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WOOD ANATOMY OF *FORSELLESIA* (*GLOSSOPETALON*) AND *CROSSOSOMA* (CROSSOSOMATACEAE, ROSALES)

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Transfer of *Forsellesia* Greene (*Glossopetalon* A. Gray) from the Celastraceae to the Crossosomataceae has been proposed by Thorne and Scogin (1978). Evidence for this transfer was drawn from a comparison of similarities in vegetative and floral morphology of *Forsellesia*, *Crossosoma* Nutt., and *Apacheria* Mason. In order to accumulate additional data relating to this transfer, the wood of three species of *Forsellesia* was examined and compared with the wood of *Crossosoma*. Data from wood anatomy have proved to be a useful tool for systematic work (Carlquist, 1976, 1977a, 1977b; Carlquist and DeBuhr, 1976; DeBuhr, 1977; Dickison, 1967). Although certain aspects of the wood of *Crossosoma* have been reported by Metcalfe and Chalk (1950) and Solereder (1908), quantitative data were not supplied, and both species of *Crossosoma* were reexamined.

Materials and Methods

Transverse, tangential, and radial sections of the wood of those species listed in Table 1 were cut on a sliding microtome at 25 μm, and were stained in safranin. Mascerations, prepared using Jeffrey's solution, were also stained in safranin.

Wood of *Crossosoma californicum* Nutt. and *Forsellesia nevadensis* (Gray) Greene was collected in the field, wood of *Crossosoma bigelovii* Wats. was collected from cultivated material, and wood of the remaining species was taken from herbarium specimens. For comparison, the wood of *Mortonia utahensis* (Cov.) A. Nels. was prepared as described above, and examined. The wood anatomy of *Apacheria* is under investigation by a student at the University of Maryland, and is not included in this study.

Features of the wood of the Crossosomataceae are presented in Table 1, and the quantitative averages are based upon the following numbers of measurements: vessel-element length, vessel-element diameter, tracheid length—50 each; vessels per group—25; height of multiseriate rays—15; vessels per mm^2, height of uniseriate rays—10 each.

Anatomical Description

Comparative quantitative and qualitative features of the wood of the Crossosomataceae are recorded in Table 1. Abbreviations and other features of the table are explained below. Descriptive terms of length and width

Table 1. Characteristics of the wood anatomy of the Crossosomataceae. Abbreviations and other features of the table are described in the text.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Crossosoma californicum Nutt. (*Carlquist 1831*; RSA)	Srp	436	35	Si	1.28	A	Tr	700	D, s	1.6	513	eSP	172	ESp	—
Crossosoma bigelovii Wats. (*DeBuhr s.n.*; cult.)	Srp	373	23	Si	1.24	A	Tr	614	D, s	1.6	1013	eSP	282	Esp	Cu
Forsellesia nevadensis (Gray) Greene (*Thorne & Tilforth 43694*; RSA)	Rp	292	19	Si	1.28	A	Tr	422	D, d-a	1.4	415	esP	113	ESP	—
Forsellesia stipulifera (St. John) Ensign (*Duran 548*; RSA)	Rp	237	19	Si	1.32	A	Tr	333	D, d-a	1.4	582	ESP	268	Es	—
Forsellesia meionandra (Koehne) Heller (*Jones s.n.*; POM)	Rp	219	19	Si	1.16	A	Tr	382	D	1.7	411	ESp	175	Es	—

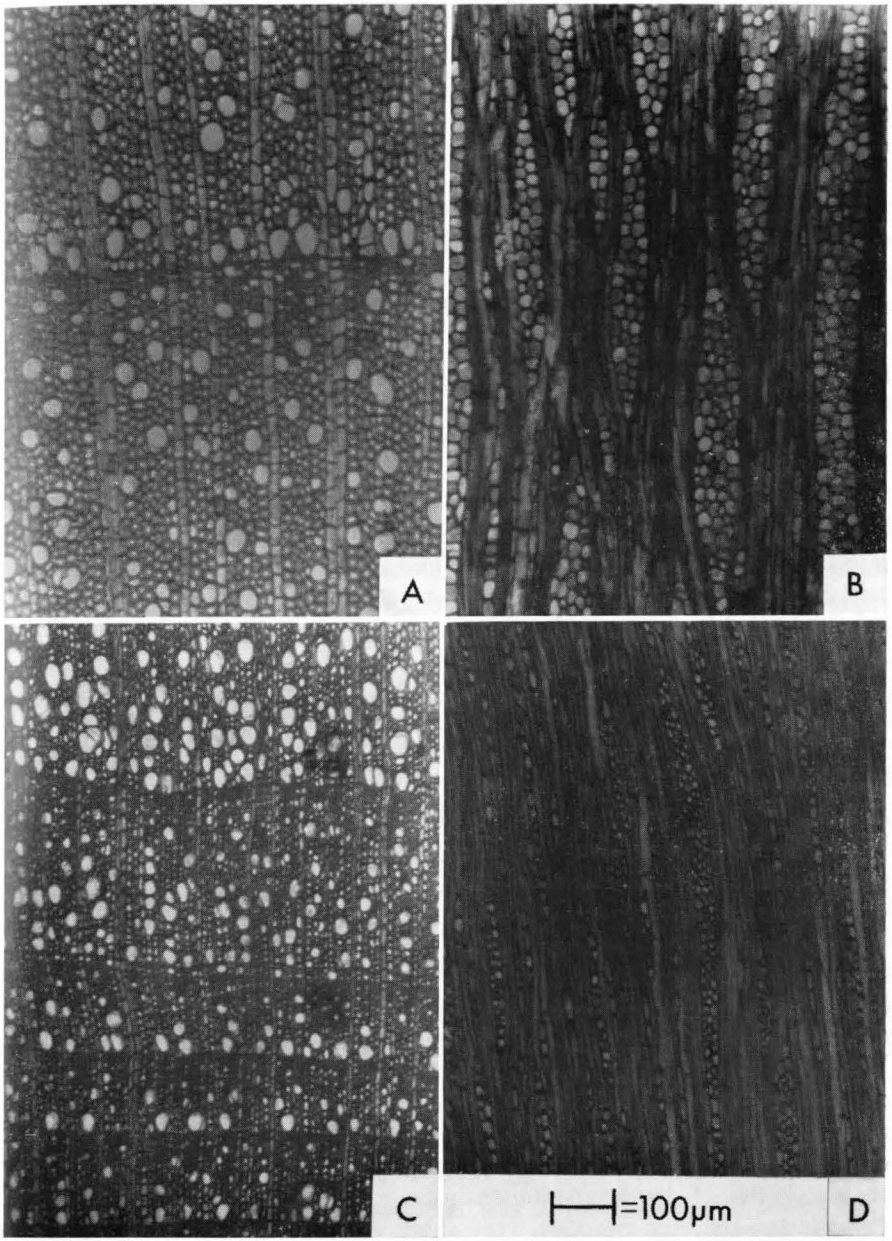

Fig. 1. A. *Crossosoma californicum.* Transection of wood. Vessel elements solitary in distribution; wood semi-ring porous.—B. *Crossosoma bigelovii.* Tangential section of wood. Rays primarily multiseriate with square and procumbent cells predominating.—C–D. *Forsellesia nevadensis.*—C. Transection of wood. Vessels solitary in distribution; wood ring porous; growth rings narrow.—D. Tangential section of wood. Cells of multiseriate rays primarily procumbent. (All photographs enlarged to same scale.)

of vessel elements and tracheids are adopted from Dickison (1967). 1—wood ring porous (Rp), or semi-ring porous (Srp); 2—average vessel-element length (μm); vessel elements of medium length in *Crossosoma*, and moderately short to very short in *Forsellesia*; 3—average vessel-element diameter (μm); vessels very small (*Crossosoma californicum*) to extremely small; 4—perforation plates simple (Si); 5—average number of vessels per group; vessels primarily solitary in distribution; 6—lateral wall pitting alternate (A); 7—imperforate elements fully bordered; wood with tracheid imperforate elements (Tr); 8—average tracheid length (μm); tracheids very short; 9—axial parenchyma apotracheal, diffuse (D), occasionally with aggregate strands (d-a), or with a tendency toward scanty paratracheal parenchyma (s); 10—ratio of tracheid length to vessel-element length; 11—average height of multiseriate rays (μm); 12—multiseriate ray types; multiseriate rays heterocellular, cells erect (E), square (S), and procumbent (P), upper-case letters (E, S, P) represent predominant cell types, and lower-case letters (e, s, p) represent infrequent cell types; 13—average height of uniseriate rays (μm); 14—uniseriate ray cell types; uniseriate rays heterocellular, composed of erect and square cells, or composed of erect cells only; abbreviations as in 12; 15—crystals lacking (—), or present and cuboidal (Cu) in ray parenchyma.

Discussion

Wood of the species of *Forsellesia* examined for this study is very similar to the wood of *Crossosoma* (Table 1; Fig. 1) and the wood anatomy supports the inclusion of *Forsellesia* in the Crossosomataceae. The xylem of both genera share the following characteristics: 1) ring porosity or semi-ring porosity, 2) very short to medium-length vessel elements, 3) extremely small to very small vessels, 4) simple perforation plates, 5) solitary vessels, 6) alternate lateral wall pitting, 7) tracheid imperforate elements, 8) very short tracheids, 9) primarily apotracheal diffuse parenchyma, 10) presence of multiseriate and uniseriate rays, 11) heterocellular multiseriate rays, 12) uniseriate rays with predominantly erect and square cells.

For comparative purposes, the wood of *Mortonia utahensis* (Celastraceae) (*Thorne & Tilforth 44536*; RSA) was examined. *Mortonia utahensis* grows sympatrically with *Forsellesia nevadensis*, and the two species are similar in habit and habitat preferences. Although a number of xylem characteristics of *Mortonia utahensis* are similar to those of the wood of *Forsellesia* (i.e., ring porosity, very short vessel elements with simple perforation plates and alternate pitting, very small vessels, and tracheid imperforate elements), vessel elements and tracheids in *Mortonia* have spiral thickenings. The axial parenchyma in *Mortonia* is paratracheal abaxial with a few diffuse strands, and the multiseriate ray cells are predominantly pro-

cumbent with some square cells present. Spiral thickenings were also noted on vessel elements and tracheids of *Canotia holocantha* Torr. (*Gill 458*; POM) and *Euonymus japonicus* Gray (collection data not available).

Metcalfe and Chalk (1950) reported that the wood of the Celastraceae was general with no distinctive characteristics. In addition to the relatively specialized wood of *Mortonia*, some species of the Celastraceae have wood with more primitive features. For example, wood of *Elaeodendron capensis* Eckl. & Zeyh. (collection data not available) and *Perrotetia sandwichensis* Gray (*USw 26053*) (examined from the slide collection of S. Carlquist at Rancho Santa Ana Botanic Garden) had long vessel elements with oblique scalariform perforation plates. The vessel elements lacked spiral thickenings, and tracheids or libriform fibers were present in the wood. Wood of *Elaeodendron* showed fairly tall multiseriate and uniseriate rays composed primarily of erect cells. The wood of *Forsellesia* is much more similar to the wood of the Crossosomataceae than it is to the wood of the Celastraceae.

Features of the leaf anatomy of *Forsellesia* also support the placement of the genus in the Crossosomataceae. Unusual masses of yellow acicular crystals (different from the raphides and crystal sand in the Dilleniaceae) have been found in the leaves of *Crossosoma* (Solereder, 1908; Metcalfe and Chalk, 1950; Richardson, 1970). Solereder (1908) described the same type of crystals in the leaves of *Forsellesia spinescens* (Gray) Greene, and I found similar crystals in the leaves of *F. meionandra*. Preliminary anatomical evidence from the leaves of *Forsellesia*, i.e., *F. planitierum* Ensign, *F. pungens* (Brandg.) Heller, *F. stipulifera*, and *F. nevadensis*, indicate that the genus has the following additional leaf characteristics in common with the leaf anatomy of *Crossosoma*: 1) anomocytic stomata, 2) stomata on both surfaces of the leaves, 3) veins sheathed by large parenchyma cells, 4) epidermis with thick outer cell walls, 5) isolateral leaves, and 6) the presence of phloem fibers.

Aspects of the wood anatomy of the Crossosomataceae offer some evidence regarding the relationships of the family. Based primarily upon floral morphology, a number of workers (Eames, 1953, 1961; Cronquist, 1968) have suggested a relationship between the Crossosomataceae and the Dilleniaceae. Others (Solereder, 1908; Metcalfe and Chalk, 1950; Thorne, 1968, 1977) have emphasized a relationship between the Crossosomataceae and the Rosaceae. After studying the wood of the Dilleniaceae, Dickison (1967) reported that the wood of *Crossosoma* was different from the wood of the Dilleniaceae in a number of features. These features include 1) semi-ring porosity, 2) simple perforation plates, 3) alternate lateral wall pitting, 4) very short tracheids, 5) heterocellular rays, and 6) axial parenchyma types. The wood anatomy of the Crossosomataceae resembles that of the Rosaceae more than it does the wood of the Dilleniaceae. The Rosaceae include many

species having small vessels of moderate length, ring porous wood, simple perforation plates, alternate lateral wall pitting, imperforate elements with bordered pits, and apotracheal diffuse parenchyma (some in short bands), or with scanty paratracheal parenchyma (Metcalfe and Chalk, 1950). Richardson (1970) expressed the opinion that the vegetative anatomy of *Crossosoma* supported a closer relationship to the Rosaceae than to the Dilleniaceae.

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