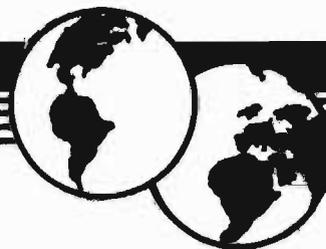


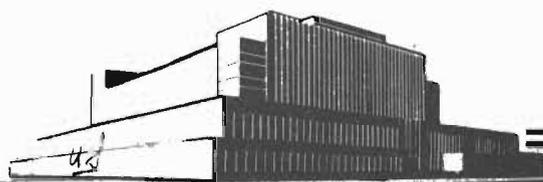
FOREIGN WOOD SERIES



CHARACTERISTICS OF SOME IMPORTED WOODS

April 1962

No. 2242



FOREST PRODUCTS LABORATORY
MADISON 5, WISCONSIN

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

In Cooperation with the University of Wisconsin

CHARACTERISTICS OF SOME IMPORTED WOODS

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Abstract

The gross features, shrinkage, mechanical properties and uses of 91 botanical species imported into the United States are described. These are listed alphabetically under 58 common or trade names.

Introduction

Each year the U. S. Forest Products Laboratory receives many requests for information regarding the properties of imported woods. To fulfill the majority of these requests, this publication has brought together the most recent information from authoritative sources throughout the world as well as that developed at the Laboratory. This report does not purport to be a compendium of all of the woods that have been at one time or another imported into the United States. Only those species about which repeated inquiries have been received were included. Many of the species listed have been known in the trade for many years and a few are relatively recent introductions.

Text information is necessarily brief but, when used in conjunction with the shrinkage and strength tables, a reasonably good picture may be obtained of a particular wood. In many instances, descriptions of individual woods refer to other sources of information that contain more details as well as colored illustrations. The publications in the "References" also contain information on many species not described here.

¹—Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

Those interested in kiln drying schedules for imported woods should consult a "Handbook of Hardwoods" (4)² or the March 1961 Forest Products Research Society News-Digest (23), for the British and suggested United States schedules.

An index of the common names used here is listed in the back of the report.

Descriptions of Woods

Alerce (*Fitzroya cupressoides* [Molina] Johnston)

Alerce is a softwood or conifer that is native to southern Chile. The heartwood is reddish brown in color, deepening on exposure to air, to a red, often with alternate light and dark streaks. The grain is straight, and the wood is very fine textured and uniform. The wood is fairly light and soft, weighing about 26 pounds per cubic foot in the air-dry condition. Its local reputation for durability is unexcelled, and it is regarded as the finest wood of Chile. Alerce is similar in many respects to redwood (*Sequoia sempervirens*).

Forest Products Laboratory Report No. 1982 (53) has additional information about alerce.

Angelique (*Dicorynia guianensis* Amsh.)

Angelique, or basra locus, occurs in French Guiana and Surinam. This species was previously identified under the name *Dicorynia paraensis* Benth., which is native to the Amazon region, and does not occur in French Guiana or Surinam. Most of the published literature with regard to angelique will be found under the incorrectly applied name of *D. paraensis*.

Because of the variability in heartwood color between different trees, two forms are commonly recognized by producers. Heartwood that is russet colored when freshly cut and becomes superficially dull brown with a purplish cast is referred to as angelique gris. Heartwood that is more distinctly reddish and frequently shows wide bands of purplish color is called angelique rouge.

The texture is about equal to that of limba and somewhat coarser than that of black walnut. The grain is generally straight or slightly interlocked. In strength, angelique is superior to teak and white oak, when either green or air dry, in all properties except tension perpendicular to grain. Angelique

²Underlined numbers in parentheses refer to "References" at the end of the report.

is rated as highly resistant to decay, marine borers, and termites. Machining properties vary and may be due to differences in density, moisture content, and silica content. After the wood is thoroughly air dried or kiln dried, it can be worked effectively only with carbide-tipped tools.

The strength and durability of angelique make it especially suitable for heavy construction, harbor installations, bridges, heavy planking for pier and platform decking, and railroad bridge ties. The heartwood is particularly suitable for ship decking, planking, boat frames, and underwater members. It is currently being used in the United States for pier and dock fenders and flooring.

For detailed information on angelique see Forest Products Laboratory Report No. 1787 (38).

Apitong (Dipterocarpus spp.)

Apitong is the most common structural timber of the Philippine Islands and comprises approximately 20 percent of the standing timber. The principal species are apitong (Dipterocarpus grandiflorus Blanco), panau (D. gracilis Blume), and hagakhak (D. warburgii Brandis). All members of the genus are timber trees, and all are marketed under the name apitong.

The wood is light to dark reddish brown in color, comparatively coarse to comparatively fine textured, straight grained or very nearly so, strong, hard, and heavy. The wood is characterized by the presence of resin ducts, which occur in short arcs as seen from end grain surfaces.

Although the heartwood is fairly resistant to decay and insect attack, the wood should be treated with preservatives when it is to be used in contact with the ground.

In machining research at the Forest Products Laboratory on apitong and the various species of "Philippine mahogany," apitong ranked appreciably above the average in all machining operations.

Apitong is used for heavy-duty purposes as well as for such items as mine guides, truck floors, chutes, flumes, agitators, pallets, and board walks.

Keruing is the name applied to a number of species of Dipterocarpus originating in Malaya, Sarawak, and North Borneo. The properties of the wood are generally similar to those of apitong, but the characteristic exudation of resin seems more prevalent in the timber shipped under the name keruing. With care in selection, however, keruing can be recognized and its use avoided for such purposes where the exudation of resin may be objectionable.

For additional information consult references (1), (4), and (48).

Avodire (*Turraeanthus africanus* [Welw. ex C. DC.] Pellegr.)

Avodire is widely distributed in tropical West Africa and the Belgian Congo. It is a medium-sized tree of the rain forest in which it forms fairly dense but localized and discontinuous stands.

The wood is cream to pale yellow in color with a high natural luster and eventually darkens to a golden yellow. The grain is sometimes straight but more often is wavy or irregularly interlocked, which produces an unusual and attractive mottled figure when sliced or cut on the quarter.

Although its weight is only 85 percent that of English oak, avodire has almost identical strength properties except for shock resistance and in shear, where English oak has superior values. The wood works fairly easily with hand and machine tools and finishes well in most operations.

Figured material is usually converted into veneer for use in decorative work and it is this kind of material that is chiefly imported into the United States.

Forest Products Laboratory Report No. 1905 (31) may be consulted for further information as well as references (4) and (46). A color plate may be seen in reference (17).

Balsa (*Ochroma lagopus* Sw.)

Balsa is widely distributed throughout tropical America from southern Mexico to southern Brazil and Bolivia, but Ecuador has been the principal area of growth since the wood gained commercial importance.

Balsa possesses several characteristics that make possible a wide variety of uses. It is the lightest and softest of all woods on the market. The lumber when dry weighs on the average of about 11 pounds per cubic foot and often as little as 6 pounds. Because of its light weight and exceedingly porous composition, balsa is highly efficient in uses where buoyancy, insulation against heat and cold, or absorption of sound and vibration are important considerations.

The wood is readily recognized by its light weight, white to very pale gray color, and its unique "velvety" feel.

The principal uses of balsa are in life-saving equipment, floats, rafts, core stock, insulation, cushioning, sound modifiers, models, and novelties. Balsa is imported at the rate of 12 to 15 million board feet annually and is imported in larger volume than most of the foreign woods entering the United States.

Additional information will be found in the Forest Service Foreign Woods Leaflet on balsa (7). A color photograph of balsa may be seen in reference (18). Detailed information on the mechanical properties is available in Forest Products Laboratory Report No. 1511 (55).

Banak (*Viola* spp.)

More than 40 species of *Viola* occur in tropical America, but only 3 species supply the bulk of the timber known as banak. These are: *V. koschnyi* Warb. of Central America, and *V. surinamensis* (Rol.) Warb. and *V. sebifera* Aubl. of northern South America.

The heartwood is usually pinkish brown or grayish brown in color and is not differentiated from the sapwood. The wood is straight grained and is of a medium to coarse texture.

The various species are nonresistant to decay and insect attack but can be readily treated with preservatives. Their machining properties are very good.

Banak is considered as a general utility wood in both lumber and plywood form.

For more information on banak consult references (2), (17), and (52).

Boxwood, Maracaibo (*Gossypiospermum praecox* [Gris.] P. Wilson)

Maracaibo boxwood, Venezuelan boxwood, or West Indian boxwood, is a small- to medium-sized tree native to Dominican Republic, Cuba, the Maracaibo Lake region of Venezuela, and eastern Colombia. The timber found in the United States markets is almost exclusively of Venezuelan origin with occasional small lots from Cuba.

The wood is lemon yellow to nearly white in color, with a very fine and uniform texture. Its grain is generally straight, it is easy to carve and turn, and finishes very smoothly with a high natural polish. The wood is hard and heavy weighing between 50 to 56 pounds per cubic foot air dry.

This species is by far the most important boxwood commercially, and it has very largely replaced Turkish boxwood (*Buxus sempervirens* L.) for all purposes except the finest engraving blocks. The principal use of the wood is for the manufacture of precision rules. Other uses include engravers blocks, carving, and turning.

A color illustration may be seen in reference (17).

Bubinga (Guibourtia spp.)

The timbers of Guibourtia demeusei (Harms) J. Leonard, G. pellegriniana J. Leonard, and G. tessmannii (Harms) J. Leonard are similar in general character and are known as bubinga in the Cameroons and kevazingo in Gabon in French Equatorial Africa. The standard British name for the timber of all three species is bubinga. These are large trees, commonly exceeding 100 feet in height with clear boles 30 to 60 feet long and 3 to 5 feet in diameter. Their distributions overlap, but G. tessmannii is reported to be most common in the Cameroons and is the principal source of the local bubinga, while G. pellegriniana is the most common in Gabon and is the principal source of kevazingo. G. demeusei is widely distributed from southeastern Nigeria through the Cameroons, Gabon, and the Congo region.

Bubinga when freshly cut is red to reddish brown with purple veining, but, on exposure to air, becomes yellow or medium brown with a pronounced pinkish or reddish tint. The veining then becomes less conspicuous and the timber bears a superficial resemblance to some types of rosewood. The grain is usually straight or interlocked but in some logs is very irregular and wild, which gives highly figured veneers when rotary cut. Highly figured wood is considered to be more common in the timber from Gabon (shipped as kevazingo) than in the timber from the Cameroons, and there is a tendency in some quarters to use the name kevazingo for the highly figured timber irrespective of its origin.

Although moderately hard and heavy, the timber is reported to saw without difficulty and takes a fine polish. It is used mostly in the form of veneer for decorative paneling and inlay work although it offers possibilities for high-class furniture and fancy turnery work.

References to bubinga and kevazingo in the older literature use the generic names Brachystegia, Didelotia, Copaifera, and Macrolobium.

Although benge (Guibourtia arnoldiana [DeWild. & Th. Dur.] Leonard) belongs to the same botanical genus as bubinga, benge is finer textured and differs rather markedly with respect to color. The heartwood of benge is yellow brown to medium brown with gray or almost-black stripes. This species is as yet little known in the United States, and its properties have not been investigated. The wood is fairly hard and heavy but appears to machine and veneer rather well. Because of the fine texture of the wood, fillers are not required for finishing.

The wood has been used for furniture, paneling, and in the manufacture of high-quality decorative articles.

This species is of West African origin.

Cativo (*Prioria copaifera* Gris.)

Cativo is one of the few tropical American species that occur in abundance and often in nearly pure stands. Commerical stands are found in Nicaragua, Costa Rica, Panama, and Colombia. The sapwood is usually thick, and in trees up to 30 inches in diameter the heartwood may be only 7 inches in diameter. The sapwood that is utilized commercially may be a very pale-pinkish color or may be distinctly reddish. The grain is straight and the texture of the wood is uniform, comparable to that of mahogany. Figure on flat-sawn surfaces is rather subdued and results from the exposure of the narrow bands of parenchyma tissue. Odor and taste are not distinctive, and the luster is low.

The wood can be seasoned rapidly and easily with very little degrade. The dimensional stability of the wood is very good; it is practically equal to that of mahogany. Cativo is classed as a nondurable wood with respect to decay and insects. Cativo may contain appreciable quantities of gum, which may interfere with finishes. In wood that has been properly seasoned, however, the gum presents no difficulties.

Cativo has come into extensive use in the United States only in recent years. The tendency of the wood to bleed in use and the warping of narrow cuttings kept this species in disfavor for many years. Improved drying and finishing techniques have materially reduced the prominence of these inherent characteristics, and the uses for this wood are rapidly increasing. Considerable quantities are used for interior trim, and resin-stabilized veneer has become an important pattern material, particularly in the automotive industry. Cativo is widely used for furniture and cabinet parts, lumber core for plywood, picture frames, edge banding for doors, and bases for piano keyboards.

In 1958 an estimated 20,000,000 board feet of cativo was imported into the United States.

For detailed information on cativo see Forest Products Laboratory Report No. 1998 (41).

Ceiba (Ceiba pentandra [L.] Gaertn.)

Wood of this species from tropical America enters the United States under the name ceiba, and that originating in the Congo is known as fuma.

The wood is white or grayish, very soft and light, weighing about 25 pounds per cubic foot air dry. The wood is coarse textured and has a dull luster. The wood is nondurable; hence, it is best suited for interior use. This tree produces the kapok used commercially, and the wood is used as core stock material.

Additional information may be found in reference (50).

Corisa (Chorisia insignis HBK)

Corisa is a very large tree found in the Peruvian-Amazon region, where it is known as lupuna. The wood is white or grayish to very pale reddish, very soft and light, weighing about 25 pounds per cubic foot air dry. The wood is coarse textured and has a dull luster. The wood is nondurable with respect to decay and insect attack. The wood is almost identical with that of Ceiba.

The wood is available in large sizes, and its low density combined with a rather high degree of dimensional stability make it ideally suited for pattern and core stock.

For more information on corisa, consult Forest Products Laboratory Report No. 1996 (35). The mechanical properties have not been investigated. There is still some doubt as to the exact botanical identity of this tree.

Crabwood (Carapa guianensis Aubl.)

Because of the widespread distribution of crabwood in tropical America, the wood is known under a variety of names that include cedro macho, bateo, carapa, andiroba, and tangare. These names are also applied to the related species Carapa nicaraguensis, whose properties are generally inferior to those of C. guianensis. Attempts to establish a regular market for crabwood in the United States have not been successful, which perhaps was due to the fact that shipments may have consisted of both species or entirely of C. nicaraguensis, the less desirable wood.

The heartwood color varies from reddish brown to dark reddish brown. The texture (size of pores) is like that of mahogany (Swietenia). The grain is usually interlocked but is rated as easy to work, paint, and glue. The wood

is rated as durable to very durable with respect to decay and insects. Crabwood is heavier than mahogany and accordingly is markedly superior in all static bending properties, compression parallel to the grain, hardness, shear, and toughness.

On the basis of its properties, crabwood appears to be suited for such uses as flooring, frame construction in the tropics, furniture and cabinet work, millwork, and utility and decorative veneer and plywood.

For more information on crabwood, consult Forest Products Laboratory Report No. 1991 (33). A color illustration of this species appears in reference (18).

Ebony (Diospyros spp.)

The true ebony of the trade is the product of a number of species belonging to the genus Diospyros. Numerous species are recognized, which are widely distributed throughout the tropics of the world. Many of these have overlapping ranges and are very similar botanically. In a few instances, the botanical source of the commercial ebony is known with certainty and the wood can be definitely stated to be the product of a given species. The identity of the great majority, however, is still in doubt, and it is the practice to apply adjective modifications that indicate the geographical source of the timber, such as Indian ebony, Ceylon ebony, and Gabon ebony. The ebony woods are also classified into two distinct color groups: Black ebony includes woods of a uniform black color; whereas streaked ebony woods, as the term implies, are striated with darker and lighter zones. D. ebenum Koen. produces a uniformly black heartwood and D. crassiflora Hiern, and D. piscatoria Gurke are African species reputed to produce a similar wood. D. celebica Bakh. (Macassar ebony) and D. marmorata Park. (Andaman marblewood) have a pale to medium brown heartwood streaked or mottled with black.

The heartwood is extremely hard, heavy, and difficult to work. The black ebony woods weigh about 73 pounds per cubic foot seasoned, while the streaked ebony woods weigh about 63 pounds per cubic foot in the seasoned condition.

A color illustration of D. celebica (Macassar) appears in reference (17) and D. marmorata in reference (18).

Emeri (*Terminalia ivorensis*) A. Chev.

Emeri is a West African species that is also referred to in the trade as idigbo, framire, afara, and ireme.

The heartwood is pale yellow to a light brown in color, showing relatively little contrast between sapwood and heartwood. The texture is somewhat coarse and uneven, and the grain may vary from straight to rather wavy. Longitudinal surfaces exhibit a slight satiny luster. The wood is soft to medium hard and weighs about 35 pounds per cubic foot in the air-dry condition. Emeri machines easily and takes glues and finishes readily.

This wood falls into the "blond wood" category and is used for decorative veneer, paneling, and furniture.

The related limba (*Terminalia superba*) is lighter colored and somewhat coarser textured than emeri.

More detailed information may be found in reference (4) and a color plate in reference (17).

Greenheart (*Ocotea rodiaei* [Schomb.] Mez.)

Greenheart is essentially a British Guiana tree although small stands also occur in Surinam. The heartwood varies in color from light to dark olive green or nearly black. The texture is fine and uniform.

Greenheart is stronger and stiffer than white oak and generally more difficult to work with tools. The heartwood is rated as very resistant to decay and termites. It also is very resistant to marine borers in temperate waters but much less so in warm tropical waters.

Greenheart is used principally where strength and resistance to wear are required and include ship and dock building, lock gates, wharves, piers, jetties, engine bearers, planking, flooring, bridges, and trestles.

For additional information, consult the Forest Service Foreign Woods Leaflet on greenheart (10). See also references (4) and (42). A color plate appears in reference (17).

Guanacaste (*Enterolobium cyclocarpum* [Jacq.] Gris.)

Guanacaste is a Central American species that also enters commercial channels under the names jenisero and kelobra. The heartwood generally dries

various shades of brown and sometimes approaches the color of black walnut. The texture is coarse.

The wood is rated only fair with respect to durability, insects, and decay. The wood varies considerably in weight but is comparatively easy to work. The dry wood is without odor; the pungent dust arising from machining operations, however, produces allergic responses in certain individuals. The wood is used for paneling, interior trim, furniture, and cabinet work.

Imbuia (*Phoebe porosa* [Nees & Mart.] Mez)

Although there are a large number of species in the genus Phoebe, the only commercially important one is imbuia from the Araucaria forests of Parana and Santa Catharina, Brazil.

The heartwood color is quite variable and ranges from yellowish to olive or a rich chocolate brown, which may be plain or markedly variegated. The wood has a rather fine texture and medium luster. The freshly cut wood has a spicy odor, but this is generally absent in dried material.

The wood is moderately hard and heavy and is considered easy to dry, work, and glue. It is used in the solid veneer form for decorative purposes.

For other uses, see Forest Products Laboratory Report No. 1924 (26).

Iroko (*Chlorophora excelsa* [Welw.] Benth.)

Iroko is a large tree widely distributed in tropical Africa. The heartwood varies from light to greenish yellow with occasional darker streaks. Upon exposure to light and air, it darkens to various shades of brown. The wood is without odor or taste but may have a slightly oily or waxy feel. The grain is interlocked and the texture is coarse.

The heartwood is very resistant to decay and resistant but not immune to termite attack and marine borers. The heartwood is very resistant to preservative treatment. It works fairly well in most hand and machine operations and has fairly good nail- and screw-holding properties.

Iroko resembles teak in a number of properties, but its strength values are somewhat lower.

The principal uses of iroko are in heavy construction, furniture, and boat construction.

For further discussion consult reference (4) and the Forest Service Foreign Woods Leaflet on iroko (12). A color plate appears in reference (17).

Ishpingo (*Amburana acreana* [Ducke] A. G. Smith)

Ishpingo is reported to supply one of the best timbers in Peru and has a well established reputation in that country for durability and decorative purposes. This wood is as yet little known in the United States although it appears to show considerable promise as a shipbuilding wood as well as for other uses that require an attractive, durable, and dimensionally stable wood.

The heartwood is yellowish to light brown with a slight orange cast. The color deepens on exposure to a golden brown or light brown. The vessel or pore lines show distinctly on longitudinal surfaces because of the abundance of encircling soft tissue (parenchyma). The grain is interlocked; the resulting stripe is narrow on quartered surfaces. The heartwood has a slightly oily or waxy feel and a pronounced coumarin odor.

The heartwood appears to have very good natural durability, and its dimensional stability is on par with that of teak.

The best usage of ishpingo has not yet been established, but its properties indicate that it would be well suited for boat building, furniture, decorative veneer, and other uses demanding an attractive and dimensionally stable wood.

For more details, see Forest Products Laboratory Report No. 1915 (34).

Jarrah (*Eucalyptus marginata* Sm.)

Jarrah occurs in a compact belt of forest about 20 miles wide that runs parallel to the coast of western Australia from the latitude of Perth about 200 miles southward. It is the only species of commercial value in the area.

The wood is hard and heavy and is reddish brown in color, although it varies from light red to very dark red when first cut. The texture is coarse, and the grain commonly is interlocked. It has good durability with respect to decay and is resistant to termites. It is comparatively easy to work with machine tools. It is a heavy wood, weighing about 51 pounds per cubic foot in the air-dry condition.

It is used where high strength and durability are required.

Additional information will be found in reference (4) and color plate can be found in reference (17).

Karri (*Eucalyptus diversicolor* F. v. M.)

Karri occurs in a fairly restricted area in the southwest corner of western Australia in stands containing no other species of commercial value. It is one of the giant trees of Australia; trees have been found 270 feet high with diameters at the butt exceeding 9 feet.

The wood is reddish brown, closely resembling jarrah but generally lighter in color. A wavy or striped figure due to interlocked grain is often shown. It is hard and heavy, weighing about 56 pounds per cubic foot in the air-dry condition.

Karri is popular in the heavy construction field because of its strength, availability in large sizes and long lengths that are free of defects. It is used widely in wharf and bridge structures.

For additional details, see reference (4) and color plate in reference (17).

Khaya or "African Mahogany"³

The bulk of the khaya shipped from West Africa is *Khaya ivorensis* A. Chev., which is the most widely distributed and most plentiful species of the genus found in the coastal belt of the so-called closed or high forest. The closely allied species, *Khaya anthotheca* (Welw.) C. DC. has a more restricted range and is found further inland in regions of lower rainfall but well within the area now being worked for the export trade.

The heartwood varies from a pale pink to a dark reddish brown. The grain is interlocked, and the texture is equal to that of mahogany (*Swietenia*). The wood is very well known in the United States and large quantities are imported annually. The wood is easy to season, machines and finishes well. In decay resistance, it is generally rated below American mahogany.

Principal uses include furniture, interior finish, boat construction, and veneer.

For additional information consult reference (4) and the Forest Service Foreign Woods Leaflet on khaya (13). A color plate may be seen in reference (18).

³The Forest Service in its nomenclature restricts the name mahogany to the species belonging to the botanical genus *Swietenia*.

Koa (Acacia koa Gray)

Koa is the best-known fine hardwood of the Hawaiian Islands.

The heartwood is a golden brown marked with dark streaks and a high luster. The wood has a walnut-like texture but is not so hard.

Limited quantities have been used in the United States, but the wood has never been widely exploited here, possibly because of the fear that the quantity available would be insufficient to satisfy a substantial demand.

Koa is used essentially in the manufacture of art objects, musical instruments, furniture, and veneer.

Kokrodua (Afroormosia elata Harms)

Kokrodua is the vernacular name used in Ghana and is also known under its generic name afroormosia.

This large West African tree shows promise of becoming a substitute for teak (Tectona grandis). The heartwood is fine textured, with straight to interlocked grain. The wood is brownish yellow with darker steaks, moderately hard and heavy, weighing about 44 pounds per cubic foot at 15 percent moisture content. The wood strongly resembles teak in appearance but lacks the oily nature of teak and furthermore is finer textured.

The wood seasons readily with little degrade and has good dimensional stability. It is somewhat heavier than teak and stronger. The heartwood appears to be highly resistant to decay and should prove extremely durable under adverse conditions. The wood can undoubtedly be used for the same purposes as teak.

For additional information, consult Forest Products Laboratory Report No. 1978 (36), reference (4), and the color plate in reference (18).

Lauans or "Philippine Mahogany"³

The term "Philippine mahogany" is applied commercially to Philippine woods belonging to three genera--Shorea, Parashorea, and Pentacme. These woods are usually grouped by the United States trade into "dark red Philippine mahogany" and "light red Philippine mahogany." The species found in these two groups and their heartwood colors are:

"Dark red Philippine mahogany"

Red lauan, <u>Shorea negrosensis</u> Foxw.	:	Dark reddish brown to brick red
Tangile, <u>Shorea polysperma</u> (Blanco) Merr.	:	Red to reddish brown
Tiaong, <u>Shorea</u> sp.	:	Light red to light reddish brown

"Light red Philippine mahogany"

Almon, <u>Shorea almon</u> Foxw.	:	Light red to pinkish
Bagtikan, <u>Parashorea plicata</u> Brandis	:	Grayish brown
Mayapis, <u>Shorea squamata</u> (Turcz.) Dyer	:	Light red to reddish brown
White lauan, <u>Pentacme contorta</u> (Vid.) Merr. and Rolfe	:	Grayish to very light red
White lauan, <u>Pentacme mindanensis</u> Foxw.	:	Grayish to very light red

The species within each group are shipped interchangeably when purchased in the form of lumber. Mayapis of the light red group is quite variable with respect to color and frequently shows exudations of resin. For this reason, some purchasers of "Philippine mahogany" specify that mayapis be excluded from their shipments.

"Philippine mahoganies" as a whole have a coarser texture than mahogany or the "African mahoganies" and do not have the dark-colored deposits in the pores. Forest Products Laboratory studies showed that the average decay resistance was greater for mahogany than for either the "African mahoganies" or the "Philippine mahoganies." The resistance of "African mahogany" was of the moderate type and seemed no greater than that of some of the "Philippine mahoganies." Among the Philippine species, the woods classified as "dark red Philippine mahogany" usually were more resistant than the woods belonging to the light red group.

In machining trials made at the Laboratory the Philippine species appeared to be about equal with the better of the hardwoods found in the United States. Tangile was consistently better than average in all or most of the tests. Mayapis, almon, and white lauan were consistently below average in all or most of the trials. Red lauan and bagtikan were intermediate. All of the species showed interlocked grain.

The shrinkage and swelling characteristics of the Philippine species are comparable to those found in the oaks and maples of the United States.

Upwards of 75 million board feet are imported annually into the United States in logs, lumber, and finished products.

Principal uses include interior trim, paneling, flush doors, plywood, cabinets, furniture, siding, and boat construction. The use of the woods of the dark red group for boat building in the United States exceeds in quantity that of any foreign wood.

Additional information may be found in reference (48) and in the Forest Service Foreign Woods Leaflet on lauans (14). Mechanical properties may be consulted in reference (1).

Lemonwood (*Calycophyllum candidissimum* [Vahl] DC.)

This species occurs in Cuba and from southern Mexico through Central America to Colombia and Venezuela. Most of the wood entering the United States originally came from Cuba where it is known as degame.

The thick sapwood is white to brownish white and the heartwood is usually small and a variegated brown color. The wood is uniformly fine textured, straight grained, and is not difficult to work despite its density. The wood is similar in strength, toughness, and resilience to hickory.

The wood is used in the United States for the manufacture of archery bows.

Additional details regarding this species may be found in reference (52).

Lignumvitae (*Guaiacum* spp.)

The principal sources of lignumvitae are *Guaiacum officinale* L., which occurs in the West Indies, southern Central America, Colombia, and Venezuela, and *G. sanctum* L., which has the same range as *G. officinale* but which also occurs in southern Mexico and Central America.

Lignumvitae is one of the heaviest and hardest woods on the market. The wood is characterized by its unique green color and oily or waxy feel. The wood has a fine, uniform texture and closely interlocked grain. Its resin content may constitute up to about one-fourth of the air-dry weight of the heartwood.

Lignumvitae wood is used chiefly for bearing or bushing blocks for the lining of stern tubes of steamship propeller shafts. The great strength and tenacity of lignumvitae, combined with the self-lubricating properties that are due to the high resin content, make it especially adaptable for underwater usage. It is also used for such articles as mallets, pulley sheaves, caster wheels, stencil and chisel blocks, various turned articles, and brush backs.

Vera or verawood (Bulnesia arborea [Jacq.] Engl.) of Colombia and Venezuela is sometimes substituted for lignumvitae; however, vera is not suitable for underwater bearings.

For additional information, consult the Forest Service Foreign Woods Leaflet on lignumvitae (15). A color plate appears in reference (17).

Limba (Terminalia superba Engl. & Diels)

Abundant supplies of limba occur in West Africa and Belgian Congo.

The wood varies in color from a gray white to creamy brown and may contain dark streaks, which are valued for special purposes. The light-colored wood is considered an important asset for the manufacture of blond furniture. The wood is generally straight grained and of uniform but coarse texture.

The wood is easy to season and the shrinkage is reported to be rather small. Limba is not resistant to decay, insects, or termites. It is easy to work with all types of tools and is veneered without difficulty.

Principal uses include interior trim, paneling, and furniture.

For additional details, see reference (4) and color plate in reference (18).

Mahogany (Swietenia macrophylla King)

Mahogany ranges from southern Mexico through Central America into South America as far south as Bolivia. Mexico, British Honduras, and Nicaragua furnish about 70 percent of the mahogany imported into the United States.

The heartwood varies from a pale to a dark-reddish brown. The grain is generally straighter than that of "African mahogany;" however, a wide variety of grain patterns are obtained from this species.

Among the properties that mahogany possesses to a high degree are dimensional stability, fine finishing qualities, and ease of working with tools.

The principal uses for mahogany are furniture, models and patterns, boat construction, radio and television cabinets, caskets, interior trim, paneling, precision instruments, and many other uses where an attractive and dimensionally stable wood is required.

More complete and detailed information may be found in Forest Products Laboratory Report No. 2167 (37).

Makore (*Mimusops heckelii* Hutch. & Dalz.)

Makore is native to West Africa, principally to Nigeria and the Gold Coast.

The heartwood varies from a pinkish or purplish brown to dark blood red. The wood from normal straight-grained logs is fairly plain in appearance, but the grain of selected figured timber produces a mottled broken stripe or broken roe when quartersawn. In exceptional cases, the wood may be marked with irregular veins of darker color. The wood weighs about 39 pounds per cubic foot in the air-dry condition.

The heartwood is regarded as being very durable but extremely resistant to preservative treatment. The wood works fairly readily with machine tools but causes rapid dulling, which is due to the presence of silica in the wood. The fine dust that arises from machining operations may cause irritation of the nose and throat to some individuals.

The wood from straight-grained logs resembles cherry to some extent when it is rotary cut and used for paneling and flush doors. The figured wood is used for decorative plywood and to some extent in the boat building industry.

See also reference (4).

Mansonia (*Mansonia altissima* A. Chev.)

Mansonia, also known as aprono and ofun, is native to West Africa.

The heartwood varies from a yellowish brown to a grayish or gray brown and may frequently show a purplish cast. The grain is usually straight and the texture is fine. It is fairly hard and weighs about 38 pounds per cubic foot when thoroughly air seasoned. The wood air-seasons and kiln-drys rapidly with little degrade, and the amount of shrinkage is small.

Mansonia is harder than black walnut, more resistant to shock loads, and stronger in bending, but in other properties they are about equal.

The heartwood of mansonina is very resistant to decay. The wood is easy to work, glue, and takes a fine finish.

Mansonina is used primarily for decorative purposes.

For additional details, see reference (4) and color plate in reference (17).

Meranti (Shorea spp.)

The trade name meranti covers a number of closely related species of Shorea from which light or only moderately heavy timber is produced. This timber is imported from Malaya, Sarawak, and Indonesia. In Malaya this timber is commonly classified for export either as light red or dark red meranti. Each of these color varieties is the product of several species of Shorea. Meranti exported from Sarawak and various parts of Indonesia is generally similar to the Malayan timber. Meranti corresponds roughly to seraya from North Borneo and lauan from the Philippines, which are names used for the lighter types of Shorea and allied genera.

Meranti shows considerable variation in color, weight, texture, and related properties, according to the species. The grain tends to be slightly interlocked so that quartered stock shows a broad stripe figure. The texture is moderately coarse but even. Resin ducts with or without white contents occur in long tangential lines on the end surfaces of the wood, but the wood is not resinous like some of the keruing species. Wood from near the center of the log is apt to be weak and brittle.

Light red meranti is classed as a light-weight utility hardwood and comprises those species yielding a red or reddish but not a dark-red timber. The actual color of the heartwood varies from pale pink to light-reddish brown. The weight of the wood is liable to vary over a rather wide range, from 25 to 44 pounds per cubic foot in the seasoned condition.

Dark red meranti is darker in color than ordinary red meranti and appreciably heavier, weighing on the average about 43 pounds per cubic foot seasoned. This color variety is the product of a more limited number of species, principally S. pauciflora, and consequently tends to be more uniform in character than light-red meranti. Because of the number of species contributing to the production of meranti, appreciable variation may be encountered with respect to mechanical and physical properties, durability, and working characteristics.

The wood is used in both plywood and solid form for much the same purposes as the Philippine lauans.

For additional details, see reference (4).

Mora (Mora excelsa Benth.), Morabukea (Mora gonggrijpii [Kleinh.] Sandw.)

Mora is native to the Guianas and eastern Venezuela, and morabukea occurs mainly in the Guianas.

The heartwood varies in color from chocolate brown to reddish brown or occasionally a pinkish brown, particularly in morabukea. The grain of both species is interlocked, and the texture is coarse. The wood is very heavy, averaging about 64 pounds per cubic foot in the air-dry condition.

The timber dries very slowly with appreciable degrade and, a mild kiln-drying schedule is recommended for both species. The woods are similar in their mechanical properties to greenheart although they tend to be somewhat harder. The heartwood is classified as durable and extremely resistant to preservative treatment.

The timbers are used primarily for heavy construction, such as piling, piers, docks, and other heavy duty purposes.

Consult reference (4) for additional information and the color plate in reference (18).

Oak, Brown (Quercus spp.)

Brown oak, or English brown oak, is the product of two species of white oaks, Quercus robur (Syn. Q. pedunculata) and Q. petraea (Syn. Q. sessiliflora), which are native to the European continent.

In its natural color, English oak approaches white oak (Q. alba). As the primary demand in the United States, however, is for the the brown-tinted

wood, Brown English Oak dominates the trade. The color varies from a bright nut brown to a deep brown, frequently with streaks tending toward black. The lighter varieties are highly lustrous while the darker material has littler luster. The brown color of the wood is due to fungus attack that may follow after pruning, damage to limbs and roots, and other causes. Although brown oak is slightly weaker than white oak, the difference is not important for the purpose for which it is used. After the wood has been seasoned, further development of the fungus ceases.

The supply entering the market is rather limited and is converted for the most part into veneer; in this form it is used in the manufacture of fine furniture and decorative paneling.

Oak, Japanese (*Quercus mongolica* var. *grosseserrata* [Bl.] Rehd. & Wils.)

Information relative to this Japanese species may also be found under the synonymous name *Quercus crispula* Bl. The common name applied to this wood in Japan is mizunara.

The heartwood is yellowish brown, somewhat paler than white oak (*Q. alba*) and typically of slow, even growth, weighing on the average about 42 pounds per cubic foot at a moisture content of 15 percent.

Variations in growth rate and quality occur in Japanese as in other oaks but, owing to the restricted area from which commerical supplies are obtained, it is on the whole fairly uniform in character. According to American furniture manufacturing standards, this wood would be classified as "soft textured;" thus, it is very similar in all respects to the "soft-texture Appalachian white oak" and is used for the same purposes.

Obeche (*Triplochiton scleroxylon* K. Schum.)

Obeche trees of West Africa reach heights of 150 feet or more and diameters of up to 5 feet. The trunk is usually free of branches for considerable heights so that clear lumber of considerable size is obtainable.

The wood is creamy white to pale yellow with little or no difference between the sapwood and heartwood. It is fairly soft, of uniform texture, and the grain is straight or more often interlocked. The wood weighs about 24 pounds per cubic foot in the air-dry condition.

The wood seasons readily with little degrade. The wood is not resistant to decay, and the sapwood blue stains readily unless appropriate precautions

are taken after the trees are felled as well as after it has been converted into lumber.

The wood is easy to work and machine, veneers and glues well, and takes nails and screws without splitting.

The characteristics of this species make it especially suitable for veneer and corestock.

This species is also called ayous, samba, and wawa.

See also reference (4) and color plate in reference (17).

Okoume (*Aucoumea klaineana* Pierre)

The natural distribution of okoume is rather restricted and is found only in Gabon in French Equatorial Africa and Spanish Guinea. This species has been popular in European markets for many years, but its extensive use in the United States is rather recent. When first introduced in volume in the plywood and door fields, its acceptance was phenomenal because it provided attractive appearance at moderate cost. The wood has a salmon-pink color with a uniform texture and high luster. The texture is slightly coarser than that of birch. Okoume offers unusual flexibility in both working and finishing because the color, which is of medium intensity, permits toning to either lighter or darker shades.

Its use in this country is restricted to decorative plywood paneling and for doors. Its use as solid lumber has been hampered because special saws and planer knives are required to effectively machine this species. This is due to the silica content of the wood.

The Forest Service Foreign Woods Series Leaflet on okoume (11) provides additional information on this species, and a color plate of this wood may be seen in reference (17).

Padauk (*Pterocarpus* spp.)

The three principal species of woods produced from *Pterocarpus* and known as padauk are: African padauk (*P. soyauxii* Taub.), Andaman padauk (*P. dalbergioides* Roxb.), and Burma padauk (*P. macrocarpus* Kurz).

The heartwood of the African padauk is a unique golden red or red color. The Andaman and Burma padauk are usually variegated golden red with streaks of golden yellow and frequently with darker streaks of violet red.

The three species are coarse textured. Supplies in this country are very limited, and the wood is very expensive.

The closely related species (P. indicus Willd.) of the Philippines is called narra rather than padauk. The wood is coarse textured. The trade divides narra into two types on the basis of colors: yellow or brown narra, which is yellow to yellow brown in color; and red, which is predominantly red or golden red. Narra is regarded as the finest cabinet wood in the Philippines. As is the case with the padauks, narra supplies are limited, and it is an expensive wood.

The padauks and narra are used either in veneer or solid form in the manufacture of furniture and decorative paneling.

Additional information on African, Andaman, and Burma padauk may be found in reference (4). Color plates may be seen in references (17) and (18).

Pao Rosa (*Swartzia fistuloides* Harms)

Pao rosa is a recent introduction from the West African forests and may well be classified as one of the fancy hardwoods of the world.

The heartwood is yellowish brown striped with bands of reddish brown as seen on quartered surfaces. Flat-sawn surfaces display a mild "partridge wood" figure. The wood is hard and heavy, weighing about 64 pounds per cubic foot in the air-dry condition, so seasoned specimens readily sink in water. Although the wood is hard and heavy, it machines well and glues readily. Pao rosa bears a striking resemblance to Brazilian tulipwood (Dalbergia) with respect to color.

This species is currently being used in this country for the manufacture of high-quality decorative articles.

"Parana pine" (*Araucaria angustifolia* [Bert.] O. Kuntze)

The wood that is commonly called "Parana pine" is not a true pine. It is a softwood that comes from southeastern Brazil and adjacent areas of Paraguay and Argentina.

"Parana pine" has many desirable characteristics. It is available in large sizes of clear boards with uniform texture. The small pinhead knots (leaf traces) that appear on flat-sawn surfaces and the light-brown or reddish-brown heartwood, which is frequently streaked with red, provide desirable figured

effects for matching in paneling and interior finishes. The growth rings are fairly distinct and more nearly like those of white pine (Pinus strobus) rather than those of the yellow pines. The wood has relatively straight grain, takes paint well, glues easily, and is free from resin ducts, pitch pockets, and streaks.

The strength values of this species compare favorably with those softwood species of similar density found in the United States and, in some cases, approach the strength values of species with greater specific gravity. It is especially good in shearing strength, hardness, and nail-holding ability, but notably deficient in strength in compression across the grain.

Some tendency towards splitting of kiln-dried "Parana pine" and warping of seasoned and ripped lumber is caused by the presence of compression wood, an abnormal type of wood structure with intrinsically large shrinkage along the grain. Boards containing compression wood should be excluded from exacting uses. The principal uses of "Parana pine" include framing lumber, interior trim, sash and door stock, furniture, case goods, and veneer.

This species is known in Brazil as pinheiro do Parana or pinho do Parana.

For additional information, consult reference (3) and the Forest Service Foreign Woods Leaflet on "Parana pine" (9). A color plate of this wood may be seen in reference (17).

Peroba do campo (Paratecoma peroba [Record] Kuhl.)

Peroba do campo is a large and important forest tree of eastern Brazil. The heartwood is pale reddish or yellowish brown and occasionally a pale olive color. The texture is medium and the grain varies from straight to interlocked and may show a variety of figure patterns.

Straight-grained material is strong and durable and has replaced teak to some extent in ship building. Figured material is used for paneling and furniture.

The wood is considered as being very durable but resistant to preservative treatment.

For additional information consult Forest Products Laboratory Report No. 2000 (25).

Primavera (Cybistax donnell-smithii [Rose] Siebert)

The natural distribution of primavera is restricted to southwestern Mexico, the Pacific coast of Guatemala and El Salvador, and north central Honduras.

Primavera is regarded as one of the primary light-colored woods, but its use has been limited because of its rather restricted range and the relative scarcity of wild trees within its natural growing area.

Plantations now coming into production will, no doubt, increase the availability of this species and provide a more constant source of supply. The quality of the plantation-grown wood is equal in all respects to that obtained from wild trees.

The heartwood is whitish to straw yellow and in some logs may be tinted with pale brown or pinkish streaks. The wood has a very high luster.

Primavera produces a wide variety of figure patterns.

The shrinkage properties are very good, and the wood shows a high degree of dimensional stability. Although the wood has considerable grain variation, it machines remarkably well. Its durability with respect to decay resistance is rated as durable to very durable.

The dimensional stability, ease of working, and pleasing appearance recommend primavera for solid furniture, paneling, interior trim, and special exterior uses.

For detailed information on plantation-grown primavera, see Forest Products Laboratory Report No. 2021 (39), and also reference (51).

Pycnanthus (Pycnanthus angolensis [Welw.] Warb.)

Pycnanthus is also known in the trade by the names ilomba, boma, okersa, okouma, and gobi. It is imported from West Africa.

The wood is gray white to a very light-reddish color, straight grained, and moderately coarse textured. Soft and light, pycnanthus weighs about 25 to 30 pounds per cubic foot in the air-dry condition.

The wood is currently being used in the solid form for paneling and interior trim and also in the plywood form for decorative purposes.

Ramin (Gonystylus bancanus [Miq.] Baill.)

Ramin is one of the very few moderately heavy woods that are classified as a "blond" wood. This species is native to southeast Asia, and most of the importation has been from Sumatra.

The wood is a uniform pale straw or yellowish to whitish in color. The grain is straight or shallowly interlocked. The texture is moderately fine, similar to that of mahogany (Swietenia), and even. The wood is without figure or luster. Ramin is moderately hard and heavy, weighing about 42 pounds per cubic foot in the air-dry condition. The wood is easy to work, finishes well, and glues satisfactorily.

Ramin has been used in the United States in the form of plywood for doors and in the solid form for interior trim.

Additional information can be found in reference (4) and the color plate in reference (18).

Rosewood (Dalbergia spp.)

All of the true rosewoods known to cabinetmakers are various species of the genus Dalbergia from Asia, Madagascar, Brazil, and Central America. The wood has excellent technical properties, attractive appearance, and is usually fragrant.

The heartwood of these species varies in color from black to reddish brown with black streaks or mottlings. The wood is easy to work and finishes smoothly with a high natural polish. It holds its place well in the finished items and is very durable.

The chief obstacles to a wider use of rosewood are the high cost and the fact that the trees are usually small and defective. Only the heartwood has any commercial value. A great deal of the better timber, especially that which was readily accessible, has already been utilized. Formerly used in making pianos and fine cabinets, its uses now are limited to levels, brush backs, cutlery handles, and marquetry. Principal species are Brazilian rosewood (D. nigra Fr. Allem.), East Indian rosewood (D. latifolia Roxb.), and Honduras rosewood (D. stevensonii Standl.), Madagascar rosewood (D. greveana Baill.), and African blackwood (D. melanoxylem), which is used primarily for the manufacture of clarinets.

Reference (4) contains information about the above species.

Sakar (Agathis philippinensis Warb.)

Sakar is a softwood, or conifer, that is widely distributed throughout the Philippine Islands and is known there by the name almaciga.

The wood is a pinkish-brown color and sometimes shows dark-brown streaks that demarcate the growth rings. There is no color difference between heartwood and sapwood. The grain is straight and the texture is very fine. The wood seasons well and is very easy to work. The wood is nondurable, with respect to decay.

It is currently being used in the United States for interior trim and plywood.

The mechanical and physical properties of sakar have not been investigated but presumably would be very similar to those of related species in the southwestern Asia and Australian areas.

Information relative to these related species may be found in reference (3) and color plates in references (17) and (18).

Santa Maria (*Calophyllum brasiliense* var. *rekoi* [Standl.] Standl.)

Santa maria occurs in practically all of the tropical American countries; consequently, it is known under a large number of common names.

The heartwood varies in color from pink or yellowish pink to brick red or a rich-reddish brown. The grain is interlocked and the texture is medium and uniform. The wood is fairly dense, but the working qualities are generally good. The Santa maria thus far imported into the United States has been principally from British Honduras. The chief deterrent to its regular importation has been the fact that the logs are difficult to remove from the forest; thus, the cost tends to be out of proportion to relative value of the wood.

The properties of the wood indicate that it can be used for agricultural implements and vehicles, boat frames, boat keels and underwater structural members, flooring, tropical frame construction, furniture and cabinet work, millwork, and decorative plywood.

For additional information, consult references (4) and (52), and the color plate in reference (17).

Sapele (*Entandrophragma cylindricum* [Sprague] Sprague)

Sapele is native to West Africa and the Congo. Most of the wood, however, is imported into the United States in log form from Ghana and Nigeria.

The heartwood is pinkish when freshly cut and eventually darkens to a red-brown color. Sapele has a uniform texture similar to that of Khaya and is characterized by its narrow-stripe pattern on quarter-cut surfaces. It is harder and heavier than African mahogany, weighing about 40 pounds per cubic foot when air dry.

Sapele is generally quartersawn or quartersliced so that seasoning may be accomplished with a minimum of distortion as well as to emphasize the stripe pattern. The heartwood is fairly resistant to decay.

The wood machines and veneers well and glues easily.

Sapele is used primarily as a veneer for decorative purposes and furniture.

Information relative to sapele and related species may be consulted in reference (4). A color plate may be seen in reference (17).

Sen (*Kalopanax pictus* [Thunb.] Nakai)

Sen is imported from Japan and comes from the mountainous forests in the northern part of Honshu and Hokkaido.

The sapwood of sen is white and the heartwood may be pale-yellowish brown or a grayish brown. There is no sharp line of demarcation between heartwood and sapwood. The wood is ring porous, and the figure produced by the zone of large pores in the springwood suggests ash and American elm.

The wood is straight grained, lustrous, and similar to ash and elm in texture. In the United States, sen is used primarily in the form of veneer for decorative plywood.

For additional information, consult Forest Products Laboratory Report No. 1979 (40).

Spanish-cedar (*Gedrela* spp.)

Spanish-cedar comprises a group of about seven species that are widely distributed in tropical America from southern Mexico to northern Argentina. The wood is more or less distinctly ring porous, and the heartwood varies from light-reddish brown to dark-reddish brown. The heartwood is characterized by its distinctive cedar-like odor.

The wood seasons readily. It is not high in strength but is roughly rated to have about a third or more of the strength of mahogany. It is considered decay resistant and works and glues well.

Spanish-cedar was formerly in great demand for the manufacture of cigar boxes. The invasion of substitute materials into the field of cigar containers has practically eliminated Spanish-cedar for this purpose. It is still, however, being used to a large extent to make individual cigar wrappers, which are enclosed in cellophane packets and give the cigar a cedar odor that was formerly supplied by the cigar box itself.

The important species are Cedrela odorata L. (syn. C. mexicana Roem.) and C. angustifolia Sesse & Moc. ex DC., which occur throughout the tropical American range of the genus. C. oaxacensis C. DC. & Rose is native to Mexico and Central America, C. fissilis Vell. to Brazil and Peru, and C. montana Turcz. to northwestern South America.

For more information, consult references (4) and (51) and Forest Products Laboratory Report No. 1948 (32). A color plate may be seen in reference (17). The taxonomy of Cedrela is thoroughly covered in reference (47).

Tamo (Fraxinus mandshurica Rupr.)

None of the various species of ash has received more attention in the fancy wood trade than tamo. The wood that is imported into the United States comes from the northern islands of Japan.

Tamo varies in color from a straw yellow to a bright brown and is characterized by its high luster. The wood is ring porous and exhibits a wide range of figure ranging from curly, fiddle-mottled, to blister. The highly figured wood is confined to the lower portion of selected trees, varies from 4 to 12 feet in length, and usually is very irregular in shape.

Tamo weighs about 36 pounds per cubic foot in the seasoned condition.

All of the figured wood is converted into veneer, which is used for decorative plywood.

A good color plate of figured tamo may be seen in reference (18).

Teak (Tectona grandis L. f.)

Teak occurs in commercial quantities in India, Burma, Thailand, Indo-China, and the East Indies. Numerous plantations have been developed and many of these are now producing timber.

The heartwood varies from a yellow brown to a rich brown. It has a coarse texture, is usually straight grained, and has a distinctly oily feel. The heartwood has excellent dimensional stability and possesses a very high degree of natural durability.

Intrinsically, teak is one of the most valuable of all woods, but its use is limited by scarcity and high cost. Teak is unique in that it does not cause rust or corrosion when in contact with metal; hence, it is extremely useful in the ship building industry. It is currently used in the construction of expensive boats, furniture, flooring, and decorative objects.

For a more complete discussion of teak, see reference (4) and the Forest Service Foreign Woods Leaflet on teak (8). A color plate may be seen in reference (17).

Virola (Dialyanthera spp.)

Virola is the common name being currently applied to the wood of one or more species of Dialyanthera originating in southwestern Colombia. The local name for this wood is cuangare.

The wood is a pale-pinkish brown with a high luster. There is no sharp demarcation between heartwood and sapwood. The wood is generally straight grained, easy to work, holds nails well, and finishes smoothly. The texture is quite similar to that of okoume.

Virola is a relatively low-density wood. On the dry-weight basis, it is equal to that of alder, aspen, and basswood. Shrinkage properties of virola are about the same as those of sugar maple. The wood is rated very low with respect to natural durability; hence, it is best suited for use under interior conditions.

Currently the wood is being used for paneling, interior trim, and core stock.

The mechanical properties have not been investigated but presumably would be generally lower than those for the closely related banak.

Walnut, European (Juglans regia L.)

Although generally referred to as European walnut or by its country of origin, walnut is a native of western and central Asia, extending to China and northern India. Trees are grown in commercial quantities mainly in Turkey, Italy, France, and Yugoslavia.

Walnut is variable in color, with a grayish-brown background, marked with irregular dark-colored streaks. The figure, which is due to the infiltration of coloring matter, is sometimes accentuated by the naturally wavy grain. The highly figured veneers used in cabinet making and decorative paneling are obtained from the stumps, burls, and crotches of a relatively small percentage of the trees. The wood weighs about 40 pounds per cubic foot in the air-dry condition.

The product of any one locality may vary considerably in color, figure, and texture, but the selected export timber generally shows certain typical characteristics. French walnut is typically paler and grayer than English walnut, while the Italian wood is characterized by its elaborate figure and dark, streaky coloration. Because of the ease of machining, finishing, and gluing, walnut is used extensively in both veneer form as well as in the solid form for furniture, paneling, and decorative objects. It is the classic wood for rifle stocks.

Yama (*Aesculus turbinata* Blume)

Yama is a coined name applied to the curly-figured wood of the Japanese buckeye or tochinoki.

The sapwood is usually buff colored and the heartwood a very pale brown. The texture is very fine and uniform, much like Ohio buckeye. Only the figured wood is imported and is used in the veneer form for decorative purposes. In the solid form, it is used in the manufacture of fancy gunstocks.

The wood weighs about 32 pounds per cubic foot in the seasoned condition.

Zebrano (*Microberlinia brazzavillensis* A. Chev.)

Zebrano is a West African species, which is also known in the trade as zingana and zebrawood.

Zebrano wood is very distinctive, and few other woods on the market produce a similar type of pigmented figure. The background color that varies from yellowish white to pale brown is striped with deep-brown to blackish lines of variable width and contour. When cut on the quarter, zebrano produces a narrow-striped figure of more or less uniform lines. When flat cut, it displays a figure of highly variable design. The wood weighs about 52 pounds per cubic foot at a moisture content of 12 percent.

The wood is used primarily in the form of veneer for decorative plywood.

Earlier references to this species placed the wood under the genera Cynometra and Brachystegia.

A very good color plate may be seen in reference (17).

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Table 1.--Shrinkage values for some woods imported into the United States

Common and botanical names of species	Shrinkage ¹		Source of values ²	Common and botanical names of species	Shrinkage ¹		Source of values ²
	Radial	Tangential			Radial	Tangential	
	Percent	Percent	Reference No.		Percent	Percent	Reference No.
Alerce (<i>Fitzroya cupressoides</i>)	3.8	5.8	(22)	Emeri			
Angelique (<i>Dicorynia guianensis</i>)	5.8	9.5	(38)	(<i>Terminalia ivorensis</i>)	3.1	4.9	(46)
				(<i>Terminalia ivorensis</i>)	4.6	6.2	(28)
Apitong				Greenheart			
(<i>Dipterocarpus gracilis</i>)	7.0	11.3	(1)	(<i>Ocotea rodiaei</i>)	3.4	4.2	(28)
(<i>Dipterocarpus grandiflorus</i>)	7.2	13.8	(1)	(<i>Ocotea rodiaei</i>)	8.2	9.0	(42)
(<i>Dipterocarpus hasseltii</i>)	4.7	9.8	(1)				
(<i>Dipterocarpus kerrii</i>)	5.9	11.3	(1)	Guanacaste (<i>Enterolobium cyclocarpum</i>)	3.0	5.4	(20)
(<i>Dipterocarpus orbicularis</i>)	4.0	10.0	(1)	Imbuia (<i>Phoebe porosa</i>)	3.5	9.0	(42)
Avodire							
(<i>Turraeanthus africanus</i>)	4.0	6.2	(28)	Iroko			
(<i>Turraeanthus africanus</i>)	4.0	7.9	(24)	(<i>Chlorophora excelisa</i>)	3.4	4.8	(28)
(<i>Turraeanthus africanus</i>)	3.4	5.9	(46)	(<i>Chlorophora excelisa</i>)	3.4	3.7	(24)
				(<i>Chlorophora excelisa</i>)	3.1	4.7	(46)
Balsa (<i>Ochroma lagopus</i>)	1.4-2.1	3.4-7.0	(55)	Ishpingo (<i>Amburana acreana</i>)	2.7	4.4	(34)
Banak (<i>Virola surinamensis</i>)	5.3	12.4	(50)	Jarrah (<i>Eucalyptus marginata</i>)	6.9	9.4	(27)
Bubinga (<i>Guibourtia tessmannii</i>)	4.9	5.9	(46)				
Cativo				Karri (<i>Eucalyptus diversicolor</i>)	7.3	13.7	(27)
(<i>Prioria copaifera</i>)	2.1	5.2	(42)				
(<i>Prioria copaifera</i>)	2.4	5.3	(29)	Khaya, "African Mahogany"	4.1	5.8	(54)
(<i>Prioria copaifera</i>)	4.4	5.6	(41)				
Ceiba				Koa (<i>Acacia koa</i>)	5.5	6.2	(28)
(<i>Ceiba pentandra</i>)	2.9	4.3	(46)				
(<i>Ceiba pentandra</i>)	4.5	5.7	(20)	Kokrodua (<i>Afrormosia elata</i>)	3.2	6.3	(24)
(<i>Ceiba pentandra</i>)	2.1	4.1	(50)				
Corisa (<i>Chorisia insignis</i>)	3.5	6.3	(34)	Lauans, "Philippine Mahogany"			
				White lauan (<i>Pentacme contorta</i>)	3.3	6.5	(1)
Crabwood				Bagtikan (<i>Parashorea plicata</i>)	4.0	7.4	(1)
(<i>Carapa guianensis</i>)	3.1	7.6	(29)	Almon (<i>Shorea almon</i>)	2.8	6.8	(1)
(<i>Carapa nicaraguensis</i>)	5.5	8.3	(33)	Red lauan (<i>Shorea negrosensis</i>)	3.7	7.4	(1)
(<i>Carapa surinamensis</i>)	4.7	8.3	(29)	Tangile (<i>Shorea polysperma</i>)	4.1	7.9	(1)
<i>Dipterocarpus</i> spp. - 59 trees	5.1	10.8		Lenomwood (<i>Calycophyllum candidissimum</i>)	4.8	8.6	(32)
				Limba (<i>Terminalia superba</i>)	4.4	5.4	(46)
				Mahogany (<i>Swietenia macrophylla</i>)	3.7	5.1	(37)
				(Central America)			

Table 1.--Shrinkage values for some woods imported into the United States--Continued

Common and botanical names of species	Shrinkage ¹		Source of values ²	Common and botanical names of species		Shrinkage ¹		Source of values ²
	Radial	Tangential		Radial	Tangential	Percent	Reference No.	
Makore (<u>Dumoria heckelii</u>)	5.3	7.8	(28)	Sen (<u>Kalopanax pictus</u>)	5.1	10.2	(56)	
Mansonia (<u>Mansonia altissima</u>)	4.6	6.4	(28)	Spanish cedar (<u>Cedrela angustifolia</u>)	3.9	5.9	(29)	
Oak, Japanese (<u>Q. mongolica grosseserrata</u>)	5.7	10.5	(56)	(<u>Cedrela fissilis</u>)	4.1	6.2	(49)	
Obeche (<u>Tripluchiton scleroxylon</u>)	2.5	5.1	(28)	(<u>Cedrela fissilis</u>)	4.1	5.6	(30)	
(<u>Tripluchiton scleroxylon</u>)	3.3	5.3	(46)	(<u>Cedrela fissilis</u>)	4.0	5.8	(6)	
Okoume (<u>Aucoumea klaineana</u>)	5.6	6.1	(28)	(<u>Cedrela oaxacensis</u>)	4.2	6.3	(21)	
Padauk (<u>Pterocarpus dalbergioides</u>)	3.3	4.4	(43)	(<u>Cedrela odorata</u>)	3.6	6.4	(32)	
(<u>Pterocarpus indicus</u>)	2.9	4.6	(1)	Tamo (<u>Fraxinus mandshurica</u>)	5.1	9.3	(56)	
(<u>Pterocarpus macrocarpus</u>)	3.4	5.1	(43)	Teak (<u>Tectona grandis</u>)	2.2	4.0	(43)	
(<u>Pterocarpus sovauxii</u>)	3.3	6.2	(24)	Virola (<u>Dialyanthera</u> spp.)	5.3	8.8	(2)	
Parana pine (<u>Araucaria angustifolia</u>)	4.0	7.9	(6)	Walnut, European (<u>Juglans regia</u>)	4.3	6.4	(43)	
(<u>Araucaria angustifolia</u>)	3.9	7.2	(49)	Yama (<u>Aesculus turbinata</u>)	4.5	8.4	(56)	
Peroba do campo (<u>Paratecoma peroba</u>)	3.8	6.6	(6)	Zebrano (<u>Microberlinia brazzavillensis</u>)	4.8	9.1	(46)	
Pao Rosa (<u>Swartzia fistuloides</u>)	4.1	5.7	(46)	SHRINKAGE OF SOME U.S. WOODS FOR COMPARISON (54) ²				
Primavera (<u>Cyrtax donnell-smithii</u>)	3.1	5.3	(39)	Ponderosa pine (<u>Pinus ponderosa</u>)	5.1	7.1	(54)	
Pycnanthus (<u>Pycnanthus angolensis</u>)	3.9	7.8	(46)	Yellow birch (<u>Betula alleghaniensis</u>)	7.2	9.2	(54)	
Rosewood (<u>Dalbergia greveana</u>)	3.3	5.4	(28)	Sugar maple (<u>Acer saccharum</u>)	4.9	9.5	(54)	
(<u>Dalbergia latifolia</u>)	2.5	5.7	(43)	Yellow-poplar (<u>Liriodendron tulipifera</u>)	4.0	7.1	(54)	
(<u>Dalbergia nigra</u>)	3.4	7.7	(28)	Black walnut (<u>Juglans nigra</u>)	5.5	7.8	(54)	
(<u>Dalbergia retusa</u>)	2.7	4.3	(28)	¹ -Shrinkage values represent shrinkage from the green to the oven-dry condition expressed as a percentage of the green dimension. ² -Numbers in parentheses refer to publications listed under "References." ³ -Based upon investigations conducted at the U.S. Forest Products Laboratory, the data for which have never been published.				
(<u>Dalbergia sissoo</u>)	2.9	5.3	(43)	Santa Maria (<u>Calophyllum brasiliense</u>)	4.8	7.1	(17)	
Sapele (<u>Entandrophragma cylindricum</u>)	5.9	7.4	(28)	Sapele (<u>Entandrophragma cylindricum</u>)	5.6	9.5	(28)	

Table 2.- Mechanical properties of some woods imported into the United States

Common and botanical names of species	Moisture Specific Gravity		Static bending		Compression		Shear		Hardness (side)	Source of values
	Condition	Modulus of rupture	Modulus of elasticity	Work to failure	Parallel to grain (maximum crushing strength)	Perpendicular to grain (at proportional limit)	Parallel to grain (maximum shearing strength)	Perpendicular to grain		
		P. s. i.	In.-lb. per cu. in.	P. s. i.	P. s. i.	P. s. i.	P. s. i.	P. s. i.	Lb.	Reference No.
Alerce (<i>Fitzroya cupressoides</i>)	{ Green : 0.40 12	6,000	6.4	2,690	370	650				(22)
Angeliqne (<i>Dicorynia guianensis</i>)	{ Green : .62 12	12,320	13.8	5,750	1,110	1,420	1,390	1,780	1,290	(38)
Apitons (<i>Dipterocarpus</i> spp.)	{ Green : .58 12	8,890	7.5	4,320	600	1,100	1,040	1,740	800	(1)
Avodire (<i>Turraeanthus africanus</i>)	12	12,700	9.4	7,180			2,040		1,080	(2)
Balsa (<i>Ochroma lagopus</i>)	12	2,750		1,700	90		300		100	(35)
Barak (<i>Virola koschnii</i>)	{ Green : .51 12	6,200	5.3	3,050			660		440	(2)
Banak (<i>Virola melinonii</i>)	{ Green : .42 12	6,340	4.6	3,100	250	330	730	1,220	400	(52)
Banak (<i>Virola surinamensis</i>)	{ Green : .42 12	5,600	4.1	2,390	200	270	720	980	320	(52)
Bubinga (<i>Guibourtia</i> spp.)	12	20,010		9,740						(46)
Cativo (<i>Prioria copaifera</i>)	12	8,730	7.2	4,490	530		1,040		610	(41)
Ceiba (<i>Ceiba pentandra</i>)	12	4,330	2.8	2,380	320		550		240	(50)
Corisa (<i>Chorisia insignis</i>)	14	6,060		2,955					500	(35)
Crabwood (<i>Carapa guianensis</i>)	{ Green : .56 12	11,110	11.4	4,930	960	850	1,320	1,680	1,060	(51)
Crabwood (<i>Carapa surinamensis</i>)	{ Green : .53 12	9,480	8.2	4,640	500	810	1,120	1,340	710	(51)
Crabwood (<i>Carapa nicaraguensis</i>)	13	15,450	14.7	8,340					610	FPL
Emeri (<i>Terminalia ivorensis</i>)	12	11,500	7.9	6,670			1,550		840	(2)

Table 2.--Mechanical properties of some woods imported into the United States--Continued

Common and botanical names of species	Moisture: Specific gravity		Static bending		Compression: Parallel to grain		Compression: Perpendicular to grain		Shear: (side)	Hardness: (side)	Source of values
	Condition	Moisture	Modulus of rupture	Work to failure	Modulus of rupture	Work to failure	Modulus of rupture	Work to failure			
			P. s. i.	In. lb. per cu. in.	P. s. i.	In. lb. per cu. in.	P. s. i.	In. lb. per cu. in.	P. s. i.	Lb.	Reference No.
Greenheart (<i>Ocotea rodiaei</i>) 3 trees.....	{ Green	0.89	19,300	12.7	2,970	12.7	10,500	14,940	1,320	2,110	(2)
	{ 12								2,830	2,650	
Imbuia (<i>Phoebe porosa</i>) 3 trees.....	{ Green	.52	7,700	8.9	1,080	8.9	3,380	6,650	680	880	(42)
	{ 12								890	950	
Iroko (<i>Chlorophora excelsa</i>) 2 trees and 7 planks.....	{ Green	.59	10,200	10.5	1,280	10.5	4,930		1,320	1,080	(2)
	{ 12								1,810	1,260	
1 tree.....	{ Green	.56	9,300	7.8	1,220	7.8	5,260		880	1,280	(42)
8 trees.....	{ 9								1,350	1,280	
	{ 12								1,510	1,280	(46)
Jarrah (<i>Eucalyptus marginata</i>).....	{ Green	.77	9,400		1,410		4,970		1,300	1,280	(5)
	{ 12								1,990	1,870	
Karri (<i>Eucalyptus diversicolor</i>).....	{ Green	.81	11,300		2,320		5,850		1,320	1,470	(5)
	{ 12								2,270	1,890	
Keruing (<i>Dipterocarpus caudiferus</i> and spp.) 9 trees from Borneo.....	{ Green	.62	10,410	10.4	1,920	10.4	5,160		880	870	(2)
	{ 12								1,530	1,150	
Keruing (<i>Dipterocarpus</i> sp.) 1 tree from Malaya.....	{ Green	.69	11,500	13.2	2,480	13.2	6,020			920	(2)
	{ 12									1,310	
Khaya (<i>Khaya anthotheca</i>) 5 trees.....	{ Green	.46	7,300	8.5	1,150	8.5	3,540		1,060	730	(2)
2 trees.....	{ 12								1,600	860	(46)
Khaya (<i>Khaya ivorensis</i>) 11 trees.....	{ Green	.42	7,410	7.1	1,150	7.1	3,750		940	640	(2)
10 trees, 39 backboards.....	{ Green	.43	7,750	8.3	1,390	8.3	6,480		1,505	830	FPL
8 trees.....	{ 12								690	540	
	{ 12								510	720	(22)
Kokrodua (<i>Afformosia elata</i>) 6 trees.....	{ Green	.65	14,790	19.5	1,760	19.5	7,510		1,680	1,600	(2)
	{ 12								2,100	1,560	

Table 2.--Mechanical properties of some woods imported into the United States--Continued

Common and botanical names of species	Moisture: Specific gravity	Static bending		Compression:		Shear	Hardness:	Source of values
		Modulus of rupture	Work to rupture	parallel to grain	perpendicular to grain				(side)
	Green	P. S. I.	In. lb. per cu. in.	P. S. I.	P. S. I.	P. S. I.	lb.	Reference No.
Padauk (<i>Pterocarpus dalbergioides</i>) 5 trees.....	{Green : 0.62 8.3	12,160	9.9	6,830	1,370	1,320	1,270	(43)
Padauk (<i>Pterocarpus macrocarpus</i>) 5 trees.....	{Green : .75 12.5	15,980	15.7	8,200	1,980	1,750	2,040	(43)
Padauk (<i>Pterocarpus soyauxii</i>) 3 trees.....	12	19,700	.....	10,300	.....	.....	.....	(46)
Parana pine (<i>Araucaria angustifolia</i>) 26 planks.....	{Green : .53 12	7,130	9.8	4,000	.....	880	560	(2)
Peroba do campo (<i>Paratecoma peroba</i>) 11 planks.....	12	15,400	10.2	8,920	.....	2,140	1,600	(2)
Pao rosa (<i>Swarzizia fistuloides</i>) 2 trees.....	12	24,080	.....	13,450	.....	.....	.....	(46)
Primavera (<i>Cybistax donnell-smithii</i>) 10 trees.....	{Green : .39 12	7,710	6.9	3,630	730	1,050	660	(39)
Pycnanthus (<i>Pycnanthus angolensis</i>)	12	8,910	.....	5,510	.....	.....	750	(16)
Ramin (<i>Conostylus bancanus</i>) 9 trees.....	{Green : .58 12	9,790	9.0	5,400	.....	900	640	(2)
Rosewood (<i>Dalbergia greveana</i>) 1 tree.....	12	26,240	.....	14,270	.....	.....	.....	(46)
Rosewood (<i>Dalbergia latifolia</i>) 5 trees.....	11.8	16,920	13.1	9,220	2,610	2,090	2,630	(43)
Rosewood (<i>Dalbergia sissoo</i>) 10 trees.....	10.3	15,550	13.1	8,830	2,080	1,880	1,750	(43)
Santa Maria (<i>Calophyllum brasiliense</i>)	{Green : .52 12	10,490	12.7	4,560	570	1,260	890	(52)
3 trees.....	{Green : .55 12	14,640	16.1	6,910	890	2,080	1,150	(2)
14 trees.....	{Green : .55 12	14,900	12.4	8,410	.....	1,310	1,040	(2)
Sapele (<i>Entandrophragma cylindricum</i>)	12	15,300	15.7	8,160	.....	2,080	1,510	(2)
4 trees.....	12	16,200	.....	8,530	.....	.....	.....	(46)
Sen (<i>Kalopanax pictus</i>).....	15	10,650	.....	5,250	.....	1,070	.....	(56)

Table 2.--Mechanical properties of some woods imported into the United States--Continued

Common and botanical names of species	Moisture: Specific gravity:		Static bending:		Compression:		Shear (maximum): (fiber stress: shearing strength):	Hardness: (side):	Source of values:
	Condition:	Moisture:	Modulus of rupture:	Work to rupture:	Parallel to grain:	Perpendicular to grain:				at proportional limit:
			P. S. I.	In. lb. per cu. in.	P. S. I.	P. S. I.	P. S. I.	Lb.	Reference No.
Seraya, dark red (<i>Shorea pauciflora</i>) 5 trees from North Borneo.	Green:	0.56	9,410	1,500	8.5	4,720	1,010	700	(2)
	12		12,640	1,770	13.8	7,360	1,330	780	
Seraya, light red (<i>Shorea leptoclados</i>) 5 trees from North Borneo.	Green:	.43	6,940	1,080	6.3	3,760	680	450	(2)
	12		9,310	1,290	8.4	5,160	1,060	510	
Seraya, light red (<i>Shorea parvifolia</i>) 5 trees from North Borneo.	Green:	.43	6,650	1,040	6.2	3,320	650	440	(2)
	12		9,500	1,220	8.5	5,920	880	450	
Seraya, light red (<i>Shorea smithiana</i>) 5 trees from North Borneo.	Green:	.44	6,840	1,120	5.9	3,520	550	440	(2)
	12		10,260	1,410	8.8	6,310	880	540	
Spanish cedar (<i>Cedrela angustifolia</i>) Syn. <i>C. huberi</i> , 2 trees....	Green:	.38	6,730	1,170	7.4	3,100	790	450	(51)
	12		11,300	1,420	12.5	6,010	1,200	570	
Spanish cedar (<i>Cedrela oaxacensis</i>) Syn. <i>C. hondurii</i> , 3 trees....	Green:	.41	7,510	1,310	7.1	3,370	990	550	(57)
	12		11,530	1,440	9.4	6,210	1,100	600	
Spanish cedar (<i>Cedrela odorata</i>) 1 tree.....		.36				5,700		540	FPL
	3 trees.....	.39	9,000			4,910			(46)
Tamo (<i>Fraxinus mandschurica</i>).....		.48	13,500			6,250	1,560		(56)
Teak (<i>Tectona grandis</i>) 14 trees.....	Green:	.60	11,440	1,670	9.3	5,870	1,060	1,040	(43)
	13.9		13,910	1,820	10.4	7,900	1,410	1,320	
Walnut, European (<i>Juglans regia</i>) 10 trees.....	Green:	.47	8,710	1,310	10.4	4,910	640	670	(43)
	7.7		13,090	1,540	9.8	7,320	1,160	840	
Yama (<i>Aesculus turbinata</i>).....		.45	10,650			5,250			(56)
Zebrano (<i>Microberlinia brazzavillensis</i>) 3 trees.....		.67	15,760			8,410			(46)

SOME U. S. WOODS FOR COMPARISON (54) 3

Birch, yellow (<i>Betula alleghaniensis</i>).....	Green:	.55	8,300	1,500	16.1	3,380	530	1,110	780
	12		16,600	2,010	20.8	8,170	1,190	1,880	1,260
Cherry, black (<i>Prunus serotina</i>).....	Green:	.47	8,000	1,310	12.8	3,540	440	1,130	660
	12		12,300	1,490	11.4	7,110	850	1,700	950

Table 2.--Mechanical properties of some woods imported into the United States--Continued

Common and botanical names of species	Moisture: Specific gravity ²	Static bending Modulus of elasticity of rupture	Compression: parallel to grain Modulus of elasticity of crushing	Compression: perpendicular to grain Modulus of elasticity of crushing	Shear (maximum strength)	Hardness (side)	Source of values ³	
								P.s.i.
Oak, white (<i>Quercus alba</i>)	{Green : 0.60 12	8,300 : 15,200	1,250 : 1,750	11.6 : 14.8	3,560 : 7,440	830 : 1,320	1,250 : 2,000	1,060 : 1,360
Poplar, yellow (<i>Liriodendron tulipifera</i>)	{Green : .40 12	6,000 : 10,100	1,220 : 1,580	7.5 : 8.8	2,660 : 5,540	300 : 560	790 : 1,190	440 : 540
Ponderosa pine (<i>Pinus ponderosa</i>)	{Green : .38 12	5,000 : 9,200	970 : 1,260	5.1 : 6.6	2,400 : 5,270	360 : 740	680 : 1,160	310 : 450

¹Values shown are for green material or for material at the specified moisture content.

²Specific gravity based on volume when green and weight when oven-dry.

³Numbers in parentheses refer to publications listed under "References."

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