GROWTH RING CONTRAST ENHANCEMENT AND THE DIFFERENTIATION OF SAPWOOD AND HEARTWOOD ZONES

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ABSTRACT

A simple technique for growth ring contrast enhancement and the differentiation of sapwood and heartwood zones is described. A dried wood specimen was smoothed and wetted before the image of the growth rings and the boundary between the sapwood and heartwood was copied with a paper copy machine. The high contrast image of the growth rings and the sapwood and heartwood boundary was attributed to the capillary phenomenon of various sizes of cell elements and the difference of permeability between the sapwood and heartwood. This technique can be used for most species, and is especially useful for those species with a narrow latewood zone and without color differentiation between the sapwood and heartwood. This method is very helpful for data interpretation with various comparative studies of wood properties.

Keywords: Sapwood, heartwood, growth rings, differentiation.

INTRODUCTION

In forest inventory, counting the ring numbers and measuring the ring width are the two most routine and important parts of this work. In some species, especially those of diffuse porous woods, details of the growth ring are often obscure because of the lack of contrast.

In diffuse porous species, poor contrast of the growth ring can be traced to the anatomical structure of the earlywood and latewood zones. The uniform size of the vessel element across most parts of the growth ring prohibits the contrast between two growth rings. The zone of latewood is too narrow to stand out in contrast.

In most gymnosperms and angiosperms, the boundary of sapwood and heartwood can be differentiated by the color of the heartwood zone. However, in some species, such as black spruce and poplar, there is no color contrast between the sapwood and heartwood zones. The measure of the width of sapwood of these species becomes troublesome.

A simple technique is described based on the capillary phenomenon and the permeability of sapwood and heartwood for enhancing the contrast of the growth rings and the zones of sapwood and heartwood.

TECHNIQUE

1. Wood cores, strips or disks are smoothed with a sander with an 80 grit or finer sand paper to expose the cross-sectional surface.
2. If the specimen is dry, skip step no. 3.
3. If the specimen is green, place in an oven at 60 C overnight. More aspirated pits will be formed in the heartwood after this drying treatment.
4. Wet the cross-sectional surface of the specimen with a piece of wet towel.

5. Wait for a few seconds until the color of the heartwood zone turns to white (dries up).
6. Copy the image of the growth ring with a regular paper copy machine. Adjust the copy machine to obtain the maximum contrast.

OBSERVATIONS AND DISCUSSION

The image of the growth ring was clearly copied with a regular paper copy machine as shown in Fig. 1. The contrast of the growth ring was enhanced tremendously with the application of water; compare A (dried) with B (wetted). This method has been applied successfully in *Pinus strobus* L., *Pinus resinosa* Ait., *Pinus banksiana* Lamb., *Thuja occidentalis* L., *Abies balsamea* (L.) Mill., *Picea glauca* (Moench.) Voss., *Picea mariana* (Mill.) B.S.P., *Larix laricina* (Du Roi) K. Koch, *Populus balsamifera* L., *Populus tremuloides* Michx. and *Betula papyrifera* Marsh. The contrast of the growth ring on the copied image is even sharper than on the wood specimen itself. The paper copy machine picks up the difference in contrast because of different water levels within the various sizes of cell elements (capillary). The light differences due to different water levels can be sensed with a copy machine, but not the human eye. However, the quality of image may vary with the type of paper copy machine. In this study, a Royal 1803 ZMR copier,* which is capable of magnifying the image and equipped with 7 image density levels, was used.

In the past, a number of techniques had been reported for annual ring contrast enhancement. For example, Eisendrath (1938) used powdered anthracene on the surface of a wood block; Larson (1959) applied alumina powder on the surface of the wood specimen; Parker et al. (1976) used zinc oxide and 10% acetic acid solution for X-ray densitometry studies; and Douglass (1941) stated that cutting the wood surface 30° to the wood grain would produce a sharp boundary of the growth ring. However, the technique proposed here is a simple and nontoxic procedure. Moreover, the copied paper can be stored easily in a data file for further processing.

The application of water for the growth ring enhancement can also be used for the differentiation of sapwood and heartwood, especially for those species without color differences between the sapwood and heartwood. As illustrated in Fig. 1B, the boundaries of the sapwood and heartwood are clearly delineated (arrows). The outcome of sharp contrast between these two wood zones is due mainly to the different degree of permeability of these two types of wood. This result and phenomenon are the same as those reported by Keith (1977) and Wengert (1976), but with a different application.

The differentiation of these two wood zones can also be accomplished with the chemical composition of sapwood and heartwood, such as done by Cummins (1972), who used a modified Azo-dye test to separate *Pinus* heartwood from sapwood; Eades (1958), who applied chemical indicators to distinguish western hemlock sapwood and heartwood; and Barton (1973), who used chemical color tests for various Canadian woods; Behr (1974), used the ferric compounds to

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* Manufactured by Konica Business Machines, U.S.A., Inc., Windsor, CT, U.S.A. No endorsement for this product.

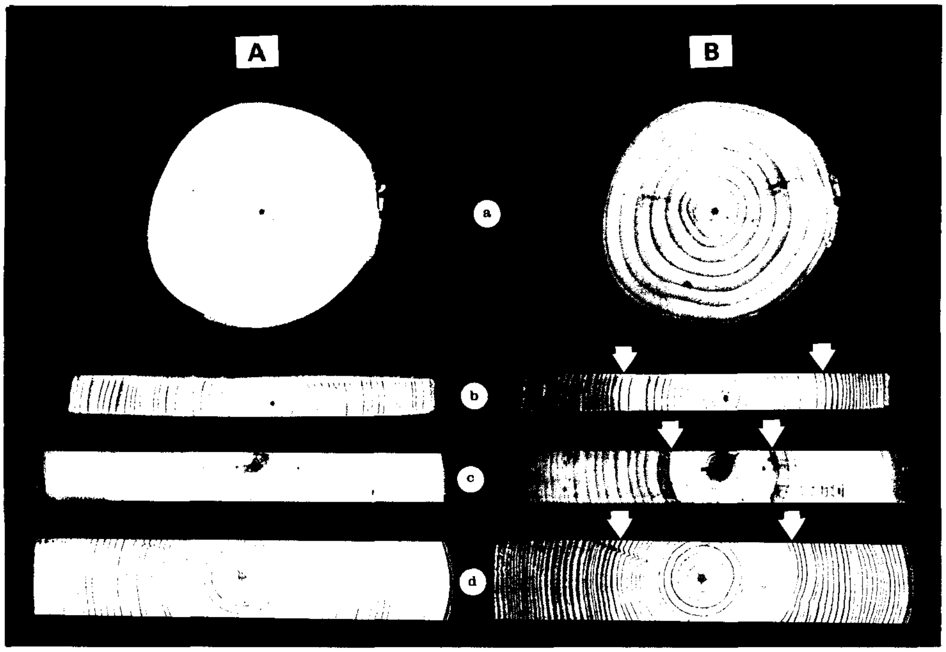

FIG. 1. The result of before (A) and after (B) water treatments. The arrows indicate the boundaries of sapwood and heartwood. a) *Populus tremuloides* Michx., b) *Pinus banksiana* Lamb., c) *Populus balsamifera* L., and d) *Picea mariana* (Mill.) B.S.P.

outline the sapwood–heartwood boundary of *Thuja occidentalis.* Kutscha and Sachs (1962) employed 21 chemical indicators to differentiate sapwood and heartwood of certain softwood species. Sandermann and Schmitz (1965) used the concrete-relief method based on the different chemical constituents and pH values between these two zones to differentiate sapwood and heartwood. Furthermore, Bamber and Colley (1983) used a histochemical test for sapwood and heartwood differentiation in *Pinus radiata,* based on the development of lignification of parenchymatous tissue surrounding the resin canals. However, the above chemical tests had one drawback: a specific chemical solution had to be prepared for a given species. No single chemical can be used to separate the sapwood and heartwood of most species. On the other hand, the proposed method of water application can be used for most species, regardless of their chemical difference between the sapwood and heartwood.

The novelties of this application are:

1. A higher contrast image of growth ring than that seen by the human eye can be obtained by using a paper copy machine. This higher contrast image on the paper can be handled easily for growth rate studies with a digital microcomputer.
2. This technique can be helpful in conjunction with other wood property studies. For instance, specific gravity and fiber length require the destruction of the original whole specimen which, in turn, destroys evidence of wood characteristics, such as compression wood, that are only readily evident when the spec-

imen is whole. The copied image preserves the appearance of the specimen for further examination after the specimen itself is long gone.

3. This method is valued mostly for data checking and interpretation with a large data collection and with various comparative studies of wood properties.

REFERENCES

Bamber, R. K., and R. L. Colley. 1983. A histochemical test for sapwood and heartwood in *Pinus radiata*. J. Inst. Wood Sci. 9(5):228.

Barton, G. M. 1973. Chemical colour tests for Canadian woods. Can. For. Industries. Pp. 57–61.

Behr, E. A. 1974. Distinguish heartwood in northern white cedar. Wood Sci. 6(4):394–395.

Cummins, N. H. O. 1972. Heartwood differentiation in *Pinus* species—A modified Azo-dye test. N.Z. J. For. Sci. 2(2):188–191.

Douglass, A. G. 1941. Note on the technique of tree-ring analysis, II. Tree-Ring Bull. 7(4):28–34.

Eades, H. W. 1958. Differentiation of sapwood and heartwood in western hemlock by colour tests. For. Prod. J. 8(3):104–106.

Eisendrath, D. B., Jr. 1938. On photographing the rings of oak specimens. Tree-Ring Bull. 5(1): 7–8.

Keith, C. T. 1977. A method for differentiating heartwood and sapwood in unseasoned timber. Bimonthly Res. Notes, For. Prod. Lab., Can. For. Serv., Ottawa 33(3):24–25.

Kutscha, N. P., and I. B. Sachs. 1962. Colour tests for differentiating heartwood and sapwood in certain softwood tree species. For. Prod. Lab., Forest Service, U.S.D.A., Madison, Wis. Rept. No. 2246.

Larson, P. R. 1959. Preparation of small wood blocks for photomicrography. Stain Technology 34: 155–156.

Parker, M. L., G. M. Barton, and J. H. G. Smith. 1976. Annual ring contrast enhancement without affecting X-ray densitometry studies. Tree-Ring Bull. 36(1):29–31.

Sandermann, W., and G. Schmitz. 1965. New methods of the differentiation of sapwood, heartwood and growth ring. Part I. The concrete-relief analysis. Holz Roh-Werkst. 23:221–227. Translated by L. Paszner.

Wengert, E. M. 1976. A quick method to distinguish aspen heartwood and sapwood. Wood Fiber 8(2):114–115.