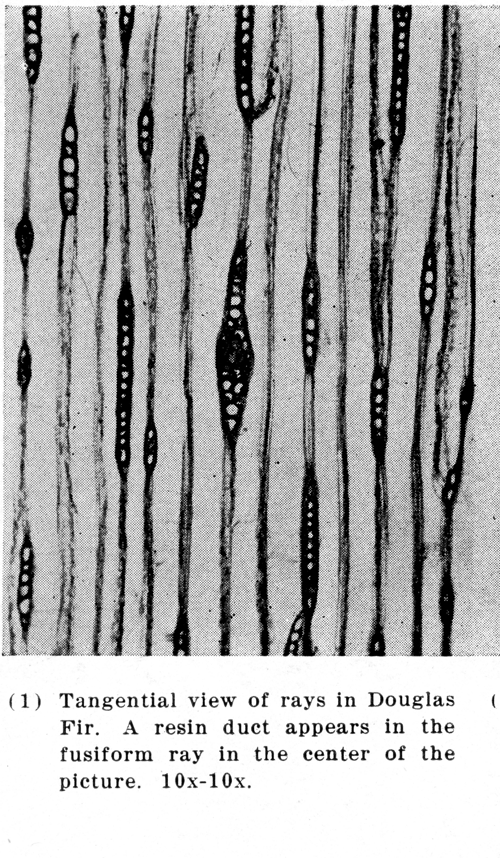
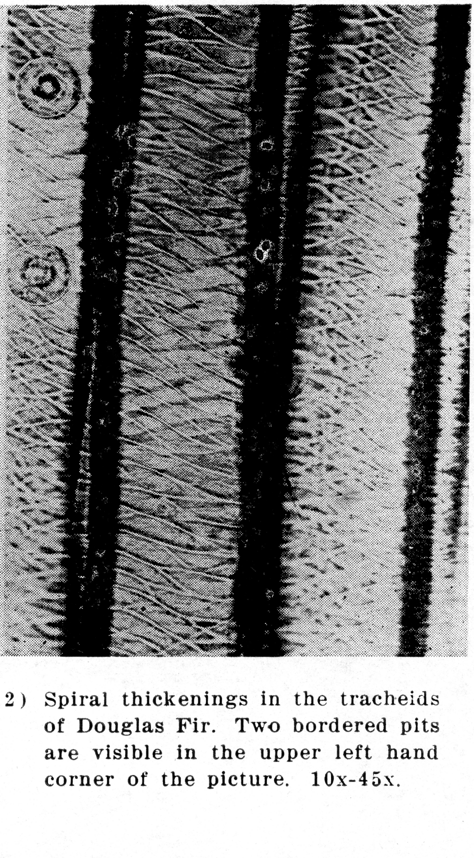
THE TECHNICIAN IN THE POLICE LABORATORY



(1) Tangential view of rays in Douglas Fir. A resin duct appears in the fusiform ray in the center of the picture. 10x-10x.



(2) Spiral thickenings in the tracheids of Douglas Fir. Two bordered pits are visible in the upper left hand corner of the picture. 10x-45x.

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This month's cover carries a photograph of (1) a tangential section of the wood of Douglas Fir (10x-10x), showing the vertical tracheids interspersed with medullary rays (cross sections of the latter). Spiral thickenings of the tracheids may be seen here and there. A fusiform ray (one containing a transverse resin duct,) is visible near the center of the field. (2) Shows at higher magnification (10x-45x) the spiral thickenings in this wood. A few bordered pits are visible in the field also. Hand sections, clarite mounts.

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Responsibility for all statements made in material published in this bulletin rests with the author of the particular contribution; neither that material nor the editorial comments appearing herein are to be considered as necessarily reflecting the views or opinions of the Missouri State Highway Patrol, nor the Laboratory of that Department.

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THE TECHNICIAN

Vol. 1, No. 10 - February-March 1944

CONTENTS

WOOD IDENTIFICATION PROCEDURES #II

By John E. Davis

Technician with the Laboratory of the Missouri
State Highway Patrol

ED. NOTE:

In the January issue of THE TECHNICIAN there appeared the first in this series of articles on wood-identification. The present discussion is a continuation of that article.

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Types of Wood Producing Plants.

There are a number of plants from which woody substance may be obtained, but generally speaking, all of that material which we know as "wood" is derived from those plants known botanically as (1) the Gymnosperms, and (2) the Angiosperms. These are the two classes of plants which concern us here --- accordingly a brief comment on the two is in order.

THE GYMNOSPERMS:

The word "gymnosperm" indicates "naked-seeded plants" and has reference to those plants which do not bear their seeds within a closed structure or fruit as the other seed-bearing plants do, but rather exposed, generally on the surface of a cone-scale. Almost all of the gymnospermae have narrow, needle-like or scale-like evergreen leaves, and bear cones. Such trees as the Pines, Firs, Spruce, Larch, etc. are of this type. Wood from the Gymnosperms is known to the wood-technologist as "softwood." This group, as will be mentioned later, forms one of the primary divisions of the woods as described in the "key".

THE ANGIOSPERMS:

The Angiosperms are those seed-bearing plants which produce their seeds within a closed structure as a pod, nut, berry, or other fruit. Under the Angiosperms, there are two sub-classes. These are (1) the monocotyledons (grasses, palms, etc.), and (2) the dicotyledons.* Both of these sub-classes include many varieties of plants, but only among the dicotyledons are there any true wood-plants. Such trees as the Elm (Ulmus), Ash (Fraxinus), Oak (Quercus), Chestnut (Castanea), Birch (Betula), etc. are of this type. Generally the plants of this group have broad leaves, as compared to the narrow needles and scales of the evergreens or Gymnosperms.

From this it should be apparent that the main concern in the identification of wood, is with the Gymnosperms (or softwoods) and the dicotyledonous Angiosperms. The latter are known as "hardwoods".**

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* In an article such as this, it is necessary that scientific terms be employed from time-to-time. The reader is urged not to "skip over" such terms merely because they cannot be pronounced at sight, are large, have a Latin derivation, or otherwise lack immediate significance. If such material is to be meaningful, the terms used must be exact. The proper names for the various woods and wood-elements are no more difficult to remember than are common terms, once they have been learned--and they are much more significant. "White pine" is indefinite -- "Pinus Strobus" is not.

** The terms "hardwood" and "softwood" do not mean specifically hard wood and soft wood respectively, but only indicate the general tendency of the group to be hard or soft. Some of the softest of woods are actually of the hardwood group (basswood, e.g.) whereas some of the softwoods may be quite hard in comparison (red cedar, yew, etc.)

The Elements of Wood

Wood is not a solid substance as is iron, copper, or glass, but is formed of many minute elements known as "cells". These cells are produced by the division of others already existent. In plants, there are certain regions of tissue which have as their function the production of the cells which later become differentiated into the many different types found in the more mature section of the plant.

In woods, there are found four main types of elements or cells. These four elements are:

(1) Tracheids

(2) Fibers

(3) Parenchyma cells

(4) Vessels

These cells are distinguished from one another on the basis of morphological differences in character -- size, shape, thickness of the walls, function, etc.

Essentially, cells are microscopically small box-like structures, ranging from a more or less cubical shape, in the parenchyma, to elongated spindle-like forms in the wood fibers. The walls surrounding the cavity (lumen) of such cells are not solid and unbroken formations, but have small "windows" or gaps here and there, which permit passage of food materials from one cell to another. These "windows" are known as "pits." Pits may be "bordered", or "simple". The type of pitting which one finds in a cell is a valuable characteristic in indicating which of the four types of elements may be represented.

Simple pits are generally seen as rather large openings in the wall of a cell, seemingly being nothing more

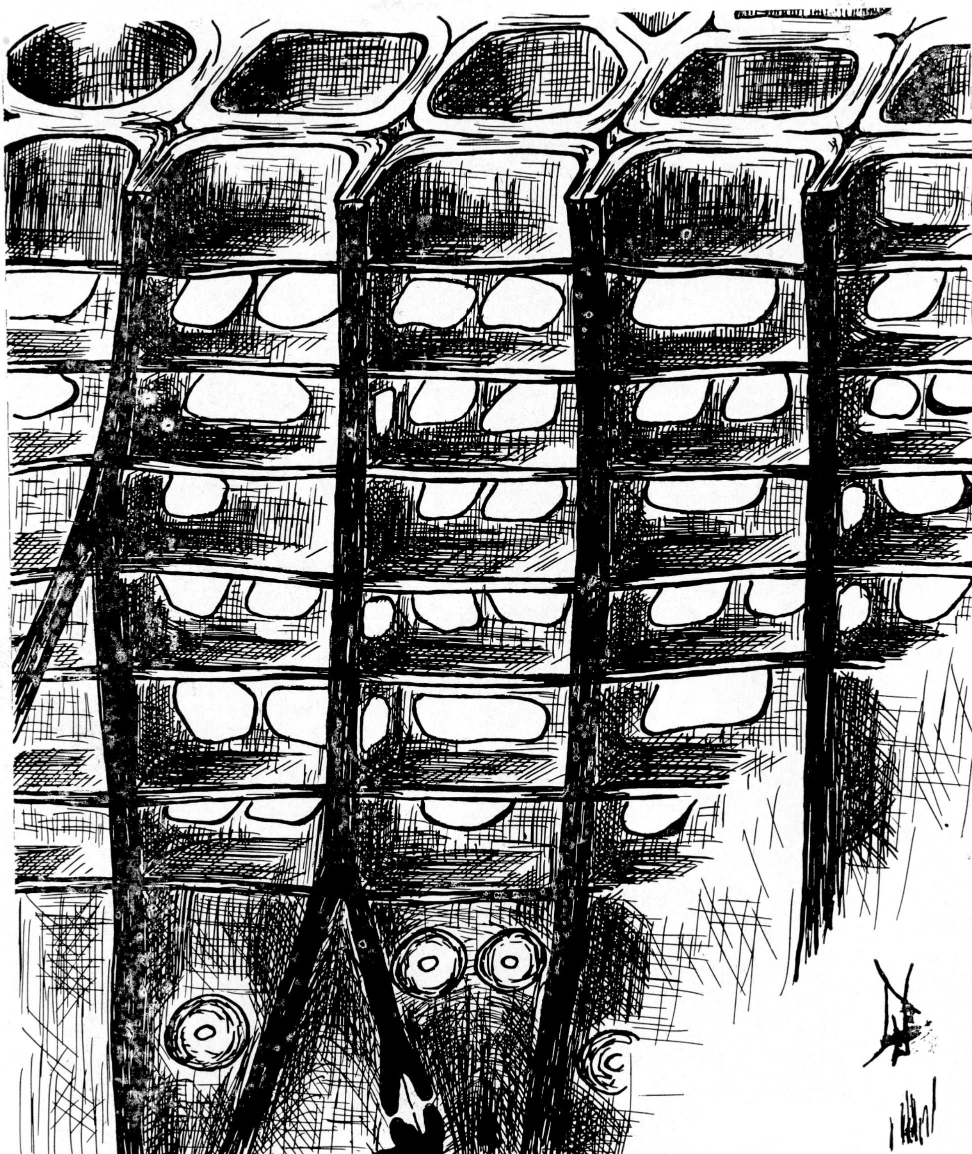

Figure I—Diagrammatic representation of simple pits of a softwood. The cells shown are parenchyma cells forming a 'wood ray' crossing the vertical tracheids.

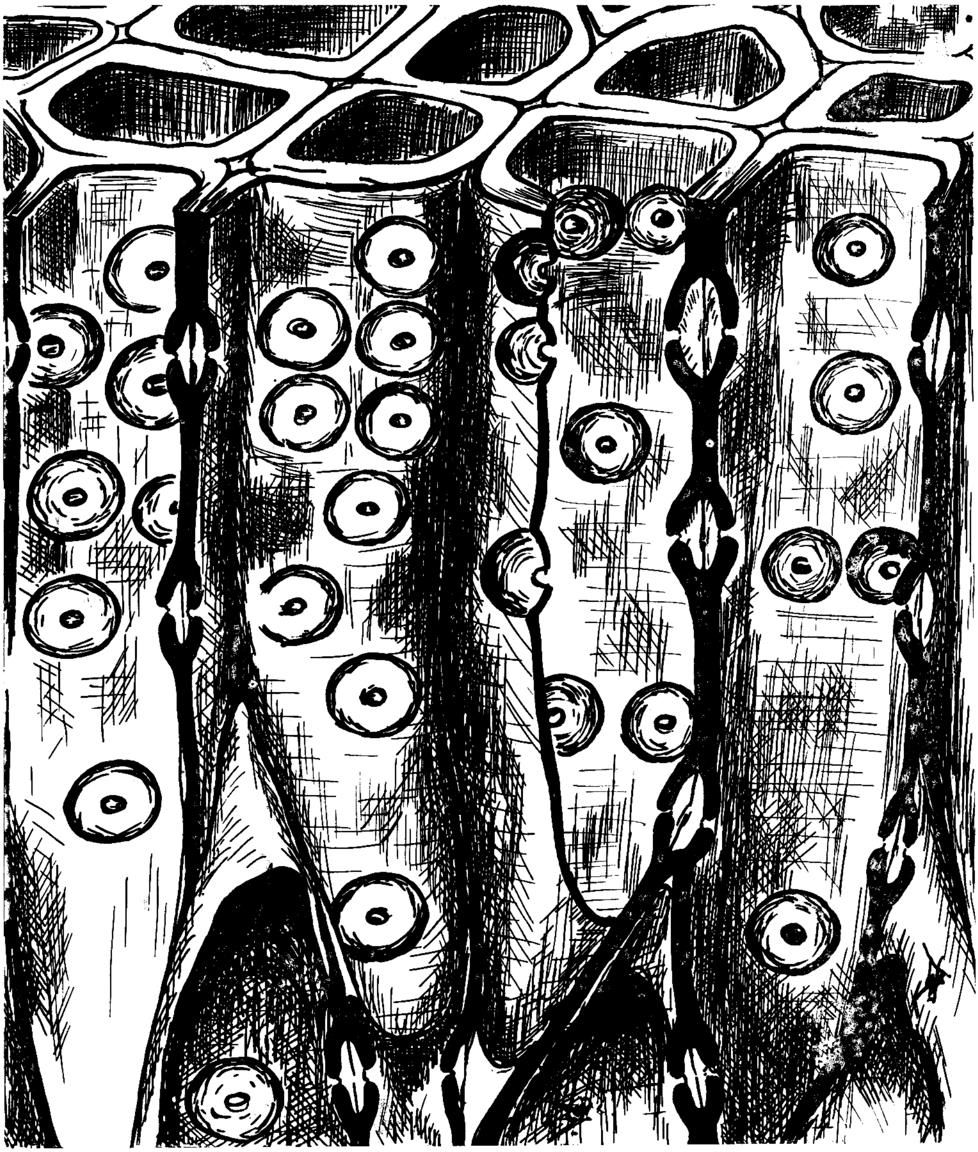

Figure II—Tracheids of a softwood showing bordered pits both in "face view' and in cross section.

than a blank space in the cell wall. Viewed in cross section, simple pits are observed to have a constant diameter throughout the thickness of the cell wall. (See figure I.)

Bordered pits, on the other hand, are somewhat more complex in their make-up, and present a different appearance altogether. Further, there are a greater number of different forms of bordered pits than of simple pits. In bordered pits, the opening or window in the cell wall is larger on one side than on the other, so that in cross section it appears as if a perforated dome had been built over the original opening. Thus, in face-view, the bordered pit appears to be a very small aperture, surrounded by a circular or oval ring. The size, shape, and arrangement of these pits often serves as a valuable microscopic identification characteristic. Usually a pit in one cell wall opens directly into a similar pit in an adjacent cell so that a "pit-pair" obtains, giving in cross section of bordered pits, a hollow lens-shaped formation of the cell walls at that point. (See figure II.)

Returning to a consideration of the cells of wood, it may be well to describe more fully the characteristics of the individual elements, with a presentation of their identification peculiarities.

TRACHEIDS

These cells are generally box-like in shape, are much longer than they are wide, and in cross section may be rounded, square, or rectangular. The long axis of the cell is generally parallel with the vertical (long) axis of the tree trunk, and the ends of the cells are usually tapered to a point, though they may have a more blunt or square end in some instances. Blunt-ended tracheids are more often found among the cells of the "spring wood", whereas the pointed type occur more frequently in the "summer wood". Tracheids have bordered pits only. In some woods, the cell walls of tracheids develop what are known as "spiral thickenings". These spiral thickenings may be easily seen in a microscopic section of some woods, and resemble coil springs. They are especially prominent in Douglas Fir (Pseudotsuga taxifolia) and may serve to distinguish this wood from others (Larch) where ordinary means fail. Tracheids may occur in the hardwoods; they are the predominating cell in the softwood group.

FIBERS

Although in the paper making industry, and others, various types of cell structures may be regarded as "wood fibers", this term is reserved by the wood-technologist to a particular type of cell having certain specific characteristics.

Fibers are long, spindle-shaped cells, and are found only in the hardwoods. They may have either bordered or simple pits. They are the cells which lend strength and hardness to those woods, and are peculiar in that the cell wall is especially thick. In fact, the lumen or cell cavity may be almost completely absent due to the thickness of these walls.

PARENCHYMA* CELLS

The cells of this group are the food-storage cells of the plant. They are generally box-like in shape. In view of their function, they have, as might be expected, rather thin walls (generally) and have only simple pits. They occur both in the hardwoods and in the softwoods.

VESSELS

Vessels are not individual cells as are the other elements of wood, but rather are elongated tubular structures formed by a combination or union of adjacent cells

* The term "parenchyma" is frequently applied to the tissue formed of these cells, or to aggregates of the cells at various places within the wood.

which are specifically adapted to this purpose. These elements are found in vertical arrangement in the hardwoods (Angiosperms) and are produced by a process in which adjacent end-walls of the cells are dissolved away, leaving a single tube-like structure known as a vessel. (In cross-section of the wood these vessels may be seen as enlarged apertures called "pores". They are particularly prominent in the cross-sectional view of ring-porous woods such as oak, chestnut, elm, etc., where they may form the greater part of the spring-wood; or may be seen in longitudinal section of the same woods, as fine, long, grooves or depressions.)

When the end-walls of these cells is dissolved away to form a vessel, there may be left a sort of "seive" formation where the end-walls were. This structure is known as a "perforation plate", and is of value as an identification characteristic (microscopically), due to the fact that various forms are taken by them, depending upon the type of wood concerned. Vessels do not occur in the soft-wood group.

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Although not an element of wood in the ordinary sense it might be mentioned that another feature of wood exists which also may be likened to cell-structure, and which is of value in identification procedures. This is the "tylose." Tyloses may be defined as "proliferations, into the lumens of dead tracheids and vessels, of parenchyma cells". Tracheids have a relatively short life, and after such a cell dies, (especially at the region along which the heartwood and sapwood join) living parenchyma cells in the sapwood may make intrusion into the cavity of the tracheid, via the pits. In other words, the thin cell wall of the parenchyma cell, in growing, expands and forces its way into the cavity of the non-living adjacent cells, where it again expands to form a frothy filling in the cavity or lumen of the tracheid or vessel. Tyloses are of common occurence in some woods, and may serve to distinguish closely related species. Thus, the pores (vessels) of white oak are generally plugged with tyloses, whereas the vessels of the Black-oak group are not so filled.

A last feature which bears mentioning in connection with our discussion of the elements of wood, is the "resin duct". Resin ducts are not cells, but are merely tubular spaces (otherwise similar to vessels) found in certain woods, and representing the absence of cellular structure. Resin ducts occur only in the softwoods or Gymnosperms, and are found in but a part of these. They have no walls of their own, but rather are formed by the arrangement and presence of the surrounding cells. They are generally classed as "intercellular canals", and frequently contain resinous substances which may be seen in woods such as the Pines. Resin ducts are particularly prominent in the Pines -- especially sugar pine -- where they appear as small brownish flecks on the end or cross section of a specimen of the wood. The color is due to an exudation of resinous compounds. With the unaided eye they sometimes appear white, although this is due to the surrounding cells (parenchyma tissue) and not to the resin duct itself (spruce, e.g.) Resin ducts, unlike vessels, may be horizontally (as well as vertically) placed.

(To be Continued)

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NOTE: IN THE DIAGRAMMATIC ILLUSTRATION OF SIMPLE PITS IN A WOOD RAY (FIG. I), IT APPEARS THAT THE RAY CELLS MERELY FORM CHAMBERS WITHIN THE VERTICAL TRACHEIDS. ACTUALLY, THE RAYS ARE WEDGED IN BETWEEN THE VERTICAL ELEMENTS, ALTHOUGH THE END-WALLS OF THE RAY ELEMENTS ARE FREQUENTLY COINCIDENT WITH THE SIDE WALLS OF THE VERTICAL CELLS.

EDITORS NOTE: --

This issue of THE TECHNICIAN represents a combination of the February and March numbers. We had originally planned to publish twelve copies during the year; however, the February issue has been so long delayed, due to unavoidable conditions, that we have decided to combine these two months and issue but eleven numbers.

The third in the "Wood Identification" series of articles is presented immediately following this note. Originally written for the March issue, it has been placed here in order that space may be reserved in the April issue for other material.

WOOD IDENTIFICATION PROCEDURES #III

By John E. Davis

Technician with the Laboratory of the Missouri State Highway Patrol

The Arrangement of the Elements of Wood

The cells, or elements, of wood may be arranged in two general fashions--vertically and horizontally.

The vertical elements are usually the ones most conspicuous, and the most numerous. In these, the long axis of the cells are parallel to the long axis of the tree.

The horizontal elements are those in which the axis of the elements are at right angles to the axis of the tree, and, taken collectively, form what are known as the "wood rays" (medullary rays). It is these rays which are so prominent on certain cuts of some kinds of wood. For example, the large "flakes" seen on quarter-sawn oak, and running generally at right angles to the grain, are sections through such rays.

THE WOOD RAYS

As seen on the end-section of wood, the rays appear to extend outward, in spoke-like fashion, from the center region of the tree. As a tree grows, more rays are produced, beginning at different points, so that they do not always extend from the center of the trunk, although once begun they are not discontinued. Viewed in cross section the rays may appear as narrow lines ranging from hardly visible flecks or lines of from one to hundreds of cells in height, and ranging in length from hardly visible with a magnifier to two or three inches long. The rays may be from one, to twenty or thirty cells in width.

Rays which are only one cell wide are called "uniseriate" rays. These may range from one to fifty cells in height, and are found especially in the Gymnosperms. Rays of two cell width are designated as "biseriate", and those a number of cells wide are "multiseriate". In Gymnosperms, the ray cells may surround a resin duct, in which case the ray is described as "fusiform".

When viewed macroscopically, the rays of certain woods, although uniseriate, appear to be much larger than they really are due to a close arrangement of such rays. In this case, an "aggregate" ray is said to exist. Aggregate rays may be seen in a number of woods--particularly in alder.

Rays are formed predominately of parenchyma cells in all woods, and only of parenchyma in the Angiosperms. In certain of the softwoods, ray tracheids are found. Ray tracheids may have smooth inner walls, or rough (dentate) inner walls, which factor may serve as a valuable micro-identification characteristic.

In addition to classification of rays into uniseriate, biseriate, or multiseriate; simple or compound (aggregate); rays may also be either "heterogeneous" or homogeneous".

In softwoods, homogeneous rays are those which are composed only of parenchyma cells. Heterogeneous rays are those in which ray tracheids also occur.

In the hardwoods, homogeneous rays are those in which all the parenchyma cells are arranged with their long axis at right angles to the axis of the tree---or horizontally. Heterogeneous hardwood rays are ones in which (though composed only of parenchyma cells) have rows of vertically placed cells bordering, or separating, the rows of horizontal ray elements. See figures I & II. (Line drawings are being used to illustrate these various wood elements and tissues in order that the salient features may be emphasized.)

The Sapwood and Heartwood

The trunk of a tree is formed of three main regions. These are (1) the pith, (2) the wood, and (3) the bark. The pith is that region immediately surrounding the central axis (vertical) of the tree, is of slight diameter (about a quarter of an inch) and of little significance from our standpoint. The woody part, or "xylem" as it is known botanically, surrounds the pith, and is that portion of the tree with which we are primarily concerned here. The bark, which surrounds the xylem, while of a woody nature, has not the commerical importance of wood, and so will not be discussed.

The xylem--or wood portion of the tree--is "divided" into two main regions. These are (1) the heartwood, and (2) the sapwood. The heartwood is, as would be expected from its name, that portion of the xylem immediately surrounding the pith region, or axis, of the tree. It is the innermost portion of the true wood. The heartwood is usually darker in color than the sapwood, and is completely dead, having no physiological function within the tree. The sapwood is that portion of the tree between the heartwood and the bark. It is the living part of the wood, and is generally lighter in color than the heartwood.

The Annual Growth Rings

"Growth ring" is the term applied to a cross-sectional view of an annual layer of wood. Annual layers are formed of the wood which is produced in any one season of growth.

The form and appearance of the growth layers may be influenced by a number of different factors (length of the growing season, soil conditions, humidity, presence of other trees in close proximity, etc.); they are, in general, characteristic of a particular type of wood. Usually, the growth layer is comprised of two obviously different parts--especially in those woods from regions of the earth in which there are definite seasons. These two parts are (1) the "early wood", or spring wood as it is often called, and (2) the "late wood" or summer wood. During the earlier part of the growing season, cells are rather rapidly added to the tree trunk, increasing its diameter with a layer of thin-walled cells which form the early wood. Later on, in the summer, the character of the cells changes somewhat, so that the cell walls become thicker, and the cells stronger generally. Such tissue is of the "late wood" type, and completes the season's growth of tissue.

Although growth rings may show a good bit of variation on appearance and character, they may all be classified as belonging to one of three general classes. These basic types are:

(1) Transition from early wood to late wood abrupt.

(2) Transition from early to late wood gradual.

(3) Transition absent---all cells of about the same character.

In the first (1), the early wood is sharply deliniated from the late wood, in such a manner that (on a cross-sectional view of the log) there appears to be a series of concentric rings, alternatingly light and dense (and usually light and dark in color). This type may be observed particularly in the yellow pines, douglas fir, larch, etc. of the softwood group, and in the ring-porous (oak, chestnut, etc.) woods of the hardwood group.

In the second (2) class may be included those woods in which (although the late wood is more dense than the early wood) no sharp line of demarcation between the two growth-periods is evident in the annual ring. Woods such as spruce (at times), firs, hemlock, etc. may present this characteristic of the growth ring.

In the third group, as stated above, there is relatively little difference between the early and the late wood. This feature is particularly noticeable in the hardwood group, and of these, the tropical woods show it to best advantage. Birch, cottonwood, etc., mahogany, spanish cedar, etc. may be given as examples. It is sometimes difficult to differentiate this group from the second. However, this may depend more on the individual specimen of wood than does the differentiation between the first two classes.

The Macroscopical Examination of Wood

Macroscopic, as opposed to microscopic, has reference to the more gross features of a relatively large object, as visible without the aid of a compound microscope. (Magnifications of from 1 to 50 diameters, generally.)

In the identification of wood, it is the cross-sectional view which, in most instances, provides the greater number of reliable identification characteristics. A cross-section is obtained by cutting the wood at right angles to the long axis of the tree.*

In certain cases, an examination of the radial or tangential section of a wood specimen may be necessary or at least adviseable. A familiarity with woods may permit an identification on this basis alone, provided the particular type of wood has been examined and recognized before.

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* The average person familiar with woods, but untrained in specific identification procedures, generally examines the tangential and radial sections first. The cross section is frequently neglected altogether whereas it actually is the most informative of the three.

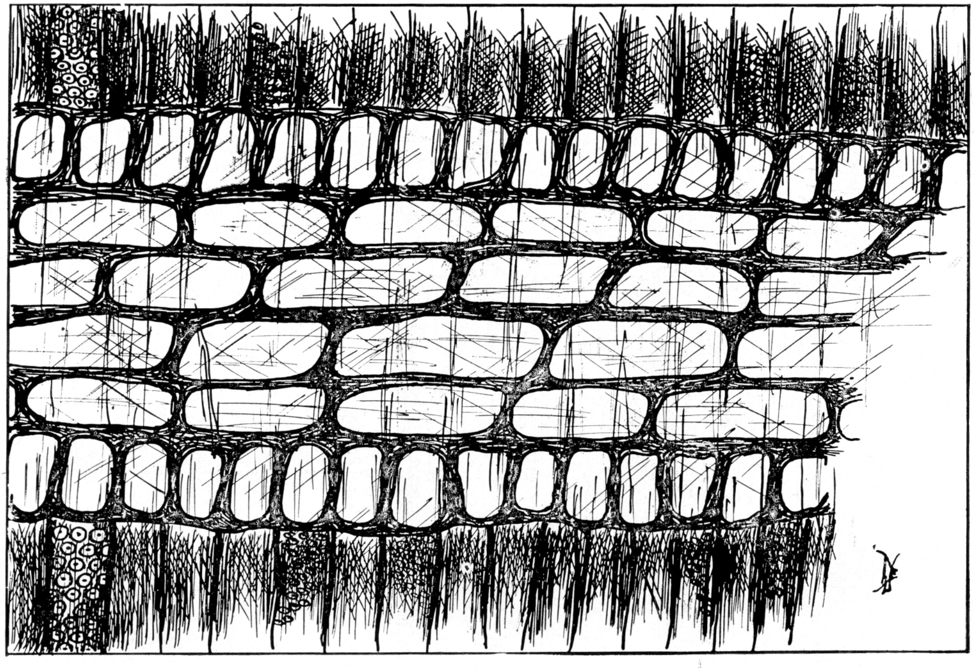

Figure II—Heterogenous Ray in a hardwood. Vertically placed parenchyma cells may be seen bordering the procumbent cells, which form the main part of the ray

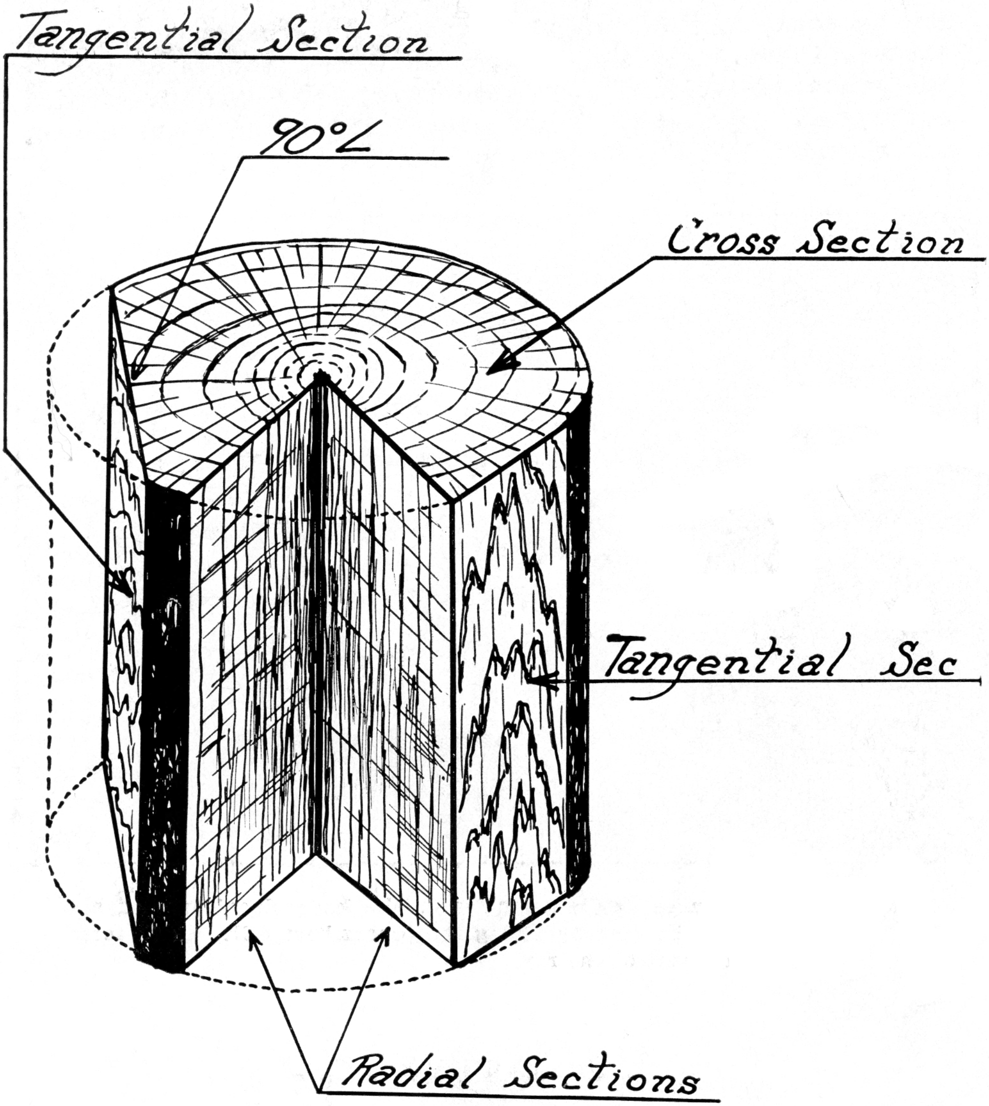
Tangential Section
90°∠
Cross Section
Tangential Sec
Radial Sections

Figure III.

In Figure III there is illustrated, diagramatically, each of these three sections of wood. The annual rings may be seen on the cross section, as circular rings of tissue. These, on a radial section form a series of parallel lines crossed by the wood rays, and on a tangential section as (usually) "feathered" light and dark areas, variations of rings, or hardly visible at all.

(To be continued.)

OF INTEREST:

In the March issue of the JOURNAL OF THE BIOLOGICAL PHOTOGRAPHIC ASSOCIATION, (Leo C. Massopust, Editor; Marquette University School of Medicine, Milwaukee 3, Wis.) there appears an interesting article by Arthur L. Smith, titled "Illumination Problems With Low Power Magnifications". Various methods of illumination are described, with respect to magnifications of from 2-x to 20-x. In the same issue, there is presented an article on Fluorescence Photomicrography. Both of these articles contain material which should prove of practical value to the Police Laboratory Technician.

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TECHNICAL NOTE

With the lamps ordinarily supplied with the comparison microscope, it is often difficult to satisfactorily illuminate the subject with a sufficiently brilliant light to permit easy observation on the ground glass, and a short exposure in producing the negative.

One method which we have applied in our laboratory to overcome this difficulty is by the use of a pair of 200 watt projection bulbs, in conjunction with concave mirrors affixed to the instrument.

By making an adaptor or holder, the mirror from an ordinary microscope is attached to the body tube, lens tube, or a separate vertical rod, in such a manner that it is at right angles to the vertical plane. A mirror is so attached to each of the microscopes, with the concave side down. On the base of the instrument, and in front of it, are placed two separate 200 to 500 watt projection bulbs, suitably housed, in such a manner that the light from them may be reflected back from the mirrors, and downward toward the object under examination.

By placing a ground, heat-absorbing glass between the filament and the mirror, one obtains a satisfactory light with a minimum of heat on the object. By raising or lowering the mirrors, and by tilting the reflecting faces, various types of illumination effects may be obtained.

J.K.B.

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CHEMICAL MICROSCOPY

In previous issues of THE TECHNICIAN, we have listed a few of the many peculiar reactions which one may obtain in performing chemical tests on the microscope slide.

In the first issue of this publication there was presented a discussion of one practical application of chemical microscopy in the identification of an unknown organic substance.

Mention has been made of some of the more important and valuable texts and references for use in this work, and a few comments of readers presented for the interest of all.

This particular section of our publication has been carried on in a rather informal style, and without any particular reference to a standard outline; there has been little or no discussion of practical applications of the work, technique, etc., nor of the factors which influence the success with which the work may be carried on.

We should greatly appreciate it if more workers would submit comments, notes, or discussions on this subject.

The role of the microscope in the police laboratory is most important. Applications of chemistry in its use of immediate interest and practicability. Especially is this true in the police field due to the oft-necessitated analyses of minute amounts of material. The microscopic identification of materials is most important, and while one cannot satisfactorily perform such procedures as the extractions of poisons from viscera, destruction of large amounts of organic material, etc. on a micro-scale, chemical microscopy is in every way as important in this field as is macro-chemistry, from the qualitative standpoint. There are some disadvantages to the process in the fact that a systematic or schematic procedure (such as is followed in the macro-identification of the metallics---

sulfide precipitations e.g.) is not worked out for many of the ions. On the other hand, under most circumstances rapid group tests are possible which serve just about as satisfactorily as the schematic method; further, the fact that one is often looking for one or a few particular elements adds to the convenience of the whole precedure, and facilitates the determinations generally.

There is some distinction between the terms "Chemical Microscopy", and "micro-chemistry", which bear mentioning. Micro-chemistry is a rather all inclusive term generally applied to all those procedures involved in chemically separating or analyzing small amounts of material. In other words, it is macro-chemistry on a small scale. Whereas in macro-chemistry one works with rather large amounts of material, in large vessels, performs digestions, filtrations, precipitations, etc. in standard laboratory glassware, in micro-chemistry, similar procedures are carried out on a small scale, in small vessels, (often of special or modified construction). This may be at the same time supplemented by chemical-microscopy---the whole thing constituting micro-chemistry. Actually there is, of course, no sharp line of distinction between macro and micro-chemistry, any more than between macro and micro-photography. The technique of micro-chemistry and the many features involved are probably more difficult than either macro-chemistry or chemical-microscopy, if entered into as a standard procedure. The methods may be quantitative as well as qualitative, just as with macro-chemistry.

The term "Chemical Microscopy" was presumably coined by Mssrs. Chamot and Mason. While closely related to micro-chemistry, it represents a more restricted phase of that work---namely the final qualitative identification of a material by means of reactions observed with the microscope, upon treatment of the substance with various reagents while on a microscope slide. In preparing such material for analysis, micro-chemistry is often resorted to in some of its aspects at least. However, this is largely incidental to the chemical-microscopy being employed and does not necessarily require a broad experience or great ability in micro-chemical methods generally, a reasonable knowledge of chemistry sufficing.

Both in writing and in speaking, it is not uncommon to find these two terms used interchangeably. While this does not generally result in any great confusion, it would probably be better if they could be more restrictively utilized.

The technician or student just beginning a study of chemical microscopy would do well to obtain a standard text or reference such as "Chemical Microscopy", vol 2, by Chamot & Mason. This should be thoroughly studied, step by step, and supplemented with concurrent practice in the actual testing of the various ions. The reference not only describes the test and presents illustrations of the crystals obtained, but gives detailed information regarding the effect on sensitivity which may be produced by presence of other ions in the solution, effect of various concentrations of test and reagent drops, etc.

Once such directions have been studied and understood, testing is simpler, and the results of atypical reactions appreciated. It is not necessary that the technician remember all of the factors which may influence any particular test, the effect of various contaminating ions, etc., provided he knows where to look for information about it in the event peculiar results are obtained.

Much experience is required of the analyst who performs micro-chemical tests, before he may satisfactorily handle the many types of material which will come to his attention. It is well, for that reason, to run tests, not only on known pure solutions of the various ions, but on different "contaminated" solutions similarly prepared. It is also adviseable to check by chemical microscopy the results of other tests. One may then learn of the relative efficiency of the different procedures, and note the reactions obtained under varying circumstances.

Practice and experience in separating different ions from a complex mixture is not only of inestimable value in actual case work analyses, but is a most interesting procedure generally. When one is working with the amount of material which may exist in solution in one or two drops of water on a glass slide, and finds it necessary to separate two or more components before satisfactory tests may be run, an interesting problem is at hand, which may tax the ingenuity of even the most experienced worker. A successful separation and analysis provides a source of pleasure as well as being of practical value from the scientific standpoint.

Considering the endless combination possibilities which may exist, it is not easy to discuss in a satisfactory manner the actual testing, or separation, of ions. However, in future issues we shall attempt to illustrate the use to which these methods may be put, by reference to actual laboratory cases.

J.E.D.

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TECHNICAL NOTE

Probably every photographer has had the embarrassing experience of producing at one time or another, a series of "thin" negatives, either due to incorrect or underdevelopment, or to an underexposure. It is often difficult to determine which of the two was actually the case, unless there happens to be a few of the negatives of the group which are of the proper density.

One method of examination which may assist the technician or photographer in making this determination is by a reference to the printed letters, words, and numbers appearing on the edges of the film. These letters are exposed on the film during its manufacture, and are developed out at the time the film is processed. For proper development, the figures should be quite dense. If they are pale, and the negative thin, an underdevelopment is indicated. If they are dense and the negative is thin, then underexposure is the cause.

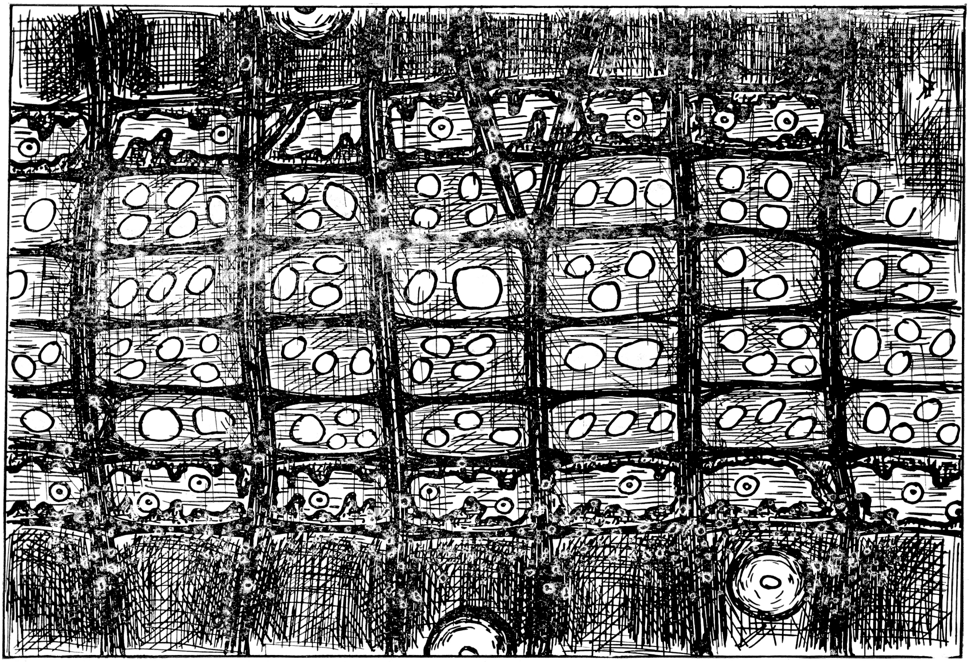

Figure I—Heterogeneous Ray in a softwood. Ray parenchyma is bordered by ray tracheids, recognized by the bordered pits (and dentate inner walls in this case.)