

# BIOSYNTHESIS OF *AVICENNIA* L IN RELATION TO TAXONOMY

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## ABSTRACT

The common mangrove genus *Avicennia* is provided with some typical characters like differential wood anatomy, articulate branching, free-central placentation, 3-colporate pollen with lolongate ora and reticulate surface pattern, etc. These characters suggest that it should not be retained in Verbenaceae. The collective morphological (gross and pollen), and anatomical characters found in combination in *Avicennia* are not encountered in any other mangrove species. *Avicennia* happens to be the only verbenaceous member which serves as a major constituent of mangrove community. Gross and pollen morphological characters, typically found in *Avicennia* are not exhibited in any other member of Verbenaceae. Its affinity with Verbenaceae was drawn from the assumption that *Avicennia* originated from tropical East Asian and Malaysian Symphoremioideae consisting of *Congea*, *Symphorema* and *Sphenodesme* during Tertiary period and later flourished in the tropical coastal regions. Considering the above factors it seems that the segregation of *Avicennia* to form a family for itself is justified.

## INTRODUCTION

The genus *Avicennia* is an important constituent of mangrove vegetation in almost all tropical coastal regions. It is the solitary representative of the final tribe Avicenniaceae of Verbenaceae of SCHAUER (1847) and BENTHAM and HOOKER (1876). BRIQUET (1895) kept it as the ultimate subfamily, Avicennioideae. VAN TIEGHEM (1898) was the first to propose the family status for *Avicennia* as "les Avicenniacees" and went even further to create a separate order in modern sense, the Avicenniales, comprising the families like "les Hermandiacees", "les Avicenniacees" and "les Symphoremacees". MOLDENKE and MOLDENKE (1946) endorsed the creation of the family Avicenniaceae.

The wood anatomy of *Avicennia* together with a few mangrove species has been worked out by MUKHERJEE (1969) but no work has yet been done on the synthesis of *Avicennia* so far as taxonomy is concerned.

## MATERIAL AND METHODS

For wood anatomical study, macerations were prepared following Jeffery's method (JOHANSEN, 1940) while secondary xylem was studied from transverse, longitudinal and radial sections of mature wood from different parts of the stem, prepared at about 15  $\mu$  thickness with sledge microtome. For pollen morphological studies, permanent slides were prepared following the modified acetolysis method as suggested by ERDTMAN (1960). The terminology and main morphological concepts are based on ERDTMAN, BERGLUND and PRAGLOWSKI (1961), REITSMA (1970) and others, and the system of NPC classification has been adopted from ERDTMAN (1963).

The study was conducted with a Leitz Laborlux Microscope (apochromat 100 $\times$ )

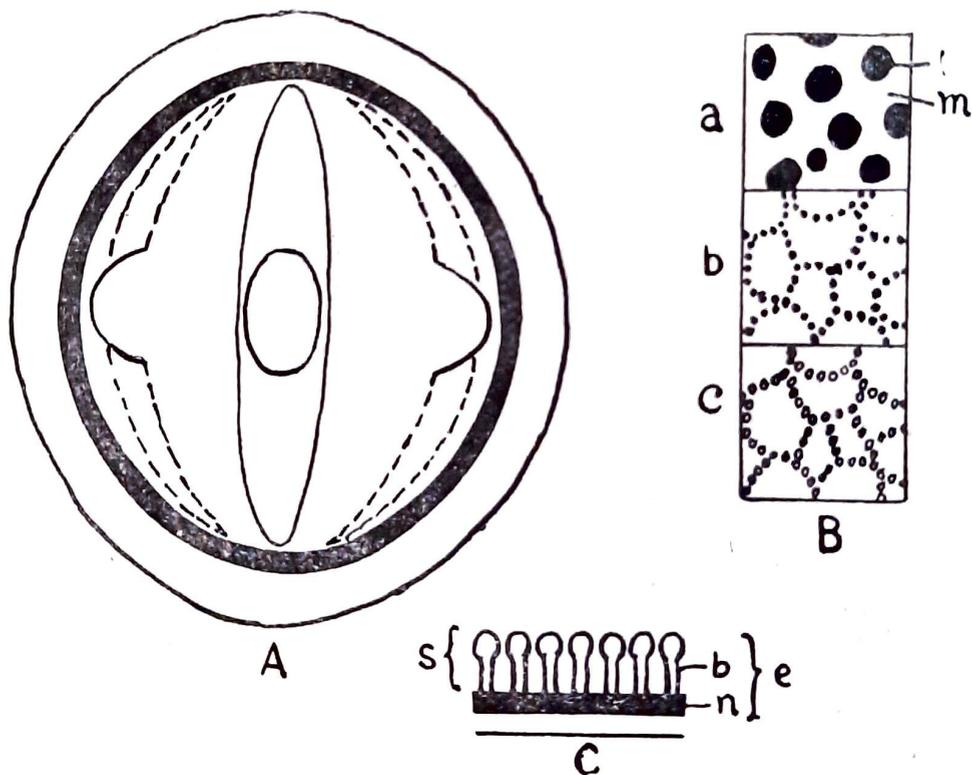
N.A. = 1.32; eye piece 10 ×, 1 ocular micrometer division = 1.2 μ). Measurements of the grain are based on ten readings.

Pollen morphology of the following species has been studied:

1. *Avicennia eucalyptifolia* Zipp. (Nova-Guinea; Nov. 6, 1907; Versteeg 1893; U).
2. *A. marina* (Forsk.) Vierh. (Tandjong Prick, Java, Indonesia; Nov. 11, 1917; Bakhuizen v. d. Brink 449; U).
3. *A. officinalis* L. .. (Sundarbans, Bengal; March, 1968; B. B. Mukherjee; Fresh).
4. *E. tomentosa* Roxb. .. (Sundarbans, Bengal; July, 1962; Fresh).

#### OBSERVATIONS

The wood of *Avicennia officinalis* shows distinct growth rings, which are diffuse porous and non-storied. Simple perforated vessels are generally multiple, 2-3 in radial sequence, diameter 20 μ—100 μ and 150 μ × 40 μ in size. Fibres 300 μ—350 μ × 20 μ—25 μ in size, aseptate. Axial parenchyma with paratracheal vesicentric and apotracheal boundary parenchyma of 2-4 cells, thick layers having crystals. Multiseriate, heterogeneous rays are 260 μ—480 μ × 32 μ in size (Pl. 1, Fig. 1).



Text-Fig.-1. *Avicennia eucalyptifolia*, A: Equatorial view, B: LO-analysis, C: Sporoderm in optical section. (l=lumina; m=muri; b=bacula; e=exine; s=sexine; n=nexine; a, b & c denote first, second and third foci in LO-analysis).

Pollen morphology of the four species of *Avicennia* (*A. eucalyptifolia*, Pl. 1, Fig. 2; Text-fig. 1), *A. marina*, (Pl. 1, Fig. 3-6), *A. officinalis* and *A. tomentosa*) furnish an assemblage of interesting characters. Pollen grains of all the four species are tricolporate; colpi about 25 μ × 5 μ (range 22 μ—35 μ × 4 μ—5.5 μ) with thin margin. Ora lolongate, confined within the limits of colpi, about 9 μ × 5 μ (range 5 μ—12 μ × 3 μ—6 μ). Mean intercolporal distance 13 μ. Amb convex. Sexinal part of exine projected outward, and devoid of any ornamentation. Mean apocolpium diam. 11 μ. Prolate-spheroidal to spheroidal, P/E about 32 μ × 31 μ (range 27.5 μ—36 μ × 26.5 μ—36 μ).

Exine  $3.5 \mu$  thick. Sexine  $2.5 \mu$  thick, reticulate, intectate, muri simplibaculate, rarely duplibaculate, heterobrochate, lumina polygonal, dimension gradually becomes smaller towards the aperture. Bacula provided with distinct globular knoblike head. Nexine  $1 \mu$  thick, tenuinexinous. NPC classification 345.

## DISCUSSION

Fixation of the generic status of *Avicennia* is still a question. Whether it should be segregated to form a family of its own or whether it should be retained in Verbenaceae is still not known. With regard to habit and gross morphology, this genus is either shrub or small tree with opposite leaves, inflorescence densely capitate cyme and flowers complete, bisexual with four epipetalous and didynamous stamens. Such taxonomic characters put *Avicennia* in Verbenaceae. But distinctive characters like articulate branching, imperfectly 4-celled ovary by a 4-winged central column (HOOKER, 1885), free central placentation, orthotropous ovule, fruit being capsule, dehiscence by 2 valves and the presence of endosperm (LAWRENCE, 1965), etc., are not typical verbenaceous characters. A general verbenaceous member has ovary which is 2 or 4 celled with axile placentation having anatropous ovules, fruit a drupe or nutlets, without any endosperm. Such distinguishing morphological characters of *Avicennia* perhaps placed the genus in a separate unigeneric tribe or subfamily of Verbenaceae by various taxonomists like SCHAUER (1847), BENTHAM and HOOKER (1876), BRIQUET (1895) and others. Phylogenetically, the occurrence of free central placentation has generally been accepted to evolve from axile placentation by the persistence of central column and its placenta and due to the disappearance of partition walls (LAWRENCE, 1965). *Avicennia* may be considered as an advanced member so far as gynoeceum morphology is concerned.

The characteristics of wood anatomy of *Avicennia* is different from the arboreal verbenaceous members. Although ecologically *Avicennia* is regarded as an important constituent of mangrove community, it has practically no anatomical resemblance with any other mangrove species (MUKHERJEE, 1969). The characteristic vessels, fibres, ray and wood parenchyma, etc., of *Avicennia* present a distinct variability in wood anatomical structures from the scanty arboreal Verbenaceae. Moreover, the general outline of *Avicennia* stem is ribbed hexagonal while other verbenaceous members have either square or round or triangular ribbed stem. This may also be regarded as a criterion for segregation.

Pollen morphologically *Avicennia* is distinctly different from all other verbenaceous members. The presence of tricolporate aperture with lalongate ora which are confined within the limits of colpi coupled with reticulate surface ornamentation are absent from other members (170 species from 55 genera) of Verbenaceae (MUKHERJEE, 1971). Pollen morphologically *Avicennia* pollen types are regarded as more advanced than any other verbenaceous member so far as primary and secondary characters, i.e., apertural configurations and surface patterns are concerned, as 3-colporate composite aperture with lalongate ora is considered to be more advanced than 3-colpate or 3-colporate with lalongate ora (PUNT, 1967). Regarding surface pattern, it is considered that those types which serve to provide maximum protection to germplasm are primitive. Thus, the line of evolution is considered to run from grains with excrescences to grains without excrescences or tectum (NAIR, 1967).

Phytogeographically it may be assumed that the distribution of tropical East Asian and Malaysian Symphoremioideae along with Avicennioideae during the middle Tertiary was confined to the tropical coastal regions (MULLER, 1964) where it was characterised

by the dominance of only *Avicennia*. It has been suggested that palynologically diversified Symphoremoideae group irregularly produced 2-3 ora in each of the three colpi of pollen grains and reticulate sexine, specially in *Sphenodesme triflora*, while *Avicennia* pollen are regularly 3-colporate with lolongate ora and reticulate sexine, suggesting ecological diversity. It has, so far, not been possible to trace origin, speed and direction of the wave of migration in detail, but there is some indication that the pollen diversification directly proves to be of evolutionary significance from essentially symphoremoideaceous pollen types to a more specialised *Avicennia* type, having a higher level of symmetry in apertural configuration.

The distinctive characteristics of *Avicennia*, e.g. wood anatomy, outline of stem structure, pollen morphology, etc., when considered together with imperfectly 4-celled ovary with free central placentation having orthotropous ovule, 2 valved capsule and albuminous seed exceptionally met with in this genus, etc., they all seem to suggest that it would be reasonable to segregate this genus from Verbenaceae to form a unigeneric family, the Avicenniaceae, as was earlier suggested by VAN TIEGHEM (1898).

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\*Not consulted in original.

## PLATE 1

1. *Avicennia officinalis*—T. L. S. showing ray ( $\times 200$ ). By courtesy B. B. Mukherjee.
2. *A. eucalyptifolia*—Lolongate os confined within the limits of colpus ( $\times 2400$ ).
- 3-6. *A. marina*  $\times 2250$ .
3. Reticulate pattern in first focus; 4, the same in second focus; 5. Optical section; 6. lolongate os confined within the limits of colpus.

