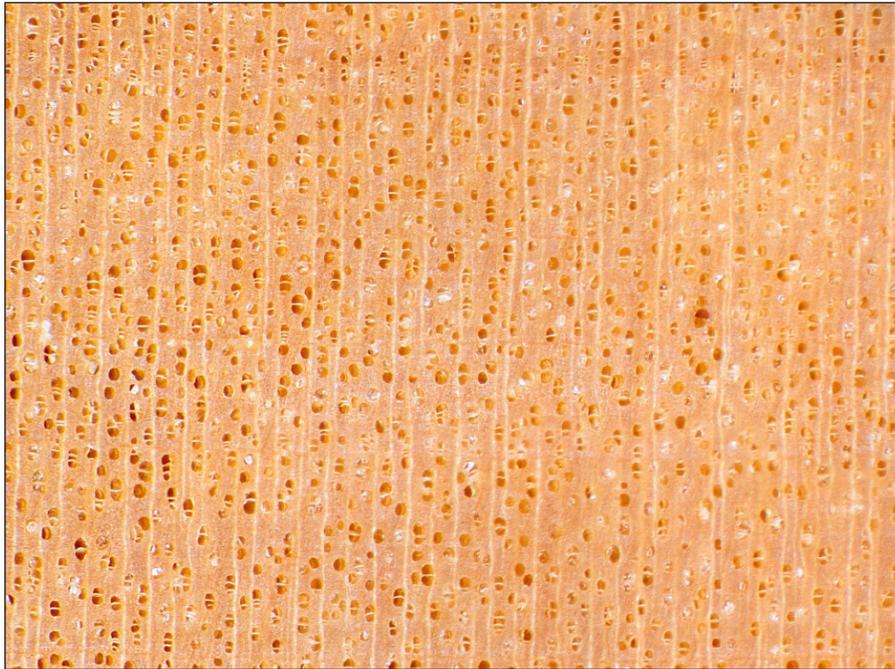


## IDENTIFYING WOOD—*A Primer for Everyone*

# First Steps in Identifying Wood

Terry Conners, Forestry



Wood samples need to be identified for all sorts of reasons, and they come in all shapes, sizes and conditions. I've received samples that were sound, samples that were waterlogged, samples that were rotted or otherwise degraded, painted samples, furniture samples, even samples containing wood preservatives. Most of the samples I receive have a North American origin, but I also receive pieces from art museums and antique dealers that can originate from just about anywhere. This sometimes means that identifying the sample by a common name alone doesn't provide enough information.

### Species Identification: Possibilities and Limits

Trees are usually fairly easy to identify, especially if they're in leaf. The shape and arrangement of the leaves, the appearance of the bark, the presence of fruits, nuts or berries, where the tree grows—all of these things provide a forester with information about the kind of tree he or she is looking at. Wood samples don't usually arrive on my doorstep with such complete information, however, and that makes the process of wood species identification more difficult. Without the leaves, the bark and so forth, the only features remaining are the wood cells and features such as density, color and odor. With so much botanical informa-

tion missing, a specimen of wood cannot always be identified as coming from a single species; it might only be identifiable as belonging to a group of species that have identical wood characteristics. For example, within the oaks there are white oak and red oak **species groups**, but within those groups samples cannot be differentiated by species. A specimen of scarlet oak can only be identified as being a member of the red oak species group; there is nothing about its wood structure that makes it uniquely scarlet oak.<sup>1</sup> Other common North American species groups that combine indistinguishable species include hard maple, soft maple, and southern pine.

Sawmills and vendors who sell lumber to the North American wood construction markets have also created several species groups bases on similar strength properties. The lumber from these species is bundled together and stamped with a short label for identification; examples of these groups include **SPF** (spruce-pine-fir) and **HEM-FIR** (hemlock-true fir).

### Binomial Nomenclature

In much of the world people use both a first and a last name to identify themselves, and scientists have named the different tree species using the same two-name convention (which they call **binomial nomenclature**). It works like this: every type of tree is given both a **genus** and a **species** name. Scarlet oak is thus called *Quercus coccinea*, where *Quercus* is the genus name (capitalized by convention and either italicized or underlined) and *coccinea* is the species name (not

<sup>1</sup> Besides scarlet oak, the red oak group includes the black oak, northern red oak, southern red oak, pin oak, water oak, willow oak and others.

capitalized but italicized or underlined in the same manner as the genus). All the oaks are members of the *Quercus* genus, for example, but different oaks would have different species names.<sup>2</sup>

Knowing the scientific name is very helpful, because referring to common names can create confusion. In different parts of the United States, for example, the common name “poplar” refers either to a true poplar (a tree of the *Populus* genus growing in the northern part of the country) or to yellow-poplar (a different genus altogether, *Liriodendron tulipifera*, which is also known by the common names of tuliptree and tulip-poplar). As another example, what I called “swamp maple” growing up in New England is also commonly known as “red maple,” but both names refer to *Acer rubrum*.

Clusters of related genera (the plural form of the word *genus*) are called **families**. In order of increasing specificity, trees could be named by their family, then their genus, then finally by their species. All of the oaks, for example, are in the *Fagaceae* family (ex., *Fagaceae Quercus coccinea*), but there are also other genus groups contained with the *Fagaceae* as well. One example of this is American beech, and in this case the genus name is similar to the family name (i.e., *Fagaceae Fagus grandifolia*, where *Fagaceae* is the family name, *Fagus* is the genus name, and *grandifolia* is the species name.) Like the genus names, family names are capitalized by convention.

Family names usually end in *-aceae*, and sometimes the names look intimidating or hard to remember simply because they have an unusual-looking ending. The ending letters are pronounced in three syllables; **a** is pronounced as in “day,” **ce** is pronounced as in “seh,” and **ae** is pronounced as a long *E* sound. For example, *Fagaceae* would be pronounced fa-GAY-seh-ee. The family name for black walnut, *Juglandaceae*, would be pronounced joo-glan-DAY-seh-ee (and so forth).<sup>3</sup>

2 *Quercus* is pronounced KWARE-cuss.

3 See “The Biologists Handbook of Pronunciations” by Edmund C. Jaeger, published by Charles C. Thomas, 1960, 336 pages.

## Forming an Initial Impression

The first thing I do when I receive a sample is to note its origin and overall appearance, as these can be important clues. Every wood sample has some characteristics (such as color, density, hardness, and odor) that are readily observable or visible to the naked eye. Taken in combination, these characteristics might suggest an initial species identification. This initial impression can’t be relied upon—it’s more like an “educated guess” at this point—but it’s a place to start. Educated guesses need to be confirmed by examining the sample further. This is true for everyone, regardless of their level of expertise.

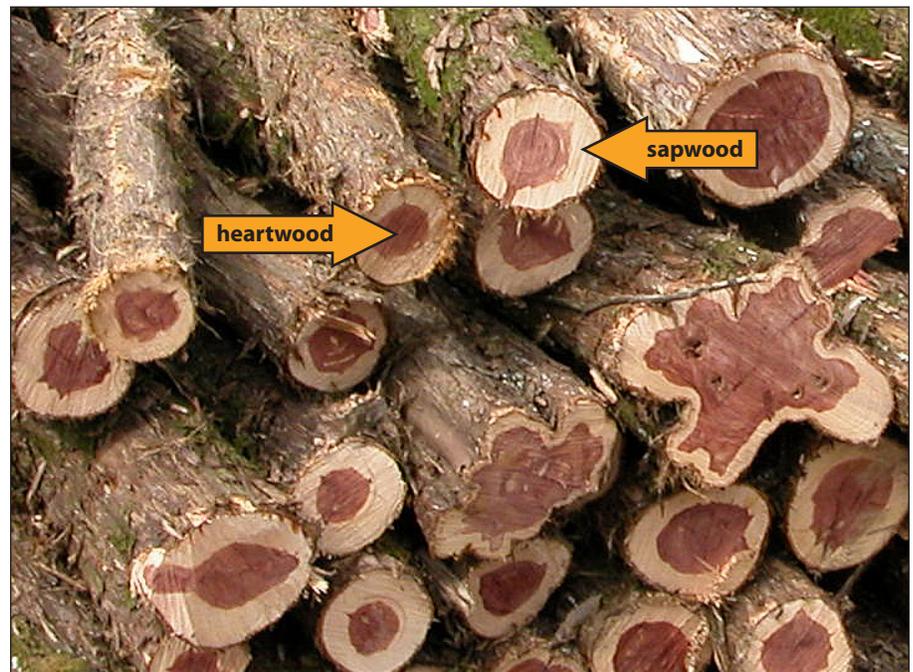
## Color and Odor

Color and odor can help to suggest the correct identification of a sample, but neither has to be distinctive to make a species identification; sometimes the *absence* of color or odor is what’s important in separating species. To complicate things slightly, the wood color isn’t always uniform throughout the tree. The center of the tree often has a darker colored

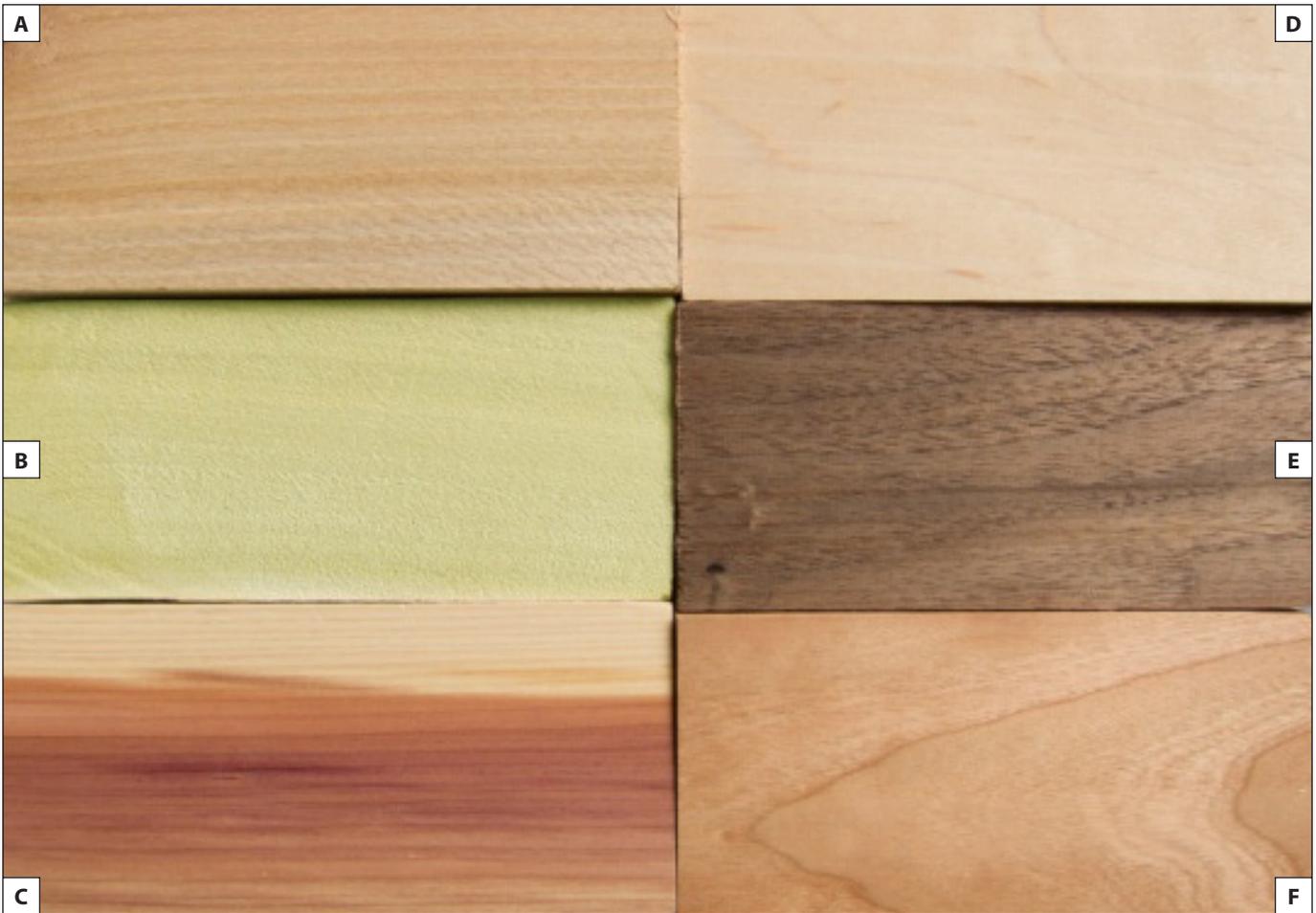
wood compared to the wood that lies just beneath the bark. The darker-colored wood is called **heartwood**, while the lighter wood surrounding it is called **sapwood** (see Figure 2-1 for an example).

There is an incredible range of heartwood color exhibited by woods worldwide, though many of them are variations on different shades of brown (cream, tan, light brown, red brown, dark brown, etc.). There are, however, a few species with colors that are less common (such as green or yellow), and for those species color can assist in identification by narrowing down the initial range of possibilities (Figure 2-2).

Not every species has distinctly-colored heartwood; in some species the heartwood and sapwood colors are similar. The proportions of sapwood and heartwood also vary according to species, and some trees need to get very large before the heartwood becomes visible. Persimmon is an example of a species in this category; it’s in the same genus as ebony (*Diospyros*), but it only begins to form heartwood (which is black) when the tree is large.



**Figure 2-1.** These are eastern redcedar logs (*Juniperus virginiana*). The darker, reddish-brown wood surrounding the center of the log (the pith) is the heartwood, and the light-colored wood just beneath the bark is the sapwood.



**Figure 2-2.** Examples of color variation in a few North American species: **A:** American sycamore, **B:** yellow-poplar, **C:** eastern redcedar (with sapwood), **D:** hard maple, **E:** black walnut, and **F:** black cherry.<sup>4</sup>

<sup>4</sup> The genus and species names are as follows: American sycamore (*Platanus occidentalis*); yellow-poplar (*Liriodendron tulipifera*); eastern redcedar (*Juniperus virginiana*); hard maple (for example, *Acer saccharum*—there are other species in the hard maple group as well); black walnut (*Juglans nigra*); and black cherry (*Prunus serotina*).

Some species have color patterns that help make them identifiable. This is particularly true of tropical species. See the photograph of zebrawood (*Microberlinia* spp.) in Figure 2-3, so known because of its distinctive striped appearance.

**Effect of heartwood, sapwood, machining, dryness, and storage conditions on odor**

In many species, the heartwood is more strongly scented than the sapwood; the chemicals that cause noticeable odors in the colored heartwood are more concentrated in that part of the tree. The reddish-brown heartwood in eastern redcedar, for example, has a much stronger

“cedar” odor than the lighter-colored sapwood.

Having a distinctly colored heartwood does not automatically indicate that a species will have a noticeable odor (and vice versa). In many species with a distinct heartwood color, neither the sapwood nor the heartwood will have a detectable scent (redwood is one example). Other species may have distinct heartwood odors even though their heartwood is light- or neutral-colored (Alaska yellow-cedar and incense-cedar for example). Alaska yellow-cedar heartwood is a very pale creamy yellow and the wood smells like raw potatoes; incense-cedar heartwood is an undistinguished light reddish-brown color, but the wood



**Figure 2-3.** Zebrawood (*Microberlinia* spp.) is so named because of its distinctive dark-and-light striped pattern.

has a pungent aroma and flavor that many older Americans are likely familiar with.<sup>5</sup>

Because light-colored samples might be entirely sapwood, the absence of an odor isn't always significant.

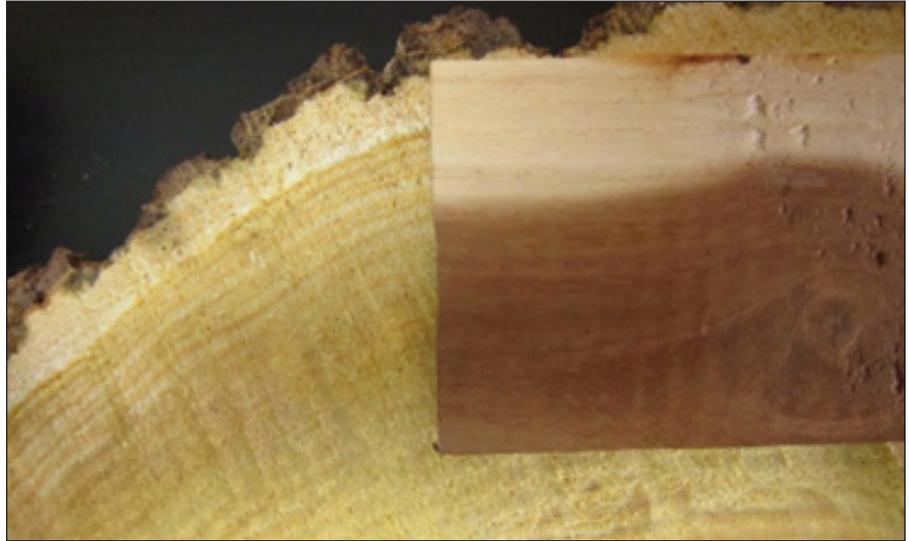
Sometimes a characteristic fragrance is most noticeable when the wood is machined—cherry, walnut or yellow-poplar are examples of species that have characteristic odors that are more noticeable when they're run through a saw. (Even white oak may smell like buttered popcorn when it's machined.)

Wetter samples are more likely to have obvious odors than dry samples, and different samples of heartwood can have differing fragrance strengths as well; this may be caused by the history of the sample (the temperature at which it was dried, perhaps) or by variation within the species.

Finally, when confronted with an unknown piece of wood, remember that wood can absorb odors of other species or articles that it's been stored with. A colleague had a professor who purposely stored redwood (an unscented wood with a heartwood color similar to eastern redcedar) with blocks of eastern redcedar, hoping to transfer some of the cedar smell to the redwood so he could see if his students got confused on quizzes. Be cautious in interpreting odor.

### More reasons not to rely on color or odor

Color and odor can be disguised or hidden by stains or coatings, and color can also be affected by wood's exposure both to air and to UV radiation (sunlight or fluorescent lighting), even through wood finishes; from personal observation, the combination of UV radiation from sunlight (or fluorescent illumination) and air can darken wood more quickly than air by itself (in shadow). Heartwood is affected most of all (Figure 2-4). Sometimes this is desirable; one of



**Figure 2-4.** Two pieces of red mulberry (*Morus rubra*). The underside piece with the bright golden yellow heartwood was freshly cut. The piece on top with the ruddy brownish-red heartwood color is a sample that was cut around thirty-five years ago; it's mostly been in dark storage throughout that time. The heartwood color has changed significantly although the sapwood color has shown very little change.

the reasons we appreciate black cherry wood so much is because of the rich, dark reddish brown tones that cherry furniture acquires over time. On the other hand, though, this behavior is one of the reasons that it's so hard to add a new cabinet to a cherry kitchen after a few years—the colors of the new and old cabinets are almost impossible to match.

Color and odor will always be important clues that shouldn't be overlooked when you're examining an unknown wood sample, but because they'll vary according to how the wood was stored or used, the ability to observe the wood structure is always of paramount importance in being able to correctly identify a piece of wood.

There are other reasons for wood to change color besides exposure to air and light. Wood appearance can also be affected by decay fungi, so it's important to be able to recognize the various stages of decay; color changes due to decay are of no diagnostic value whatsoever. Advanced decay should be easy to identify—the wood will be notably softer. Before decay advances to that stage, however, the wood color is affected as the fungi colonize the wood. The wood color may become lighter because of the fungi, or (sometimes) there may be somewhat decorative black lines throughout the piece; the colored wood

is described as “**spalted wood**” and the lines themselves are often called “**zone lines**.” Zone lines are colored mycelium showing the borders of fungal advance; they can also be places where different fungi are interacting and competing for the same volume of wood (Figure 2-5).<sup>6</sup>

### Two Classes of Wood: Softwoods and Hardwoods

In everyday terms, there are two classes of trees: *softwood* trees and *hardwood* trees. In North America, native softwoods have cones and leaves that resemble needles or overlapping scales; because they have cones, these trees are also sometimes called **conifers**. As a group people tend to casually think of these species as *evergreens*, but many species actually lose some or all of their needles in the fall. (Pines lose only a portion of their needles each fall—I vividly remember having to sweep brown fallen needles from my white pine trees off my windshield every morning before driving to work when I lived in Massachusetts—but other species such as baldcypress, larch and dawn redwood lose all of their needles.) Besides these species,

5 Pencils were originally made from redcedar in the U.S., but the supply began to run short in the early 1900s and North American pencils were increasingly made from incense cedar after the 1920s; pencils made after about 1990 might be made from incense cedar, Chinese basswood, a tropical species such as jelutong (*Dyera costulata*) or even plastic!

6 (If you're interested in spalted wood, I recommend you visit <http://www.northenspaling.com/>).

the conifer group also includes the firs, spruces and cedars. Botanists identify these trees as **gymnosperms**. (Ginkgo, a non-conifer with deciduous leaves, is also a gymnosperm, but it's the sole species of its kind—sort of a living fossil. A native of China, it is planted in North America as an ornamental.)

In contrast to softwoods, hardwood trees have broad leaves, and these leaves frequently drop at the end of the growing season (particularly in temperate climates). Some familiar examples of hardwoods include the oaks, maples, dogwood, beech, walnut and cherry. **Broad-leaved trees** are referred to as **angiosperms** by botanists. There are a few species in North America (ex., holly, live oak or magnolia) that essentially have leaves year-round, but even these trees drop their old leaves in the late fall or early spring; they aren't true evergreens either. Balsa and mahogany trees are tropical species whose wood you may be familiar with, and these are considered to be hardwoods too; even though they grow in tropical climates, they drop their old leaves at about the same time the new leaves come forth.

Softwoods aren't necessarily softer than hardwoods, and hardwoods aren't necessarily harder than softwoods; the terms are misnomers in that respect. Balsa, for example, though a hardwood, is one of the lightest and softest wood species on Earth; it is much softer than southern pine, which is a softwood.

### Wood Structure is Best Thing to Use for Species Identification

Being able to determine whether an unknown sample is a hardwood or a softwood is the first step in identifying a piece of wood. Unlike color, odor, or other characteristics, the structure of each piece of wood—the types of cells it contains, how they are arranged, etc.—is not affected by wood finishes, nor is it usually affected by whether the sample is sapwood or heartwood. Wood structure differs very greatly between hardwoods and softwoods, however; there are additional significant differences among species that make species identifications possible.



**Figure 2-5.** Two different pieces of wood in the initial stages of decay (“incipient decay”). The piece on the left is white oak, and the lighter patches (indicated by the arrow) are caused by a fungal infection. The plate on the right is turned from a piece of spalted red maple, and there are multiple black zone lines present.

Sometimes you can look at the sample using nothing more than a hand lens under a strong light, but for other samples you might need to cut into the sample, maybe even make a thin section for a microscope. It all depends on the sample—it might be large, it might be decayed, it might be very small—and the method of examination has to be adjusted to suit the sample. In some cases a species can be identified just from the morphology of a single cell! Even sawdust can usually be identified, at least to a certain extent. Sawdust often doesn't have any recognizable cells or identifiable cell fragments, but it can be identified as coming either from a hardwood or a softwood species through a simple chemical reaction.<sup>7</sup> Obviously, there are different features to look for at each level of magnification.



**Figure 2-6.** Schematic of tree growth. Photo courtesy of Kate Pullen.

<sup>7</sup> The chemical reaction referred to is the Mäule reaction. Samples from hardwood species turn red, while softwood samples yield undistinguished pale yellow or pale brown colors. The separation works because the reagent reacts differently with hardwood lignin and softwood lignin; these are similar but not identical polymers.



**Figure 2-7.** White ash cross-sections, fast- to slow-grown. The fast-grown samples have significantly wider growth rings; the lighter-colored wood is the earlywood and the darker wood is the latewood.

### Growth Rings

A tree is made of cells, and more cells are added each year; the existing cells don't just continue to get larger. The cambium layer just beneath the bark adds cells to both the tree tip and the outer diameter, so each year's growth makes the tree both taller and thicker.<sup>8</sup> You might be able to visualize each year's growth by imagining a stack of inverted paper cones (one per year of growth), as in Figure 2-6. Reality differs from the illustration in that each year's growth actually extends completely from the top to the bottom of the tree.

Provided there is sufficient water, trees will grow well in warm, well-lit seasons and go into dormancy in cold/dark/dryer seasons. The wood structure and appearance responds to these changes, so when we look at the end grain of a piece of wood (the top of a stump or the end of a board, known as the "cross-section") we often see ring-like patterns called "**growth rings**." Growth rings, also known as **annual increments**, are formed in temperate-zone tree species because the cells respond to temperature and/or moisture as they grow.<sup>9</sup> When these



**Figure 2-8.** The cross-section of southern pine on the left is from a tree that was selected for fast-growth characteristics and grown in a plantation. The piece of wood on the right is from an unimproved tree. Photo courtesy of Steve McKeand, North Carolina State University, Bugwood.org.

species come out of dormancy each spring the thin sheath of cambium beneath the outer bark begins to produce new cells; these new cells are called **earlywood**, while wood produced later in the growing season is called "**latewood**." In a temperate climate the production of earlywood or latewood is considerably affected by the length of the day, so earlywood and latewood are sometimes called "**springwood**" and "**summerwood**."

Earlywood and latewood tissues look different; earlywood is lighter-colored than latewood, and this is due to differences at the cellular level. In softwoods, for example, earlywood cells have thinner

**Counting Growth Rings:** At one time or another we've all had a chance to teach children how to count growth rings on a stump to see how old a tree was. Make sure to do it right! Count either the light rings (the earlywood) or the dark rings (the latewood), whichever is easier to see, but don't count them both, or you'll end up with a count that's twice as old as it should be!

<sup>8</sup> Trees don't grow from the bottom up; if you attached a clothesline to a tree you wouldn't find that it creeps higher and higher year after year!

<sup>9</sup> Many tropical species don't form growth rings; one source states that "75 percent of the trees of the Indian rain forest, 45 percent of those of the Amazonas Basin and 15 percent of the Malaysian trees have no annual rings." (<http://www.biologie.uni-hamburg.de/b-online/e06/06h.htm> (last accessed 2014))

cell walls compared to the latewood cells; light reflects differently from thin- and thick-walled cells, so softwood earlywood cells look light and latewood cells look dark. Observations of earlywood and latewood appearance on the cross-section can be very important to species identification.

The width of the growth ring can be influenced by the length of the growing season; oak grown in Michigan, for example, would have a shorter growing season than oak grown in Mississippi, and the growth rings would be narrower or wider by comparison, respectively. Here's an example of different growth rates in some white ash (*Fraxinus americana*) cross-sections (Figure 2-7).

Genetic differences may also account for different growth ring widths, as shown in the photo in Figure 2-8 which compares wood from an "improved" southern pine tree selected for faster growth to an "unimproved" tree.

The rate of growth of any individual tree won't be constant throughout its lifetime. In addition to the effects of the length of the growing season and genetics, growth ring width can be affected by local competition for sunlight, water and nutrients. Trees grown in a plantation, where saplings are planted all at the same time, might start out with vigorous growth and wide growth rings when the tree is young. As the plantation grows older, however, the tree canopies begin to



**Figure 2-9.** This railroad tie is made from southern pine. The center of the tree has wide growth rings, indicating that the growing conditions were probably uncrowded for the first few years after the tree was planted. After about eight years or so, the adjoining tree canopies began to close in and the overall growth started to slow down (as indicated by the narrower growth rings). Notice the pumpkin-colored heartwood surrounding pencil-sized pith in the center of the tree.

shade each other and growth slows down, resulting in narrower growth rings. Figure 2-9 shows the effect of changing growing conditions on the growth rings of a piece of plantation-grown southern pine.

Competition is something that all trees face, not just trees grown in a plantation. Figure 2-10 shows an increment core taken from a white oak tree (*Quercus alba*) that began to grow in a relatively open area. As the tree ma-



**Figure 2-10.** An increment core from a 137-year old white oak tree (*Quercus alba*) showing the growth rings from the pith to the bark; it's displayed in three overlapping photos here so you can more easily see how the growth ring widths change. The numbers correspond to the age of the tree. The earlywood bands are lighter colored than the darker wood in white oak. Source: John Lhotka, University of Kentucky Department of Forestry.

tured, the surrounding trees also grew and began to diminish this oak's access to sunlight as their leaf canopies grew closer (this begins at about year 20–25). The increasingly-closer growth rings tell us that the surrounding trees continued to grow closer to this oak's canopy until it was almost 95 years old, at which point the surrounding trees were cleared away by a thinning operation (though the same effect could also occur naturally through storm or disease) and the growth rings became significantly wider once more. This cycle repeated itself until this tree was cored at 137 years old.

The differences between earlywood and latewood are not always as distinctly as I've shown here for ash, southern pine and oak. In some species the earlywood and latewood intergrade instead of having clear boundaries, and in other species distinct earlywood and latewood areas aren't readily apparent. The growth ring widths aren't really useful for identification, either, though they may give clues as to the origin of the sample; for some species, the width of the growth rings may be affected as much by the amount of rainfall as by the length of the growing season. Notably, if the rainfall significantly varies during a growing season, some tree species can produce several "growth rings" in that year as growth starts, stops, and restarts. Seasonal or climatic influences are frequently less variable in tropical species, and the wood in some tropical species can look fairly uniform.

The most important thing to remember from this discussion is that the width of the growth ring isn't usually particularly helpful in identifying a wood species. The growth ring width might help indicate whether the tree was grown in a temperate cool or temperate warm climate or even perhaps a tropical climate, but, because ring width varies so much even within a species, it's not possible to compare the ring width of an unknown against an authenticated sample and use that as evidence for a species identification. Context—the known or likely origin of the wood specimen—can be very helpful in narrowing down the list of the most logical species. (I think of wood identification as a process of building up layers and layers of observations, so if there is some clue to the conditions under which a sample of wood was grown or the location, it might be useful information.)

## Summary

Wood will always be easier to identify if you're provided with a reasonable sample—not too small, rotted, painted, etc. The first thing to do is to take stock of the obvious features: color, odor, and the density/weight. Document what you can about the likely origin of the sample, as this can be immensely helpful.

## Vocabulary

If you don't remember what any of the following words mean, please review this section.

1. Species group
2. Binomial nomenclature
3. Genus
4. Species
5. Family
6. Heartwood
7. Sapwood
8. Spalted wood
9. Spalting
10. Softwoods (conifers)
11. Hardwoods (broad-leaved trees)
12. Gymnosperms
13. Angiosperms
14. Growth rings
15. Earlywood
16. Latewood
17. Springwood
18. Summerwood

Where trade names are used, no endorsement is intended, nor criticism implied of similar products not named.