THE WOOD ANATOMY AND THE TAXONOMIC POSITION OF SONNERATIACEAE

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EXCEPT for brief and generalised descriptions[8-10] of the secondary xylem of the genera *Sonneratia* and *Duabanga* heretofore, no systematic approach to the family on the basis of wood anatomy has been endeavoured. The present communication concerns the study of the secondary xylem of *Sonneratia apetala* Ham., *S. acida* Linn. and *Duabanga sonneratioides* Ham.

Table I presents the summary of the pertinent anatomical features found in the woods under study.

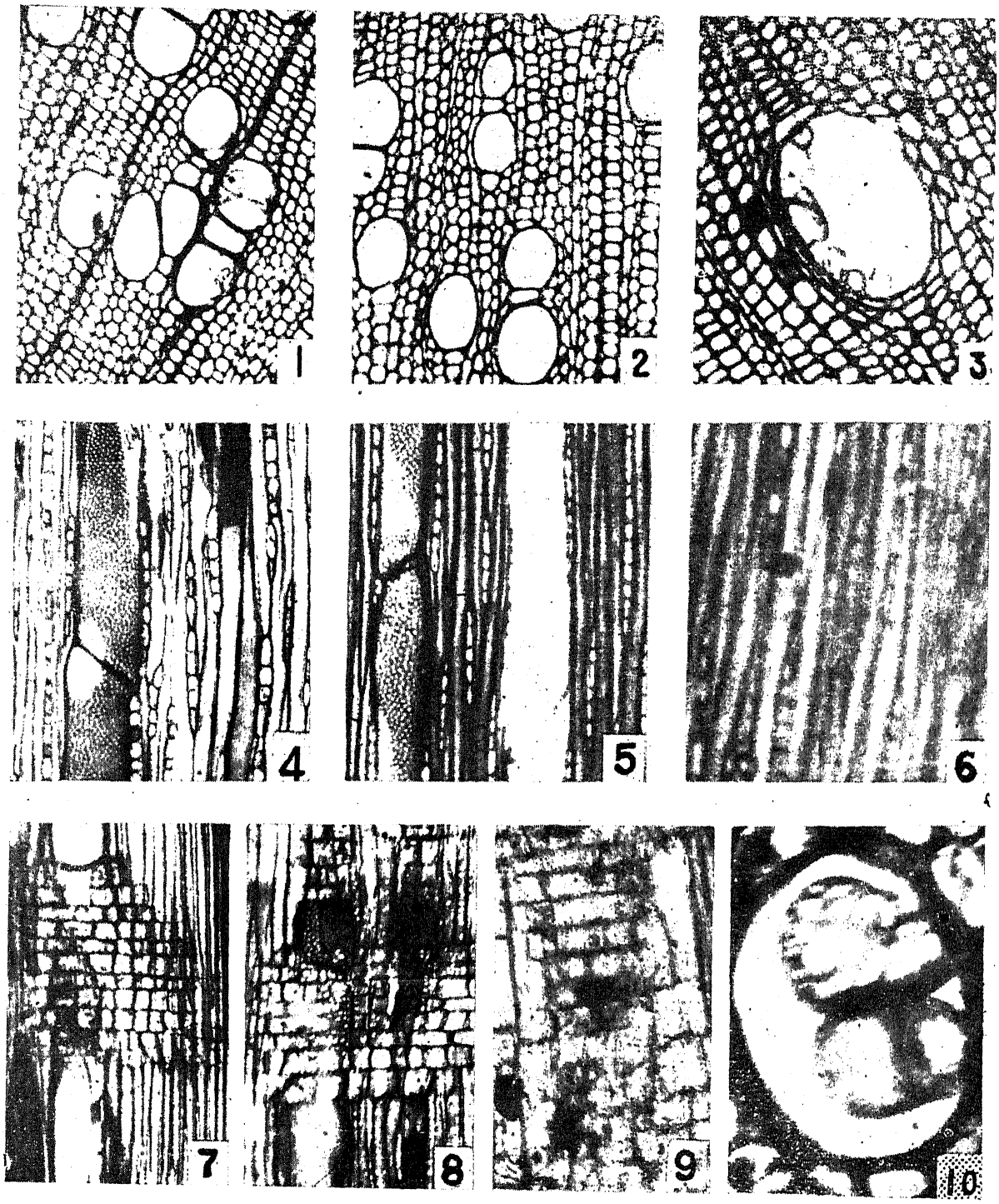
TABLE I
Summary of the pertinent anatomical features of the woods investigated

Specimen	Pore distribution per mm.	Pore arrangement: Singles	Pore arrangement: Radial multiples	Pore arrangement: Aggregates	Vessel diameter (range in microns)	Vessel element length (range in microns)	Parenchyma	Fibre and fibre tracheid length (range in microns)	Fibre wall thickness (in microns)	Ray height in cells
S. apetala ..	20–25	40	58	2	120–160	300–800	..	700–1000	3–7·5	1–20
S. acida ..	20–29	45	53	2	120–160	275–750	..	750–1100	3–6·0	1–15
D. sonneratioides ..	2–8	45	49	6	125–230	800–1100	Present	750–1025	3·5–0	1–20

The growth rings are present in all the specimens worked out and are easily discernible by hand-lens, although they look ill-defined to the naked eye. The woods are exclusively diffuse porous (Figs. 1, 2, 3). The vessels are distinct in *Duabanga* and barely visible to the naked eye in both the specimens of *Sonneratia* and are being fairly uniformly spaced within the growth ring without much variation in size. The number of pores per square millimeter are numerous in *Sonneratia* species and few to moderately few in *Duabanga*. The vessel distribution is both in radial groups of 2 to 3 and in singles (Figs. 1, 2, 3) and very occasionally in aggregates. The isolated pores are strikingly broadly oval to circular and those in groups are decidedly flattened in outline. The thickness of the vessel-wall ranges from 2-10 μ and most show thickness between 2 and 5 μ. The tangential pore diameters are medium-sized in *Sonneratia apetala* and *S. acida* and moderately large-sized in *Duabanga*. The slope of the end-walls in the vessel element shows wide variance and ranges from moderately horizontal to very oblique, but usually intermediate (Figs. 4, 5). Perforation plates are exclusively simple. The vessel-member lengths in the specimens surveyed range from moderately short to medium-sized in *Sonneratia* and moderately long in *Duabanga*. The vessel segments are truncate or attenuately tailed. Inter-vessel pitting is profuse; the pits are of medium size, circular, predominantly alternate (Figs. 4, 5) and definitely vestured. The vessel-ray pits (Figs. 7, 8, 9) are of two types: (*a*) somewhat large, flattened, few in number for the field, gash-like and often extending almost the width of the cross-field in scalariform arrangement and (b) very minute, generally more in number and oval to round in shape. The two types associated with the intermediates sometimes do occur in the same cell. The pits are simple to narrowly bordered. The vessels usually are open but at some places their cavities are occluded with dark gummy or tanniferous material. Tyloses occur very abundantly in *Sonneratia apetala* and *Duabanga* (Figs. 1, 3) and very sparsely in *S. acida*. They are variable in size, spherical to sub-spherical and occur either in singles or in close clusters within the vessel element. Mostly they are thin-walled, but in *Sonneratia apetala* a low percentage of them are thick-walled with ramiform pitting (Fig. 10).

The occurrence of axial parenchyma is restricted to the genus *Duabanga* alone and it is predominantly paratracheal forming one to three cells thick vasicentric sheaths around the vessel members (Fig. 3).

The fibres constitute the most part of the ground tissue of the wood. They are semi-libriform, polygonal in cross-section and aligned in regular radial seriations. They are short to moderately long and are both septate and non-septate in *Sonneratia* species (Figs. 4, 5) and exclusively non-septate in *Duabanga* (Fig. 6). The pits to fibres are few to many, minute and



FIGS. 1-10. Fig. 1. *Sonneratia apetala*. Cross-section showing diffuse-porosity, vessel distribution and tyloses in the vessels. Fig. 2. *S. acida*, cross-section to show diffuse porosity and pores in solitary and radial multiple arrangement. Fig. 3. *Duabanga sonneratioides*, cross-section to show diffuse-porosity, paratracheal parenchyma in vasicentric sheaths and tyloses in vessel element. Fig. 4. *S. apetala*, tangential section showing uniseriate rays, semi-libriform fibres with and without septa. Fig. 5. *S. acida*, tangential section to show the fibrous elements, uniseriate rays, inter-vessel pitting and vessel element end-walls. Fig. 6. *D. sonneratioides*, tangential section showing non-septate fibres and uniseriate rays. Figs. 7-8. Radial sections of *S. apetala* and *S. acida*, showing bordered pits in fibres and ray-vessel pitting. Fig. 9. *D. sonneratioides*, radial section showing ray-vessel pitting. Fig. 10. *S. apetala*, cross-section showing the vessel element with tyloses. Figs. 1-9, × 72; Fig. 10, × 950.

simple to bordered. Panshin[9] also records bordered pits in the wood fibres of *S. caseolaris*. The bordered pits usually exhibit round apertures, but the occurrence of crossed apertures in the bordered pits of the fibres is not infrequent. Janssonius[6] notes a distinct type of fibre cells around the vessels in *Sonneratia* and these are distinguished from the rest in that they are shorter, thin-walled and rounded with untapering ends leaving intercellular spaces in between them. Brown,[2] however, doubts if such distinction can be made in the Indian species, although he records some markedly shorter fibres with blunt ends in *Duabanga*. Such fibre cells were, in fact, recorded by the authors in both the species of *Sonneratia* and these fibre cells resemble the normal ones except that they are quite narrow. Those reported by Brown are not present in *Duabanga*.

The vascular rays are indistinct to the naked eye. They are numerous, narrow and closely distributed. They are usually uniseriate (Figs. 4, 5, 6) and only very occasionally do we come across biseriate and triseriate conditions in these taxa. They correspond to Kribs[7] homogeneous Type III in *Sonneratia* species as opposed to the heterogeneous condition reported by Pearson and Brown.[10] *Duabanga*, however, displays heterogeneous rays of Type III. The height of rays in cells ranges from 1–20, 1–15 and 1–20 in *S. apetala*, *S. acida* and *D. sonneratioides* respectively. In general, the ray cells are made up of short procumbent cells of varied sizes and shapes apart from the row of crystalliferous cells in the species of *Sonneratia*. The ray cells are thin-walled and bear very few, minute and oval to rounded simple pits. In *Sonneratia* species certain of the ray cells bear dark brownish-black gummy deposits.

From these studies it is quite evident that the woods display an assemblage of features which signify primitiveness as also moderate phyletic advancement. These characters are: the presence of both fibre-tracheids and semi-libriform wood fibres; the length of the fibrous elements being very short to medium-sized; the predominance of oval or circular thin-walled vessel elements; vessel elements ranging from short to moderately long but averaging to medium size; predominance of vessel elements with simple perforation plates; occurrence of at least a low percentage of vessel elements with almost transverse end walls; exclusively alternate inter-vessel pitting; vascular rays mostly uniseriate and which are either homogeneous or heterogeneous and, finally, the presence of paratracheal parenchyma of vasicentric type. These features of secondary xylem suggest that sonneratiaceous members are somewhat specialised taxa of the angiosperms.

From a close comparison of the sonneratiaceous woods with those of the putatively related families it becomes clear that they share in common the highly specialised characters, namely, simple perforation plates, alternate intervascular pitting but differing from one another in one or more features like the nature and distribution of parenchyma, nature of the fibres, presence and absence of vestured pits and in the nature and type of vascular rays. It is only Lythraceæ among the families of Myrtiflorae that shows most features in common with Sonneratiaceæ, namely, small to medium-sized vessels; vessel elements with simple perforation plates; numerous intervascular pits which are predominantly alternate, bordered and vestured; wood fibres libriform and septate; vascular rays nearly always uniseriate and heterogeneous to homogeneous and parenchyma distributed paratracheally when present. Besides these similarities in the secondary xylem, both the genera, as has already been shown by Venkateswarlu,[12] agree in their embryological features with those of the Lythraceæ. Erdtman,[4] while describing the structure of the mature pollen grains of Lythraceæ, writes: "The grains in *Diplusodon* and *Pemphis* (less so those in *Galpinia*) have some characters in common with the Sonneratiaceæ. The latter family was previously (and more correctly?) referred to Lythraceæ." Further the following morphological traits are held in common among these two familial taxa: (1) arborescent habit, (2) simple, exstipulate leaves, (3) entirely bisexual actinomorphic flowers, (4) presence of calyx-tube, (5) presence and absence of petals and (6) seeds non-endospermic. Thus from the available evidence (embryological, xylotomical, palynological and morphological) it can at once be seen that *Sonneratia* and *Duabanga* show most features in common with Lythraceæ. There are, however, a few distinct differences in morpho-anatomical features between the genera *Sonneratia* and *Duabanga* on the one hand and between the two genera and the Lythraceæ on the other. In the light of these observations it appears that erection of a separate family Sonneratiaceæ,[3,5,11,13] with only these two genera included in it, is not justified. Therefore the two genera *Sonneratia* and *Duabanga* may be brought under the family Lythraceæ as proposed

by Bentham and Hooker[1] and treat them as members of separate subfamily Sonneratioideæ within Lythraceæ.

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* Original not seen.

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