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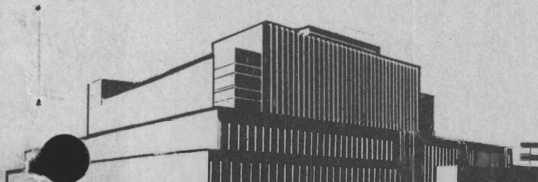

FOREST PRODUCTS LABORATORY
MADISON 5, WISCONSIN

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
In Cooperation with the University of Wisconsin

WOOD IDENTIFICATION AT THE U.S. FOREST PRODUCTS LABORATORY[1]

By

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Abstract

Wood anatomy continues to play a fundamental role in the identification of wood and wood products to the generic or subgeneric level. Recent research has shown that the many different types of inclusions found in the various cell types may have high diagnostic value, permitting determinations to be made in many instances to the species level. The occurrence of such inclusions as crystals and silica particles, which in the past were largely overlooked, prove in many instances to be important diagnostic features. Ultraviolet radiation effect on wood and wood extracts, because of the limited number of reactive species, permits rapid screening of unknown specimens. Simple chemical and physical tests, although very much restricted in their application, have an important role in the final delimitation of species or groups of species.

Importance of Wood Identification

Over the 51 years of its service in the field of wood research, the U.S. Forest Products Laboratory has become known for many accomplishments. Yet, the item for which many people outside the wood industry remember it best was for work in wood identification--work that led to the conviction of an accused kidnapper in one of the most famous crimes in the United States during the past three decades.

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[1] Presented by Dr. Edward G. Locke, Director of the U.S. Forest Products Laboratory, at the 13th Congress of the International Union of Forest Research Organizations (Section 41, Mechanical Conversion) September 10 to 29, 1961, in Vienna, Austria.

[2] Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

You may remember the case. Col. Charles Lindbergh, the pilot who captured worldwide recognition for his solo flight across the Atlantic in the 1920's, had been shocked and saddened by the kidnapping and murder of his small son. When the case came to trial, one of the prosecution's strongest pieces of evidence against the accused kidnapper was the ladder used for the crime. It was the wood identification specialist at the U.S. Forest Products Laboratory, Arthur Koehler, who was able to identify the wood in the ladder with pieces still in the defendant's possession. This evidence was a key feature in tying up the case. Even today many Americans, even though they are not familiar with Laboratory work in other fields of wood research, still remember the Forest Products Laboratory for the part it played in the "Lindbergh kidnapping case."

While few cases of wood identification attract such headlines, exacting identification is vital in thousands of instances. In research we are insistent that we know what wood we are working with in a particular research problem. In industry, problems and questions come up frequently when the true identity of a commercial timber or wood product is lost; exact identification is the only answer to avoid misunderstandings and questions of fraud. In still other cases, assistance might be given to archeologists in determining the identity of wood found in ancient ruins, or in aiding taxonomists in classification of species. Any of these tasks may be part of the daily work of the Laboratory's section on the structure and identification of wood. Often this identification must be based on wood structure because other features were lost in conversion.

The Laboratory performs all the identification work for the U.S. Forest Service, with this service also extended to other Govermental agencies and the general public. Over 125,000 specimens of wood and wood products have been identified to date, and each year adds between 2,500 and 3,000 more. These consist of about 60 percent native species and 40 percent from outside the United States. Although this 40 percent originates in a large number of countries, it is made up essentially of woods from Latin America, West Africa, and the southwest Pacific area.

General Procedures

Because of the large number of specimens processed each year, it is imperative to identify the material rapidly, while still maintaining the highest possible degree of accuracy. Although it is possible to identify a large number of species simply on the basis of their gross structure or with the aid of a low-power magnifier, the microscope is still the most important tool available. Even though a specimen may be recognized on sight, it is our policy to check each specimen under the microscope and use auxiliary tests whenever they are available. Comparison is also made with specimens in our wood collection that are backed by herbarium vouchers. Our wood collection contains slightly over 20,000 specimens at the present time.

The mechanics of identification used are well known, and employ keys in various forms, the dichotomous type, in chart form, or the more recent use of marginally perforated cards. Tissues and their arrangements, together with cell wall sculptoring, form the basis for identification. One point here is that preparation of the wood for examination varies among different institutions. In order to maintain the integrity of the specimen--its natural color, color of cell inclusions, crystals, and so on--we cut the wood in its original state, employing the freehand method. In other words, the wood is not chemically treated or boiled to soften it before it is cut. The sections are then mounted on a slide covered with a half-and-half mixture of glycerine and alcohol, and heated on a hot plate to expell air from the sections. Thus, within the space of several minutes one is ready to study the section. Stains are not used since, in many cases, they would obscure the diagnostic features; for example, separating the balsam firs from the white firs depends on the color of the ray cell contents.

Ultraviolet Fluorescence

Most specimens received at the Laboratory, particularly of tropical species, are exposed to ultraviolet light before any other examination. The instrument used for this purpose is a 100-watt mercury vapor spotlight tube equipped with a Corning filter. This type of light does not have to be used in a dark room since it is of sufficient intensity to show fluorescence even under daylight conditions. At the present time, we know of some 120 genera which exhibit the property of fluorescence, with the color generally in the yellow or yellow-green range. The Anacardiaceae has 18 known genera showing this property, while three subfamilies of the Leguminosae have 70 genera that exhibit fluorescence. The remaining 32 genera are distributed among 17 different families. A wood showing this property comes under one of about 120 genera, thus eliminating about 2,000 other genera.

Generally the fluorescence is confined to the heartwood but, in some instances, certain cell types or tissues may exhibit fluorescence. In the Dipterocarpaces, the resin ducts of certain species fluoresce, in the Lauraceae it is the oil cells of certain species, and in Strychnos, the included phloem. In the case of the Populus species, fluorescence is limited to the Section Leuce; this permits separation of woods of this group from the poplars and cottonwoods. In this instance the fluorescence is confined to the pith area, knots, or brown streaks commonly found in this genus.

The fluorescence of water or alcohol extracts has also been found very helpful in delimiting certain groups. The colors usually exhibited are blues, greens, and yellows. Both the color and the speed with which it develops are important criteria. In certain woods, the color will appear the moment a small shaving of the heartwood is dropped into the water, while in other woods a much longer time is required for evidence of color. Pterocarpus indicus is a good example of a wood that shows fluorescence immediately; moreover, the fluorescence is so intense that it can be seen without the use of ultraviolet.

Silica in Wood

The fact that silica occurs in wood has been known for a very long time; however, its possible use as a criterion in identification was suggested only recently by Amos of Australia's Commonwealth Scientific and Industrial Research Organization. In his publication in 1952, he lists 144 genera, distributed among 32 plant families, and comprising some 400 species known to accumulate silica that is visible under a microscope. Our work at the Madison Laboratory has uncovered 5 additional families and 40 additional genera. Use of silica as a reliable diagnostic feature in identification has introduced some rather interesting problems in systematic botany. Silica occurs in a wide variety of sizes and shapes and may be found in all the cell types in the xylem. It may occur in cells free of other inclusions or may occur in cells with dark-colored contents or with typical crystals. Because of this wide range of possibilities, the presence of silica provides a very reliable means of identification. The range of possibilities is still not completely explored, as suggested by tests made on Canarium villosum, which showed that the silica particles found in the fibers and those in the ray cells have different indices of refraction.

With regard to problems in systematics, it is of interest to note that, of the eight genera of Legumes in which silica is known to occur, all belong to the Caesalpinaceae in three closely related tribes: Four genera in the Cassieae, two genera in the Sclerolobieae, and two genera in the Amherstieae. The African and American members of the genus Dialium accumulate silica while those of the Malayan region do not. The American Nothofagus species do not accumulate silica while those of the western Pacific do. The genera Quiina and Lacunaria of the Quiinaceae are anatomically similar yet can be readily separated by the fact that the Lacunaria accumulate silica while the Quiina species do not.

Crystals in Wood

Crystals are of very common occurrence in wood, having been recorded in approximately 1,000 genera of 160 families. They occur so frequently that at first sight it appears unlikely that they can be of any diagnostic significance. Further examination shows, however, that there are certain less common types of crystals such as raphides and druses; that certain arrangements of crystals occur, such as a large one accompanied by smaller ones; and that certain crystal patterns are characteristic of certain families. All these become valuable features for use in identification. Silica and crystals usually occur in different genera and species, but Amos has shown that there are some species in which both occur and sometimes in the same cell.

In many genera and species, the crystal type apparently has little significance, although the modifications of the crystal-containing cells may be sufficiently consistent and infrequent to form useful guides in identification. Some of these modifications are: (1) Presence of crystals in enlarged cells or idioblasts, (2) changes in the cell wall, causing the cell to become sclerosed, and (3) the presence of numbers of crystals of variable size and shape in one cell. The work of Chattaway (1955-56) with regard to crystal type and occurrence has proven extremely valuable in wood identification.

Crystals in wood are generally presumed to be calcium oxalate, although certainly many other crystalline compounds must occur. This field of research has hardly been explored and offers opportunities for study, not only from the chemical standpoint, but from the systematic and diagnostic standpoint as well. It is important to note that many of the softening agents used on wood may alter the crystals or completely destroy them.

Additional Tests

In a number of instances, it is possible to resort to the use of rather simple chemical and physical tests after anatomical features are no longer useful in further separation. A few examples of these are (1) the burning splinter test for separating *Cardwellia* and *Grevillea*, (2) the methyl alcohol-hydrochloric acid test for separating woods of the Negundo series from the other maples, (3) the frothing test for separating members of the Sapotaceae and certain Leguminosae, and (4) use of Aurin tricarboxylic acid for identifying the Symplocaceae and certain genera in the Theaceae and Rubiaceae. There are scores of cases where simple tests could be utilized in identification of genera and species that are anatomically similar. Unfortunately, this process requires a great deal of time because it is not possible to predict which reagent may be reactive with a given group of woods.

Summary

Identification of wood and wood products is vital in numerous fields of industrial and scientific endeavor. Specific identification is necessary for all types of research efforts involving wood. Often the identity of commercial timbers or manufactured products must be determined solely on the basis of wood structure. Frequently, such identification plays a significant part in checking adulteration, substitution, and fraud. On occasion, identification of specific pieces of wood has been instrumental in helping establish the guilt or innocence of suspected criminals. In still other cases, assistance can be given to aid such specialists as taxonomists or archeologists.

It is the Laboratory policy to check every specimen for identification under the microscope and use supporting tests whenever they are available. As one example, ultraviolet light effects on wood and wood extracts help in the screening of specimens. Silica and crystals that occur in wood aid in determinations of identity, as do simple chemical and physical tests.