



**PDHonline Course S182 (15 PDH)**

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# **Wood as an Engineering Material - Part I**

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**2020**

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# Characteristics and Availability of Commercially Important Woods

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## Contents

Timber Resources and Uses	1–2
Hardwoods and Softwoods	1–2
Commercial Sources of Wood Products	1–2
Use Classes and Trends	1–3
Species Descriptions	1–3
U.S. Wood Species	1–3
Hardwoods	1–3
Softwoods	1–10
Imported Woods	1–17
Hardwoods	1–17
Softwoods	1–33
References	1–34

**T**hroughout history, the unique characteristics and comparative abundance of wood have made it a natural material for homes and other structures, furniture, tools, vehicles, and decorative objects. Today, for the same reasons, wood is prized for a multitude of uses.

All wood is composed of cellulose, lignin, hemicelluloses, and minor amounts (5% to 10%) of extraneous materials contained in a cellular structure. Variations in the characteristics and volume of these components and differences in cellular structure make woods heavy or light, stiff or flexible, and hard or soft. The properties of a single species are relatively constant within limits; therefore, selection of wood by species alone may sometimes be adequate. However, to use wood to its best advantage and most effectively in engineering applications, specific characteristics or physical properties must be considered.

Historically, some species filled many purposes, while other less available or less desirable species served only one or two needs. For example, because white oak is tough, strong, and durable, it was highly prized for shipbuilding, bridges, cooperage, barn timbers, farm implements, railroad crossties, fence posts, and flooring. Woods such as black walnut and cherry were used primarily for furniture and cabinets. Hickory was manufactured into tough, hard, and resilient striking-tool handles, and black locust was prized for barn timbers. What the early builder or craftsman learned by trial and error became the basis for deciding which species were appropriate for a given use in terms of their characteristics. It was commonly accepted that wood from trees grown in certain locations under certain conditions was stronger, more durable, more easily worked with tools, or finer grained than wood from trees in other locations. Modern research on wood has substantiated that location and growth conditions do significantly affect wood properties.

The gradual reductions in use of old-growth forests in the United States has reduced the supply of large clear logs for lumber and veneer. However, the importance of high-quality logs has diminished as new concepts of wood use have been introduced. Second-growth wood, the remaining old-growth forests, and imports continue to fill the needs for wood in the quality required. Wood is as valuable an engineering material as ever, and in many cases, technological advances have made it even more useful.

The inherent factors that keep wood in the forefront of raw materials are many and varied, but a chief attribute is its availability in many species, sizes, shapes, and conditions to suit almost every demand. Wood has a high ratio of strength to weight and a remarkable record for durability and performance as a structural material. Dry wood has good insulating properties against heat, sound, and electricity. It tends to absorb and dissipate vibrations under some conditions of use, and yet it is an incomparable material for such musical instruments as the violin. The grain patterns and colors of wood make it an esthetically pleasing material, and its appearance may be easily enhanced by stains, varnishes, lacquers, and other finishes. It is easily shaped with tools and fastened with adhesives, nails, screws, bolts, and dowels. Damaged wood is easily repaired, and wood structures are easily remodeled or altered. In addition, wood resists oxidation, acid, saltwater, and other corrosive agents, has high salvage value, has good shock resistance, can be treated with preservatives and fire retardants, and can be combined with almost any other material for both functional and esthetic uses.

## Timber Resources and Uses

In the United States, more than 100 wood species are available to the prospective user, but all are unlikely to be available in any one locality. About 60 native woods are of major commercial importance. Another 30 species are commonly imported in the form of logs, cants, lumber, and veneer for industrial uses, the building trade, and crafts.

A continuing program of timber inventory is in effect in the United States through the cooperation of Federal and State agencies, and new information on wood resources is published in State and Federal reports. Two of the most valuable sourcebooks are *An Analysis of the Timber Situation in the United States 1989–2040* (USDA 1990) and *The 1993 RPA Timber Assessment Update* (Haynes and others 1995).

Current information on wood consumption, production, imports, and supply and demand is published periodically by the Forest Products Laboratory (Howard 1997) and is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC.

## Hardwoods and Softwoods

Trees are divided into two broad classes, usually referred to as hardwoods and softwoods. These names can be confusing since some softwoods are actually harder than some hardwoods, and conversely some hardwoods are softer than some softwoods. For example, softwoods such as longleaf pine and Douglas-fir are typically harder than the hardwoods basswood and aspen. Botanically, hardwoods are Angiosperms; the seeds are enclosed in the ovary of the flower. Anatomically, hardwoods are porous; that is, they contain vessel elements. A vessel element is a wood cell with open ends; when vessel elements are set one above another, they form a continuous tube (vessel), which serves as a conduit for transporting water

or sap in the tree. Typically, hardwoods are plants with broad leaves that, with few exceptions in the temperate region, lose their leaves in autumn or winter. Most imported tropical woods are hardwoods. Botanically, softwoods are Gymnosperms or conifers; the seeds are naked (not enclosed in the ovary of the flower). Anatomically, softwoods are nonporous and do not contain vessels. Softwoods are usually cone-bearing plants with needle- or scale-like evergreen leaves. Some softwoods, such as larches and baldcypress, lose their needles during autumn or winter.

Major resources of softwood species are spread across the United States, except for the Great Plains where only small areas are forested. Softwood species are often loosely grouped in three general regions, as shown in Table 1–1. Hardwoods also occur in all parts of the United States, although most grow east of the Great Plains. Hardwood species are shown by region in Table 1–2.

## Commercial Sources of Wood Products

Softwoods are available directly from the sawmill, wholesale and retail yards, or lumber brokers. Softwood lumber and plywood are used in construction for forms, scaffolding, framing, sheathing, flooring, moulding, paneling, cabinets, poles and piles, and many other building components. Softwoods may also appear in the form of shingles, sashes, doors, and other millwork, in addition to some rough products such as timber and round posts.

Hardwoods are used in construction for flooring, architectural woodwork, interior woodwork, and paneling. These items are usually available from lumberyards and building supply dealers. Most hardwood lumber and dimension stock are remanufactured into furniture, flooring, pallets, containers, dunnage, and blocking. Hardwood lumber and dimension

**Table 1–1. Major resources of U.S. softwoods according to region**

Western	Northern	Southern
Incense-cedar	Northern white-cedar	Atlantic white-cedar
Port-Orford-cedar	Balsam fir	Baldcypress
Douglas-fir	Eastern hemlock	Fraser fir
White firs	Fraser fir	Southern Pine
Western hemlock	Jack pine	Eastern redcedar
Western larch	Red pine	
Lodgepole pine	Eastern white pine	
Ponderosa pine	Eastern redcedar	
Sugar pine	Eastern spruces	
Western white pine	Tamarack	
Western redcedar		
Redwood		
Engelmann spruce		
Sitka spruce		
Yellow-cedar		

**Table 1–2. Major resources of U.S. hardwoods according to region**

Southern	Northern and Appalachia	Western
Ash	Ash	Red alder
Basswood	Aspen	Oregon ash
American beech	Basswood	Aspen
Butternut	Buckeye	Black cottonwood
Cottonwood	Butternut	California black oak
Elm	American beech	Oregon white oak
Hackberry	Birch	Bigleaf maple
Pecan hickory	Black cherry	Paper birch
True hickory	American chestnut <sup>a</sup>	Tanoak
Honeylocust	Cottonwood	
Black locust	Elm	
Magnolia	Hackberry	
Soft maple	True hickory	
Red oaks	Honeylocust	
White oaks	Black locust	
Sassafras	Hard maple	
Sweetgum	Soft maple	
American sycamore	Red oaks	
Tupelo	White oaks	
Black walnut	American sycamore	
Black willow	Black walnut	
Yellow-poplar	Yellow-poplar	

<sup>a</sup>American chestnut is no longer harvested, but chestnut lumber from salvaged timbers can still be found on the market.

stock are available directly from the manufacturer, through wholesalers and brokers, and from some retail yards.

Both softwood and hardwood products are distributed throughout the United States. Local preferences and the availability of certain species may influence choice, but a wide selection of woods is generally available for building construction, industrial uses, remanufacturing, and home use.

## Use Classes and Trends

The production and consumption levels of some of the many use-classifications for wood are increasing with the overall national economy, and others are holding about the same. The most vigorously growing wood-based industries are those that convert wood to thin slices (veneer), particles (chips, flakes), or fiber pulps and reassemble the elements to produce various types of engineered panels such as plywood, particleboard, strandboard, veneer lumber, paper, paperboard, and fiberboard products. Another growing wood industry is the production of laminated wood. For a number of years, the lumber industry has produced almost the same volume of wood per year. Modest increases have occurred in the production of railroad crossties, cooperage, shingles, and shakes.

## Species Descriptions

In this chapter, each species or group of species is described in terms of its principal location, characteristics, and uses. More detailed information on the properties of these and other species is given in various tables throughout this handbook. Information on historical and traditional uses is provided for some species. Common and botanical names follow the *Checklist of United States Trees* (Little 1979).

## U.S. Wood Species

### Hardwoods

#### Alder, Red

Red alder (*Alnus rubra*) grows along the Pacific coast between Alaska and California. It is the principal hardwood for commercial manufacture of wood products in Oregon and Washington and the most abundant commercial hardwood species in these two states.

The wood of red alder varies from almost white to pale pinkish brown, and there is no visible boundary between heartwood and sapwood. Red alder is moderately light in weight and intermediate in most strength properties but low in shock resistance. It has relatively low shrinkage.

The principal use of red alder is for furniture, but it is also used for sash and door panel stock and other millwork.

#### Ash (White Ash Group)

Important species of the white ash group are American white ash (*Fraxinus americana*), green ash (*F. pennsylvanica*), blue ash (*F. quadrangulata*), and Oregon ash (*F. latifolia*). The first three species grow in the eastern half of the United States. Oregon ash grows along the Pacific Coast.

The heartwood of the white ash group is brown, and the sapwood is light-colored or nearly white. Second-growth trees are particularly sought after because of the inherent qualities of the wood from these trees: it is heavy, strong, hard, and stiff, and it has high resistance to shock. Oregon ash has somewhat lower strength properties than American white ash, but it is used for similar purposes on the West Coast.

American white ash is used principally for nonstriking tool handles, oars, baseball bats, and other sporting and athletic goods. For handles of the best grade, some handle specifications call for not less than 2 nor more than 7 growth rings per centimeter (not less than 5 nor more than 17 growth rings per inch). The additional weight requirement of 690 kg/m<sup>3</sup> (43 lb/ft<sup>3</sup>) or more at 12% moisture content ensures high quality material. Principal uses for the white ash group are decorative veneer, cabinets, furniture, flooring, millwork, and crates.

## Ash (Black Ash Group)

The black ash group includes black ash (*F. nigra*) and pumpkin ash (*F. profunda*). Black ash grows in the Northeast and Midwest, and pumpkin ash in the South.

The heartwood of black ash is a darker brown than that of American white ash; the sapwood is light-colored or nearly white. The wood of the black ash group is lighter in weight (basic specific gravity of 0.45 to 0.48) than that of the white ash group (>0.50). Pumpkin ash, American white ash, and green ash that grow in southern river bottoms, especially in areas frequently flooded for long periods, produce buttresses that contain relatively lightweight and brash wood.

Principal uses for the black ash group are decorative veneer, cabinets, millwork, furniture, cooperage, and crates.

## Aspen

Aspen is a generally recognized name that is applied to bigtooth (*Populus grandidentata*) and quaking (*P. tremuloides*) aspen. Aspen does not include balsam poplar (*P. balsamifera*) and the other species of *Populus* that are included in the cottonwoods. In lumber statistics of the U.S. Bureau of the Census, however, the term cottonwood includes all the preceding species. Also, the lumber of aspen and cottonwood may be mixed in trade and sold as either popple or cottonwood. The name popple should not be confused with yellow-poplar (*Liriodendron tulipifera*), also known in the trade as poplar. Aspen lumber is produced principally in the Northeastern and Lake States, with some production in the Rocky Mountain States.

The heartwood of aspen is grayish white to light grayish brown. The sapwood is lighter colored and generally merges gradually into the heartwood without being clearly marked. Aspen wood is usually straight grained with a fine, uniform texture. It is easily worked. Well-dried aspen lumber does not impart odor or flavor to foodstuffs. The wood of aspen is lightweight and soft. It is low in strength, moderately stiff, and moderately low in resistance to shock and has moderately high shrinkage.

Aspen is cut for lumber, pallets, boxes and crating, pulpwood, particleboard, strand panels, excelsior, matches, veneer, and miscellaneous turned articles. Today, aspen is one of the preferred species for use in oriented strandboard, a panel product that is increasingly being used as sheathing.

## Basswood

American basswood (*Tilia americana*) is the most important of the native basswood species; next in importance is white basswood (*T. heterophylla*), and no attempt is made to distinguish between these species in lumber form. In commercial usage, "white basswood" is used to specify the white wood or sapwood of either species. Basswood grows in the eastern half of the United States from the Canadian provinces southward. Most basswood lumber comes from the Lake, Middle Atlantic, and Central States.

The heartwood of basswood is pale yellowish brown with occasional darker streaks. Basswood has wide, creamy white or pale brown sapwood that merges gradually into heartwood. When dry, the wood is without odor or taste. It is soft and light in weight, has fine, even texture, and is straight grained and easy to work with tools. Shrinkage in width and thickness during drying is rated as high; however, basswood seldom warps in use.

Basswood lumber is used mainly in venetian blinds, sashes and door frames, moulding, apiary supplies, wooden ware, and boxes. Some basswood is cut for veneer, cooperage, excelsior, and pulpwood, and it is a favorite of wood carvers.

## Beech, American

Only one species of beech, American beech (*Fagus grandifolia*), is native to the United States. It grows in the eastern one-third of the United States and adjacent Canadian provinces. The greatest production of beech lumber is in the Central and Middle Atlantic States.

In some beech trees, color varies from nearly white sapwood to reddish-brown heartwood. Sometimes there is no clear line of demarcation between heartwood and sapwood. Sapwood may be roughly 7 to 13 cm (3 to 5 in.) wide. The wood has little figure and is of close, uniform texture. It has no characteristic taste or odor. The wood of beech is classed as heavy, hard, strong, high in resistance to shock, and highly suitable for steam bending. Beech shrinks substantially and therefore requires careful drying. It machines smoothly, is an excellent wood for turning, wears well, and is rather easily treated with preservatives.

Most beech is used for flooring, furniture, brush blocks, handles, veneer, woodenware, containers, and cooperage. When treated with preservative, beech is suitable for railway ties.

## Birch

The three most important species are yellow birch (*Betula alleghaniensis*), sweet birch (*B. lenta*), and paper birch (*B. papyrifera*). These three species are the source of most birch lumber and veneer. Other birch species of some commercial importance are river birch (*B. nigra*), gray birch (*B. populifolia*), and western paper birch (*B. papyrifera* var. *commutata*). Yellow, sweet, and paper birch grow principally in the Northeast and the Lake States; yellow and sweet birch also grow along the Appalachian Mountains to northern Georgia.

Yellow birch has white sapwood and light reddish-brown heartwood. Sweet birch has light-colored sapwood and dark brown heartwood tinged with red. For both yellow and sweet birch, the wood is heavy, hard, and strong, and it has good shock-resisting ability. The wood is fine and uniform in texture. Paper birch is lower in weight, softer, and lower in strength than yellow and sweet birch. Birch shrinks considerably during drying.

Yellow and sweet birch lumber is used primarily for the manufacture of furniture, boxes, baskets, crates, wooden ware, cooperage, interior woodwork, and doors; veneer plywood is used for flush doors, furniture, paneling, cabinets, aircraft, and other specialty uses. Paper birch is used for toothpicks, tongue depressors, ice cream sticks, and turned products, including spools, bobbins, small handles, and toys.

### **Buckeye**

Buckeye consists of two species, yellow buckeye (*Aesculus octandra*) and Ohio buckeye (*A. glabra*). These species range from the Appalachians of Pennsylvania, Virginia, and North Carolina westward to Kansas, Oklahoma, and Texas. Buckeye is not customarily separated from other species when manufactured into lumber and can be used for the same purposes as aspen (*Populus*), basswood (*Tilia*), and sapwood of yellow-poplar (*Liriodendron tulipifera*).

The white sapwood of buckeye merges gradually into the creamy or yellowish white heartwood. The wood is uniform in texture, generally straight grained, light in weight, weak when used as a beam, soft, and low in shock resistance. It is rated low on machinability such as shaping, mortising, boring, and turning.

Buckeye is suitable for pulping for paper; in lumber form, it has been used principally for furniture, boxes and crates, food containers, wooden ware, novelties, and planing mill products.

### **Butternut**

Also called white walnut, butternut (*Juglans cinerea*) grows from southern New Brunswick and Maine west to Minnesota. Its southern range extends into northeastern Arkansas and eastward to western North Carolina.

The narrow sapwood is nearly white and heartwood is light brown, frequently modified by pinkish tones or darker brown streaks. The wood is moderately light in weight (about the same as eastern white pine), rather coarse textured, moderately weak in bending and endwise compression, relatively low in stiffness, moderately soft, and moderately high in shock resistance. Butternut machines easily and finishes well. In many ways, butternut resembles black walnut especially when stained, but it does not have the same strength or hardness.

Principal uses are for lumber and veneer, which are further manufactured into furniture, cabinets, paneling, interior woodwork, and miscellaneous rough items.

### **Cherry, Black**

Black cherry (*Prunus serotina*) is sometimes known as cherry, wild black cherry, and wild cherry. It is the only native species of the genus *Prunus* of commercial importance for lumber production. Black cherry is found from southeastern Canada throughout the eastern half of the United States. Production is centered chiefly in the Middle Atlantic States.

The heartwood of black cherry varies from light to dark reddish brown and has a distinctive luster. The nearly white sapwood is narrow in old-growth trees and wider in second-growth trees. The wood has a fairly uniform texture and very good machining properties. It is moderately heavy, strong, stiff, and moderately hard; it has high shock resistance and moderately high shrinkage. Black cherry is very dimensionally stable after drying.

Black cherry is used principally for furniture, fine veneer panels, and architectural woodwork. Other uses include burial caskets, wooden ware, novelties, patterns, and paneling.

### **Chestnut, American**

American chestnut (*Castanea dentata*) is also known as sweet chestnut. Before this species was attacked by a blight in the 1920s, it grew in commercial quantities from New England to northern Georgia. Practically all standing chestnut has been killed by blight, and most supplies of the lumber come from salvaged timbers. Because of the species' natural resistance to decay, standing dead trees in the Appalachian Mountains continued to provide substantial quantities of lumber for several decades after the blight, but this source is now exhausted.

The heartwood of chestnut is grayish brown or brown and darkens with age. The sapwood is very narrow and almost white. The wood is coarse in texture; growth rings are made conspicuous by several rows of large, distinct pores at the beginning of each year's growth. Chestnut wood is moderately light in weight, moderately hard, moderately low in strength, moderately low in resistance to shock, and low in stiffness. It dries well and is easy to work with tools.

Chestnut was once used for poles, railroad crossties, furniture, caskets, boxes, shingles, crates, and corestock for veneer panels. At present, it appears most frequently as wormy chestnut for paneling, interior woodwork, and picture frames.

### **Cottonwood**

Cottonwood includes several species of the genus *Populus*. Most important are eastern cottonwood (*P. deltoides* and varieties), also known as Carolina poplar and whitewood; swamp cottonwood (*P. heterophylla*), also known as cottonwood, river cottonwood, and swamp poplar; black cottonwood (*P. trichocarpa*); and balsam poplar (*P. balsamifera*). Eastern and swamp cottonwood grow throughout the eastern half of the United States. Greatest production of lumber is in the Southern and Central States. Black cottonwood grows on the West Coast and in western Montana, northern Idaho, and western Nevada. Balsam poplar grows from Alaska across Canada and in the northern Great Lakes States.

The heartwood of cottonwood is grayish white to light brown. The sapwood is whitish and merges gradually with the heartwood. The wood is comparatively uniform in texture and generally straight grained. It is odorless when well dried. Eastern cottonwood is moderately low in bending and

compressive strength, moderately stiff, moderately soft, and moderately low in ability to resist shock. Most strength properties of black cottonwood are slightly lower than those of eastern cottonwood. Both eastern and black cottonwood have moderately high shrinkage. Some cottonwood is difficult to work with tools because of its fuzzy surface, which is mainly the result of tension wood (see discussion of Reaction Wood in Ch. 4).

Cottonwood is used principally for lumber, veneer, pulpwood, excelsior, and fuel. Lumber and veneer are used primarily for boxes, crates, baskets, and pallets.

## Elm

Six species of elm grow in the eastern United States: American (*Ulmus americana*), slippery (*U. rubra*), rock (*U. thomasi*), winged (*U. alata*), cedar (*U. crassifolia*), and September (*U. serotina*) elm. American elm is also known as white, water, and gray elm; slippery elm as red elm; rock elm as cork and hickory elm; winged elm as wahoo; cedar elm as red and basket elm; and September elm as red elm. American elm is threatened by two diseases, Dutch Elm disease and phloem necrosis, which have killed hundreds of thousands of trees.

Sapwood of elm is nearly white and heartwood light brown, often tinged with red. Elm may be divided into two general classes, soft and hard, based on the weight and strength of the wood. Soft elm includes American and slippery elm. It is moderately heavy, has high shock resistance, and is moderately hard and stiff. Hard elm includes rock, winged, cedar, and September elm. These species are somewhat heavier than soft elm. Elm has excellent bending qualities.

Historically, elm lumber was used for boxes, baskets, crates, and slack cooperage; furniture; agricultural supplies and implements; caskets and burial boxes; and wood components in vehicles. Today, elm lumber and veneer are used mostly for furniture and decorative panels. Hard elm is preferred for uses that require strength.

## Hackberry

Hackberry (*Celtis occidentalis*) and sugarberry (*C. laevigata*) supply the lumber known in the trade as hackberry. Hackberry grows east of the Great Plains from Alabama, Georgia, Arkansas, and Oklahoma northward, except along the Canadian boundary. Sugarberry overlaps the southern part of the hackberry range and grows throughout the Southern and South Atlantic States.

Sapwood of both species varies from pale yellow to greenish or grayish yellow. The heartwood is commonly darker. The wood resembles elm in structure. Hackberry lumber is moderately heavy. It is moderately strong in bending, moderately weak in compression parallel to grain, moderately hard to very hard, and high in shock resistance, but low in stiffness. Hackberry has high shrinkage but keeps its shape well during drying.

Most hackberry is cut into lumber; small amounts are used for furniture parts, dimension stock, and veneer.

## Hickory (Pecan Group)

Species of the pecan hickory group include bitternut hickory (*Carya cordiformis*), pecan (*C. illinoensis*), water hickory (*C. aquatica*), and nutmeg hickory (*C. myristiciformis*). Bitternut hickory grows throughout the eastern half of the United States; pecan hickory, from central Texas and Louisiana to Missouri and Indiana; water hickory, from Texas to South Carolina; and nutmeg hickory, in Texas and Louisiana.

The sapwood of this group is white or nearly white and relatively wide. The heartwood is somewhat darker. The wood is heavy and sometimes has very high shrinkage.

Heavy pecan hickory is used for tool and implement handles and flooring. The lower grades are used for pallets. Many higher grade logs are sliced to provide veneer for furniture and decorative paneling.

## Hickory (True Group)

True hickories are found throughout the eastern half of the United States. The species most important commercially are shagbark (*Carya ovata*), pignut (*C. glabra*), shellbark (*C. laciniosa*), and mockernut (*C. tomentosa*). The greatest commercial production of the true hickories for all uses is in the Middle Atlantic and Central States, with the Southern and South Atlantic States rapidly expanding to handle nearly half of all hickory lumber.

The sapwood of the true hickory group is white and usually quite wide, except in old, slow-growing trees. The heartwood is reddish. The wood is exceptionally tough, heavy, hard, and strong, and shrinks considerably in drying. For some purposes, both rings per centimeter (or inch) and weight are limiting factors where strength is important.

The major use for high quality hickory is for tool handles, which require high shock resistance. It is also used for ladder rungs, athletic goods, agricultural implements, dowels, gymnasium apparatuses, poles, and furniture. Lower grade hickory is not suitable for the special uses of high quality hickory because of knottiness or other growth features and low density. However, the lower grade is useful for pallets and similar items. Hickory sawdust, chips, and some solid wood are used to flavor meat by smoking.

## Honeylocust

The wood of honeylocust (*Gleditsia triacanthos*) has many desirable qualities, such as attractive figure and color, hardness, and strength, but it is little used because of its scarcity. Although the natural range of honeylocust has been extended by planting, this species is found most commonly in the eastern United States, except for New England and the South Atlantic and Gulf Coastal Plains.

Sapwood is generally wide and yellowish, in contrast to the light red to reddish-brown heartwood. The wood is very heavy, very hard, strong in bending, stiff, resistant to shock, and durable when in contact with the ground.

When available, honeylocust is primarily used locally for fence posts and general construction. It is occasionally used with other species in lumber for pallets and crating.

### **Locust, Black**

Black locust (*Robinia pseudoacacia*) is sometimes called yellow or post locust. This species grows from Pennsylvania along the Appalachian Mountains to northern Georgia and Alabama. It is also native to western Arkansas and southern Missouri. The greatest production of black locust timber is in Tennessee, Kentucky, West Virginia, and Virginia.

Locust has narrow, creamy white sapwood. The heartwood, when freshly cut, varies from greenish yellow to dark brown. Black locust is very heavy, very hard, very resistant to shock, and very strong and stiff. It has moderately low shrinkage. The heartwood has high decay resistance.

Black locust is used for round, hewed, or split mine timbers as well as fence posts, poles, railroad crossties, stakes, and fuel. Other uses are for rough construction, crating, and mine equipment. Historically, black locust was important for the manufacture of insulator pins and wooden pegs used in the construction of ships, for which the wood was well adapted because of its strength, decay resistance, and moderate shrinkage and swelling.

### **Magnolia**

Commercial magnolia consists of three species: southern magnolia (*Magnolia grandiflora*), sweetbay (*M. virginiana*), and cucumbertree (*M. acuminata*). Other names for southern magnolia are evergreen magnolia, big laurel, bull bay, and laurel bay. Sweetbay is sometimes called swamp magnolia. The lumber produced by all three species is simply called magnolia. The natural range of sweetbay extends along the Atlantic and Gulf Coasts from Long Island to Texas, and that of southern magnolia extends from North Carolina to Texas. Cucumbertree grows from the Appalachians to the Ozarks northward to Ohio. Louisiana leads in the production of magnolia lumber.

Sapwood of southern magnolia is yellowish white, and heartwood is light to dark brown with a tinge of yellow or green. The wood, which has close, uniform texture and is generally straight grained, closely resembles yellow-poplar (*Liriodendron tulipifera*). It is moderately heavy, moderately low in shrinkage, moderately low in bending and compressive strength, moderately hard and stiff, and moderately high in shock resistance. Sweetbay is much like southern magnolia. The wood of cucumbertree is similar to that of yellow-poplar (*L. tulipifera*); cucumbertree that grows in the yellow-poplar range is not separated from that species on the market.

Magnolia lumber is used principally in the manufacture of furniture, boxes, pallets, venetian blinds, sashes, doors, veneer, and millwork.

### **Maple, Hard**

Hard maple includes sugar maple (*Acer saccharum*) and black maple (*A. nigrum*). Sugar maple is also known as hard and rock maple, and black maple as black sugar maple. Maple lumber is manufactured principally in the Middle Atlantic and Great Lake States, which together account for about two-thirds of production.

The heartwood is usually light reddish brown but sometimes considerably darker. The sapwood is commonly white with a slight reddish-brown tinge. It is roughly 7 to 13 cm or more (3 to 5 in. or more) wide. Hard maple has a fine, uniform texture. It is heavy, strong, stiff, hard, and resistant to shock and has high shrinkage. The grain of sugar maple is generally straight, but birdseye, curly, or fiddleback grain is often selected for furniture or novelty items.

Hard maple is used principally for lumber and veneer. A large proportion is manufactured into flooring, furniture, cabinets, cutting boards and blocks, pianos, billiard cues, handles, novelties, bowling alleys, dance and gymnasium floors, spools, and bobbins.

### **Maple, Soft**

Soft maple includes silver maple (*Acer saccharinum*), red maple (*A. rubrum*), boxelder (*A. negundo*), and bigleaf maple (*A. macrophyllum*). Silver maple is also known as white, river, water, and swamp maple; red maple as soft, water, scarlet, white, and swamp maple; boxelder as ash-leaved, three-leaved, and cut-leaved maple; and bigleaf maple as Oregon maple. Soft maple is found in the eastern United States except for bigleaf maple, which comes from the Pacific Coast.

Heartwood and sapwood are similar in appearance to hard maple: heartwood of soft maple is somewhat lighter in color and the sapwood, somewhat wider. The wood of soft maple, primarily silver and red maple, resembles that of hard maple but is not as heavy, hard, and strong.

Soft maple is used for railroad crossties, boxes, pallets, crates, furniture, veneer, wooden ware, and novelties.

### **Oak (Red Oak Group)**

Most red oak comes from the Eastern States. The principal species are northern red (*Quercus rubra*), scarlet (*Q. cocinea*), Shumard (*Q. shumardii*), pin (*Q. palustris*), Nuttall (*Q. nuttallii*), black (*Q. velutina*), southern red (*Q. falcata*), cherrybark (*Q. falcata* var. *pagodaefolia*), water (*Q. nigra*), laurel (*Q. laurifolia*), and willow (*Q. phellos*) oak.

The sapwood is nearly white and roughly 2 to 5 cm (1 to 2 in.) wide. The heartwood is brown with a tinge of red. Sawn lumber of the red oak group cannot be separated by species on the basis of wood characteristics alone.



Red oak lumber can be separated from white oak by the size and arrangement of pores in latewood and because it generally lacks tyloses in the pores. The open pores of red oak make this species group unsuitable for tight cooperage, unless the barrels are lined with sealer or plastic. Quartersawn lumber of the oaks is distinguished by the broad and conspicuous rays. Wood of the red oaks is heavy. Rapidly grown second-growth wood is generally harder and tougher than finer textured old-growth wood. The red oaks have fairly high shrinkage in drying.

The red oaks are primarily cut into lumber, railroad crossties, mine timbers, fence posts, veneer, pulpwood, and fuelwood. Ties, mine timbers, and fence posts require preservative treatment for satisfactory service. Red oak lumber is remanufactured into flooring, furniture, general millwork, boxes, pallets and crates, agricultural implements, caskets, wooden ware, and handles. It is also used in railroad cars and boats.

### Oak (White Oak Group)

White oak lumber comes chiefly from the South, South Atlantic, and Central States, including the southern Appalachian area. Principal species are white (*Quercus alba*), chestnut (*Q. prinus*), post (*Q. stellata*), overcup (*Q. lyrata*), swamp chestnut (*Q. michauxii*), bur (*Q. macrocarpa*), chinkapin (*Q. muehlenbergii*), swamp white (*Q. bicolor*), and live (*Q. virginiana*) oak.

The sapwood of the white oaks is nearly white and roughly 2 to 5 cm or more (1 to 2 in. or more) wide. The heartwood is generally grayish brown. Heartwood pores are usually plugged with tyloses, which tend to make the wood impenetrable by liquids. Consequently, most white oaks are suitable for tight cooperage. Many heartwood pores of chestnut oak lack tyloses. The wood of white oak is heavy, averaging somewhat greater in weight than red oak wood. The heartwood has good decay resistance.

White oaks are usually cut into lumber, railroad crossties, cooperage, mine timbers, fence posts, veneer, fuelwood, and many other products. High-quality white oak is especially sought for tight cooperage. Live oak is considerably heavier and stronger than the other oaks, and it was formerly used extensively for ship timbers. An important use of white oak is for planking and bent parts of ships and boats; heartwood is often specified because of its decay resistance. White oak is also used for furniture, flooring, pallets, agricultural implements, railroad cars, truck floors, furniture, doors, and millwork.

### Sassafras

Sassafras (*Sassafras albidum*) ranges through most of the eastern half of the United States, from southeastern Iowa and eastern Texas eastward.

Sassafras is easily confused with black ash, which it resembles in color, grain, and texture. Sapwood is light yellow, and heartwood varies from dull grayish brown to dark brown, sometimes with a reddish tinge. Freshly cut surfaces have the

characteristic odor of sassafras. The wood is moderately heavy, moderately hard, moderately weak in bending and endwise compression, quite high in shock resistance, and resistant to decay.

Sassafras was highly prized by the Indians for dugout canoes, and some sassafras lumber is still used for small boats. Locally, sassafras is used for fence posts and rails and for general millwork.

### Sweetgum

Sweetgum (*Liquidambar styraciflua*) grows from southwestern Connecticut westward into Missouri and southward to the Gulf Coast. Almost all lumber is produced in the Southern and South Atlantic States.

The lumber from sweetgum is usually marked as sap gum (the light-colored sapwood) or redgum (the reddish-brown heartwood). Sweetgum often has a form of cross grain called interlocked grain, and it must be dried slowly. When quartersawn, interlocked grain produces a ribbon-type stripe that is desirable for interior woodwork and furniture. The wood is moderately heavy and hard. It is moderately strong, moderately stiff, and moderately high in shock resistance.

Sweetgum is used principally for lumber, veneer, plywood, slack cooperage, railroad crossties, fuel, pulpwood, boxes and crates, furniture, interior moulding, and millwork.

### Sycamore, American

American sycamore (*Platanus occidentalis*) is known as sycamore and sometimes as buttonwood, buttonball-tree, and in the United Kingdom, planetree. Sycamore grows from Maine to Nebraska, southward to Texas, and eastward to Florida.

The heartwood of sycamore is reddish brown; the sapwood is lighter in color and from 4 to 8 cm (1-1/2 to 3 in.) wide. The wood has a fine texture and interlocked grain. It has high shrinkage in drying; is moderately heavy, moderately hard, moderately stiff, and moderately strong; and has good resistance to shock.

Sycamore is used principally for lumber, veneer, railroad crossties, slack cooperage, fence posts, and fuel. The lumber is used for furniture, boxes (particularly small food containers), pallets, flooring, handles, and butcher blocks. Veneer is used for fruit and vegetable baskets and some decorative panels and door skins.

### Tanoak

Tanoak (*Lithocarpus densiflorus*) has recently gained some commercial value, primarily in California and Oregon. It is also known as tanbark-oak because high-grade tannin was once obtained from the bark in commercial quantities. This species is found in southwestern Oregon and south to Southern California, mostly near the coast but also in the Sierra Nevadas.

Sapwood of tanoak is light reddish brown when first cut and turns darker with age to become almost indistinguishable from heartwood, which also ages to dark reddish brown. The wood is heavy and hard; except for compression perpendicular to grain, the wood has roughly the same strength properties as those of eastern white oak. Tanoak has higher shrinkage during drying than does white oak, and it has a tendency to collapse during drying. Tanoak is quite susceptible to decay, but the sapwood takes preservatives easily. Tanoak has straight grain, machines and glues well, and takes stains readily.

Because of its hardness and abrasion resistance, tanoak is excellent for flooring in homes or commercial buildings. It is also suitable for industrial applications such as truck flooring. Tanoak treated with preservative has been used for railroad crossties. The wood has been manufactured into baseball bats with good results, and it is also suitable for veneer, both decorative and industrial, and for high quality furniture.

### **Tupelo**

The tupelo group includes water (*Nyssa aquatica*), black (*N. sylvatica*), swamp (*N. sylvatica* var. *biflora*), and Ogeechee (*N. ogeche*) tupelo. Water tupelo is also known as tupelo gum, swamp tupelo, and sourgum; black tupelo, as blackgum and sourgum; swamp tupelo, as swamp blackgum, blackgum, and sourgum; and Ogeechee tupelo, as sour tupelo, gopher plum, and Ogeechee plum. All except black tupelo grow principally in the southeastern United States. Black tupelo grows in the eastern United States from Maine to Texas and Missouri. About two-thirds of the production of tupelo lumber is from Southern States.

Wood of the different tupelo species is quite similar in appearance and properties. The heartwood is light brownish gray and merges gradually into the lighter-colored sapwood, which is generally many centimeters wide. The wood has fine, uniform texture and interlocked grain. Tupelo wood is moderately heavy, moderately strong, moderately hard and stiff, and moderately high in shock resistance. Buttresses of trees growing in swamps or flooded areas contain wood that is much lighter in weight than that from upper portions of the same trees. Because of interlocked grain, tupelo lumber requires care in drying.

Tupelo is cut principally for lumber, veneer, pulpwood, and some railroad crossties and slack cooperage. Lumber goes into boxes, pallets, crates, baskets, and furniture.

### **Walnut, Black**

Black walnut (*Juglans nigra*), also known as American black walnut, ranges from Vermont to the Great Plains and southward into Louisiana and Texas. About three-quarters of walnut wood is grown in the Central States.

The heartwood of black walnut varies from light to dark brown; the sapwood is nearly white and up to 8 cm (3 in.) wide in open-grown trees. Black walnut is normally straight grained, easily worked with tools, and stable in use. It is

heavy, hard, strong, and stiff, and has good resistance to shock. Black walnut is well suited for natural finishes.

Because of its good properties and interesting grain pattern, black walnut is much valued for furniture, architectural woodwork, and decorative panels. Other important uses are gunstocks, cabinets, and interior woodwork.

### **Willow, Black**

Black willow (*Salix nigra*) is the most important of the many willows that grow in the United States. It is the only willow marketed under its own name. Most black willow comes from the Mississippi Valley, from Louisiana to southern Missouri and Illinois.

The heartwood of black willow is grayish brown or light reddish brown and frequently contains darker streaks. The sapwood is whitish to creamy yellow. The wood is uniform in texture, with somewhat interlocked grain, and light in weight. It has exceedingly low strength as a beam or post, is moderately soft, and is moderately high in shock resistance. It has moderately high shrinkage.

Black willow is principally cut into lumber. Small amounts are used for slack cooperage, veneer, excelsior, charcoal, pulpwood, artificial limbs, and fence posts. The lumber is remanufactured principally into boxes, pallets, crates, caskets, and furniture.

### **Yellow-Poplar**

Yellow-poplar (*Liriodendron tulipifera*) is also known as poplar, tulip-poplar, and tulipwood. Sapwood from yellow-poplar is sometimes called white poplar or whitewood. Yellow-poplar grows from Connecticut and New York southward to Florida and westward to Missouri. The greatest commercial production of yellow-poplar lumber is in the South and Southeast.

Yellow-poplar sapwood is white and frequently several centimeters wide. The heartwood is yellowish brown, sometimes streaked with purple, green, black, blue, or red. These colorations do not affect the physical properties of the wood. The wood is generally straight grained and comparatively uniform in texture. Slow-grown wood is moderately light in weight and moderately low in bending strength, moderately soft, and moderately low in shock resistance. The wood has moderately high shrinkage when dried from a green condition, but it is not difficult to dry and is stable after drying. Much of the second-growth wood is heavier, harder, and stronger than that of older trees that have grown more slowly.

The lumber is used primarily for furniture, interior moulding, siding, cabinets, musical instruments, and structural components. Boxes, pallets, and crates are made from lower-grade stock. Yellow-poplar is also made into plywood for paneling, furniture, piano cases, and various other special products.



**Figure 1–1. Cypress-tupelo swamp near New Orleans, LA. Species include baldcypress (*Taxodium distichum*), tupelo (*Nyssa*), ash (*Fraxinus*), willow (*Salix*), and elm (*Ulmus*). Swollen buttresses and “knees” are typically present in cypress.**

## Softwoods

### Baldcypress

Baldcypress or cypress (*Taxodium distichum*) is also known as southern-cypress, red-cypress, yellow-cypress, and white-cypress. Commercially, the terms tidewater red-cypress, gulf-cypress, red-cypress (coast type), and yellow-cypress (inland type) are frequently used. About half of the cypress lumber comes from the Southern States and about a fourth from the South Atlantic States (Fig. 1–1). Old-growth baldcypress is no longer readily available, but second-growth wood is available.

Sapwood of baldcypress is narrow and nearly white. The color of heartwood varies widely, ranging from light yellowish brown to dark brownish red, brown, or chocolate. The wood is moderately heavy, moderately strong, and moderately hard. The heartwood of old-growth baldcypress is one of the most decay resistant of U.S. species, but second-growth wood is only moderately resistant to decay. Shrinkage is moderately low but somewhat higher than that of the cedars and lower than that of Southern Pine. The wood of certain baldcypress trees frequently contains pockets or localized areas that have been attacked by a fungus. Such wood is known as pecky cypress. The decay caused by this fungus is stopped when the wood is cut into lumber and dried. Pecky cypress is therefore durable and useful where water tightness is unnecessary, appearance is not important, or a novel effect is desired.

When old-growth wood was available, baldcypress was used principally for building construction, especially where resistance to decay was required. It was also used for caskets, sashes, doors, blinds, tanks, vats, ship and boat building,

and cooling towers. Second-growth wood is used for siding and millwork, including interior woodwork and paneling. Pecky cypress is used for paneling in restaurants, stores, and other buildings.

### Douglas-Fir

Douglas-fir (*Pseudotsuga menziesii*) is also known locally as red-fir, Douglas-spruce, and yellow-fir. Its range extends from the Rocky Mountains to the Pacific Coast and from Mexico to central British Columbia.

Sapwood of Douglas-fir is narrow in old-growth trees but may be as much as 7 cm (3 in.) wide in second-growth trees of commercial size. Young trees of moderate to rapid growth have reddish heartwood and are called red-fir. Very narrow-ringed heartwood of old-growth trees may be yellowish brown and is known on the market as yellow-fir. The wood of Douglas-fir varies widely in weight and strength. When lumber of high strength is needed for structural uses, selection can be improved by selecting wood with higher density.

Douglas-fir is used mostly for building and construction purposes in the form of lumber, marine fendering (Fig. 1–2), piles, and plywood. Considerable quantities are used for railroad cross-ties, cooperage stock, mine timbers, poles, and fencing. Douglas-fir lumber is used in the manufacture of various products, including sashes, doors, laminated beams, general millwork, railroad-car construction, boxes, pallets, and crates. Small amounts are used for flooring, furniture, ship and boat construction, and tanks. Douglas-fir plywood has found application in construction, furniture, cabinets, marine use, and other products.

### Firs, True (Eastern Species)

Balsam fir (*Abies balsamea*) grows principally in New England, New York, Pennsylvania, and the Great Lake States. Fraser fir (*A. fraseri*) grows in the Appalachian Mountains of Virginia, North Carolina, and Tennessee.

The wood of the eastern true firs, as well as the western true firs, is creamy white to pale brown. The heartwood and sapwood are generally indistinguishable. The similarity of wood structure in the true firs makes it impossible to distinguish the species by examination of the wood alone. Balsam and Fraser firs are lightweight, have low bending and compressive strength, are moderately low in stiffness, are soft, and have low resistance to shock.

The eastern firs are used mainly for pulpwood, although some lumber is produced for structural products, especially in New England and the Great Lake States.

### Firs, True (Western Species)

Six commercial species make up the western true firs: subalpine fir (*Abies lasiocarpa*), California red fir (*A. magnifica*), grand fir (*A. grandis*), noble fir (*A. procera*), Pacific silver fir (*A. amabilis*), and white fir (*A. concolor*). The western true firs are cut for lumber primarily in Washington, Oregon, California, western Montana, and northern Idaho, and they are marketed as white fir throughout the United States.



**Figure 1–2. Wood is favored for waterfront structures, particularly fendering, because of its shock-absorbing qualities. The fendering on this dock in Key West, FL, is made of creosote-treated Douglas-fir (*Pseudotsuga menziesii*). Some tropical species are resistant to attack by decay fungi and marine borers and are used for marine construction without preservative treatment.**

The wood of the western true firs is similar to that of the eastern true firs, which makes it impossible to distinguish the true fir species by examination of the wood alone. Western true firs are light in weight but, with the exception of subalpine fir, have somewhat higher strength properties than does balsam fir. Shrinkage of the wood is low to moderately high.

Lumber of the western true firs is primarily used for building construction, boxes and crates, planing-mill products, sashes, doors, and general millwork. In house construction, the lumber is used for framing, subflooring, and sheathing. Some western true fir lumber is manufactured into boxes and crates. High-grade lumber from noble fir is used mainly for interior woodwork, moulding, siding, and sash and door stock. Some of the highest quality material is suitable for aircraft construction. Other special uses of noble fir are venetian blinds and ladder rails.

### **Hemlock, Eastern**

Eastern hemlock (*Tsuga canadensis*) grows from New England to northern Alabama and Georgia, and in the Great Lake States. Other names are Canadian hemlock and hemlock–spruce. The production of hemlock lumber is divided fairly evenly among the New England States, Middle Atlantic States, and Great Lake States.

The heartwood of eastern hemlock is pale brown with a reddish hue. The sapwood is not distinctly separated from the heartwood but may be lighter in color. The wood is coarse and uneven in texture (old trees tend to have considerable shake); it is moderately lightweight, moderately hard, moderately low in strength, moderately stiff, and moderately low in shock resistance.

Eastern hemlock is used principally for lumber and pulpwood. The lumber is used primarily in building construction (framing, sheathing, subflooring, and roof boards) and in the manufacture of boxes, pallets, and crates.

## Hemlock, Western and Mountain

Western hemlock (*Tsuga heterophylla*) is also known as West Coast hemlock, Pacific hemlock, British Columbia hemlock, hemlock–spruce, and western hemlock–fir. It grows along the Pacific coast of Oregon and Washington and in the northern Rocky Mountains north to Canada and Alaska. A relative of western hemlock, mountain hemlock (*T. mertensiana*) grows in mountainous country from central California to Alaska. It is treated as a separate species in assigning lumber properties.

The heartwood and sapwood of western hemlock are almost white with a purplish tinge. The sapwood, which is sometimes lighter in color than the heartwood, is generally not more than 2.5 cm (1 in.) wide. The wood often contains small, sound, black knots that are usually tight and dimensionally stable. Dark streaks are often found in the lumber; these are caused by hemlock bark maggots and generally do not reduce strength. Western hemlock is moderately light in weight and moderate in strength. It is also moderate in hardness, stiffness, and shock resistance. Shrinkage of western hemlock is moderately high, about the same as that of Douglas-fir (*Pseudotsuga menziesii*). Green hemlock lumber contains considerably more water than does Douglas-fir and requires longer kiln-drying time. Mountain hemlock has approximately the same density as that of western hemlock but is somewhat lower in bending strength and stiffness.

Western hemlock and mountain hemlock are used principally for pulpwood, lumber, and plywood. The lumber is used primarily for building material, such as sheathing, siding, subflooring, joists, studding, planking, and rafters, as well as in the manufacture of boxes, pallets, crates, flooring, furniture, and ladders.

## Incense-Cedar

Incense-cedar (*Calocedrus decurrens* (synonym *Libocedrus decurrens*)) grows in California, southwestern Oregon, and extreme western Nevada. Most incense-cedar lumber comes from the northern half of California.

Sapwood of incense-cedar is white or cream colored, and heartwood is light brown, often tinged with red. The wood has a fine, uniform texture and a spicy odor. Incense-cedar is light in weight, moderately low in strength, soft, low in shock resistance, and low in stiffness. It has low shrinkage and is easy to dry, with little checking or warping.

Incense-cedar is used principally for lumber and fence posts. Nearly all the high-grade lumber is used for pencils and venetian blinds; some is used for chests and toys. Much incense-cedar wood is more or less pecky; that is, it contains pockets or areas of disintegrated wood caused by advanced stages of localized decay in the living tree. There is no further development of decay once the lumber is dried. This low-quality lumber is used locally for rough construction where low cost and decay resistance are important. Because of its resistance to decay, incense-cedar is well suited for fence posts. Other uses are railroad crossties, poles, and split shingles.

## Larch, Western

Western larch (*Larix occidentalis*) grows in western Montana, northern Idaho, northeastern Oregon, and on the eastern slope of the Cascade Mountains in Washington. About two-thirds of the lumber of this species is produced in Idaho and Montana and one-third in Oregon and Washington.

The heartwood of western larch is yellowish brown and the sapwood, yellowish white. The sapwood is generally not more than 2.5 cm (1 in.) wide. The wood is stiff, moderately strong and hard, moderately high in shock resistance, and moderately heavy. It has moderately high shrinkage. The wood is usually straight grained, splits easily, and is subject to ring shake. Knots are common but generally small and tight.

Western larch is used mainly for rough dimension wood in building construction, small timbers, planks and boards, and railroad crossties and mine timbers. It is used also for piles, poles, and posts. Some high-grade material is manufactured into interior woodwork, flooring, sashes, and doors. The properties of western larch are similar to those of Douglas-fir (*Pseudotsuga menziesii*), and these species are sometimes sold mixed.

## Pine, Eastern White

Eastern white pine (*Pinus strobus*) grows from Maine to northern Georgia and in the Great Lake States. It is also known as white pine, northern white pine, Weymouth pine, and soft pine. About one-half the production of eastern white pine lumber occurs in New England, about one-third in the Great Lake States, and most of the remainder in the Middle Atlantic and South Atlantic States.

The heartwood of eastern white pine is light brown, often with a reddish tinge. It turns darker on exposure to air. The wood has comparatively uniform texture and is straight grained. It is easily kiln dried, has low shrinkage, and ranks high in stability. It is also easy to work and can be readily glued. Eastern white pine is lightweight, moderately soft, moderately low in strength, low in shock resistance, and low in stiffness.

Practically all eastern white pine is converted into lumber, which is used in a great variety of ways. A large proportion, mostly second-growth knotty wood or lower grades, is used for structural lumber. High-grade lumber is used for patterns for castings. Other important uses are sashes, doors, furniture, interior woodwork, knotty paneling, caskets, shade and map rollers, and toys.

## Pine, Jack

Jack pine (*Pinus banksiana*), sometimes known as scrub, gray, and black pine in the United States, grows naturally in the Great Lake States and in a few scattered areas in New England and northern New York. Jack pine lumber is sometimes not separated from the other pines with which it grows, including red pine (*Pinus resinosa*) and eastern white pine (*Pinus strobus*).

Sapwood of jack pine is nearly white; heartwood is light brown to orange. Sapwood may constitute one-half or more of the volume of a tree. The wood has a rather coarse texture and is somewhat resinous. It is moderately lightweight, moderately low in bending strength and compressive strength, moderately low in shock resistance, and low in stiffness. It also has moderately low shrinkage. Lumber from jack pine is generally knotty.

Jack pine is used for pulpwood, box lumber, and pallets. Less important uses include railroad crossties, mine timber, slack cooperage, poles, posts, and fuel.

### **Pine, Jeffrey (see Pine, Ponderosa)**

#### **Pine, Lodgepole**

Lodgepole pine (*Pinus contorta*), also known as knotty, black, and spruce pine, grows in the Rocky Mountain and Pacific Coast regions as far northward as Alaska. Wood for lumber and other products is produced primarily in the central Rocky Mountain States; other producing regions are Idaho, Montana, Oregon, and Washington.

The heartwood of lodgepole pine varies from light yellow to light yellow-brown. The sapwood is yellow or nearly white. The wood is generally straight grained with narrow growth rings. The wood is moderately lightweight, is fairly easy to work, and has moderately high shrinkage. It is moderately low in strength, moderately soft, moderately stiff, and moderately low in shock resistance.

Lodgepole pine is used for lumber, mine timbers, railroad crossties, and poles. Less important uses include posts and fuel. Lodgepole pine is being used increasingly for framing, siding, millwork, flooring, and cabin logs.

#### **Pine, Pitch**

Pitch pine (*Pinus rigida*) grows from Maine along the mountains to eastern Tennessee and northern Georgia.

The heartwood is brownish red and resinous; the sapwood is wide and light yellow. The wood of pitch pine is moderately heavy to heavy, moderately strong, stiff, and hard, and moderately high in shock resistance. Shrinkage ranges from moderately low to moderately high.

Pitch pine is used for lumber, fuel, and pulpwood. The lumber is classified as a minor species in grading rules for the Southern Pine species group.

#### **Pine, Pond**

Pond pine (*Pinus serotina*) grows in the coastal region from New Jersey to Florida. It occurs in small groups or singly, mixed with other pines on low flats.

Sapwood of pond pine is wide and pale yellow; heartwood is dark orange. The wood is heavy, coarse grained, and resinous. Shrinkage is moderately high. The wood is moderately strong, stiff, moderately hard, and moderately high in shock resistance.



**Figure 1–3. Ponderosa pine (*Pinus ponderosa*) growing in an open or park-like habitat.**

Pond pine is used for general construction, railway crossties, posts, and poles. The lumber of this species is also graded as a minor species in grading rules for the Southern Pine species group.

#### **Pine, Ponderosa**

Ponderosa pine (*Pinus ponderosa*) is also known as ponderosa, western soft, western yellow, bull, and blackjack pine. Jeffrey pine (*P. jeffreyi*), which grows in close association with ponderosa pine in California and Oregon, is usually marketed with ponderosa pine and sold under that name. Major ponderosa pine producing areas are in Oregon, Washington, and California (Fig. 1–3). Other important producing areas are in Idaho and Montana; lesser amounts come from the southern Rocky Mountain region, the Black Hills of South Dakota, and Wyoming.

The heartwood of ponderosa pine is light reddish brown, and the wide sapwood is nearly white to pale yellow. The wood of the outer portions of ponderosa pine of sawtimber size is generally moderately light in weight, moderately low in strength, moderately soft, moderately stiff, and moderately low in shock resistance. It is generally straight grained and has moderately low shrinkage. It is quite uniform in texture and has little tendency to warp and twist.

Ponderosa pine is used mainly for lumber and to a lesser extent for piles, poles, posts, mine timbers, veneer, and railroad crossties. The clear wood is used for sashes, doors, blinds, moulding, paneling, interior woodwork, and built-in cases and cabinets. Low-grade lumber is used for boxes and crates. Much intermediate- or low-grade lumber is used for sheathing, subflooring, and roof boards. Knotty ponderosa pine is used for interior woodwork.

## **Pine, Red**

Red pine (*Pinus resinosa*) is frequently called Norway pine and occasionally known as hard pine and pitch pine. This species grows in New England, New York, Pennsylvania, and the Great Lake States.

The heartwood of red pine varies from pale red to reddish brown. The sapwood is nearly white with a yellowish tinge and is generally from 5 to 10 cm (2 to 4 in.) wide. The wood resembles the lighter weight wood of the Southern Pine species group. Latewood is distinct in the growth rings. Red pine is moderately heavy, moderately strong and stiff, moderately soft, and moderately high in shock resistance. It is generally straight grained, not as uniform in texture as eastern white pine (*Pinus strobus*), and somewhat resinous. The wood has moderately high shrinkage, but it is not difficult to dry and is dimensionally stable when dried.

Red pine is used principally for lumber, cabin logs, and pulpwood, and to a lesser extent for piles, poles, posts, and fuel. The lumber is used for many of the same purposes as for eastern white pine (*Pinus strobus*). Red pine lumber is used primarily for building construction, including treated lumber for decking, siding, flooring, sashes, doors, general mill-work, and boxes, pallets, and crates.

## **Pine, Southern**

A number of species are included in the group marketed as Southern Pine lumber. The four major Southern Pine species and their growth ranges are as follows: (a) longleaf pine (*Pinus palustris*), eastern North Carolina southward into Florida and westward into eastern Texas; (b) shortleaf pine (*P. echinata*), southeastern New York and New Jersey southward to northern Florida and westward into eastern Texas and Oklahoma; (c) loblolly pine (*P. taeda*), Maryland southward through the Atlantic Coastal Plain and Piedmont Plateau into Florida and westward into eastern Texas; (d) slash pine (*P. elliottii*), Florida and southern South Carolina, Georgia, Alabama, Mississippi, and Louisiana east of the Mississippi River. Lumber from these four species is classified as Southern Pine by the grading standards of the industry. These standards also classify lumber produced from the longleaf and slash pine species as longleaf pine if the lumber conforms to the growth-ring and latewood requirements of such standards. Southern Pine lumber is produced principally in the Southern and South Atlantic States. Georgia, Alabama, North Carolina, Arkansas, and Louisiana lead in Southern Pine lumber production.

The wood of these southern pines is quite similar in appearance. Sapwood is yellowish white and heartwood, reddish brown. The sapwood is usually wide in second-growth stands. The heartwood begins to form when the tree is about 20 years old. In old, slow-growth trees, sapwood may be only 2 to 5 cm (1 to 2 in.) wide.

Longleaf and slash pine are classified as heavy, strong, stiff, hard, and moderately high in shock resistance. Shortleaf and loblolly pine are usually somewhat lighter in weight than is longleaf. All the southern pines have moderately high

shrinkage but are dimensionally stable when properly dried. To obtain heavy, strong wood of the southern pines for structural purposes, a density rule has been written that specifies a certain percentage of latewood and growth rates for structural timbers.

The denser and higher strength southern pines are extensively used in the form of stringers in construction of factories, warehouses, bridges, trestles, and docks, and also for roof trusses, beams, posts, joists, and piles. Lumber of lower density and strength is also used for building material, such as interior woodwork, sheathing, and subflooring, as well as boxes, pallets, and crates. Southern Pine is used also for tight and slack cooperage. When used for railroad cross-ties, piles, poles, mine timbers, and exterior decking, it is usually treated with preservatives. The manufacture of structural-grade plywood from Southern Pine is a major wood-using industry, as is the production of preservative-treated lumber.

## **Pine, Spruce**

Spruce pine (*Pinus glabra*), also known as cedar, poor, Walter, and bottom white pine, is classified as a minor species in the Southern Pine species group. Spruce pine grows most commonly on low moist lands of the coastal regions of southeastern South Carolina, Georgia, Alabama, Mississippi, and Louisiana, and northern and northwestern Florida.

The heartwood of spruce pine is light brown, and the wide sapwood is nearly white. Spruce pine wood is lower in most strength values than the wood of the major Southern Pine species group. Spruce pine compares favorably with the western true firs in important bending properties, crushing strength (perpendicular and parallel to grain), and hardness. It is similar to denser species such as coast Douglas-fir (*Pseudotsuga menziesii*) and loblolly pine (*Pinus taeda*) in shear parallel to grain.

In the past, spruce pine was principally used locally for lumber, pulpwood, and fuelwood. The lumber reportedly was used for sashes, doors, and interior woodwork because of its low specific gravity and similarity of earlywood and latewood. In recent years, spruce pine has been used for plywood.

## **Pine, Sugar**

Sugar pine (*Pinus lambertiana*), the world's largest species of pine, is sometimes called California sugar pine. Most sugar pine lumber grows in California and southwestern Oregon.

The heartwood of sugar pine is buff or light brown, sometimes tinged with red. The sapwood is creamy white. The wood is straight grained, fairly uniform in texture, and easy to work with tools. It has very low shrinkage, is readily dried without warping or checking, and is dimensionally stable. Sugar pine is lightweight, moderately low in strength, moderately soft, low in shock resistance, and low in stiffness.



Sugar pine is used almost exclusively for lumber products. The largest volume is used for boxes and crates, sashes, doors, frames, blinds, general millwork, building construction, and foundry patterns. Like eastern white pine (*Pinus strobus*), sugar pine is suitable for use in nearly every part of a house because of the ease with which it can be cut, its dimensional stability, and its good nailing properties.

### **Pine, Virginia**

Virginia pine (*Pinus virginiana*), also known as Jersey and scrub pine, grows from New Jersey and Virginia throughout the Appalachian region to Georgia and the Ohio Valley. It is classified as a minor species in the grading rules for the Southern Pine species group.

The heartwood is orange, and the sapwood is nearly white and relatively wide. The wood is moderately heavy, moderately strong, moderately hard, and moderately stiff and has moderately high shrinkage and high shock resistance.

Virginia pine is used for lumber, railroad crossties, mine timbers, and pulpwood.

### **Pine, Western White**

Western white pine (*Pinus monticola*) is also known as Idaho white pine or white pine. About four-fifths of the wood for lumber from this species is from Idaho and Washington; small amounts are cut in Montana and Oregon.

The heartwood of western white pine is cream colored to light reddish brown and darkens on exposure to air. The sapwood is yellowish white and generally from 2 to 8 cm (1 to 3 in.) wide. The wood is straight grained, easy to work, easily kiln-dried, and stable after drying. This species is moderately lightweight, moderately low in strength, moderately soft, moderately stiff, and moderately low in shock resistance and has moderately high shrinkage.

Practically all western white pine is sawn into lumber, which is used mainly for building construction, matches, boxes, patterns, and millwork products, such as sashes and door frames. In building construction, lower-grade boards are used for sheathing, knotty paneling, and subflooring. High-grade material is made into siding of various kinds, exterior and interior woodwork, and millwork. Western white pine has practically the same uses as eastern white pine (*Pinus strobus*) and sugar pine (*Pinus lambertiana*).

### **Port-Orford-Cedar**

Port-Orford-cedar (*Chamaecyparis lawsoniana*) is sometimes known as Lawson-cypress, Oregon-cedar, and white-cedar. It grows along the Pacific Coast from Coos Bay, Oregon, southward to California. It does not extend more than 64 km (40 mi) inland.

The heartwood of Port-Orford-cedar is light yellow to pale brown. The sapwood is narrow and hard to distinguish from the heartwood. The wood has fine texture, generally straight grain, and a pleasant spicy odor. It is moderately light-

weight, stiff, moderately strong and hard, and moderately resistant to shock. Port-Orford-cedar heartwood is highly resistant to decay. The wood shrinks moderately, has little tendency to warp, and is stable after drying.

Some high-grade Port-Orford-cedar was once used in the manufacture of storage battery separators, matchsticks, and specialty millwork. Today, other uses are archery supplies, sash and door construction, stadium seats, flooring, interior woodwork, furniture, and boats.

### **Redcedar, Eastern**

Eastern redcedar (*Juniperus virginiana*) grows throughout the eastern half of the United States, except in Maine, Florida, and a narrow strip along the Gulf Coast, and at the higher elevations in the Appalachian Mountain Range. Commercial production is principally in the southern Appalachian and Cumberland Mountain regions. Another species, southern redcedar (*J. silicicola*), grows over a limited area in the South Atlantic and Gulf Coastal Plains.

The heartwood of redcedar is bright or dull red, and the narrow sapwood is nearly white. The wood is moderately heavy, moderately low in strength, hard, and high in shock resistance, but low in stiffness. It has very low shrinkage and is dimensionally stable after drying. The texture is fine and uniform, and the wood commonly has numerous small knots. Eastern redcedar heartwood is very resistant to decay.

The greatest quantity of eastern redcedar is used for fence posts. Lumber is manufactured into chests, wardrobes, and closet lining. Other uses include flooring, novelties, pencils, scientific instruments, and small boats. Southern redcedar is used for the same purposes. Eastern redcedar is reputed to repel moths, but this claim has not been supported by research.

### **Redcedar, Western**

Western redcedar (*Thuja plicata*) grows in the Pacific Northwest and along the Pacific Coast to Alaska. It is also called canoe-cedar, giant arborvitae, shinglewood, and Pacific redcedar. Western redcedar lumber is produced principally in Washington, followed by Oregon, Idaho, and Montana.

The heartwood of western redcedar is reddish or pinkish brown to dull brown, and the sapwood is nearly white. The sapwood is narrow, often not more than 2.5 cm (1 in.) wide. The wood is generally straight grained and has a uniform but rather coarse texture. It has very low shrinkage. This species is lightweight, moderately soft, low in strength when used as a beam or posts, and low in shock resistance. The heartwood is very resistant to decay.

Western redcedar is used principally for shingles, lumber, poles, posts, and piles. The lumber is used for exterior siding, decking, interior woodwork, greenhouse construction, ship and boat building, boxes and crates, sashes, and doors.



## Redwood

Redwood (*Sequoia sempervirens*) grows on the coast of California and some trees are among the tallest in the world. A closely related species, giant sequoia (*Sequoiadendron giganteum*), is volumetrically larger and grows in a limited area in the Sierra Nevadas of California, but its wood is used in very limited quantities. Other names for redwood are coast redwood, California redwood, and sequoia. Production of redwood lumber is limited to California, but the market is nationwide.

The heartwood of redwood varies from light “cherry” red to dark mahogany. The narrow sapwood is almost white. Typical old-growth redwood is moderately lightweight, moderately strong and stiff, and moderately hard. The wood is easy to work, generally straight grained, and shrinks and swells comparatively little. The heartwood from old-growth trees has high decay resistance; heartwood from second-growth trees generally has low to moderate decay resistance.

Most redwood lumber is used for building. It is remanufactured extensively into siding, sashes, doors, blinds, millwork, casket stock, and containers. Because of its durability, redwood is useful for cooling towers, decking, tanks, silos, wood-stave pipe, and outdoor furniture. It is used in agriculture for buildings and equipment. Its use as timbers and large dimension in bridges and trestles is relatively minor. Redwood splits readily and plays an important role in the manufacture of split products, such as posts and fence material. Some redwood veneer is produced for decorative plywood.

## Spruce, Eastern

The term eastern spruce includes three species: red (*Picea rubens*), white (*P. glauca*), and black (*P. mariana*). White and black spruce grow principally in the Great Lake States and New England, and red spruce grows in New England and the Appalachian Mountains.

The wood is light in color, and there is little difference between heartwood and sapwood. All three species have about the same properties, and they are not distinguished from each other in commerce. The wood dries easily and is stable after drying, is moderately lightweight and easily worked, has moderate shrinkage, and is moderately strong, stiff, tough, and hard.

The greatest use of eastern spruce is for pulpwood. Eastern spruce lumber is used for framing material, general millwork, boxes and crates, and piano sounding boards.

## Spruce, Engelmann

Engelmann spruce (*Picea engelmannii*) grows at high elevations in the Rocky Mountain region of the United States. This species is also known as white spruce, mountain spruce, Arizona spruce, silver spruce, and balsam. About two-thirds of the lumber is produced in the southern Rocky Mountain States and most of the remainder in the northern Rocky Mountain States and Oregon.

The heartwood of Engelmann spruce is nearly white, with a slight tinge of red. The sapwood varies from 2 to 5 cm (3/4 to 2 in.) in width and is often difficult to distinguish from the heartwood. The wood has medium to fine texture and is without characteristic odor. Engelmann spruce is rated as lightweight, and it is low in strength as a beam or post. It is also soft and low in stiffness, shock resistance, and shrinkage. The lumber typically contains many small knots.

Engelmann spruce is used principally for lumber and for mine timbers, railroad crossties, and poles. It is used also in building construction in the form of dimension lumber, flooring, and sheathing. It has excellent properties for pulp and papermaking.

## Spruce, Sitka

Sitka spruce (*Picea sitchensis*) is a large tree that grows along the northwestern coast of North America from California to Alaska. It is also known as yellow, tideland, western, silver, and west coast spruce. Much Sitka spruce timber is grown in Alaska, but most logs are sawn into cants for export to Pacific Rim countries. Material for U.S. consumption is produced primarily in Washington and Oregon.

The heartwood of Sitka spruce is a light pinkish brown. The sapwood is creamy white and shades gradually into the heartwood; the sapwood may be 7 to 15 cm (3 to 6 in.) wide or even wider in young trees. The wood has a comparatively fine, uniform texture, generally straight grain, and no distinct taste or odor. It is moderately lightweight, moderately low in bending and compressive strength, moderately stiff, moderately soft, and moderately low in resistance to shock. It has moderately low shrinkage. On the basis of weight, Sitka spruce rates high in strength properties and can be obtained in long, clear, straight-grained pieces.

Sitka spruce is used principally for lumber, pulpwood, and cooperage. Boxes and crates account for a considerable amount of the remanufactured lumber. Other important uses are furniture, planing-mill products, sashes, doors, blinds, millwork, and boats. Sitka spruce has been by far the most important wood for aircraft construction. Other specialty uses are ladder rails and sounding boards for pianos.

## Tamarack

Tamarack (*Larix laricina*), also known as eastern larch and locally as hackmatack, is a small to medium tree with a straight, round, slightly tapered trunk. It grows from Maine to Minnesota, with the bulk of the stand in the Great Lake States.

The heartwood of tamarack is yellowish brown to russet brown. The sapwood is whitish, generally less than 2.5 cm (1 in.) wide. The wood is coarse in texture, without odor or taste, and the transition from earlywood to latewood is abrupt. The wood is intermediate in weight and in most mechanical properties.

Tamarack is used principally for pulpwood, lumber, railroad crossties, mine timbers, fuel, fence posts, and poles. Lumber

is used for framing material, tank construction, and boxes, pallets, and crates. The production of tamarack lumber has declined in recent years.

### White-Cedar, Northern and Atlantic

Two species of white-cedar grow in the eastern part of the United States: northern white-cedar (*Thuja occidentalis*) and Atlantic white-cedar (*Chamaecyparis thyoides*). Northern white-cedar is also known as arborvitae or simply as cedar. Atlantic white-cedar is also known as southern white-cedar, swamp-cedar, and boat-cedar. Northern white-cedar grows from Maine along the Appalachians and westward through the northern part of the Great Lake States. Atlantic white-cedar grows near the Atlantic Coast from Maine to northern Florida and westward along the Gulf Coast to Louisiana. It is strictly a swamp tree. Production of northern white-cedar lumber is greatest in Maine and the Great Lake States. Production of Atlantic white-cedar centers in North Carolina and along the Gulf Coast.

The heartwood of white-cedar is light brown, and the sapwood is white or nearly so. The sapwood is usually narrow. The wood is lightweight, rather soft, and low in strength and shock resistance. It shrinks little in drying. It is easily worked and holds paint well, and the heartwood is highly resistant to decay. Northern and Atlantic white-cedar are used for similar purposes, primarily for poles, cabin logs, railroad crossties, lumber, posts, and decorative fencing. White-cedar lumber is used principally where a high degree of durability is needed, as in tanks and boats, and for wooden ware.

### Yellow-Cedar

Yellow-cedar (*Chamaecyparis nootkatensis*) grows in the Pacific Coast region of North America from southeastern Alaska southward through Washington to southern Oregon.

The heartwood of yellow-cedar is bright, clear yellow. The sapwood is narrow, white to yellowish, and hardly distinguishable from the heartwood. The wood is fine textured and generally straight grained. It is moderately heavy, moderately strong and stiff, moderately hard, and moderately high in shock resistance. Yellow-cedar shrinks little in drying and is stable after drying, and the heartwood is very resistant to decay. The wood has a mild, distinctive odor.

Yellow-cedar is used for interior woodwork, furniture, small boats, cabinetwork, and novelties.

## Imported Woods

This section does not purport to describe all the woods that have been at one time or another imported into the United States. It includes only those species that at present are considered to be commercially important. The same species may be marketed in the United States under other common names. Because of the variation in common names, many cross-references are included. Text information is necessarily brief, but when used in conjunction with the shrinkage and strength data tables (Ch. 3 and 4), a reasonably good picture

may be obtained of a particular wood. The references at the end of this chapter contain information on many species not described in this section.

## Hardwoods

### Afara (see Limba)

### Afromosia

Afromosia or kokrodua (*Pericopsis elata*), a large West African tree, is sometimes used as a substitute for teak (*Tectona grandis*).

The heartwood is fine textured, with straight to interlocked grain. The wood is brownish yellow with darker streaks and moderately hard and heavy, weighing about 700 kg/m<sup>3</sup> (43 lb/ft<sup>3</sup>) at 15% moisture content. The wood strongly resembles teak in appearance but lacks its oily nature and has a different texture. The wood dries readily with little degrade and has good dimensional stability. It is somewhat heavier and stronger than teak. The heartwood is highly resistant to decay fungi and termite attack and is extremely durable under adverse conditions.

Afromosia is often used for the same purposes as teak, such as boat construction, joinery, flooring, furniture, interior woodwork, and decorative veneer.

### Albarco

Albarco, or jequitiba as it is known in Brazil, is the common name applied to species in the genus *Cariniana*. The 10 species are distributed from eastern Peru and northern Bolivia through central Brazil to Venezuela and Colombia.

The heartwood is reddish or purplish brown and sometimes has dark streaks. It is usually not sharply demarcated from the pale brown sapwood. The texture is medium and the grain straight to interlocked. Albarco can be worked satisfactorily with only slight blunting of tool cutting edges because of the presence of silica. Veneer can be cut without difficulty. The wood is rather strong and moderately heavy, weighing about 560 kg/m<sup>3</sup> (35 lb/ft<sup>3</sup>) at 12% moisture content. In general, the wood has about the same strength as that of U.S. oaks (*Quercus* spp.). The heartwood is durable, particularly the deeply colored material. It has good resistance to dry-wood termite attack.

Albarco is primarily used for general construction and carpentry wood, but it can also be used for furniture components, shipbuilding, flooring, veneer for plywood, and turnery.

### Amaranth (see Purpleheart)

### Anani (see Manni)

### Anaura (see Marishballi)

### Andiroba

Because of the widespread distribution of andiroba (*Carapa guianensis*) in tropical America, the wood is known under a variety of names, including cedro macho, carapa, crabwood,

and tangare. These names are also applied to the related species *Carapa nicaraguensis*, whose properties are generally inferior to those of *C. guianensis*.

The heartwood varies from medium to dark reddish brown. The texture is like that of true mahogany (*Swietenia macrophylla*), and andiroba is sometimes substituted for true mahogany. The grain is usually interlocked but is rated easy to work, paint, and glue. The wood is rated as durable to very durable with respect to decay and insects. Andiroba is heavier than true mahogany and accordingly is markedly superior in all static bending properties, compression parallel to grain, hardness, shear, and durability.

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

### **Angelin (see Sucupira)**

#### **Angelique**

Angelique (*Dicorynia guianensis*) comes from French Guiana and Suriname.

Because of the variability in heartwood color between different trees, two forms are commonly recognized by producers. The heartwood that is russet-colored when freshly cut and becomes superficially dull brown with a purplish cast is referred to as “gris.” The heartwood that is more distinctly reddish and frequently shows wide purplish bands is called “angelique rouge.” The texture of the wood is somewhat coarser than that of black walnut (*Juglans nigra*), and the grain is generally straight or slightly interlocked. In strength, angelique is superior to teak (*Tectona grandis*) and white oak (*Quercus alba*), when green or air dry, in all properties except tension perpendicular to grain. Angelique is rated as highly resistant to decay and resistant to marine borer attack. Machining properties vary and may be due to differences in density, moisture content, and silica content. After the wood is thoroughly air 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 wood is also suitable for ship decking, planking, boat frames, industrial flooring, and parquet blocks and strips.

### **Apa (see Wallaba)**

### **Apamate (see Roble)**

### **Apitong (see Keruing)**

#### **Avodire**

Avodire (*Turraeanthus africanus*) has a rather extensive range in Africa, from Sierra Leone westward to the Congo region and southward to Zaire and Angola. It is most common in the eastern region of the Ivory Coast and is scattered elsewhere. Avodire is a medium-size tree of the rainforest

where it forms fairly dense but localized and discontinuous timber stands.

The wood is cream to pale yellow with high natural luster; it eventually darkens to a golden yellow. The grain is sometimes straight but more often wavy or irregularly interlocked, which produces an unusual and attractive mottled figure when sliced or cut on the quarter. Although avodire weighs less than northern red oak (*Quercus rubra*), it has almost identical strength properties except that it is lower in shock resistance and shear. 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. Other uses include furniture, fine joinery, cabinetwork, and paneling.

### **Azobe (Ekki)**

Azobe or ekki (*Lophira alata*) is found in West Africa and extends into the Congo basin.

The heartwood is dark red, chocolate-brown, or purple-brown with conspicuous white deposits in the pores (vessels). The texture is coarse, and the grain is usually interlocked. The wood is strong, and its density averages about 1,120 kg/m<sup>3</sup> (70 lb/ft<sup>3</sup>) at 12% moisture content. It is very difficult to work with hand and machine tools, and tools are severely blunted if the wood is machined when dry. Azobe can be dressed to a smooth finish, and gluing properties are usually good. Drying is very difficult without excessive degrade. The heartwood is rated as very durable against decay but only moderately resistant to termite attack. Azobe is very resistant to acid and has good weathering properties. It is also resistant to teredo attack. The heartwood is extremely resistant to preservative treatment.

Azobe is excellent for heavy construction work, harbor construction, heavy-duty flooring, and railroad crossties.

### **Bagtikan (see Seraya, White)**

#### **Balata**

Balata or bulletwood (*Manilkara bidentata*) is widely distributed throughout the West Indies, Central America, and northern South America.

The heartwood of balata is light to dark reddish brown and not sharply demarcated from the pale brown sapwood. Texture is fine and uniform, and the grain is straight to occasionally wavy or interlocked. Balata is a strong and very heavy wood; density of air-dried wood is 1,060 kg/m<sup>3</sup> (66 lb/ft<sup>3</sup>). It is generally difficult to air dry, with a tendency to develop severe checking and warp. The wood is moderately easy to work despite its high density, and it is rated good to excellent in all machining operations. Balata is very resistant to attack by decay fungi and highly resistant to subterranean termites but only moderately resistant to dry-wood termites.

Balata is suitable for heavy construction, textile and pulpmill equipment, furniture parts, turnery, tool handles, flooring, boat frames and other bentwork, railroad cross-ties, violin bows, billiard cues, and other specialty uses.

### **Balau**

Balau, red balau, and selangan batu constitute a group of species that are the heaviest of the 200 *Shorea* species. About 45 species of this group grow from Sri Lanka and southern India through southeast Asia to the Philippines.

The heartwood is light to deep red or purple-brown, and it is fairly distinct from the lighter and yellowish- to reddish- or purplish-brown sapwood. The texture is moderately fine to coarse, and the grain is often interlocked. The wood weighs more than 750 kg/m<sup>3</sup> (47 lb/ft<sup>3</sup>) at 12% moisture content. Balau is a heavy, hard, and strong timber that dries slowly with moderate to severe end checks and splits. The heartwood is durable to moderately durable and very resistant to preservative treatments.

Balau is used for heavy construction, frames of boats, decking, flooring, and utility furniture.

### **Balau, Red (see Balau)**

### **Balsa**

Balsa (*Ochroma pyramidale*) is widely distributed throughout tropical America from southern Mexico to southern Brazil and Bolivia, but Ecuador has been the principal source of supply since the wood gained commercial importance. It is usually found at lower elevations, especially on bottom-land soils along streams and in clearings and cutover forests. Today, it is often cultivated in plantations.

Several characteristics make balsa suitable for a wide variety of uses. It is the lightest and softest of all woods on the market. The lumber selected for use in the United States weighs, on the average, about 180 kg/m<sup>3</sup> (11 lb/ft<sup>3</sup>) when dry and often as little as 100 kg/m<sup>3</sup> (6 lb/ft<sup>3</sup>). The wood is readily recognized by its light weight; nearly white or oatmeal color, often with a yellowish or pinkish hue; and unique velvety feel.

Because of its light weight and exceedingly porous composition, balsa is highly efficient in uses where buoyancy, insulation against heat or cold, or low propagation of sound and vibration are important. Principal uses are for life-saving equipment, floats, rafts, corestock, insulation, cushioning, sound modifiers, models, and novelties.

### **Banak (Cuangare)**

Various species of banak (*Virola*) occur in tropical America, from Belize and Guatemala southward to Venezuela, the Guianas, the Amazon region of northern Brazil, and southern Brazil, and on the Pacific Coast to Peru and Bolivia. Most of the wood known as banak is *V. koschnyi* of Central America and *V. surinamensis* and *V. sebifera* of northern South America. Botanically, cuangare (*Dialyanthera*) is closely related to banak, and the woods are so similar that they are

generally mixed in the trade. The main commercial supply of cuangare comes from Colombia and Ecuador. Banak and cuangare are common in swamp and marsh forests and may occur in almost pure stands in some areas.

The heartwood of both banak and cuangare is usually pinkish or grayish brown and is generally 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. Machining properties are very good, but when zones of tension wood are present, machining may result in surface fuzziness. The wood finishes readily and is easily glued. Strength properties of banak and cuangare are similar to those of yellow-poplar (*Liriodendron tulipifera*).

Banak is considered a general utility wood for lumber, veneer, and plywood. It is also used for moulding, millwork, and furniture components.

### **Benge (Ehie, Bubinga)**

Although benge (*Guibourtia arnoldiana*), ehie or ovankol (*Guibourtia ehie*), and bubinga (*Guibourtia* spp.) belong to the same West African genus, they differ rather markedly in color and somewhat in texture.

The heartwood of benge is pale yellowish brown to medium brown with gray to almost black stripes. Ehie heartwood tends to be more golden brown to dark brown with gray to almost black stripes. Bubinga heartwood is pink, vivid red, or red-brown with purple streaks, and it becomes yellow or medium brown with a reddish tint upon exposure to air. The texture of ehie is moderately coarse, whereas that of benge and bubinga is fine to moderately fine. All three woods are moderately hard and heavy, but they can be worked well with hand and machine tools. They are listed as moderately durable and resistant to preservative treatment. Drying may be difficult, but with care, the wood dries well.

These woods are used in turnery, flooring, furniture components, cabinetwork, and decorative veneers.

### **Brown Silverballi (see Kaneelhart)**

### **Bubinga (see Benge)**

### **Bulletwood (see Balata)**

### **Carapa (see Andiroba)**

### **Cativo**

Cativo (*Prioria copaifera*) is one of the few tropical American species that occur in abundance and often in nearly pure stands. Commercial stands are found in Nicaragua, Costa Rica, Panama, and Colombia.

Sapwood may be very pale pink or distinctly reddish, and it is usually wide. In trees up to 76 cm (30 in.) in diameter, heartwood may be only 18 cm (7 in.) in diameter. The grain is straight and the texture of the wood is uniform, comparable with that of true mahogany (*Swietenia macrophylla*). On flat-sawn surfaces, the figure is rather subdued as a result of

exposure of the narrow bands of parenchyma tissue. The wood can be dried rapidly and easily with very little degrade. Dimensional stability is very good—practically equal to that of true mahogany. Cativo is classified as a nondurable wood with respect to decay and insects. It may contain appreciable quantities of gum. In wood that has been properly dried, however, the aromatics in the gum are removed and there is no difficulty in finishing.

Considerable quantities of cativo are used for interior woodwork, and resin-stabilized veneer is an important pattern material. Cativo is widely used for furniture and cabinet parts, lumber core for plywood, picture frames, edge banding for doors, joinery, and millwork.

### **Cedro (see Spanish-Cedar)**

### **Cedro Macho (see Andiroba)**

### **Cedro-Rana (see Tornillo)**

### **Ceiba**

Ceiba (*Ceiba pentandra*) is a large tree, which grows to 66 m (200 ft) in height with a straight cylindrical bole 13 to 20 m (40 to 60 ft) long. Trunk diameters of 2 m (6 ft) or more are common. Ceiba grows in West Africa, from the Ivory Coast and Sierra Leone to Liberia, Nigeria, and the Congo region. A related species is lupuna (*Ceiba samauma*) from South America.

Sapwood and heartwood are not clearly demarcated. The wood is whitish, pale brown, or pinkish brown, often with yellowish or grayish streaks. The texture is coarse, and the grain is interlocked or occasionally irregular. Ceiba is very soft and light; density of air-dried wood is 320 kg/m<sup>3</sup> (20 lb/ft<sup>3</sup>). In strength, the wood is comparable with basswood (*Tilia americana*). Ceiba dries rapidly without marked deterioration. It is difficult to saw cleanly and dress smoothly because of the high percentage of tension wood. It provides good veneer and is easy to nail and glue. Ceiba is very susceptible to attack by decay fungi and insects. It requires rapid harvest and conversion to prevent deterioration. Treatability, however, is rated as good.

Ceiba is available in large sizes, and its low density combined with a rather high degree of dimensional stability make it ideal for pattern and corestock. Other uses include blockboard, boxes and crates, joinery, and furniture components.

### **Chewstick (see Manni)**

### **Courbaril (Jatoba)**

The genus *Hymenaea* consists of about 25 species that occur in the West Indies and from southern Mexico through Central America into the Amazon basin of South America. The best-known and most important species is *H. courbaril*, which occurs throughout the range of the genus. Courbaril is often called jatoba in Brazil.

Sapwood of courbaril is gray–white and usually quite wide. The heartwood, which is sharply differentiated from the

sapwood, is salmon red to orange–brown when freshly cut and becomes russet or reddish brown when dried. The heartwood is often marked with dark streaks. The texture is medium to rather coarse, and the grain is mostly interlocked. The wood is hard and heavy (about 800 kg/m<sup>3</sup> (50 lb/ft<sup>3</sup>) at 12% moisture content). The strength properties of courbaril are quite high and very similar to those of shagbark hickory (*Carya ovata*), a species of lower specific gravity. Courbaril is rated as moderately to very resistant to attack by decay fungi and dry-wood termites. The heartwood is not treatable, but the sapwood is treatable with preservatives. Courbaril is moderately difficult to saw and machine because of its high density, but it can be machined to a smooth surface. Turning, gluing, and finishing properties are satisfactory. Planing, however, is somewhat difficult because of the interlocked grain. Courbaril compares favorably with white oak (*Quercus alba*) in steam bending behavior.

Courbaril is used for tool handles and other applications that require good shock resistance. It is also used for steam-bent parts, flooring, turnery, furniture and cabinetwork, veneer and plywood, railroad crossties, and other specialty items.

### **Crabwood (see Andiroba)**

### **Cristobal (see Macawood)**

### **Cuangare (see Banak)**

### **Degame**

Degame or lemonwood (*Calycophyllum candidissimum*) grows in Cuba and ranges from southern Mexico through Central America to Colombia and Venezuela. It may grow in pure stands and is common on shaded hillsides and along waterways.

The heartwood of degame ranges from light brown to oatmeal-colored and is sometimes grayish. The sapwood is lighter in color and merges gradually with the heartwood. The texture is fine and uniform. The grain is usually straight or infrequently shows shallow interlocking, which may produce a narrow and indistinct stripe on quartered faces. In strength, degame is above the average for woods of similar density; density of air-dried wood is 817 kg/m<sup>3</sup> (51 lb/ft<sup>3</sup>). Tests show degame superior to persimmon (*Diospyros virginiana*) in all respects but hardness. Natural durability is low when degame is used under conditions favorable to stain, decay, and insect attack. However, degame is reported to be highly resistant to marine borers. Degame is moderately difficult to machine because of its density and hardness, although it does not dull cutting tools to any extent. Machined surfaces are very smooth.

Degame is little used in the United States, but its characteristics have made it particularly adaptable for shuttles, picker sticks, and other textile industry items that require resilience and strength. Degame was once prized for the manufacture of archery bows and fishing rods. It is also suitable for tool handles and turnery.

## Determa

Determa (*Ocotea rubra*) is native to the Guianas, Trinidad, and the lower Amazon region of Brazil.

The heartwood is light reddish brown with a golden sheen and distinct from the dull gray or pale yellowish brown sapwood. The texture is rather coarse, and the grain is interlocked to straight. Determa is a moderately strong and heavy wood (density of air-dried wood is 640 to 720 kg/m<sup>3</sup> (40 to 45 lb/ft<sup>3</sup>)); this wood is moderately difficult to air dry. It can be worked readily with hand and machine tools with little dulling effect. It can be glued readily and polished fairly well. The heartwood is durable to very durable in resistance to decay fungi and moderately resistant to dry-wood termites. Weathering characteristics are excellent, and the wood is highly resistant to moisture absorption.

Uses for determa include furniture, general construction, boat planking, tanks and cooperage, heavy marine construction, turnery, and parquet flooring.

## Ehie (see Bengé)

## Ekki (see Azobe)

## Ekop

Ekop or gola (*Tetraberlinia tubmaniana*) grows only in Liberia.

The heartwood is light reddish brown and is distinct from the lighter colored sapwood, which may be up to 5 cm (2 in.) wide. The wood is medium to coarse textured, and the grain is interlocked, with a narrow striped pattern on quartered surfaces. The wood weighs about 735 kg/m<sup>3</sup> (46 lb/ft<sup>3</sup>) at 12% moisture content. It dries fairly well but with a marked tendency to end and surface checks. Ekop works well with hand and machine tools and is an excellent wood for turnery. It also slices well into veneer and has good gluing properties. The heartwood is only moderately durable and is moderately resistant to impregnation with preservative treatments.

Ekop is a general utility wood that is used for veneer, plywood, and furniture components.

## Encino (see Oak)

## Gola (see Ekop)

## Goncalo Alves

Most imports of goncalo alves (*Astronium graveolens* and *A. fraxinifolium*) have been from Brazil. These species range from southern Mexico through Central America into the Amazon basin.

Freshly cut heartwood is russet brown, orange-brown, or reddish brown to red with narrow to wide, irregular, medium- to very-dark brown stripes. After exposure to air, the heartwood becomes brown, red, or dark reddish brown with nearly black stripes. The sapwood is grayish white and sharply demarcated from the heartwood. The texture is fine to

medium and uniform. The grain varies from straight to interlocked and wavy.

Goncalo alves turns readily, finishes very smoothly, and takes a high natural polish. The heartwood is highly resistant to moisture absorption; pigmented areas may present some difficulties in gluing because of their high density. The heartwood is very durable and resistant to both white- and brown-rot organisms. The high density (1,010 kg/m<sup>3</sup> (63 lb/ft<sup>3</sup>)) of the air-dried wood is accompanied by equally high strength values, which are considerably higher in most respects than those of any U.S. species. Despite its strength, however, goncalo alves is imported primarily for its beauty.

In the United States, goncalo alves has the greatest value for specialty items such as archery bows, billiard cue butts, brushbacks, and cutlery handles, and in turnery and carving applications.

## Greenheart

Greenheart (*Chlorocardium rodiei* [= *Ocotea rodiei*]) is essentially a Guyana tree although small stands also occur in Suriname.

The heartwood varies from light to dark olive green or nearly black. The texture is fine and uniform, and the grain is straight to wavy. Greenheart is stronger and stiffer than white oak (*Quercus alba*) and generally more difficult to work with tools because of its high density; density of air-dried wood is more than 960 kg/m<sup>3</sup> (60 lb/ft<sup>3</sup>). The heartwood is rated as very resistant to decay fungi and termites. It is also 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. Uses include ship and dock building, lock gates, wharves, piers, jetties, vats, piling, planking, industrial flooring, bridges, and some specialty items (fishing rods and billiard cue butts).

## Guatambu (see Pau Marfim)

## Guayacan (see Ipe)

## Hura

Hura (*Hura crepitans*) grows throughout the West Indies from Central America to northern Brazil and Bolivia.

It is a large tree, commonly reaching a height of 30 to 43 m (90 to 130 ft), with clear boles of 12 to 23 m (40 to 75 ft). The diameter often reaches 1 to 1.5 m (3 to 5 ft) and occasionally to 3 m (9 ft).

The pale yellowish-brown or pale olive-gray heartwood is indistinct from the yellowish-white sapwood. The texture is fine to medium and the grain straight to interlocked. Hura is a low-strength and low-density wood (density of air-dried wood is 240 to 448 kg/m<sup>3</sup> (15 to 28 lb/ft<sup>3</sup>)); the wood is moderately difficult to air dry. Warping is variable and sometimes severe. The wood usually machines easily, but green material is somewhat difficult to work because of tension

wood, which results in a fuzzy surface. The wood finishes well and is easy to glue and nail. Hura is variable in resistance to attack by decay fungi, but it is highly susceptible to blue stain and very susceptible to wood termites. However, the wood is easy to treat with preservative.

Hura is often used in general carpentry, boxes and crates, and lower grade furniture. Other important uses are veneer and plywood, fiberboard, and particleboard.

### **Ilomba**

Ilomba (*Pycnanthus angolensis*) is a tree of the rainforest and ranges from Guinea and Sierra Leone through tropical West Africa to Uganda and Angola. Common names include pycnanthus, walele, and otie.

The wood is grayish white to pinkish brown and, in some trees, a uniform light brown. There is generally no distinction between heartwood and sapwood. The texture is medium to coarse, and the grain is generally straight. This species is generally similar to banak (*Viola*) but has a coarser texture. Air-dry density is about 512 kg/m<sup>3</sup> (31 lb/ft<sup>3</sup>), and the wood is about as strong as yellow-poplar (*Liriodendron tulipifera*). Ilomba dries rapidly but is prone to collapse, warp, and splits. It is easily sawn and can be worked well with hand and machine tools. It is excellent for veneer and has good gluing and nailing characteristics. Green wood is subject to insect and fungal attack. Logs require rapid extraction and conversion to avoid degrade. Both sapwood and heartwood are permeable and can be treated with preservatives.

In the United States, this species is used only in the form of plywood for general utility purposes. However, ilomba is definitely suited for furniture components, interior joinery, and general utility purposes.

### **Ipe**

Ipe, the common name for the lapacho group of the genus *Tabebuia*, consists of about 20 species of trees and occurs in practically every Latin America country except Chile. Other commonly used names are guayacan and lapacho.

Sapwood is relatively wide, yellowish gray or gray-brown, and sharply differentiated from heartwood, which is light to dark olive brown. The texture is fine to medium. The grain is straight to very irregular and often narrowly interlocked. The wood is very heavy and averages about 1,025 kg/m<sup>3</sup> (64 lb/ft<sup>3</sup>) at 12% moisture content. Thoroughly air-dried heartwood specimens generally sink in water. Because of its high density and hardness, ipe is moderately difficult to machine, but glassy smooth surfaces can be produced. Ipe is very strong; in the air-dried condition, it is comparable with greenheart (*Chlorocardium rodiei*). Hardness is two to three times that of white oak (*Quercus alba*) or keruing (*Dipterocarpus*). The wood is highly resistant to decay and insects, including both subtropical and dry-wood termites, but susceptible to marine borer attack. The heartwood is impermeable, but the sapwood can be readily treated with preservatives.

Ipe is used almost exclusively for heavy-duty and durable construction. Because of its hardness and good dimensional stability, it is particularly well suited for heavy-duty flooring in trucks and boxcars. It is also used for decks, railroad crossties, turnery, tool handles, decorative veneers, and some specialty items in textile mills.

### **Ipil (see Merbau)**

### **Iroko**

Iroko consists of two species (*Milicia excelsa* [= *Chlorophora excelsa*] and *M. regia* [= *C. regia*]). *Milicia excelsa* grows across the entire width of tropical Africa from the Ivory Coast southward to Angola and eastward to East Africa. *Milicia regia*, however, is limited to extreme West Africa from Gambia to Ghana; it is less resistant to drought than is *M. excelsa*.

The heartwood varies from a pale yellowish brown to dark chocolate brown with light markings occurring most conspicuously on flat-sawn surfaces; the sapwood is yellowish white. The texture is medium to coarse, and the grain is typically interlocked. Iroko can be worked easily with hand or machine tools but with some tearing of interlocked grain. Occasional deposits of calcium carbonate severely damage cutting edges. The wood dries rapidly with little or no degrade. The strength is similar to that of red maple (*Acer rubrum*), and the weight is about 688 kg/m<sup>3</sup> (43 lb/ft<sup>3</sup>) at 12% moisture content. The heartwood is very resistant to decay fungi and resistant to termite and marine borer attack.

Because of its color and durability, iroko has been suggested as a substitute for teak (*Tectona grandis*). Its durability makes it suitable for boat building, piles, other marine work, and railroad crossties. Other uses include joinery, flooring, furniture, veneer, and cabinetwork.

### **Jacaranda (see Rosewood, Brazilian)**

### **Jarrah**

Jarrah (*Eucalyptus marginata*) is native to the coastal belt of southwestern Australia and is one of the principal species for that country's sawmill industry.

The heartwood is a uniform pink to dark red, often turning to deep brownish red with age and exposure to air. The sapwood is pale and usually very narrow in old trees. The texture is even and moderately coarse, and the grain is frequently interlocked or wavy. The wood weighs about 865 kg/m<sup>3</sup> (54 lb/ft<sup>3</sup>) at 12% moisture content. The common defects of jarrah include gum veins or pockets, which in extreme instances, separate the log into concentric shells. Jarrah is a heavy, hard timber possessing correspondingly high strength properties. It is resistant to attack by termites and rated as very durable with respect to decay. The wood is difficult to work with hand and machine tools because of its high density and irregular grain.

Jarrah is used for decking and underframing of piers, jetties, and bridges, as well as piles and fenders for docks and

harbors. As flooring, jarrah has high resistance to wear, but it is inclined to splinter under heavy traffic. It is also used for railroad cross-ties and other heavy construction.

### **Jatoba (see Courbaril)**

#### **Jelutong**

Jelutong (*Dyera costulata*) is an important species in Malaysia where it is best known for its latex production in the manufacture of chewing gum rather than for its wood.

The wood is white or straw colored, and there is no differentiation between heartwood and sapwood. The texture is moderately fine and even. The grain is straight, and luster is low. The wood weighs about 465 kg/m<sup>3</sup> (28 lb/ft<sup>3</sup>) at 12% moisture content. The wood is very easy to dry with little tendency to split or warp, but staining may cause trouble. It is easy to work in all operations, finishes well, and glues satisfactorily. The wood is rated as nondurable but readily permeable to preservatives.

Because of its low density and ease of working, jelutong is well suited for sculpture and pattern making, wooden shoes, picture frames, and drawing boards.

### **Jequitiba (see Albarco)**

### **Kakaralli (see Manbarklak)**

#### **Kaneelhart**

Kaneelhart or brown silverballi are names applied to the genus *Licaria*. Species of this genus grow mostly in New Guinea and Papua New Guinea and are found in association with greenheart (*Chlorocardium rodiei*) on hilly terrain and wallaba (*Eperua*) in forests.

The orange or brownish yellow heartwood darkens to yellowish or coffee brown on exposure to air. The wood is sometimes tinged with red or violet. The texture is fine to medium, and the grain is straight to slightly interlocked. The wood has a fragrant odor, which is lost in drying. Kaneelhart is a very strong and very heavy wood (density of air-dried wood is 833 to 1,153 kg/m<sup>3</sup> (52 to 72 lb/ft<sup>3</sup>)); the wood is difficult to work. It cuts smoothly and takes an excellent finish but requires care in gluing. Kaneelhart has excellent resistance to both brown- and white-rot fungi and is also rated very high in resistance to dry-wood termites.

Uses of kaneelhart include furniture, turnery, boat building, heavy construction, and parquet flooring.

#### **Kapur**

The genus *Dryobalanops* consists of nine species distributed over parts of Malaysia and Indonesia. For the export trade, the species are combined under the name kapur.

The heartwood is reddish brown and clearly demarcated from the pale sapwood. The wood is fairly coarse textured but uniform. In general, the wood resembles keruing (*Dipterocarpus*), but on the whole, kapur is straighter grained and not quite as coarse in texture. Density of the wood averages about 720 to 800 kg/m<sup>3</sup> (45 to 50 lb/ft<sup>3</sup>) at

12% moisture content. Strength properties are similar to those of keruing at comparable specific gravity. The heartwood is rated resistant to attack by decay fungi; it is reported to be vulnerable to termites. Kapur is extremely resistant to preservative treatment. The wood works with moderate ease in most hand and machine operations, but blunting of cutters may be severe because of silica content, particularly when the dry wood is machined. A good surface can be obtained from various machining operations, but there is a tendency toward raised grain if dull cutters are used. Kapur takes nails and screws satisfactorily. The wood glues well with urea formaldehyde but not with phenolic adhesives.

Kapur provides good and very durable construction wood and is suitable for all purposes for which keruing (*Dipterocarpus*) is used in the United States. In addition, kapur is extensively used in plywood either alone or with species of *Shorea* (lauan–meranti).

#### **Karri**

Karri (*Eucalyptus diversicolor*) is a very large tree limited to southwestern Australia.

Karri resembles jarrah (*E. marginata*) in structure and general appearance. It is usually paler in color and, on average, slightly heavier (913 kg/m<sup>3</sup> (57 lb/ft<sup>3</sup>)) at 12% moisture content. Karri is a heavy hardwood with mechanical properties of a correspondingly high order, even somewhat higher than that of jarrah. The heartwood is rated as moderately durable, though less so than that of jarrah. It is extremely difficult to treat with preservatives. The wood is fairly hard to machine and difficult to cut with hand tools. It is generally more resistant to cutting than is jarrah and has a slightly more dulling effect on tool edges.

Karri is inferior to jarrah for underground use and waterworks. However, where flexural strength is required, such as in bridges, floors, rafters, and beams, karri is an excellent wood. Karri is popular in heavy construction because of its strength and availability in large sizes and long lengths that are free of defects.

### **Kauta (see Marishballi)**

#### **Kempas**

Kempas (*Koompassia malaccensis*) is distributed throughout the lowland forest in rather swampy areas of Malaysia and Indonesia.

When exposed to air, the freshly cut brick-red heartwood darkens to an orange–red or red–brown with numerous yellow–brown streaks as a result of the soft tissue (axial parenchyma) associated with the pores. The texture is rather coarse, and the grain is typically interlocked. Kempas is a hard, heavy wood (density of air-dried wood is 880 kg/m<sup>3</sup> (55 lb/ft<sup>3</sup>)); the wood is difficult to work with hand and machine tools. The wood dries well, with some tendency to warp and check. The heartwood is resistant to attack by decay fungi but vulnerable to termite activity. However, it treats readily with preservative retention as high as 320 kg/m<sup>3</sup> (20 lb/ft<sup>3</sup>).



Kempas is ideal for heavy construction work, railroad crossties, and flooring.

### **Keruing (Apitong)**

Keruing or apitong (*Dipterocarpus*) is widely scattered throughout the Indo-Malaysian region. Most of the more than 70 species in this genus are marketed under the name keruing. Other important species are marketed as apitong in the Philippine Islands and yang in Thailand.

The heartwood varies from light to dark red–brown or brown to dark brown, sometimes with a purple tint; the heartwood is usually well defined from the gray or buff-colored sapwood. Similar to kapur (*Dryobalanops*), the texture of keruing is moderately coarse and the grain is straight or shallowly interlocked. The wood is strong, hard, and heavy (density of air-dried wood is 720 to 800 kg/m<sup>3</sup> (45 to 50 lb/ft<sup>3</sup>)); this wood is characterized by the presence of resin ducts, which occur singly or in short arcs as seen on end-grain surfaces. This resinous condition and the presence of silica can present troublesome problems. Sapwood and heartwood are moderately resistant to preservative treatments. However, the wood should be treated with preservatives when it is used in contact with the ground. Durability varies with species, but the wood is generally classified as moderately durable. Keruing generally takes to sawing and machining, particularly when green, but saws and cutters dull easily as a result of high silica content in the wood. Resin adheres to machinery and tools and may be troublesome. Also, resin may cause gluing and finishing difficulties.

Keruing is used for general construction work, framework for boats, flooring, pallets, chemical processing equipment, veneer and plywood, railroad crossties (if treated), truck floors, and boardwalks.

### **Khaya (see Mahogany, African)**

### **Kokrodua (see Afrormosia)**

### **Korina (see Limba)**

### **Krabak (see Mersawa)**

### **Kwila (see Merbau)**

### **Lapacho (see Ipe)**

### **Lapuna (see Ceiba)**

### **Lauan (see Meranti Groups)**

### **Lemonwood (see Degame)**

### **Lignumvitae**

For many years, the only species of lignumvitae used on a large scale was *Guaiaacum officinale*, which is native to the West Indies, northern Venezuela, northern Colombia, and Panama. With the near exhaustion of *G. officinale*, harvesters turned to *G. sanctum*, which is now the principal commercial species. *Guaiaacum sanctum* occupies the same range as *G. officinale* but is more extensive and includes the Pacific side of Central America as well as southern Mexico.

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 one-fourth of the air-dried weight of the heartwood.

Lignumvitae wood is used chiefly for bearing or bushing blocks for ship propeller shafts. The great strength and tenacity of lignumvitae, combined with self-lubricating properties resulting from the high resin content, make it especially adaptable for underwater use. It is also used for such articles as mallets, pulley sheaves, caster wheels, stencil and chisel blocks, and turned products.

### **Limba**

Limba (*Terminalia superba*), also referred to as afara, is widely distributed from Sierra Leone to Angola and Zaire in the rainforest and savanna forest. Limba is also favored as a plantation species in West Africa.

The heartwood varies from gray–white to creamy or yellow brown and may contain dark streaks that are nearly black, producing an attractive figure that is valued for decorative veneer. The light color of the 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 dry and shrinkage is reported to be rather low. Limba is not resistant to decay, insects, or termites. It is easy to work with all types of tools and is made into veneer without difficulty.

Principal uses include plywood, furniture, interior joinery, and sliced decorative veneer.

### **Macacauba (see Macawood)**

### **Macawood (Trebol)**

Macawood and trebol are common names applied to species in the genus *Platymiscium*. Other common names include cristobal and macacauba. This genus is distributed across continental tropical America from southern Mexico to the Brazilian Amazon region and Trinidad.

The bright red to reddish or purplish brown heartwood is more or less striped. Darker specimens look waxy, and the sapwood is sharply demarcated from the heartwood. The texture is medium to fine, and the grain is straight to curly or striped. The wood is not very difficult to work, and it finishes smoothly and takes on a high polish. Generally, macawood air dries slowly with a slight tendency to warp and check. Strength is quite high, and density of air-dried wood ranges from 880 to 1,170 kg/m<sup>3</sup> (55 to 73 lb/ft<sup>3</sup>). The heartwood is reported to be highly resistant to attack by decay fungi, insects, and dry-wood termites. Although the sapwood absorbs preservatives well, the heartwood is resistant to treatment.

Macawood is a fine furniture and cabinet wood. It is also used in decorative veneers, musical instruments, turnery, joinery, and specialty items such as violin bows and billiard cues.

## Machinmango (see Manbarklak)

### Mahogany

The name mahogany is presently applied to several distinct kinds of commercial wood. The original mahogany wood, produced by *Swietenia mahagoni*, came from the American West Indies. This was the premier wood for fine furniture cabinet work and shipbuilding in Europe as early as the 1600s. Because the good reputation associated with the name mahogany is based on this wood, American mahogany is sometimes referred to as true mahogany. A related African wood, of the genus *Khaya*, has long been marketed as “African mahogany” and is used for much the same purposes as American mahogany because of its similar properties and overall appearance. A third kind of wood called mahogany, and the one most commonly encountered in the market, is “Philippine mahogany.” This name is applied to a group of Asian woods belonging to the genus *Shorea*. In this chapter, information on the “Philippine mahoganies” is given under lauan and meranti groups.

**Mahogany, African**—The bulk of “African mahogany” shipped from west–central Africa is *Khaya ivorensis*, the most widely distributed and plentiful species of the genus found in the coastal belt of the so-called high forest. The closely allied species *K. anthotheca* has a more restricted range and is found farther inland in regions of lower rainfall but well within the area now being used for the export trade.

The heartwood varies from pale pink to dark reddish brown. The grain is frequently interlocked, and the texture is medium to coarse, comparable with that of American mahogany (*Swietenia macrophylla*). The wood is easy to dry, but machining properties are rather variable. Nailing and gluing properties are good, and an excellent finish is readily obtained. The wood is easy to slice and peel. In decay resistance, African mahogany is generally rated as moderately durable, which is below the durability rating for American mahogany.

Principal uses for African mahogany include furniture and cabinetwork, interior woodwork, boat construction, and veneer.

**Mahogany, American**—True, American, or Honduras mahogany (*Swietenia macrophylla*) ranges from southern Mexico through Central America into South America as far south as Bolivia. Plantations have been established within its natural range and elsewhere throughout the tropics.

The heartwood varies from pale pink or salmon colored to dark reddish brown. The grain is generally straighter than that of African mahogany (*Khaya ivorensis*); however, a wide variety of grain patterns are obtained from American mahogany. The texture is rather fine to coarse. American mahogany is easily air or kiln dried without appreciable warp or checks, and it has excellent dimensional stability. It is rated as durable in resistance to decay fungi and moderately resistant to dry-wood termites. Both heartwood and sapwood are resistant to treatment with preservatives. The wood is very easy to work with hand and machine tools, and it slices and

rotary cuts into fine veneer without difficulty. It also is easy to finish and takes an excellent polish. The air-dried strength of American mahogany is similar to that of American elm (*Ulmus americana*). Density of air-dried wood varies from 480 to 833 kg/m<sup>3</sup> (30 to 52 lb/ft<sup>3</sup>).

The principal uses for mahogany are fine furniture and cabinets, interior woodwork, pattern woodwork, boat construction, fancy veneers, musical instruments, precision instruments, paneling, turnery, carving, and many other uses that call for an attractive and dimensionally stable wood.

### Mahogany, Philippine (see Meranti Groups)

#### Manbarklak

Manbarklak is a common name applied to species in the genus *Eschweilera*. Other names include kakaralli machinmango, and mata–mata. About 80 species of this genus are distributed from eastern Brazil through the Amazon basin, to the Guianas, Trinidad, and Costa Rica.

The heartwood of most species is light, grayish, reddish brown, or brownish buff. The texture is fine and uniform, and the grain is typically straight. Manbarklak is a very hard and heavy wood (density of air-dried wood ranges from 768 to 1,185 kg/m<sup>3</sup> (48 to 74 lb/ft<sup>3</sup>)) that is rated as fairly difficult to dry. Most species are difficult to work because of the high density and high silica content. Most species are highly resistant to attack by decay fungi. Also, most species have gained wide recognition for their high degree of resistance to marine borer attack. Resistance to dry-wood termite attack is variable depending on species.

Manbarklak is an ideal wood for marine and other heavy construction uses. It is also used for industrial flooring, mill equipment, railroad crossties, piles, and turnery.

#### Manni

Manni (*Symphonia globulifera*) is native to the West Indies, Mexico, and Central, North, and South America. It also occurs in tropical West Africa. Other names include ossol (Gabon), anani (Brazil), waika (Africa), and chewstick (Belize), a name acquired because of its use as a primitive toothbrush and flossing tool.

The heartwood is yellowish, grayish, or greenish brown and is distinct from the whitish sapwood. The texture is coarse and the grain straight to irregular. The wood is very easy to work with both hand and machine tools, but surfaces tend to roughen in planing and shaping. Manni air-dries rapidly with only moderate warp and checking. Its strength is similar to that of hickory (*Carya*), and the density of air-dried wood is 704 kg/m<sup>3</sup> (44 lb/ft<sup>3</sup>). The heartwood is durable in ground contact but only moderately resistant to dry-wood and subterranean termites. The wood is rated as resistant to treatment with preservatives.

Manni is a general purpose wood that is used for railroad ties, general construction, cooperage, furniture components, flooring, and utility plywood.

## Marishballi

Marishballi is the common name applied to species of the genus *Licania*. Other names include kauta and anaura. Species of *Licania* are widely distributed in tropical America but most abundant in the Guianas and the lower Amazon region of Brazil.

The heartwood is generally a yellowish to dark brown, sometimes with a reddish tinge. The texture is fine and close, and the grain is usually straight. Marishballi is strong and very heavy; density of air-dried wood is 833 to 1,153 kg/m<sup>3</sup> (52 to 72 lb/ft<sup>3</sup>). The wood is rated as easy to moderately difficult to air dry. Because of its high density and silica content, marishballi is difficult to work. The use of hardened cutters is suggested to obtain smooth surfaces. Durability varies with species, but marishballi is generally considered to have low to moderately low resistance to attack by decay fungi. However, it is known for its high resistance to attack by marine borers. Permeability also varies, but the heartwood is generally moderately responsive to treatment.

Marishballi is ideal for underwater marine construction, heavy construction above ground, and railroad crossties (treated).

## Mata–Mata (see Manbarklak)

## Mayflower (see Roble)

## Melapi (see Meranti Groups)

## Meranti Groups

Meranti is a common name applied commercially to four groups of species of *Shorea* from southeast Asia, most commonly Malaysia, Indonesia, and the Philippines. There are thousands of common names for the various species of *Shorea*, but the names Philippine mahogany and lauan are often substituted for meranti. The four groups of meranti are separated on the basis of heartwood color and weight (Table 1–3). About 70 species of *Shorea* belong to the light and dark red meranti groups, 22 species to the white meranti group, and 33 species to the yellow meranti group.

Meranti species as a whole have a coarser texture than that of mahogany (*Swietenia macrophylla*) and do not have dark-colored deposits in pores. The grain is usually interlocked.

All merantis have axial resin ducts aligned in long, continuous, tangential lines as seen on the end surface of the wood. These ducts sometimes contain white deposits that are visible to the naked eye, but the wood is not resinous like some keruing (*Dipterocarpus*) species that resemble meranti. All the meranti groups are machined easily except white meranti, which dulls cutters as a result of high silica content in the wood. The light red and white merantis dry easily without degrade, but dark red and yellow merantis dry more slowly with a tendency to warp. The strength and shrinkage properties of the meranti groups compare favorably with that of northern red oak (*Quercus rubra*). The light red, white, and yellow merantis are not durable in exposed conditions or in ground contact, whereas dark red meranti is moderately durable. Generally, heartwood is extremely resistant to moderately resistant to preservative treatments.

Species of meranti constitute a large percentage of the total hardwood plywood imported into the United States. Other uses include joinery, furniture and cabinetwork, moulding and millwork, flooring, and general construction. Some dark red meranti is used for decking.

## Merbau

Merbau (Malaysia), ipil (Philippines), and kwila (New Guinea) are names applied to species of the genus *Intsia*, most commonly *I. bijuga*. *Intsia* is distributed throughout the Indo–Malaysian region, Indonesia, Philippines, and many western Pacific islands, as well as Australia.

Freshly cut yellowish to orange–brown heartwood turns brown or dark red–brown on exposure to air. The texture is rather coarse, and the grain is straight to interlocked or wavy. The strength of air-dried merbau is comparable with that of hickory (*Carya*), but density is somewhat lower (800 kg/m<sup>3</sup> (50 lb/ft<sup>3</sup>) at 12% moisture content). The wood dries well with little degrade but stains black in the presence of iron and moisture. Merbau is rather difficult to saw because it sticks to saw teeth and dulls cutting edges. However, the wood dresses smoothly in most operations and finishes well. Merbau has good durability and high resistance to termite attack. The heartwood resists treatment, but the sapwood can be treated with preservatives.

**Table 1–3. Woods belonging to *Shorea* and *Parashorea* genera**

Name	Color	Density of air-dried wood
Dark red meranti (also called tanguile and dark red seraya)	Dark brown; medium to deep red, sometimes with a purplish tinge	640+ kg/m <sup>3</sup> (40+ lb/ft <sup>3</sup> )
Light red meranti (also called red seraya)	Variable—from almost white to pale pink, dark red, pale brown, or deep brown	400 to 640 kg/m <sup>3</sup> , averaging 512 kg/m <sup>3</sup> (25 to 40 lb/ft <sup>3</sup> , averaging 32 lb/ft <sup>3</sup> )
White meranti (also called melapi)	Whitish when freshly cut, becoming light yellow-brown on exposure to air	480 to 870 kg/m <sup>3</sup> (30 to 54 lb/ft <sup>3</sup> )
Yellow meranti (also called yellow seraya)	Light yellow or yellow-brown, sometimes with a greenish tinge; darkens on exposure to air	480 to 640 kg/m <sup>3</sup> (30 to 40 lb/ft <sup>3</sup> )

Merbau is used in furniture, fine joinery, turnery, cabinets, flooring, musical instruments, and specialty items.

### Mersawa

Mersawa is one of the common names applied to the genus *Anisoptera*, which has about 15 species distributed from the Philippine Islands and Malaysia to east Pakistan. Names applied to this wood vary with the source, and three names are generally used in the lumber trade: krabak (Thailand), mersawa (Malaysia), and palosapis (Philippines).

Mersawa wood is light in color and has a moderately coarse texture. Freshly sawn heartwood is pale yellow or yellowish brown and darkens on exposure to air. Some wood may show a pinkish cast or pink streaks, but these eventually disappear on exposure to air. The wood weighs between 544 and 752 kg/m<sup>3</sup> (34 and 47 lb/ft<sup>3</sup>) at 12% moisture content and about 945 kg/m<sup>3</sup> (59 lb/ft<sup>3</sup>) when green. The sapwood is susceptible to attack by powderpost beetles, and the heartwood is not resistant to termites. The heartwood is rated as moderately resistant to fungal decay and should not be used under conditions that favor decay. The heartwood does not absorb preservative solutions readily. The wood machines easily, but because of the presence of silica, the wood severely dulls the cutting edges of ordinary tools and is very hard on saws.

The major volume of mersawa will probably be used as plywood because conversion in this form presents considerably less difficulty than does the production of lumber.

### Mora

Mora (*Mora excelsa* and *M. gonggrijpii*) is widely distributed in the Guianas and also occurs in the Orinoco Delta of Venezuela.

The yellowish red–brown, reddish brown, or dark red heartwood with pale streaks is distinct from the yellowish to pale brown sapwood. The texture is moderately fine to rather coarse, and the grain is straight to interlocked. Mora is a strong and heavy wood (density of air-dried wood is 945 to 1,040 kg/m<sup>3</sup> (59 to 65 lb/ft<sup>3</sup>)); this wood is moderately difficult to work but yields smooth surfaces in sawing, planing, turning, and boring. The wood is generally rated as moderately difficult to dry. Mora is rated as durable to very durable in resistance to brown- and white-rot fungi. *Mora gonggrijpii* is rated very resistant to dry-wood termites, but *M. excelsa* is considerably less resistant. The sapwood responds readily to preservative treatments, but the heartwood resists treatment.

Mora is used for industrial flooring, railroad crossties, shipbuilding, and heavy construction.

### Oak (Tropical)

The oaks (*Quercus*) are abundantly represented in Mexico and Central America with about 150 species, which are nearly equally divided between the red and white oak groups. More than 100 species occur in Mexico and about 25 in

Guatemala; the number diminishes southward to Colombia, which has two species. The usual Spanish name applied to the oaks is encino or roble, and both names are used interchangeably irrespective of species or use of the wood.

In heartwood color, texture, and grain characteristics, tropical oaks are similar to the oaks in the United States, especially live oak (*Quercus virginiana*). In most cases, tropical oaks are heavier (density of air-dried wood is 704 to 993 kg/m<sup>3</sup> (44 to 62 lb/ft<sup>3</sup>)) than the U.S. species. Strength data are available for only four species, and the values fall between those of white oak (*Q. alba*) and live oak (*Q. virginiana*) or are equal to those of live oak. Average specific gravity for the tropical oaks is 0.72 based on volume when green and oven-dry weight, with an observed maximum average of 0.86 for one species from Guatemala. The heartwood is rated as very resistant to decay fungi and difficult to treat with preservatives.

Utilization of the tropical oaks is very limited at present because of difficulties encountered in the drying of the wood. The major volume is used in the form of charcoal, but the wood is used for flooring, railroad crossties, mine timbers, tight cooorage, boat and ship construction, and decorative veneers.

### Obeche

Obeche (*Triplochiton scleroxylon*) trees of west–central Africa reach a height of 50 m (150 ft) or more and a diameter of up to 2 m (5 ft). The trunk is usually free of branches for a considerable height so that clear lumber of considerable size can be obtained.

The wood is creamy white to pale yellow with little or no difference between sapwood and heartwood. The wood is fairly soft, of uniform medium to coarse texture, and the grain is usually interlocked but sometimes straight. Air-dry wood weighs about 385 kg/m<sup>3</sup> (24 lb/ft<sup>3</sup>). Obeche dries readily with little degrade. It is not resistant to decay, and green sapwood is subject to blue stain. The wood is easy to work and machine, veneers and glues well, and takes nails and screws without splitting.

The characteristics of obeche make it especially suitable for veneer and corestock. Other uses include furniture, components, millwork, blockboard, boxes and crates, particleboard and fiberboard, patterns, and artificial limbs.

### Ofram (see Limba)

### Okoume

The natural distribution of okoume (*Aucoumea klaineana*) is rather restricted; the species is found only in west–central Africa and Guinea. However, okoume is extensively planted throughout its natural range.

The heartwood is salmon-pink in color, and the narrow sapwood is whitish or pale gray. The wood has a high luster and uniform texture. The texture is slightly coarser than that of birch (*Betula*). The nondurable heartwood dries readily with little degrade. Sawn lumber is somewhat difficult to

machine because of the silica content, but the wood glues, nails, and peels into veneer easily. Okoume offers unusual flexibility in finishing because the color, which is of medium intensity, permits toning to either lighter or darker shades.

In the United States, okoume is generally used for decorative plywood paneling, general utility plywood, and doors. Other uses include furniture components, joinery, and light construction.

### Opepe

Opepe (*Nauclea diderrichii*) is widely distributed in Africa from Sierra Leone to the Congo region and eastward to Uganda. It is often found in pure stands.

The orange or golden yellow heartwood darkens on exposure to air and is clearly defined from the whitish or pale yellow sapwood. The texture is rather coarse, and the grain is usually interlocked or irregular. The density of air-dried wood ( $752 \text{ kg/m}^3$  ( $47 \text{ lb/ft}^3$ )) is about the same as that of true hickory (*Carya*), but strength properties are somewhat lower. Quartersawn stock dries rapidly with little checking or warp, but flat-sawn lumber may develop considerable degrade. The wood works moderately well with hand and machine tools. It also glues and finishes satisfactorily. The heartwood is rated as very resistant to decay and moderately resistant to termite attacks. The sapwood is permeable to preservatives, but the heartwood is moderately resistant to preservative treatment.

Opepe is a general construction wood that is used in dock and marine work, boat building, railroad cross-ties, flooring, and furniture.

### Ossol (see Manni)

### Otie (see Ilomba)

### Ovangkol (see Bengé)

### Palosapis (see Mersawa)

### Para-Angelim (see Sucupira)

### Pau Marfim

The range of pau marfim (*Balfourodendron riedelianum*) is rather limited, extending from the State of Sao Paulo, Brazil, into Paraguay and the provinces of Corrientes and Misiones of northern Argentina. In Brazil, it is generally known as pau marfim and in Argentina and Paraguay, as guatambu.

In color and general appearance, pau marfim wood is very similar to birch (*Betula*) or sugar maple (*Acer saccharum*) sapwood. Although growth rings are present, they do not show as distinctly as those in birch and maple. There is no apparent difference in color between heartwood and sapwood. The wood is straight grained and easy to work and finish, but it is not considered resistant to decay. In Brazil, average specific gravity of pau marfim is about 0.73 based on volume of green wood and oven-dry weight. Average density of air-dried wood is about  $802 \text{ kg/m}^3$  ( $50 \text{ lb/ft}^3$ ). On the basis of

specific gravity, strength values are higher than those of sugar maple, which has an average specific gravity of 0.56.

In its areas of growth, pau marfim is used for much the same purposes as are sugar maple and birch in the United States. Introduced to the U.S. market in the late 1960s, pau marfim has been very well received and is especially esteemed for turnery.

### Peroba, White (see Peroba de Campos)

### Peroba de Campos

Peroba de campos (*Paratecoma peroba*), also referred to as white peroba, grows in the coastal forests of eastern Brazil, ranging from Bahia to Rio de Janeiro. It is the only species in the genus *Paratecoma*.

The heartwood varies in color but is generally shades of brown with tendencies toward olive and red. The sapwood is a yellowish gray and is clearly defined from the heartwood. The texture is relatively fine and approximates that of birch (*Betula*). The grain is commonly interlocked, with a narrow stripe or wavy figure. The wood machines easily; however, particular care must be taken in planing to prevent excessive grain tearing of quartered surfaces. There is some evidence that the fine dust from machining operations may produce allergic responses in certain individuals. Density of air-dried wood averages about  $738 \text{ kg/m}^3$  ( $46 \text{ lb/ft}^3$ ). Peroba de campos is heavier than teak (*Tectona grandis*) or white oak (*Quercus alba*), and it is proportionately stronger than either of these species. The heartwood of peroba de campos is rated as very durable with respect to decay and difficult to treat with preservatives.

In Brazil, peroba de campos is used in the manufacture of fine furniture, flooring, and decorative paneling. The principal use in the United States is shipbuilding, where peroba de campos serves as substitute for white oak (*Quercus alba*) for all purposes except bent members.

### Peroba Rosa

Peroba rosa is the common name applied to a number of similar species in the genus *Aspidosperma*. These species occur in southeastern Brazil and parts of Argentina.

The heartwood is a distinctive rose-red to yellowish, often variegated or streaked with purple or brown, and becomes brownish yellow to dark brown upon exposure to air; the heartwood is often not demarcated from the yellowish sapwood. The texture is fine and uniform, and the grain is straight to irregular. The wood is moderately heavy; weight of air-dried wood is  $752 \text{ kg/m}^3$  ( $47 \text{ lb/ft}^3$ ). Strength properties are comparable with those of U.S. oak (*Quercus*). The wood dries with little checking or splitting. It works with moderate ease, and it glues and finishes satisfactorily. The heartwood is resistant to decay fungi but susceptible to dry-wood termite attack. Although the sapwood takes preservative treatment moderately well, the heartwood resists treatment.

Peroba is suited for general construction work and is favored for fine furniture and cabinetwork and decorative veneers. Other uses include flooring, interior woodwork, sashes and doors, and turnery.

### Pilon

The two main species of pilon are *Hyeronima alchorneoides* and *H. laxiflora*, also referred to as suradan. These species range from southern Mexico to southern Brazil including the Guianas, Peru, and Colombia. Pilon species are also found throughout the West Indies.

The heartwood is a light reddish brown to chocolate brown or sometimes dark red; the sapwood is pinkish white. The texture is moderately coarse and the grain interlocked. The wood air-dries rapidly with only a moderate amount of warp and checking. It has good working properties in all operations except planing, which is rated poor as a result of the characteristic interlocked grain. The strength of pilon is comparable with that of true hickory (*Carya*), and the density of air-dried wood ranges from 736 to 849 kg/m<sup>3</sup> (46 to 53 lb/ft<sup>3</sup>). Pilon is rated moderately to very durable in ground contact and resistant to moderately resistant to subterranean and dry-wood termites. Both heartwood and sapwood are reported to be treatable with preservatives by both open tank and pressure vacuum processes.

Pilon is especially suited for heavy construction, railway crossties, marinework, and flooring. It is also used for furniture, cabinetwork, decorative veneers, turnery, and joinery.

### Piquia

Piquia is the common name generally applied to species in the genus *Caryocar*. This genus is distributed from Costa Rica southward into northern Colombia and from the upland forest of the Amazon valley to eastern Brazil and the Guianas.

The yellowish to light grayish brown heartwood is hardly distinguishable from the sapwood. The texture is medium to rather coarse, and the grain is generally interlocked. The wood dries at a slow rate; warping and checking may develop, but only to a minor extent. Piquia is reported to be easy to moderately difficult to saw; cutting edges dull rapidly. The heartwood is very durable and resistant to decay fungi and dry-wood termites but only moderately resistant to marine borers.

Piquia is recommended for general and marine construction, heavy flooring, railway crossties, boat parts, and furniture components. It is especially suitable where hardness and high wear resistance are needed.

### Primavera

The natural distribution of primavera (*Tabebuia donnell-smithii* [= *Cybistax donnell-smithii*]) 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 relative scarcity of naturally grown trees. Recent plantations have increased the availability of this species and have provided a more constant source of supply. The quality of the plantation-grown wood is equal in all respects to the wood obtained from naturally grown trees.

The heartwood is whitish to straw-yellow, and in some logs, it may be tinted with pale brown or pinkish streaks. The texture is medium to rather coarse, and the grain is straight to wavy, which produces a wide variety of figure patterns. The wood also has a very high luster. Shrinkage is rather low, and the wood shows a high degree of dimensional stability. Despite considerable grain variation, primavera machines remarkably well. The density of air-dried wood is 465 kg/m<sup>3</sup> (29 lb/ft<sup>3</sup>), and the wood is comparable in strength with water tupelo (*Nyssa aquatica*). Resistance to both brown- and white-rot fungi varies. Weathering characteristics are good.

The dimensional stability, ease of working, and pleasing appearance make primavera a suitable choice for solid furniture, paneling, interior woodwork, and special exterior uses.

### Purpleheart

Purpleheart, also referred to as amaranth, is the name applied to species in the genus *Peltogyne*. The center of distribution is in the north-central part of the Brazilian Amazon region, but the combined range of all species is from Mexico through Central America and southward to southern Brazil.

Freshly cut heartwood is brown. It turns a deep purple upon exposure to air and eventually dark brown upon exposure to light. The texture is medium to fine, and the grain is usually straight. This strong and heavy wood (density of air-dried wood is 800 to 1,057 kg/m<sup>3</sup> (50 to 66 lb/ft<sup>3</sup>)) is rated as easy to moderately difficult to air dry. It is moderately difficult to work with using either hand or machine tools, and it dulls cutters rather quickly. Gummy resin exudes when the wood is heated by dull tools. A slow feed rate and specially hardened cutters are suggested for optimal cutting. The wood turns easily, is easy to glue, and takes finishes well. The heartwood is rated as highly resistant to attack by decay fungi and very resistant to dry-wood termites. It is extremely resistant to treatment with preservatives.

The unusual and unique color of purpleheart makes this wood desirable for turnery, marquetry, cabinets, fine furniture, parquet flooring, and many specialty items, such as billiard cue butts and carvings. Other uses include heavy construction, shipbuilding, and chemical vats.

### Pycnanthus (see Ilomba)

#### Ramin

Ramin (*Gonystylus bancanus*) is native to southeast Asia from the Malaysian Peninsula to Sumatra and Borneo.

Both the heartwood and sapwood are the color of pale straw, yellow, or whitish. The grain is straight or shallowly

interlocked. The texture is even, moderately fine, and similar to that of American mahogany (*Swietenia macrophylla*). The wood is without figure or luster. Ramin is moderately hard and heavy, weighing about 672 kg/m<sup>3</sup> (42 lb/ft<sup>3</sup>) in the air-dried condition. The wood is easy to work, finishes well, and glues satisfactorily. Ramin is rated as not resistant to decay but permeable with respect to preservative treatment.

Ramin is used for plywood, interior woodwork, furniture, turnery, joinery, moulding, flooring, dowels, and handles of nonstriking tools (brooms), and as a general utility wood.

### Roble

Roble, a species in the roble group of *Tabebuia* (generally *T. rosea*), ranges from southern Mexico through Central America to Venezuela and Ecuador. The name roble comes from the Spanish word for oak (*Quercus*). In addition, *T. rosea* is called roble because the wood superficially resembles U.S. oak. Other names for *T. rosea* are mayflower and apamate.

The sapwood becomes a pale brown upon exposure to air. The heartwood varies from golden brown to dark brown, and it has no distinctive odor or taste. The texture is medium and the grain narrowly interlocked. The wood weighs about 642 kg/m<sup>3</sup> (40 lb/ft<sup>3</sup>) at 12% moisture content. Roble has excellent working properties in all machine operations. It finishes attractively in natural color and takes finishes with good results. It weighs less than the average of U.S. white oaks (*Quercus*) but is comparable with respect to bending and compression parallel to grain. The heartwood of roble is generally rated as moderately to very durable with respect to decay; the darker and heavier wood is regarded as more resistant than the lighter-colored woods.

Roble is used extensively for furniture, interior woodwork, doors, flooring, boat building, ax handles, and general construction. The wood veneers well and produces attractive paneling. For some applications, roble is suggested as a substitute for American white ash (*Fraxinus americana*) and oak (*Quercus*).

### Rosewood, Brazilian

Brazilian rosewood (*Dalbergia nigra*), also referred to as jacaranda, occurs in eastern Brazilian forests from the State of Bahia to Rio de Janeiro. Since it was exploited for a long time, Brazilian rosewood is no longer abundant.

The heartwood varies with respect to color, through shades of brown, red, and violet, and it is irregularly and conspicuously streaked with black. It is sharply demarcated from the white sapwood. Many kinds of rosewood are distinguished locally on the basis of prevailing color. The texture is coarse, and the grain is generally straight. The heartwood has an oily or waxy appearance and feel, and its odor is fragrant and distinctive. The wood is hard and heavy (weight of air-dried wood is 752 to 897 kg/m<sup>3</sup> (47 to 56 lb/ft<sup>3</sup>)); thoroughly air-dried wood will barely float in water. Strength properties of Brazilian rosewood are high and are more than adequate for the purposes for which this wood is used.

For example, Brazilian rosewood is harder than any U.S. native hardwood species used for furniture and veneer. The wood machines and veneers well. It can be glued satisfactorily, provided the necessary precautions are taken to ensure good glue bonds, with respect to oily wood. Brazilian rosewood has an excellent reputation for durability with respect to fungal and insect attack, including termites, although the wood is not used for purposes where durability is necessary.

Brazilian rosewood is used primarily in the form of veneer for decorative plywood. Limited quantities are used in the solid form for specialty items such as cutlery handles, brush backs, billiard cue butts, and fancy turnery.

### Rosewood, Indian

Indian rosewood (*Dalbergia latifolia*) is native to most provinces of India except in the northwest.

The heartwood varies in color from golden brown to dark purplish brown with denser blackish streaks at the end of growth zones, giving rise to an attractive figure on flat-sawn surfaces. The narrow sapwood is yellowish. The average weight is about 849 kg/m<sup>3</sup> (53 lb/ft<sup>3</sup>) at 12% moisture content. The texture is uniform and moderately coarse. Indian rosewood is quite similar in appearance to Brazilian (*Dalbergia nigra*) and Honduran (*Dalbergia stevensonii*) rosewood. The wood is reported to kiln-dry well though slowly, and the color improves during drying. Indian rosewood is a heavy wood with high strength properties; after drying, it is particularly hard for its weight. The wood is moderately hard to work with hand tools and offers a fair resistance in machine operations. Lumber with calcareous deposits tends to dull tools rapidly. The wood turns well and has high screw-holding properties. If a very smooth surface is required for certain purposes, pores (vessels) may need to be filled.

Indian rosewood is essentially a decorative wood for high-quality furniture and cabinetwork. In the United States, it is used primarily in the form of veneer.

### Sande

Practically all commercially available sande (mostly *Brosimum utile*) comes from Pacific Ecuador and Colombia. However, the group of species ranges from the Atlantic Coast in Costa Rica southward to Colombia and Ecuador.

The sapwood and heartwood show no distinction; the wood is uniformly yellowish white to yellowish or light brown. The texture is medium to moderately coarse and even, and the grain can be widely and narrowly interlocked. The density of air-dried wood ranges from 384 to 608 kg/m<sup>3</sup> (24 to 38 lb/ft<sup>3</sup>), and the strength is comparable with that of U.S. oak (*Quercus*). The lumber air dries rapidly with little or no degrade. However, material containing tension wood is subject to warp, and the tension wood may cause fuzzy grain as well as overheating of saws as a result of pinching. The wood is not durable with respect to stain, decay, and insect attack, and care must be exercised to prevent degrade from these agents. The wood stains and finishes easily and presents no gluing problems.

Sande is used for plywood, particleboard, fiberboard, carpentry, light construction, furniture components, and moulding.

### **Santa Maria**

Santa Maria (*Calophyllum brasiliense*) ranges from the West Indies to southern Mexico and southward through Central America into northern South America.

The heartwood is pinkish to brick red or rich reddish brown and marked by fine and slightly darker striping on flat-sawn surfaces. The sapwood is lighter in color and generally distinct from the heartwood. The texture is medium and fairly uniform, and the grain is generally interlocked. The heartwood is rather similar in appearance to dark red meranti (*Shorea*). The wood is moderately easy to work and good surfaces can be obtained when attention is paid to machining operations. The wood averages about 608 kg/m<sup>3</sup> (38 lb/ft<sup>3</sup>) at 12% moisture content. Santa Maria is in the density class of sugar maple (*Acer saccharum*), and its strength properties are generally similar; the hardness of sugar maple is superior to that of Santa Maria. The heartwood is generally rated as moderately durable to durable in contact with the ground, but it apparently has no resistance against termites and marine borers.

The inherent natural durability, color, and figure on the quarter-sawn face suggest that Santa Maria could be used as veneer for plywood in boat construction. Other uses are flooring, furniture, cabinetwork, millwork, and decorative plywood.

### **Sapele**

Sapele (*Entandrophragma cylindricum*) is a large African tree that occurs from Sierra Leone to Angola and eastward through the Congo to Uganda.

The heartwood ranges in color from that of American mahogany (*Swietenia macrophylla*) to a dark reddish or purplish brown. The lighter-colored and distinct sapwood may be up to 10 cm (4 in.) wide. The texture is rather fine. The grain is interlocked and produces narrow and uniform striping on quarter-sawn surfaces. The wood averages about 674 kg/m<sup>3</sup> (42 lb/ft<sup>3</sup>) at 12% moisture content, and its mechanical properties are in general higher than those of white oak (*Quercus alba*). The wood works fairly easily with machine tools, although the interlocked grain makes it difficult to plane. Sapele finishes and glues well. The heartwood is rated as moderately durable and is resistant to preservative treatment.

As lumber, sapele is used for furniture and cabinetwork, joinery, and flooring. As veneer, it is used for decorative plywood.

### **Selangan Batu (see Balau)**

### **Sepetir**

The name sepetir applies to species in the genus *Sindora* and to *Pseudosindora palustris*. These species are distributed throughout Malaysia, Indochina, and the Philippines.

The heartwood is brown with a pink or golden tinge that darkens on exposure to air. Dark brown or black streaks are sometimes present. The sapwood is light gray, brown, or straw-colored. The texture is moderately fine and even, and the grain is narrowly interlocked. The strength of sepetir is similar to that of shellbark hickory (*Carya laciniosa*), and the density of the air-dried wood is also similar (640 to 720 kg/m<sup>3</sup> (40 to 45 lb/ft<sup>3</sup>)). The wood dries well but rather slowly, with a tendency to end-split. The wood is difficult to work with hand tools and has a rather rapid dulling effect on cutters. Gums from the wood tend to accumulate on saw teeth, which causes additional problems. Sepetir is rated as nondurable in ground contact under Malaysian exposure. The heartwood is extremely resistant to preservative treatment; however, the sapwood is only moderately resistant.

Sepetir is a general carpentry wood that is also used for furniture and cabinetwork, joinery, flooring (especially truck flooring), plywood, and decorative veneers.

### **Seraya, Red and Dark Red (see Meranti Groups)**

#### **Seraya, White**

White seraya or bagtikan, as it is called in the Philippines, is a name applied to the 14 species of *Parashorea*, which grow in Sabah and the Philippines.

The heartwood is light brown or straw-colored, sometimes with a pinkish tint. The texture is moderately coarse and the grain interlocked. White seraya is very similar in appearance and strength properties to light red meranti, and sometimes the two are mixed in the market. White seraya dries easily with little degrade, and works fairly well with hand and machine tools. The heartwood is not durable to moderately durable in ground contact, and it is extremely resistant to preservative treatments.

White seraya is used for joinery, light construction, moulding and millwork, flooring, plywood, furniture, and cabinet work.

### **Seraya, Yellow (see Meranti Groups)**

#### **Silverballi, Brown (see Kaneelhart)**

#### **Spanish-Cedar**

Spanish-cedar or cedro consists of a group of about seven species in the genus *Cedrela* that are widely distributed in tropical America from southern Mexico to northern Argentina.

Spanish-cedar is one of only a few tropical species that are ring-porous. The heartwood varies from light to dark reddish brown, and the sapwood is pinkish to white. The texture is rather fine and uniform to coarse and uneven. The grain is not interlocked. The heartwood is characterized by a distinctive odor. The wood dries easily. Although Spanish-cedar is not high in strength, most other properties are similar to those of American mahogany (*Swietenia macrophylla*), except for hardness and compression perpendicular to the



grain, where mahogany is definitely superior. Spanish-cedar is considered decay resistant; it works and glues well.

Spanish-cedar is used locally for all purposes that require an easily worked, light but straight grained, and durable wood. In the United States, the wood is favored for millwork, cabinets, fine furniture, boat building, cigar wrappers and boxes, humidores, and decorative and utility plywood.

### **Sucupira (Angelin, Para-Angelim)**

Sucupira, angelin, and para-angelin apply to species in four genera of legumes from South America. Sucupira applies to *Bowdichia nitida* from northern Brazil, *B. virgilioides* from Venezuela, the Guianas, and Brazil, and *Diploptropis purpurea* from the Guianas and southern Brazil. Angelin (*Andira inermis*) is a widespread species that occurs throughout the West Indies and from southern Mexico through Central America to northern South America and Brazil. Para-angelin (*Hymenolobium excelsum*) is generally restricted to Brazil.

The heartwood of sucupira is chocolate-brown, red-brown, or light brown (especially in *Diploptropis purpurea*). Angelin heartwood is yellowish brown to dark reddish brown; para-angelin heartwood turns pale brown upon exposure to air. The sapwood is generally yellowish to whitish and is sharply demarcated from the heartwood. The texture of all three woods is coarse and uneven, and the grain can be interlocked. The density of air-dried wood of these species ranges from 720 to 960 kg/m<sup>3</sup> (45 to 60 lb/ft<sup>3</sup>), which makes them generally heavier than true hickory (*Carya*). Their strength properties are also higher than those of true hickory. The heartwood is rated very durable to durable in resistance to decay fungi but only moderately resistant to attack by dry-wood termites. Angelin is reported to be difficult to treat with preservatives, but para-angelin and sucupira treat adequately. Angelin can be sawn and worked fairly well, except that it is difficult to plane to a smooth surface because of alternating hard (fibers) and soft (parenchyma) tissue. Para-angelin works well in all operations. Sucupira is difficult to moderately difficult to work because of its high density, irregular grain, and coarse texture.

Sucupira, angelin, and para-angelin are ideal for heavy construction, railroad cross-ties, and other uses that do not require much fabrication. Other suggested uses include flooring, boat building, furniture, turnery, tool handles, and decorative veneer.

### **Suradan (see Pilon)**

### **Tangare (see Andiroba)**

### **Tanguile (see Lauan–Meranti Groups)**

### **Teak**

Teak (*Tectona grandis*) occurs in commercial quantities in India, Burma, Thailand, Laos, Cambodia, North and South Vietnam, and the East Indies. Numerous plantations have been developed within its natural range and in tropical areas

of Latin America and Africa, and many of these are now producing teakwood.

The heartwood varies from yellow-brown to dark golden-brown and eventually turns a rich brown upon exposure to air. Teakwood has a coarse uneven texture (ring porous), is usually straight grained, and has a distinctly oily feel. The heartwood has excellent dimensional stability and a very high degree of natural durability. Although teak is not generally used in the United States where strength is of prime importance, its properties are generally on par with those of U.S. oaks (*Quercus*). Teak is generally worked with moderate ease with hand and machine tools. However, the presence of silica often dulls tools. Finishing and gluing are satisfactory, although pretreatment may be necessary to ensure good bonding of finishes and glues.

Teak is one of the most valuable woods, but its use is limited by scarcity and high cost. Because teak does not cause rust or corrosion when in contact with metal, it is extremely useful in the shipbuilding industry, for tanks and vats, and for fixtures that require high acid resistance. Teak is currently used in the construction of boats, furniture, flooring, decorative objects, and decorative veneer.

### **Tornillo**

Tornillo (*Cedrelinga cateniformis*), also referred to as cedrona, grows in the Loreton Huanuco provinces of Peru and in the humid terra firma of the Brazilian Amazon region. Tornillo can grow up to 52.5 m (160 ft) tall, with trunk diameters of 1.5 to 3 m (5 to 9 ft). Trees in Peru are often smaller in diameter, with merchantable heights of 15 m (45 ft) or more.

The heartwood is pale brown with a golden luster and prominently marked with red vessel lines; the heartwood gradually merges into the lighter-colored sapwood. The texture is coarse. The density of air-dried material collected in Brazil averages 640 kg/m<sup>3</sup> (40 lb/ft<sup>3</sup>); for Peruvian stock, average density is about 480 kg/m<sup>3</sup> (30 lb/ft<sup>3</sup>). The wood is comparable in strength with American elm (*Ulmus americana*). Tornillo cuts easily and can be finished smoothly, but areas of tension wood may result in woolly surfaces. The heartwood is fairly durable and reported to have good resistance to weathering.

Tornillo is a general construction wood that can be used for furniture components in lower-grade furniture.

### **Trebol (see Macawood)**

### **Virola (see Banak)**

### **Waika (see Manni)**

### **Walele (see Ilomba)**

### **Wallaba**

Wallaba is a common name applied to the species in the genus *Eperua*. Other names include wapa and apa. The center of distribution is in the Guianas, but the species

extends into Venezuela and the Amazon region of northern Brazil. Wallaba generally occurs in pure stands or as the dominant tree in the forest.

The heartwood ranges from light to dark red to reddish or purplish brown with characteristically dark, gummy streaks. The texture is rather coarse and the grain typically straight. Wallaba is a hard, heavy wood; density of air-dried wood is 928 kg/m<sup>3</sup> (58 lb/ft<sup>3</sup>). Its strength is higher than that of shagbark hickory (*Carya ovata*). The wood dries very slowly with a marked tendency to check, split, and warp. Although the wood has high density, it is easy to work with hand and machine tools. However, the high gum content clogs saw-teeth and cutters. Once the wood has been kiln dried, gum exudates are not a serious problem in machining. The heartwood is reported to be very durable and resistant to subterranean termites and fairly resistant to dry-wood termites.

Wallaba is well suited for heavy construction, railroad crossties, poles, industrial flooring, and tank staves. It is also highly favored for charcoal.

**Wapa (see Wallaba)**

**Yang (see Keruing)**

## Softwoods

### Cypress, Mexican

Native to Mexico and Guatemala, Mexican cypress (*Cupressus lusitanica*) is now widely planted at high elevations throughout the tropical world.

The heartwood is yellowish, pale brown, or pinkish, with occasional streaking or variegation. The texture is fine and uniform, and the grain is usually straight. The wood is fragrantly scented. The density of air-dried wood is 512 kg/m<sup>3</sup> (32 lb/ft<sup>3</sup>), and the strength is comparable with that of yellow-cedar (*Chamaecyparis nootkatensis*) or western hemlock (*Tsuga heterophylla*). The wood is easy to work with hand and machine tools, and it nails, stains, and polishes well. Mexican cypress air dries very rapidly with little or no end- or surface-checking. Reports on durability are conflicting. The heartwood is not treatable by the open tank process and seems to have an irregular response to pressure–vacuum systems.

Mexican cypress is used mainly for posts and poles, furniture components, and general construction.

### Parana Pine

The wood commonly called parana pine (*Araucaria angustifolia*) is a softwood but not a true pine. It grows in southeastern Brazil and adjacent areas of Paraguay and Argentina.

Parana pine has many desirable characteristics. It is available in large-size clear boards with uniform texture. The small pinhead knots (leaf traces) that appear on flat-sawn surfaces and the light or reddish-brown heartwood provide a desirable figure for matching in paneling and interior woodworking.

Growth rings are fairly distinct and similar to those of eastern white pine (*Pinus strobus*). The grain is not interlocked, and the wood takes paint well, glues easily, and is free from resin ducts, pitch pockets, and pitch streaks. Density of air-dried wood averages 545 kg/m<sup>3</sup> (34 lb/ft<sup>3</sup>). The strength of parana pine compares favorably with that of U.S. softwood species of similar density and, in some cases, approaches that of species with higher density. Parana pine is especially strong in shear strength, hardness, and nail-holding ability, but it is notably deficient in strength in compression across the grain. The tendency of the kiln-dried wood to split and warp is caused by the presence of compression wood, an abnormal type of wood 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 woodwork, sashes and door stock, furniture case goods, and veneer.

### Pine, Caribbean

Caribbean pine (*Pinus caribaea*) occurs along the Caribbean side of Central America from Belize to northeastern Nicaragua. It is also native to the Bahamas and Cuba. This low-elevation tree is widely introduced as a plantation species throughout the world tropics.

The heartwood is golden- to red-brown and distinct from the sapwood, which is light yellow and roughly 2 to 5 cm (1 to 2 in.) wide. This softwood species has a strong resinous odor and a greasy feel. The weight varies considerably and may range from 416 to 817 kg/m<sup>3</sup> (26 to 51 lb/ft<sup>3</sup>) at 12% moisture content. Caribbean pine may be appreciably heavier than slash pine (*P. elliotii*), but the mechanical properties of these two species are rather similar. The lumber can be kiln dried satisfactorily. Caribbean pine is easy to work in all machining operations, but its high resin content may cause resin to accumulate on the equipment. Durability and resistance to insect attack vary with resin content; in general, the heartwood is rated as moderately durable. The sapwood is highly permeable and is easily treated by open tank or pressure–vacuum systems. The heartwood is rated as moderately resistant to preservative treatment, depending on resin content.

Caribbean pine is used for the same purposes as are the southern pines (*Pinus* spp.).

### Pine, Ocote

Ocote pine (*Pinus oocarpa*) is a high-elevation species that occurs from northwestern Mexico southward through Guatemala into Nicaragua. The largest and most extensive stands occur in Guatemala, Nicaragua, and Honduras.

The sapwood is a pale yellowish brown and generally up to 7 cm (3 in.) wide. The heartwood is a light reddish brown. The grain is not interlocked. The wood has a resinous odor, and it weighs about 656 kg/m<sup>3</sup> (41 lb/ft<sup>3</sup>) at 12% moisture content. The strength properties of ocote pine are comparable in most respects with those of longleaf pine (*P. palustris*).

Decay resistance studies have shown ocote pine heartwood to be very durable with respect to white-rot fungal attack and moderately durable with respect to brown rot.

Ocote pine is comparable with the southern pines (*Pinus*) in workability and machining characteristics. It is a general construction wood suited for the same uses as are the southern pines.

### **Pine, Radiata**

Radiata pine (*Pinus radiata*), also known as Monterey pine, is planted extensively in the southern hemisphere, mainly in Chile, New Zealand, Australia, and South Africa. Plantation-grown trees may reach a height of 26 to 30 m (80 to 90 ft) in 20 years.

The heartwood from plantation-grown trees is light brown to pinkish brown and is distinct from the paler cream-colored sapwood. Growth rings are primarily wide and distinct. False rings may be common. The texture is moderately even and fine, and the grain is not interlocked. Plantation-grown radiata pine averages about 480 kg/m<sup>3</sup> (30 lb/ft<sup>3</sup>) at 12% moisture content. Its strength is comparable with that of red pine (*P. resinosa*), although location and growth rate may cause considerable variation in strength properties. The wood air or kiln dries rapidly with little degrade. The wood machines easily although the grain tends to tear around large knots. Radiata pine nails and glues easily, and it takes paint and finishes well. The sapwood is prone to attack by stain fungi and vulnerable to boring insects. However, plantation-grown stock is mostly sapwood, which treats readily with preservatives. The heartwood is rated as durable above ground and is moderately resistant to preservative treatment.

Radiata pine can be used for the same purposes as are the other pines grown in the United States. These uses include veneer, plywood, pulp, fiberboard, construction, boxes, and millwork.

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*From*

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