Department of Forest Products
School of Forestry
Oregon State University
Corvallis, Oregon

SEGREGATION AND IDENTIFICATION OF SOUTHEAST ASIAN HARDWOODS

by
Robert L. Krahmer
and
J. D. Wellons

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Contents

Conclusions

1. Trade groups of wood for plywood veneer from Southeast Asia could contain from 1 to over 50 different tree species if no other differentiation than the trade name in the Plywood Standard was used to describe the material.

2. Segregation of trade groups called Keruing (Apitong), Meranti (Lauan), Kapur, Mersawa and Mengkulang is possible using a combination of anatomical characteristics of the genera represented in each group. Table 1 on page 3 summarizes characteristics of these woods that can be observed either without the aid of a hand lens or with a 10-power hand lens. Some training would be required for the mill worker to become familiar with these characteristics, and additional skill in sample preparation and observation is required for the hand lens characteristics.

   A key which includes microscope characteristics for segregating these trade groups is given on pages 9-10.

3. Some segregation of wood species into subgroups within a trade group is possible. The species segregated into a subgroup will depend on the number and type of anatomical and/or physical properties used to define the subgroup.

4. Identification of single species of Southeast Asian woods is not possible to the extent of providing positive identification. Species segregated into a subgroup could be compared with authentic wood samples in a wood collection to narrow down the identification to the fewest number of species.

5. Because tree species are established on the basis of botanical characteristics of the foliage, flowers and fruit of the tree, positive

identification can only be established at the site of the growing tree. Countries like Malaysia have completed basic studies of species now imported to the United States for veneer and other purposes, and familiarity with location of tree species and the mere handling of quantities of material undoubtedly make species segregation much easier at the source of supply (1, 2).

Table 1. Summary of Characteristics for Segregating Trade Groups of Southeast Asian Hardwoods

Genera	Gross features; trained mill worker				Hand lens features; skilled technician	
	Heartwood color	Positive test with ferric ammonium sulfate	Pores large and obvious on veneer surface	Pores and rays appear much darker than other tissue on veneer surface	Arrangement of longitudinal canals on end surface	Arrangement of pores
Shorea, Parashorea Pentacme spp. Meranti, Lauan, Seraya Dark red Red Light Red	Dark red	No	Yes	No	Lines	Multiple
Dryobalanops spp. Kapur Keladan	Dark red	Yes	No	No	Lines	Solitary
Dipterocarpus spp. Keruing Apitong	Dark red	No	No	No	Diffuse	Solitary
Heritiera (Tarrietia) spp. Mengkulang	Dark red	No	Yes	Yes	None	Multiple
Shorea, Parashorea Pentacme spp. Meranti, Lauan, Seraya Light Red White	Light red	A few species	Yes	No	Lines	Multiple
Shorea spp. Yellow White	Yellowish, straw	A few species	Yes	No	Lines	Multiple
Anisoptera spp. Mersawa	Yellowish straw	No	No	No	Diffuse	Solitary

Introduction

The specific objective of this report is to give information that currently is necessary for segregating wood veneer referred to as Keruing, Apitong, Kapur, and Lauan into their respective genera and species.

Southeast Asian hardwoods are being imported into the United States to supplement domestic supplies of the better veneer grades. Veneers of the genera *Shorea*, *Parashorea*, *Pentacme*, *Dryobalanops*, *Dipterocarpus*, and *Durio* have been identified in plywood siding although as many as 10 to 12 other genera have been tentatively identified as being included in veneer shipments.

Some problems with delamination of exterior plywood siding in use have been encountered by the industry, particularly with species of *Dryobalanops* and dark colored *Dipterocarpus*. Exclusion of offending species is an alternative for reducing the occurrence of delamination problems. This alternative was studied by the Forest Products Department, School of Forestry, Oregon State University, Corvallis, with support of the Research Foundation of the American Plywood Association.

Trade Names for Veneer Woods from Southeast Asia

Establishing a basis for segregation and identification of wood into respective genera and species first requires a common terminology among people to indicate just what wood is being discussed. Each tree in a forest is a species and is given a scientific (Latin) name, which includes a generic name, followed by a species name. Many tree species can belong to a single genera; therefore, a forest can be made of trees of the same species, trees of different species of the same genera, and trees of different genera.

The scientific names of trees are not generally used in the trade, so trade names have been given to wood. Some trade names refer to a single species, while others will refer to a group of species. It is also common that a group of woods under a trade name will include species from more than one genera.

Because trade names for veneer species from Southeast Asia vary from country to country, Table 2 attempts to show the more common trade names used. These trade groups include several tree species, and the approximate number of species is given with each of the trade names.

In the countries where these trees grow, the groups in Table 2 are often divided into subgroups, and some of these subgroups are listed in the Plywood Standard PS 1-66. The classification of species in PS 1-66, along with proposed additions to this list and some other wood species actually identified in plywood veneer, results in the following groups of wood species that have been included in imported veneer from Southeast Asia:

Lauan, Meranti	(*Shorea*, *Parashorea*, *Pentacme spp.*)
Red (Red Lauan)	*Shorea spp.*
Tangile (Red Lauan)	*Shorea polysperma*
White (White Lauan)	*Pentacme* and *Shorea spp.*
Almon (White Lauan)	*Shorea almon*
Bagtikan (White Lauan)	*Parashorea plicata*
Mayapis (Red/White Lauan)	*Shorea squamata*
Apitong, Keruing	*Dipterocarpus spp.*
Kapur, Keladan	*Dryobalanops spp.*
Mengkulang	*Heritiera* (*Tarrietia*) *spp.*
Mersawa	*Anisoptera spp.*
Durian	*Durio spp.*
Nyatoh	*Paloquium spp.*

Table 2. Trade Names for Veneer Species from Southeast Asia

Genera	(Indonesia) Sumatra	Malay Peninsula	Sarawak	(Indonesia) Borneo	Sabah	Philippines
Dipterocarpus spp.	Keroeing (21)[1]	Keruing (30+)	Keruing (17+)	Keruing (17+)	Keruing (23)	Apitong
Dryobalanops spp.	Kapur	Kapur (2+) (Keladan)	Kapur (6) (Keladan)	Kapur (5)	Kapur (5)	-----
Shorea, Parashorea, Pentacme spp.	Meranti (21+)	Meranti (58+)	Meranti	Meranti (82)	Seraya (80)	Lauan (80+)
Anisoptera spp.	Mersawa (3)	Mersawa (7+)	Mersawa (3)	Mersawa (3)	Mersawa (4)	Palosapis (4)

[1]Numbers in parentheses are the approximate number of species reported in each of the trade groups.

Segregating Veneer Species into Genera or Trade Groups

Several references have been used to arrive at the information for identifying Southeast Asian woods, in particular, "Timbers of Sabah" and "Dipterocarp Timbers of the Malay Peninsula" (1, 2). These report anatomical and physical properties of many woods now exported as veneer.

Segregation of trade groups of veneer from one another requires use of gross features of wood, such as color and odor, as well as anatomical characteristics that require at least a hand lens (10-power) and sometimes even a microscope to see them. A key for segregating the trade groups has been prepared and begins on page 9. This key allows the user a choice between two different anatomical descriptions, and then proceeds to additional steps until identification is achieved. Microscopic characteristics often aid in making positive identification of a particular genera or group of species, and these characteristics are included in this key. Photographs on pages 11-15 are provided to illustrate anatomical features used in this key.

Most keys published by the countries exporting these woods (1, 2) indicate that segregation into the major trade groups is best achieved by first observing the occurrence and distribution of longitudinal resin canals on a clean cut cross section (end surface). This is done in the key on page 9, and of the trade groups in the key, Mengkulang, Durian and Nyatoh do not have longitudinal resin canals. In Meranti and Kapur, the resin canals are in long tangential bands, extending up to several inches following the curvature of the growth rings. The resin canals in Keruing and Mersawa are diffusely scattered, and in only a few species do very short tangential bands occur, but individual, diffuse canals can still be found. Further segregation is then based on other anatomical and physical

characteristics. Because color and density of the wood are frequently used to segregate within the Merantis, some tree species can be found in more than one of the subgroups because of density and color variations within a species.

Key for Segregating Trade Groups of Southeast Asian Veneer Woods

1.	Normal longitudinal resin canals present (Figure 2)	2
1.	Normal longitudinal resin canals absent	14
2.	Resin canals random or in short (less than 7) tangential bands: rays of two distinct sizes; pores solitary (Figure 3)	3
2.	Resin canals in long tangential bands (Figure 3)	4
3.	Wood purple red color	Keruing
3.	Wood straw color	Mersawa
4.	Pores exclusively solitary; rays of single size only (Figures 6 & 7)	Kapur
4.	Pores include pairs and multiples (Figure 6)	5
5.	Wood hard and heavy, or very hard and very heavy (over 50 lbs/cu ft air dry)	6
5.	Wood moderately hard and heavy, or light and soft (under 50 lbs/cu ft air dry)	9
6.	Color red or purple-red	Red Balau (*S. kunstleri*) Red Selangan Batu Red Lauan
6.	Color light brown or yellow brown (not markedly red)	7
7.	Wood parenchyma and rays yellow; vessels reticulate in arrangement; silica present (Figures 1c & 2b)	White meranti (*S. sericeiflora*)
7.	Wood parenchyma and rays not yellow; vessels not reticulate; silica wanting	8
8.	Air dry density 55 pounds or more per cubic foot; end cut generally shiny or waxy in appearance	Balau Selangan Batu No. 1
8.	Air dry density less than 55 pounds per cubic foot; end cut generally dull	Balau Selangan Batu No. 2
9.	Color shades of pink or red, or light brown	10
9.	Color whitish or yellowish or green, no red tinge	13

10.	Longitudinal resin canals prominent on longitudinal faces; color deep red	Dark Red Meranti Obar Suluk Red Lauan
10.	Longitudinal resin canals not prominent on longitudinal faces	11
11.	Color pink or light red; no chambered parenchyma strands	Light Red Meranti Red Seraya Heavy Red Saraya Red Lauan
11.	Color light brown rather than light red; chambered parenchyma strands present (Figure 1a)	12
12.	Horizontal canals present (Figure 1d, e); wood rather dense	Heavy White Seraya
12.	No horizontal canals; wood light weight	White Meranti White Seraya White Lauan
13.	Vessels reticulate in arrangement; silica present; pores in characteristic groups of 3 to 5 in a group; wood fairly lustrous; wood parenchyma and ray tissue bright yellow	White Meranti Melapi White Lauan
13.	Vessels radial (not reticulate) in arrangement (Figure 2c); silica absent; (horizontal canals present as seen with microscope); pores diffuse and not grouped; wood without luster; wood parenchyma and ray tissue not bright yellow	Yellow Meranti Yellow Seraya Yellow Lauan
14.	Vessels in radial chains; wood rays fine not visible to naked eye; banded parenchyma regularly spaced; tile cells absent	Nyatoh
14.	Vessels not obviously in chains; wood rays visible to naked eye	15
15.	A few comet-shaped vessels invariably present (Figure 4); pores fairly numerous; rays of two distinct sizes; large rays easily seen on tangential surface; tile cells absent	Mengkulang
15.	Comet-shaped vessels absent; pores widely spaced; rays narrow and of single size, not easily seen on tangential surface; tile cells present (Figure 5)	Durian

Best scan available. Original is a photocopy.

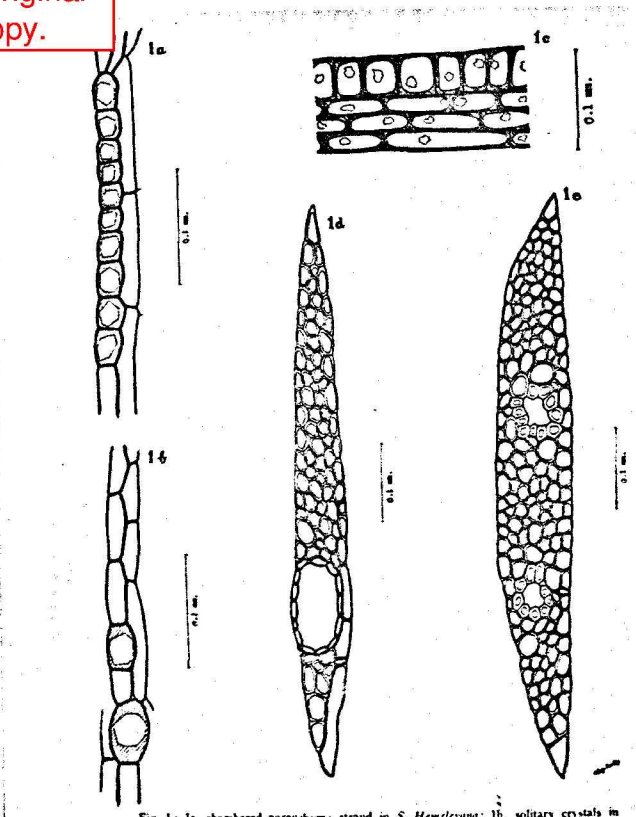
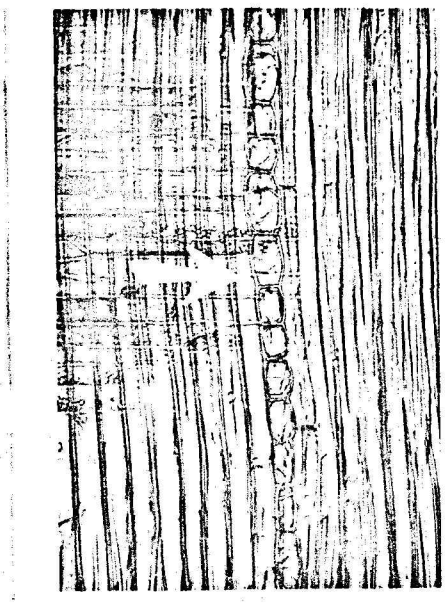
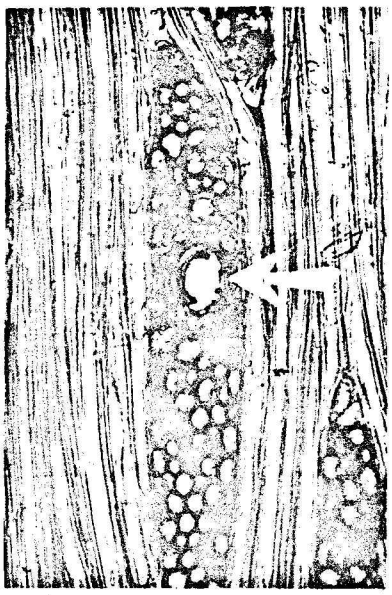


Fig. 1: 1a, chambered parenchyma strand in *S. Hewetsyana*; 1b, solitary crystals in wood parenchyma cells of *S. sumatrana*; 1c, ray cells (*white meranti*) showing deposits of silica (*S. sericeiflora*); 1d, radial intercellular canal (red meranti type), note the thin walled epithelial cells (*S. leprosula*); and 1e, radial intercellular canals (yellow meranti type), note the thick walled epithelial cells (*S. resina-negra*).

Figure 1. The drawings above illustrate a chambered parenchyma strand (1a), normal longitudinal parenchyma (1b), silica in ray cells (1c), and horizontal resin canals in rays (1d, 1e). The left photograph below shows a chambered parenchyma strand, and the right photograph below shows a horizontal resin canal in a ray.





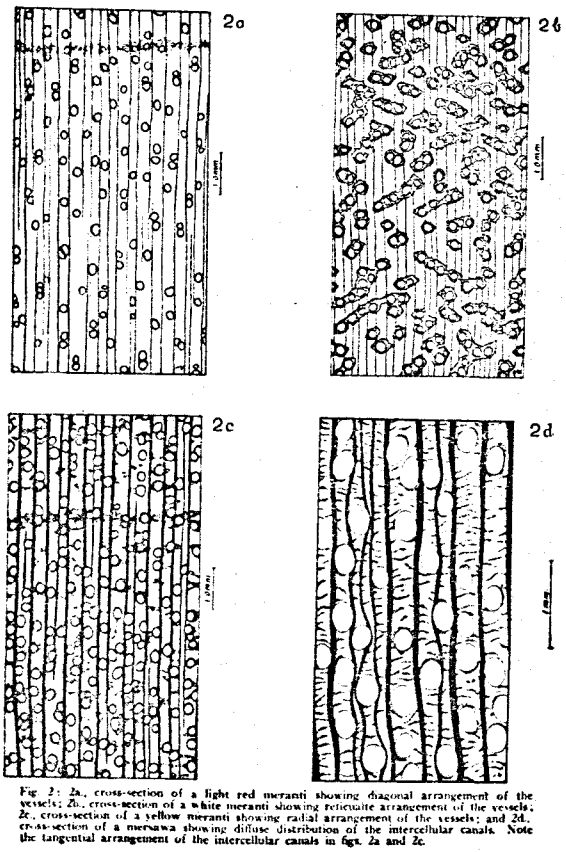
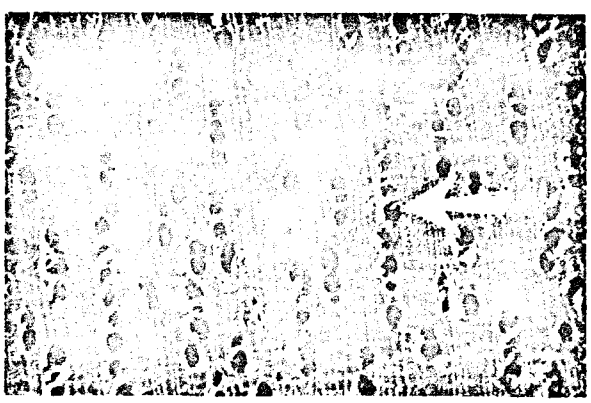


Fig. 2: 2a., cross-section of a light red meranti showing diagonal arrangement of the vessels; 2b, cross-section of a white meranti showing reticulate arrangement of the vessels; 2c., cross-section of a sellow meranti showing radial arrangement of the vessels; and 2d., cross-section of a mersawa showing diffuse distribution of the intercellular canals. Note the tangential arrangement of the intercellular canals in figs. 2a and 2c.

Figure 2. The four drawings above illustrate typical arrangements of vessels and longitudinal canals. A radial arrangement of vessels (2c) is shown in the left photograph below. A diagonal arrangement of vessels (2a) is illustrated in the right photograph below.



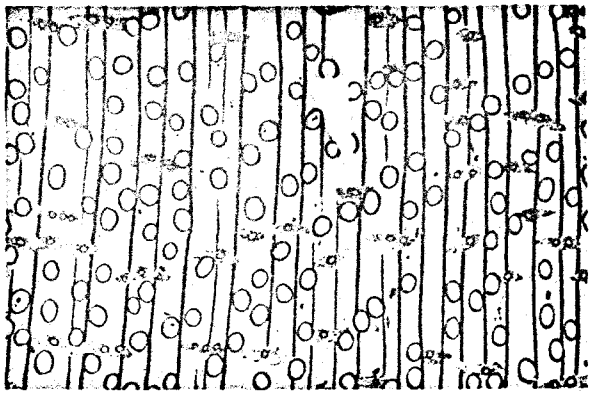
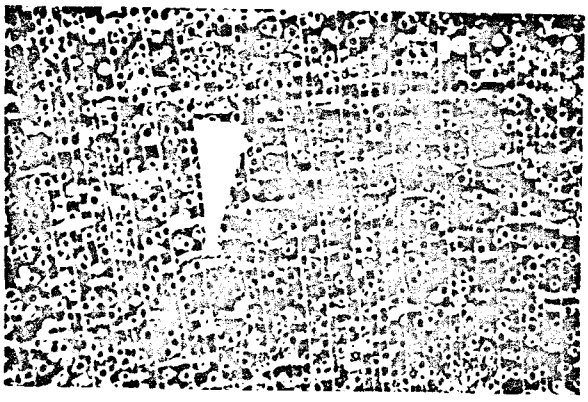


Figure 3. The drawing above illustrates a diffuse arrangement of longitudinal resin canals with some in short tangential bands. The photograph to the left below is Keruing with this arrangement. The photograph to the right below is Kapur with longitudinal canals arranged in long tangential bands.



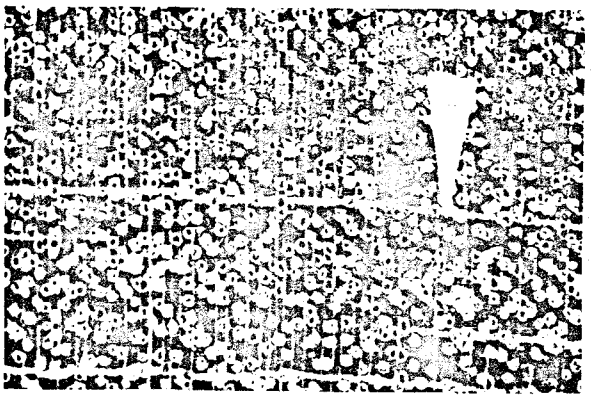


Figure 4. Comet-shaped vessels. A large vessel with a tail-like appendage of several radially aligned small vessels.

Figure 5. Tile cells. Short upright cells in the body of a ray.

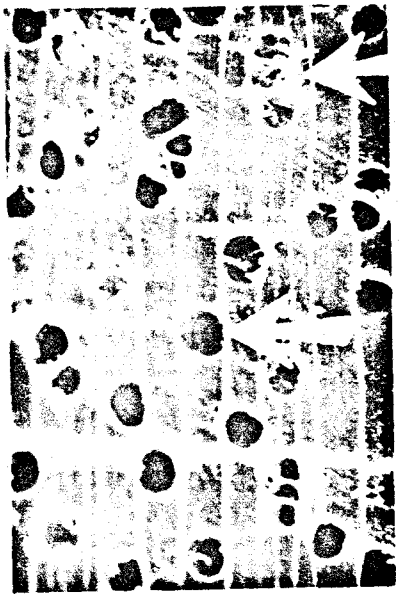


Figure 6.

Pores in multiples

Pores solitary

Figure 7. Rays of a single size. Refers to a condition where all the rays appear to be the same width on the cross section.

Color Test with 3% Ferric Ammonium Sulfate

George Sleet at the APA Laboratory, Tacoma, found that a drop of 3% ferric ammonium sulfate on Kapur (Keladan) would turn a dark black color immediately on contact with the wood. This color test was done on Southeast Asian woods in the wood collection at Oregon State University, and the results are shown in Table 3. From these results, it appears that this color test is rather selective for Kapur, although a few species in the other veneer groups would also react to this test similar to Kapur.

Most color tests with chemical solutions are results of a reaction between the extractives of the wood and the solution. Color descriptions for 3% ferric ammonium sulfate on wood are somewhat difficult to describe because the only colors produced are shades of gray to black, and the intensity of the color is dependent on the length of time the solution has been in contact with the wood. In Table 3, "slightly black" was judged to be a condition where the color was black enough to cause confusion if a person was not familiar with the intense black reaction on Kapur. In some instances, the darkening was merely a wetting of the wood, which sometimes reduced in intensity after drying. Most of the Yellow Meranti and a few of the White Meranti samples were responsible for the color results of the Meranti/Lauan group in Table 3.

Veneer samples of Kapur, Keruing, and Dark and Light Meranti were sequentially extracted with benzene, ether, ethanol and water to determine if there were noticeable differences in the quantities or composition of extractives in these groups of woods that might account for the reaction with 3% ferric ammonium sulfate. These data are summarized in Table 4. Data for individual veneer samples are in Tables 18-21 (Appendix).

Ethanol-water extractives were high in Kapur and some Light Meranti samples, as compared with Keruing, Dark Meranti and other samples of Light Meranti. This could account for the immediate black color produced by ferric ammonium sulfate on Kapur. The Light Meranti veneer samples with the high ethanol-water extractives (Group 2, Table 4) also turned black immediately with the ferric solution, but those with low ethanol-water extractives did not react immediately or become very black when treated with the ferric solution. Large quantities of ethanol-water extractives in these woods, therefore, appear to be the source of the positive test with 3% ferric ammonium sulfate.

If the ferric solution was being used to help segregate these groups of Southeast Asian hardwoods, the natural light color of the Yellow and White Meranti woods that react with the ferric solution would aid in separating these Light Merantis from Kapur.

All samples contained extractives that could be removed with each of the solvents, indicating that a specific color test for general categories of components would not be possible. Some differences in pH existed between the veneer groups in Table 4, and total extractives content of the wood appeared closely related to pH. Group 2 of the Light Merantis with the largest extractives content had the lowest pH and Group 1 with the smallest extractive content had the highest pH. However, the range of pH values in a veneer group often overlapped values of another group.

Table 3. Color Test with 3% Ferric Ammonium Sulfate

	Total number of samples observed	Immediate[1]		Dry spot[2]	
		Black	Slightly Black	Black	Slightly Black
Kapur/Keladan	13	11	2	13	--
Keruing/Apitong	32	1	14	1	14
Meranti/Lauan	108	1	16	8	6
Durian	3	--	1	--	1
Sindora	2	--	2	--	2
Others	217	7	6	10	14

[1]Color becomes black in less than 5 seconds.

[2]Color becomes black over the time it takes the spot to dry on the wood surface; usually over 1 minute.

Table 4. Extractives Content of Southeast Asian Veneer (Percent of Unextracted, Oven-Dry Weight of Wood)[1]

	Kapur	Keruing	Dark Meranti	Light Meranti[2]	
				Group 1	Group 2
Benzene	0.73 (0.22-3.64)	0.87 (0.44-1.82)	1.32 (0.43-2.21)	1.19 (0.30-2.11)	1.61 (0.90-2.93)
Ether	0.14 (0.06-0.37)	0.23 (0.08-1.46)	0.37 (0.07-0.82)	0.20 (0.09-0.61)	1.93 (0.73-3.36)
Ethanol	6.26 (0.96-11.87)	2.59 (0.91-4.75)	2.88 (0.58-7.98)	2.08 (1.06-3.26)	10.90 (9.15-14.02)
Water	2.73 (1.49-6.11)	1.58 (0.49-4.24)	1.70 (0.53-8.11)	1.36 (0.55-2.59)	1.47 (1.04-2.84)
Total	9.87 (4.64-15.65)	5.26 (2.28-10.70)	6.27 (2.53-10.95)	4.84 (3.13-5.90)	15.90 (13.08-20.08)
pH[3]	3.97 (3.43-5.90)	4.70 (4.00-5.82)	3.96 (3.52-4.90)	4.50 (3.92-5.11)	3.53 (3.42-3.92)

[1]Average of data on veneer samples that included both air dried and kiln dried material. The average value is given, along with the range of observations, which is in parentheses below each average value. Data for each sample are in the Appendix.

[2]Two groups of Light Meranti were evident, based on extractives content.

[3]pH of veneer is based on unextracted veneer.

Density Distribution of Woods

The distribution of wood density at 15% moisture content for the trade groups is shown in Table 5. This is based on published data for all species that have been listed under the groups by the country of origin (1, 2), assuming that any one of the species might be included in a veneer shipment.

Samples of commercial veneers used in extractives studies at Oregon State University had density values at 0% moisture content as shown in Table 6. These values were calculated from specific gravity data shown in Tables 18-21. Adjustment of these values to a moisture content of 15% was not made because the amount of swelling of each wood was not available and is needed to account for dimensional changes occurring with the increased moisture content.

From the data in Table 6, commercial veneers of Keruing and Kapur could be segretated from Meranti on the basis of density, at the same moisture content, but Keruing and Kapur could not be distinguished from each other on the basis of density. The data in Table 5 indicate that wood with an air-dry density of below 36 pounds per cubic foot would be species listed in this table other than Keruing and Kapur.

Table 5. Reported Densities at 15% Moisture Content (pounds/cubic foot)

Species group	Minimum	Average	Maximum
Lauan, Meranti			
White	24	35	57
Red	18	35	57
Yellow	25	39	63
Durian	25	40	53
Mersawa	32	41	53
Nyatoh	25	42	67
Mengkulang	32	45	62
Kapur/Keladan	36	46	51
Keruing	37	46	59

Table 6. Density of Commercial Veneers at 0% Moisture Content (pounds/cubic foot)

	Minimum	Average	Maximum
Keruing	38	42	48
Kapur/Keladan	38	43	48
Red Meranti	23	28	34
Light Meranti	22	28	35

Identification of Wood Species Within Trade Groups

As can be noticed in Table 2 the actual number of tree species that can occur within any trade group will vary from 3 to over 80, and the number will even vary from country to country in Southeast Asia. Not all tree species of a trade group will be of commercial importance in the production of veneer, although it is somewhat necessary to include all possible species when identification is required. Because many of the tree species in a trade group have similar properties and belong to the same genera, studies by the countries where these trees grow indicate that within a major trade group, only a certain amount of subgrouping of species can be made. The number and kind of tree species that will occur in a subgroup will depend on the anatomical or physical basis for segregating one subgroup from another.

The trade groups examined for purposes of segregating species were Keruing, Kapur and Meranti (Lauan). Durian is not listed as an acceptable species group for plywood veneer, so no attempt was made in this report to summarize possible methods for grouping the approximately 16 species of *Durio*, 3 species of *Coelostegia* and 5 species of *Neesia* that fall in the trade group called Durian.

Kapur (*Dryobalanops spp.*)

Although Kapur has given difficulties in obtaining satisfactory long-term adhesion in exterior glue lines (3), this group was examined for species differentiation because of its inclusion in the proposed Plywood Standards PS 1-74 and its satisfactory use for interior purposes.

Seven species are listed as occurring in Southeast Asian countries. Species specific to the Malay Peninsula (West Malaysia), Sabah and Sarawak

are given in Table 7. From the Malay Peninsula, *D. aromatica* and *D. oblongifolia* are commercial species, the first being called Kapur and the latter called Keladan. In Sabah, *D. lanceolata* is the most common species and is called Kapur. Differentiation between species is difficult, but the following information would accomplish some degree of segregation, particularly between Kapur (*D. aromatica*) and Keladan (*D. oblongifolia*).

1. Color
   a. Sapwood - light yellow brown with a pink tinge
   b. Heartwood - rose red or red brown; *D. oblongifolia* (Keladan) usually darker, approaching the purple-red color of some Keruing
2. Vessels (pores)
   a. Tyloses present; most developed in *D. aromatica* (Kapur)
3. Fibers and other axial elements
   a. Thick-walled fibers abundant in *D. aromatica* (Kapur); some in *D. oblongifolia* and *D. lanceolata*
   b. Parenchyma storied in *D. aromatica* (Kapur), but poorly developed in some specimens
4. Rays
   a. Moderately fine in *D. aromatica* (Kapur); mostly 2-4 seriate
   b. Medium-sized in other *Dryobalanops spp.*; up to 8 seriate, but mostly 3-5 seriate; frequently 5 seriate
   c. Less than 1 mm high in *D. aromatica* (Kapur)
   d. Commonly greater than 1 mm high in other *Dryobalanops spp.*
   e. Storied rays in *D. aromatica* (Kapur), but less so in some specimens
   f. Sometimes storied in *D. oblongifolia* (Keladan)

5. Ripple marks
   a. Distinct in many specimens of *D. aromatica* (Kapur), but not in all
   b. Less distinct in other *Dryobalanops spp.*
6. Silica, crystals, extractives
   a. Silica in all *Dryobalanops spp.*, but more abundant in *D. oblongifolia* (Keladan)
   b. Solitary crystals observed in ray and wood parenchyma cells of some specimens of *D. oblongifolia* (Keladan)
7. Odor
   a. Camphor-like in dry *D. aromatica* (Kapur); some specimens will have little odor, however
   b. Not distinctive in other *Dryobalanops spp.*

Summary of Differentiation of Kapur and Keladan

At low magnification, difficult to segregate. *D. oblongifolia* (Keladan) usually has a deeper color and lacks camphor-like odor in dry material, although some *D. aromatica* (Kapur) has very little odor. Ripple marks generally are present in *D. aromatica* (Kapur), although sometimes apparent in some specimens of *D. oblongifolia* (Keladan).

With the microscope, *D. aromatica* (Kapur) has small rays, 2-4 seriate and less than 1 mm high. *D. oblongifolia* (Keladan) and other *Dryobalanops spp.* have wider rays, frequently 5 seriate and up to 8 seriate. There is more silica in *D. oblongifolia* (Keladan) than in *D. aromatica* (Kapur).

Table 7. *Dryobalanops spp.* Scientific and Common Names

	Malay Peninsula	Sarawak	Sabah
D. aromatica	Kapur	Kapur Bukit Keladan	Kapur Biasa
D. becarri or *D. beccarii*		Kapur Bukit Kapur Peringgi	Kapur Merah Borneo Camphorwood
D. fusca		Kapur Bukit Kapur Emedu	
D. keithii			Kapur Gumpait
D. lanceolata		Kapur Bukit Kapur Paji	Kapur Kapore Kapur Paji Kapur Barus
D. oblongifolia	Keladan	Kapur Bukit Kelansau	
D. rappa or *D. rappi*		Kapur Paya	Kapur Rangii Kapur Paya

Philippines - No commercial importance for *Dryobalanops spp.*

Java - No *Dryobalanops spp.* listed in key to Javanese woods.

Keruing (*Dipterocarpus spp.*)

For the countries of Southeast Asia, at least 51 different species of *Dipterocarpus* are listed (see Tables 8 and 9). On the Malay Peninsula, 28 different species are reported (2), but other sources (4) indicate that there may actually be more than 30 species growing there. In Sabah and Sarawak, at least 16 species occur. An interim report by IUFRO on "Veneer Species of the World" (5) lists *D. acutangulus*, *D. caudiferus* and *D. spp.*, and of course *D. spp.* could include a number of different species. Geographical location could be useful in some species segregation, but only if the location of the tree was known.

1. Density

Reported densities for Keruing species from the Malay Peninsula and Sabah are given in Table 10, and listed in order of increasing average density. Because the density values for some species are based on only a few samples, the ranges listed could in fact be greater than shown.

Some major segregation into groups of Keruing species could be accomplished with the use of the density data. This would be true for the very heavy pieces (over 55 lbs/cu ft) and the light weight pieces (less than 40 lbs/cu ft), but all of the listed species would be included in a density range of 40-55 lbs/cu ft.

2. Color

Although heartwood of Keruing is generally red-brown, but varying from a deep pink to purple red, some species grouping can be done on heartwood color. Again, it is only the wood samples that are either light pinkish color or dark colored with a purplish tinge that can be differentiated. Table 11 lists the color for species of Keruing with distinctive coloration.

Because time and exposure to light and temperature can affect the color of wood, color differences between species cannot always be a reliable method for species identification.

3. Anatomy

Because the gross anatomical features of all Keruing species are the same, the Keruing group can be separated from other genera according to the anatomical key on page 9. Within the Keruing group, however, only variations in such anatomical characteristics as the number of longitudinal resin canals and vessels per square millimeter of end surface, the size of the longitudinal resin canals compared to the size of the vessels, the diameter of the vessels, and, some slight variations in patterns and visibility of longitudinal parenchyma can be used to narrow down the list of species for a particular veneer sample. Information on these characteristics are tabulated in Table 12-15.

Segregation of Keruing Species

Because the variation of physical and anatomical properties of a Keruing wood species overlaps the properties of many other Keruing wood species, identification of a veneer sample would only be possible if the tree species from which the veneer was cut had a wood property that was obviously different from the remainder of the Keruing species. By using several properties, however, a sample of wood could be keyed into a relatively small number of species names.

Table 8. *Dipterocarpus spp.* Scientific and Common Names

Malay Peninsula	Philippines	India	North Borneo Sarawak	Ceylon
Keruing (30+ species)	Apitong Bagac	Gurjun Kanyin Eng In	Keruing Kuren (17+ species)	Hora

Sumatra	(Borneo) Kalimantan	Java	Thailand
Keruing Lagan Merluang Damar ketjawai (21 species)	Keruing Keroeing Kruen (49 species)	Pahalar (5 species)	Yang

Malayan Peninsula	Keruing (*Dipterocarpus spp.*)
North Borneo	Kruen or Keruing (*Dipterocarpus spp.*)
Burma	Gurjun (*D. alatus*)
India	Gurjun (*Dipterocarpus spp.*)
Indonesia	Keroeing (*D. cornutus*)
Philippines	Apitong (*D. grandiflorus*)
Thailand	Yang (*D. alatus*)
Sabah	Keruing (*Dipterocarpus spp.*)
Sarawak	Keruing (*Dipterocarpus spp.*)
Vietnam, Cambodia	Dau (*Dipterocarpus spp.*)

Table 9. Specific Listing of Species

	Malay Peninsula	Philippines	Sabah	Sumatra	Java	(South Borneo) Kalimantan
1. *D. acutangulus*			X			
2. *D. appendiculatus*	X					
3. *D. applanatus*			X			
4. *D. apterus*	X			X		X
5. *D. balsamifera*					X	
6. *D. baudii*	X			X		
7. *D. caudiferus*			X			
8. *D. chartaceus*	X					
9. *D. concavus*	X					
10. *D. confertus*			X			
11. *D. conformis*			X			
12. *D. coriaceus*	X					X
13. *D. cornutus*	X					X
14. *D. costatus*	X					
15. *D. costulatus*		X		X		X
16. *D. crinitus*	X		X	X		X
17. *D. Dyeri*	X					
18. *D. exalatus*			X			
19. *D. fagineus*	X					X
20. *D. geniculatus*			X			
21. *D. globosus*			X			
22. *D. gracilis*	X		X	X	X	X
23. *D. grandiflorus*	X	X	X	X		X
24. *D. Hasseltii*	X				X	X
25. *D. humeratus*			X	X		
26. *D. kerrii*	X		X			
27. *D. kunstleri*	X			X		X
28. *D. lamellatus*			X			

Table 9. Continued

	Malay Peninsula	Philippines	Sabah	Sumatra	Java	(South Borneo) Kalimantan
29. *D. littoralis*					X	
30. *D. Lowii*	X		X			X
31. *D. oblongifolius*	X		X			X
32. *D. obtusifolius*	X					
33. *D. ochraceous*			X			
34. *D. pachyphyllus*			X			
35. *D. palembanicus*	X		X	X		
36. *D. penangianus*	X					
37. *D. pilosus*		X				
38. *D. polyspermus*		X				
39. *D. pseudo-fagineus*	X					
40. *D. pubescens*					X	
41. *D. retusus*	X				X	
42. *D. rigidus*	X					X
43. *D. rotundifolius*	X					
44. *D. semivestitus*	X					X
45. *D. stellatus*			X			
46. *D. sublamellatus*	X					
47. *D. tempehes*			X			
48. *D. trinervis*					X	
49. *D. verniciflorus*		X				
50. *D. verrucosus*	X		X			X
51. *D. warburgii*			X			

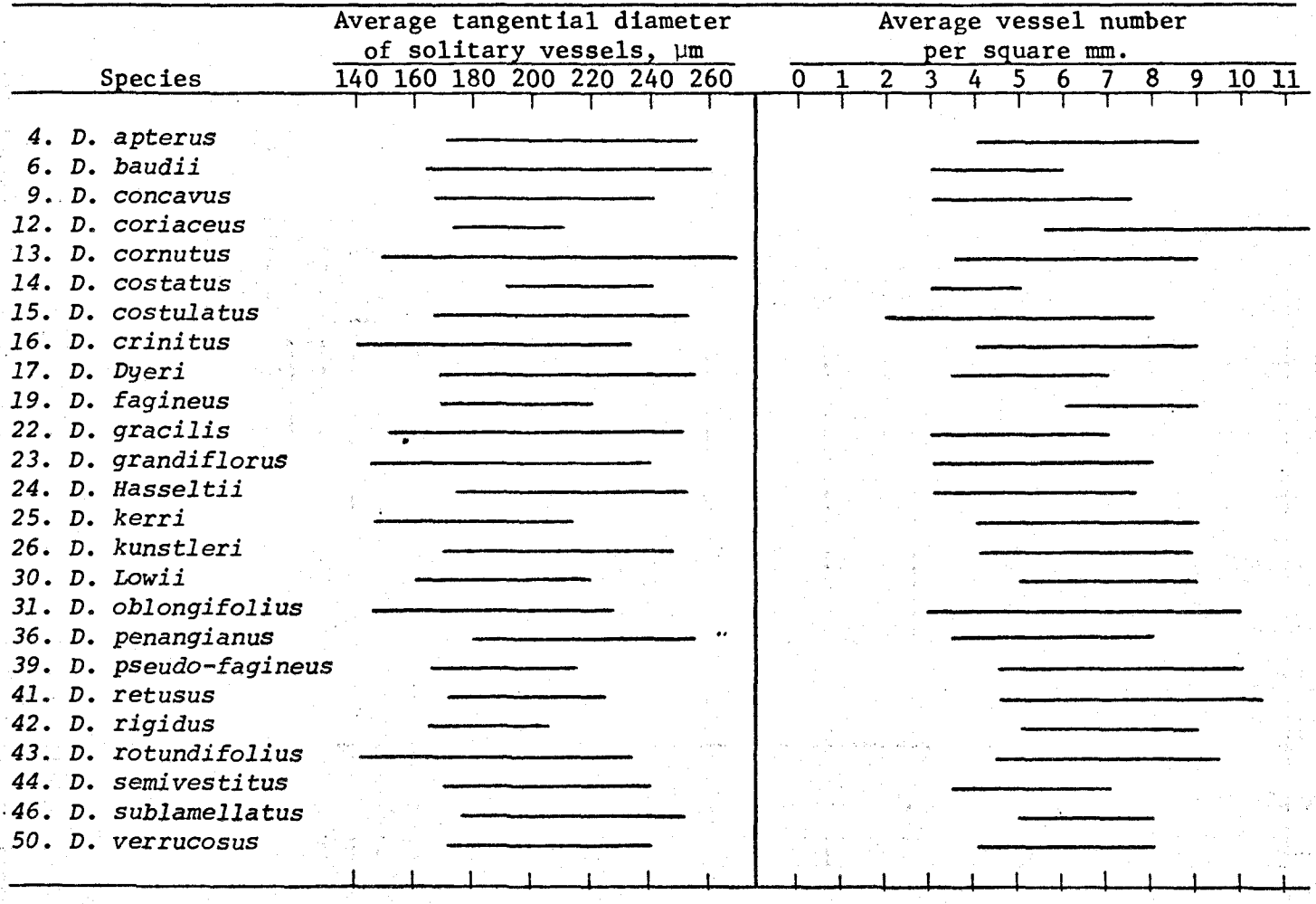
Table 10. Reported Air Dry Density of Keruing Species

Species	Number of samples	Weight per cubic foot at 15% moisture content	
		Range	Mean
24. D. Hasseltii	13	35.4-44.2	40
47. D. tempehes	1	---	40.1
51. D. warburgii	3	39.9-42.3	41.1
18. D. exalatus	1	---	41.6
7. D. caudiferus	6	36.8-54.0	41.8
12. D. coriaceus	10	37.2-46.9	42
3. D. applanatus	2	40.3-44.1	42.2
35. D. palembanicus	3	37.5-45.4	42.4
31. D. oblongifolius	9	39.5-45.6	43
26. D. kerrii	14	37.9-51.0	44
27. D. kunstleri	18	37.1-49.0	44
41. D. retusus	7	40.1-47.7	44
1. D. acutangulus	4	43.3-50.6	45.0
4. D. apterus	15	38.2-51.2	45
6. D. baudii	12	43.1-48.4	46
8. D. chartaceus	3	45.0-47.1	46
17. D. Dyeri	10	43.0-49.9	46
22. D. gracilis	9	43.8-54.4	47
32. D. obtusifolius	1	---	47
34. D. pachyphyllus	2	45.5-50.2	47.3
20. D. geniculatus	1	---	47.4
33. D. ochraceus	1	---	47.9
46. D. sublamellatus	8	42.2-52.8	48
13. D. cornutus	13	41.1-54.8	49
44. D. semivestitus	9	46.0-56.8	50
10. D. confertus	3	49.2-51.1	50.1
45. D. stellatus	2	47.7-54.5	51.1
23. D. grandiflorus	12	44.8-59.2	52
42. D. rigidus	6	45.2-56.0	52
50. D. verucosus	15	47.9-57.2	52
30. D. Lowii	16	43.9-58.6	53
14. D. costatus	5	52.6-55.8	54
39. D. pseudo-fagincus	12	49.3-61.0	54
9. D. concavus	14	48.7-59.2	55
15. D. costulatus	16	50.0-61.4	55
36. D. penangianus	8	46.6-60.9	55
19. D. fagineus	5	49.9-57.1	56
16. D. crinitus	25	50.3-65.7	57
28. D. lamellatus	1	---	57.8
43. D. rotundifolius	7	56.9-65.9	62

Table 11. Color of Heartwood in Keruing Woods

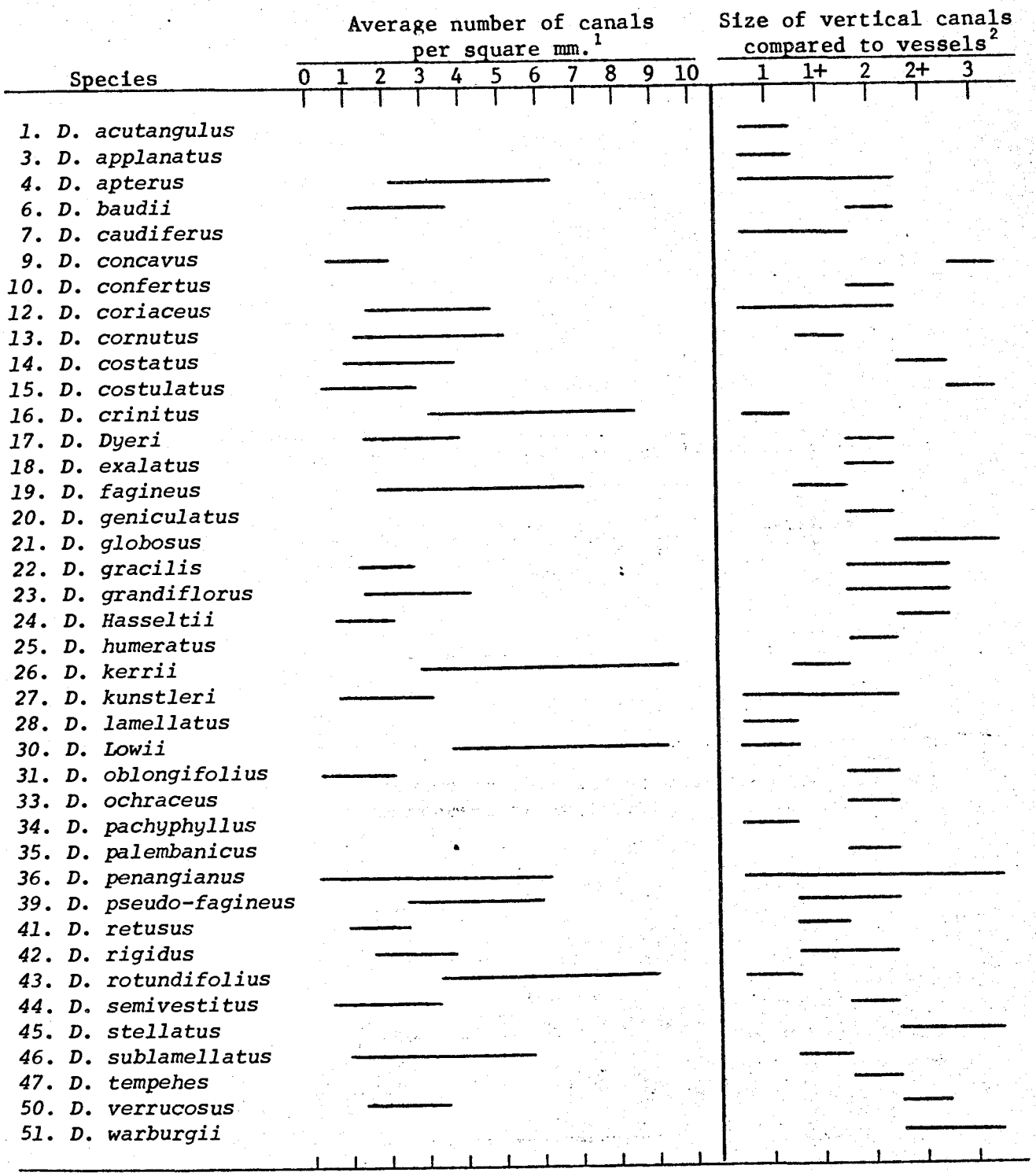
Species	Heartwood color
1. *D. acutangulus*	Light colored, pinkish
7. *D. caudiferus*	Light colored, pinkish
47. *D. tempehes*	Light colored, pinkish
51. *D. warburgii*	Light colored, pinkish to orange
6. *D. baudii*	Speckeled appearance of dark brown and red dots or lines
10. *D. confertus*	Dark colored, purplish
20. *D. geniculatus*	Dark colored, purplish
22. *D. gracilis*	Dark colored, purplish
23. *D. grandiflorus*	Dark colored, purplish
28. *D. lamellatus*	Dark colored, purplish
30. *D. Lowii*	Dark colored, purplish
33. *D. ochraceus*	Dark colored, purplish
34. *D. pachyphyllus*	Dark colored, purplish
35. *D. palembanicus*	Dark colored, purplish
45. *D. stellatus*	Dark colored, purplish

Table 12. Anatomical Measurements[1] of Vessels (Pores) in *Dipterocarpus spp.* (Keruing)



[1]The length of each line is 2 standard deviations from the average value, which is at the center of the line. The average value for a wood sample is first determined and then compared with these data.

Table 13. Anatomical Measurements of Resin Canals in *Dipterocarpus spp.* (Keruing)



[1]The length of each line is 2 standard deviations from the average value, which is at the center of the line. The average value for a wood sample is first determined and then compared with these data.

[2]1 = much smaller than the vessels; 2 = about 1/2 the size of the vessels; 3 = as large as the vessels; 1+, 2+ = intermediate between 1 and 2.

Table 14. Parenchyma Visible with Lens

Species	Paratracheal as incomplete borders around vessels	Apotracheal as ray to ray lines
6. *D. baudii*		X
10. *D. confertus*	X	X
17. *D. Dyeri*		X
23. *D. grandiflorus*	X	
31. *D. oblongifolius*	X	X
34. *D. pachyphyllus*	X	
41. *D. retusus*		X
51. *D. warburgii*	X	

All Sabah woods had been included in this investigation of parenchyma patterns. Not all Malaysian woods were included.

Table 15. Fiber Types and Parenchyma Patterns in *Dipterocarpus spp.* (Keruing)

Species	Fiber tracheids			Vascular tracheids	Parenchyma confined to vertical canals		Parenchyma other than in association with canals abundant		
	-	+	++	+	-	+	-	+	++
4. *D. apterus*	X	X		X	X		X		
6. *D. baudii*		X		X	X		X		
8. *D. chartaccus* (a)		X		X	X			X	
9. *D. concavus* (a)			X	X	X	X	X		
12. *D. coriaceus* (a)		X		X	X			X	
13. *D. cornutus*		X		X	X		X	X	
14. *D. costalus* (b)		X		X	X		X	X	
15. *D. costulatus*		X		X	X	X	X		
16. *D. crinitus*			X	X		X	X		
17. *D. Dyeri* (a)		X		X	X				X
19. *D. fagineus*			X	X	X	X	X		
22. *D. gracilis*		X		X	X			X	
23. *D. grandiflorus*	X	X		X	X		X	X	
24. *D. Hasseltii*	X	X	X	X				X	
26. *D. kerrii*	X	X		X	X	X	X		
27. *D. kunstleri*	X	X		X	X		X	X	
30. *D. Lowii*			X	X		X	X		
31. *D. oblongifolius*	X	X		X	X			X	
32. *D. obtusifolius* var. *subuudus* (b)			X	X	X			X	
36. *D. penangianus*		X		X	X		X	X	
39. *D. pseudo-fagincus*		X		X	X		X	X	
41. *D. retusus* (c)	X	X		X	X				X
42. *D. rigidus*		X		X	X		X	X	
43. *D. rotundifolius* (a)			X	X		X	X		
44. *D. semivestitus*	X	X		X	X			X	
46. *D. sublamellatus*	X	X		X	X		X	X	
50. *D. verrucosus*	X	X		X	X		X	X	

- = not present + = present, but not abundantly so ++ = abundant

Meranti (*Shorea, Parashorea* and *Pentacme spp.*)

Over 140 different species of wood could be included in these genera in Malaysia and the Philippines. Many species are quite similar in properties and a series of trade groups have been established. The names of similar trade groups of species for West Malaysia (Malay Peninsula), Sabah and the Philippines are listed in Table 16, along with air-dry density data for each group. Table 17 lists all species of these genera and indicates the trade group that each is associated with.

The previous identification key, beginning on page 9, has included characteristics to help differentiate one trade group of Merantis from another. Much of this differentiation is based on color and density, and further identification of species within a trade group becomes difficult. Some information on anatomical characteristics such as vessel (pore) diameters has been published, but variation within a single species usually is large and prevents the use of these data for positive species identification.

In PS 1-66 (Plywood Standards), the Lauans from the Philippines are subdivided into groups of species and single species, as shown on page 5 of this report. Two White Lauan species are listed individually, as well as White Lauan as a group. One Red Lauan is listed as a single species, and Red Lauan is also listed as a group. Yellow Lauan is not included. The inclusion of Meranti as a single group in the Plywood Standard implies that all species carrying this trade name would be accepted.

Some of the subdivision of the Lauans from the Philippines into single trade species probably results because species identification is often possible from information on the exact location where the trees were growing. Many of the commercial species listed in Table 17 for the Philippines are not listed as species occurring in Malaysia.

Table 16. Trade Groups for Species of *Shorea*, *Parashorea* and *Pentacme* and Their Reported Density Distribution

West Malaysia	Sabah	Philippines
Red Balau (1)[1] (56 lb/cu ft)	Red Selangan Batu (2) (50-55 lb/cu ft)	Red Lauan
Balau (15) (53-66 lb/cu ft)	Selangan Batu No. 1 (17) (55+ lb/cu ft)	Red Lauan
	Selangan Batu No. 2 (5+) (43-55 lb/cu ft)	Red Lauan
Dark Red Meranti (2) (41-55 lb/cu ft)	Obar Suluk (9) (40+ lb/cu ft)	Red Lauan
	Heavy Red Seraya (15) (40+ lb/cu ft)	Red Lauan
Light Red Meranti (18) (30-46 lb/cu ft)	Red Seraya (38) (18-40 lb/cu ft)	Red Lauan
White Meranti (11) (36-57 lb/cu ft)	White Seraya (2) (31-33 lb/cu ft)	White Lauan
	Melapi (7) (30-40 lb/cu ft)	White Lauan
Yellow Meranti (9) (36-46 lb/cu ft)	Yellow Seraya (10) (30-40 lb/cu ft)	Yellow Lauan

[1]The number in parentheses following the trade name is the number of tree species that are included in the trade group. The numbers in parentheses under the trade name are air-dry density values (15% moisture content), and a range of the published species averages are given.

Table 17. Wood Species of the Lauan, Meranti and Seraya

Shorea spp.	Philippines	West Malaysia	Sabah
S. acuminata		Light or Dark Red Meranti (1)[1]	
S. almon	White Lauan		Red Seraya
S. amplexicaulis			Red Seraya
S. andulensis			Red Seraya
S. asahi			Selagan Batu No. 1
S. atrinervosa		Balau	Selagan Batu No. 1&2
S. argentifolia			Obar Suluk
S. beccariana			Red Seraya[2]
S. biawak			Selagan Batu No. 1
S. ciliata		Balau	
S. collina		Balau	
S. coriacea			Heavy Red Seraya
S. cristata			Obar Suluk
S. curtisii		Dark Red Meranti (1)	Obar Suluk
S. dasyphylla		Light Red Meranti (1)	Red Seraya[2]
S. domatiosa			Selagan Batu No. 1
S. exelliptica			Selagan Batu No. 1
S. fallax			Red Seraya
S. ferruginea			Red Seraya
S. foxworthyi		Balau	Selagan Batu No. 1
S. glauca			Selagan Batu No. 1&2
S. glaucescens			Red Selagan Batu
S. guiso		Balau	Red Selagan Batu
S. gysbertsiana		Balau	Red Seraya
S. havilandii			Selagan Batu No. 1
S. hemsleyana		Dark Red Meranti (2)	
S. hypoleuca			Selagan Batu No. 1
S. inappendiculata			Selagan Batu No. 1&2
S. isoptera			Selagan Batu No. 1
S. johorensis		Light Red Meranti (1)	
S. kunstleri		Red Balau (3)	Red Selagan Batu
S. laevis		Balau	Selagan Batu No. 1
S. lepidota		Light Red Meranti (1)	
S. leprosula		Light Red Meranti (1)	Red Seraya[2]

Table 17. Continued

Shorea spp.	Philippines	West Malaysia	Sabah
S. leptoclados		Light Red Meranti (1)	Red Seraya[2]
S. leptoderma			Selagan Batu No. 1
S. lumutensis		Balau	
S. macrantha		Dark Red Meranti	
S. macroptera		Light Red Meranti (1)	Red Seraya
S. materialis		Balau	
S. maxwelliana		Balau	Selagan Batu No. 1
S. meadiana		Balau	
S. mecistopteryx			Red Seraya[2]
S. monticola			Obar Suluk
S. myronerva			Red Seraya
S. nebulosa			Red Seraya
S. negrosensis	Red Lauan		
S. obscura			Selagan Batu No. 1
S. ochrophloia		Balau	
S. oleosa			Red Seraya[2]
S. ovalis		Light Red Meranti (1)	Red Seraya[2]
S. ovata		Dark Red Meranti (1)	Obar Suluk
S. palembanica		Light Red Meranti (1)	
S. parvifolia		Light Red Meranti (1)	Red Seraya[2]
S. parvistipulata			Red Seraya
S. pauciflora		Dark Red Meranti (1)	Obar Suluk
S. pilosa			Red Seraya
S. pinanga			Red Seraya
S. platycarpa		Light Red Meranti (1)	Heavy Red Seraya
S. platyclados		Dark Red Meranti (1)	Obar Suluk
S. polysperma	Red Lauan		
S. quadrinervis			Red Seraya[2]
S. retusa			Red Seraya
S. revaluta			Red Seraya
S. rubella			Red Seraya[2]
S. rubra			Obar Suluk
S. rugosa		Dark Red Meranti (1)	Heavy Red Seraya
S. scaberrima			Red Seraya[2]

Table 17. Continued

Shorea spp.	Philippines	West Malaysia	Sabah
S. scabrida			Red Seraya[2]
S. seminis			Selagan Batu No. 1&2
S. singkawang		Dark Red Meranti (1)	
S. slootenii			Red Seraya
S. smithiana			Red Seraya[2]
S. squamata	Red/White Lauan		
S. submontana		Balau	
S. sumatrana		Balau	
S. superba			Selagan Batu No. 1&2
S. teysmanniana		Light Red Meranti (1)	Red Seraya[2]
S. acuminatissima			Yellow Seraya
S. augustifolia			Yellow Seraya
S. blanocarpoides		Yellow Meranti	
S. blumutensis		Yellow Meranti	
S. faguetiana		Yellow Meranti	Yellow Seraya
S. gibbosa		Yellow Meranti	Yellow Seraya
S. hopeifolia		Yellow Meranti	Yellow Seraya
S. kalunti	Yellow Lauan		
S. kudatensis			Yellow Seraya
S. laxa			Yellow Seraya
S. maxima		Yellow Meranti	
S. multiflora		Yellow Meranti	Yellow Seraya
S. patoiensis			Yellow Seraya
S. peltata		Yellow Meranti	
S. resina-nigra		Yellow Meranti	
S. xanthoplylla			Yellow Seraya
S. agami			Melapi
S. assamica	Yellow Lauan	White Meranti	
S. bentongensis		White Meranti	
S. bracteolata		White Meranti	Melapi
S. dealbata		White Meranti	
S. gratissima		White Meranti	Melapi
S. hypochra		White Meranti	
S. lamellata		White Meranti	Melapi

Table 17. Continued

Shorea spp.	Philippines	West Malaysia	Sabah
S. ochracea			Melapi
S. resinosa		White Meranti	
S. sericeiflora		White Meranti	
S. symingtonii			Melapi
S. talura		White Meranti	
S. virescens			Melapi
Parashorea spp.			
P. densiflora		Red Meranti	
P. globosa		Red Meranti	
P. lucida		Red Meranti	
P. malaanonan			White Seraya
P. parvifolia			Heavy White Seraya
P. plicata	White Lauan		
P. smythiesii			Heavy White Seraya
P. tomentella			White Seraya
Pentacme spp.			
P. contorta	White Lauan		
P. mindanensis	White Lauan		
P. siamensis		Red Meranti	

[1]The number in parentheses is the subgroup number under "Red Meranti".

[2]Some wood from this species will be in a different group because of density.

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2. Dipterocarp Timbers of the Malay Peninsula (Malayan Forest Records No. 14) by H. E. Desch. Forest Research Institute, Kepong. 1941. 171 pages.

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4. Forests of Southeast Asia by R. C. Stadelman, Memphis, Tennessee. (Self-published book). 1966. 245 pages.

5. Veneer species of the World - An Interim Report of the International Union of Forestry Research Organizations. Printed by Forest Products Laboratory, Madison, Wisconsin. 1973. 150 pages.

Table 18. Properties of Light Meranti Veneers

Sample number	Extractive content, based on original dry weight					pH	Specific gravity
	Benzene	Ether	Ethanol	Water	Total		
142	2.66	1.93	14.02	1.47	20.08	3.49	0.35
320*	2.93	3.09	9.22	2.84	18.08	3.54	--
43*	1.70	3.36	11.36	1.04	17.46	3.48	--
143	1.36	1.83	12.70	1.40	17.29	3.57	0.44
147	2.27	2.03	11.55	1.13	16.98	3.43	0.45
49*	1.38	2.27	11.79	1.40	16.84	3.50	--
52*	1.50	2.57	10.90	1.07	16.04	3.49	--
146	1.82	1.43	11.23	1.36	15.84	3.50	0.39
47*	0.94	2.43	10.69	1.69	15.75	3.92	--
144	1.16	1.72	10.88	1.19	14.95	3.52	0.43
321*	1.33	0.73	9.75	1.86	13.67	3.50	--
148	1.08	1.35	9.75	1.29	13.47	3.42	0.45
145	0.90	1.20	9.54	1.44	13.08	3.53	0.43
149	1.48	1.05	9.15	1.40	13.08	3.46	0.41
Avg.**	1.61 ±0.36	1.93 ±0.44	10.90 ±0.79	1.47 ±0.26	15.90 ±1.19	3.53 ±0.07	0.42 ±0.03
183	2.04	0.09	2.08	1.69	5.90	4.58	0.45
203	1.83	0.11	2.05	1.83	5.82	4.54	0.56
187	1.80	0.14	1.82	1.99	5.75	4.75	0.53
195	0.70	0.09	1.88	2.59	5.26	4.63	0.39
316*	0.42	0.61	2.85	1.17	5.05	4.25	--
193	1.75	0.12	1.53	1.54	4.94	4.72	0.55
186	2.11	0.09	1.15	1.38	4.73	5.11	0.44
317*	0.31	0.28	3.26	0.65	4.51	3.92	--
318*	0.30	0.32	2.88	0.85	4.35	4.56	--
319*	0.63	0.25	2.36	0.55	3.79	4.30	--
205	1.23	0.11	1.06	0.73	3.13	4.15	0.39
Avg.**	1.19 ±0.49	0.20 ±0.10	2.08 ±0.47	1.36 ±0.43	4.84 ±0.56	4.50 ±0.22	0.47 ±0.07

*Airdried samples; all other samples were dried in a commercial veneer dryer.

**Arithmetic average ±95% confidence limits.

Table 19. Properties of Dark Meranti Veneers

Sample number	Extractive content, based on original dry weight					pH	Specific gravity
	Benzene	Ether	Ethanol	Water	Total		
190	1.86	0.07	4.73	4.29	10.95	4.80	0.38
198	0.92	0.80	7.98	1.08	10.78	3.75	0.51
180	0.43	0.07	2.14	8.11	10.75	4.71	0.45
67*	1.61	0.48	6.47	2.11	10.67	3.68	--
197	1.20	0.49	6.62	2.33	10.64	4.03	0.50
178	0.66	0.63	7.16	1.25	9.70	3.38	0.47
202	1.29	0.35	5.96	1.97	9.57	3.52	0.49
182	1.71	0.66	4.37	2.22	8.96	3.70	0.49
199	1.45	0.30	3.13	1.86	6.74	3.61	0.55
74*	1.15	0.58	3.04	1.65	6.42	3.70	--
88	1.12	0.30	2.77	0.96	5.15	3.87	0.48
420*	1.82	0.56	0.87	1.82	5.07	4.90	--
87	1.57	0.25	2.12	1.12	5.06	3.74	0.47
417*	1.35	0.59	1.73	1.27	4.94	3.69	--
201	1.69	0.82	1.76	0.53	4.80	4.52	0.36
421*	2.21	0.46	1.06	1.06	4.79	3.62	--
69*	1.60	0.31	1.44	1.27	4.62	4.19	--
92	1.33	0.20	1.34	1.68	4.55	3.76	0.49
419*	1.40	0.32	1.58	0.77	4.07	3.57	--
90	1.43	0.16	1.26	0.89	3.74	3.71	0.49
196	1.02	0.16	1.20	1.00	3.38	4.75	0.41
416*	0.87	0.24	1.06	0.95	3.12	3.75	--
422*	1.57	0.23	0.58	0.69	3.07	4.65	--
184	1.03	0.08	0.79	0.68	2.58	3.66	0.40
418*	0.73	0.12	0.84	0.84	2.53	3.70	--
Avg.**	1.32 ±0.17	0.37 ±0.09	2.88 ±0.94	1.70 ±0.64	6.27 ±1.23	3.96 ±0.19	0.46 ±0.03

*Airdried samples; all other samples were dried in a commercial veneer dryer.

**Arithmetic average ±95% confidence limits.

Table 20. Properties of Keruing Veneers

Sample number	Extractive content, based on original dry weight					pH	Specific gravity
	Benzene	Ether	Ethanol	Water	Total		
169	1.06	0.18	6.22	3.24	10.70	4.84	0.57
522*	0.85	1.46	3.64	2.61	8.56	5.56	--
521*	0.67	0.16	4.64	2.54	8.01	5.57	--
520*	0.51	0.11	2.42	4.24	7.28	5.80	--
82*	0.94	0.17	4.03	1.96	7.10	4.32	--
167	0.84	0.22	4.75	1.21	7.02	4.00	0.77
171	1.19	0.15	3.12	2.36	6.82	4.48	0.68
162	0.93	0.21	4.03	1.42	6.59	4.18	0.61
77*	0.88	0.31	3.25	2.09	6.53	4.30	--
117	0.44	0.15	2.76	3.04	6.39	5.08	0.65
519*	1.82	0.16	3.61	0.56	6.15	5.82	--
163	1.06	0.14	3.57	1.09	5.86	4.22	0.66
517*	0.81	0.13	3.27	1.16	5.37	5.19	--
166	1.32	0.12	2.14	0.87	4.45	4.38	0.68
79*	0.95	0.13	1.84	1.15	4.07	4.32	--
168	0.65	0.10	0.96	2.09	3.80	4.93	0.71
170	0.54	0.11	1.42	1.67	3.74	5.00	0.70
164	0.99	0.13	1.54	0.78	3.44	4.00	0.70
20	0.86	0.75	1.16	0.67	3.44	4.21	0.69
518*	0.90	0.08	1.13	1.29	3.40	5.05	--
516*	0.76	0.13	1.11	0.81	2.81	5.32	--
165	0.89	0.10	1.16	0.63	2.78	4.25	0.69
102	0.48	0.09	1.08	0.92	2.57	4.42	0.67
95	0.78	0.22	0.91	0.56	2.47	4.21	0.67
98	0.64	0.12	1.03	0.49	2.28	4.03	0.64
Avg.**	0.87 ±0.12	0.23 ±0.12	2.59 ±0.61	1.58 ±0.41	5.26 ±0.92	4.70 ±0.24	0.67 ±0.03

*Airdried samples; all other samples were dried in a commercial veneer dryer.

**Arithmetic average ±95% confidence limits.

Table 21. Properties of Kapur Veneers

Sample number	Extractive content, based on original dry weight					pH	Specific gravity
	Benzene	Ether	Ethanol	Water	Total		
130	2.67	0.10	10.97	1.91	15.65	3.94	0.67
19	1.08	0.32	11.87	2.23	15.50	3.43	--
176	0.46	0.15	11.57	2.44	14.62	3.52	0.78
177	0.46	0.16	10.31	3.36	14.29	3.52	--
58*	0.70	0.25	10.99	1.49	13.43	3.63	--
18	1.58	0.28	9.19	1.94	12.99	3.58	0.74
60*	0.48	0.17	10.46	1.80	12.91	3.89	--
126	3.64	0.12	6.95	2.18	12.89	3.62	0.68
59*	0.31	0.12	8.06	3.36	11.85	3.65	--
57*	0.61	0.17	9.31	1.70	11.79	3.69	--
21	0.51	0.19	7.01	2.99	10.70	3.68	0.63
17	0.73	0.01	6.54	3.33	10.61	3.71	0.65
129	1.22	0.12	6.14	3.01	10.49	3.63	0.72
128	0.56	0.11	6.65	2.50	9.82	3.64	0.70
609*	0.44	0.08	3.54	5.58	9.64	4.73	--
121	0.27	0.11	6.62	2.53	9.53	3.63	0.67
125	0.31	0.11	7.26	1.61	9.29	3.65	0.68
123	0.34	0.10	5.73	2.91	9.08	3.58	0.70
122	0.68	0.09	5.27	2.87	8.91	3.62	0.78
610*	0.42	0.07	2.20	6.11	8.80	4.50	--
207	0.45	0.14	4.66	3.07	8.32	3.58	--
22	0.81	0.37	5.41	1.72	8.31	3.60	0.61
612*	0.45	0.07	4.52	2.83	7.87	5.28	--
16	0.37	0.34	4.36	2.05	7.12	3.71	0.61
613*	0.60	0.06	1.34	5.11	7.11	5.78	--
174	0.34	0.11	3.87	2.04	6.36	3.50	--
172	0.38	0.12	3.70	1.76	5.96	3.72	--
611*	0.60	0.06	1.80	3.36	5.82	5.98	--
175	0.22	0.10	3.74	1.75	5.81	3.58	0.66
173	0.29	0.07	3.23	2.12	5.71	3.61	--
614*	0.61	0.07	0.96	3.00	4.64	5.90	--
Avg.**	0.73 ±0.26	0.14 ±0.03	6.26 ±1.15	2.73 ±0.41	9.87 ±1.14	3.97 ±0.27	0.69 ±0.03

*Airdried samples; all other samples were dried in a commercial veneer dryer.

**Arithmetic average ±95% confidence limits.