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Akira TAKAHASHI* : Wood Anatomical Report of Some Magnoliaceae from Borneo

高橋 晃*：ボルネオ産モクレン科数種の材解剖学

Abstract

The wood structure of six species belonging to three genera, *Aromadendron, Elmerrillia,* and *Talauma,* of the Magnoliaceae collected from East Kalimantan, Indonesian Borneo, is described. Some of those species are endemic to Borneo, and their wood anatomy has not been reported. The result shows that examined species of *Aromadendron* and *Elmerrillia* are almost identical to one another in wood anatomy, except for the occurrence of oil cells in the rays, and that the four species of *Talauma* examined have basically similar features, with slight variations in some characters. Most of the anatomical features of the six species are characteristic of the Magnoliaceae wood, with some differences from the already reported descriptions. The four species of *Talauma* examined are wood anatomically more primitive than those of the other two genera. With regard to a distinction in the wood anatomy between *Aromadendron* and *Talauma,* CANRIGHT (1955) was able to distinguish one from another by some features. The present study supports his view concerning the relation between these two genera, but I distinguished them by different features from his ; i. e., the four species of *Talauma* are different from the *Aromadendron* species studied in having the following features : 1) longer vessel elements and fiber-tracheids, 2) more bars in scalariform perforation plates, 3) thicker walls of fiber-tracheids, 4) higher uniseriate and multiseriate rays, and 5) more cells in the margins of the multiseriate rays.

Key Words : *Aromadendron*—Borneo—*Elmerrillia*—Magnoliaceae—*Talauma*—Wood anatomy

The Magnoliaceae are a family of trees and shrubs, comprising over 200 species belonging to 13 genera, and distributed from tropical areas to the temperate northern hemisphere of Asia and the Americas. Concerning the wood anatomy of the family, there are many studies on the temperate species of *Magnolia* and *Liriodendron*, but fewer on the tropical species or genera (see METCALFE, 1987). With regard to anatomical identification of tropical genera *Aromadendron* and *Talauma,* MCLAUGHLIN (1933) stated in his wood anatomical study of Magnoliales that no marked characteristics were found to distinguish *Aromadendron* from *Talauma.* In contrast, CANRIGHT (1955) noted that *Aromadendron* has much wider vessels than *Talauma* and differs also in parenchyma distribution and fiber characters from the latter. Since their investigations, it does not seem that the number of species examined has been increasing, nor a conclusion has been reached concerning the discrimination of those two genera.

In 1981 Professor K. IWATSUKI of the University of Tokyo headed a botanical expedition to the Long Bawan region in the northwestern part of East Kalimantan, Indonesian Borneo (IWATSUKI *et al.,* 1983). In the expedition Dr. K. UEDA collected some wood samples of the Magnoliaceae, which belong to six species of three genera, *Aromadendron*, *Elmerrillia,* and *Talauma.* Some of them are endemic to Borneo (UEDA, 1983), and their wood anatomy has not been reported. In this paper, the wood anatomy of those species is described and the anatomical differences among them are discussed.

Materials and Methods

The collection data for the wood samples examined are given in Table 1. Sectioning, macerations, and measurements for descriptions are similar to those described earlier (TAKAHASHI, 1985). Further information on each

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Table 1. Collection data and diameter of wood sample of each species examined.

Species	Locality and Date	Specimens No.	Diameters of Wood Samples
Aromadendron borneensis	Pa Malim near Long Bawan, 900-1000 m alt., July 8, 1981.	KATO *et al*. B-8383.	55×50 mm
Elmerrillia mollis	Gunung Buduk Rakik, 1100 m alt., Aug. 12, 1981.	KATO *et al*. B-11256	40×40 mm
Talauma gitingensis	Gunung Muruk, 1350 m alt., July 20, 1981.	UEDA & DARNAEDI B-8673	50×45 mm
	Maru, near Long Bawan, 950 m alt., Aug. 18, 1981.	UEDA & DARNAEDI B-11540	50×45 mm
T. lasia	Gunung Malim near Long Bawan, 900-1100 m alt., July 8, 1981.	KATO *et al*. B-7830	>250 mm
T. incrassata	Along Pa Milau River, between Gunung Seribu and Pa Binuang, 950 m alt., Aug. 8, 1981.	UEDA & DARNAEDI B-8975	40×40 mm
T. singapurensis	Long Takan, between Pa Binuang and Pa Padi, 900 m, Aug. 11, 1981.	UEDA & DARNAEDI B-8994	60×55 mm

species together with the field observations is given by UEDA (1983).

Descriptions

Aromadendron borneensis DANDY (Figs. 1A-1C and 3A, 3B)

Growth rings indistinct. Pores evenly distributed, 12-17 per square mm; solitary (59%) and in radial multiples of 2-4, occasionally in clusters of 4-6; solitary pores round in outline; 60-135 and 50-135 μm in tangential and radial diameters, respectively; walls 1.5-3 μm thick. Vessel elements 380-930 (mean 677) μm long; end walls oblique; perforation plates scalariform with 4-8 bars; spiral thickenings invisible. Intervessel pits scalariform; vessel-ray pits large and scalariform, sometimes unilaterally compound. Tyloses present, sometimes sclerosed. Fiber-tracheids polygonal in cross sectional outline; 12-30 μm in diameter; walls 3-5 μm thick; 320-1580 (mean 965) μm long; with circular bordered pits, 3-4 μm in diameter; spiral thickenings invisible; non-septate. Wood parenchyma apotracheal bands of 2-5 cells wide; intervals between two bands variable, 120-1200 μm. Rays heterogeneous; mostly multiseriate (70%), sometimes uniseriate; 5-10 rays per mm length in tangential section. Uniseriate rays 12-30 μm wide and 1-8 cells (70-500 μm) high; composed of upright and square cells. Multiseriate rays 2-4 cells (30-80 μm) wide and 5-25 cells (150-600 μm) high; with usually 1-2, rarely up to 8, marginal rows of upright and square cells; multiseriate parts composed of procumbent cells. Oil cells invisible. Brownish gum present in ray cells.

Elmerrillia mollis DANDY (Fig. 1D-1F)

Growth rings indistinct. Pores evenly distributed, 15-35 per square mm; solitary (59%) and in radial multiples of 2-4, occasionally in clusters of 4-6; solitary pores round in outline; 65-150 and 70-160 μm in tangential and radial diameters, respectively; walls 3-4 μm thick. Vessel elements 420-1000 (mean 654) μm long; end walls oblique; perforation plates scalariform with 4-8 bars; spiral thickenings invisible. Intervessel pits scalariform; vessel-ray pits large and scalariform, sometimes unilaterally compound. Tyloses sometimes present. Fiber-tracheids polygonal in cross sectional outline; spiral thickenings invisible; non-septate. Wood parenchyma apotracheal bands of 2-5 cells wide; intervals between two bands variable, 180-1800 μm. Rays heterogeneous; mostly multiseriate (69%), sometimes uniseriate; 4-8 rays per mm length in tangential section. Uniseriate rays 15-25 μm wide and 1-8 cells (50-300 μm) high; composed of upright and square cells. Multiseriate rays 2-4 cells (40-80 μm) wide and 5-20 cells (160-500 μm) high; with 1-2, rarely 3, marginal rows of upright and square cells; multiseriate parts composed of procumbent cells. Oil cells present in uniseriate rays or margins of multiseriate rays; rather abundant, 5-10 cells per square mm in tangential section; 60×120 μm in size.

Talauma gitingensis ELMER (Fig. 1G-1I)

Growth rings indistinct. Pores evenly distribut-

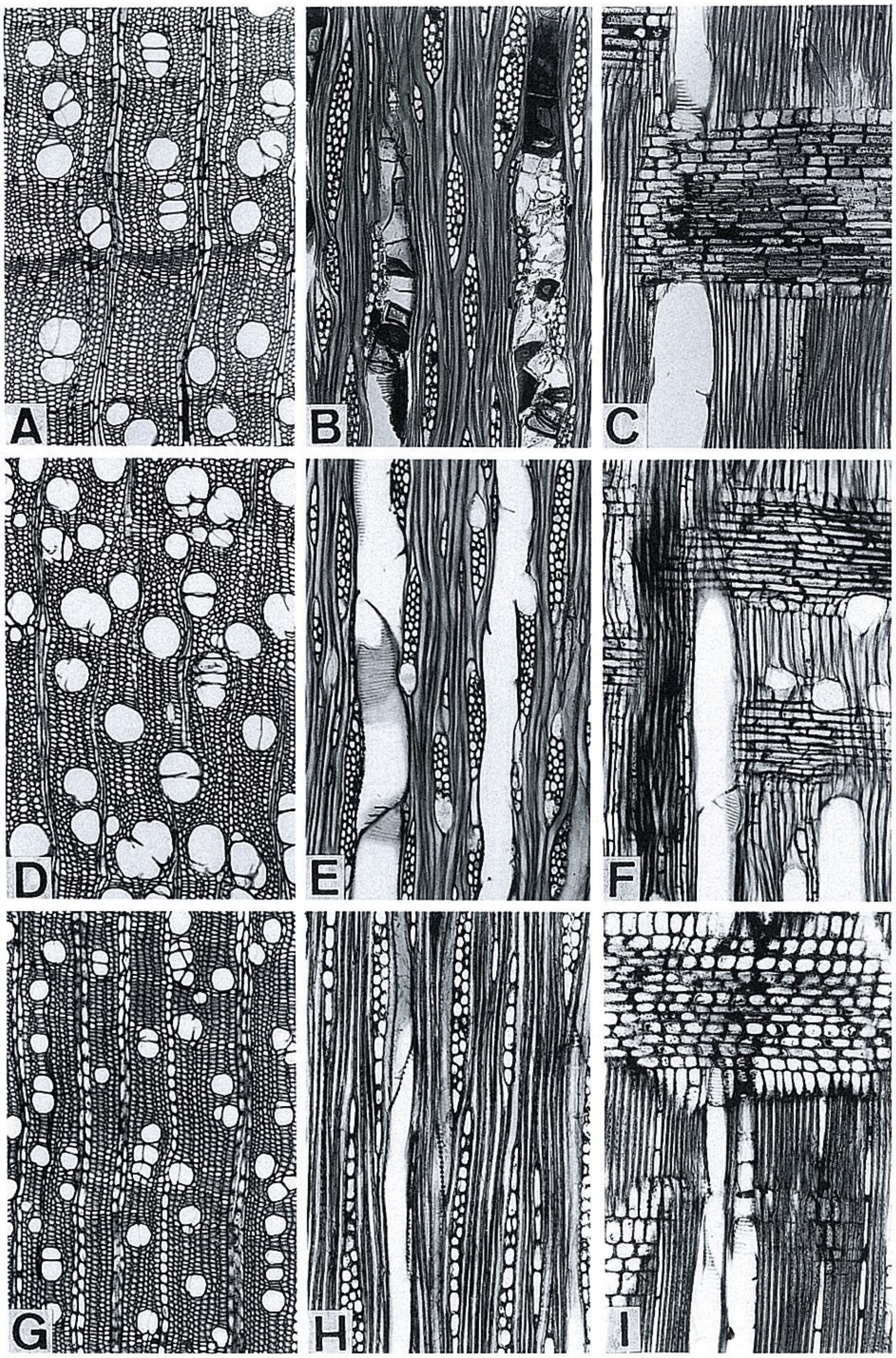

Fig. 1. Woods of *Aromadendron, Elmerrillia,* and *Talauma.* A-C. *Aromadendron borneensis.* D-F. *Elmerrillia mollis.* G-I. *Talauma gilingensis.* A, D, G=cross section (×40); B, E, H=tangential section (×50); C, F, I=radial section (×50).

ed, 13-40 per square mm; mostly solitary (71%), sometimes in radial multiples of 2-4, occasionally in clusters of 4-6; solitary pores round or polygonal in outline; 40-110 μm and 35-130 μm in tangential and radial diameters, respectively; walls 2-3 μm thick. Vessel elements 380-1280 (mean 930) μm long; end walls oblique; perforation plates scalariform with 10-20 bars; spiral

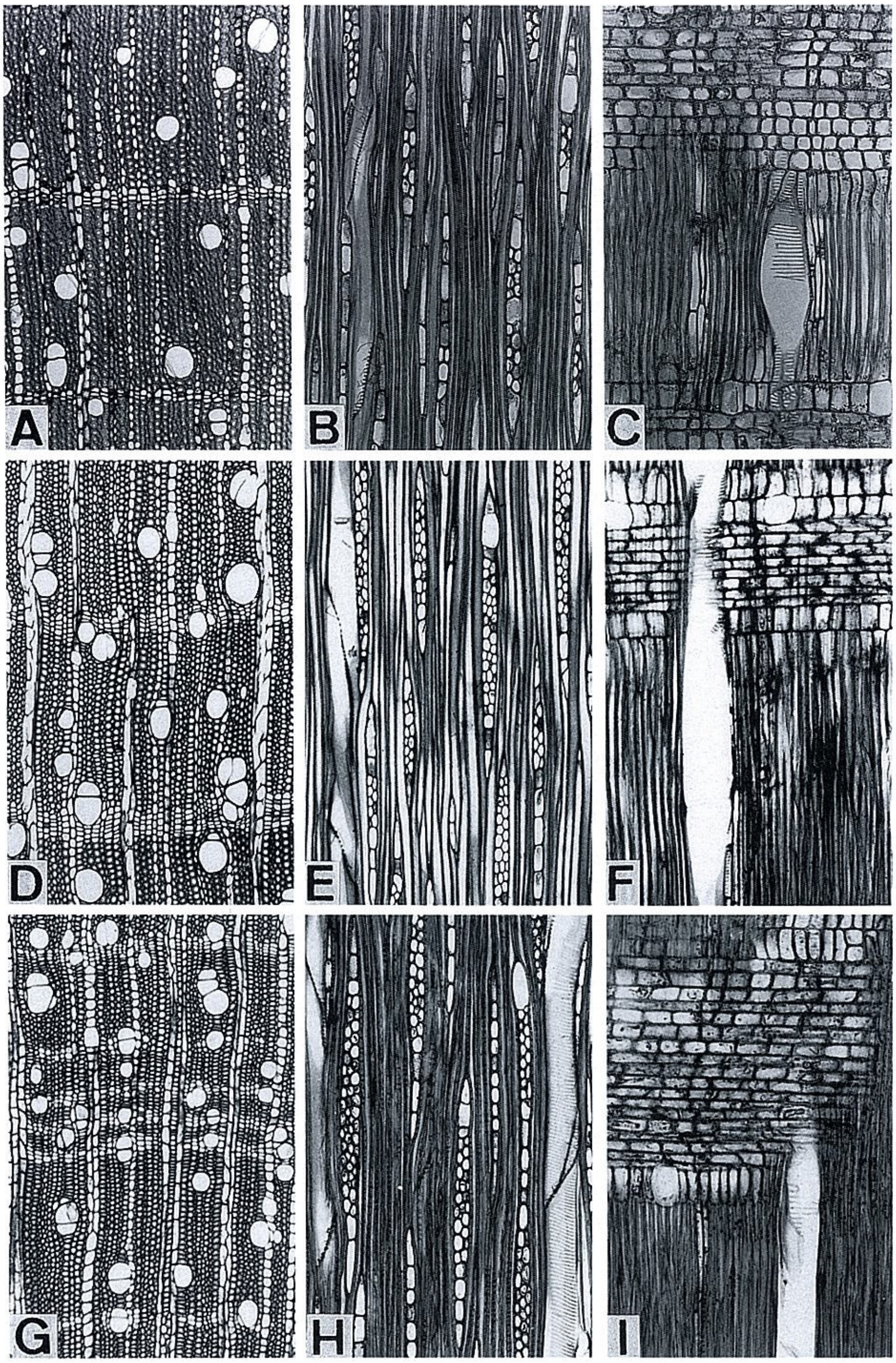

Fig. 2. Woods of *Talauma*. A-C. *T. incrassata*. D-F. *T. lasia*. G-I. *T. singapurensis*. A, D, G=cross section (×40); B, E, H=tangential section (×50); C, F, I=radial section (×50).

thickenings invisible. Intervessel pits scalariform; vessel-ray pits large and scalariform, sometimes unilaterally compound. Tyloses sometimes present. Fiber-tracheids polygonal in cross sectional outline; 10-35 μm in diameter; walls 4-6 μm thick; 730-2000 (mean 1428) μm long; with circular bordered pits, 3-5 μm in diameter; spiral thickenings invisible; non-septate. Wood parenchyma apotracheal bands of 1-4 cells wide; intervals between two bands variable, 100-1600

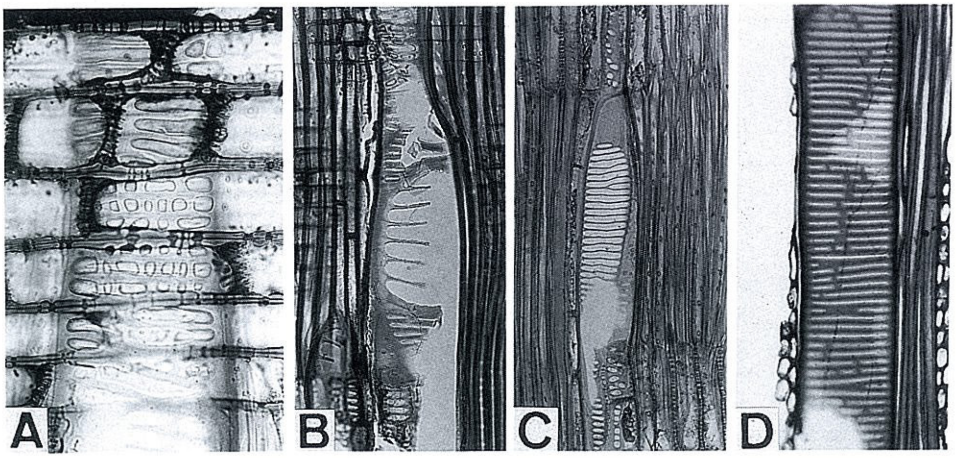

Fig. 3. Woods of *Aromadendron* and *Talauma*. A. Tangential section of *Aromadendron borneensis* showing ray-vessel pittings (×270). B. Radial section of *Aromadendron borneensis* showing scalariform perforation plate with six bars (×100). C. Radial section of *Talauma incrassata* showing scalariform perforation plate with about 20 bars (×100). D. Tangential section of *Talauma lasia* showing scalariform intervessel pitting (×100).

μm. Rays heterogeneous; mostly multiseriate (70%), sometimes uniseriate; 7-10 rays per mm length in tangential section. Uniseriate rays 12-30 μm wide and 1-12 cells (100-700 μm), rarely up to 20 cells (1350 μm) high; composed of upright and square cells. Multiseriate rays 2-3 cells (35-60 μm) wide and 5-25 cells (200-1200 μm), rarely up to 50 cells (1500 μm), high; with 1-6, up to 16, marginal rows of upright and square cells; multiseriate parts composed of procumbent cells. Oil cells rarely present in uniseriate rays or in margins of multiseriate rays; 0-2 cells per square mm in tangential section; 80×120 μm in size.

Other three species of *Talauma*

Talauma incrassata DANDY (Figs. 2A-2C and 3C), *T. lasia* DANDY (Figs. 2D-2F and 3D), and *T. singapurensis* RIDL. (Fig. 2G-2I) are basically similar to *T. gitingensis* in the wood anatomy. The difference in the anatomical characters among those species is listed in Table 2 and can be summarized as follows: number of pores per square mm is fewer in *T. incrassata* (8-15/sq. mm) and *T. lasia* (6-15/sq. mm); solitary pores are more in *T. incrassata* (85%); pores are larger in *T. lasia* (80-145 μm); bars of scalariform perforation plates are more in *T. singapurensis* (15-30); fibers are longer in the three species (up to 2800 μm); circular bordered pits of fibers are larger in *T. singapurensis* (6-8 μm); banded parenchyma is wider in *T. lasia* (3-5 cells wide); multiseriate rays are fewer in *T. incrassata* (56%) and more in *T. lasia* (80%); oil cells per square mm in longitudinal sections are more in *T. incrassata* (3-5).

Discussion

From an investigation of the wood anatomy of the present materials, it is recognized that two species of *Aromadendron* and *Elmerrillia* are similar to one another in their wood anatomy, except for the occurrence of oil cells in the rays, and four species of *Talauma* have basically similar features with slight variations in some characters. Most of the anatomical features shown by the present study—i. e., pore distribution in solitary and in short radial multiples, vessels with scalariform perforation plates and scalariform intervessel pits, parenchyma in apotracheal bands several cells wide, hetetogeneous rays (KRIBS' Type IIA or IIB), and frequent or infrequent occurrence of oil cells in the rays—are characteristic of the woods of the Magnoliaceae, as already described by MCLAUGHLIN (1933), CANRIGHT (1955), and METCALFE (1987), although some differences from these descriptions are also present. According to CANRIGHT (1955), *Elmerrillia mollis* has no uniseriate rays, but the present material of the same species has them rather frequently. Occurrence of oil cells in *Aromadendron* was reported by MCLAUGHLIN (1933) and CANRIGHT (1955). In the present study,

Table 2. Quantitative anatomical characters of *Aromadendron*, *Elmerrillia*, and *Talauma*.

Characters	*Aromadendron borneensis*	*Elmerrillia mollis*	*Talauma gitingensis*	*T. incrassata*	*T. lasia*	*T. singapurensis*
1. VESSELS						
a. Number of pores/sq. mm	12-17	15-35	13-40	8-15	6-15	20-30
b. Frequency of solitary pores (%)	59	59	71	85	66	73
c. Range (average) of tangential diameter (μm)	60-135 (98)	65-150 (105)	40-110 (74)	50-100 (73)	80-145 (99)	50-115 (81)
d. Range (average) of element length (μm)	370-930 (677)	420-1000 (654)	380-1250 (904)	530-1200 (909)	780-1450 (1142)	730-1300 (1053)
e. Number of bars of scalariform perforation plate	4-8	4-8	10-20	10-20	10-20	15-30
2. FIBERS						
a. Range (average) of element length (μm)	320-1580 (965)	550-1600 (1077)	730-1950 (1450)	750-2600 (1796)	830-2800 (2104)	1430-2800 (2181)
b. Wall thickness (μm)	3-5	3-4	4-6	4-8	4-6	4-8
c. Size of circular bordered pits (μm)	3-4	2-3	3-5	3-5	4-5	6-8
3. PARENCHYMA						
a. Width of bands (cells)	2-5	2-5	1-4	1-4	3-5	2-4
b. Intervals between two bands (μm)	120-1200	180-1800	100-1600	150-1000	200-1800	100-1350
4. RAYS						
a. Number of rays/mm	5-10	4-8	7-10	6-9	6-9	6-11
b. Frequency of uniseriates and multiseriates (%)	30-70	31-69	30-70	44-56	20-80	35-65
c. Height of uniseriates (μm)	70-500	50-300	100-700-(1350)	120-900	100-650	150-750
(cells)	1-8	1-8	1-10-(20)	1-10	1-10	1-10
d. Width of multiseriates (μm)	30-80	40-80	35-60	30-50	30-40	25-70
(cells)	2-4	2-4	2-3	2-3	2-3	2-4
e. Height of multiseriates (μm)	150-600	160-460-(530)	200-1200-(1500)	400-1100	400-1200-(1600)	300-1300-(2300)
(cells)	5-25	5-20	5-25-(50)	7-20	8-25-(40)	7-40-(55)
f. Height of margins of multiseriates (cells)	1-2-(8)	1-2-(3)	1-6-(16)	1-5-(10)	1-6-(10)	1-8-(12)
g. Number of oil cells/sq. mm	0	5-10	0-2	3-5	0-5	0-3

however, oil cells are invisible in *Aromadendron borneesis,* while brownish gum is frequent in the ray cells, as is noted by MCLAUGHLIN (1933). In the examined species of *Talauma,* long fibers are up to 2800 μm long and multiseriate rays are often over 1 mm high. These characteristics are not seen in the previous descriptions.

Among the features shown by the present species, vessels with scalariform perforations and apotracheal banded parenchyma are characteristic of tropical species in the family, as stated by CANRIGHT (1955). Temperate species of the family, such as Japanese species of *Magnolia* (TAKAHASHI, 1985), have vessels with simple perforations and terminal parenchyma related to the occurrence of distinct growth rings. CANRIGHT (1955) further stated that most tropical species of *Talauma* exhibited the largest assembly of primitive characters. In this study, four species of *Talauma* also show more primitive characters than *Aromadendron* and *Elmerrillia,* for example slightly angular pore outlines, long vessel elements and fibers, more bars in scalariform perforation plates, and high uniseriate margins of the multiseriate rays (the ray system is KRIBS' Type IIA, in contrast with Type IIB in *Aromadendron* and *Elmerrillia*).

MCLAUGHLIN (1933) stated in his wood anatomical study of Magnoliales that no marked characteristics were found to distinguish *Aromadendron* from *Talauma.* CANRIGHT (1955) did not support MCLAUGHLIN's view, and noted that *Aromadendron* has much wider vessels (240 μm in tangential diameter in *A. elegans*) than those of *Talauma* and differs also in parenchyma distribution and fiber characters. The present study supports CANRIGHT's view concerning the relation between *Aromadendron* and *Talauma.* Vessel diameters of the two genera, however, are not so clearly different in my study. The vessel diameters of *Aromadendron borneensis* are certainly larger than those of the examined three species of *Talauma,* but one species, *T. lasia,* has similar vessel diameter (Table 2). Parenchyma distribution is also not much different among the examined six species. Eventually, the four species of *Talauma* are different from *Aromadendron borneensis* in having the following features: 1) both vessel elements and fiber-tracheids are longer; 2) the number of bars per each scalariform perforation plate is larger; 3) the walls of fiber-tracheids are thicker; 4) the uniseriate and multiseriate rays are higher; 5) the number of cells in the margins of multiseriate rays is larger (Table 2).

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摘　要

ボルネオ産のモクレン科の3属 *Aromadendron, Elmerrillia* と *Talauma* に属する6種について材構造を記載した。それらのいくつかはボルネオに固有の種で，これまで材解剖学的報告がない。結果は，*Aromadendron* の1種と *Elmerrillia* の1種の解剖学的特徴は放射組織における油細胞の有無以外ほとんど同じであることと，*Talauma* の4種は各形質に若干の変異はあるものの，基本的に同じ特徴を有することがわかった。それら6種によって示された材

解剖学的特徴のほとんど，すなわち，単独管孔および数個が放射複合する管孔の配列，階段穿孔と階段状壁孔を有する道管，狭い帯状の独立柔組織，異性放射組織(クリブスのタイプII AまたはII B)，そして放射組織における油細胞の存在などはモクレン科の材の特徴であり，従来の記載に一致するが，いくつかの相違もみられた。このうち *Talauma* の4種は管孔が角張る，道管要素と繊維状仮道管が長い，階段P孔の横線数が多い，多列放射組織の縁辺が高いなどの特徴を有し，解剖学的観点からは他2属のものより原始的である。*Aromadendron* と *Talauma* 間の材解剖学的識別に関し，CANRIGHT (1955) はいくつかの特徴で両者を区別できるとしたが，本研究はCANRIGHTとは異なる特徴で両者を区別できる結果を得た。すなわち，*Talauma* の4種は1)道管要素と繊維状仮道管がより長いこと。2)階段状穿孔板の横線数がより多いこと。3)繊維状仮道管の壁がより厚いこと。4)単列および多列の放射組織がより高いこと。5)多列放射組織の縁辺細胞の数が多いこと，で *Aromadendron* の1種と異なる。

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○ **ケンロクヒサカキの新産地**（清野嘉之・井鷺裕司）Yoshiyuki KIYONO and Yuuji ISAGI: New Locality of *Eurya japonica* THUNB. var. *ovata* MASAMUNE et SATOMI.

1987年11月に広島県（広島営林署花茎山国有林：標高280 m）のアカマツ林で，楕円体の果実（Fig. 1）をつけたヒサカキを1株見つけた。似たものにケンロクヒサカキ（正宗・里見，1954）があるが，その果実は卵形体と報告されている。しかし，ケンロクヒサカキが天然分布する石川県金沢市では，楕円体の果実と卵形体の果実をともにもつ個体が見られるので，本品はケンロクヒサカキの一型と考えられる。京都市の桃山御陵照憲皇太后陵参道ぞいにも楕円体の果実をもつ個体（植栽）がある。ケンロクヒサカキの天然分布は石川県以外では報告されていないようであるので，ここに新産地として報告する。このケンロクヒサカキは，地際直径4 cm，樹高2 mで，周囲のヒサカキが同3 cm，1.5 m程度であるのに比べて大きく，生育はよい。

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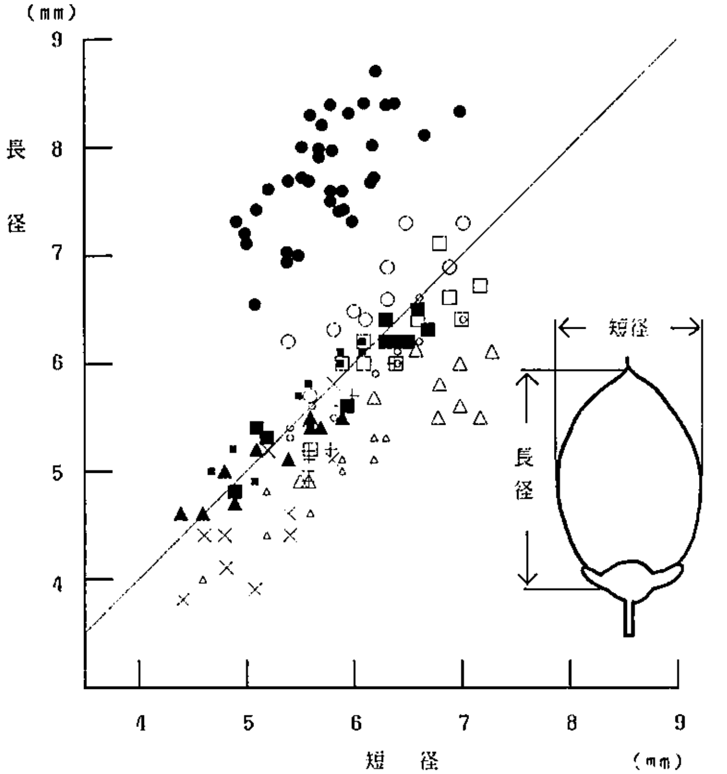

Fig. 1.　漿果の短径と長径の関係　シンボルは個体の違いを表す。●はケンロクヒサカキ，ほかは周囲の普通のヒサカキ。