

Wood Anatomy of Some Nepalese Species of Genus *Boehmeria*

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Abstract

In Nepal, *Boehmeria* is an important genus of family Urticaceae represented by 11 different species. The species are *B. canescens*, *B. rotundifolia*, *B. platyphylla*, *B. densiflora* var. *penduliflora*, *B. glomerulifera*, *B. minuticymosa*, *B. kamley*, *B. polystachya*, *B. ternifolia*, *B. clidemoides* and *B. hamiltoniana*. Wood structure of eighteen samples belonging to eleven Nepalese plant species of genus *Boehmeria* was studied. The study showed the presence or absence of growth ring, diffuse porous wood, alternate inter vessel pit, simple perforation, septate fiber tracheid, apotracheal, marginal and paratracheal vasicentric parenchyma and uni and multiseriate homogeneous rays. Tyloses, sheath cell and crystals present or absent. Identification key is prepared on the basis of wood characters.

Keywords: Key characters, Nepalese *Boehmeria* species, Urticaceae, Wood structure

Introduction

There are 50-100 species in the genus *Boehmeria* of the nettle family Urticaceae (Chang, 1989). In Nepal, there are altogether 11 species (Rajbhandari et al., 2012). These species are perennial herbs, shrubs and small trees. Although related to nettles, this genus does not have stinging hairs. The taxonomy of the genus *Boehmeria* is very controversial. Earlier 10 species of *Boehmeria* was reported (Press et al., 2000). However, later Acharya and Yonekura (2002) added two species *B. kamley* and *B. minuticymosa*. Similarly in 2002, they proposed a new combination *B. densiflora* var. *penduliflora* (Wedd. ex D.G. Long) N. Acharya & Yonek by discussing the status of *B. penduliflora* Wedd. ex D.G. Long and *B. densiflora* Hook & Arn. *Boehmeria rugulosa* was changed into *Pouzolzia rugulosa*. Anatomical studies of the Urticaceae were done by Tipppo (1938), Kachroo and Bhat (1982), Bonsen and Welle (1984), Metcalfe and Chalk (1950). But until now wood anatomical study on the Nepalese species of genus *Boehmeria* has not been done so far. The main objective of the study was to highlight the wood structure of Nepalese plant species of the genus *Boehmeria* and to identify based on wood character.

Materials and Methods

Eighteen wood samples belonging to eleven Nepalese plant species of the genus *Boehmeria* are

collected from different places Godawari, Royal Botanical Garden, and Central Nepal (Table 1). Some are taken from the KATH herbarium sheet. All are with voucher specimens deposited in Kathmandu (KATH). The species are *B. canescens*, *B. rotundifolia*, *B. platyphylla*, *B. densiflora* var. *penduliflora*, *B. glomerulifera*, *B. minuticymosa*, *B. kamley*, *B. polystachya*, *B. ternifolia*, *B. clidemoides*, *B. hamiltoniana*. Samples are boiled in water in order to soften the material so that the section can be taken easily. Sections were taken using a sliding microtome at a thickness of 30µm and stained with safranin 'o', and fast green. Light microscopic studies of sections and maceration are carried out following the methods of Baas & Zhang (1986). Vessel density, vessel diameter, vessel element length, fiber element length and diameter, ray density, ray height cells, and some other characters are measured and compared. A recommendation in the IAWA List of Microscopic Features for Hardwood Identification (IAWA Committee 1989) was followed. Microscopic slides of wood and their voucher specimens are deposited at National Herbarium and Plant Laboratories, Godawari, Nepal.

Results and Discussion

Quantitative wood characters of eleven Nepalese species, *B. canescens*, *B. rotundifolia* var. *platyphylla*, *B. platyphylla*, *B. densiflora* var. *penduliflora*,

Table 1 : Some Nepalese species of genus *Boehmeria* collected from different places

S.N.	Name of the Plants	Specimen no.	Locality	Altitude (m)
1	<i>Boehmeria canescens</i> Wedd.	959	Godawari	1500
2	<i>Boehmeria canescens</i> Wedd.	200609	Godawari	1500
3	<i>B. densiflora</i> Hook & Arn. Var. <i>penduliflora</i> (Wedd. ex D.G. Long) N. Achrya & Yonek	200607	Godawari	1500
4	<i>B. glomerulifera</i> Miq.	9255516	Sukuthum	1650
5	<i>B. glomerulifera</i> Miq.	9455147	Yakleghar-Sar	2170
6	<i>B. kamley</i> . N. Achrya & Yonek	11054	Harelo-Chichile	1790
6	<i>B. minuticymosa</i> N. Achrya & Yonek	2359	Grang	1000
8	<i>B. platyphylla</i> D. Don	9495071	Sarjung	750
9	<i>B. polystachya</i> Wedd.	8571178	Choarma-Kyama	2600-2760
10	<i>B. polystachya</i> Wedd.	9154241	Baidep-Num	950
11	<i>B. clidemioides</i> Miq.	6307137	Taplejung-Danra	1000
12	<i>B. hamiltoniana</i> Wedd.	6307103	Ghatte-khebang	1550
13	<i>B. rotundifolia</i> D. Don	394	Chinkhola	1220
14	<i>B. rotundifolia</i> D. Don	200610	Godawari	1500
15	<i>B. ternifolia</i> D. Don	6224	Danda kateri	1950
16	<i>B. ternifolia</i> D. Don	9495156	Sarjung khola	1600
17	<i>B. ternifolia</i> D. Don	9495166	Sarjung khola	1600
18	<i>B. ternifolia</i> D. Don	200608	Godawari	1500

B. glomerulifera, *B. minuticymosa*, *B. kamley*, *B. polystachya*, *B. ternifolia*, *B. clidemioides*, *B. hamiltoniana* of the genus *Boehmeria* are given in Table 1. Wood structure of 11 species of the genus *Boehmeria* is described as follows and the described specimen no. is star marked.

Boehmeria canescens Wedd. No.959, 200609*

Growth ring distinct, demarcated by radially flattened fiber tracheids, marginal parenchyma and tangentially arranged small pores near the growth ring (Figure 1a) Wood diffuse porous, diffusely arranged, mostly solitary or in radial multiple of 2-6, few in cluster multiple (Figure 1a). Number of pore per square mm is 20-38 (27). Solitary pores are oval or round in outline 38-150 (101) and 38-100 (71) μm in radial and tangential diameter respectively and thin walled (1.2 μm). Pores are attached to one or both sides of the ray cells. Pores are 70-360 (205) μm long. Vessel perforation simple. End wall oblique with 45° angle slope Inter-vessel pit is oval, round, angled (5-8 μm in diameter), alternate, bordered with included lenticular aperture and compactly arranged (Figure 1d). Tyloses absent.

Wood parenchyma apotracheal, marginal and paratracheal. Apotracheal parenchyma sparsely diffused and paratracheal parenchyma scanty

vescicentric (Figure 1b). Cell oval, angular, square in apotracheal parenchyma and polygonal, tubular, radially elongated in paratracheal parenchyma, 10-28 (16) and 8-38 (21) μm in radial and tangential diameter respectively and thin walled (Figure 1a). No. of cells per strand is 2-8. Pit simple. Vessel-parenchyma pit oval, horizontally elongated (5-20 μm in diameter) and half bordered (Figure 1d). A row of 6-8 cluster crystals are present (Figure 1g).

Fiber tracheids constitute the ground mass of the wood and compactly arranged. Cells oval, round, square, angular in outline 8-23 (14) μm and 12-24 (18) μm in radial and tangential diameter respectively and thin and moderately thick walled (2.5-5 μm in diameter) (Figure 1a). Fiber tracheids septate (2 septa/cell), 375-650 (551) μm long (Figure 1c). Pit oval, half bordered with excluded aperture and noted in tangential and radial longitudinal section.

Ray uni and multiseriate (11), homogeneous, 2-3 rays per mm. Body cell consists of wholly of upright cells and few square cells. Uniseriate rays are few, 1- 7 cells (50-475 μm) in height. Multiseriate rays are 2-11 cells (50-125 μm) in width and 375-4500 μm in height (Figure 1c). Upright or square cells are vertically elongated, hexagonal in outline in tangential section, 25-75, 50-200 and 25-50 μm in

radial, vertical and tangential diameter respectively (Figure 1c,e). Sheath cell presents. Pit simple. Ray vessel pit is oval, elongated, half bordered (4-20 μ m in diameter) (Figure 1e). Simple and chambered cluster crystals present (Figure 1f).

Boehmeria densiflora var. *penduliflora* (Wedd. ex D.G. Long) Acharya & Yonek No. 200607

Growth ring indistinct, demarcated by radially flattened fiber tracheids and tangentially arranged small pores near the growth ring (Figure 2a). Wood diffuse porous, radially arranged, mostly solitary or in radial multiple of 2-4. Number of pore per square mm ranges from 6-9. Solitary pores oval or round in outline, 38-125(84) μ m and 38-100(66) μ m in radial and tangential diameter respectively and thick walled (4 μ m in diameter) (Figure 2a). Pores are 75-650 (364) μ m long. Pores attached to one or both sides of the ray cells. Vessel perforation simple. End wall oblique with 45° angle slope. Inter-vessel pit is oval, round, angled (5-8 μ m in diameter), alternate, bordered with included lenticular aperture and compactly arranged (Figure 2d). Tyloses present (Figure 2a).

Wood parenchyma apotracheal, marginal and paratracheal. Apotracheal parenchyma sparsely diffused and paratracheal parenchyma scanty vasicentric (Figure 2b). Cell oval, angular, square in apotracheal parenchyma and polygonal, tubular, radially elongated in paratracheal parenchyma, 8-40 and 10-40 μ m in radial and tangential diameter respectively and thin walled. 2-12 cells per strand (Figure 2c). Pit simple. Vessel-parenchyma pit oval, horizontally elongated (5-15 μ m in diameter) and half bordered (Figure 2d). Crystals absent. Darkly stained substance present.

Fiber tracheids constitute the ground mass of the wood and compactly arranged. Cells oval, round, square, angular in outline, 10-35 (22) and 10-20 (18) μ m in radial and tangential diameter respectively and thin and moderately thick walled (4 μ m in diameter) (Figure 2a). Fiber tracheids septate, 420-610 (546) μ m long (Figure 2c). Pit oval, half bordered with excluded aperture and noted in tangential and radial longitudinal section.

Ray uni and multiseriate (6), homogeneous, 2-3 rays per mm. Body cell consists of wholly of upright cells and few square cells (Figure 2e,f). Uniseriate rays are few, 1-34 cells, 50-2830 (533) μ m in height. Multiseriate rays are 2-6 cells (μ m) in width and 330-more than 6330 μ m in height with long uniseriate tails (Figure 2c). Upright or square cells are vertically elongated, hexagonal in outline in tangential section, 20-25, 25-100 and 13-38 μ m in radial, vertical and tangential diameter respectively. Sheath cell present. Pit simple. Ray vessel pit is oval, elongated, half bordered (5-20 μ m in diameter) (Figure 2f). Crystals absent.

Boehmeria glomerifolia Miq. No. 9255516*, 9455147

Growth ring absent. Wood diffuse porous. Pore density ranges from 53-66, mostly solitary or in radial multiple of 2-4. Solitary pore is oval or round in outline, 30-70 (51) and 30-100 (52) μ m in radial and tangential diameter respectively and thin walled (Figure 3a). Pores are 80-350 (230) μ m long. Vessel perforation simple. End wall oblique with 45° angle slope. Inter-vessel pit oval, round, angled (5-12 μ m in diameter), alternate, bordered with included lenticular aperture and compactly arranged (Figure 3d). Tyloses and pith flecks present (Figure 3a).

Wood parenchyma apotracheal, and paratracheal. Apotracheal parenchyma diffuse and paratracheal parenchyma scanty vasicentric (Figure 3b). Cell oval in apotracheal parenchyma and polygonal, tubular, radially elongated in paratracheal parenchyma, 4-19 (10) and 7-29 (18) μ m in radial and tangential diameter respectively and thin walled. 2-6 cells per strand. Pit simple. Vessel-parenchyma pit oval, horizontally elongated (5-14 μ m in diameter) opposite and half bordered (Figure 3d). Crystals absent.

Fiber tracheids constitute the ground mass of the wood and radially arranged. Cells oval, round, angular in outline, 5-17 (12) and 5-17 (11) μ m in radial and tangential diameter respectively and thick walled (3 μ m in diameter) (Figure 3a). Fiber tracheids are 408-720 (569) μ m long (Figure 3c). Pit oval, half bordered with excluded aperture and not seen in tangential longitudinal section.

Ray uni and multiseriate (6), homogeneous (Figure 3c). No. of rays per mm ranges from 11-26. Body cell consists of wholly of upright cells and few square cells (Figure 3e). Uniseriate rays are few, 1- 10 cells (120-672 μm) in height. Multiseriate rays are 2-6 cells (48-168 μm) in width and 960-7920 in height with long uniseriate tails. Upright or square cells are vertically elongated, hexagonal in outline in tangential section, 15-30, 15-160 and 15-30 μm in radial, vertical and tangential diameter respectively. Pit simple. Ray vessel pit is oval, elongated, half bordered (5-14 μm in diameter) (Figure 3f). Crystals absent.

Boehmeria Kamley Acharya & Yonek No. 11054

Growth ring indistinct, demarcated by radially flattened fiber tracheids, marginal parenchyma and tangentially arranged small pores near the growth ring (Figure 4a). Wood diffuse porous. Pore density ranges from 54-69, mostly solitary or in radial multiple of 2-5. Solitary pore is oval or round in outline, 15-110(60) and 20-70(53) μm in radial and tangential diameter respectively and slightly thick walled (Figure 4a). Pores are 120-420(287) μm long. Vessel perforation simple. End wall oblique with 45° angle slope. Inter-vessel pit oval, round, angled (4-10 μm in diameter), alternate, bordered with included lenticular aperture and compactly arranged (Figure 4d). Tyloses and pith flecks present (Figure 4a,c).

Wood parenchyma apotracheal, and paratracheal. Apotracheal parenchyma diffuse and paratracheal parenchyma scanty vasicentric (Figure 4b). Cell oval in apotracheal parenchyma and polygonal, tubular, radially elongated in paratracheal parenchyma, 10-29(14) and 7-36(14) μm in radial and tangential diameter respectively and thin walled. 2-8 cells per strand. Pit simple. Vessel-parenchyma pit oval, horizontally elongated (5-17 μm in diameter) alternate and half bordered (Figure 4d). Crystals present.

Fiber tracheids constitute the ground mass of the wood and radially arranged. Cells oval, round, angular in outline, 7-19(13) and 7-17(13) μm in radial and tangential diameter respectively and moderately thick walled (5 μm in diameter) (Figure 4a,b). Fiber tracheids septate, 1-3 per cell. 300-650(484) μm long (Figure 4c). Pit oval, half bordered with excluded

aperture and not seen in tangential longitudinal section.

Ray uni and multiseriate (5), homogeneous. No. of rays per mm range from 18-26. Body cell consists of wholly of upright cells and few square cells (Figure 4e). Uniseriate rays are few, 1- 13 cells (20-300 μm) in height. Multiseriate rays are 2-5 cells (24-72 μm) in width and 360-8832 (2633) μm in height with long uniseriate tails (Figure 4c). Upright or square cells are vertically elongated, hexagonal in outline in tangential section, 15-30, 20-120 and 10-25 μm in radial, vertical and tangential diameter respectively. Pit simple. Ray vessel pit is oval, elongated, half bordered (5-12 μm in diameter) (Figure 4f). Cluster crystals and sheath cells present (Figure 4d).

Boehmeria minuticymose Acharya & Yonek No. 2359

Growth ring absent. Wood diffuse porous, radially arranged near the pore region. Pore density ranges from , mostly solitary or in radial multiple of 2-9. Solitary pore is oval or round in outline, 40-100(68) and 20-6(43) μm in radial and tangential diameter respectively and slightly thick walled (Figure 5a). Pores are 180-350 μm long. Vessel perforation simple. End wall oblique with 45° angle slope. Inter-vessel pit oval, round, angled (3-5 μm in diameter), alternate, bordered with included lenticular aperture and compactly arranged (Figure 5d). Tyloses present and spiral thickenings noticed in small pores (Figure 5a,e).

Wood parenchyma apotracheal, and paratracheal. Apotracheal parenchyma diffuse and paratracheal parenchyma scanty vasicentric (Figure 5b). Cell oval in apotracheal parenchyma and polygonal, tubular, radially elongated in paratracheal parenchyma, 7-24(15) and 10-26(16) μm in radial and tangential diameter respectively and thin walled. 2-11 cells per strand (Figure 5c). Pit simple. Vessel-parenchyma pit oval, horizontally elongated (4-12 μm in diameter) opposite and half bordered (Figure 5d). Crystals present.

Fiber tracheids constitute the ground mass of the wood and radially arranged. Cells oval, round, angular in outline, 10-19(13) and 10-14(11) μm in radial and tangential diameter respectively and moderately thick walled (5 μm in diameter) (Figure

5b). Fiber tracheids septate, 200-420(325) μm long (Figure 5c). Pit oval, half bordered with excluded aperture and not seen in tangential longitudinal section.

Ray uni and multiseriate (12), homogeneous (Figure 5b). Uniseriate rays very few. No. of rays per mm ranges from 7-15. Body cell consists of wholly of upright cells and few square cells (Figure 5f). Uniseriate rays are few, 1-10 cells (150-300 μm) in height. Multiseriate rays are 2-12 cells (40-80 μm) in width and to indefinite height with long uniseriate tails. (Figure 5c) Upright or square cells are vertically elongated, hexagonal in outline in tangential section, 10-15, 10-90 and 15-40 μm in radial, vertical and tangential diameter respectively. Aggregate rays noted. These rays are 700-820 μm in width Pit simple. Ray vessel pit is oval, elongated, half bordered (μm in diameter) (Figure 5g). Crystals present (Figure 5h).

Boehmeria platyphylla D.Don No.9495071*, 6307113

Growth ring distinct, demarcated by thickness of the fiber tracheids and marginal parenchyma cells (Figure 6b). Wood is diffuse porous. Pores are diffusely arranged, mostly solitary, radial or in cluster multiple of 2-4. No. of pores per mm. ranges from 53-70. Solitary pores are oval or round in outline. 40-100(68) and 30-80(50) μm in radial and tangential diameter respectively and thin walled (Figure 6a,b). Pores are generally attached to the ray cell. Pores are 100-400 μm long. Vessel perforation is simple. End wall is oblique with its slope 45° angle. Inter-vessel pit is oval, round (3-8 μm in diameter), bordered with included lenticular aperture and alternately arranged compactly (Figure 6d). Tyloses are present. (Figure 6a).

Wood parenchyma apotracheal, marginal and paratracheal. Apotracheal parenchyma sparsely diffused and paratracheal parenchyma scanty vescicentric (Figure 6b). Cell oval, radially flattened and tubular in outline, 5-45 and 5-60 μm in radial and tangential diameter respectively and thin walled. 2-8 cells per strand (Figure 6c). Pit simple. Vessel-parenchyma pit oval, horizontally elongated (7-

19 μm in diameter) and half bordered (Figure 6d). Simple crystals present.

Fiber tracheids and libriform fibers constitute the ground mass of the wood and compactly arranged (Figure 6b). Cells are oval, round, square, in outline 5-20 and 5-15 μm in radial and tangential diameter respectively and moderately thick walled (5 μm in diameter) (Figure 6b). Fibers are μm long and septate (2 septa) (Figure 6c). Pit is oval, half bordered with excluded aperture.

Ray uni and multiseriate (3), homogeneous, 5-8 rays per mm. Body cell consists of wholly of upright cells and few square cells (Figure 6g). Uniseriate rays are few, 1-6 cells (180-350 μm) in height. Multiseriate rays 2-3 cells (40 μm) in width and 450-2200 μm in height with uniseriate tail of cells. (Figure 6c) Multiseriate ray consists of upright or square cells. Upright or square cells are vertically elongated, square in outline in 10-30, 35-80 and 8-20 μm in radial, vertical and tangential diameter respectively. Sheath cell present. Pit simple. Ray vessel pit oval, elongated and half bordered (5-20 μm in diameter) (Figure 6f). Simple crystals present.

Boehmeria polystachya Wedd. No. 8571178*, 9154241

Growth ring absent. Wood diffuse porous, diffusely arranged. Pores mostly solitary, or in radial multiple of 2-4. Pore density ranges from 72-119. Solitary pores are oval, angular in outline. 30-100(60) and 20-70(45) μm in radial and tangential diameter respectively and thin walled. Pores are generally attached to the ray cell. Pores are 70-400(216) μm long. Vessel perforation simple. End wall is oblique with its slope 45° angle. Inter-vessel pit is oval, round (5-7 μm in diameter), bordered with included lenticular aperture, compact and alternately arranged (Figure 7e). Tyloses absent. Darkly stained substance presents in the pore. Spiral thickening noticed in pore (Figure 7f).

Wood parenchyma apotracheal, and paratracheal. Apotracheal parenchyma scanty, diffuse, paratracheal parenchyma scanty vescicentric (Figure 7b). Cell oval, radially or tangentially elongated near the pore in outline, 50-70 and 60-120 μm in radial and

tangential diameter respectively and thin walled. 2-6 cells per strand. Pit simple. Vessel-parenchyma pit oval, horizontally elongated (4-22 μ m in diameter) and half bordered (Figure 7e). Chamber cluster crystals absent. Darkly stained substance noticed mostly in the parenchyma cell near the pore.

Fiber tracheids constitute the groundmass of the wood and compactly arranged. Cells oval, angular, square, in outline 7-19(13) and 7-19(11) μ m in radial and tangential diameter respectively and thick walled (4 μ m in diameter) (Figure 7a). Fibers are 350-450(400) μ m long and septate (Figure 7c). Pit is round, half bordered with excluded aperture, seen in both TLS and RLS.

Ray uni and multiseriate, homogeneous, 2-3 rays per mm. Body cell consists of wholly of upright cells and few square cells (Figure 7d). Uniseriate rays are few, 1-17 cells (120-1200(653) μ m) in height. Multiseriate rays 2-5 cells (20-150 μ m) in width and 1600-3000(2200) μ m in height with long uniseriate tail (Figure 7c). Multiseriate ray consists of upright or square cells. Upright or square cells are vertically elongated, oval in outline in tangential diameter, 10-30(20), 30-120(67) and 15-30(22) μ m in radial, vertical and tangential diameter respectively. Sheath cell presents. Pit simple. Ray vessel pit oval, elongated and half bordered (5-17 μ m in diameter) (Figure 7g). Aggregate rays present. Chambered cluster crystals present in aggregate cell.

Boehmeria rotundifolia var. *pachyphylla* D. Don. 200610*, 4795

Growth ring distinct, demarcated by radially flattened fiber tracheids and tangentially arranged small pores near the growth ring (Figure 8 a). Wood diffuse porous. Pores are diffusely arranged but tangentially arranged near the growth rings. Pore density ranges from 64-133. Pores are mostly solitary rarely in radial multiple of 2-5. Multiple cluster group are found near the growth ring. Solitary pore oval or round in outline. 25-100(54) and 25-75(48) μ m in radial and tangential diameter respectively and thin walled (2 μ m in diameter). Pores attached to one or both sides of the ray cells (Figure 8a). Pores are 75-400(236) μ m long Vessel

perforation simple (Figure 8c). End wall oblique with 45° angle slope Inter-vessel pit is oval, round, angled (5-8 μ m in diameter), alternate, bordered with included lenticular aperture and compactly arranged (Figure 8d). Tyloses absent.

Wood parenchyma apotracheal and paratracheal. Apotracheal parenchyma sparsely diffused and paratracheal parenchyma scanty vescicentric. Cell oval, angular, square in apotracheal parenchyma and polygonal, tubular, radially elongated in paratracheal parenchyma, 15-25(20) and 5-25(16) μ m in radial and tangential diameter respectively and thin walled (Figure 8a,b). 2-6 cells per strand. Pit simple. Vessel-parenchyma pit oval, horizontally elongated (3-15 μ m in diameter) and half bordered (Figure 8c). Simple crystals present. Darkly stained substance present.

Fiber tracheids constitute the ground mass of the wood and radially arranged. Cells oval, round, square, angular in outline, 15-10(12) and 10-20(16) μ m in radial and tangential diameter respectively and moderately thick walled (2 μ m in diameter) (Figure 8b). Fiber tracheids septate, 300-560 μ m long (Figure 8c). Pit oval, half bordered with excluded aperture.

Ray uni and multiseriate(6), homogeneous, 5- rays per mm (Figure 8c). Body cell consists of wholly of upright cells and few square cells (Figure 8e). Uniseriate rays are few, 1- 10 cells (250-3200 μ m) in height. Multiseriate rays are 2-6 cells(μ m) in width and 450-9000(3050) μ m in height with long uniseriate tails (Figure 8c). Upright or square cells are vertically elongated, hexagonal in outline in tangential section, 10-20, 40-170 and 10-25 μ m in radial, vertical and tangential diameter respectively. Multiseriate rays are dumbell like structure in tangential section. Sheath cell presents. Pit simple. Ray vessel pit is oval, elongated, half bordered (3-10 μ m in diameter) (Figure 8f). Cluster crystals present (Figure 8c),

Boehmeria ternifolia D. Don No.6224. 9495156, 9495166, 200608*

Growth ring distinct, demarcated by radially flattened 1-2 layer of fiber tracheids and marginal parenchyma

(Figure 9a). Wood diffuse porous, diffusely arranged, 46-53 pore per square mm, mostly solitary rarely in radial multiple of 2-7. Solitary pores oval or round in outline. 20-50(30) and 20-30(22) μm in radial and tangential diameter respectively and thin walled (Figure 9a,b). Pores attached to one or both sides of the ray cells. Pores are 100-400(225) μm long. Vessel perforation simple. 2-3 perforation is noted in a single pore in sample no. 9495156. End wall oblique with 45° angle slope Inter-vessel pit is oval, round, angled (5 μm in diameter), alternate, bordered with included lenticular aperture and compactly arranged (Figure 9d). Tyloses present.

Wood parenchyma marginal, apotracheal and paratracheal. Apotracheal parenchyma diffuse in uniseriate band and paratracheal parenchyma scanty vasicentric (Figure 9a,b). Cell oval, angular, square in apotracheal parenchyma and polygonal, tubular, radially elongated in paratracheal parenchyma, 4-10 and 6-20 μm in radial and tangential diameter respectively and thin walled. 2-7 cells per strand. Pit simple. Vessel-parenchyma pit oval, horizontally elongated (5- μm in diameter) and half bordered (Figure 9). Crystals present.

Fiber tracheids constitute the ground mass of the wood and compactly arranged. Cells oval, round, square, angular in outline 8-15 and 8-20 μm in radial and tangential diameter respectively and thin and moderately thick walled (3 μm in diameter) (Figure 9b). Fiber tracheids are 300-700 μm long and septate (2-3 septa) (Figure 9c). Pit oval, half bordered with excluded aperture.

Ray uni and multiseriate (5), homogeneous, 10-13 rays per mm. Body cell consists of wholly of upright cells and few square cells (Figure 9e). Uniseriate rays are few, 1-2 cells (20-25 μm) in height. Multiseriate rays are 2-6 cells (30-80 μm) in width and 1500-7500(3570) μm in height with long uniseriate tails (Figure 9c). Upright or square cells are vertically elongated, in outline in tangential section, 5-10, 15-40 and 5-10 μm in radial, vertical and tangential diameter respectively. Multiseriate rays are dissected by parenchymatous cells Pit simple. Ray vessel pit is oval, elongated, half bordered (μm in diameter) (Figure 9f). Simple and cluster crystals present.

Boehmeria clidemioides Miq. No. 6307137

Growth ring absent. Wood diffuse porous, diffusely arranged. Pores mostly solitary, or in radial multiple of 2-4. Pore density ranges from 72-263. Solitary pores are oval, angular in outline. 20-60 (40) and 20-60(38) μm in radial and tangential diameter respectively and thin walled. (Figure 10a) Pores are generally attached to the ray cell. Pores are 300-450(374) μm long. Vessel perforation simple. End wall is oblique with its slope 45° angle. Inter-vessel pit is oval, round (5-7 μm in diameter), bordered with included lenticular aperture, compact and alternately arranged (Figure 10d). Tyloses present (Figure 10a,c).

Wood parenchyma apotracheal, and paratracheal. Apotracheal parenchyma scanty, diffuse and paratracheal parenchyma vasicentric (Figure 10a). Cell oval, radially or tangentially elongated near the pore in outline, 5-10 and 12-24 μm in radial and tangential diameter respectively and thin walled. 2-6 cells per strand (Figure 10b). Pit simple. Vessel-parenchyma pit oval, horizontally elongated (7-19 μm in diameter) and half bordered (Figure 10e). Simple crystal present (Figure 10g).

Fiber tracheids constitute the ground mass of the wood and compactly arranged. Cells oval, angular, square, in outline 7-24(17) and 12-17(14) μm in radial and tangential diameter respectively and thick walled (4 μm in diameter) (Figure 10a). Fibers are 300-520(448) μm long and septate (Figure 10b). Pit is round, half bordered with excluded aperture, seen in both TLS and RLS.

Ray uni and multiseriate (6), homogeneous, 5-7 rays per mm. Body cell consists of wholly of upright cells and few square cells (Figure 10f). Uniseriate rays are few, 1-10 cells (428-720(592) μm) in height. Multiseriate rays 2-6 cells (30-100 μm) in width and 1200-2160 (1598) μm in height with long uniseriate tail (Figure 10c). Multiseriate ray consists of upright or square cells. Upright or square cells are vertically elongated, oval in outline in tangential diameter, 3-6(5), 20-200(95) and 3-5(4) μm in radial, vertical and tangential diameter respectively. Sheath cell presents. Pit simple. Ray vessel pit oval, elongated and half bordered (7 μm in diameter) (Figure 10e).

Boehmeria hamiltoniana Wedd. No.6307103

Growth ring absent. Wood diffuse porous, diffusely arranged. Pores mostly solitary, or in radial multiple of 2-4. Pore density ranges from 28-53. Solitary pores are oval, angular in outline. 20-60(39) and 30-50(39) μm in radial and tangential diameter respectively and thin walled (Figure 11a). Pores are generally attached to the ray cell. Pores are 80-350(229) μm long (Figure 11b). Vessel perforation simple. End wall is oblique with its slope 45° angle. Inter-vessel pit is oval, round (5 μm in diameter), bordered with included lenticular aperture, compact and alternately arranged (Figure 11c).

Wood parenchyma apotracheal, and paratracheal. Apotracheal parenchyma in short uniseriate band, diffuse, paratracheal parenchyma vesicentric (Figure 11a). Cell oval, radially or tangentially elongated near the pore in outline, 10-20(13) and 10-20(16) μm in radial and tangential diameter respectively and thin walled. 2-5 cells per strand (Figure 11b). Pit simple. Vessel-parenchyma pit oval, horizontally elongated (5-17 μm in diameter) and half bordered (Figure 11d).

Fiber tracheids constitute the groundmass of the wood and compactly arranged. Cells oval, angular, square, in outline 10-20(15) and 15-20(18) μm in radial and tangential diameter respectively and thick walled (4 μm in diameter) (Figure 11a). Fibers are 300-700(536) μm long and septate (Figure 11b). Pit is round, half bordered with excluded aperture.

Ray uni and multiseriate(5), homogeneous, 8-15 rays per mm. Body cell consists of wholly of upright cells and few square cells (Figure 11e). Uniseriate rays are few, 1-20cells (100-800(317) μm) in height. Multiseriate rays 2-7cells(48-120 μm) in width and 312-4320(2167) μm in height with long uniseriate tail(Figure 11b). Multiseriate ray consists of upright or square cells. Upright or square cells are vertically elongated, oval in outline in tangential diameter, 10-25(17), 20-80(47) and 10-20(14) μm in radial, vertical and tangential diameter respectively. Sheath cell presents. Pit simple. Ray vessel pit oval, elongated and half bordered (5-12 μm in diameter) (Figure 11f). Aggregate rays present. Cluster crystals present (Figure 11g).

General wood anatomical character of the genus *Boehmeria* is summarized as follows.

Growth ring distinct, indistinct or absent demarcated by radially flattened few layer of fiber tracheids, marginal parenchyma and tangentially arranged small pores near the growth ring.

Wood is diffuse porous. Pores are radially arranged, mostly solitary or in radial multiple of 2-4(-9), rarely in multiple cluster. Solitary pores are angular, oval or round in outline and thin walled. Pores are generally attached to the ray cell. Vessel perforation is simple. End wall is oblique with its slope 45° angle. Inter-vessel pit is oval, round alternate, bordered with included lenticular aperture and compactly arranged. Tyloses, spiral thickenings and pith flecks are present or absent.

Wood parenchyma is marginal, apotracheal, and paratracheal. Apotracheal parenchyma is sparsely diffused or diffused in uniseriate and paratracheal parenchyma vesicentric Cell is oval, radially flattened and tubular in outline and thin walled. No. of cells per strand is 2-12. Pit is simple. Vessel-parenchyma pit is oval, horizontally elongated and half bordered. Simple and chamber cluster crystals are present or absent.

Fiber tracheids and libriform fibers constitute the ground mass of the wood and compactly arranged. Cells are oval, round, square in outline and thick walled Septa is present or absent. Pit is oval, half bordered with excluded aperture.

Ray is uni and multiseriate, homogeneous. Body cell consists of wholly of upright cells and few square cells. Upright or square cells are vertically elongated, square in outline in tangential section. Sheath cell present or absent. Ray cell is interrupted by parenchymatous cell. Pit is simple. Ray vessel pit is oval, elongated and half bordered. Simple and chambered cluster crystals are present or absent.

The study shows presence of growth ring in *Boehmeria canescens*, *B. ternifolia*, *B. platyphylla*, *B. rotundifolia* are indistinct in *B. densiflora* var. *penduliflora*, *B. Kamley*, absent in *B. minuticymose*, *B. hamiltoniana*, *B. clidemioides* *B. polystachya*

and *B. glomerifolia*. Growth ring is demarcated by radially flattened 2-3 layer of fiber tracheids, marginal parenchyma and tangentially arranged small pores near the growth ring. Wood is diffuse porous. Pores are radially arranged, mostly solitary or in radial multiple of 2-4(-9), rarely in multiple cluster. Solitary pores are angular, oval or round in outline ranges from 20-216 and 15-300 μm in radial and tangential diameter respectively and thin walled. Smallest diameter is noted in the species *B. ternifolia* and *B. hamiltoniana* highest in the species *canescens*. Pores are generally attached to the ray cell. Pores are 104-412 μm long, short in *ternifolia* and long in *B. densifolia*. Vessel perforation is simple. End wall is oblique with its slope 45° angle. Inter-vessel pit is oval, round (μm in diameter), alternate, bordered with included lenticular aperture and compactly arranged. Tyloses are noted in the species *minuticymosa*, *B. Kamley*, *B. Ternifolia*, *B. densifolia*, *B. clidemioides*, *B. glomerifolia* and *B. platyphylla*. Spiral thickenings are noted in the species *polystachya* and *minuticymosa*. Pith flecks are noted in *B. Kamley*, *B. densifolia*. Wood parenchyma is marginal, apotracheal, and paratracheal except in *B. minuticymose*, *B. hamiltoniana*, *B. polystachya*, *B. clidemioides* and *B. glomerifolia* where marginal parenchyma is absent. Apotracheal parenchyma is sparsely diffused or in short uniseriate band in the species *B. ternifolia*, *B. hamiltoniana* and scanty vasicentric paratracheal parenchyma except in *B. polystachya*, *B. rotundifolia* and *B. minuticymosa* where it is vasicentric. Cell is oval, radially flattened and tubular in outline, No. of cells per strand is 2-12. Pit is simple. Vessel-parenchyma pit is oval, horizontally elongated and half bordered. Crystals are absent in *B. densifolia*, *B. glomerifolia*, *B. clidemioides* and *B. hamiltoniana*. Fiber tracheids and libriform fibers constitute the ground mass of the wood and compactly arranged. Cells are oval, round, square, in outline and moderately thick walled. Septa is present except in *B. glomerifolia* and *B. polystachya*, 1-3 septa per cell. Fibers are long pointed ends. Pit is oval, half bordered with excluded aperture. Ray is uni and multiseriate, homogeneous. Body cell consists of wholly of upright cells and few square cells. Uniseriate rays are few, 1-34 cells (μm) in height. Multiseriate rays

are 2-6(-12) cells in width and very high in height with uniseriate long tail. Multiseriate ray consists of upright or square cells. Upright or square cells are vertically elongated, square in outline in tangential diameter and μm in radial, vertical and tangential diameter respectively. Sheath cell present. Ray cell is interrupted by parenchymatous cell. Pit is simple. Ray vessel pit is oval, elongated and half bordered (μm in diameter). Chambered cluster crystals are present except in *B. densifolia*, *B. glomerifolia*, *B. clidemioides*. In the species *B. canescens* chamber crystals are in 1-8 vertical rows. On the basis of these characters, 11 species of the genus *Boehmeria* are identified.

The anatomical characters showed that the genus *Boehmeria* is highly specialized as having high pore density, thin walled tyloses, short vessel length and septate fibers. Tippon (1938) concluded from his study of the Moraceae and presumed allies that septate fibers are more specialized than non septate fibers.

Identification key characters of 11 species of the genus *Boehmeria*

A tentative key is prepared on the basis of wood anatomical characters which are as follows:

Growth ring present or absent. Wood diffuse porous. Vessel perforation simple. Inter-vessel pit alternate. Spiral thickening present or absent in the pore. Tyloses and pith flecks present or absent. Wood parenchyma marginal, apotracheal and paratracheal. Fiber tracheid septate or unseptate. Rays homogeneous, uniseriate and multiseriate. Cluster crystal present or absent in axial parenchyma and ray cells. Sheath cell present or absent in ray cell. *Boehmeria*

A. Growth ring distinct.

B. canescens, *B. ternifolia*, *B. platyphylla*, *B. rotundifolia*

Aa. Tyloses present *B. ternifolia*, *B. platyphylla*,

Aaa. Apotracheal parenchyma sparsely diffused. *B. platyphylla*

Aab. Apotracheal parenchyma diffuse in short uniseriate band. *B. ternifolia*

Ab. Tyloses absent. *B. canescens*, *B. rotundifolia*

Aba. Paratracheal parenchyma scanty

vescicentric and chamber cluster crystal in 1-8 vertical rows in ray cell.

B. canescens

Abb. Paratracheal parenchyma vescicentric, chamber cluster crystal not in 1-8 vertical rows in ray cell *B. rotundifolia*

- B. Growth ring indistinct *B. Kamley*, *B. densifolia*
- Ba. Chamber cluster crystal present. Septa present in fiber tracheid. *B. Kamley*
- Bb. Chamber cluster crystal absent. Septa absent in fiber tracheid. *B. densifolia*
- C. Growth ring absent. *B. minuticymose*, *B. hamiltoniana*, *B. clidemioides* *B. glomerifolia*, *B. polystachya*
- Ca. Tyloses present *B. minuticymose*, *B. clidemioides*. *B. glomerifolia*
- Caa Chamber cluster crystal present. Spiral thickening noted in pore *B. minuticymose*
- Cab. Chamber cluster crystal absent.
- Cab1 Paratracheal parenchyma scanty vescicentric *B. clidemioides*
- Cab2 Paratracheal parenchyma vescicentric *B. glomerifolia*
- Cb. Tyloses absent. *B. hamiltoniana* *B. polystachya*,
- Cba. Apotracheal parenchyma diffuse in short uniseriate band. Paratracheal parenchyma scanty vescicentric *B. hamiltoniana*
- Cbb. Apotracheal parenchyma sparsely diffused. Paratracheal parenchyma vescicentric. *B. glomerifolia*

Conclusion

The study shows that wood structure is found very similar in all the studied species of the genus *Boehmeria*. Differentiation is pronounced in their quantitative wood characters. So it is very difficult to distinguish on the species level based on wood anatomical characters only.

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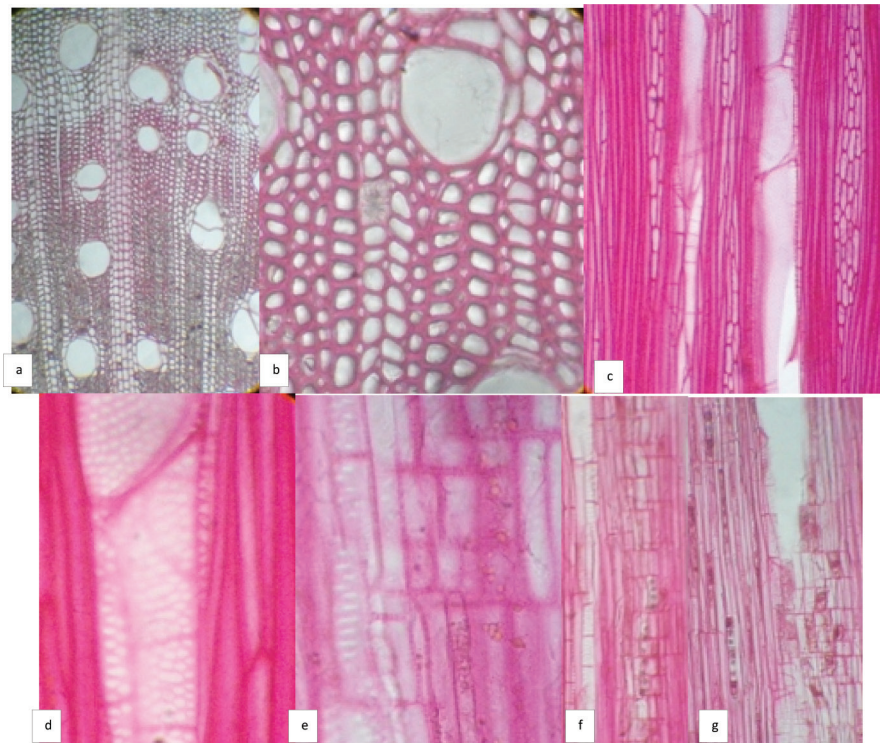


Figure 1: a & b. Cross section of *B.canescens* sp.no.200609 showing diffuse porous wood, distinct growth ring in (a) and scanty vescentric paratracheal parenchyma, apotracheal parenchyma and crystal in ray cell in(b), c & d, TLS showing fibertracheid, parenchymatous cell and uni and multiseriate ray cell in (c), inter-vessel pit ,vessel-parenchyma pit in(d), e, f & g RLS showing upright ray cell and ray vessel pit in (e), cluster crystal in ray cell in(f), and row of cluster crystal in parenchymatous cell in (g). Mgn. 60x (a), 150x (b,c,f,g), 600x(d,e)

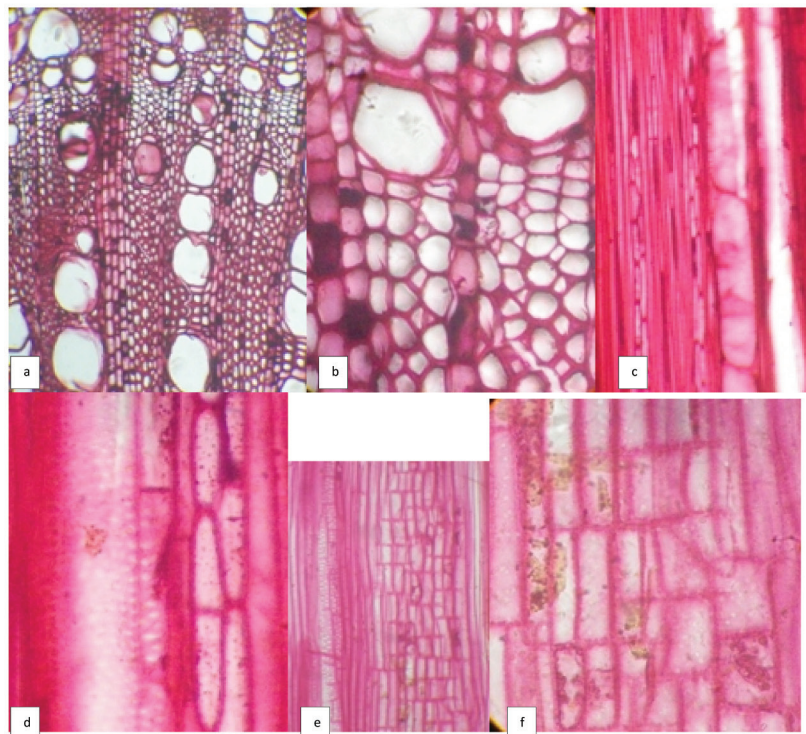


Figure 2: a & b. Cross section of *B.densifloravar. pendulifera*sp.no.200607 showing diffuse porous wood, indistinct growth ring and tyloses in (a) and marginal,scanty vescentric paratracheal and apotracheal parenchyma in(b), c & d, TLS showing fibertracheid, parenchymatous cell and uni and biseriolate ray cell in (c), inter-vessel pit and vessel parenchyma pit in(d), e & f RLS showing upright ray cell in (e), and ray vessel pit in (f). Mgn. 150x (a,c,e), 600x(b,d,f)

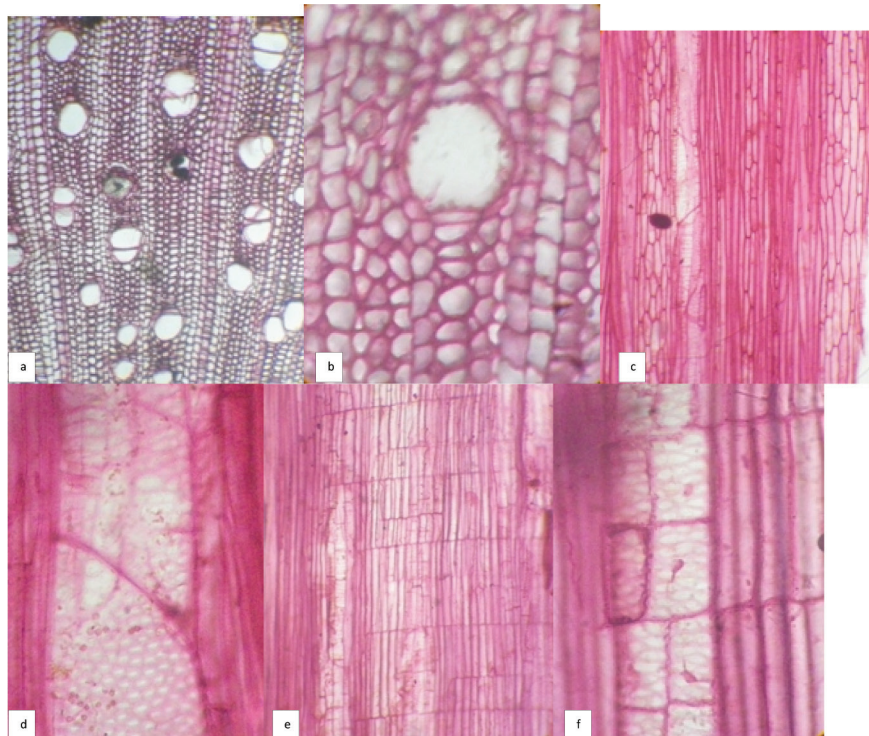


Figure 3: a & b, Cross section of *B. glomerifolia* sp. no. 925516 showing pore and tyloses in (a) and scanty vescentric paratracheal parenchyma in (b), c & g, TLS showing pore, fibertracheid, parenchymatous cell and uni and multiseriate ray cell in (c), inter-vessel pit, and vessel-parenchyma pit in (d), e & f, RLS showing upright ray cell in (g), and ray vessel pit in (f). Mgn. 150x (a,c,e), 600x (b,d,f)

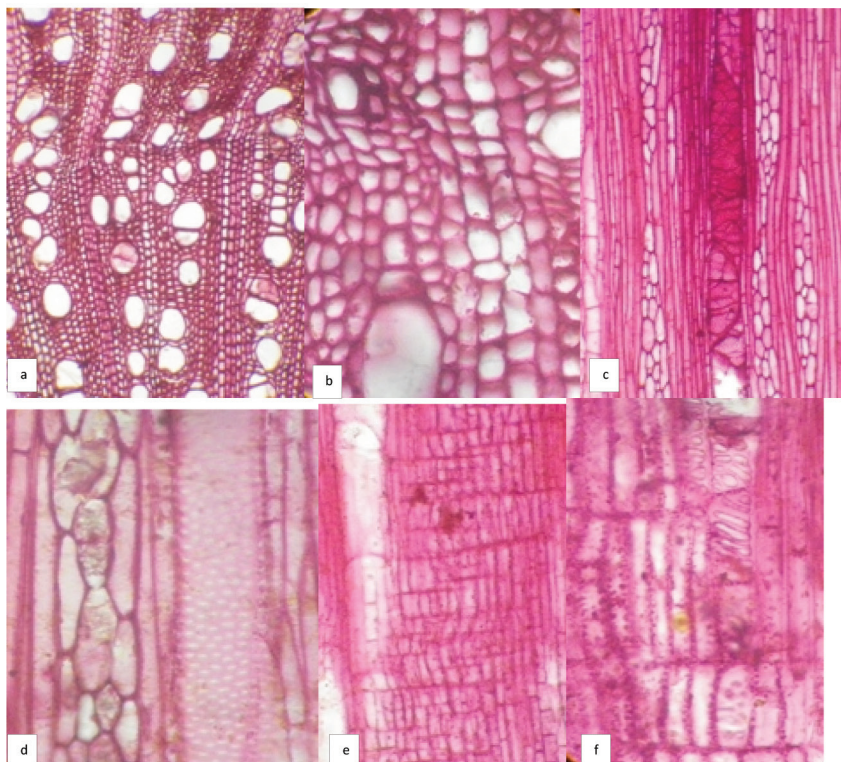


Figure 4: a & b, Cross section of *B. Kamley* sp. no. 11054 showing pore and tyloses in (a) and growth ring and vescentric paratracheal parenchyma in (b), c & d, TLS showing pore with tyloses, fibertracheid, parenchymatous cell and uni and multiseriate ray cell in (c), inter-vessel pit, vessel-parenchyma pit and cluster crystal in (d), e & f RLS showing upright ray cell in (e), ray vessel pit in (f). Mgn. 150x (a,c,e), 600x (b,d,f)

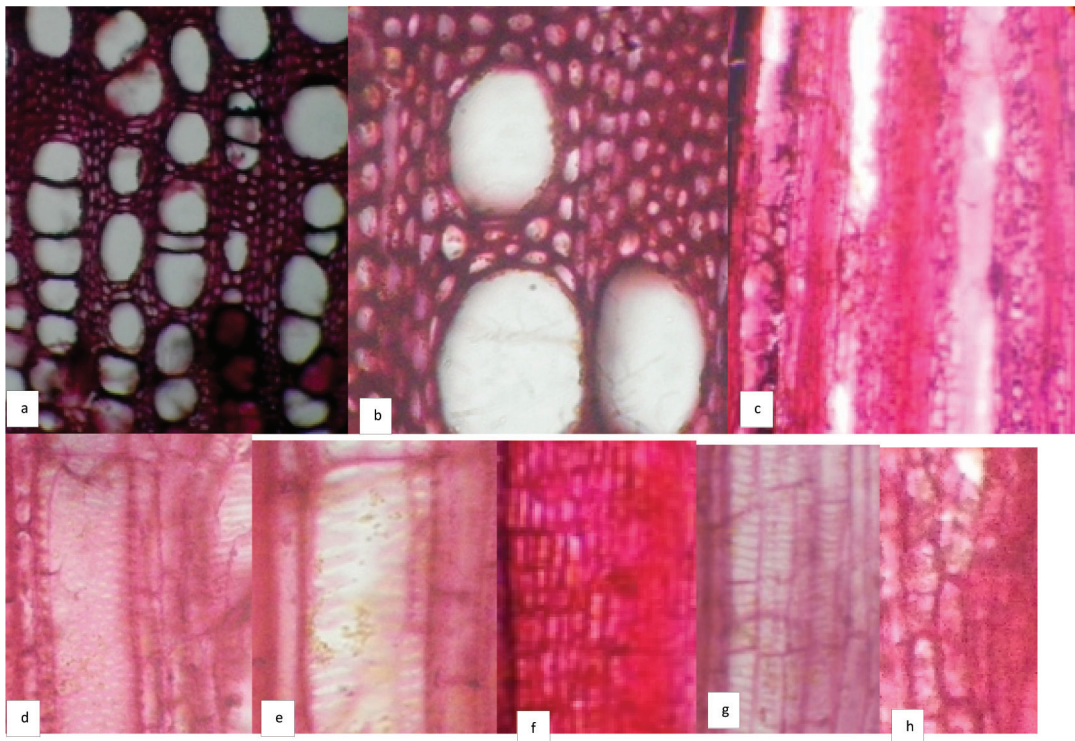


Figure 5: a & b, Cross section of *B.minuticymosa* sp.no. 2359 showing diffuse porous wood and tyloses in(a)and vescentric paratracheal parenchyma in(b), c,d & e, TLS showing pore with tyloses, fibertracheid and multiseriate ray cell in (c), inter-vessel pit in (d), vesselparenchymA PIT IN (e). f, g & h RLS showing homogeneous upright ray cell in (f), ray vessel pit in (g) and cluster crystal in (h). Mgn. 150x (a,c,f), 600x(b,d,e,g,h)

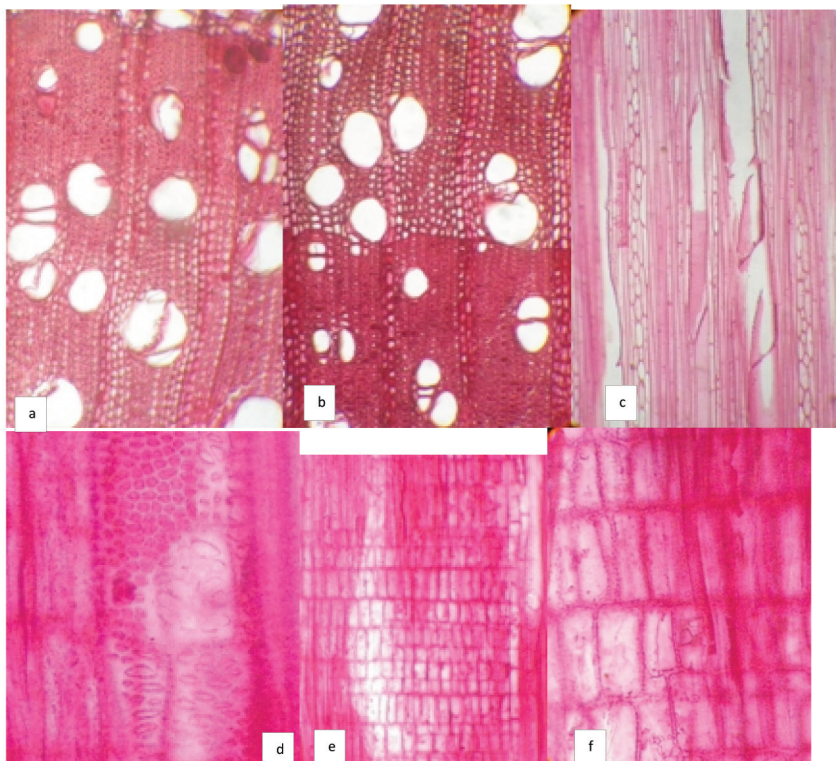


Figure 6: a & b. Cross section of *B.platyphylla* sp.no.9496071,showing diffuse porous wood, , tyloses in (a), growth ring and marginal and scanty vescentric paratracheal parenchyma in(b), c & d, TLS showing fibertracheid, parenchymatous cell and uni and multiseriate ray cell in (c), inter-vessel pit and vessel-parenchyma pit jn(d), e & f RLS showing upright ray cell in (e), and ray vessel pit in (f). Mgn. 150x (a,b,c,e), 600x(d,f)

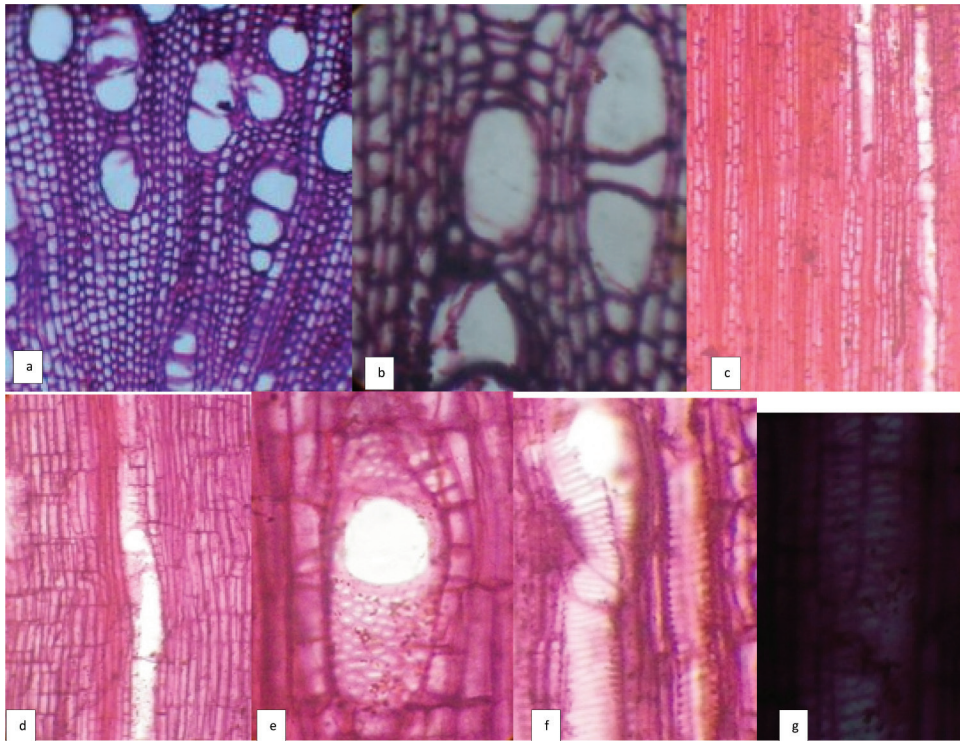


Figure 7: a&b, Cross section of *B. polystachyasp.* no.8571178 showing diffuse porous wood, in(a) and vescentric paratracheal parenchyma in(b), c, TLS showing pore, fibertracheid, parenchymatous cell and multiseriate ray cell in (c), in (d), d,e,f & g RLS showing upright ray cell in (d), oval perforation, inter -vessel pit ,vessel-parenchyma pit in (e) spiral thickening in (f) and ray-vessel pit in (g). Mgn. 150x (a,c,d), 600x(b,e,f,g)

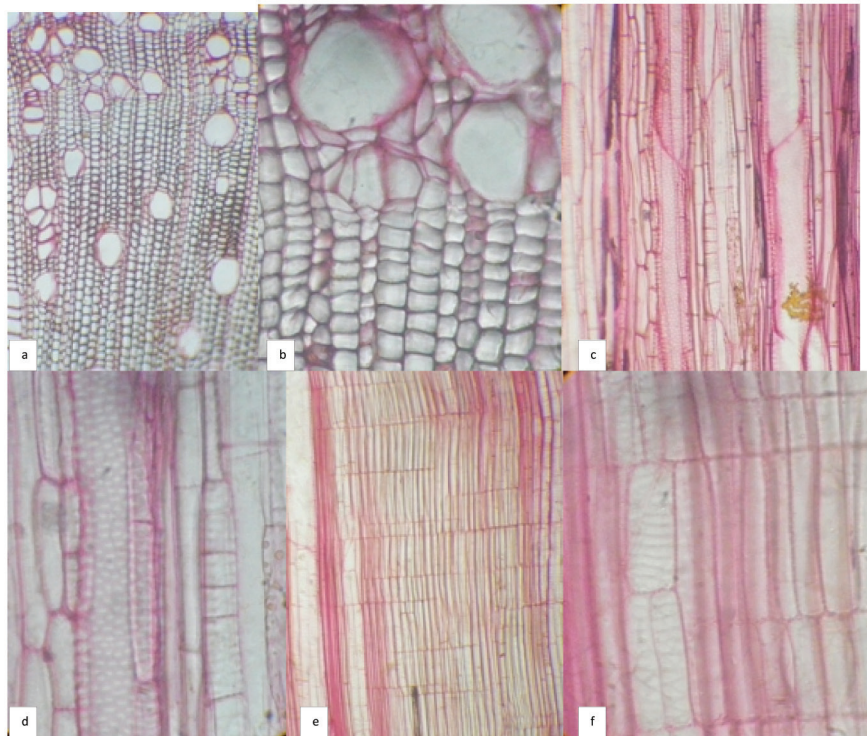


Figure 8: a & b. Cross section of *B. rotundifolia* var.pachyphylla no. 200610,showing diffuse porous wood, indistinct growth ring in (a), and marginal and scanty vescentric paratracheal and apotracheal parenchyma in(b), c & d, TLS showing septate fibertracheid, parenchymatous cell and uni and multiseriate ray cell in (c), inter-vessel pit and vessel-parenchyma pit and stranded parenchymatous cell in(d), e & f,RLS showing upright ray cell in (e), and ray vessel pit in (f). Mgn. 150x (a,c,e), 600x(b,d,f)

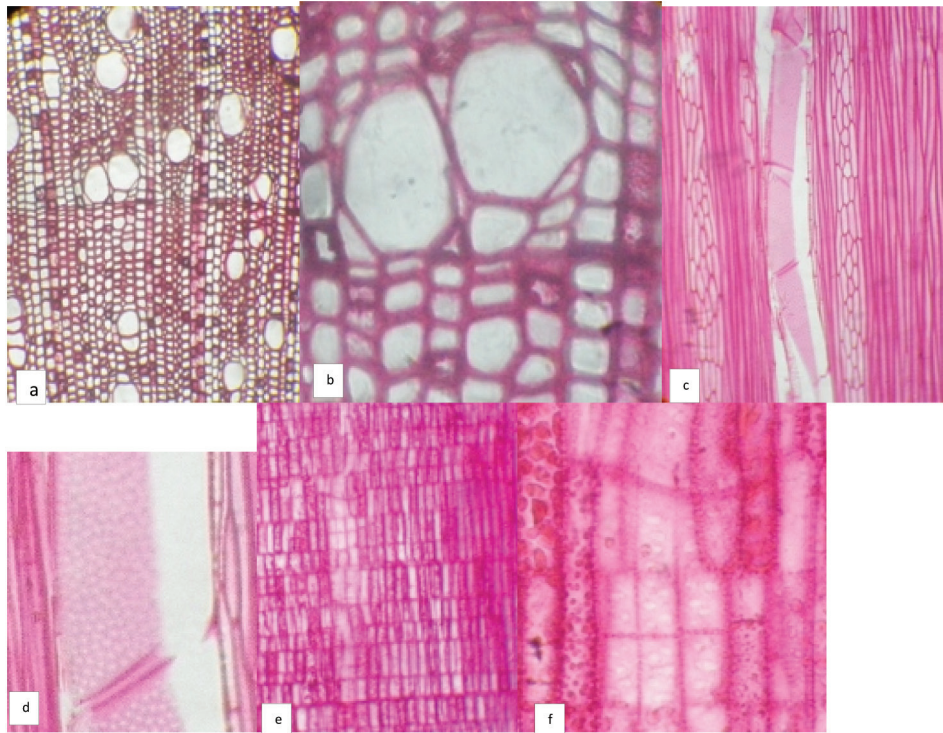


Figure 9: a & b. Cross section of *B.ternifolia* sp.no.200608 showing diffuse porous wood, growth ring in (a) and marginal, scanty vescentric paratracheal and apotracheal parenchyma in (b), c & d, TLS showing fibertracheid, parenchymatous cell and multiseriate ray cell in (c), inter-vessel pit junction (d), e & f RLS showing upright ray cell in (e), and ray vessel pit in (f). Mgn. 150x (a,c,e), 600x(b,d,f)

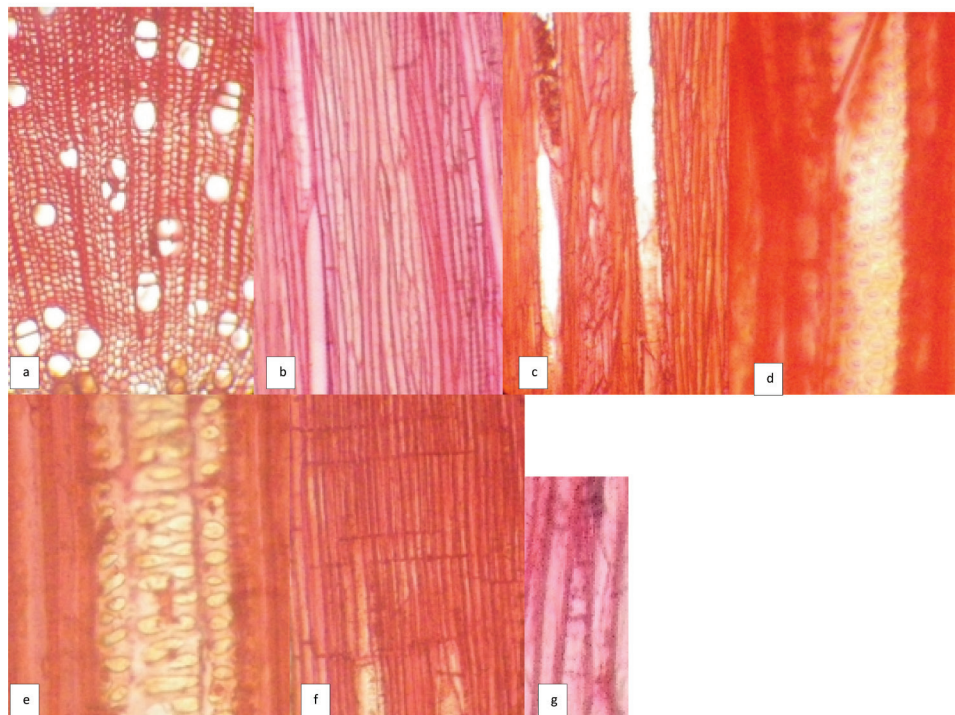


Figure 10: a, Cross section of *B.clidemioides* sp.no.6307137 showing diffuse porous wood, tyloses and scanty vescentric paratracheal parenchyma in (a), b,c d and e, TLS showing pore, fibertracheid, parenchymatous cell and uniseriate ray in (b), multiseriate ray cell in (c), inter-vessel pit in (d) and vessel-parenchyma pit in (e) f & g RLS showing upright ray cell in (f), and simple crystal in (g). Mgn. 150x (a,b,c,f), 600x(d,e,g)

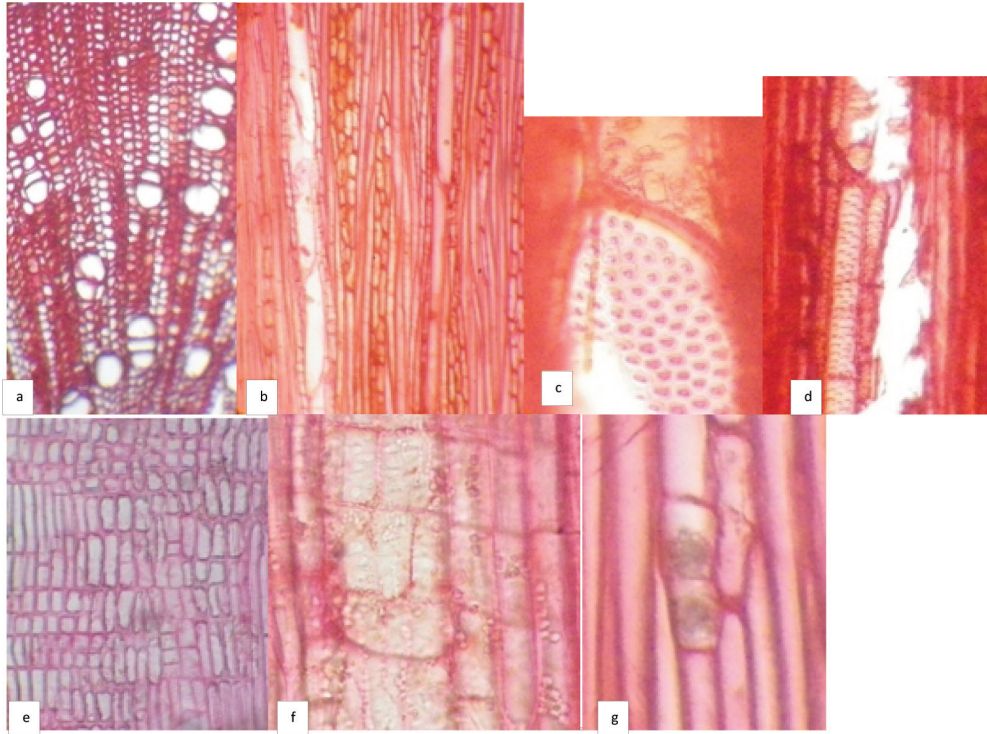


Figure 11: a , Cross section of *B.hamiltoniana* sp.no.630703 showing diffuse porous wood, scanty vescentric paratracheal parenchyma and uniseriate apotracheal parenchyma in(a), b,c ,d&g, TLS showing fibertracheid, parenchymatous cell and uni and multiseriate ray cell in (b), inter-vessel pit in(c),vesselparenchyma pit in(d) and cluster crystal in (g), e & f RLS showing upright ray cell in (e), ray vessel pit in (f). Mgn. 150x (a,c,d,e), 600x(c,f,g)