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Wood Anatomy and Phylogeny of *Laurus*(Lauraceae)

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ABSTRACT

Wood and bark structure of *Laurus*, which is considered as an important spice resources, was characterized by several transitional and advanced features. Annual rings are distinct; vessel elements are moderately short and narrow, both simple and scalariform perforation plates, alternate intervascular pitting; irregularly septate fiber are present; parenchyma strands are scanty paratracheal; rays are both homogeneous and heterogeneous with multiseriate; phloem rays are dilated. Comparisons with other genera of Lauraceae suggest that *Laurus* is transitional and advanced state in evolutionary trends in the family.

Key words: diffuse porous, essential oil, spice, vessel, wood rays, xylem

INTRODUCTION

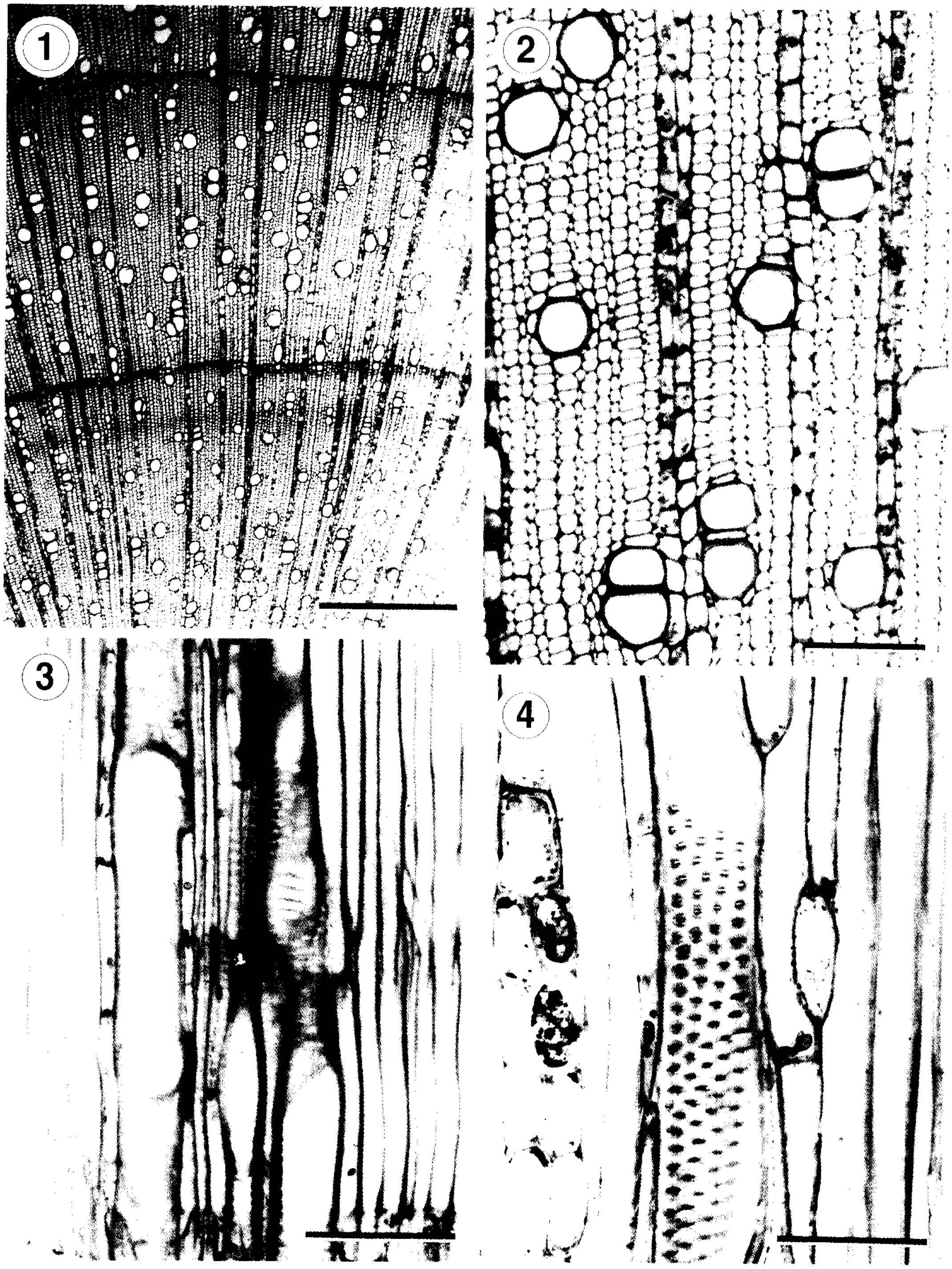
Laurus L. is a small genus with two species, of which *Laurus azorica*(Seub.)Franco occurs in the Canary islands, Madeira, and the Azores islands; *L. nobilis* L. is distributed in Mediterranean regions. It occurs mostly along the coasts(Rohwer, 1993; Kasapligil, 1951). This genus is characterized by features as follow; evergreen small tree, leaves alternate, penninerved, inflorescences pseudo-umbels, arranged on a short shoot, each pseudo-umbel with usually 5 flowers with decussate involucre and persistent bracts; flowers dioecious, involucrate, dimerous and unisexual, tepals equal size and deciduous; male flowers usually with 12 fertile stamens in three whorls, anthers bisporangia and introrse, receptacle small and flat; female flowers with four large staminodes, which is uncommon in Lauraceae. Fruits a fleshy, dark purple drupe with a small knob-like cupule on a pedicle. Fruits shape is ellipsoid 10-14mm length, 8-10mm in diameter(Rohwer, 1993; Kostermans, 1957).

Economically, it has important value. It' s aromatic leaves are included some essential oil such as cineole, eugenol, and geraniol. Therefore, dried leaves are used as a food flovonoid spice(Ogata, 1996). Also, because their fruits included fat oil and essential oil, they are used as cure ointment of rheumatism and veterinary medicine in Europe(Perry, 1980). Genus name *Laurus* means 'green' and species name *nobilis* means 'noble.' The common names of *Laurus* are "laurel" and "sweet bay." *Laurus nobilis* is cultivated as an ornamental tree all over the world. It is very often planted in churchyards, since it is one of the holy plants mentioned in the Bible(Ogata, 1996). In Korea, it is cultivated in southern area of Korean peninsula(Lee, 1980).

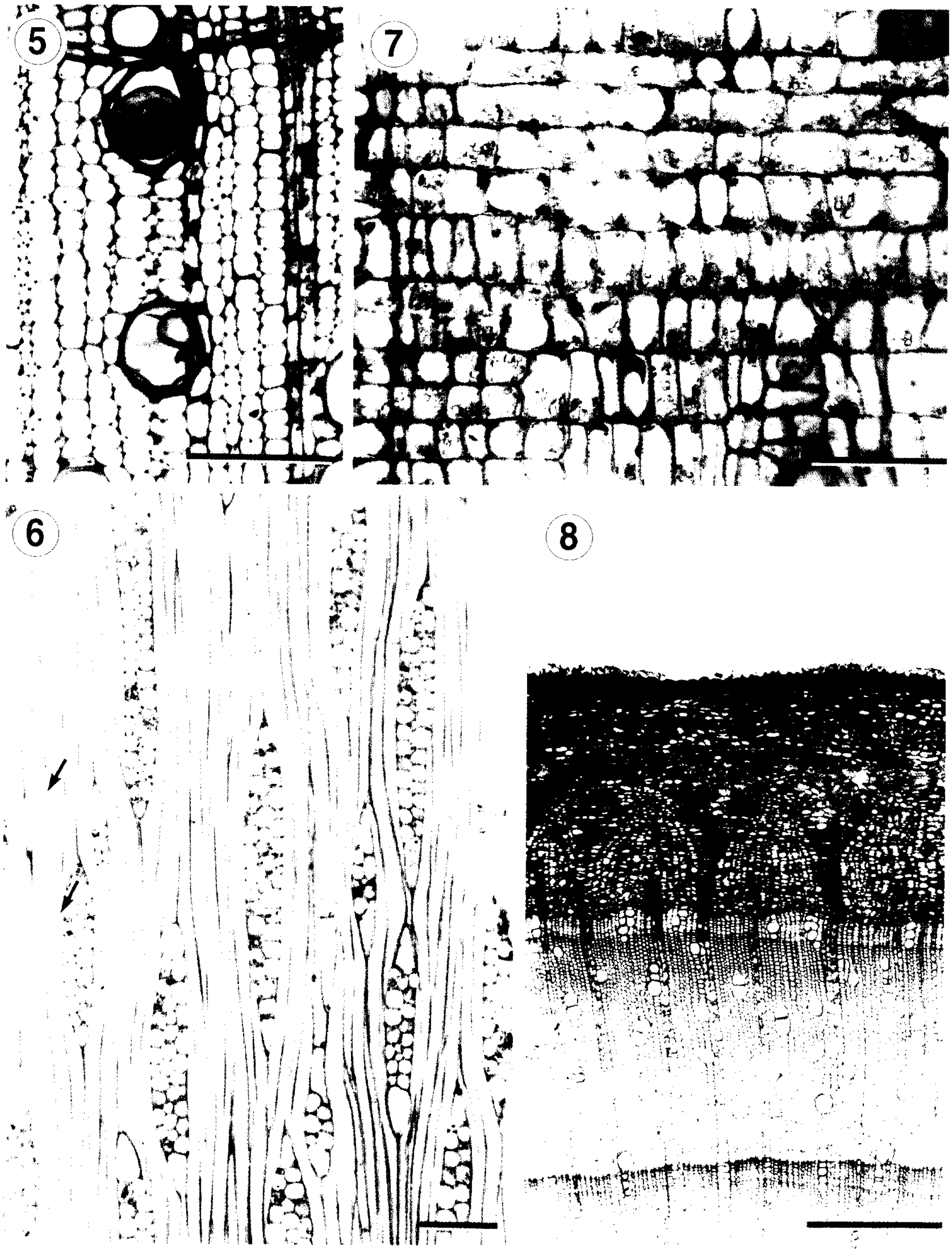
On the other hand, wood characters of this genus are insufficiently described without any illustration(Richter, 1981). The purpose of this paper is to provide full descriptions for the wood and bark anatomical characters of *Laurus*. A phylogenetic relationships of *Laurus* in Lauraceae will also be discussed on the basis of wood anatomical characters.

MATERIALS AND METHODS

Three wood samples from *Laurus nobilis* were investigated in this study. Wood specimens were collected by author(K. Heo #48 in 1995; trunk 15cm in diameter, 8m height) in Kyoto, Japan. They were fixed in 50% ethyl alcohol until before experiment is started. First of all, wood samples were trimminged to appropriate size for microtoming, approximately 1.5×1.5×1.5cm. After that, transverse,



Figs. 1-4. Wood anatomy of *Laurus nobilis*. Fig. 1. Transverse section (TS) showing diffuse-porous wood with distinct annual rings. Fig. 2. TS showing paratracheal diffuse parenchyma and thin-walled fiber-tracheds. Fig. 3. Radial section showing both simple and scalariform perforation plate with 4-5 bars. Fig. 4. Tangential section showing alternate arrangement of intervessel pits. Scale bars equal 50μm in Fig. 4; 100μm in Figs. 2 and 3; 500μm in Fig. 1.



Figs. 5-8. Wood anatomy of *Laurus nobilis*. Fig. 5. Transverse section showing tyloses. Fig. 6. Tangential section showing multiseriate fusiform rays and partially septate fibers(arrow). Fig. 7. Radial section showing heterogeneous ray with crystal sand in each cells. Fig. 8. Transverse section showing dilated rays and aggregated fiber in the bark. Scale bars equal 50 ㎛ in Fig. 5; 100㎛ in Figs. 6 and 7; 500㎛ in Fig. 8.

radial, and tangential sections were made by cutting at 15-20㎛ in thickness with sliding microtome. Dehydration was conducted with ethyl alcohol series, and stained by a 1% safranin O and fast green FCF. After destaining, sections were mounted with Entellan. Wood and bark structure was observed with BX-50 Olympus light microscope, and photographed with attached automatic camera system. Size of individual xylem elements was measured by macerate of wood tissue(Johansen, 1940). The data are the average of 30 measurements. The terminology basically follows Radford et al(1974).

RESULTS

Wood

Wood is diffuse-porous(Fig. 1). Annual rings are distinct(Fig. 1). Pores are angular, evenly distributed, mostly solitary and radial multiples of 2-4 pores arranged, the largest pores 70-75㎛ in tangential diameter and 40-65㎛ in radial diameter. Pore density varies numerous from 16 to 37 pores per mm^2(mean 27 pores per mm^2) by the early and late wood. Pore wall is thin (4-5㎛ in thickness) (Figs. 1 and 2).

Vessel elements are usually moderately short(220-550㎛) and small(mean 52㎛) (Fig. 2). End wall is more or less inclined(Fig. 3). Vessel perforation plates are both simple and scalariform plates with 4-5 bars(Fig. 3). Intervascular pits are mostly circular in outline, alternate arrangement, and 7-8㎛ in horizontal diameter(Fig. 4). Tyloses are present in partially, thin-walled, and no gum deposits observed(Fig. 5). Fibers are libriform, medium wall thickness, sometimes septate fibers present and not stratified (Fig. 6). Fibers are generally about 15㎛ in diameter of tangential section. Fiber pits very small and inconspicuous, mostly radial walls. Fiber length are 450-600㎛. No imperforated tracheal elements are observed.

Axial wood parenchyma strands are paratracheal with scanty parenchyma, polygonal in transverse section(Fig. 2). Marginal parenchyma is absent. Crystals are not observed. Oil cells are rarely observed in parenchyma strands.

Wood rays are conspicuous, fusiform and predominantly multiseriate with uniseriate tails in tangential view(Fig. 6). Heterogeneous type II and III with procumbent or uplight, square cells in radial section(Fig. 7) (Kribs, 1935). The largest rays 900-1,000㎛(mean 544㎛) in height, and narrow(42-55㎛) in width. Vessel-ray pits are enlarged, oval to irregular or gashlike, and gum deposits are sometimes present. Crystal sand deposits are predominantly present in the rays(Fig. 7). Oil cells and silica deposits were not observed in the rays.

Bark

Phloem fibers are present into solitary island shape. Phloem rays are well-developed with marked dilatation(Fig. 8). Individual cells of dilated rays contain large quantities of small acicular crystal sand(Fig. 8). Phloem parenchyma cells are lignified. Aggregated sclerotic cells are present in the outer zone of phloem(Fig. 8).

DISCUSSION

Wood and bark anatomical features of *Laurus* can be summarized as follows. Wood diffuse-porous; annual rings well-developed, vessel elements moderately short and small; perforation plates both scalariform and simple plates, end walls more or less inclined; intervascular pitting alternate arrangements; fibers partially septate and non-stratified; axial parenchyma scanty paratracheal, no banded parenchyma strand; rays dominantly multiseriate, both heterogeneous and homogeneous, fusiform, with crystal sand present. In bark, phloem fibers, aggregated sclerotic cells, dilated rays and lignified parenchyma were presented in phloem.

Concerning to the wood character evolution, generally, scalariform perforation plates, heterogeneous rays, scalariform intervessel pits, non-septate fiber, and diffuse-porous are usually considered primitive characters. Whereas the simple perforation plates, homogeneous rays, alternate intervascular pits, septate fiber, and ring-porous wood are treated as advanced characters in the dicotyledons(Carlquist, 1961; Tippo, 1946). In this study, *Laurus* has both primitive and advanced characters. For example, *Laurus* shows the vessel perforation both scalariform plates and simple plates(Fig. 4). Most genera of Lauraceae have both scalariform and simple perforation, which are considered a transitional position in the Lauraceae, or only simple perforation plates. It suggest that Lauraceae, as well as *Laurus*, are more transitional processing rather than primitive among the allied families of Laurales. Also, the rays of *Laurus* surely agree with the both heterogeneous type II, III, and homogeneous type I(Kribs, 1935), because they are composed of procumbent, square, and upright cells(Fig. 7), and sometimes all cells of rays are radially elongated.

On the other hand, *Laurus* has a few advanced characters such as annual rings, alternate intervascular pittings, and dilated rays. Annual rings are well-developed in *Lindera, Neolitsea* and *Sassafras* as well as *Laurus* in the family. Also, dilated rays are presented in *Actinodaphne, Apollonias, Laurus, Neolitsea* and *Neocinnamomum*. These features, annual rings and dilated rays, are especially presented in woods of the temperate rigion(Radford et al., 1974 p.170). In addition, the floral characters of *Laurus* have a few remarkable advanced features, i.e., dimerous and unisexual flowers, bisporangia anthers, and alternate leaves. Directly, these features indicate that *Laurus* lies on through the transitional to advanced state rather than primitive in phyllogenetic aspect within the family.

Consequently, comparison with those of the other genera of Lauraceae based on information available, the wood structure of *Laurus* has considered transitional and advanced state in evolutionary trends.

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