Basic Guide to Identification of Hardwoods and Softwoods Using Anatomical Characteristics

This publication is a basic guide to both the anatomy of wood and the identification of wood using these anatomical characteristics. A hand lens or magnifying glass is needed to see many of these characteristics.

Like a tree's leaves, its cells and cell types are distinctive. Different cell types make it possible to identify wood long after all of the leaves and bark have been removed. The size, type, shape, and distribution of these cells allow the trees to transport water and nutrients to the crown and then food back to the cambium and roots, from the leaves.

Wood (also known as xylem) serves two functions in a standing tree. One function is to keep the tree standing tall and to withstand wind. The second function is to move water and nutrients from the soil to the leaves of the tree. After a tree has been harvested, water will continue to move in and out of the wood freely.

Wood Surfaces

There are three surfaces, or planes, that we look at to identify wood. These surfaces allow us to see different cells and structures in the wood. Figure 1 shows the three surfaces of wood. When a tree is cut down, the flat surface of the stump is the cross-sectional surface. The cross-sectional surface shows most of the cell types needed to identify wood. The tangential surface is the next most important surface, followed by the radial surface.

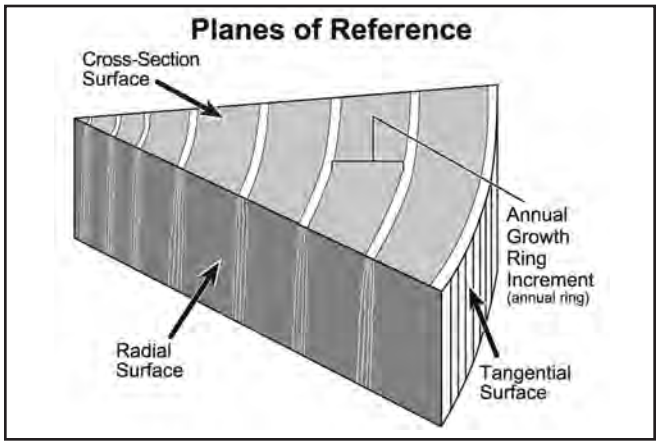

Figure 1. Three-dimensional orientation of wood material.

There are several wood types within a tree. They are named based on when the wood was formed or where the wood is within the tree. Heartwood is the center of older trees and is often darker because of the chemicals deposited there as the tree ages. Sapwood is the younger wood in a tree and is active in transporting water and nutrients. It generally has a lighter color and is closer to the bark.

Each year trees add one growth ring. Each growth ring is usually two different colors. A lighter portion, called earlywood, is formed in the spring. Latewood is darker and formed in the summer. Figure 2 shows the difference in earlywood and latewood in a piece of Southern yellow pine.

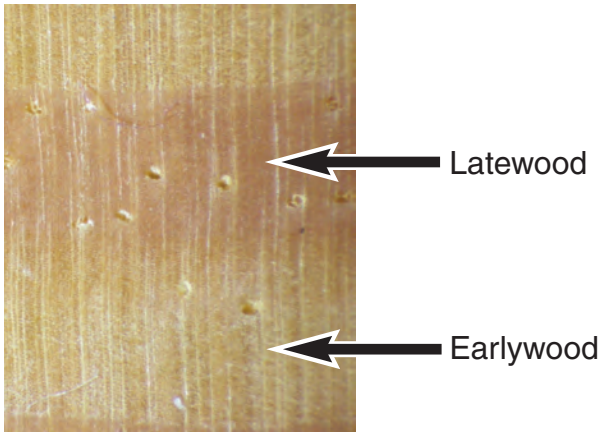

Figure 2.
Latewood and earlywood in Southern yellow pine

Examining Wood Samples

You should prepare the surface of a wood sample before you examine its cells. Preparing the cross-sectional surface of a piece of wood properly can be frustrating and time consuming, but it is worthwhile. Make a thin, clean cut across the wood's surface with a sharp knife or razor blade. Make the thinnest slice possible to reduce tearing of the wood.

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After removing the slice, use a hand lens or magnifying glass to look at the surface. Identifying wood is often a process of elimination. Look for different cell types and write down what you observe. Your notes will help you remember what you have seen and help you identify the wood.

Softwood vs. Hardwood

Trees are classified into two different types: hardwoods and softwoods. This classification has nothing to do with the wood itself, but with the type of leaves and flowers the tree has.

About 90 to 95 percent of softwood cells are called longitudinal tracheids. They transport water. Because there are so few other cell types in softwoods, it can be difficult to distinguish between types of softwoods.

The structure of hardwoods is much more complex. There is also a lot of variation from one species of tree to another in hardwoods. Hardwoods contain vessel elements, or pores, that softwoods do not have. Pores vary greatly; they can be very small, very large, present in great numbers, or almost completely absent.

If pores are present, the wood is a hardwood. If no pores are present, it is likely a softwood.

Hardwood Anatomy and Identification

Pore arrangement

After you determine a piece of wood is a hardwood, you should examine the pores in greater detail. Examine the size, distribution, and changes in number of pores. Hardwoods can be classified into three groups based on the **Pores:**

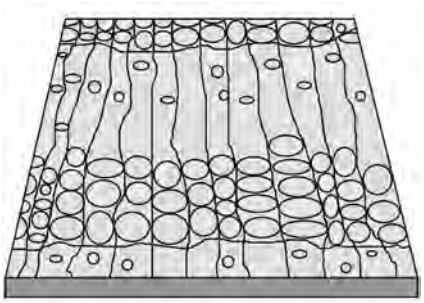
- Ring-porous hardwoods (Figure 3) Oaks and elms have pores that transition from small to large abruptly from the earlywood to the latewood. The largest of the pores are clearly visible to the naked eye.
- Semi-ring porous hardwoods (Figure 4) Walnut, pecan, and hickory have pores that gradually change from small to large in a growth ring.
- Diffuse-porous hardwoods (Figure 5) Yellow poplar, gum, and maple have pores that are the same size throughout the growth ring.

Pores are also distributed in other ways in wood. They can be arranged as follows:

A. Solitary pores- Individual pores evenly spaced.
B. Pore chains- Multiple pores chained together.
C. Nested pores- Clusters of pores connected together.
D. Multiple pore- Two or more pores clustered together.
E. Wavy bands- Bands of pores with a wavy appearance.

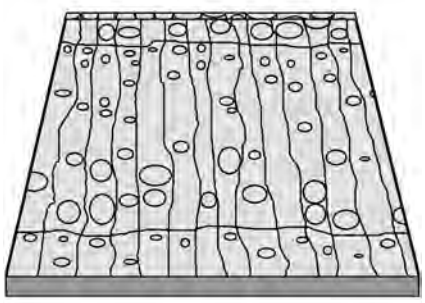
Figure 6 illustrates these features.

Figure 3



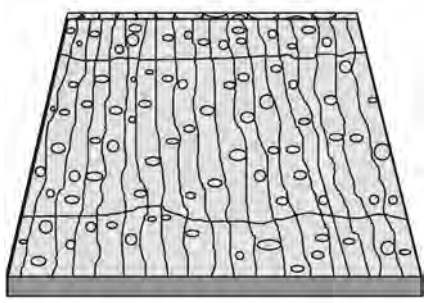
Ring-porous

Figure 4



Semi-ring-porous

Figure 5



Diffuse-porous

Classification of pore transition from earlywood to latewood

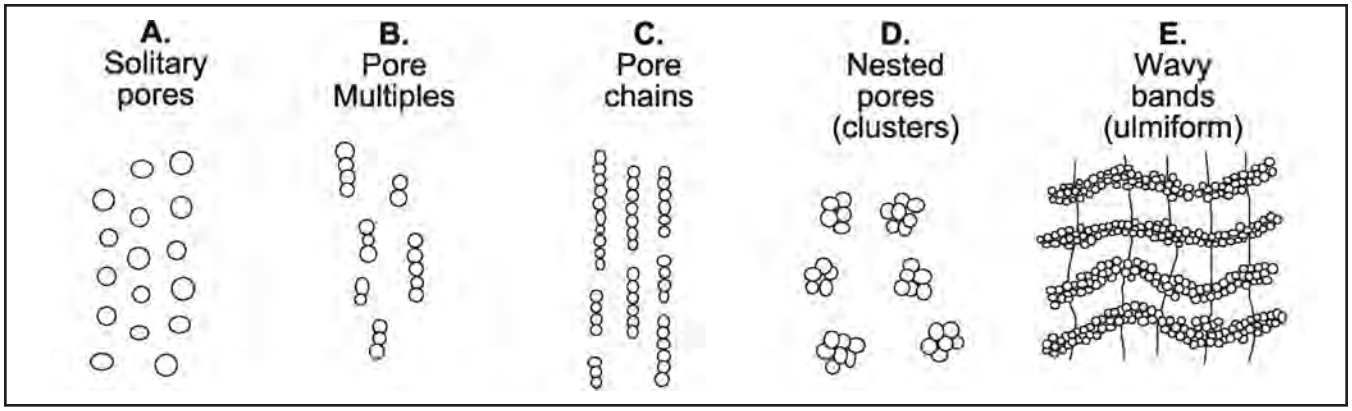


Figure 6. Vessel (pore) arrangement

Wood Rays

After you examine the pores, look at the rays. Wood rays look like small stripes that go from one edge of a piece of wood to the other edge on the cross-sectional face. Wood rays transport food and water horizontally in the tree.

The rays in most species are unique and allow for easy identification. Oaks, for example, have very large rays that are visible to the naked eye. Sycamores can be identified by the number of rays.

Examining the tangential and radial surfaces of wood for the characteristics of rays can help you identify wood species. Rays vary both in height and width, so examining both surfaces is key in identifying wood species. Looking at the tangential surface will allow you to look at ray height. Some rays are several inches tall, while others are difficult to see at all. The rays in oak can be over an inch high (white oak) or less than an inch (red oak).

On the radial face of a cut piece of wood, the rays are often exposed. Many species have rays in great numbers, causing the wood to have what is called "ray fleck," a very attractive characteristic.

Parenchyma

Thin-walled cells that store food in the wood are called parenchyma. These cells are rare in softwoods but present in large numbers in many hardwoods. Parenchyma are often hard to see but can be useful in wood identification.

Parenchyma can be separated into two groups, paratracheal (contact pores or vessels) or aportracheal (not attached to vessels or pores). Figure 7 shows different parenchyma cells.

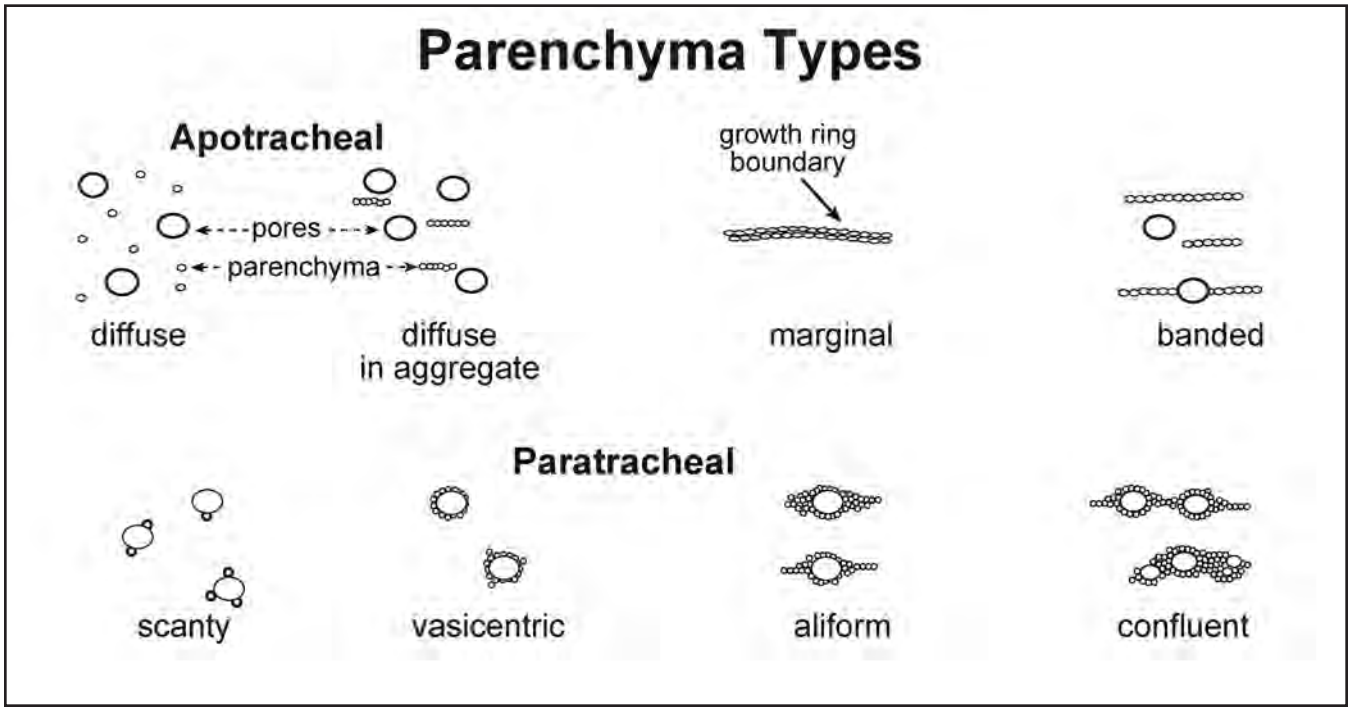


Figure 7. Classification of parenchyma arrangements around hardwood pores. (cross-section view)

Softwoods

Resin Canals

Resin canals look similar to the vessels in hardwoods but are often much smaller. They create resin to defend against insect attacks and general damage. Resin canals are most often found in the latewood of a growth ring.

Some softwoods contain resin canals, and some don't. Species that have resin canals are often pines, spruce, larch, or Douglas fir. Species that do not have resin canals are often fir, hemlock, cedar, redwood, baldcypress, and yew.

Woods with resin canals can be separated by resin canal size. Those with large resin canals are generally pines.

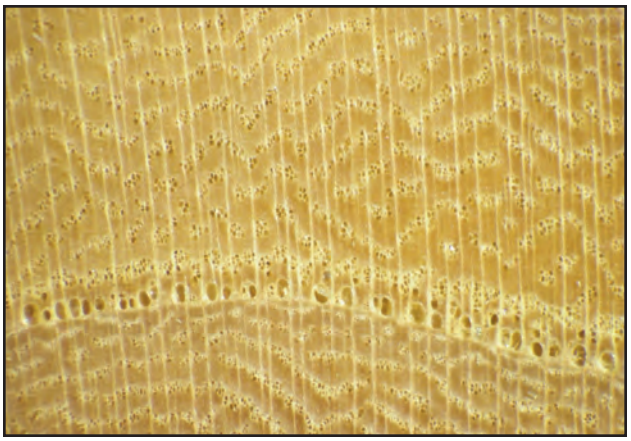
Growth Rings

You can also look at growth rings to help identify wood species. For example, the transition from light colored wood to darker wood is abrupt in Southern yellow pine. The transitions are very gradual in other species, such as white pine and cedar.

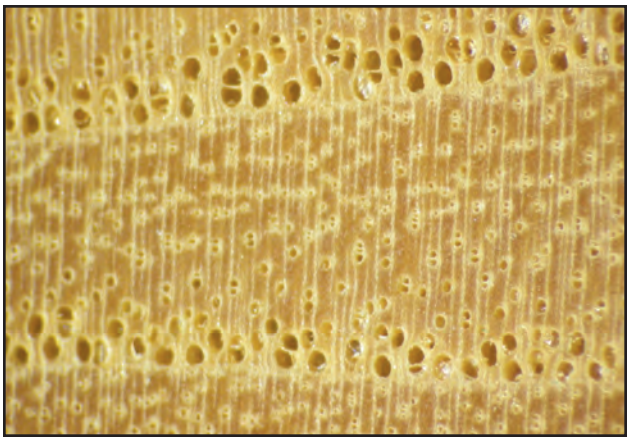
Wood ID

(Adapted from Agricultural Extension Service, University of Tennessee publication PB1692)

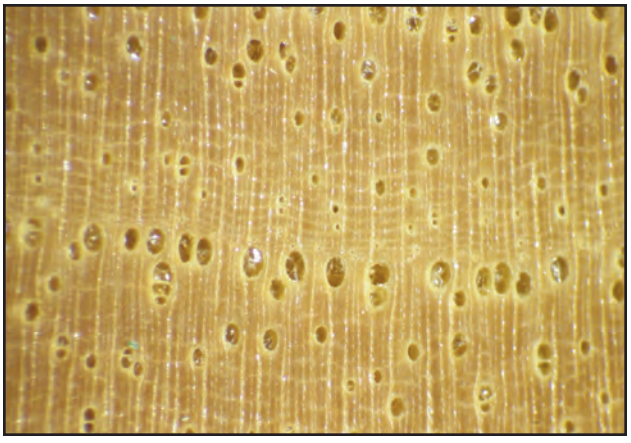
Ring-porous hardwoods



AMERICAN ELM
Ulmus Americana
Average density: 31.2 lbs/ft3
Heartwood color: Light brown to brown or reddish brown
Pore distribution: Ring-porous
Earlywood: Pores large, in continuous row
Latewood: Pores in wavy bands
Tyloses: Present in earlywood, but usually sparse
Rays: Not distinct without lens; homogeneous 1-7 (mostly 4-6) seriate.

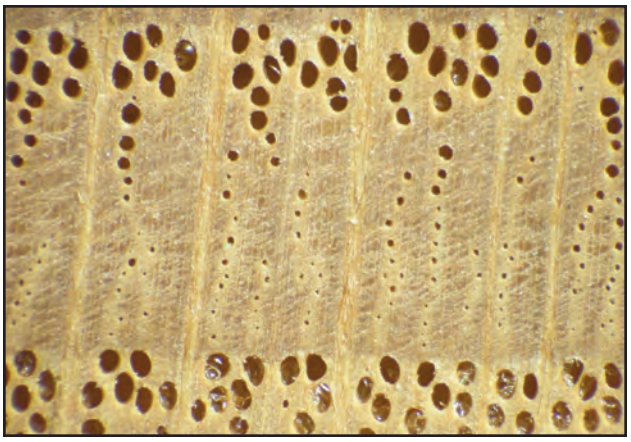


ASH
Fraxinus spp.
Average density: 37.44 lbs/ft3
Heartwood color: Light brown or grayish brown.
Sapwood color: Creamy white (may be very wide)
Pore distribution: Ring-porous
Earlywood: 2-4 pores wide; pores moderately large surrounded by lighter tissue
Latewood: Pores solitary and in radial multiples o 2-3, surrounded by vasicentric parenchyma or connected by confluent parenchyma in outer latewood. Thick-walled.
Tyloses: Fairly abundant (some vessels open)
Rays: Not distinct to eye, but clearly visible with lens; 1-3 seriate



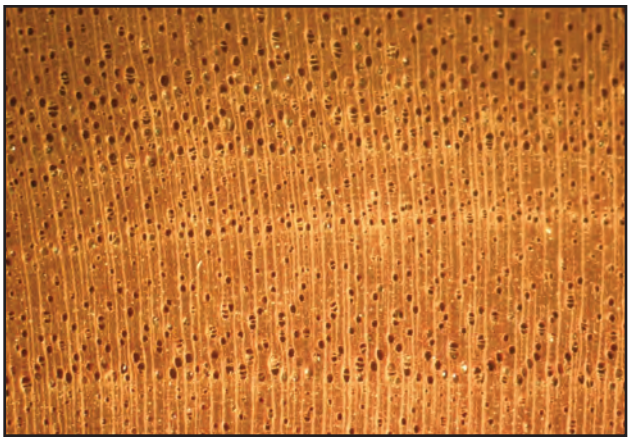
HICKORY
Carya spp.
Average density: 44.9 lbs/ft3
Heartwood color: Light to medium brown or reddish brown
Pore distribution: Ring-porous
Earlywood: Mostly an intermittent single row or thick-walled pores with fiber mass where interrupted
Latewood: Pores not numerous, solitary and in radial multiples of 2-5. Thick-walled.
Tyloses: Moderately abundant
Rays: 1-4 seriate
Parenchyma: Banded parenchyma and rays form a reticulate pattern distinctly visible against the background fiber mass with a hand lens (but banded parenchyma absent from earlywood zone)

SOUTHERN RED OAK
Quercus falcata
Average density: 39.3 lbs/ft3
Heartwood color: Light brown, usually with flesh or pinkish-colored cast.
Pore distribution: Ring-porous
Earlywood: Up to 4 or 5 rows or large solitary pores.
Latewood: Pores solitary in radial lines, few and distinct (countable), vessels thick-walled
Tyloses: Absent or sparse in earlywood
Rays: Largest rays conspicuous; tallest less than 1 in. (tangential surface). Narrow rays uniseriate (one cell wide) or in part bisariate (two cells wide)



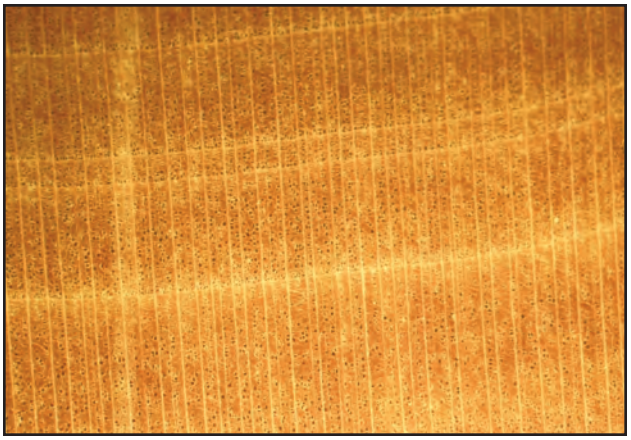
WHITE OAK
Quercus alba
Average density: 42.4 lbs/ft3
Heartwood color: Light to dark brown to grayish brown.
Pore distribution: Ring-porous
Earlywood: Up to 4 rows of large pores
Latewood: Pores small, solitary or in multiples, in spreading radial arrangement, numerous and indistinct (uncountable), grading to invisibly small with lens. Vessels thin-walled.
Tyloses: Abundant
Rays: Largest rays conspicuous; tallest greater than 1/4 in. Narrow rays uniseriate or in part biseriate.

Semi-Ring-Porous Hardwoods

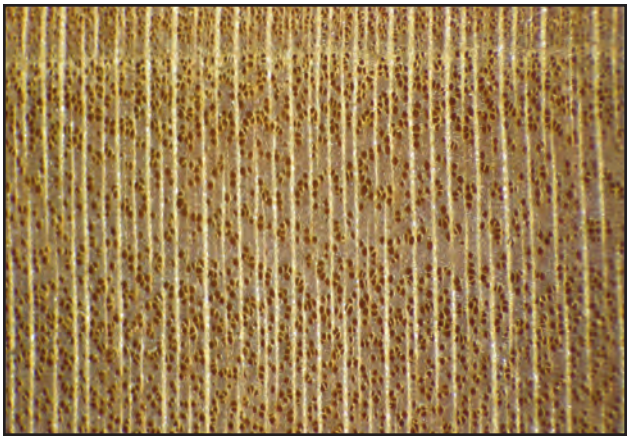


BLACK WALNUT
Juglans nigra
Average density: 34.32 lbs/ft3
Heartwood color: medium brown to deep chocolate brown
Pore distribution: semi-ring-porous
Pores: earlywood pores fairly large, decreasing gradually to quite small in outer latewood; pores solitary or in radial multiples of two to several
Tyloses: Moderately abundant
Rays: fine, visible but not conspicuous with hand lens, 1-5 seriate, cells appear round in tangential view
Crystals: Occur sporadically in longitudinal parenchyma cells

Diffuse-Porous Hardwoods

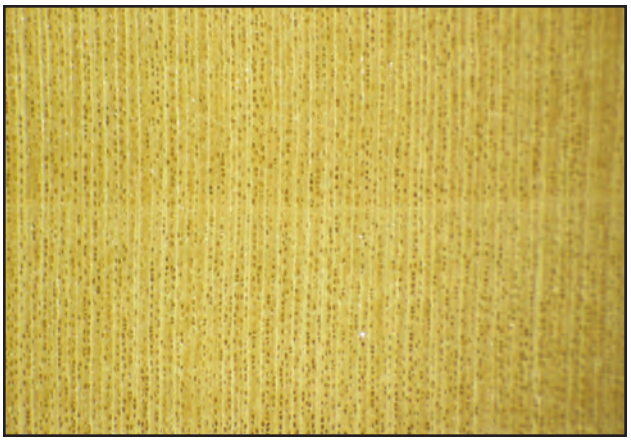


AMERICAN BASSWOOD
Tilia americana
Average density: 23.1 lbs/ft3
Heartwood color: Creamy white to pale brown
Odor: Faint but characteristic musty odor
Pore distribution: Diffuse-porous; growth rings indistinct or faintly delineated by marginal parenchyma, sometimes with blurry whitish spots along the growth ring boundary
Pores: Small, mostly in irregular multiples and clusters
Rays: Distinct but not conspicuous on transverse surface with lens. 1-6 seriate; ray cells appear laterally compressed in tangential view; rays have bright yellow cast



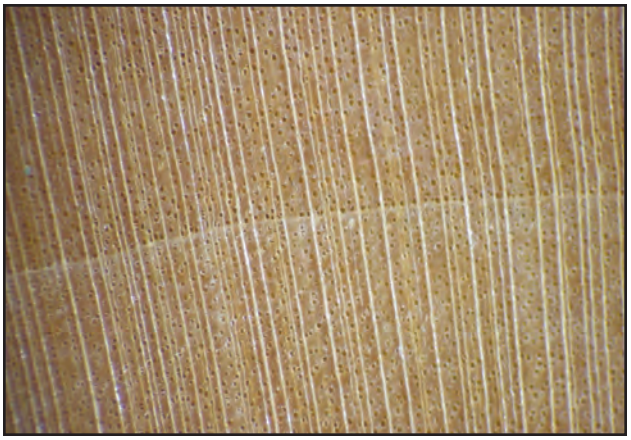
BLACK CHERRY
Prunus serotina
Average density: 31.2 lbs/ft3
Heartwood color: Light to dark cinnamon or reddish brown
Pore distribution: Diffuse-porous; growth rings sometimes distinct because of narrow zone or row of numerous slightly larger pores along initial earlywood.
Pores: Pores through growth ring solitary and in radial or irregular multiples and small clusters
Gum Defects: Common
Rays: Not visible on tangential surface; conspicuous light ray fleck on radial surfaces; distinct bright lines across transverse surface, conspicuous with lens. 1-6 (mostly 3-4) seriate.

BLACK GUM
Nyssa sylvatica
Average density: 31.2 lbs/ft3
Heartwood color: Medium grey or grey with green or brown cast (wood usually has interlocked grain)
Pore distribution: Diffuse-porous
Pores: Very small, numerous, solitary and in multiples and small clusters
Rays: Barely visible even with hand lens; 1-4 seriate

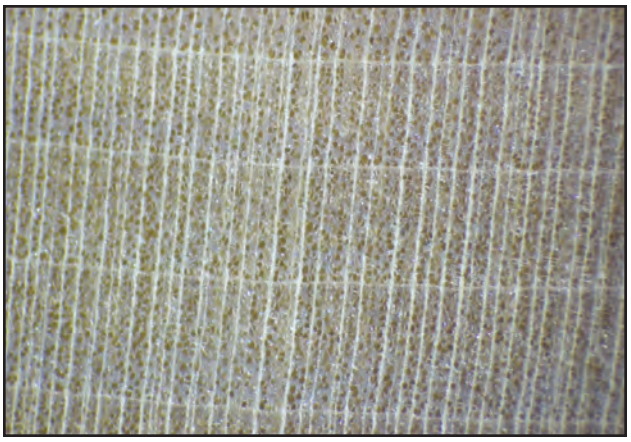


EASTERN COTTONWOOD
Populus deltoides
Average density: 24.96 lbs/ft3
Heartwood color: Grayish to light grayish-brown. Occasionally olive.
Pore distribution: Diffuse porous or semi-diffuse-porus. Usually a visible size graduation from earlywood to latewood
Pores: Small to medium small; Solitary and in radial multiples of 2 to several
Rays: Very fine, not easily seen with hand lens

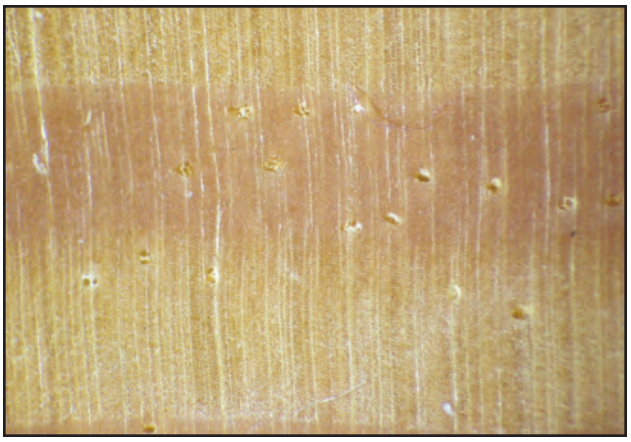
RED MAPLE
Acer rubrum
Average density: 33.7 lbs/ft3
Heartwood color: Creamy white to light reddish- brown, commonly with grayish cast or streaks.
Pore distribution: Diffuse-porous
Pores: Small, solitary and in radial multiples, very evenly distributed; largest as large or slightly larger than widest rays on cross section.
Rays: May be visible on tangential surface as very fine, even-sized and evenly spaced lines; on radial surface, ray fleck usually conspicuous. 1-5 seriate.



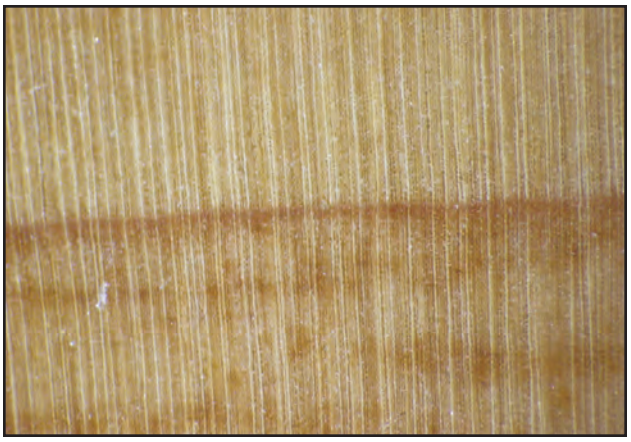
YELLOW POPLAR
Liriodendron tulipifera
Average density: 26.2 lbs/ft3
Heartwood color: Green, or yellow to tan with greenish cast
Sapwood color: creamy white (often wide)
Pore distribution: Diffuse-porous; growth rings delineated by distinct light cream or yellowish line of marginal parenchyma.
Pores: Small, solitary, but mostly in radial or irregular multiples and small clusters
Rays: Distinct on cross section with lens; produce conspicuous fine light ray fleck on radial surfaces. 1-5 (mostly 2-3) seriate



Softwood Identification



SOUTHERN YELLOW PINE
Pinus spp.
Average density: 31.8 to 38.1 lbs/ft3
Odor: "pitchy" pine odor
Heartwood: Distinct
Grain appearance: Uneven
Earlywood / Latewood transition: abrupt
Resin Canals: Large, numerous, mostly solitary, evenly distributed



BALDCYPRESS
Taxodium distichum
Average specific gravity: 28.7 lbs/ft3
Odor: Faint to moderately rancid
Heartwood: Usually distinct
Grain appearance: Uneven
Earlywood / Latewood transition: Abrupt; earlywood medium yellow-brown; latewood amber to dark brown
Texture: Coarse to very coarse

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