COOPERATIVE EXTENSION SERVICE
UNIVERSITY OF KENTUCKY COLLEGE OF AGRICULTURE, FOOD AND ENVIRONMENT, LEXINGTON, KY, 40546
FOR-123

University of Kentucky College of Agriculture, Food and Environment

IDENTIFYING WOOD—*A Primer for Everyone* PART 1

Introduction to Wood Structure and Characteristics

Terry Conners, Forestry

Wood is identified using the features and tools that are appropriate to the size of the sample. Large timbers are identified by looking at the color, the appearance of the end and side grain, whether a saw cuts cleanly or leaves lots of splinters behind, whether the wood has straight or curly drying cracks, and so forth. The hardness and density provide valuable information as well. For smaller pieces of wood, it's more practical to look directly at the wood cells with a 10X hand lens (also called a loupe). Different species have different characteristics and combinations of these features are used to identify the sample using a key.

The features you want to examine under the hand lens aren't present in all cases; the sample could be too small, for example, or it might have a finish that conceals the wood structure or color. If a small sample can be taken from an inconspicuous area, often the species may be identified by cutting thin sections and looking at them with a light microscope. Special keys have been developed to distinguish species based on microscopic features.

Knowing how to identify unknown pieces of wood using a hand lens is the only skill you will need for most situations—and that's the purpose behind most of this manual. A section at the end about how to identify wood using a microscope is available should you want to develop your wood identification expertise.

Let's get started.

Introduction to Wood Structure and Characteristics

Wood is such a ubiquitous material that we often don't stop to consciously consider what makes one piece of wood different from another. We unthinkingly recognize the differences between pine and walnut for example, but what are the factors involved in our rapid decision-making? Characteristics such as color or the evenness of the grain are evident by sight, but others (such as smell, density, or hardness) might only be observed if the piece of wood is handled.

Wood has three different types of characteristics that can be useful for identification:

- Anatomical structure
- Chemical characteristics
- Physical properties

Wood-structure differences affect how uniform or non-uniform the wood appears; wood chemicals color the wood and contribute to any odor (as in Eastern red cedar); and physical property differences such as hardness or density can often be readily detected by handling (think of the obvious differences between balsa and oak, for example).

Let's take a minute to look at these characteristics more closely.

Anatomical Structure of Wood

Wood is a cellular material, but it's very different from man-made cellular materials such as sponge rubber balls. In sponge rubber, the individual foam cells are hollow, fairly uniform and lack any orientation. In trees, however, the wood cells have to support loads from above (the upper stem and the foliage). For this reason, most of the cells in a tree are oriented longitudinally, i.e., parallel to the axis of the tree. These cells are hollow, yet they provide support for the weight of the tree as well as pathways for the conduction of water and nutrients (sap). There are several types of longitudinally-oriented cells, but for the time being we're going to call all of them by the generic name **fibers**. You might think of fibers as being similar to a bunch of soda straws held in your fist, all pointing up and down the tree, with each straw representing a single fiber.

A small percentage of cells is oriented perpendicular to the stem, extending from the cambium layer just beneath the bark towards the center of the tree. Each of these cells is called a **ray** cell. Individual ray cells resemble bricks, but they don't appear individually; instead, multiple ray cells are "stacked" as in a brick wall to form thin structures known collectively as rays.[1] The function of rays is to help move nutrients between cells and store metabolic waste products.

Ray dimensions vary according to species—in some species, rays have multiple rows of ray cells side-by-side, and rays can also be taller or shorter depending on how many cells are stacked up to make the "wall." This means that the ray dimensions can sometimes be useful as clues to the identity of a wood specimen. Some species have rays that are tall enough or thick enough to see with the naked eye, but sometimes the rays are so narrow that it's necessary to use a hand lens or a microscope to see them. Rays often have a different color than the surrounding wood tissue, and this can make them easier to see without magnification. If the ray is tall enough, the sides of the rays might even reflect light differently from the surrounding wood, making them look a little like a ribbon on a split wood surface.

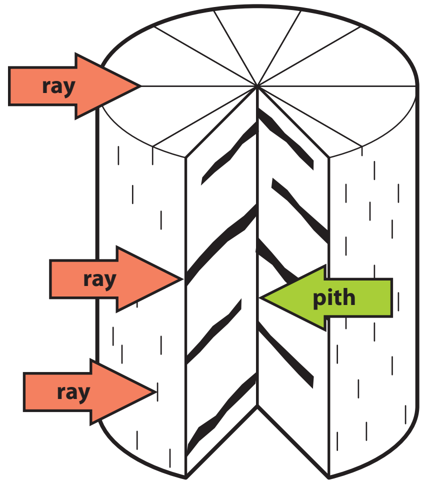

Figure 1-1. This sketch shows how rays extend from the cambial layer just beneath the bark (where ray cross-sections appear as short thin lines) toward the pith in the center of the tree. Rays may appear to be discontinuous because the plane of the cut and the plane of the rays may be slightly different, especially if the grain has small local deviations. Note the pith that runs longitudinally in the center of the tree parallel to the fibers.

Figure 1-1 illustrates how rays might appear in a piece of wood; one ray is labeled on the end of the log (the cross-section), another is labeled on the outer surface immediately below the bark, and a third (showing the ribbon-like appearance) is shown on the exposed interior wedge. In an ideal piece of wood the rays follow a perfectly straight line between the center (the pith) of the tree and the bark, but slight deviations often occur. When a piece of wood is opened with a saw it's common to see interrupted rather than continuous ribbons of ray tissue on that inner surface. Fibers go up and down the tree (vertically in Figure 1-1); they aren't marked here, but if you could magnify the sketch and look at the cross-section the fibers would look similar to the ends of that bunch of soda straws.

Rays look different for different species, and the way they look can be helpful in wood identification. As examples, the photographs below (Figure 1-2) show how rays actually look in two different North American species.

Wood Chemicals

To keep things simple, you could think of all wood chemicals as belonging to one of two groups: a) those that make up the wood cell structures and the chemicals that stick the cells together (the primary constituents), and b) those that don't contribute to any structural properties, such as the chemicals responsible for color and odor (the secondary constituents).

Primary constituents. Of those chemicals that constitute the wood cell wall, the most important is cellulose. Cellulose is the same polymer that makes up almost all of a cotton fiber; it's approximately 40-45 percent of the weight of a piece of wood (regardless of species), and it's a long straight-chain carbohydrate polymer. Cellulose is particularly strong in tension, and it's the primary chemical that gives strength to wood cell walls.

The second principal polymer in cell walls is called hemicellulose. Hemicellulose is a branched carbohydrate polymer and therefore has somewhat different properties than cellulose; it's much less strong, and it's also much more able to absorb water (hygroscopic). Wood contains approximately 18-35 percent hemicellulose, depending on the species.

The third primary constituent of wood is called lignin. Lignin is not a carbohydrate; it's a polymer made up of phenolic molecules, and it's approximately 20-35 percent of a dry piece of wood. Lignin has much less affinity for water than either cellulose or hemicellulose. Together, lignin and hemicellulose stiffen individual wood fibers and act as an adhesive that hold the fibers together.

Secondary constituents. Cellulose, hemicellulose and lignin—together they comprise the essential wood components. Other chemicals are also present, though these vary according to the species. Since some of these chemicals could (in theory) be removed from a piece of wood using solvents (leaving the wood structure intact), these chemicals are called extractives. Extractives can be present in small or large amounts (from 3 percent to 30

1 Rays are sometimes called *medullary rays* in botanical publications and European texts, though this terminology seems to be used less frequently in North American publications.

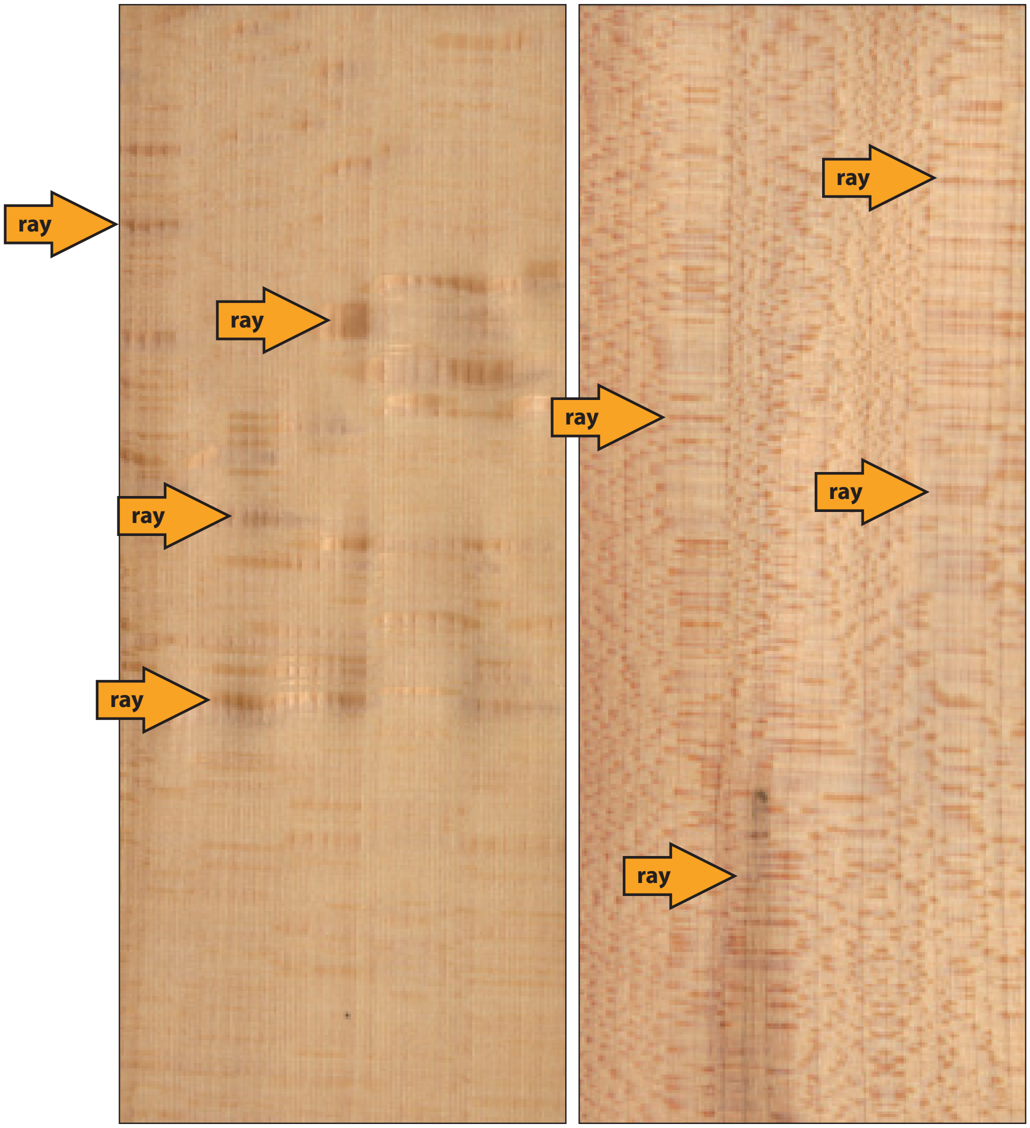

Figure 1-2. These photographs of American beech (on the left) and silver maple (on the right) show how different species can have different looking rays (some of which are indicated by arrows here). These photographs were taken at the same magnification, showing that the rays in American beech are larger and easier to see than in the silver maple. The rays look like interrupted ribbons because the rays and the saw didn't follow the exact same plane when these samples were cut. In the maple sample, some rays are shorter than others (in terms of their length) because they weren't perfectly straight in the wood.

percent[2]), depending on the species. Extractives are responsible for odor (ex., in Eastern red cedar), color (ex., the warm brown heartwood color in black walnut), decay resistance (ex., the natural decay resistance of black locust), and materials such as gum deposits in black cherry or the pitch in pine trees.

2 Bowyer, J.L., Shmulsky, R. and J.G. Haygreen. 2007. Forest Products and Wood Science: An Introduction. Blackwell Publishing, fifth edition, 558 pages.

Finally, no discussion of wood chemicals is complete without noting the inorganic wood component called ash. As you probably expect, ash is what remains after the thorough combustion of a wood sample. Wood in temperate climates usually contains about 0.5-1 percent ash, though tropical species might contain much more. The appearance of the ash left behind by burning a splinter of wood in still air is still used as a diagnostic test for some tropical species. Typically, wood might contain small amounts of calcium, potassium, phosphorus, magnesium and aluminum (among other elements). Because of the variability of the soils in which tree species grow, however, chemical analyses aren't generally helpful for wood identification.

Wood density. Wood species vary considerably in their density, from approximately 6 to 84 pounds/cubic foot (air-dry). This means that some woods are much lighter, or much heavier than the density of water—some woods will sink completely below the water surface, many will sink only to about mid-thickness, and a few will float so high in the water that they barely get wet (Figure 1-3).

If the sample is large enough to be readily handled, density is one of the characteristics that can be quickly evaluated when making a wood identification. Density is seldom determined as part of an identification procedure, but at the very least we can ask the question, "Is the density of this sample consistent based on other considerations?"

Having reference species is useful for density comparisons, but density differences aren't easy to judge when you're handling different-sized pieces of wood. Luckily, density is well-correlated with hardness, so denser pieces of wood are harder than less dense pieces of wood. Use your thumbnail as a built-in hardness gauge. The ability to judge how easily a piece of wood can be scratched or dented is sometimes useful.

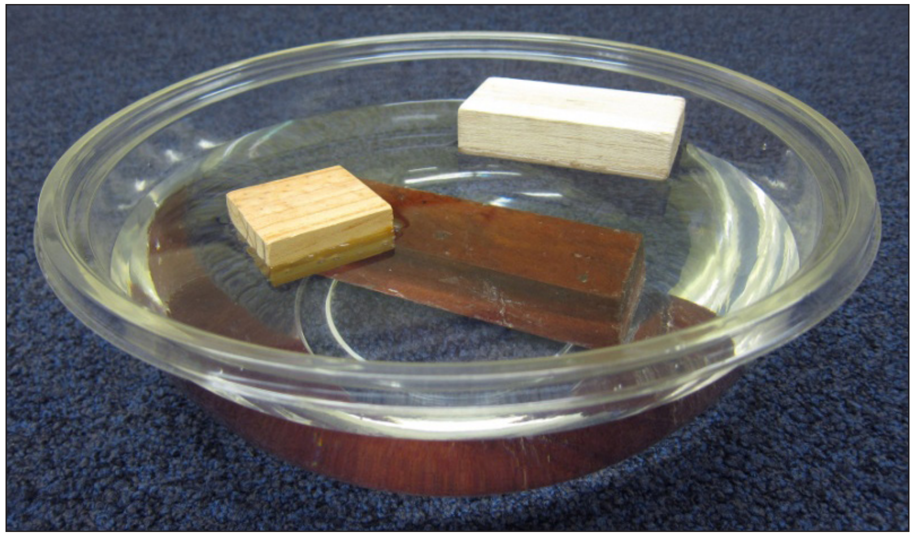

Figure 1-3. The densities of different wood species can vary considerably. Here we see balsa (density = 0.1 g/cm^3) floating very high in the water; southern pine (density = 0.55 g/cm^3) floating but with about half of its volume submerged; and cocobolo, a tropical species (density = 1.1 g/cm^3), completely submerged. The density of water is 62.4 lb/ft^3, or 1.0 g/cm^3.

Summary

Wood is composed primarily of fibers that are oriented parallel to the trunk of the tree, but ray cells are also present and run perpendicular to the fibers, between the cambium layer and the pith. When we hold a piece of wood in our hands, some of its characteristics are readily discernible and can be useful in identification. The wood color, density, odor and smoothness all provide important information about the wood structure and composition. These features become part of a mental inventory that you can then use to compare the features of the unknown specimen against a set of expected features in a remembered reference sample.

Vocabulary

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

1. Cellulose
2. Hemicellulose
3. Lignin
4. Extractives
5. Ash
6. Pith
7. Rays
8. Medullary ray
9. Fibers
10. Density

Acknowledgements

I've been continually involved with wood identification since I took my first wood identification course back in 1974, and I've taught people to identify wood pieces as small as paper fibers and as large as railroad ties. One of the reasons I wrote this series of publications is that I don't feel other resources teach enough about the actual process of wood identification; students need to know how to recognize clues about the features that are most important to look for and they need to know about potential pitfalls as well. I've tried to write this publication the way I wish wood identification had been taught to me: in layers, a little bit at a time, with successively more detail as the basics are mastered.

I'd like to thank some of my own instructors and those colleagues who helped me learn more along the way, in particular Robert Baldwin, Wayne Murphey, Bruce Hoadley, Walter Rantanen, Jim Watt, and Jim Ringe. I "test drove" the material presented here at some of the short courses I've taught in wood identification in Kentucky and Ohio, and it's also been used by the conservation staff and participants in short courses held at the Cincinnati Art Museum. I also want to thank friends and colleagues who've taken the time to read this material and make comments. Larry Osborn of West Virginia University has been particularly helpful, sharing his own years of experience and giving me lots of helpful remarks. Thanks, pal!

Issued 12-2015