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Comparative Wood Anatomy Of Family Lythraceae Of Assam/NE India With Reference To Their Identification

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Abstract

The main objective of study was to evaluate variation in anatomical features of *Duabanga grandiflora*, *Lagerostroemia parviflora* and *Lagerostroemia speciosa*. The present study showed that the wood of *Duabanga grandiflora* and *Lagerostroemia parviflora* was diffuse-porous with indistinct growth rings, while semi- ring-porous wood was present in *Lagerostroemia speciosa*. Vessels were mostly solitary, in radial multiples of 2-3, oval in outline except *L. speciosa*. Oblong, drum, linear, barrel shaped vessels with or without tails were present in selected genera of this family. Simple perforation plate, alternate and vestured intervessel pits were present in all species. Coalescent apertures were also present in some vessel elements of *L. speciosa*. Different types of axial parenchyma like vasicentric, diffuse, diffuse in aggregates, lozenge aliform, winged aliform and confluent parenchyma were present. Prismatic crystals were present in chambered parenchyma. Rays were uniseriate. Most of the rays were homocellular, vessel shapes, crystals in chambered axial parenchyma, cellular composition of rays were the diagnostic feature at generic level. Vessel-ray pits, axial parenchyma distribution and absence of crystals in fibres were the features to distinguish *Duabanga grandiflora* from *Lagerostroemia* species. Presence of fibre dimorphism and crystals in rays, fibres and parenchyma were the diagnostic features of *L. speciosa*.

Keywords: *Anatomical variations, Coalescent apertures, Prismatic crystals, Fibre dimorphism*

1. Introduction

The family Lythraceae comprises of about 25 genera and 550 species few herbs, shrubs and trees. This family is of considerable importance as it yields economic important other than wood. The leaves of *Lawsonia inermis* are used as hair dye while red dye obtained from flowers of *Woodfordia fruiticosa* is used for dyeing silk. The genera *Lagerstroemia* and *Duabanga* are important from timber point of view.

Duabanga Walp. is a small genus with three species. Only one species *D. grandiflora* occurs in India. The wood is used for general purposes light packing cases, planking and for face veneers of block boards.

(Purkayastha, 1982) reported 50 species of *Lagerstroemia* of which 5 species occur in India. *L. speciosa* is also grown as an avenue tree. The bark, leaves and fruits of *Lagerstroemia* species are rich in tannin. Inferior quality of fibres is also obtained from the bark. The woods of *Lagerostroemia* species are used for making furniture, wooden crates, battens for plywood cases etc.

A little information is available on the wood anatomy of family Lythraceae. (Solereder, 1908), (Metcalfe, and Chalk, 1950). made investigation on earlier anatomical work of this family (Baas, and Zweypfenning, 1979) described the diversity in wood anatomy of 18 genera and prevailed number of anatomical characters like scanty paratracheal parenchyma, heterogeneous uniseriate and multiseriate rays, septate libriform fibres with minute bordered pits and simple perforations. Rays specialization towards uniseriate homogeneous rays accompanied with fibre dimorphism leading to abundant parenchyma differentiation and advent of chamber crystalliferous fibres have also been traced in number of genera. They also discussed the affinities of Lythraceae with other families of order Myrtales. They are of opinion that *Lagerostroemia* has the most specialized wood anatomy with abundant parenchyma and alternate bands of dimorphous septate fibres. In continuation of earlier work on family Lythraceae, (Baas, 1986). showed resemblance between wood anatomy of genera Capuronia and Galpinia and genera *Peliria* and *Ginoria*. He observed a much similarity of *Orias* (*Lagerostroemia excelsa*) with *L. subcostrata*. (Kshirsagar, and Vaikos, 2012a), (Kshirsagar, and Vaikos, 2012b) studied vessel

elements of different species of *Ammania*, *Rotala*, *Cuphea*, *Woodfordia*, *Lawsonia* and *Lagerostroemia*. They recorded variation in vessel element length and breadth in different species or in the plants of the same species. The main characteristics of the vessels observed were simple perforation plate with terminal and sub terminal position, presence of pits on lateral walls and vessels with tail. They found vestured pits as the characteristic of the family. While making a detailed study on fossil woods, C. (Ye-Ming et. al. 2007) carried out the investigation on wood structure of *Lagerostroemia yuanmovensis* and showed that all anatomical characters like distinct growth rings, diffuse porous wood, simple perforation, intervessel pits and vessel ray pits alternate, septate fibres, vasicentric and marginal axial parenchyma fall in the range of modern *Lagerostroemia* species. M. (Asim et. al. 2014) did not record any significant variation in vessel diameter of *L. speciosa* collected from different geographical areas while intervessel pits, vessel-ray pits, ray length and ray width exhibited variation with different localities.

2. Materials And Methods

The wood samples of selected species namely *Duabanga grandiflora*, *Lagerostroemia parviflora* and *Lagerostroemia speciosa* were collected from different forest regions of Assam, North East India. For each species, five mature trees with uniform crown and straight boles were selected and wood sample of $5cm^3$ size was taken from each tree with the help of chisel and hammer at breast- height. Collected wood samples were trimmed to $2cm^3$size and were fixed in FAA for 24-48 hours, after which they were preserved in 50% alcohol for further studies.

Wood sections of about 15-25 microns thickness were cut in three planes (cross, tangential longitudinal and radial longitudinal) with the help of a sliding microtome for microscopic analysis. Permanent slides were prepared by following standard laboratory protocol. Fibre diameter, fibre wall thickness, vessel diameter, vessel frequency and tissue proportion were studied from cross sections while ray height and ray width were measured from tangential longitudinal sections. For preparation of temporary slides, small radial slivers were macerated with (Franklin, 1945) and measurements of fibre length and vessel length were taken by using 50% alcohol. The terminology, measurements and anatomical features were carried out using IAWA list of anatomical features.

3. Results

The quantitative features of selected species were presented in Table1.

3.1 *Duabanga grandiflora* Walp.- Growth rings boundaries indistinct. A diffuse porous wood. Vessels mostly solitary, in radial multiples of 2-3, oval in outline, drum shaped, barrel to oblong and linear, with or without tail at one end, 200.16-1200.16µm (Mean 476.78±180.96 µm) in length, 114.62-312.6µm (Mean 236.49±37.30µm) in diameter, vessel frequency 4-12 (Mean 7.84±2.01) per mm^2, simple perforation plate, intervessel pits alternate, medium to large, 7.8-13 µm (Mean 8.96±1.52µm) in size, vestured pits, vessel ray pits with much reduced border to apparently simple, pits horizontal, scalariform (gash like) and vertical (palisade like) (Fig.1)

Fibres thin to thick walled, 625.5-2502µm (Mean 1279.02±356.70µm) long, 20.8-67.8µm (Mean 37.46±8.83µm) and 7.8-46.8µm (Mean 19.57±6.55µm) in diameter and lumen diameter, 1.3-20.8µm (Mean 8.94±4.49µm) in wall thickness (Table 1), septate fibres present.Parenchyma vasicentric, diffuse, 2-6 cells per parenchyma strand.

Rays mostly uniseriate, biseriate, mean ray height and ray width 83.36-1104.52µm (Mean 378.70±207.92µm) and ray width 10.42-31.26µm (Mean 11.08±2.88µm), rays both homocellular and heterocellular, body ray cells procumbent in homocellular rays, body ray cells procumbent with one or more rows of upright and/or square marginal cells in heterocellular ray (Fig. 1). Rays 6-15 (Mean 10.32±1.93) per mm.

3.2 *Lagerostroemia parviflora* Roxb.– Growth ring boundary indistinct. A semi-ring-porous wood. Vessels mostly solitary, in radial multiples of 2-3, oval in outline, drum shaped, linear without or with tails at both ends, 150.12 – 525.42µm (Mean 366.09± 88.31µm) in length, 119.83 – 307.39µm (Mean 203.14±33.67 µm) in diameter in early wood, 72.94 – 104.20µm (Mean 92.91± 12.06µm) in latewood, vessel frequency 3-5 (Mean 4±1) per mm^2 in early wood and 3-12 (Mean 6±2) per mm^2 in latewood, simple perforation plate. Intervessel pits alternate, medium to large, 5.2 – 23.4 (Mean 10.02±4.47µm) in size, vestured pits, vessel ray pits with much reduced border to apparently simple, tyloses present in vessels (Fig. 2).

Fibres thin to thick walled, 550.44- 1626.30µm (Mean 1052.84± 245.65µm) long, 15.60-52µm (Mean 26.68±6.73µm) and 7.8-28.6µm (Mean

13.39± 3.82µm) in diameter and lumen diameter, 1.3-20.8µm (Mean 6.68±3.20µm) in wall thickness, septate fibres present (Table 1), Prismatic crystals present in fibres.
Parenchyma diffuse, diffuse in aggregate, vasicentric, winged aliform. 2-8 cells per parenchyma strand (Fig. 2).

Rays mostly uniseriate, rarely biseriate, mean ray height and ray width 20.84- 573.1µm (Mean 190.14±136.10µm) and ray width 10.42 - 31.26µm (Mean 11.67±3.64µm), rays both homocellular and heterocellular, body ray cells procumbent in homocellular ray, body ray cells procumbent with one or more rows of upright and/or square marginal cells in heterocellular ray Rays 9 - 25 (Mean 16.46± 2.97) per mm (Table 1).

3.3 *Lagerostroemia speciosa* Pers. – Growth ring boundary distinct due to parenchyma bands (Fig. 2F). A semi-ring-porous wood. Vessels mostly solitary, in radial multiples of 2-3, circular in outline, drum shaped to oblong, without or with tail like extensions at both ends, 200.16 - 750.60µm (Mean 367.49± 105.78µm) in length, 92.45 - 270.92µm (Mean 172.58±36.47µm) in diameter in early wood, 52.10 - 88.57µm (Mean 67.07± 12.89µm) in latewood, vessel frequency 5-8 (Mean 7±1) per mm^2 in early wood and 5-19 (Mean 10±3) per mm^2 in latewood, simple perforation plate. Intervessel pits alternate, medium to large, 5.2 - 20.8µm (Mean 9.04±3.70µm) in size, occasionally with coalescent aperture, vestured pits, vessel ray pits with much reduced border to apparently simple, pits rounded or angular, tyloses present (Fig. 3).

Fibres thin to thick walled, 550.44 - 1751.4µm (Mean 964.97± 233.42µm) long, 15.6 -39 µm (Mean 24.89±5.59µm) and 7.8 - 23.4µm (Mean 11.91± 3.13µm) in diameter and lumen diameter, 1.3 - 14.30µm (Mean 6.48±2.78µm) in wall thickness (Table 1), parenchyma like fibre bands alternating with ordinary fibres, septate fibres present.
Parenchyma diffuse, diffuse in aggregate, vasicentric, banded. 2-6 cells per parenchyma strand (Fig. 3).

Rays mostly uniseriate, rarely biseriate, mean ray height and ray width 83.36 - 593.94µm (Mean 274.50±106.12µm) and ray width 10.42 - 41.68µm (Mean 13.00±5.86µm), rays mostly homocellular and occasionally heterocellular, body ray cells procumbent in homocellular rays and body ray cells with two rows of upright and/or square marginal cells. Rays 9- 20 (Mean 13.54±2.37) per mm. Prismatic crystals present in septate fibres, chambered axial parenchyma and procumbent cells of ray (Fig. 3).

A key for identification of Lythraceae family is given below:

1	Fibre dimorphism present -----------	*Lagerostroemia speciosa*
1a	Fibre dimorphism absent ----------	2
2	Ray frequency more than 12 µm ----------	*Lagerostroemia parviflora*
2a	Ray frequency less than 12 µm ----------	*Duabanga grandiflora*

4. Discussion

Wood structure in family Lythraceae is uniform. The woods of *Duabanga grandiflora* and *Lagerostroemia parviflora* were diffuse porous with indistinct growth rings, while *Lagerostroemia speciosa* was semi- ring porous. The growth rings were distinct due to presence of large early wood vessels in the beginning of the growth rings. Vessels were mostly solitary and in radial multiples of 2-3, oval in outline except *L. speciosa*. Different shapes of vessels i.e. oblong, drum, linear, barrel shapes with or without tails were present in both *D. grandiflora* and *L. parviflora*. Drum and linear shaped vessel were observed in *L. speciosa*. Simple perforation plates, intervessel pits alternate and vestured pits were the common features in selected genera. In *L. speciosa*, coalescent apertures were also recorded in some vessel elements. Vessel ray pits with much reduced border to apparently simple, pits horizontal scalariform (gash like) and vertical (palisade) like was present in *D. grandiflora* while vessel ray pits with much reduced border to apparently simple, pits rounded or angular was present in *Lagerostroemia* species. The features like diffuse porous and semi- ring porous wood, alternate and vestured intervessel pits are also reported in genera of family Lythraceae by other workers (Baas and Zweypfenning, 1979), (Baas, 1986) and (Asim et. al., 2014). (Kshirsagar and Vaikos, 2012a), (Kshirsagar and Vaikos, 2012b) investigated cylindrical and tubular shapes of vessels in members of family Lythraceae. On contrary to this, drum and barrel shaped vessels were commonly reported in *Lagerostroemia* species which may be due to difference in habitat conditions.

Fibres were thin to thick walled. Septate fibres were present in all selected genera. Crystals were present in fibres of *Lagerostroemia* species. According to (Baas and Zweypfenning, 1979), (Baas, 1986) fibre dimorphism occurs in members of Lythraceae and particularly in *Lagerostroemia* species. On the other hand, (Asim et. al. 2014) suggested thin walled fibre bands as parenchyma. To examine whether these bands present in cross section are of parenchyma or fibres, the radial and

tangential longitudinal sections were examined thoroughly. It was observed that these bands were of septate fibres in tangential longitudinal sections and is in confirmation with the findings of (Baas and Zweypfenning, 1979). Crystals were present in fibres of both *L. parviflora* and *L. speciosa*. Various types of axial parenchyma like vasicentric, diffuse, diffuse in aggregates, lozenge aliform, winged aliform and confluent parenchyma were present in selected members of family Lythraceae. Prismatic crystals were present in chambered parenchyma. Rays were mostly uniseriate and rarely biseriate or partly biseriate. They were mostly homocellular and rarely heterocellular. Homocellular rays were composed of procumbent cells and heterocellular rays consisted of procumbent body cells with one row of upright and/or square marginal cells. Uniseriate rays with occasionally biseriate rays are designated as juvenilistic rays due to their resemblance with rays of young twigs of shrubs or trees. Since the present investigations are made on bole of mature trees, therefore these rays cannot be juvenile rays as reported in the literature by (Baas and Zweypfenning, 1979). Hence, the uniseriate rays may be used as diagnostic characteristics of this family. Crystals were also present in procumbent cells of rays of *L. speciosa*.

5. Conclusions

In family Lythraceae, the wood of *Duabanga grandiflora* and *Lagerostroemia parviflora* was diffuse-porous with indistinct growth rings, while semi- ring-porous wood was present in *Lagerostroemia speciosa*. Vessels were mostly solitary, in radial multiples of 2-3, oval in outline except *L. speciosa*. Oblong, drum, linear, barrel shaped vessels with or without tails were present in selected genera of this family. Simple perforation plate, alternate and vestured intervessel pits were present in all species. Coalescent apertures were also present in some vessel elements of *L. speciosa*. Different types of axial parenchyma like vasicentric, diffuse, diffuse in aggregates, lozenge aliform, winged aliform and confluent parenchyma were present. Prismatic crystals were present in chambered parenchyma. Rays were mostly uniseriate. Most of the rays were homocellular, vessel shapes, crystals in chambered axial parenchyma, cellular composition of rays were the diagnostic feature at generic level. Vessel- ray pits, axial parenchyma distribution and absence of crystals in fibres were the features to distinguish *Duabanga grandiflora* from *Lagerostroemia* species. Presence of fibre dimorphism and crystals in rays, fibres and parenchyma were the diagnostic features of *L. speciosa*.

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Table and Figures

Table 1: Quantitative features of selected species of family Lythraceae

Parameters	*D. grandiflora*	*L. parviflora*	*L. speciosa*
FL(µm) (Mean±SD)	625.50-2502 (1279.02±356.70)	550.44-1626.30 (1052.84±245.65)	550.44-1751.40 (964.97±233.42)
FD(µm) (Mean±SD)	20.80-67.80 (37.46±8.83)	15.60-52 (26.68±6.73)	15.60-39 (24.89±5.59)
FLD(µm) (Mean±SD)	7.80-46.80 (19.57±6.55)	7.80-28.60 (13.39±3.82)	7.80-23.40 (11.91±3.13)
FWT(µm) (Mean±SD)	1.3-20.80 (8.94±4.49)	1.3-20.80 (6.68±3.20)	1.30-14.30 (6.48±2.78)
VL(µm) (Mean±SD)	200.16-1200.16 (476.78±180.96)	150.12-525.42 (366.09±88.31)	200.16-750.60 (367.49±105.78)
VD(µm) (Mean±SD)	114.62-312.60 (236.49±37.30)	72.94-104.2 (92.91±12.06)	52.10-88.57 (67.07±12.89)
IVP(µm) (Mean±SD)	7.80-13 (8.96±1.52)	5.2-23.40 (10.02±4.47)	5.20-20.80 (9.04±3.70)
VF/mm^2 (Mean±SD)	4-12 (7.84±2.01)	3-12 (6±2)	5-19 (10±3)
APS(µm) (Mean±SD)	2-6 (2.96±0.87)	2-8 (3.94±1.60)	2-6 (3.26±1.13)
RH(µm) (Mean±SD)	83.36-1104.52 (378.70±207.92)	20.84-573.10 (190.14±136.10)	83.36-593.94 (274.50±106.12)
RW(µm) (Mean±SD)	10.42-31.26 (11.08±2.88)	10.42-31.26 (11.67±3.64)	10.42-41.68 (13.00±5.86)
RF/mm (Mean±SD)	6-15 (10.32±1.93)	9-25 (16.46±2.97)	9-20 (13.54±2.37)

FL fibre length, FD fibre diameter, FLD fibre lumen diameter, FWT fibre wall thickness, VL vessel length, VD vessel diameter, IVP intervessel pitting, VF vessel frequency, APS axial parenchyma strand, RH ray height, RW ray width, RF ray frequency

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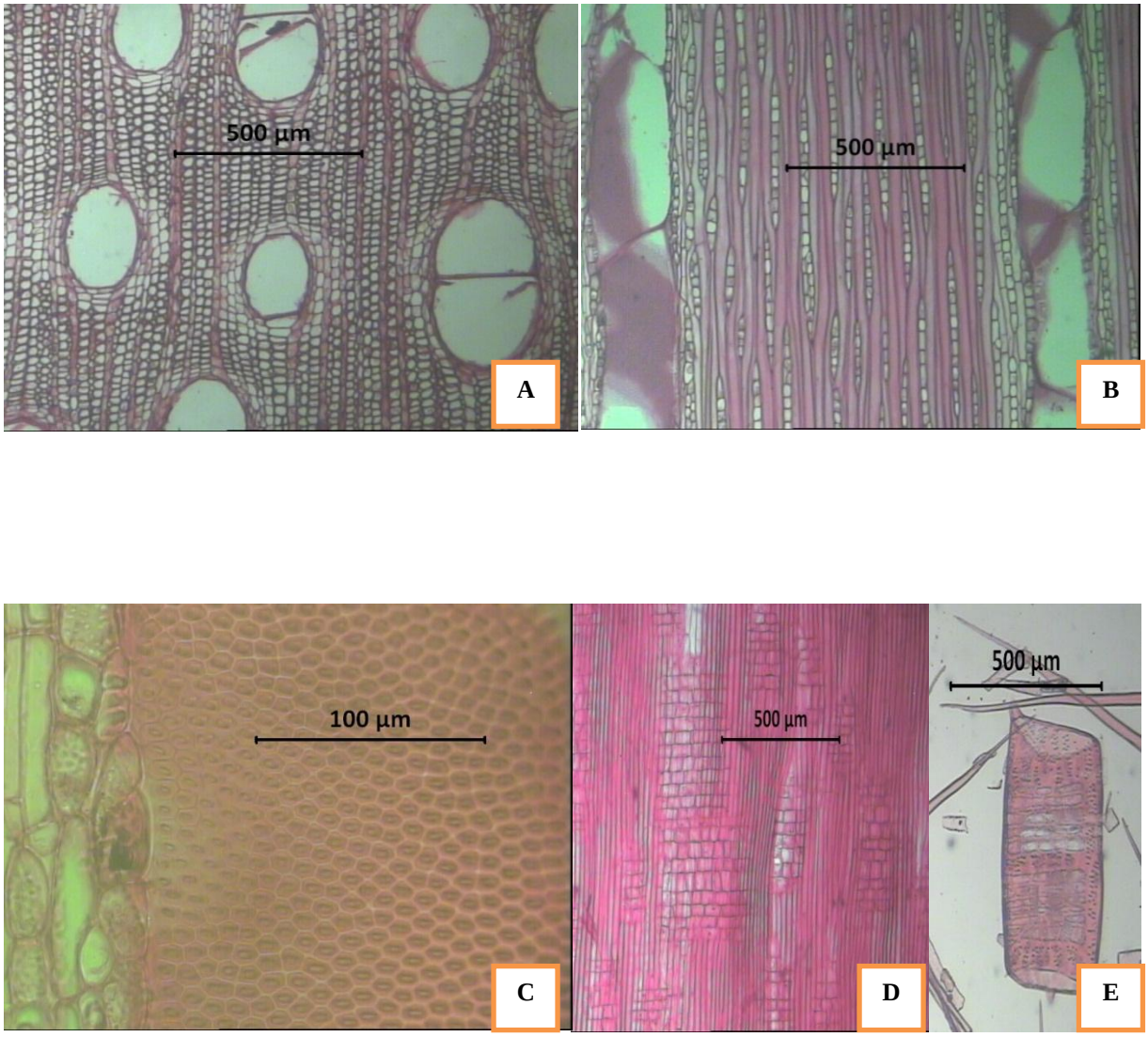

D. grandiflora

Figure 1: *Duabanga grandiflora:* **A** Cross- sections showing diffuse-porous wood, vessel outline oval, Parenchyma diffuse and vasicentric. **B** Tangential longitudinal sections showing uniseriate to partly biseriate, parenchyma 2-4 strand. **C** Tangential longitudinal sections showing intervessel pits alternate, vestured. **D** Radial longitudinal sections showing vessel ray pits with much reduced borders to apparently simple, pits vertical (palisade). **E** Macerated vessel.

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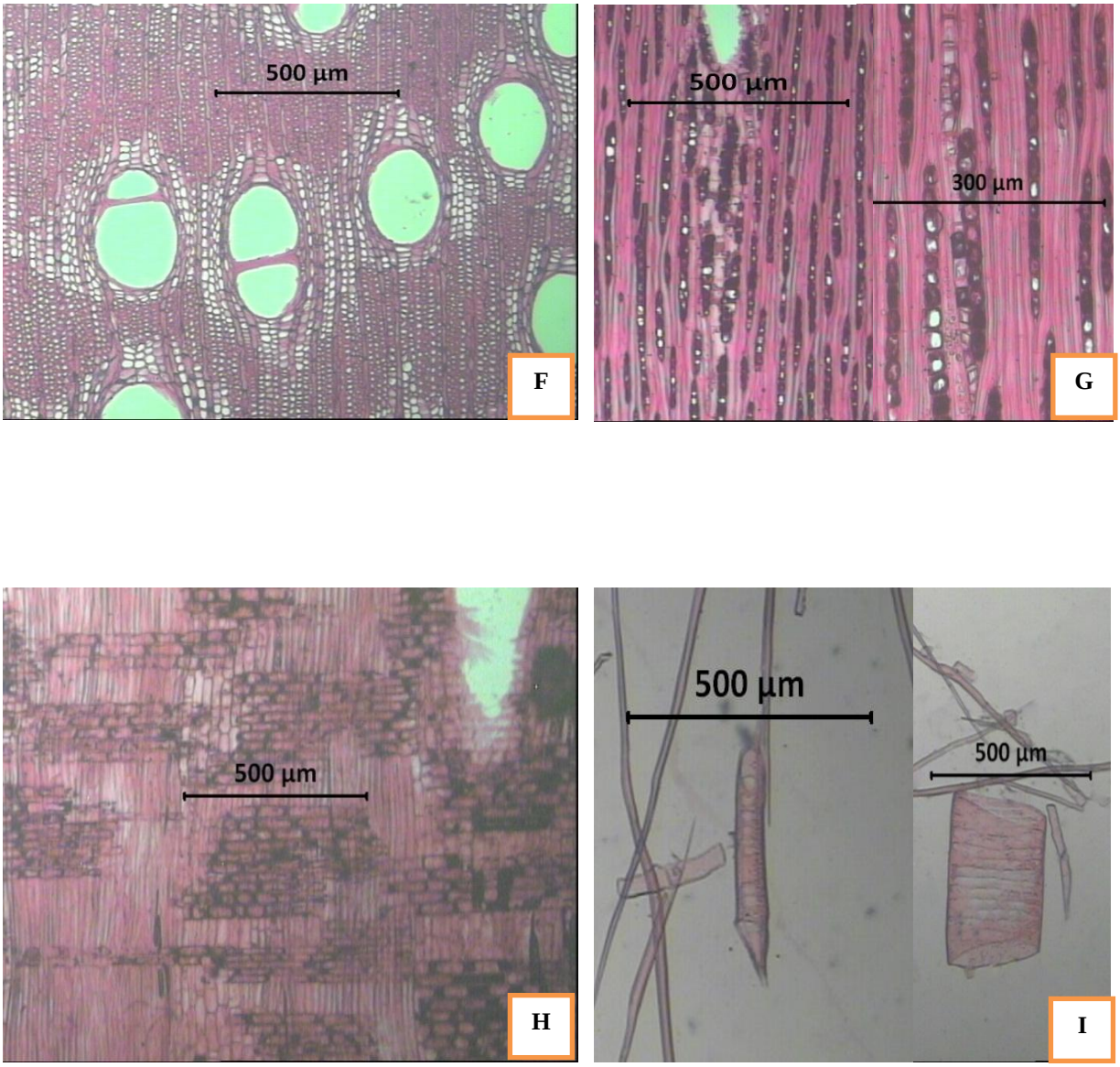

L. parviflora

Figure 2: *Lagerostroemia parviflora:* **F** Cross- sections showing diffuse-porous wood, vessel outline oval, Parenchyma diffuse, diffuse-in-aggregate, lozenge aliform and confluent. **G** Tangential longitudinal sections showing uniseriate rays, parenchyma 3-5 strand, crystals in axial parenchyma. **H** Radial longitudinal sections showing homocellular rays, body ray cells procumbent. **I** Macerated fibres and vessels.

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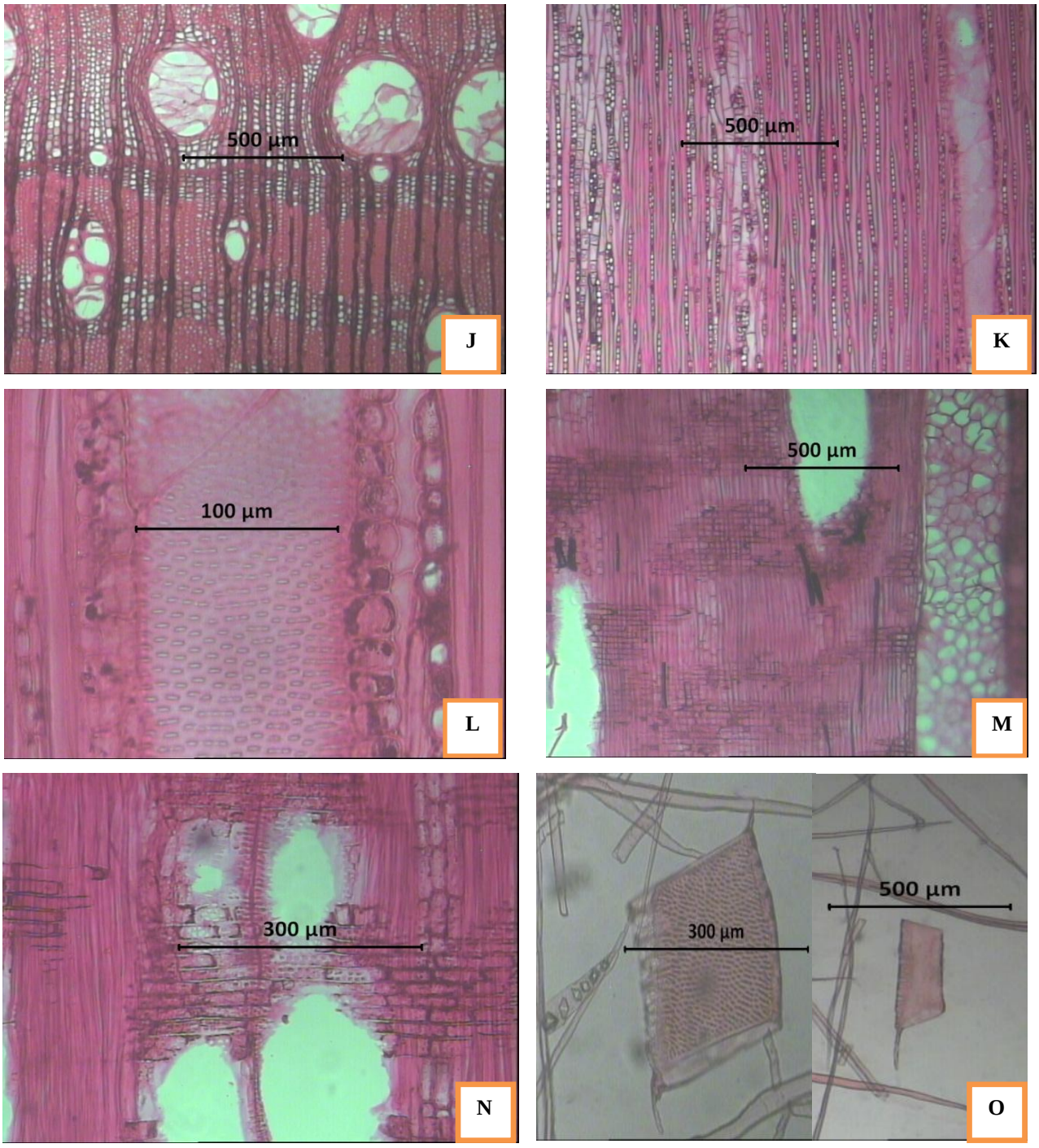

L. speciosa

Figure 3: *Lagerostroemia speciosa:* **J** Cross- sections showing diffuse-porous wood, vessel outline oval to circular, Parenchyma diffuse, diffuse-in-aggregate and banded bands more than three cells wide, tyloses in vessels **K** Tangential longitudinal sections showing uniseriate rays partly biseriate, parenchyma 3-8 strands, crystals in axial parenchyma. **L** Tangential longitudinal sections showing intervessel pits alternate, vestured. **M** Rays homocellular made of procumbent body ray cells, tyloses in vessel, Laticifers present. **N** Vessel-ray pits with much reduced borders to apparently simple: pits rounded or angular. **O** Macerated vessels and fibres, crystals in parenchyma.