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UNIVERSITY OF KENTUCKY
College of Agriculture, Food and Environment

PART 3

IDENTIFYING WOOD—*A Primer for Everyone*

Distinguishing Softwoods from Hardwoods

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Softwood and hardwood trees are made up of different types of cells. With just a little magnification, it's easy to see that softwood growth rings look different from hardwood growth rings. Additionally, growth rings don't look the same for all of the trees, and the growth ring appearance is one of the things we will look at to identify wood.

What Softwoods Look Like

The overall composition of softwoods is simpler than hardwoods: softwoods have fewer cell types, and their arrangement is more regular. As one might expect, this varies a bit from species to species, but in all softwood species about 90 percent of the wood is made up of the cells that we commonly call fibers (more correctly known as **tracheids**[1]); softwoods also have **rays**. If you look at the cross-section of a piece of softwood with a hand lens, you'll see that the tracheids are arranged in straight rows perpendicular to the growth rings. It's harder to pick out the rays—they're narrower than the tracheids, and they look like thin straight lines. Figure 3-1 shows an enlarged cross-section of western redcedar (*Thuja plicata*); notice how the size of the tracheids changes from earlywood through the latewood. The cell walls are getting thicker as the cell openings (the **lumens**) change dimension, but changes in the cell wall thickness are hard to see at this level of magnification.

1 Because these fibers are aligned with the axial of the tree, they are also known as *longitudinal tracheids.*

What Hardwoods Look Like

The most important distinction between softwoods and hardwoods is that almost all hardwoods contain a type of cell called a **vessel element**.[2] Vessel elements are similar to segments of small pipes that run throughout the tree in the longitudinal direction, connecting the top of the tree with the root system. A collection of vessel elements joined end-to-end is known as a **vessel**. Vessels can be readily seen on the cross-sectional surface of any hardwood species, where they appear as holes (**pores**); hardwoods are hence frequently known colloquially as **porous woods** *(or porous species).* The observation of vessels (pores) on a cross-section is the determining factor in deciding that an unknown sample is a hardwood and not a softwood.

Besides the presence of vessels, there are two other differences between softwoods and hardwoods. The first difference is that the thick-walled longitudinal cells in hardwoods are true **fibers** and not tracheids as found in softwoods. Without a microscope the only apparent difference is the size of the cells. Many softwoods have tracheids large enough to see with a hand lens, but hardwood fibers cannot be distinguished without a microscope. Vessels are significantly larger in diameter than the fibers (so size can be used to tell them apart from the hard-to-see fibers on the cross-section).

The remaining difference between hardwoods and softwoods lies in the widths of their rays. Softwoods generally have rays that are only one or two cells wide, and these rays are so narrow that they are hard to see even with a

2 There are only a few exceptions (ex., *Pseudowintera* spp. from New Zealand), but these species are of little commercial value and are seldom encountered except in wood collections (see http://www.woodcollectors.org/).

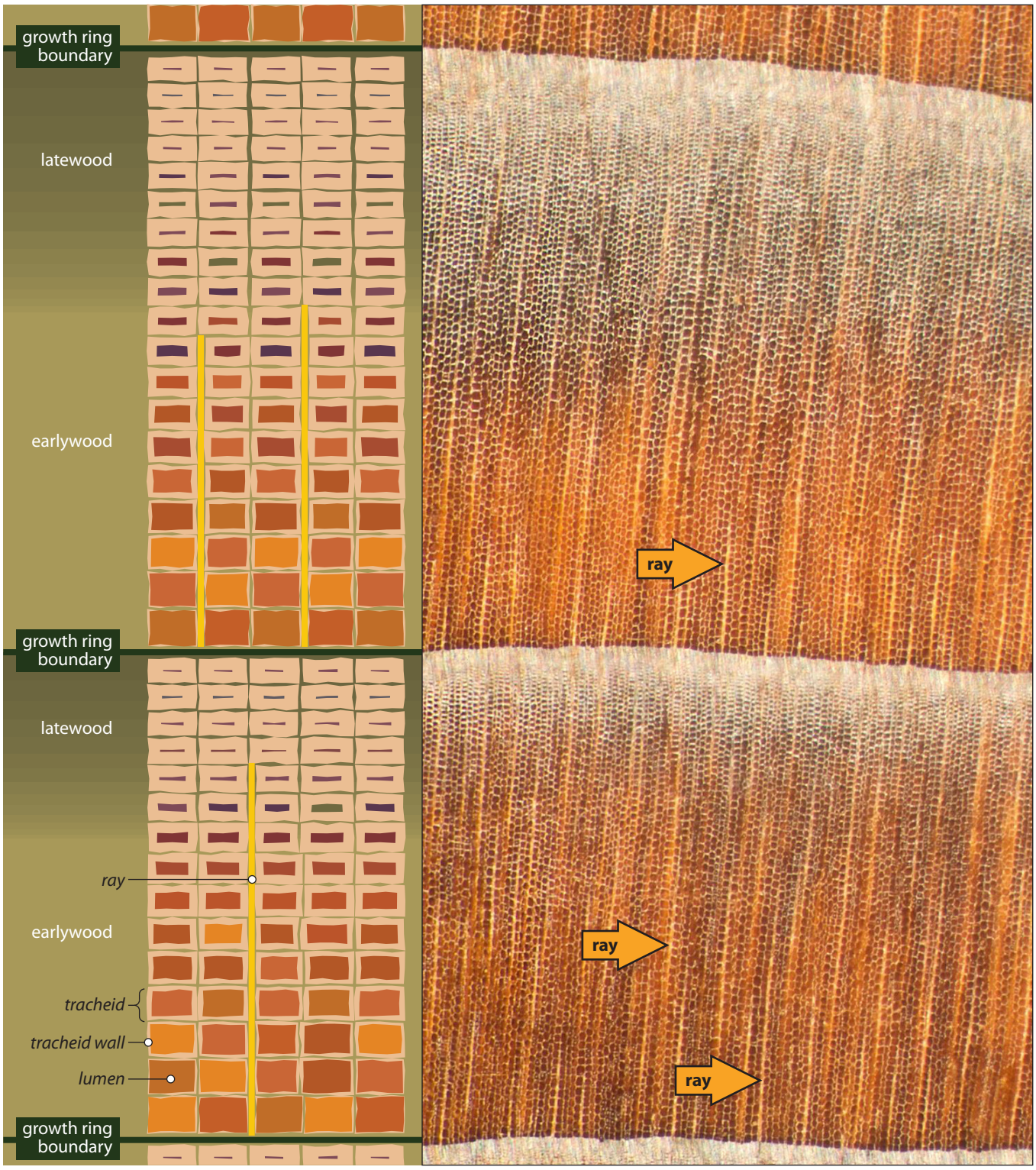

Figure 3-1. A cross-section of a growth ring of western red cedar (*Thuja plicata*); some of the tracheids and the rays are labeled. The tracheids have hollow centers called **lumens**, and these become smaller when the tracheid walls thicken as they make the transition from earlywood to latewood. Note how the tracheids are arranged in neat rows perpendicular to the growth ring boundaries.The rays look like bright lines in this micrograph, and they also run perpendicular to the growth rings; you are really looking at the sides of the ray cells as they extend outwards from the pith (which would be somewhere below the bottom of this picture).

hand lens.[3] To be concise, the words "**uniseriate**" and "**biseriate**" are used to refer to rays that are one cell wide and two cells wide, respectively, and for wider rays the term **multiseriate** is used. Many hardwood species have both narrow rays and multiseriate rays that are wider and easier to see. (In any event, a microscope is needed to determine how many cells make up the width of a ray.)

Refer to the illustration of a sugar maple cross-section in Figure 3-2 for an example of a hardwood; as it happens, sugar maple (*Acer saccharum*) is one of those species that contains both uniseriate and multiseriate rays.

In hardwoods, earlywood and latewood are sometimes more difficult to detect because the fiber diameter doesn't change during the growing season; what changes (at least in some species) is the size and the distribution of the pores. In hard maple, however, the vessels are all about the same size and they are uniformly distributed across each growth ring. There is no way to point to some part of the growth ring and state that "this is earlywood" or "this is latewood" based on the appearance of the growth ring. This isn't true for all hardwood species, however. To illustrate my point, look at the photograph of white ash in Figure 3-3. White ash earlywood and latewood have distinctly different pore sizes—the earlywood pores are much larger than the latewood pores—and the proportion of the space occupied by the earlywood pores is significantly greater than that taken up by the latewood pores. This is different from the maple specimens shown above, where everything looks more uniform.

The important thing to remember is that, if a sample has vessels (pores), it's a hardwood species. Don't get confused by the fact that different hardwood species can have different pore sizes and pores distributions.

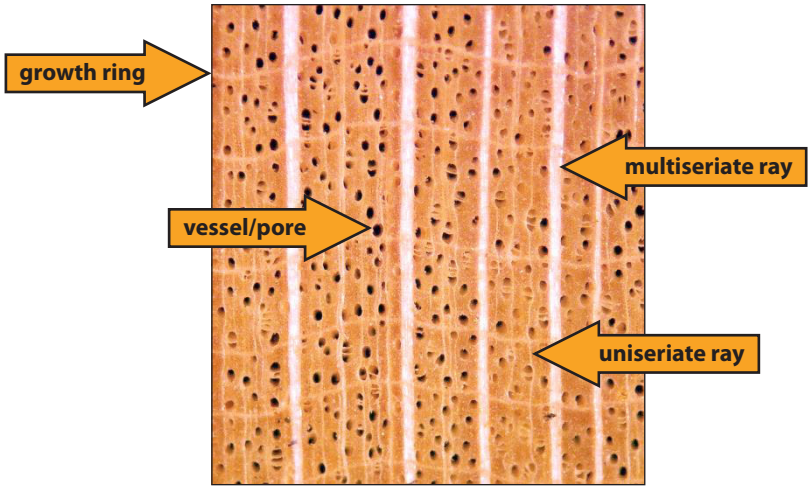

Figure 3-2. This illustration shows several growth rings of sugar maple (*Acer saccharum*) as they would look at about 20X magnification; the growth rings are marked by the thin, irregular bands of light-brown tissue in this micrograph. Pores and rays can be readily observed. The blank-looking reddish-brown space in-between the pores is filled with fibers (too small to distinguish at this magnification). Micrograph by Larry Osborn.

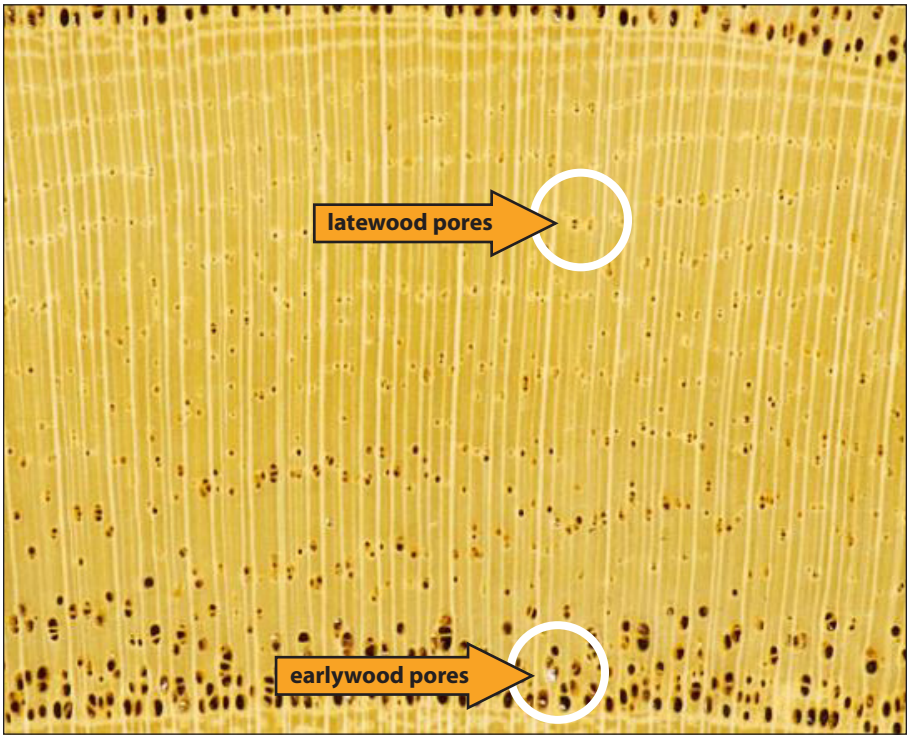

Figure 3-3. The earlywood of white ash (*Fraxinus americana*) has large pores that occupy a high percentage of the wood volume. The pores in the latewood are much smaller and less numerous.

3 In a few softwood species the rays can be two cells wide, but this is unusual enough that, when present, the ray width is noted and used as a diagnostic feature for identification with a microscope.

Unconfusing Yourself: Distinguishing Softwoods from Hardwoods

Deciding whether or not vessels are present is a common point of confusion for many people when they begin to look at magnified images of wood; they're often unsure whether they're looking at softwood tracheids or vessels, especially when they're trying to tell the difference between a softwood and a hardwood where all the pores are about the same size, like maple.

Let's assume for the moment that you're looking at a cross-section with a hand lens, and you see a lot of "holes." Are those holes on the cross-section separated or are they adjacent to each other? Tracheids are always side by side, and they're arranged in rows that are parallel to the rays. On the other hand, vessels/pores are mostly separated from each other, particularly in the direction perpendicular to the rays. Compare the two species in the photographs below (Figure 3-4):

Softwood **Hardwood**

Figure 3-4. A softwood, eastern hemlock (*Tsuga canadensis*), is on the left, and a hardwood, sweetgum (*Liquidambar styraciflua*), is on the right (same magnification). In sweetgum, all the vessels are about the same size. Notice how the tracheids in the softwood occupy essentially all of the cross-section area and are lined up in neat rows parallel with the rays. This is very different from the hardwood, where the pores occupy a smaller fraction of the growth ring and are much larger than the adjacent fibers (which you can't even distinguish). (The micrograph of sweetgum actually encompasses a couple of growth rings, whereas there is only one growth ring in the eastern hemlock micrograph. This is only an indication of the growth rate for these samples, and it doesn't represent species characteristics.)

The pores in hardwoods aren't always as close together as they are in the sweetgum example above. Compare that photograph to the one of sugar maple presented earlier, and you'll quickly notice that the sugar maple pores are more widely scattered. This is something to notice, but by itself the pore spacing has no diagnostic value.

Summary

To decide whether the sample you're looking at is a hardwood or a softwood, look for the presence of vessels/pores on the cross-section. If you find them, you're examining a hardwood. Pores may be present in different sizes, and it's important to distinguish them from tracheids. Take note of additional features; the appearance of rays to the naked eye or under a hand lens, for example, may be useful information as you continue your examination.

Vocabulary

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

1. Tracheids
2. Uniseriate
3. Biseriate
4. Multiseriate
5. Vessel
6. Vessel element
7. Pore
8. Porous wood
9. Fiber
10. Cross-section
11. *Juniperus virginiana* (eastern redcedar)
12. *Morus rubra* (red mulberry)
13. *Prunus serotina* (black cherry)
14. *Quercus alba* (white oak)
15. *Sequoia sempervirens* (redwood)
16. *Acer saccharum* (sugar maple)
17. *Fraxinus americana* (white ash)
18. *Sequoia sempervirens* (redwood)
19. *Liquidambar styraciflua* (sweetgum)
20. *Tsuga canadensis* (eastern hemlock)
21. *Fagaceae* (the family name for the oaks and for beech)
22. *Juglandaceae* (the family name for black walnut)

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