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Making Excellent Thin Sections for Wood Identification: A Quick and Easy Method—Part II

ABSTRACT—Making thin sections by hand for microscopic wood identification is a precise exercise with often frustrating results. With microtomes being out of reach for most private conservators, it is difficult to produce good sections that include all desired information. Poor sections result in poor analysis, hence the need for an improved method.

This article explores one such method that has had excellent results. The technique combines a resin (developed for making fish lures and currently also used for forensic analysis), an embedding method for cross sectional stratification analysis, and sectioning with a simplified microtome. The method has three major advantages over conventional systems: it is fast, inexpensive (using simple tools and materials), and reliable, generating thin sections that are large enough for wood identification.

1. INTRODUCTION

This article is the second of two parts and delves into the development of a technique to make excellent thin sections for wood identification. The first part, by Randy S. Wilkinson, introduced reasons for needing a better technique.

The ideal sample for wood identification is thin, even, and includes all desired information, such as a complete annual ring. It should also be exactly transverse, radial, or tangential. Figure 1 shows an example of a section made with the hand microtome method that this article describes and that meets all of the preceding requirements.

Unless one has access to (and experience with) a microtome, one would section by hand. Hand sectioning has two major benefits: it is inexpensive and fast. However, depending on one's skill level, it is hard to make sections that are thin and even. When making a thin section, one often needs multiple slices to make up the complete picture of an entire annual ring, vessel perforation plates, parenchyma patterns, and so forth. There are multiple techniques for holding the material and the blade, but they all take quite a bit of practice to make good sections.

With a rotary microtome, one can make larger sections that are very even. However, microtomes are an expensive purchase and require sample embedding (and rinsing), experience with operating it, and specialized sharpening of the blades. A hand microtome may aid in guiding and steadying the blade, but most hand microtomes that are sold commercially have a large opening and still need a system for holding a wood specimen down and steady while making a cut (fig. 2). A wide variety of blades can be used with a hand microtome, from large old-fashioned razor blades to single- or double-edge razor blades, or a chisel.

Considering that the premise of a low-tech way to guide the blade and obtain larger sections was interesting, a better version of a hand microtome was developed. There were two areas that could use improvement for this purpose. First, the specimen embedding method needed to be fast and clean, and preferably not require rinsing of the sample. Second, the opening in the specimen holder needed to be much smaller. The right type of cutting blades was a third consideration.

2. EMBEDDING RESIN

Embedding a sample before sectioning ensures the proper shape for clamping and mounting in a microtome and can also help reduce fraying or breaking of more fragile material.

It turned out that the Tuffleye embedding resin we currently use for preparing samples for cross sectional stratification analysis is soft enough to be cut with a razor blade after curing. The embedding method with Tuffleye was developed by James Martin, then at Orion Analytical LLC but currently at Sotheby's as director of scientific research. The Tuffleye resin is a blue light (not UV)-cured acrylic resin (aliphatic urethane methacrylate blend) that sets in 10 to 30 seconds. The resin was developed for making fish lures but has had attention in the forensic field because of its quick cure time and clear color (Groves and Palenik 2016). The specimen is mounted on the cap of a bullet-shaped plastic embedding capsule, after which the capsule is filled up completely and cured with a blue light (fig. 3). The shape of the capsule and the insertion of the syringe tip in a narrow hole at the top aids in spreading the resin. Because the small hole is closed off by the syringe, the resin is forced all around the specimen, decreasing air bubbles. Curing the resin-filled capsules on a mirror can help distribution of the blue light. Once the resin is cured, the embedded sample can usually be removed by pushing it out with the aid of a skewer, saving the capsule for future use. Alternatively, the capsule can be cut open

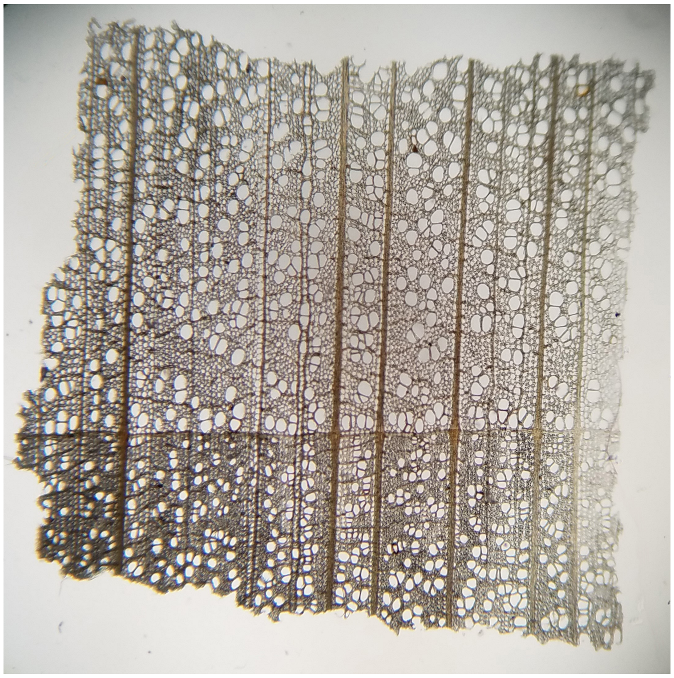

Fig. 1. Thin section made with hand microtome, basswood, transverse, 40x.

with a razor blade. The residual stickiness on the surface of the embedded samples can be wiped off with ethanol. Even wood that was damp after boiling until it sank could be embedded without a problem.

For smaller specimens, usually radial and tangential orientation, multiple sections of the same orientation can be glued together with superglue to form a stacked specimen. This will provide more volume and prevent the specimen from getting dislodged from the resin during slicing. If multiple blocks are not available, one can superglue any other orientation or species, such as a section of bamboo skewer, to the specimen to provide sufficient length and volume for secure embedding.

As with a rotary microtome, it is very important to have the orientation exactly right. Once the wood sample is embedded, the orientation cannot be changed. It is therefore prudent to be extremely precise during the embedding process to have one of the three orientations as perfect as possible.

3. HAND MICROTOME

Having found a satisfactory, quick way to embed the samples, a hand microtome was developed that would fit the cylindrical-shaped samples. The first prototype of a homemade hand microtome used a regular 5/16 in. coupling nut for connecting threaded rods. One side was drilled out to remove the threads. The cylindrical embedded specimen fit in it well, but nothing prevented it from being lifted up when slicing. In addition, the thread of the screw to turn up the specimen was too coarse, making it hard to accurately and consistently produce an even slice. A coupling nut with a finer machine thread was not a significant improvement. The bolts also had too much slack to stay stationary during slicing (fig. 4).

Fig. 2. Example of a commercially available hand microtome.

Fig. 3. Embedding wood specimens in plastic capsules with the Tuffleye Core embedding resin.

Fig. 4. Different prototypes for a hand microtome, made out of coupling nuts.

Next came a smooth shaft coupling, used for connections in machinery (fig. 5). A small micrometer was mounted on one end, whereas the other side held the specimen. Turning the knob on the micrometer advanced the specimen in a controllable and measurable way. A pair of set screws on either end of the coupling provided stability of the micrometer as well as the sample. The coupling was made of stainless steel—a more durable cutting surface than aluminum. The small cutting table avoided unnecessary dulling of the razor blades. This new model proved to be much more controllable as far as sample advancement and security within the holder. It was fairly easy to produce multiple large slices that were extremely thin and even.

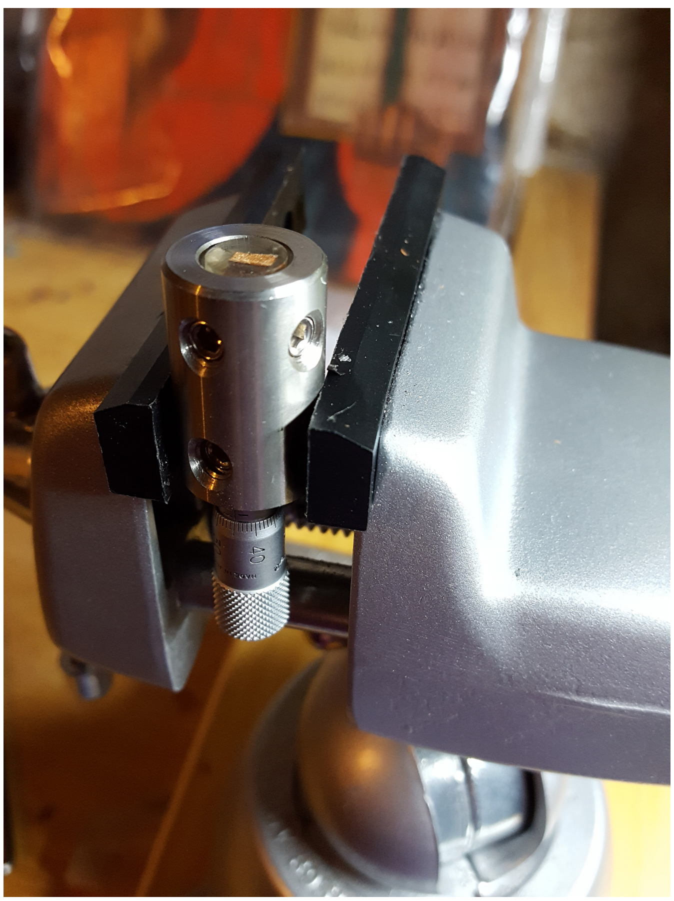

Fig. 5. Final version of the hand microtome, made with a small micrometer and a smooth shaft coupling.

4. BLADES

Another consideration while developing the method were the blades to cut the thin sections. Both the regular and more expensive razor blades from a hardware store did not last. They dulled very quickly and sometimes did not even make a clean cut straight out of the box. The results were often unsatisfactory with ripped or distorted sections. The Forest Products Laboratory in Madison, Wisconsin, uses GEM blades, which were a great improvement as far as being—and staying—sharp. GEM and PAL are well-known brands that produce several types of blades for different scientific applications. The GEM PTFE (polytetrafluoroethylene [or Teflon]-coated) single-edge blades that slide through the resin easily became a favorite. For transverse sections, especially harder woods, the heavy-duty carbon steel blades sometimes produced a more even thickness and a cleaner cut. Although it was easier to hold the blade in a razor blade holder, it did not allow for a sufficiently low cutting angle.

A dedicated, well sharpened chisel still needed occasional sharpening and in general was not an improvement over the hardware store razor blades. A regular utility knife blade was nice and rigid but not sharp enough, whereas flexible double-edge razor blades were so flexible that the sections would be "scooped" out of the resin, producing slices that were markedly thicker in the middle.

5. SLICING

The best practice for slicing was to apply a drop of water with a pipet and use a sideways slicing motion to cut a section. A smooth sweeping motion rather than a sawing action yielded the best results. Once a clean-cut surface was established, the micrometer would advance 50, 75, or 100 µm, depending on the hardness of the wood and the grain direction. Before slicing, it was necessary to tighten the set screws on the side of the specimen to keep it from being lifted up during slicing. One can divide the blade in three sections by writing numbers 1 through 3 on them with a permanent marker and only use each section for one or two slices. This way, one does not use an already dulled portion of the blade.

The literature suggests 15 to 25 µm for a good wood section (Schoch et al. 2004). However, even the 50-µm advancement would usually not allow for a proper cut. Despite the larger advancement of the micrometer, the sections had the correct thickness for wood identification.

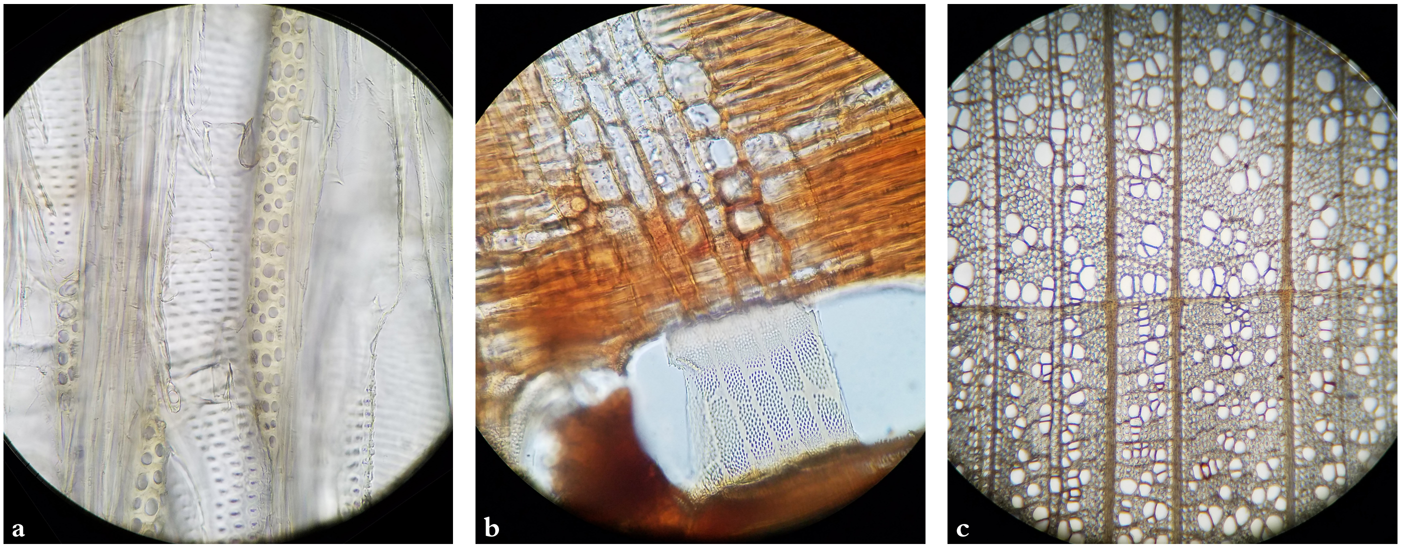

Fig. 6. (a) Poplar, tangential, 40x. (b) Mahogany look-alike, radial, 40x (note the particularly nice example of ray-vessel pitting). (c) Basswood, transverse, 10x.

6. ALTERNATIVES

When sample size and location are not an objection, an 8-mm plug cutter can be used to make a cylindrical specimen in tangential, radial, or transverse orientation. This saves the time to embed the samples, but one can still use the hand microtome to guide the razor blade and make sections. There is more wood loss, however, and the correct orientation would need to be checked before drilling. The cylinder can usually be removed from the substrate by wiggling it until it breaks at the base rather than cross cutting it with a saw.

Paraffin is the most common embedding medium for samples in preparation for slicing on a microtome. However, paraffin is messier, leaving wax slivers all around the cutting area in addition to a waxy residue in the sections. The residue needs to be removed by several solvent rinses, which adds extra steps and time to the process. If not properly removed, the residue presents itself as gray matter in the cell cavities. Another disadvantage of the paraffin is its softness, allowing a more flexible blade to dig too deep and produce sections that are too thick, especially in the middle. A heavy-duty, thicker blade yields better results.

7. PREPARING THIN SECTIONS FOR VIEWING

Once several good sections were cut, they were prepared for mounting on a microscope slide. First, the sections were removed from the surrounding embedding resin with a needle or scalpel blade, leaving only the specimen on the slide. They were all rotated to have the same orientation on the slide, making it easier to scroll through them during viewing.

A cover slip was laid over them, and a small drop of ethanol/glycerin (1:1 ratio) was wicked under the slip. Air bubbles were subsequently boiled off on a hot plate. Making a simple U-shaped aluminum foil tray for the slides aided in easy removal from the hot plate without burning one's fingers.

Alternatively, one can mount the sections more permanently in Cytoseal 60 or 280.

Figure 6 shows a few examples of sections made with the hand microtome: a tangential and transverse section of poplar on either side of a radial section of a mahogany-like wood. The ray-vessel pitting in the middle section is a particularly nice example of the quality one can get with the hand microtome.

8. LIMITATIONS

Although there are many advantages to using this method for making wood sections, there are a few limitations as well. The size of wood specimen is limited to the size of the embedding capsule, which is 8 mm (just under 5/16 in.) in diameter. Once embedded, the orientation of the specimens cannot be altered. Sections are still cut by hand, so some unevenness will remain, as compared with sections made with a rotary microtome. The method is not as fast as doing hand sections, and it is not as good as a rotary microtome.

9. ADVANTAGES

For the right application, the benefits outweigh the disadvantages.

The method is relatively quick. Embedding takes minutes, and mounting in the holder and slicing take just a few more minutes. All supplies are inexpensive and readily available. It is a reliable and easy-to-replicate process. It allows one to take smaller samples that can be useful once embedded, whereas they would be much harder to handle during conventional hand sectioning. Sections are larger, so there is less searching through multiple small sections. It is easier to compare features to a published microtomed section, as it is less obscured by air bubbles and variations in thickness. Sections are good enough to be photographed for reports or other publications.

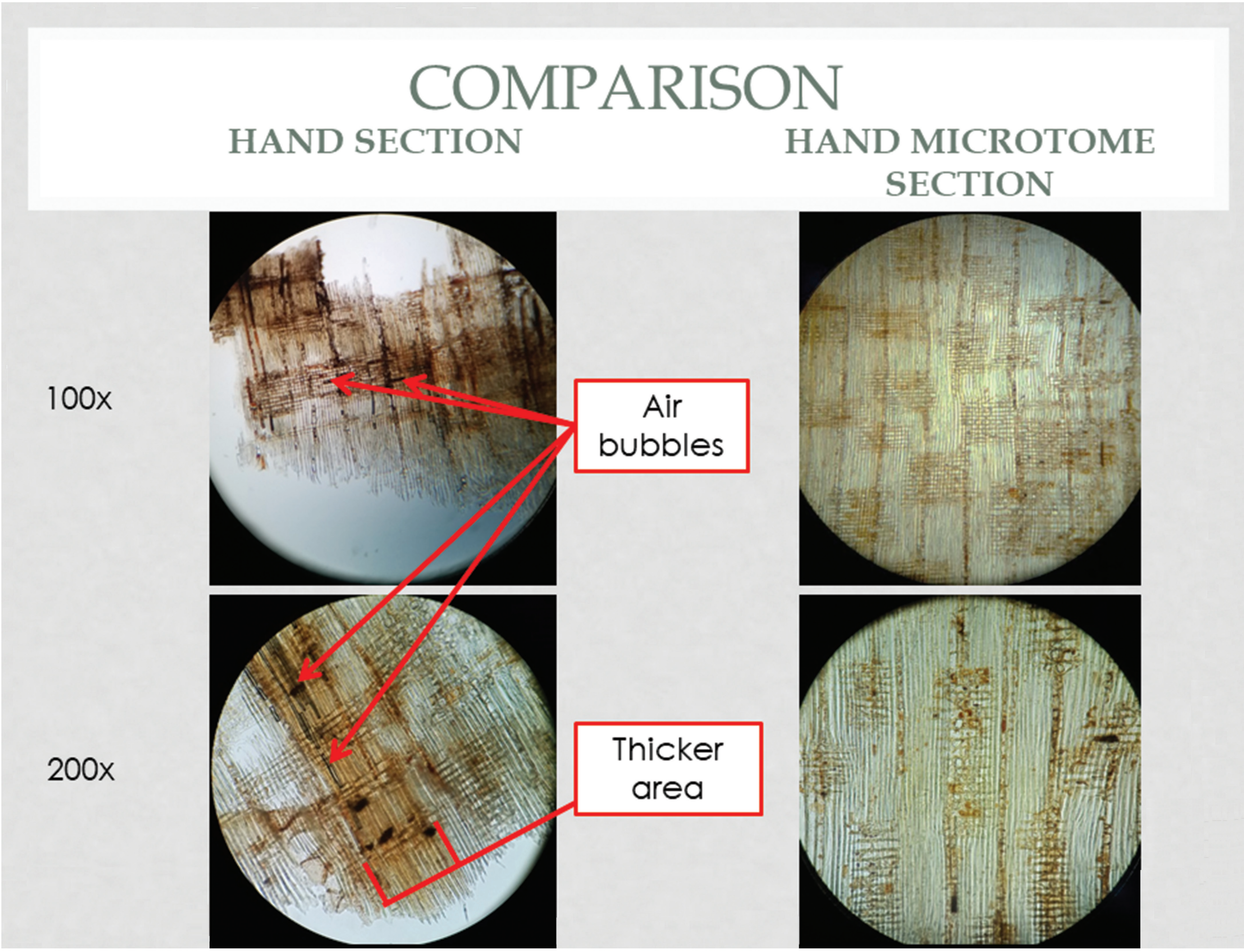

Fig. 7. Manchineel, radial, 100x at top and 200x below; cut by hand on the left and with the hand microtome on the right. Note the lack of air bubbles and more even thickness in the hand microtome sections.

Figure 7 compares a hand section to a section made with the aid of the hand microtome. Both the 100x and 200x views clearly show that the hand microtome section on the right is larger; it fills the view. It is in plane throughout the entire view. It has fewer air bubbles because it is even and thin. Finally, the images from the sections made with the hand microtome are of publishable quality.

10. CONCLUSION

This sectioning method has high potential for delivering larger and very even thin sections for wood identification and probably other identification techniques, such as textile fiber identification. It is relatively quick, easy, and inexpensive. The design of the hand microtome can be fine-tuned a little more, perhaps by having a better-fitting sleeve made by a machinist.

REFERENCES

Groves, E., and C. S. Palenik. 2016. "Applications of Blue Light-Curing Acrylic Resin to Forensic Sample Preparation and Microtomy." *Journal of Forensic Sciences* 61 (2): 489–493.

Schoch, W., I. Heller, F. H. Schweingruber, and F. Kienast. 2004. "Preparation of Wood for Microscopic Examination." Wood Anatomy website. Accessed August 27, 2019. http://www.woodanatomy.ch/preparation.html.

FURTHER READING

Hather, Jon G. 2000. *The Identification of Northern European Woods*. London, UK: Archetype.

Hoadley, R. Bruce. 1990. *Identifying Wood*. Newtown, CT: Taunton Press.

Snedden, A. "'Tuffleye' Instructions and Tutorials." Wet a Hook Technologies website. Accessed August 27, 2019. http://www.wetahook.net/page16/page16.html.

SOURCES OF MATERIALS

- Beem Embedding Capsules, Size 00, 100/pk $8.25 https://www.emsdiasum.com
- Climax Metals coupling RC031-S-4H, $15.50 https://www.Amazon.com
- GEM blades, PTFE coated, $23.00 for 100 blades https://www.emsdiasum.com
- Mitutoyo micrometer, MHT-6.5, 148-201, $8.00 https://www.ebay.com
- Wet a Hook Tuffleye Core, 30 cc, $21.95 https://www.shop.wetahook.net

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