

The Railway Tie Association

***COMMONLY USED
CROSSTIE SPECIES***



IDENTIFICATION OF WOODS

The material included here has been excerpted from the U.S.D.A. Forest Service Booklet titled:

**GUIDEBOOK FOR THE
IDENTIFICATION OF
WOODS USED FOR
TIES AND TIMBERS**

by

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dated 1917

This information is as pertinent today as when it was written except for the scientific names of the various species. The current scientific nomenclature can be had by referring to **U.S.D.A. FOREST SERVICE CHECKLIST OF UNITED STATES TREES (Agriculture Handbook No. 541)** or to **DENDROLOGY** by Harlow & Harrar or to any other textbook dealing with timber species identification.

Description of Hardwoods

The Oaks

THE WHITE-OAK GROUP.

The following features are characteristic of the wood of all species of the white-oak group:

Pores.—In the springwood, large and easily visible to the unaided eye, forming a porous ring one or two rows, and in broad rings three rows, of pores wide. The pores decrease in size more or less abruptly toward the summerwood, where they are grouped in V-shaped radial bands. In the summerwood they are somewhat angular and so small and numerous that it is exceedingly difficult to count them even with the aid of a good hand lens.

The large pores in the springwood are usually plugged with tyloses (see Plate I), except in the outer portion of the sapwood. In chestnut oak the pores are more open, in this respect resembling those in the red oaks.

Rays.—Some of the rays are very broad and conspicuous and from one-half inch to 4 inches high (i. e., measured with the grain), while others are so fine as to be barely visible with a lens. The broad rays appear as conspicuous streaks where the bark has been removed.

Parenchyma.—Plainly visible with a lens as light-colored tangential lines and also as a lighter colored area surrounding the pores of the summerwood.

Annual rings.—Mostly from moderately wide to narrow; occasionally wide.

Sapwood.—From 1 to several inches in thickness, often discolored by tannin and other material leached out of the bark.

Heartwood.—Grayish brown, usually without reddish tinge.

Physical properties.—The wood is heavy but varies considerably in weight. It is usually straight-grained and checks easily on drying. When dry the wood is without characteristic odor and taste.

Similar Woods.

Because of the broad rays the woods of the white-oak group are not easily confused with any other woods excepting those of the red-oak group. For a method of distinguishing these two groups see above and study the illustrations in Plates II, III, IV, and V.

Some of the southern white oaks grow rapidly and have wide annual rings, so that they appear different on the end surface from those of slower growth. In examining the summerwood pores of such oaks an effort should be made to locate annual rings of moderate width, which can often be found near the bark.

WHITE OAK.

Quercus alba Linn.*Other Names.*

The true white oak is the most important tree of the white-oak group. Throughout its range it is known as white oak, although in Arkansas it is also named stave oak because it is cut in large quantities for tight cooperage.

Geographic Distribution.

See map, page 14.

Distinguishing Characteristics.

Since no reliable method has yet been found for distinguishing true white-oak ties from post oak, swamp white oak, cow oak, and others of the white oak group, all these species are described collectively on page 37.

CHESTNUT OAK.

Quercus prinus Linn.*Other names.*

Rock chestnut oak; rock oak; tanbark oak.

Geographic Distribution.

See map, page 14.

Distinguishing Characteristics.

(See white-oak group, p. 37.)

Chestnut oak differs from the other white oaks in not having the pores in the heart wood densely plugged with tyloses. Occasional closed or partly closed pores may be found, but in general the pores are more open, as in the red oaks.

Discoloration of the sapwood due to the tannin being leached out of the bark is common in chestnut oak, but is not always reliable for identification.

POST OAK.

Quercus minor (Marsh.) Sargent.*Other Names.*

Iron oak; box white oak; white oak. The name post oak is derived from the abundant use of this species for posts in the northern portion of its range where the tree is comparatively small.

Geographic Distribution.

See map, page 14.

Distinguishing Characteristics.

(See white-oak group, p. 37.)

No reliable means of readily distinguishing this wood from all other white oaks is known.

OTHER WHITE OAKS USED FOR TIES AND TIMBERS.

COW OAK (*Quercus michauxii* Nutt.), also known as basket oak, swamp white oak (Del., Ala.), and swamp chestnut oak (Fla.). For geographic distribution, see map, page 16.

OVERCUP OAK (*Quercus lyrata* Walt.), also known as swamp post oak, water white oak, and swamp white oak (Tex.). For geographic distribution, see map, page 16.

BUR OAK (*Quercus macrocarpa* Michx.), also known as mossycup oak, overcup oak, blue oak, scrub oak, overcup white oak (Vt.), and mossycup white oak (Minn.). For geographic distribution, see map, page 14.

SWAMP WHITE OAK (*Quercus platanooides* (Lam.) Sudworth) or swamp oak. For geographic distribution, see map, page 16.

CHINQUAPIN OAK (*Quercus acuminata* (Michx.) Houba), also known as chestnut oak, yellow oak, shrub oak, dwarf chestnut oak, shrub oak (Nebr.), white oak (Tenn.), and rock oak (Ark.). For geographic distribution, see map, page 16.

THE RED-OAK GROUP.

The following features are characteristic of the wood of all species of the red-oak group:

Pores.—In the springwood, large and easily visible without a lens, forming a porous ring from two to three rows, or in very wide rings, four rows of pores wide. They decrease in size more or less abruptly or in wide rings somewhat gradually, toward the summerwood, where they are grouped in radial bands often branching or widening toward the outer limit of the annual ring. The pores in the summerwood are well rounded and very distinct under a lens and occasionally barely visible even without a lens. They are not too numerous or crowded to be easily counted with the aid of a magnifying glass.

The large pores in the springwood are open for the most part, although occasionally tyloses are present in the pores, notably in blackjack, in which they are almost as abundant as in the white-oak group.

Rays.—Some of the rays are very broad and conspicuous; others are so fine as to be barely visible with a lens and are easily overlooked. The large rays range from one-fourth to one inch, or occasionally more, in height (i. e., measured with the grain), averaging somewhat less than in the white oaks. They appear as conspicuous darker streaks where the bark has been removed.

Parenchyma.—Plainly visible as light-colored tangential lines in the summerwood and as a lighter area surrounding the smaller pores.

Annual rings.—Mostly from moderate in width to wide.

Sapwood.—Highly variable in thickness, from 1 to 3 inches.

Heartwood.—Mostly brown with reddish tinge, especially in the vicinity of knots. Exceptional pieces resembling white oak in color may be found.

Physical properties.—The wood of the various species of the red-oak group is heavy, but varies considerably in weight, the variation depending more on the conditions under which the tree grew than on the species. It is usually straight-grained and is subject to considerable checking in seasoning.

Similar Woods.

The red oaks resemble the white oaks in being heavy and in having broad rays, but the characteristic reddish tinge and open pores of the red-oak woods are usually sufficiently pronounced to distinguish them from the woods of the white-oak group. In case of doubt as to which group a piece of oak belongs to, examine the pores in the summerwood as directed on page 37.

RED OAK.

Quercus rubra Linn.

Other Names.

The true red oak, like the true white oak, is rarely known by any other name. Occasionally it is called black oak or Spanish oak.

Geographic Distribution.

See map, page 18.

Distinguishing Characteristics.

Red-oak wood can not be distinguished from most of the other oaks belonging to the same group.

YELLOW OAK.

Quercus velutina Lam.

Other Names.

Black oak; quercitron oak; tanbark oak (Ill.); yellow-barked oak (Minn.); spotted oak (Mo.); dyer's oak (Tex.).

Geographic Distribution.

See map, page 18.

Distinguishing Characteristics.

The yellowish inner bark, part of which may nearly always be found on ties even when peeled, is sufficient to distinguish yellow oak from all other oaks. Yellow-oak ties or timbers sawed or hewn on all sides can not be distinguished from other red oaks.

PIN OAK.

Quercus palustris Muenchh.

Other Names.

Swamp Spanish oak; water oak; water Spanish oak (Ark.). Pin oak is so called because of the numerous small branches scattered along the trunk, appearing like so many pins promiscuously inserted. These branches leave their corresponding "pin" knots in the wood, thus suggesting another origin of the common name.

Geographic Distribution.

See map, page 18.

Distinguishing Characteristics.

The numerous knots in pin-oak ties afford a rough but not absolutely reliable means of identification; for any oak that might accidentally have numerous, small knots would be classed as pin oak by this method. No more accurate means of identifying the species by means of the wood alone is known, however.

WILLOW OAK.

Quercus phellos Linn.

Other Names.

Peach oak; water oak. The willow oak belongs to a group of nonevergreen oaks with narrow leaves that are not cut or notched at the edges, known collectively as willow oaks. The other important species are shingle oak and laurel oak.

Geographic Distribution.

See map, page 18.

Distinguishing Characteristics.

The willow oaks belong to the red-oak group. They can not be identified individually by the wood alone.

OTHER RED OAKS USED FOR TIES AND TIMBERS.

BLACK JACK (*Quercus marilandica* Muenchh.), also known as jack oak, iron oak, black oak, barren oak, and scrub oak (S. C.). This species has the distinction of belonging to the red-oak group and yet having the pores densely plugged with tyloses as is the case in the wood of the white-oak group. This feature usually is distinct enough to distinguish the black jack from the other common red oaks, and the pores in the summerwood will distinguish it from the white-oak group. For geographic distribution, see map, page 18.

SPANISH OAK (*Quercus digitata* Marsh.) Sudworth), also known as red oak and Spanish water oak. For geographic distribution, see map, page 18.

TEXAN OAK (*Quercus texana* Buckl.), also known as red oak, spotted oak, and Spanish oak. A species often not distinguished from the true red oak (*Quercus rubra*) by woodsmen. For geographic distribution, see map, page 18.

SCARLET OAK (*Quercus coccinea* Muenchh.), also known as red oak, black oak, and Spanish oak, and not easily distinguished from the true red oak even in the forest. For geographic description, see map, page 16.

TURKEY OAK (*Quercus catesbaei* Michx.), also known as scrub oak, barren scrub oak, forked leaf (S. C.), and black jack (S. C.). For geographic distribution, see map, page 16.

WATER OAK (*Quercus nigra* Linn.), also known as spotted oak, duck oak, possum oak, and punk oak. For Geographic distribution, see map, page 16.

LAUREL OAK (*Quercus laurifolia* Michx.), also known as swamp laurel oak, Darlington oak (S. C.), willow oak, and water oak (Ga.). For geographic distribution, see map, page 18.

SHINGLE OAK (*Quercus imbricaria* Michx.), also known as jack oak (Ill.), water oak (N. C.), and laurel oak. For geographic distribution, see map, page 18.

CHESTNUT.

Castanea dentata (Marsh.) Borkh.

Other Names.

Excepting Indian names, chestnut is not known by any other name.

Geographic Distribution.

See map, page 20.

Distinguishing Characteristics.

Pores.—In the springwood, large and distinct, forming a broad porous ring; in the summerwood, very small and numerous, arranged in irregular branched radial bands. The large pores are almost entirely plugged with tyloses.

Rays.—All very fine, barely distinct with a lens.

Parenchyma.—Scattered among the pores, not distinct.

Annual rings.—Mostly moderate in width, but highly variable.

Sapwood.—Very narrow, rarely over one-half inch wide.

Heartwood.—Grayish brown.

Physical properties.—The wood is moderately light, straight-grained, has no pronounced odor, but has a mild astringent taste when chewed.

Similar Woods.

Chestnut is not easily confused with any other species. The radial bands of pores are found in no other wood used for ties, except the oaks, which, however, are easily identified by their greater weight and broad rays. Black ash resembles chestnut, but the pores in black ash summerwood are few and isolated and never arranged in radial bands.

WHITE ELM.

Ulmus americana Linn.

Other Names.

American elm; water elm; swamp elm, rock elm (hard grades).

Geographic Distribution.

See map, page 22.

Distinguishing Characteristics.

Pores.—In the springwood moderately large, forming a porous ring consisting of one row, or, in very wide annual rings, of two or more rows of pores. Throughout the summerwood the pores are very small and numerous and connected into more or less continuous wavy tangential bands. The large pores are mostly open and rarely contain tyloses.

Rays.—Fine, not distinct without a lens.

Parenchyma.—Not noticeable.

Annual rings.—Distinct, moderate in width.

Sapwood.—Mostly between 1 and 3 inches wide.

Heartwood.—Brownish, usually with reddish tinge.

Physical properties.—The wood is moderately heavy, tough, straight-grained, or somewhat cross-grained, and without characteristic odor or taste.

Similar Woods.

Hard grades of white elm are difficult to distinguish from cork elm, but it will be found that the large pores of the springwood are less conspicuous in the cork elm. Compare illustrations. Slippery elm has thinner sapwood and more porous springwood than white elm, and the inner bark becomes mucilaginous when chewed.

The elms are closely related to the hackberries; both have the conspicuous wavy tangential lines of pores in the summerwood, but hackberry has the wider sapwood, paler heartwood with slight greenish tinge, and more distinct rays.

CORK ELM.

Ulmus racemosa Thomas.*Other Names.*

Rock elm; hickory elm; corkbark elm; corky white elm.

Geographic Distribution.

See map, page 22.

Distinguishing Characteristics.

Pores.—Larger in the springwood than in the summerwood, but not conspicuous because they are comparatively small and are not close together; barely visible without a lens, and usually forming only one row. They are mostly closed with tyloses. Throughout the summerwood they are small and numerous and are arranged in more or less continuous, wavy, tangential bands.

Rays.—Fine, not distinct without a lens.

Parenchyma.—Not noticeable.

Annual rings.—Fairly distinct, moderate in width.

Sapwood.—Three-fourths of an inch to 1½ inches wide.

Heartwood.—Light brown, often tinged with red.

Physical properties.—The wood is heavy, very tough, mostly cross-grained, and without characteristic odor or taste.

Similar Woods.

Cork elm can be distinguished from the other commercial elms by its greater weight and inconspicuous rows of pores in the springwood.

The wood of the southern WING ELM (*Ulmus alata* Michx.) resembles that of the northern cork elm very closely, but is usually more lock-grained

SLIPPERY ELM.

Ulmus pubescens Walt.*Other Names.*

Red elm; rock elm (Tenn.).

Geographic Distribution.

See map, page 22.

Distinguishing Characteristics.

Pores.—In the springwood, large, forming a porous ring from 2 to 4 pores wide; throughout the summerwood, very small and numerous and arranged in more or less continuous wavy tangential bands. The large pores are mostly open, and contain few tyloses.

Rays.—Fine, not distinct without a lens.

Parenchyma.—Not noticeable.

Annual rings.—Distinct, mostly moderate in width.

Sapwood.—Narrow, mostly less than one-half inch wide, rarely over an inch.

Heartwood.—Brown, with shades of red.

Physical properties.—The wood is moderately heavy, fairly straight-grained, tough, practically tasteless, and has a slight odor resembling the taste of the bark. The inner bark when chewed becomes highly mucilaginous.

Similar Woods.

Slippery elm can most easily be distinguished from similar woods by the mucilaginous character of the inner bark whenever this is present. The other elms have wider sapwood and less porous springwood. Hackberry resembles slippery elm very much in structure, but has very wide sapwood, pale heartwood with a greenish tinge, and distinct rays.

HACKBERRY.

Celtis occidentalis Linn.*Other Names.*

Sugarberry; nettle-tree; hack-tree (Minn.); bastard elm (N. J.).

Geographic Distribution.

See map, page 20.

Distinguishing Characteristics.

Pores.—In the springwood, large, forming a porous ring two or more (one in narrow annual rings) pores wide. In the summerwood, small and numerous, arranged in more or less continuous wavy tangential bands. In the heartwood the large pores are partly closed with tyloses.

Rays.—Fairly distinct without a lens.

Parenchyma.—Not noticeable.

Annual rings.—Distinct, irregular in width and outline.

Sapwood.—Wide, usually over 3 inches, often blued with sap stain.

Heartwood.—Not always distinctly defined; yellowish or greenish gray.

Physical properties.—The wood is moderately heavy, fairly straight-grained, and without characteristic odor or taste.

Similar Woods.

Hackberry resembles elm in structure; but the wide sapwood, greenish yellow tinge in the heartwood, and wider rays in the hackberry are sufficient to distinguish it from the elm.

The wood of SUGARBERRY (*Celtis mississippiensis*, Bosc.) resembles hackberry wood very much and often is sold under that name. It grows from southern Illinois and Indiana southward to Florida and Texas.

OSAGE ORANGE.

Toxylon pomiferum Raf.*Other Names.*

Bois d'arc; mock orange; hedge-plant; yellowwood (Tenn.).

Geographic Distribution.

See map, page 20. This species is planted considerably for hedges outside of its natural range.

Distinguishing Characteristics.

Pores.—Large in the springwood, forming a lighter colored ring; not distinct individually, because they are densely plugged with tyloses, except in the outer annual ring or two of the sapwood. In the summerwood the pores are very small and grouped in short, wavy, tangential bands.

Rays.—Fine, barely visible without a lens.

Parenchyma.—Not distinguishable with a hand lens from the fine pores of the summerwood.

Annual rings.—Distinct, irregular in width and outline.

Sapwood.—Very narrow, usually less than one-half inch wide.

Heartwood.—Freshly cut surfaces are golden yellow to golden brown with reddish brown streaks, turning darker on exposure to the air. Color easily soluble in water.

Physical properties.—The wood is very heavy, exceedingly hard, somewhat cross-grained, and without characteristic odor or taste.

Similar Woods.

Osage orange resembles black locust so much in structure, color, and weight that it is exceedingly difficult at times to distinguish the two. The coloring matter in osage orange is highly soluble, however, and a wet rag or blotter applied to the surface of the wood will be stained yellow in less than 10 minutes; practically no color is re-

moved from black locust by this method. Fresh surfaces of osage orange are yellowish or golden brown; on black locust they are more of a russet brown. Osage orange ties contain numerous pin knots, which are scarce in black locust.

BLACK LOCUST.

Robinia pseudacacia Linn.

Other Names.

Yellow locust; false acacia; pea-flower locust; green locust; post locust.

Geographic Distribution.

See map, page 20. This species is planted abundantly outside of its natural range.

Distinguishing Characteristics.

Pores.—In the springwood, comparatively large but densely plugged with tyloses which cause them to appear to the unaided eye as a light-colored band rather than as a porous ring (under a lens it can be seen that this band is 2 or 3 rows of pores wide). In the summerwood, very small; in the outer portion of the summerwood, grouped in short, wavy tangential bands.

Rays.—Not visible or barely visible without a lens.

Parenchyma.—Not noticeable around the larger pores with an ordinary hand lens, and not distinguishable from the finer pores of the outer summerwood.

Annual rings.—Distinct, variable in width.

Sapwood.—Narrow, rarely over one-half inch wide.

Heartwood.—Golden brown, sometimes with a tinge of green.

Physical properties.—The wood is very, very heavy and exceedingly hard. It is mostly straight-grained and without distinct characteristic odor or taste.

Similar Woods.

The wood of black locust is easily confused with that of osage orange, being similar in weight, structure, color, and other properties. The locust has a russet brown color, while fresh surfaces of osage orange are more of a yellowish or golden brown, often with reddish brown streaks. The color of the osage orange is readily soluble in water, and pieces of the wood placed on a wet rag soon color the cloth yellow; but practically no color can be extracted with cold water from black locust. Rather large worm-holes may be found in a large proportion of locust ties. These holes are caused by a grub or larva, known as the locust borer, which does not attack the osage orange.

RED MULBERRY.

Morus rubra Linn.

Other Name.

Black mulberry.

Geographic Distribution.

See map, page 22.

Distinguishing Characteristics.

Pores.—Large in the springwood, forming a porous ring from 2 to 5 pores wide; in the summerwood, small, in irregular groups of from 3 to 10 pores, the groups usually arranged so as to form wavy, tangential bands visible without a lens.

The large pores in the springwood are densely plugged with glistening tyloses.

Rays.—Fairly conspicuous without a lens.

Parenchyma.—Not distinctly noticeable with a lens.

Annual rings.—Distinct, usually moderate in width.

Sapwood.—About one-half inch wide; yellowish.

Heartwood.—Freshly cut surfaces yellowish brown, becoming russet brown on exposure to air.

Physical properties.—The wood is heavy, fairly straight-grained, and without characteristic odor or taste.

Similar Woods.

Red mulberry is not easily confused with other woods. The yellowish brown color of freshly exposed surfaces together with the narrow sapwood, distinct rays, and glistening tyloses is sufficient to distinguish it from all other native species.

HARDY CATALPA.

Catalpa speciosa Warder.

Other Names.

Western catalpa; cigartree; Indian bean.

Geographic Distribution.

See map, page 30. The catalpa is planted in many States outside of its natural range.

Distinguishing Characteristics.

Pores.—In the springwood, large and distinct, forming a broad porous ring; in the middle of the annual ring, smaller, but usually visible without a lens, isolated, or in groups of from two to five, or more often in slightly wavy, tangential lines; in the outer part of the summerwood, very small and always in wavy, tangential lines. The larger pores are more or less plugged with glistening tyloses.

Rays.—Very fine, not distinct without a lens.

Parenchyma.—Not noticeable around the larger pores and not distinguishable from the very small pores of the outer summerwood.

Annual rings.—Usually wide; but narrow-ringed specimens may also be found.

Sapwood.—Very narrow, rarely over one-half inch wide.

Heartwood.—Grayish brown, occasionally with a lavender tinge.

Physical properties.—The wood is moderately light, straight-grained, and without pronounced taste or odor. Sometimes it has a slight odor resembling kerosene.

Similar Woods.

Sassafras and black ash resemble catalpa in color and somewhat in structure. Sassafras can easily be identified by its spicy odor; black ash is considerably heavier than catalpa and has comparatively few pores in the summerwood. In catalpa the pith usually is three sided and in black ash round.

The wood of the COMMON CATALPA (*Catalpa catalpa* (Linn.) Karst.) resembles that of the hardy catalpa so closely that the two can not readily be distinguished. The common catalpa is supposed to be indigenous only to southwestern Georgia, western Florida, central Alabama, and Mississippi, but it is widely cultivated and naturalized elsewhere east of the Rocky Mountains.

HONEY LOCUST.

Gleditsia triacanthos Linn.

Other Names.

Thorny locust; honey shucks; sweet locust; three-thorned acacia.

Geographic Distribution.

See map, page 30.

Distinguishing Characteristics.

Pores.—Comparatively large in the springwood; conspicuous without a lens, forming a wide porous ring which occupies about one-half the total width of moderately wide annual rings. In the outer portion of the summerwood, very small, openings not clearly visible with an ordinary lens; joined in short, wavy, lighter-colored, tangential bands, distinct to the unaided eye. The large pores in the springwood are not closed with tyloses but occasionally contain a bright reddish gum.

Rays.—Mostly very distinct without a lens.

Parenchyma.—Not noticeable around the larger pores and not readily distinguishable from the small pores in the summerwood.

Annual rings.—Distinct; irregular in width and outline.

Sapwood.—From three-fourths of an inch to 2 inches wide on tie material.

Heartwood.—Bright cherry red to reddish brown.

Physical properties.—The wood is very heavy, fairly straight grained, and without characteristic odor or taste.

Similar Woods.

On account of the similarity in the color and general structure of the wood of the honey locust and the coffeetree, the two are often confused in the market. The coffeetree, however, has a narrower sapwood and a much larger pith. The pith in honey locust is usually less than 0.15 inch in diameter; in coffeetree it usually is over 0.2 inch in diameter. The pores in the outer summerwood of the coffeetree are somewhat larger (the openings being plainly visible with a good lens), and are more often in rounded groups which are not joined in tangential bands. The rays in coffeetree wood are less distinct to the unaided eye than those in honey locust. Scattered, small pin knots, due to the thorns which grow on the trunks, are found in honey locust, but never in coffeetree.

COFFEETREE.

Gymnocladus dioicus (Linn.) Koch.

Other Names.

Kentucky coffeetree; coffee nut; coffee-bean tree.

Geographic Distribution.

See map, page 20.

Distinguishing Characteristics.

Pores.—In the springwood, large and distinct, forming a porous ring from 2 to 5 pores wide; in the summerwood, small, but the opening still visible with a good lens; arranged in rounded groups of from 4 to 20 or more, the groups occasionally joined in tangential bands in the extreme outer portion of the annual rings. The large pores are not plugged with tyloses, but occasionally contain an orange-reddish gum.

Rays.—Visible without a lens, but not conspicuous.

Parenchyma.—Not noticeable with a lens.

Annual rings.—Distinct, highly variable in width.

Sapwood.—Narrow, usually less than one-half inch wide, but occasionally as much as 1 inch.

Heartwood.—Bright cherry red to reddish brown.

Physical properties.—The wood has about the same weight and properties as that of the honey locust.

Similar Woods.

The wood of the coffeetree is not easily confused with any wood except that of honey locust, which has practically the same color and almost the same structure. For distinguishing these two woods, see keys or distinctions made under the heading Honey Locust.

WHITE ASH.

Fraxinus americana Linn.

Other Names.

American ash; cane ash.

Geographic Distribution.

See map, page 30.

Distinguishing Characteristics.

Pores.—Comparatively large in the springwood, forming a porous ring 2 or 3 or, in wide rings, 4 pores wide; in the summerwood, very small, appearing to the unaided eye as white specks, not numerous, scattered singly or by twos. The larger pores, excepting those of the outer sapwood, contain numerous tyloses.

Rays.—Very fine, not distinct without a lens.

Parenchyma.—Distinct as a light-colored area around the pores of the summerwood, often projecting tangentially and connecting pores somewhat separated, thereby

forming wavy, tangential lines visible without a lens, especially in the outer part of wide annual rings.

Annual rings.—Very distinct, mostly moderately wide.

Sapwood.—Several inches wide.

Heartwood.—Grayish brown, sometimes with a reddish tinge.

Physical properties.—The wood is highly variable in weight, and some surprisingly light pieces are occasionally found; it averages about 34 pounds per cubic foot oven-dry based on green volume. It is straight-grained and without characteristic odor or taste.

Similar Woods.

About 18 different species of ash are known in this country; but white, green, and black ash form about 98 per cent of the commercial cut. Most of the ash ties or timbers are either white or green ash, black ash being used comparatively little for this purpose.

The wood of GREEN ASH (*Fraxinus lanceolata* Borkh.) resembles white ash very much. The rings in the green ash average wider than those in white ash, but this feature can not be relied on for identification of species. The tangential lines of parenchyma connecting the pores in the summerwood are longer and more numerous in green ash than in white ash. Commercially, no distinction is generally made between the two species. For geographic distribution see map, page 30.

BLACK ASH (*Fraxinus nigra* Marsh.), also known as hoop ash, differs from green and white ash in being of lighter weight (about 29 pounds per cubic foot oven-dry based on green volume), in having darker heartwood, and in having comparatively narrow sapwood, rarely over an inch and usually about one-half inch wide. Projections of parenchyma from the pores of the summerwood are rare, and for this reason the tangential bands so plain in the summerwood of green ash are somewhat obscure in black ash. For geographic distribution see map, page 30.

Chestnut, catalpa, and sassafras resemble the ashes, especially black ash. In chestnut the pores in the summerwood are numerous and in radial bands; in catalpa and sassafras they are also numerous but in tangential bands; while in the ashes they are few and scattering, usually surrounded by parenchyma in such a way as to appear in tangential bands in the outer portion of the summerwood. Sassafras can readily be distinguished from the ashes by its spicy odor or taste.

SASSAFRAS.

Sassafras sassafras (Linn.) Karst.

Other Name.

Saxifrax.

Geographic Distribution.

See map; page 30.

Distinguishing Characteristics.

Pores.—The large pores in the springwood form a broad ring from three to five or even seven pores wide; in the summerwood the pores are very small (not visible without a lens), mostly isolated or in radial rows of two or three, and not crowded. The large pores contain numerous tyloses.

Rays.—Fine, but distinct without a lens.

Parenchyma.—Noticeable as a narrow lighter-colored area around the pores of the summerwood, in the outer portion often extending a little tangentially from the pores and appearing to connect them in wavy, tangential lines.

Annual rings.—Very distinct, moderate in width.

Sapwood.—Narrow, rarely over one-half inch wide.

Heartwood.—A light silvery brown.

Physical properties.—The wood is moderately heavy and straight-grained and has a spicy odor and taste.

Similar Woods.

Sassafras wood resembles the wood of the ashes, especially black ash, and of catalpa in color and structure, although the sapwood is much narrower than that of the white and green ash. The spicy odor and taste, however, are sufficient, except when the wood has been treated with a preservative, to distinguish it from all other native woods used for ties.

PERSIMMON.

Diospyros virginiana Linn.

Other Names.

Date plum; possumwood (Fla.).

Geographic Distribution.

See map, page 20.

Distinguishing Characteristics.

Pores.—Comparatively large, especially in the springwood, decreasing in size, somewhat abruptly or gradually (then classed as diffuse-porous) toward the summerwood; easily visible without a lens except in the outer portion of the annual ring; not crowded; occasionally in rows of from two to five. Tyloses absent.

Rays.—Very fine even under a lens. On the tangential surface they appear in tiers or stories producing very fine bands running across the grain and visible with the naked eye.

Parenchyma.—Visible with a lens as numerous very fine, light-colored, irregular, tangential lines no wider than the rays.

Annual rings.—Marked by a row of larger pores at the beginning of each year's growth, but not conspicuous because the pores are not numerous and decrease in size more or less gradually toward the outer portion of each ring.

Sapwood.—Wide, from 2 to 4 or 5 inches; white when fresh, but sometimes stained a grayish brown when exposed to the air for some time.

Heartwood.—Jet black or blackish brown, irregular in outline and usually very small.

Physical properties.—The wood is from very heavy to very, very heavy, straight or wavy-grained, and without characteristic odor or taste.

Similar Woods.

Persimmon can not be mistaken for any other wood when the black heart is present. Pieces of sapwood resemble hickory sapwood in weight and in having comparatively large pores and fine lines of parenchyma, but can be distinguished by the fine horizontal bands on the tangential surface, which are due to the storied arrangement of the rays.

THE HICKORIES.

Comparatively few hickory ties are used, but occasionally some are sold with other hardwoods. Eight species of hickory are of commercial importance and several other species of minor value have been named by botanists. According to the leaves, twigs, and fruit the species can be divided into two groups, the true hickories, and the pecan hickories. No method has as yet been determined for identifying each species of the wood alone, except water hickory, which has a distinct structure; and often it is impossible without the aid of a compound microscope even to determine to which group a piece of hickory belongs.

The following features are characteristic of all the hickories except the water hickory.

Pores.—Plainly visible with the unaided eye in the springwood, forming a ring 1 to 2 or 3 pores wide; decreasing in size somewhat gradually toward the summerwood, in which they are smaller but still occasionally visible without a lens. In the summerwood, not numerous, isolated or in radial groups of two or three.

Most of the larger pores, except those in the outer sapwood, are filled with tyloses.

Rays.—Rather fine, not distinct without a lens.

Parenchyma.—In numerous fine, light-colored, tangential lines not widening out and encircling the pores as in ash, but usually extending between the pores or passing around them on one side; very plain under a lens and sometimes visible without a lens.

Annual rings.—Clearly defined; highly variable in width.

Sapwood.—From 1 to 2 and occasionally as much as 3 inches wide on ties.

Heartwood.—Brown to reddish brown.

Physical properties.—The wood of the hickories is very heavy and exceedingly hard and tough. It has no characteristic odor or taste.

Similar Woods.

The hickories can be distinguished from other ring-porous woods by the numerous fine, light-colored, tangential lines of parenchyma and the presence of few pores in the summerwood. Persimmon is somewhat similar to hickory in these respects; but in the persimmon the tangential lines are much the finer, and the medullary rays are in horizontal rows plainly noticeable on the tangential surfaces as very fine bands across the grain.

The following species may occasionally be cut for ties:

TRUE HICKORIES.

SHAGBARK (HICKORY) (*Hicoria ovata* (Mill.) Britton), also named shellbark, scalybark, and upland hickory (Ill.). For geographic distribution see map, page 26.

SHELLBARK (HICKORY) (*Hicoria laciniosa* (Michx. f.) Sargent), also known as shellbark, western shellbark, thick shellbark, bottom shellbark (Ill.), kingnut, yellow-twig hickory, and big-fruited shellbark. For geographic distribution see map, page 26.

PIGNOT (HICKORY), or Black Hickory (*Hicoria glabra* (Mill.) Britton), also known as switch-top hickory and tight-bark hickory. For geographic distribution see map, page 26.

MOCKERNUT (HICKORY) (*Hicoria alba* (Linn.) Britton), also known as whiteheart hickory, big-bud hickory, white hickory, and hognut. For geographic distribution see map, page 26.

PECAN HICKORIES.

BITTERNUT (HICKORY) (*Hicoria minima* (Marsh.) Britton), often named pignut, also swamp hickory, pig hickory, bitter hickory, and willow hickory. For geographic distribution, see map, page 28.

PECAN (HICKORY) (*Hicoria pecan* (Marsh.) Britton). For geographic distribution, see map, page 28.

NUTMEG HICKORY (*Hicoria myristicæformis* (Michx. f.) Britton), also known as bitter waternut. For geographic distribution, see map, page 28.

WATER HICKORY (*Hicoria aquatica* (Michx. f.) Britton), also known as bitter pecan, swamp hickory, and water bitternut. For geographic distribution, see map, page 28.

Water hickory differs from the other hickories in having less clearly defined annual rings, and in the large pores being more scattered, thus approaching diffuse-porous woods in structure. See illustration. The fine, light-colored lines of parenchyma characteristic of the hickories are very distinct in this species. The color of the heartwood is about the same as in the other hickories, but the wood is somewhat lighter in weight.

SYCAMORE.

Platanus occidentalis Linn.*Other Names.*

Button-wood; buttonball-tree; plane-tree; water beech (Del.).

Geographic Distribution.

See map, page 20.

Distinguishing Characteristics.

Pores.—Very small, not visible without a lens or indistinctly visible in vigorous growth; crowded and of about uniform size throughout the annual ring except in the extreme outer portion, in which they are smaller and less numerous and produce a narrow, lighter colored band.

Rays.—Practically all comparatively broad and conspicuous; many over twice as wide as the largest pores; appearing on a radial surface as reddish brown "flakes," or "silver grain" similar to quartered oak, but finer.

Parenchyma.—Not noticeable even with a lens.

Annual rings.—Distinct, defined by a lighter colored band at outer limit of each; not differentiated into distinct springwood and summerwood.

Sapwood.—One and one-half to 3 inches wide.

Heartwood.—Light to moderately dark shades of reddish brown; sometimes not clearly defined from sapwood.

Physical properties.—The wood is moderately heavy, lock-grained, and without characteristic odor or taste. Cup shake, especially in butt logs, is a common defect.

Similar Woods.

Sycamore is not easily confused with other woods. Its numerous conspicuous medullary rays and interlocked grain make it easily recognizable. It resembles beech somewhat, but can be distinguished from it by the rays, only a small proportion of which are broad in beech. Beech also has a distinct darker and denser band of summerwood.

BEECH.

Fagus atropunicea (Marsh.) Sudworth.*Other Names.*

Only one species of beech is native to the United States; but because of the variability in the color of the heartwood the darker grades have been designated as red-heart beech and the lighter grades as white-heart beech.

Geographic Distribution.

See map, page 30.

Distinguishing Characteristics.

Pores.—Very small, not visible without a lens; crowded in the springwood but gradually decreasing in size and number toward the outer portion of the annual ring, forming a harder and darker band of summerwood.

Rays.—About 1 in from 10 to 20 of the rays seen on a smooth end surface is conspicuously broad and distinct without a lens. These large rays appear on the radial surface as small reddish brown "flakes" or "silver grain." The large rays are fully two times as wide as the largest pores, but the others are much narrower than the pores, and not visible without a lens.

Parenchyma.—Very fine, irregular, light-colored, tangential lines may be seen with a lens in some specimens, but usually they are not distinct.

Annual rings.—Distinct but not very conspicuous; defined by the sharp contrast between the harder and darker band of summerwood and the succeeding lighter colored and more porous springwood.

Sapwood.—Variable in thickness from 2 to 5 inches.

Heartwood.—Variable from reddish brown to almost white with a reddish tinge and then not clearly defined from the sapwood.

Physical properties.—The wood is heavy, fairly straight-grained, and without characteristic odor or taste.

Similar Woods.

Sycamore and maple resemble beech but can be distinguished from it as follows: In sycamore practically all the rays are broad and conspicuous, and the outer portion of each annual ring is lighter colored. In maple the rays are all narrower than the larger ones in beech, although they are still plainly visible without a lens, and there is practically no distinction between springwood and summerwood.

SUGAR MAPLE.

Acer saccharum Marsh.

Other Names.

Hard maple; rock maple; sugar-tree; black maple.

Geographic Distribution.

See map, page 22.

Distinguishing Characteristics.

Pores.—Small, not visible with the unaided eye; round, nearly always isolated, rarely in radial rows of two or three; practically uniform in size throughout the growth ring; not crowded.

Rays.—Two kinds; some very distinct without a lens, fully as wide as the largest pores, except near the center of a tree, and conspicuous on a radial cut as small, reddish brown "flakes;" others very fine, barely visible with a lens.

Parenchyma.—Not noticeable.

Annual rings.—Not very distinct; defined by a reddish brown line. Pith flecks rarely present.

Sapwood.—Several inches wide; white with slight reddish brown tinge.

Heartwood.—Light reddish brown.

Physical properties.—The wood is heavy, difficult to cut across the grain, straight-grained (occasionally it has a wavy or bird's-eye grain) and without characteristic odor or taste.

Similar Woods.

The soft maples (silver maple and red maple) resemble the sugar maple, but the wood of the sugar maple is usually distinctly heavier and harder. The rays in the soft maples are of more uniform width and not so large as the broadest ones in the sugar maple. The birches and beech resemble maple somewhat. However, in birch the rays are not distinct without a lens, while the pores usually are; and in beech the widest rays are much wider than the largest pores.

SILVER MAPLE.

Acer saccharinum Linn.

Other Names.

Soft maple; white maple; river maple; water maple; swamp maple.

Geographic Distribution.

See map, page 22.

Distinguishing Characteristics.

Pores.—Not visible without a lens; evenly scattered throughout the annual rings; mostly isolated but occasionally in radial rows of from two to four; not crowded.

Rays.—Visible without a lens except near the center of the tree, practically all of about uniform width, but usually not so large as the largest pores, not so conspicuous on the radial surface as in the sugar maple.

Parenchyma.—Not visible.

Annual rings.—Not very distinct; defined by a fine, darker line. Pith flecks usually abundant, although they may be absent in some pieces.

Sapwood.—Wide; white.

Heartwood.—Light reddish brown.

Physical properties.—The wood is moderately heavy, straight-grained, easily cut across the grain, and without characteristic odor or taste.

Similar Woods.

Silver maple can usually be distinguished from sugar maple by its lighter weight and abundant pith flecks. Or by examining the end surfaces with a lens, it will be found that in silver maple all the rays are practically of the same width, while in sugar maple some are conspicuously wide and others very narrow. Silver maple also resembles the river birch, but in the river birch the rays are narrower (not visible without a lens) and the pores larger (usually visible without a lens).

RED MAPLE (*Acer rubrum* Linn.) is also classed as soft maple and resembles silver maple very much, although the wood averages slightly heavier and stronger. Both grow practically in the same region. See map, page 22.

BLACK CHERRY.

Prunus serotina Ehrh.

Other Names.

Wild cherry; rum cherry.

Geographic Distribution.

See map, page 32.

Distinguishing Characteristics.

Pores.—Small, not visible with the unaided eye, evenly distributed or gradually decreasing in size and number toward the end of each annual ring; isolated or in irregular groups of from two to four; numerous, occupying one-third, or slightly more, of the space between the rays.

Rays.—Very distinct on end and radial surfaces; as wide or almost as wide as the largest pores.

Parenchyma.—Not noticeable.

Annual rings.—Fairly distinct; defined by an abrupt difference in the size of the pores in the summerwood and succeeding springwood; much more pronounced in some samples than in others. Pith flecks occasionally present but inconspicuous because the color is the same as that of the surrounding wood.

Sapwood.—Narrow, usually less than 1 inch.

Heartwood.—Reddish brown in varying shades from moderately dark to very dark.

Physical properties.—The wood is moderately heavy, fairly straight-grained, and without characteristic odor or taste.

Similar Woods.

Other woods are rarely confused with cherry. The reddish brown color and very distinct rays serve to distinguish black cherry from all other native commercial woods.

BLACK WALNUT.

Juglans nigra Linn.

Other Names.

Unlike most of our native trees, black walnut is known throughout the country by only one name. Occasionally it is named merely "walnut" for convenience, but this is not considered a distinct name.

Geographic Distribution.

See map, page 30.

Distinguishing Characteristics.

Pores.—Comparatively large and easily visible with the naked eye, especially in the springwood, and gradually decreasing in size toward the outer portion of each annual ring. (Although at first sight some pieces may give the impression of being ring-porous, they are not classed as such because the large pores in the beginning of each annual ring do not form a definite zone beyond which they decrease abruptly in size.) Tyloses present, but not filling the pores completely.

Rays.—Very fine and inconspicuous, not distinct without a lens.

Parenchyma.—Present in the form of several lighter colored, irregular, tangential lines readily visible in the sapwood but obscure in the heartwood.

Annual rings.—Distinct; marked by an abrupt difference in the size of the pores in the summerwood and succeeding springwood, and by a fine, light-colored line.

Sapwood.—Narrow, mostly less than 1 inch wide, but occasionally up to 3 inches; white, or discolored to yellowish or purplish brown.

Heartwood.—Rich chocolate brown with lustrous surface.

Physical properties.—The wood is heavy, straight-grained, and practically tasteless, but has a slight characteristic odor, especially when worked. Although the wood is not very dense, it will readily turn the edge of the woodworking tools because of the numerous crystals of mineral matter imbedded in the cells.

Similar Woods.

The color and the large pores of black walnut readily distinguish it from other woods. Butternut resembles it most closely but is lighter in color and considerably lighter in weight.

BUTTERNUT.

Juglans cinerea Linn.

Other Names.

White walnut; walnut.

Geographic Distribution.

See map, page 30.

Distinguishing Characteristics.

Pores.—Comparatively large and easily visible with the naked eye, especially in the springwood; gradually decreasing in size toward the outer portion of each annual ring; not crowded; occasionally in radial rows of from two to six. (On account of the difference in size of the pores of the summerwood and the succeeding springwood, some pieces approximate ring-porous woods in appearance but are not classed as such because the large pores in the beginning of each annual ring do not form a definite zone beyond which the pores abruptly decrease in size.) Tyloses are present, but do not appear to plug the pores completely.

Rays.—Very fine and inconspicuous; indistinct without a lens.

Parenchyma.—Visible as fine, tangential lines when the surface is smoothed with a very sharp knife; sometimes not distinct.

Annual rings.—Distinct; marked by abrupt difference in the size of the pores in the summerwood and the succeeding springwood; usually wider than in black walnut.

Sapwood.—Narrow, rarely over 1 inch wide; white to light brown.

Heartwood.—Light chestnut brown with occasional reddish tinge.

Physical properties.—The wood is moderately light, straight-grained, and without characteristic odor or taste. It cuts easily and does not readily turn the edge of a blade as does black walnut.

Similar Woods.

The plainly visible pores, which gradually decrease in size toward the outer edge of each annual ring, and the light chestnut brown color distinguish butternut from other woods. It is lighter in color and considerably lighter in weight than black walnut, to which it is closely related.

YELLOW BIRCH.

Betula lutea Michx. f.

Other Names.

Gray birch; silver birch; swamp birch (Minn.).

Geographic Distribution.

See map, page 24.

Distinguishing Characteristics.

Pores.—Usually not distinct to the unaided eye; clearly visible, however, in some pieces; not crowded, occupying less than one-third of the total area between the rays except in very narrow rings; occasionally in radial rows of from two to four. Tyloses absent.

Rays.—Fine, not distinctly visible without a lens; appearing on the radial surface as very fine reddish brown "flakes."

Parenchyma.—Not noticeable.

Annual rings.—Not distinct to the unaided eye except in specimens showing rapid growth; defined by a fine line and a slight decrease in the size of the pores at the end of each year's growth. Pith flecks usually absent.

Sapwood.—Several inches in width, but extremely variable in different pieces.

Heartwood.—Reddish brown.

Physical properties.—The wood is heavy, straight-grained, and without characteristic odor or taste. The inner bark has a mild wintergreen flavor.

Similar Woods.

River birch resembles yellow birch somewhat, but usually has abundant pith flecks. The maples also resemble the birches, but have smaller pores and wider rays. Neither the river birch nor the maples have the wintergreen flavor in the inner bark characteristic of the sweet and yellow birches.

SWEET BIRCH (*Betula lenta* Linn.), also known as cherry birch and black birch, is often associated with yellow birch but is not so plentiful. The wood resembles yellow birch so closely that it is difficult to distinguish between the two. The inner bark has a decided wintergreen flavor, which is more pronounced than in yellow birch. The outer bark of yellow birch is yellowish gray and readily separates into thin, papery layers; of sweet birch it is reddish brown and not papery. For geographic distribution see map, page 24.

PAPER BIRCH (*Betula papyrifera* Marsh.) of the Northern States, also known as white birch and canoe birch, is used for ties only locally. In general, it has the same structure as the other birches, except that the pores are smaller and can not be seen without a lens. Pith flecks are common but may be absent. The wood is lighter and softer than that of yellow or sweet birch. The sapwood is comparatively wide and almost white. The outer bark separates readily into white papery layers. For geographic distribution see map, page 24.

RIVER BIRCH.

Betula nigra Linn.*Other Names.*

Red birch; water birch; black birch.

Geographic Distribution.

See map, page 24.

Distinguishing Characteristics.

Pores.—Usually visible with the unaided eye, although not always distinct; slightly smaller in the extreme outer portion of the annual ring; not crowded, although more numerous than in sweet or yellow birch and often occupying more than one-third of the total area between the rays; isolated, or in rows of from two to four. Tyloses absent.

Rays.—Very fine, not visible without a lens.

Parenchyma.—Not noticeable.

Annual rings.—Indistinct without a lens except by careful observation; defined by a fine line and in some cases by a slight decrease in the size of the pores at the end of each year's growth. *Pith flecks abundant.*

Sapwood.—Wide, faintly reddish brown; transition to heartwood gradual.

Heartwood.—Reddish brown,

Physical properties.—The wood is heavy, straight-grained, and without characteristic odor or taste.

Similar Woods.

River birch can be distinguished from the sweet and yellow birches by its abundant pith flecks and lack of wintergreen flavor in the inner bark. It may be confused with the soft maples, which also have many pith flecks and are only slightly lighter in weight; but the rays in the soft maples are more conspicuous and the pores are much smaller. The outer bark of the river birch is light reddish brown and readily separates into small crumpled flakes, but not into papery layers, as does that of the yellow and paper birches.

COTTONWOOD.

Populus deltoides Marsh.

Other Names.

Poplar (in the Northern States); cotton-tree; whitewood.

Geographic Distribution.

See map, page 20.

Distinguishing Characteristics.

Pores.—Usually visible with the unaided eye, especially in the springwood; decreasing slightly in size toward the outer portion of each annual ring; very numerous, occupying nearly one-half of the total area between the rays except in very wide rings; scattered singly, or often in radial rows of from two to four.

Rays.—Invisible without a lens and barely distinct with a lens.

Parenchyma.—Not noticeable.

Annual rings.—Distinct but not conspicuous; defined by a slight difference in the size of the pores of the summerwood and of the succeeding springwood. Pith flecks occasionally present, but not conspicuous.

Sapwood.—Not clearly defined, and passing more or less gradually into the heartwood.

Heartwood.—Grayish white to light grayish brown.

Physical properties.—The wood is light and fairly straight-grained (occasionally cross-grained). It is practically tasteless, but has a characteristic disagreeable odor when moist.

Similar Woods.

Cottonwood may be confused with other light woods like tupelo, yellow poplar, basswood, and buckeye. It can be distinguished from these by the fact that the pores in its springwood are larger, being usually visible without a lens.

This description of the common cottonwood also applies to the BLACK COTTONWOOD (*Populus trichocarpa* Torr. and Gr.), or balm, found west of the Rocky Mountains. See map, page 20.

The SWAMP COTTONWOOD (*Populus heterophylla* Linn.), found in the Atlantic and Gulf coast region and the Mississippi Valley, is practically identical in structure with the common cottonwood, but it has a slightly darker heartwood.

ASPEN (*Populus tremuloides* Michx.) and LARGETOOTH ASPEN (*Populus grandidentata* Michx.) are closely related to the cottonwoods. The wood of these species resembles cottonwood very much, but is of a finer texture, the pores being smaller and not visible without a lens.

RED GUM.

Liquidambar styraciflua Linn.

Other Names.

Sweet gum; liquidambar; gum-tree; star-leaved gum; alligator-wood (N. J.).

Geographic Distribution.

See map, page 30.

Distinguishing Characteristics.

Pores.—Very small, not visible without a lens; uniform in size and evenly distributed throughout each annual ring; crowded, occupying from one-half to two-thirds of the space between the rays; occasionally joined in short radial rows of from two to five, but more often in rows with narrow spaces between the pores.

Rays.—Fairly distinct without a lens; comparatively numerous.

Parenchyma.—Not noticeable.

Annual rings.—Not distinct even with a lense, defined by a lighter colored line.

Sapwood.—Variable, from 1 to 5 inches, in width; white, with reddish tinge or blued by sap stain.

Heartwood.—In varying shades of reddish brown, with darker streaks in some pieces.

Physical properties.—The wood is moderately heavy, somewhat lock-grained, and without characteristic odor or taste.

Similar Woods.

The dark reddish brown heartwood of red gum is so characteristic that it usually serves to distinguish the species from all other woods used for ties.

Cherry also has a dark, reddish brown heartwood, but it is usually darker, more lustrous, and has more distinct rays.

BLACK GUM.

Nyssa sylvatica Marsh.

Other Names.

Sour gum; pepperidge; tupelo; gum; tupelo gum (Fla.).

Geographic Distribution.

See map, page 24.

Distinguishing Characteristics.

Pores.—Very small, not visible without a lens; not diminishing in size or number toward the outer portion of the annual ring except in very wide rings; mostly solitary, especially in dense pieces, but occasionally in radial rows of from two to five; crowded in lighter pieces, but in heavier pieces occupying less than one-third of the total area between the rays.

Rays.—Usually not distinct to the unaided eye but distinct with a lens; not conspicuous on the radial surface, being small and of the same color as the surrounding wood.

Parenchyma.—Not noticeable.

Annual Rings.—Indistinct, even under a lens; defined by a fine line and occasionally by a slight decrease in the size of the pores at the extreme outer edge of the ring.

Sapwood.—Varying from one to several inches in width, and passing more or less gradually into the heartwood.

Heartwood.—Brownish gray in color.

Physical properties.—The wood is moderately heavy to heavy, very lock-grained, which makes it exceedingly difficult to split, and without characteristic odor or taste.

Similar Woods.

Cotton gum, or tupelo, can not be easily distinguished from black gum, although it averages somewhat lighter in weight. The pores are slightly larger in tupelo and more often in radial rows, but this difference can be observed only by comparing woods of the two species. The brownish gray color, together with the interlocked grain, readily distinguishes black gum from most other woods.

The WATER GUM (*Nyssa biflora* Walt.) of the Atlantic and Gulf coasts also resembles black gum so much that the two can not be easily distinguished. For geographic distribution, see map, page 24.

COTTON GUM (TUPELO).

Nyssa aquatica Linn.*Other Names.*

Large tupelo; bay poplar; sour gum; wild olive tree (La.); swamp tupelo.

Geographic Distribution.

See map, page 24.

Distinguishing Characteristics.

Pores.—Not visible without a lens, uniformly distributed throughout the annual rings or slightly less numerous in the outer part; often in radial rows of from three to six, noticeable especially in the less porous pieces; widely variable in numbers, from moderately abundant to crowded. (In light grades the cavities of the wood fibers between the larger pores can also be seen with a lens, but they are always smaller than the true pores.)

Rays.—Very fine even under a lens.

Parenchyma.—Not noticeable.

Annual rings.—Not distinct even under a lens; defined by a light-colored line, and in wide rings by a slight decrease in the number and size of the pores at the end of each year's growth.

Sapwood.—Several inches wide, passing more or less gradually into the heartwood.

Heartwood.—Pale brownish gray.

Physical properties.—Wood moderately heavy, usually lighter and softer in the butt log than near the top, lock-grained, and without characteristic odor or taste.

Similar Woods.

Heavier grades of cotton gum are difficult to distinguish from black gum. Although the pores are slightly larger in cotton gum and more often in radial rows, this difference can be noticed only by comparing samples of the two species.

Cotton gum may be confused with cottonwood; but the interlocked grain and smaller pores found in cotton gum help to distinguish it from cottonwood, which usually is fairly straight grained and has pores large enough to be seen without a lens.

YELLOW POPLAR.

Liriodendron tulipifera Linn.*Other Names.*

Tulip poplar; poplar; whitewood (second growth containing much white sapwood); white poplar; blue poplar; hickory poplar.

Geographic Distribution.

See map, page 20.

Distinguishing Characteristics.

Pores.—Not visible without a lens; uniformly distributed throughout the annual ring; isolated or occasionally in short radial rows of from two to five, rarely joined tangentially except where the pores are crowded; usually numerous, occupying over half of the area between the rays, but in comparatively dense pieces occupying a little over one-third of the area between rays, and in such pieces rarely in rows.

Rays.—Distinct without a lens, fairly conspicuous under a lens.

Parenchyma.—Confined to a narrow light-colored layer on the outer portion of the annual rings.

Annual rings.—Defined by a distinct light-colored line.

Sapwood.—From one to several inches in width.

Heartwood.—Light to moderately dark yellowish brown with a greenish tinge.

Physical properties.—The wood is moderately light, straight-grained, and without characteristic odor or taste.

Similar Woods.

Yellow poplar can usually be distinguished from other woods by its greenish tinge, although in this respect it resembles cucumber, from which it can not always be distinguished without a compound microscope.

CUCUMBER-TREE (*Magnolia acuminata* Linn.), also known as mountain magnolia, is occasionally used for ties. It is related to yellow poplar, which it resembles very much, although the yellow poplar averages lighter in weight. This difference in weight is not sufficient to be used for identification purposes; for the heavier grades of yellow poplar weigh more per cubic foot than the lighter grades of cucumber. The rays are slightly less conspicuous in cucumber-tree, but this feature can be observed only by comparing pieces of wood of the two species. In SWEET MAGNOLIA, or sweet bay (*Magnolia glauca* Linn.), the rays are more conspicuous than in cucumber-tree or even yellow poplar, although in other respects the sweet magnolia wood resembles these species closely.

Cucumber-tree is found in about the same region as yellow poplar, except that it does not extend into Florida and the southeastern half of Georgia, South Carolina, North Carolina, and Virginia.

Sweet magnolia is found approximately in the territory southeast of a curve drawn from New York through central Kentucky to Galveston, Tex., excepting southern Florida.

BASSWOOD.

Tilia americana Linn.

Other Names.

Linden; linn; bass; limetree; whitewood; beetroe.

Geographic Distribution.

See map, page 20.

Distinguishing Characteristics.

Pores.—Very small but distinctly visible with a lens; decreasing gradually in number and size toward the outer portion of each annual ring; numerous, occupying from one-third to one-half of the total area between the rays, except in very wide rings; isolated or in elongated or rounded groups of from two to eight, the groups extending radially, diagonally, or tangentially within the annual ring.

Rays.—Fairly distinct to the unaided eye; conspicuous under a lens; slightly narrower than the pores.

Parenchyma.—Usually not noticeable with a hand lens but occasionally visible as very fine tangential lines.

Annual rings.—Fairly distinct; defined by a slight but abrupt difference in the size of the pores of the summerwood and succeeding springwood. Pith flecks are occasionally present but are of about the same color as the surrounding wood and therefore not conspicuous.

Sapwood.—Creamy white, up to several inches in width, passing more or less gradually into the heartwood.

Heartwood.—Creamy brown in color, with occasional brownish-black longitudinal streaks.

Physical properties.—The wood is light, soft, straight-grained, and tasteless, but has a slight characteristic odor.

Similar Woods.

Other light woods, such as yellow poplar, cottonwood, buckeye, and cotton gum are occasionally confused with basswood; but the soft and almost white character of the wood and the irregular arrangement of the pores in diagonal and even tangential groups, together with the very distinct rays under a lens, help to distinguish it from these somewhat similar woods.

YELLOW BUCKEYE.

Æsculus octandra Marsh.*Other Names.*

Large buckeye; big buckeye; sweet buckeye.

Geographic Distribution.

See map, page 30.

Distinguishing Characteristics.

Pores.—Very small, uniform in size and evenly distributed throughout the annual ring; isolated, or occasionally in short radial rows of from two to five; numerous, occupying from one-third to fully one-half of the area between the rays.

Rays.—Very fine, even under a lens; arranged in tiers producing very fine bands running across the tangential surface. These bands are visible without a lens, but are not pronounced near the center of the tree.

Parenchyma.—Not noticeable.

Annual rings.—Not always distinct; defined by light-colored lines.

Sapwood.—Not clearly defined from the heartwood.

Heartwood.—Creamy white or yellowish in color; occasionally discolored to a grayish brown at the center.

Physical properties.—The wood is light, soft, straight-grained, and without characteristic odor or taste.

Similar Woods.

Yellow buckeye resembles basswood very much; but under a lens the rays in the latter are much more conspicuous, and the fine lines across the tangential surface of buckeye distinguish it from basswood and other light woods.

OHIO BUCKEYE (*Æsculus glabra* Willd.), also known as fetid buckeye, stinking buckeye, and American horse chestnut, is very much like the yellow buckeye in appearance and properties, and grows in practically the same region. The fine lines across the tangential surface are not so pronounced in this species, although they are noticeable, especially on a moistened surface several inches from the center.

DESCRIPTION OF CONIFERS.

THE PINES.

About 36 species of pines are native to the United States, but only 13 are used for ties in commercial quantities, although others may be used locally. Pine ties are rarely mistaken for any other wood, nor are other species easily confused with pine.

The wood of the pines contains more or less pitch which usually exudes from cuts made before it is seasoned. The resinous odor and the presence of resin ducts (see p. 7) are also characteristic of the pines. The resin ducts can be seen plainly with a hand lens, and often without a lens, on a smoothly cut end surface. They are also found in Douglas fir, spruce, and larch or tamarack, but in these woods they are not so distinct and numerous as in the pines. Normally, resin ducts are not found in the wood of any other conifers.

The heartwood of the pines is usually orange to reddish brown. In piñon and lodgepole pine the difference in the color of the heartwood and the sapwood is not pronounced.

The pines are easily divided by the character of the leaves and the structure of the wood into two groups, the soft pines and the hard, yellow, or pitch pines.

In the soft pines there is little contrast between the springwood and summerwood; in the hard pines there is a decided difference, the summerwood being considerably harder and darker, although in the narrow annual rings of the sapwood of old trees, the contrast is not so marked as in wider rings. The wood of the heavier species of the soft pines, however, weighs more per cubic foot than that of the lighter hard pines.

Two hard pines, lodgepole and western yellow, furnish abundant tie material in the Western States. In the East at least seven different species of hard pines are used for ties, but so far no means of distinguishing absolutely between all of them without a high-power microscope has been found. Each species varies in weight, width of annual rings, percentage of summerwood, and thickness of sapwood, so that no sharp distinction can be made on these bases. The following figures give the average weight in pounds per cubic foot oven-dry based on green volume, for each species: Norway, 28; pitch, 29; shortleaf, 31; loblolly, 31; pond, 31; longleaf, 34; slash, 36. However, heavy grades of Norway pine weigh more than light grades of loblolly, and some shortleaf pine is heavier than the average longleaf. The annual rings and the sapwood of Norway and loblolly pine average wider than those of longleaf, but in individual pieces the reverse may be true.

For means of distinguishing longleaf from loblolly and shortleaf pine ties and timbers which contain the pith see Appendix, page 73.

Numerous tests made at the Forest Products Laboratory have shown that density, as indicated by the number of rings per inch and the proportion of summerwood, is a far better indication of strength than species.

It is a well-established fact that untreated ties with wide sapwood are less durable than those with narrow sapwood. This feature can be judged irrespective of species.

WESTERN WHITE PINE.

Pinus monticola Dougl.

Other Names.

Idaho white pine; silver pine; finger-cone pine; mountain pine; soft pine; white pine.

Geographic Distribution.

See map, page 32.

Distinguishing Characteristics.

Resin ducts.—Present; the openings are plainly visible with a lens and, under favorable conditions, even without a lens. The ducts are scattered promiscuously throughout the annual ring.

Rays.—Mostly very fine, some (containing horizontal resin ducts) slightly wider and more conspicuous under a lens.

Annual rings.—Distinct, moderate in width, the soft springwood passing very gradually into the slightly harder and darker summerwood, which does not offer appreciably more resistance in cutting than the springwood.

Sapwood.—Mostly from 1 to 2 inches in width, occasionally 3 inches.

Heartwood.—Cream to light reddish brown.

Physical properties.—The wood is moderately light, straight-grained, and practically tasteless, but has a slight, yet distinct, resinous odor.

Similar Woods.

The wood of the eastern WHITE PINE (*Pinus strobus* Linn.) resembles that of the western white pine so much that the two can not be distinguished, and the above description may be applied to both species. The eastern white pine, however, is rarely cut into ties.

Limber pine averages slightly heavier in weight, but light grades are easily confused with the western white pine. The yellow pines have more pronounced summerwood, and therefore have more uneven texture; and the spruces differ in not having a distinctly darker heartwood.

LIMBER PINE.

Pinus flexilis James.

Other Names.

White pine; Rocky Mountain white pine.

Geographic Distribution.

See map, page 32.

Distinguishing Characteristics.

Resin ducts.—Present; occasionally easily detected by slight exudations of resin; evenly distributed or confined to summerwood, if the summerwood is wide.

Rays.—Mostly very fine; a few (those with horizontal resin ducts) slightly wider and more conspicuous under a lens.

Annual rings.—Mostly narrow, occasionally moderately wide; the summerwood may be thick in wide rings, but in contrast to the summerwood of the hard pines it is not dense enough to be much more difficult to cut than the springwood.

Sapwood.—Highly variable, from one-fourth inch to 3 inches in width.

Heartwood.—Reddish brown.

Physical properties.—The wood is somewhat heavier and harder than that of the other white pines and, as a rule, contains more knots, because it comes from short-bodied timber.

Similar Woods.

The light grades of limber pine resemble the western white pine, from which they are not readily distinguished.

BRISTLE-CONE PINE (*Pinus aristata* Engelm.) is found at high elevations from central Colorado to eastern California and extends southward into northern Arizona and New Mexico. The wood resembles closely that of the limber pine in weight, grain, narrowness of rings, and abundance of knots; but the tangential surface of bristle-cone pine shows numerous slight depressions, especially on split surfaces, giving the wood a dimpled appearance similar to that of lodgepole pine.

PIÑON (PINE).

Pinus edulis Engelm.

Other Names.

Nut pine; New Mexican piñon.

Geographic Distribution.

See map, page 32.

Distinguishing Characteristics.

Resin ducts.—Present, scattered throughout the annual ring; openings not visible without a lens, and appearing as tiny specks to the unaided eye.

Rays.—Mostly very fine, a few (those containing horizontal resin ducts) slightly wider and more conspicuous under a lens.

Annual rings.—Mostly very narrow, not always distinct even with a hand lens.

Sapwood.—From one-half inch to 1½ inches wide; boundary between sapwood and heartwood not clearly defined.

Heartwood.—Creamy brown, occasionally with a slight reddish tinge.

Physical properties.—The piñon is the heaviest of the soft pine group, some pieces weighing over 40 pounds per cubic foot oven-dry. It is somewhat cross-grained, very knotty, and difficult to split. The wood is practically odorless and tasteless.

Similar Woods.

The pale, creamy brown color and the absence of dense bands of summerwood alternating with soft bands of springwood distinguish piñon from the yellow pines, with which it might otherwise be confused on account of its weight. The other pines belonging to the soft-pine group are lighter in weight, softer, and have more of a reddish brown color.

LODGEPOLE PINE.

Pinus contorta Loud.

Other Names.

Scrub pine; bird's-eye pine; tamarack; sand pine (Oreg.).

Geographic Distribution.

See map, page 32.

Distinguishing Characteristics.

Resin ducts.—Present; fairly numerous; not distinctly visible without a lens, but often indicated by exudations of resin.

Rays.—Very fine, except occasional ones (containing horizontal resin ducts) which are quite distinct under a lens.

Annual rings.—Distinct; moderately wide at the center, but soon becoming narrow; summerwood well defined as a darker but narrow band, usually not noticeably hard in cutting across the grain.

Sapwood.—Mostly about an inch wide, rarely up to 2½ inches.

Heartwood.—Only slightly darker than the sapwood and often not clearly defined.

Physical properties.—The wood is one of the lightest of the yellow pines, averaging about 24 pounds per cubic foot, oven-dry, based on green volume. It is usually straight-grained but contains numerous knots near the center. The wood is practically tasteless, but has a resinous odor when fresh.

On the surface under the bark or on split tangential surfaces numerous slight indentations may be seen, which give the surface a dimpled or "bird's-eye" appearance.

Similar Woods.

Western yellow pine resembles lodgepole somewhat, but has darker and more distinct heartwood, wider sapwood, larger resin ducts, and only rarely does the tangential surface show the slight indentations so characteristic of lodgepole pine. Bristlecone pine shows the same indentations, but has a distinct reddish brown heartwood and usually very narrow annual rings even near the center. Engelmann spruce also resembles lodgepole pine in general appearance but is entirely without the "bird's-eye" grain.

WESTERN YELLOW PINE.

Pinus ponderosa Laws.

Other Names.

Bull pine (young vigorous trees); big pine; red pine; pitch pine; western pine; white pine (lumber).

Geographic Distribution.

See map, page 32.

Distinguishing Characteristics.

Resin ducts.—Present; comparatively large, the opening usually distinctly visible without a lens; confined to the outer half of the annual ring.

Rays.—Mostly very fine, a few (containing the horizontal resin ducts) are wider and more distinct under a lens.

Annual rings.—Moderately wide in the heartwood, but very narrow in the outer sapwood of old trees; the summerwood conspicuous in wide rings but reduced in narrow rings to a thin layer not distinct without a lens. (The sapwood of western yellow pine approximates white pine in appearance.)

Sapwood.—Clearly defined, averaging from 2½ to 4 inches in width.

Heartwood.—Light reddish brown.

Physical properties.—The wood is one of the lightest of the yellow pines, averaging about 24 pounds per cubic foot air-dry. It is straight-grained and tasteless, but has a slight resinous odor. Occasional trees (especially in the Southwest) show numerous slight depressions on the tangential surface of the wood, giving it a dimpled or "bird's-eye" appearance.

Similar Woods.

Pieces of western yellow pine with the "bird's-eye" grain resemble lodgepole; but western yellow pine has darker heartwood, wider sapwood, and more distinct resin ducts. Lodgepole pine does not attain as large size as the western yellow pine; therefore, the annual rings in lodgepole are usually very narrow (from 20 to 30 per inch) beyond the fourth or fifth inch from the center, while in western yellow pine they usually continue wider (from 5 to 20 per inch) until beyond the seventh or eighth inch from the center. Exceptions, however, are found and identification can not be based on the width of the rings alone.

The distinct bands of summerwood, particularly noticeable in the heartwood, distinguish western yellow pine from the white pines; and its light weight and comparatively large resin ducts help to distinguish it from the eastern yellow pines.

NORWAY PINE.

Pinus resinosa Ait.

Other Name.

Red pine.

Geographic Distribution.

See map, page 32.

Distinguishing Characteristics.

Resin ducts.—Present; mostly in outer half of annual ring, but occasionally in inner half; openings not visible without a lens.

Rays.—Mostly very fine, occasional ones (containing horizontal resin ducts) wider and more distinct with the aid of a lens.

Annual rings.—Fairly wide; the summerwood distinct as a narrow, harder, and darker band, but not offering much resistance to cutting across the grain, except in very wide rings.

Sapwood.—From 2 to 4 inches in width.

Heartwood.—In various shades of reddish brown.

Physical properties.—The wood is the lightest of the hard pines east of the Mississippi River, averaging about 28 pounds per cubic foot, oven-dry, based on green volume. It is usually straight-grained and is practically tasteless, but has a slight resinous odor.

Similar Woods.

Norway pine resembles the lighter grades of the southern yellow pines to such an extent that it is difficult to find any features to distinguish these species. Since

Norway pine is found only in the Northern States and Canada, its origin is usually enough to identify it, although in New York, Pennsylvania, and the southern New England States it grows in mixture with pitch pine (*Pinus rigida* Mill.), from which the wood is not easily distinguished, although pitch pine is harder, more resinous, and contains more knots.

Norway pine is unique in that its cell structure is such that it can easily be distinguished from all other native pines with the aid of a compound microscope.

SHORTLEAF PINE.

Pinus echinata Mill.

Other Names.

Yellow pine; spruce pine; bull pine; oldfield pine; rosemary pine (N. C.); North Carolina yellow pine; slash pine.

Geographic Distribution.

See map, page 32.

Distinguishing Characteristics.

Resin ducts.—Present; scattered throughout the annual rings; comparatively small, openings rarely visible without a lens.

Medullary rays.—Mostly very fine, although some (containing horizontal resin ducts) are wider and more distinct under a lens.

Annual rings.—Distinct, moderately wide to narrow, the summerwood conspicuous as a narrow, harder, and darker band.

Sapwood.—Mostly from 2 to 4 inches in width in ties.

Heartwood.—Yellowish to orange-brown.

Physical properties.—The wood is moderately heavy to heavy, straight-grained, and easily split. It is practically tasteless, but has a slight resinous odor.

Similar Woods.

Shortleaf pine averages between longleaf and loblolly in width of rings and thickness of sapwood. From pitch pine it can not easily be distinguished after it is cut into ties or other material. For a method of distinguishing between shortleaf and longleaf pine, see Appendix, page 73.

PITCH PINE (*Pinus rigida* Mill.), also known as hard pine, yellow pine, black pine, and black Norway pine, is found from southeastern Canada southward in the Atlantic and Appalachian region to central Georgia. The wood resembles that of shortleaf pine and weighs approximately the same.

LOBLOLLY PINE.

Pinus taeda Linn.

Other Names.

Oldfield pine; slash pine; bull pine; bastard pine; swamp pine; rosemary pine; torch pine; shortleaf pine; sap pine.

Geographic Distribution.

See map, page 32.

Distinguishing Characteristics.

Resin ducts.—Present; scattered throughout the annual ring; openings rarely visible without a lens.

Medullary rays.—Mostly very fine, but occasionally some (containing horizontal resin ducts) slightly wider and more distinct under a lens.

Annual rings.—Distinct; mostly wide even at 6 inches or more from the center, but occasionally narrow and then producing what is known as "rosemary pine"; the summerwood variable from moderately hard in very wide rings to very hard and dense in rings of moderate width.

Sapwood.—Mostly from 3 to 5 inches in width in ties.

Heartwood.—Yellowish to orange-brown.

Physical properties.—The wood is highly variable in weight, but averages about 31 pounds per cubic foot, oven-dry, based on green volume. It is straight-grained, easily split, and has a resinous odor.

Similar Woods.

The other southern pines commonly have narrower rings and thinner sapwood than loblolly pine, but exceptions are often found, so that these features can not be used for identification. For distinguishing loblolly and longleaf pine see Appendix, page 73.

POND PINE (*Pinus serotina* Michx.), also known as marsh pine, meadow pine, loblolly pine, spruce pine, bastard pine, and bull pine, is found in low places ("ponds") along the Atlantic coast from southeastern Virginia to central Alabama, not including the lower half of the Florida Peninsula. When cut into ties or timbers it is marketed as either longleaf or shortleaf pine. No definite distinction between the wood of pond pine and that of the other southern pines has yet been found.

LONGLEAF PINE.

Pinus palustris Mill.

Other Names.

Southern yellow pine; yellow pine; turpentine pine; rosemary pine; hard pine; Georgia pine; fat pine; southern pitch pine; heart pine; longstraw pine; pitch pine.

Geographic Distribution.

See map, page 32.

Distinguishing Characteristics.

Resin ducts.—Present; numerous; scattered throughout the annual ring; comparatively large, the openings often visible to the unaided eye.

Rays.—Mostly very narrow, a few (those containing horizontal resin ducts) wider and more distinct under a lens.

Annual rings.—Very distinct; mostly narrow, especially several inches from the center; often irregular in width; the summerwood comparatively wide; often occupying one-half the annual ring.

Sapwood.—Mostly between 1 and 2 inches in width in ties, occasionally more or less.

Heartwood.—Yellowish to orange-brown.

Physical properties.—The wood is heavy and hard, straight-grained, and has a distinct resinous odor.

Similar Woods.

Although the annual rings and sapwood in longleaf pine average narrower than in the other southern pines, these features are more or less variable and can not be relied upon for identification.

For a method of distinguishing longleaf from loblolly and shortleaf pines see Appendix, page 73.

SLASH PINE (*Pinus heterophylla* (Ell.) Sudworth), also known as swamp pine, Cuban pine, and bastard pine, is found only in the coast region from southern South Carolina to Louisiana (St. Tammany and Washington Parishes), including practically all of Florida. It resembles longleaf pine in being dense and hard, but on the average it has wider sapwood and wider and more irregular annual rings.

ENGELMANN SPRUCE.

Picea engelmanni Engelm.

Other Names.

White spruce; mountain spruce (Mont.); balsam (Utah).

Geographic Distribution.

See map, page 34.

Distinguishing Characteristics.

Resin ducts.—Present; comparatively few; mostly isolated, less frequently two adjacent, and occasionally many in a tangential row; inconspicuous, easily overlooked.

often visible only as white specks in the summerwood, their presence also indicated by occasional wider medullary rays which contain the horizontal resin ducts.

Rays.—Very fine, except as indicated above.

Annual rings.—Moderate in width; summerwood narrow, not much denser or darker than the springwood; transition from springwood to summerwood gradual.

Sapwood.—Not distinctly defined, but noticeable on green timbers because of its higher moisture content; variable from three-fourths of an inch to 2 inches in width.

Heartwood.—Pale yellowish brown.

Physical properties.—The wood is light and straight-grained. It has no characteristic odor or taste.

Similar Woods.

Engelmann spruce is easily confused with Alpine fir, white fir, and lodgepole pine, which also have almost white heartwood. In the true firs, however, resin ducts are normally absent. Lodgepole pine has a dimpled surface under the bark or when split tangentially, a feature not found in Engelmann spruce.

The WHITE SPRUCE (*Picea canadensis* (Mill.) B. S. P.) found in the Lake States, New England States, and Appalachian Mountains, and the RED SPRUCE (*Picea rubens* Sargent) found in the New England States and Appalachian Mountains have practically the same structure as the Engelmann spruce, although the wood is slightly heavier and stronger, but they are rarely used for ties or timbers.

DOUGLAS FIR.

Pseudotsuga taxifolia (Lam.) Britton.

Other Names.

Douglas spruce; red fir; yellow fir; fir; Oregon pine; spruce (Mont.); red pine; Puget Sound pine.

Geographic Distribution.

See map, page 30.

Distinguishing Characteristics.

Resin ducts.—Present; small and inconspicuous; occasionally visible without a lens as elongated whitish specks, especially in the summerwood; the openings not visible without a lens; often in tangential rows of from 2 to 20 or more.

Rays.—Mostly very fine, a few (containing horizontal resin ducts) slightly wider and more conspicuous under a lens.

Annual rings.—Very distinct; variable from narrow to wide; summerwood always conspicuous as a denser and darker band but variable from very narrow in slow growth to wide and hard in trees of rapid growth.

Sapwood.—About 1 inch wide in Rocky Mountain forms, and several inches wide in Pacific coast forms.

Heartwood.—Mostly orange-reddish to red, the springwood as well as the summerwood being colored; sometimes yellowish in old Pacific coast trees.

Physical properties.—The wood is variable in weight, from moderately heavy to heavy, fairly straight grained, and practically tasteless, but has a distinct odor when fresh.

Similar Woods.

Douglas fir is not one of the true firs (*Abies*), of which balsam fir, alpine fir, white fir, and noble fir are representatives. It differs from these in being heavier and stronger, in having a distinct and darker heartwood, and in containing resin ducts. Neither is it a spruce (*Picea*) nor a pine (*Pinus*), although the names "Douglas spruce" and "Oregon pine" are applied to it.

The wood resembles that of the larch and hard pines, although a distinct reddish hue is characteristic of Douglas fir only. The larch has a russet-brown heartwood and comparatively narrow sapwood. The hard pines have a yellowish or orange-brown heartwood and usually irregular growth rings. The resin ducts in larch are

also often grouped and inconspicuous, like those in Douglas fir, but in the pines they are larger and more numerous and not in groups.

If parts of the bark are present, the thin whitish layers alternating with wider, dark reddish-brown layers form an excellent means of identification; for none of the other species with which Douglas fir might be confused have developed these lighter colored layers.

WESTERN LARCH.

Larix occidentalis Nutt.

Other Names.

Tamarack; hackmatack.

Geographic Distribution.

See map, page 34.

Distinguishing Characteristics.

Resin ducts.—Present; not numerous; scattered singly or in short tangential rows; inconspicuous even with a lens; their presence also indicated by occasional wider medullary rays, which contain the horizontal resin ducts.

Rays.—Very fine, except as stated above; distinct on radial surface because darker.

Annual rings.—Mostly very narrow, but the summerwood always distinct as a denser band.

Sapwood.—Narrow, mostly from one-half to three-fourths of an inch, rarely over 1 inch wide.

Heartwood.—Russet to reddish brown.

Physical properties.—The wood is moderately heavy, relatively narrow-ringed, and not slivery. It has no characteristic odor or taste.

Similar Woods.

Western larch shows more resemblance to Douglas fir than to any other wood with which it is associated. However, it has a distinctly brownish heartwood and narrow sapwood as contrasted with the reddish or yellowish heartwood and wider sapwood of Douglas fir. The hard pines have much wider sapwood and are more resinous.

The eastern larch or tamarack has wider rings with wider summerwood, and is more slivery. On account of the difference in the geographic distribution of these two species it is rarely necessary to distinguish between them.

TAMARACK.

Larix laricina (Du Roi) Koch.

Other Names.

Larch; eastern larch; hackmatack; juniper (Maine, New Brunswick, to Hudson Bay).

Geographic Distribution.

See map, page 34.

Distinguishing Characteristics.

Resin ducts.—Present; not numerous; scattered singly, or several in a tangential row; inconspicuous, easily overlooked even with a lens; their presence also indicated by occasional wider medullary rays, which contain the horizontal ducts.

Rays.—Very fine except as stated above.

Annual rings.—Moderately wide, the summerwood conspicuous as a dense hard band.

Sapwood.—Mostly less than an inch wide.

Heartwood.—Yellowish brown to russet brown without reddish tinge.

Physical properties.—The wood is heavy, coarse, and slivery. It has no distinct odor or taste.

Similar Woods.

Since the tamarack is found only east of the prairies, there is little possibility of its being confused with the western larch and Douglas fir, which it resembles. It is also similar to hemlock in being coarse and splintery, but the tamarack lacks the reddish

hue of hemlock, and has a decided contrast between heartwood and sapwood. The hard pines have wider sapwood and are more resinous, as is indicated by the odor or abundant exudations of resin. On carefully comparing the woods under a lens it will be found that hemlock has no resin ducts, and that in the pines the resin ducts are more distinct and numerous than in tamarack.

PORT ORFORD CEDAR.

Chamæcyparis lawsoniana (Murr.) Parl.

Other Names.

Lawson cypress; Oregon cedar; white cedar; ginger pine.

Geographic Distribution.

See map, page 30.

Distinguishing Characteristics.

Resin ducts.—Absent.

Rays.—Very narrow; uniform in width; inconspicuous.

Annual rings.—Distinct but not prominent; moderate in width; the summerwood only slightly denser than the springwood.

Sapwood.—Narrow, from 1 to 3 inches in width; not always clearly distinguishable from the heartwood.

Heartwood.—Pale brown.

Physical properties.—The wood is moderately light, straight-grained, and easily worked. It has a pronounced spicy odor and taste, which readily distinguish it from other species. The summerwood is not dense and hard as in many coniferous woods; therefore it has an unusually uniform structure, which makes it desirable for a great many purposes. This fact and its local distribution make the amount available for ties comparatively small.

Similar Woods.

Port Orford Cedar resembles the other cedars somewhat, but the light-colored heartwood and characteristic spicy odor afford an easy means of identification.

WHITE FIR.

Abies concolor (Gord.) Parry.

Other Names.

Balsam fir; balsam; white balsam; silver fir.

Geographic Distribution.

See map, page 34.

Distinguishing Characteristics.

Resin ducts.—Normally absent; occasionally present in the outer summerwood in the form of tangential rows, from one-eighth of an inch to an inch or more in length. (Plate XXVIII, fig. 2, shows a row of abnormal resin ducts.)

Rays.—Very fine and of uniform width.

Annual rings.—Mostly moderately wide, showing fairly rapid growth; the comparatively wide and almost white springwood passes gradually into the narrow, darker, and harder summerwood.

Sapwood.—Not distinguishable from the heartwood.

Heartwood.—White or with a reddish brown tinge due to darker bands of summerwood.

Physical properties.—The wood is moderately light, straight-grained, and without characteristic odor or taste.

Similar Woods.

White fir resembles alpine fir, but the alpine fir usually has narrower rings and a distinct disagreeable odor. It is lighter in color, especially in the springwood, than the noble fir and hemlocks. It can not be distinguished from grand fir, unless a por-

tion of the bark half an inch or more in thickness is present. White fir has narrow *white layers* in the outer bark; while grand fir, noble fir, and the hemlocks have thin very *dark brown layers* in the outer bark. Alpine fir has too thin a bark on the material to have developed these layers.

ALPINE FIR (*Abies lasiocarpa* (Hook.) Nutt.), also known as balsam, white fir, mountain balsam, and downy-cone fir grows throughout the high mountain slopes from Arizona to Montana and Idaho, westward through northern Oregon, and northward to Alaska. The wood is the lightest of the western firs and, being almost white in color, closely resembles that of the white fir; but the annual rings are usually narrower, though trees with rings of moderate width are occasionally found. The summerwood is not very pronounced and does not offer appreciably more resistance in cutting across the grain than the springwood. The wood has a mild but distinct *rank odor*, noticeable especially when fresh cuts are made on dry wood. Except for this odor, it would often be impossible to distinguish alpine fir from some of the other firs, particularly white fir.

GRAND FIR.

Abies grandis Lindl.

Other Names.

White fir; lowland fir; silver fir; yellow fir; great California fir.

Geographic Distribution.

See map, page 20.

Distinguishing Characteristics.

Resin ducts.—Absent, or occasionally present in the form of tangential rows of from one-eighth of an inch to over an inch long.

Rays.—Very fine and of uniform size.

Annual rings.—Usually fairly wide, showing rapid growth; the springwood, soft and almost white, passing gradually into the narrow but conspicuously darker and harder summerwood.

Sapwood.—Not distinguishable from the heartwood.

Heartwood.—White, with a reddish brown tinge, which is more pronounced in pieces of slow growth.

Physical properties.—The wood is moderately light, straight-grained, and without characteristic odor or taste.

Similar Woods.

Grand fir is not easily distinguished from the other firs except alpine fir, which has a disagreeable odor when cut. On the average, grand fir has a more nearly white springwood and wider rings than the noble fir, but specimens showing narrow rings may also be found.

NOBLE FIR (*Abies nobilis* Lindl.), also known as red fir, larch, bigtree, feather-cone red fir, and bracted red fir, is found only in Oregon and Washington. It has the same general characteristics as the other firs. The wood has somewhat of a reddish tinge, which is due to the pale reddish springwood and the slow growth, which brings the darker bands of summerwood close together. It thus resembles western hemlock, from which it is not easily distinguished without a compound microscope. Specimens of rapid growth resemble normal grand fir very closely. The wood is moderately light, straight-grained, and without distinct odor or taste.

EASTERN HEMLOCK.

Tsuga canadensis (Linn.) Carr.

Other Names.

Hemlock spruce; spruce pine.

Geographic Distribution.

See map, page 34.

Distinguishing Characteristics.

Resin ducts.—Absent.

Rays.—Very fine and of uniform width throughout.

Annual rings.—Narrow to moderately wide; the springwood soft and with a reddish hue and passing gradually into the narrow, harder, and darker summerwood.

Sapwood.—Usually not distinct from the heartwood, occasionally slightly lighter in color.

Heartwood.—Pale brown with a reddish hue.

Physical properties.—The wood is moderately light, straight-grained or twisted, and practically tasteless and odorless or with a sour odor when fresh. Cup shake is a common defect.

Similar Woods.

Hemlock is similar to the spruces and true firs in that the heartwood is not distinctly darker than the sapwood. Spruce, however, is lighter in color, weighs less, is not so slivery, and has resin ducts. The resin ducts can be seen only under a lens, but are often indicated by exudations of resin. Most of the firs also are of a lighter color than hemlock, especially in the springwood of each annual ring, and not so splintery. Noble fir, however, resembles hemlock so much in weight, color, and general appearance that they can not be distinguished easily without a compound microscope.

WESTERN HEMLOCK (*Tsuga heterophylla* (Raf.) Sargent), also known as Alaska fir, Alaska pine, and gray fir, has the same general structure as the eastern hemlock; but the wood is less splintery, and usually free from cup shake. Abnormal resin passages are often present, forming tangential rows in the outer portion of the summerwood. This feature is also found in some of the true firs but not in the eastern hemlock. For geographic distribution see map, page 34.

REDWOOD.

Sequoia sempervirens (Lamb.) Endl.

Other Name.

Sequoia.

Geographic Distribution.

See map, page 20.

Distinguishing Characteristics.

Resin ducts.—Normally absent, present only as result of injury and then in a tangential line at point of injury only.

Rays.—Narrow; uniform in width; easily visible with a lens because lighter colored than the surrounding wood.

Annual rings.—Moderate and regular in width; very distinct because of the summerwood, which is more pronounced than in the cedars. The dark specks in the illustration in Plate XXX, fig. 1, are cells containing resin ("resin cells") which are numerous in this species but, on account of the dark color of the wood, are not easily seen on the end surface. On split surfaces the resin cells are often quite distinct under a lens, appearing as dark lines running with the grain.

Sapwood.—One to several inches in width; almost white.

Heartwood.—Uniform deep reddish brown.

Physical properties.—The wood is moderately light, straight-grained, rarely wavy-grained, and splits easily. It has no characteristic odor or taste.

Similar Woods.

Redwood is not easily confused with any other wood. In color it somewhat resembles the junipers and dark grades of western red cedar. The junipers are much finer textured, have a distinct agreeable odor, and are rarely used for ties. The cedars have an aromatic odor and bitter taste.

BALD CYPRESS.

Taxodium distichum (Linn.) Rich.*Other Names.*

Cypress; swamp cypress; white cypress; yellow cypress; red cypress; black cypress; southern cypress.

Geographic Distribution.

See map, page 34.

Distinguishing Characteristics.

Resin ducts.—Absent.

Rays.—Uniformly narrow.

Annual rings.—Distinct; usually irregular in width and outline; the summerwood very noticeable as a dense, dark band, or inconspicuous in lighter grades. The dark specks in the illustration in Pl. XXX, fig. 2, are cells containing resin ("resin cells"). They are abundant in this species and can be seen with a hand lens, especially in light-colored grades. The resin cells are usually arranged in irregular tangential bands. On a split surface they are very distinct under a lens, appearing as dark lines running with the grain.

Sapwood.—Usually over an inch in width, passing more or less gradually into the heartwood.

Heartwood.—Highly variable in color from pale brown to blackish brown, sometimes with a reddish tinge.

Physical properties.—The wood varies in weight from moderately light to heavy, and averages about 26 pounds per cubic foot oven-dry. It is usually straight-grained and easily split. The odor is characteristic and may be described as rancid, although one must become familiar with it to be able to recognize it. The longitudinal surfaces feel distinctly greasy, or waxy, especially in the darker grades.

Similar Woods.

Cypress varies as much as any of our native woods in color and weight and therefore is often difficult to identify by these features. It resembles the cedars more than other woods, but the odor is entirely different. Cypress is practically tasteless, while the heartwood of the cedars is distinctly spicy or bitter. Only one species of bald cypress is found in the United States; but several grades, such as "white," "yellow," "red," and "black cypress," are known on the market, the grades being based on color and weight. Certain species (*Cupressus* sp.) in the western part of the United States are also known as CYPRESS, but they are of minor commercial importance and are not closely related to the southern bald cypress.

WESTERN RED CEDAR.

Thuja plicata Don.*Other Names.*

Canoe cedar; arborvitæ; giant arborvitæ; shinglewood; gigantic cedar; Pacific red cedar.

Geographic Distribution.

See map, page 30.

Distinguishing Characteristics.

Resin ducts.—Absent.

Rays.—Very narrow and inconspicuous; uniform in width.

Annual rings.—Distinct; moderately narrow; with a thin but dense band of summerwood.

Sapwood.—From one-fourth inch to 1 inch in width.

Heartwood.—Brown, usually with a reddish hue.

Physical properties.—The wood is light, straight-grained, and easily split. It has a distinct odor characteristic of cedar shingles, and the heartwood has a spicy bitter

taste. The wood is not resinous, although globules of resin may exude from the bark.
Similar Woods.

The western red cedar resembles most closely the arborvitæ; but since the two grow in regions widely separated they are not easily confused. The arborvitæ is of slower growth and has a plain light brown color usually without reddish tinge. Dark grades resemble redwood, but the redwood is without characteristic odor or taste.

ARBORVITÆ (NORTHERN WHITE CEDAR).

Thuja occidentalis Linn.

Other Names.

White cedar; cedar.

Geographic Distribution.

See map, page 34.

Distinguishing Characteristics.

Resin ducts.—Absent.

Rays.—All very narrow and inconspicuous.

Annual rings.—Narrow but indistinct; the summerwood thin and not noticeable on cutting with a knife.

Sapwood.—Narrow; not over 1 inch in width except in some second-growth trees.

Heartwood.—Light brown, rarely with a reddish tinge.

Physical properties.—The wood is very light, straight grained, soft, and easily split. It has the characteristic odor of the familiar cedar shingles, and the heartwood is somewhat bitter or spicy to the taste. The wood is not resinous, but globules of resin sometimes exude from the bark.

Similar Woods.

The arborvitæ resembles the western red cedar, but usually has narrower rings and is of a plain brown color without the reddish hue found in the western species. Cypress has a more dingy color and a rancid odor which in no way resembles the pleasant odor of the cedar.

WHITE CEDAR (*Chamaecyparis thyoides* (L.) B. S. P.), also known as swamp cedar and juniper, grows along the coast from Maine to northern Florida and westward to Mississippi. It resembles arborvitæ, but has more of a pinkish hue, a spicy odor, and, as a rule, wider annual rings.