marina* (Forssk.) Vierh.**: The fruit is a capsule, greenish, more or less rounded, apex acute, coriaceous, silvery tomentose with a persistent stylar beak. The average length and diameter of the fruit was 1.3 cm X 0.8 cm.

Anatomy showed the outer epidermis covered by non-glandular trichomes, followed by cortex consists of compactly arranged parenchyma cells. Brachy sclereid present in cortex. Vascular region consists of several segments of xylem and phloem in collateral position. Pith wide and parenchymatous (Plate -14).

***Avicennia officinalis* L.**: The fruit is a capsule, yellowish green in colour and mango-shaped and flattened. The apex is acute with a persistent stylar beak. The pericarp is silvery tomentose. The average length and diameter of the fruit was 1.3 cm X 0.9 cm.

Anatomy showed the epidermis with non-glandular trichomes. The cortex composed of parenchyma cells. Few brachy sclereid were present in cortex. Vascular bundles comprised of segments of xylem and phloem in collateral position (Plate -15).

Dispersal and establishment of seeds or propagules are the important parts in the life cycle of all seed plants, but it rendered difficult in case of mangroves as they grow in variable, unstable, highly saline environment and mostly in tidal influenced area. As such, all mangrove propagules should have some ability to float, at least initially for some time. In some mangroves, vivipary as a niche property allows floating of seedlings until proper conditions for establishment (McMillan, 1971)<sup>6</sup>.

## CONCLUSION

The viviparous and crypto viviparous condition is seen in the members. Fruit anatomy showed presence of outer thick cuticle, multi layered hypodermis, sclereids, crystalliferous cells, terminal tracheids are halophytic adaptations of true mangroves.

## ACKNOWLEDGEMENT

We express our deep sense of gratitude to CMS College Kottayam, for providing technical support for completion of this work

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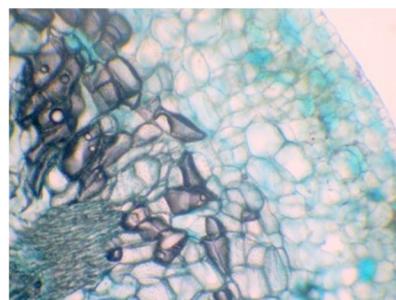


Plate-1. *Lumnitzera recemosa* Willd



Plate-2. *Sonneratia alba* Sm.

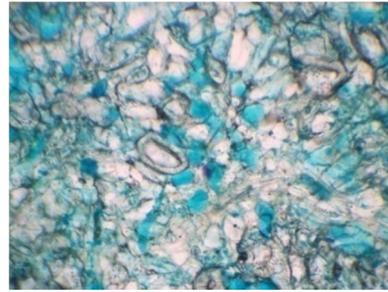


Plate-3. *Sonneratia caseolaris* (L.) Engl.

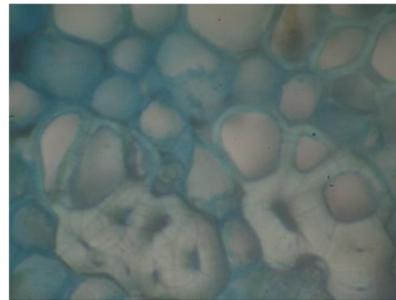


Plate-4. *Bruguiera cylindrica* (L.) Blume.

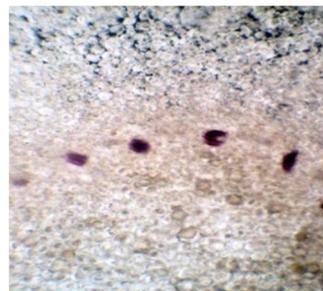


Plate-5. *Bruguiera gymnorhiza* (L.) Lam.

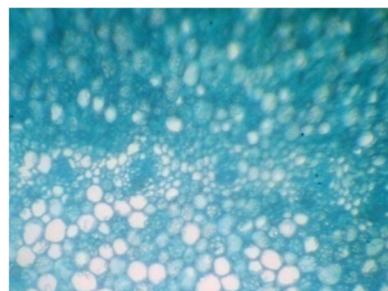


Plate-6. *Bruguiera sexangula* (Lour.) Poir

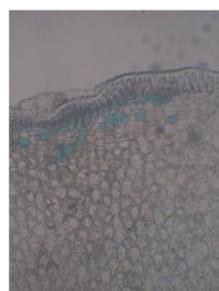




Plate-7. *Kandelia candel* (L.) Druce.

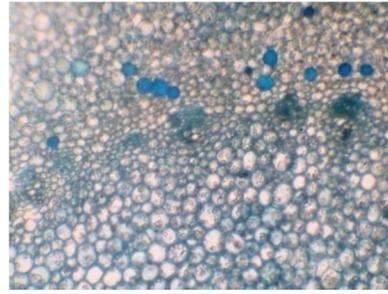


Plate-8. *Rhizophora apiculata* Blume.

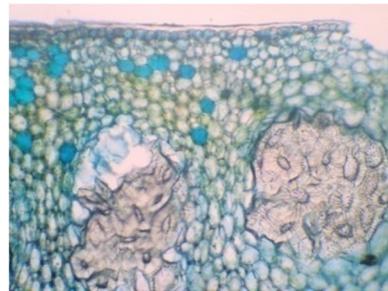


Plate-9. *Rhizophora mucronata* Lam.



Plate-10. *Excoecaria agallocha* L.

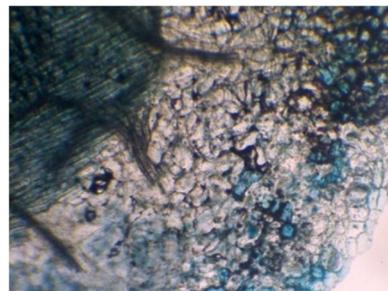


Plate-11. *Aegiceras corniculatum* (L.) Blanco

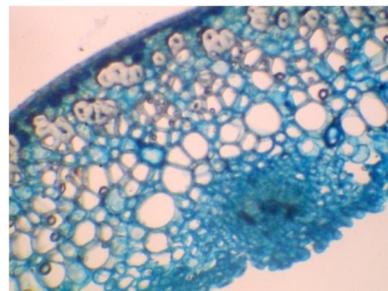




Plate-12. *Acanthus ebracteatus* Vahl

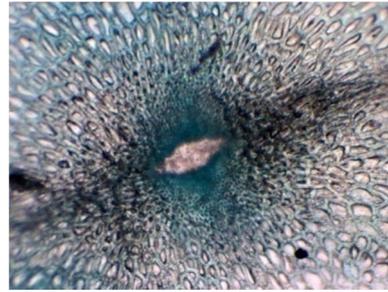


Plate-13. *Acanthus ilicifolius* L

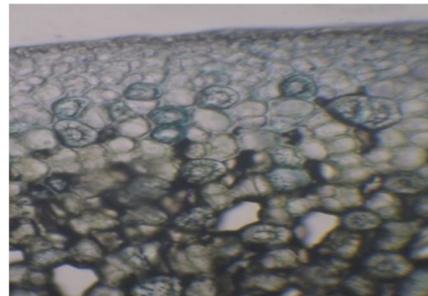


Plate-14. *Avicennia marina* (Forssk.) Vierh

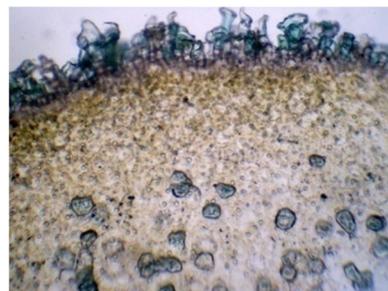


Plate-15. *Avicennia officinalis* L.

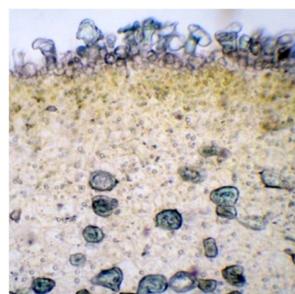


Fig-1. Fruit Morphology and anatomy of true mangrove species