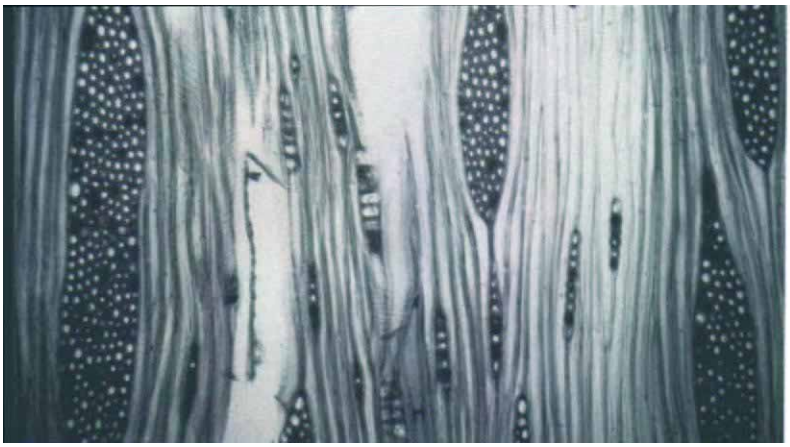


Left: *Soft maple's grayish cast may distinguish it from hard maple's creamy white to light reddish-brown color, but a microscopic check is reliable. Magnified 10 times, hard and soft maples look similar. The rays in this red maple sample (soft) look like fine, evenly sized and evenly spaced lines.* ***Far left:*** *Magnified 250 times, you see that ray width (seriation) is up to eight cells wide in this sugar maple sample (hard). Rays are only up to five cells wide in soft maple.*

Adventures of a Wood Sleuth

Making a positive ID settles each case

by Bruce Hoadley

When I was a student majoring in wood technology, I accepted my wood anatomy and identification curriculum as just one more of the many academic requirements for professional competence. I knew my wood-identification skills were important in many phases of wood technology, but I gave little thought to ever using this expertise outside my chosen field. During these subsequent years, however, I have been fascinated by the parade of wood-identification problems that have come my way from all walks of life. Of the calls and letters I receive asking for assistance in identifying wood, only the occasional inquiry is directly related to my own profession as a wood technologist and then it usually involves some routine problem in lumber sales or manufacturing technology. Most of the requests come from the unrelated fields of science, commerce and law. In some cases, identifying the wood is the only matter of concern; in others, identifying one or more wood samples is but a small piece of a much larger and more complex problem.

The anecdotes that follow are offered as a sampling of the surprising breadth of wood-identification applications in the real world. They also serve to illustrate a few of the principles, techniques and anatomical features that are involved in identifying wood.

Commercial lumber questions—As might be expected, disputes between vendors and customers concerning the species of hardwood or softwood lumber arise from time to time. If I were to single out the most frequent controversy in this category, it would be whether soft maple has been substituted for hard maple in a lumber shipment.

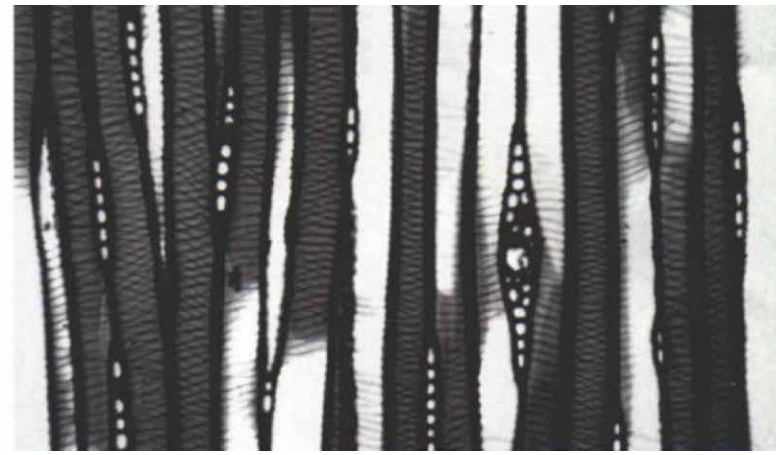
Typically, the customer suspects that the lumber is not hard maple because an unusually large number of pith flecks is evident on the tangential surfaces of boards after they are dressed. Pith flecks are found regularly in soft maples (shown in the above, right photomacrograph); however, they are occasionally numerous in hard maple, Therefore, hard and soft maples are separated more reliably by examining the rays with a microscope (see the above, left photomicrograph), rather than with a hand lens.

In one instance, I examined a total of 12 tangential sections from 3 boards, and the largest rays were 4 and 5 seriate (the width of rays measured in cells). Only 2 rays were 6 seriate, and gray-colored mineral streaks were also evident. Therefore I concluded that the lumber was indeed soft maple, as claimed by the customer. In all other instances of this hard vs. soft maple controversy, however, I was able to find many rays that counted 8 or more seriate in every tangential section sampled, indicating that the lumber was hard maple, as claimed by the supplier.

Another commercial-shipment question stands out in my mind because of the personal embarrassment it caused me. In the midst of a busy day, I received a call from an engineering firm that was participating in the renovation of a large warehouse. Douglas fir *(Pseudotsuga menziessi)* had been specified for the structural posts, but upon receiving the shipment, the firm suspected that another species had been supplied.

The project was on a tight construction schedule, and before proceeding, the contractor wanted confirmation that the timbers were Douglas fir. I assured the caller that checking for Douglas fir was a simple matter and that I would be happy to do so as soon as samples were sent to me. Unfortunately, all I said was "samples," without specifying their size. For the next two days I awaited delivery, but none came. Finally, on the third day, a trucker appeared at my office with a dolly laden with 20-in. lengths of 12x12s. I felt myself flush with embarrassment as I realized the unnecessary time and cost of shipping such large chunks when I only needed splinters, which could have been mailed in an envelope.

In examining the pieces, the reason for concern became obvious. The wood didn't look much like Douglas fir. Some pieces (like the one in the left photomacrograph on the facing page)



Right: *This slow-growth Douglas fir endgrain, magnified 10 times, shows narrow, inconspicuous latewood, giving an even-grained appearance. Normal-growth Douglas fir has uneven grain from wider growth rings and conspicuous latewood,* ***Far right:*** *Magnified 150 times, you can see Douglas fir's spindle-like fusiform rays, which contain single horizontal resin canals, and spiral thickenings in longitudinal tracheids (the main cell type in softwoods).*

were so slowly grown—there were 80 rings per inch in a few portions—that they appeared even grained, lacking the usual distinct, uneven-grained rings so characteristic of Douglas fir. The heartwood color was more yellowish brown than the familiar reddish brown of Douglas fir heartwood, and some of the pieces had only a trace of the characteristic Douglas fir odor.

Nevertheless, tangential sections examined microscopically confirmed that every piece was Douglas fir. Each sample had spindle-shaped fusiform rays (shown in the above, left photomicrograph) and abundant spiral thickenings (helical ridges along the inner surface of the cell wall) in the earlywood tracheids (non-living cells that function as food conductors and give support), as shown in the above, right photomicrograph. In reporting the results, I assured the firm that the wood was the correct species, but urged that the material be checked to determine whether the structural grade requirements had been met. Since then, I have been very careful to give clear instructions regarding the size of samples to be submitted for identification.

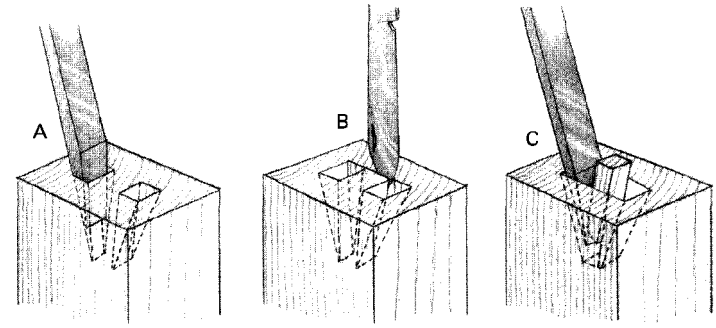
Identifying wood in furniture—Compared to identifying a single sample of wood or even a series of 20 or 30 samples, checking all the woods in a major furniture collection is a challenging task. Such an assignment presented itself when I was invited to assist in identifying more than 200 pieces of case furniture in the Garvan Collection and related collections at the Yale University Art Gallery. Here the task had an added challenge: the samples had to be taken inconspicuously and with a minimum of damage to the objects. I had to read as much as possible from the surface characteristics of the wood and assess such physical features as weight, color, evenness of grain and prominence of rays. Fortunately, woods such as beech or oak have conspicuous rays, and old stain or paint can actually help highlight ray size and distribution.

In sampling primary woods (the visible exterior woods in a piece of furniture), small fragments can be removed from an inconspicuous spot, such as under a glide caster on the bottom of a foot or under a drawer lock at the edge of the original mortise. Using the methods shown in figures 1 and 2, it was often possible to inconspicuously remove the necessary section for microscopic examination directly from the piece at a point of wear or minor damage, and it was sometimes possible to take tiny sections directly from the inside faces of shrinkage checks, which usually occur precisely along a radial plane.

The routine in surveying a piece of furniture is first to decide visually which components are of the same wood, and then to establish a sampling plan to microscopically verify a representative number of samples of each apparently different wood type. Although microscopic checking most often simply confirms the initial visual identification, occasional surprises do turn up.

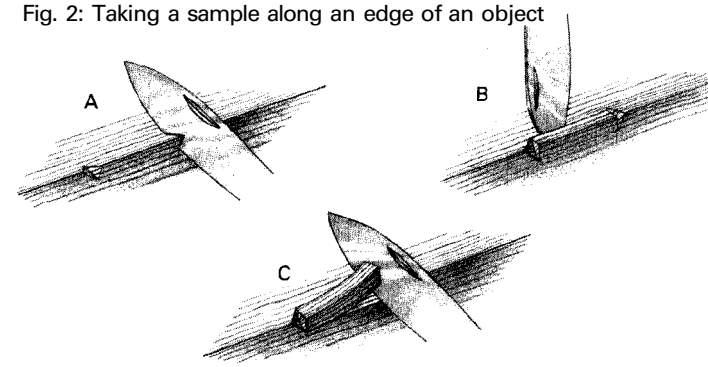
For example, I quickly glanced at the side panels in a chest and thought they were hard pine because of obvious uneven grain. I decided to examine a radial microscopic section for confirmation and, anticipating hard pine (shown in the top, left photomicrograph on the next page), expected to see dentate ray tracheids (which appear like uneven cell walls with tooth-like projections that reach into the cell cavity) and pinoid cross-field pits (which are multiple, variably sized oval- to football-shaped pits that are elongated diagonally across the field). I was startled to find myself staring at hemlock, like that shown in the top, right photomicrograph on the next page, which has smooth-wall ray tracheids and cupressoid cross-field pits (which are oval with oval apertures that are narrower than the border on either side). I had followed my intuition and had failed to check for resin canals, which are a hallmark of pine. Resin canals are easy to see with a hand lens and

Fig. 1: Taking a sample from an endgrain surface



To remove a sample from an endgrain surface, first use a narrow chisel to make a pair of wedge-shaped parallel holes (A), Use a thin knife blade to connect the walls of the two holes and define the sample (B). Finally, use the narrow chisel to undercut and pry out the sample (C).

Fig. 2: Taking a sample along an edge of an object

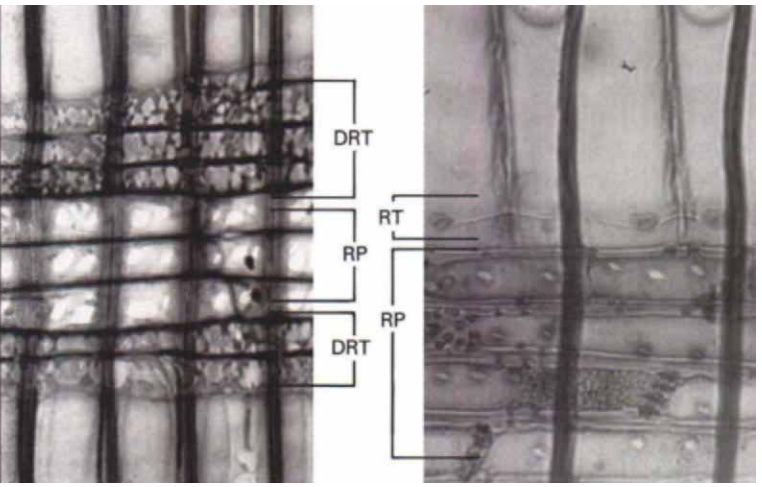


To remove a small sample from the edge of a board, first use a knife to notch a pair of stop cuts (A). With the knife tip, score the edges of the sample to guide the split (B). Finally, engage the knife edge in the bottom of one of the stop cuts and gently pry the sample free with a slight twisting motion of the knife (C).

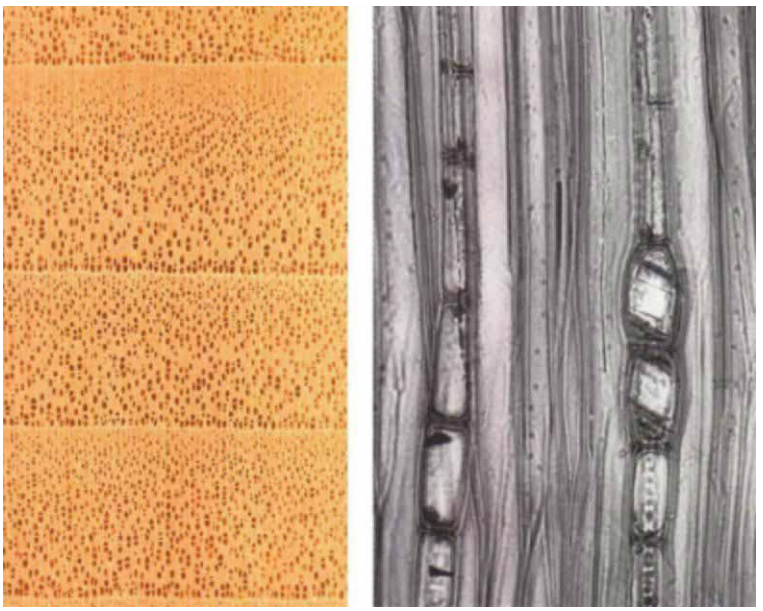
they were not present. Catching these occasional surprises is a sobering reminder that visual impressions alone can be quite deceptive and that microscopic follow-up is a comforting safely net.

The Garvan Collection experience made me especially alert when identifying woods with surface features obscured by old finish, stain or accumulated dust and dirt. A painted Windsor chair is the ultimate test in wood identification. The layers of earlywood pores in ring-porous species such as oak and ash are usually detectable, and the conspicuous rays of oak and beech will often show through even the muddiest of finishes. The diffuse-porous hardwoods are especially deceptive and sometimes impossible to identify.

Maple, and particularly soft maple, was perhaps the most commonly used wood for turnings, so it is usually assumed that legs and similar turnings are maple. But a surprising number are not.



Left: *Under 275-power magnification, you can see Southern yellow pine's uneven-wall, dentate ray tracheids (DRT), which are found in all species of hard pine. It also has oval or football-shaped pinoid pits in the ray parenchyma (SP).* ***Right:*** *This photomicrograph of Eastern hemlock, magnified 550 times, shows the smooth-wall ray tracheids and oval-shaped cupressoid cross-field pits in the ray parenchyma.*



Left: *Quaking aspen's rays are so fine that they are nearly invisible when you look at them with a hand lens; in fact its rays are uniseriate (a single cell wide).* ***Right:*** *This photomicrograph (magnified 250 times) shows crystals in the longitudinal parenchyma cells in black walnut.*

Microscopic examination of a tangential section normally puts the question to rest. For example, the stout turned legs of 17th-century chairs are often found to be aspen (shown in the bottom, left photomacrograph), as quickly revealed by its thin uniseriate rays.

Perhaps the greatest single surprise in the case furniture of the Garvan Collection was a chest that had been labeled butternut. It certainly looked like butternut in surface color and figure. But the routine microscopic sampling paid off, as the sections revealed gash-like pitting on the radial walls of the vessels and large crystals in many of the longitudinal parenchyma cells, shown in the bottom, right photomicrograph. These features reliably confirmed black walnut.

Lawsuits—I have been a consultant and expert witness in lawsuits in which wood or wood products were involved and wood identification was in some way critical to the outcome. The most difficult single problem that I have ever encountered resulted from an accident in which a window washer fell when his ladder suddenly broke. The man suffered head injuries that left him permanently incapacitated.

The ladder was sold as having hemlock rails. I identified one rail as Western hemlock, an acceptable species for ladder rails. The other was apparently fir, individual species of which are usually considered indistinguishable on the basis of wood tissue alone. Confusingly, the ladder code allows noble fir *(Abies procera),* but not other species, and so it became critical to know which fir species was used.

Crystals in the ray parenchyma cells were extremely sparse. Fortunately, I remembered a journal article on work done at Forintek Laboratory in Vancouver, B.C., Canada, that established a correlation between the ray-parenchyma crystal count and various fir species. I made crystal counts and then consulted the paper. The low number suggested that the wood was not *A. procera,* but probably *A. amabilis* or *A. lasiocarpa.*

As a check of my own work, I submitted a sample of wood to Forintek Laboratory. Their findings were similar. Next, 1 tried a color spot test that gives a purple coloration on subalpine fir *(A lasiocarpa),* but not on Pacific silver fir *(A. amabilis).* The wood sample from the ladder gave no reaction. Ray-cell contents are reported to be clear or pale yellow in A. *balsamea* and *A. lasiocarpa,* but dark brown in other Western firs. The contents of ray cells in the questionable ladder rail were dark brown.

I concluded that the ladder rail was probably Pacific silver fir, and that its extremely low density (0.25 specific gravity) and weakness were principal contributing factors in the ladder's failure.

Just for fun-Wood identification need not always be serious or important. For a change of pace, I sometimes find myself identifying wood just for fun. This is not to say that the task is always successful or easy.

A friend once dropped off a small sack of assorted woods to "check out when you get a minute." When time permitted, I laid them out on my bench. I didn't recognize a single one. With a razor blade I cleaned up an endgrain surface on each for a closer look with a hand lens, They were all hardwoods, but strangers every one. A few looked like dipterocarps, perhaps lauan or meranti. I called my friend to ask him the source of such an exotic assortment. The reply was that they were crating boards from a Japanese motorcycle. I threw in the towel. □

Bruce Hoadley is a professor of wood technology at the University of Massachusetts in Amherst and a contributing editor to FWW. *Photos by author. This article is adaptedfrom his new book,* Identifying Wood, *published by The Taunton Press, 63 S. Main St., PO Box 5506, Newtown, Conn. 06470-5506.*