FOREST GENETICS IN RELATION TO WOOD QUALITY [1/]

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When growing trees for the production of lumber, the quality of the final product is a primary consideration. The breeding of trees for disease, insect, or drought resistance, or for rapid growth, will fall short of complete success if the final wood product of inferior quality. Timber quality, according to Richens (6), [2/] includes both anatomical and chemical properties of the wood.

In the consideration of wood quality from the anatomical viewpoint, the interest lies in fiber length in proportions of springwood and summerwood, which in turn influence density; this may be high or low depending on the intended or prevailing use. High density is desired for great mechanical strength and high pulp yields on a cubic foot and on an acre basis. Shrinkage, warping, and other properties of wood affecting its satisfactory use are related to density and anatomical structure in one way or another. Appearance or figure displayed by growth rings in wood is another feature eagerly sought for special uses. In many cases, therefore, the objectives of tree breeding *need* to be two- or even threefold.

The main Object of tree breeding, according to some popular ideas, is to produce trees of very rapid growth. This at first appears to be **a** most worthy objective. If trees can be developed that will reach merchantable sizes in a small fraction of the time now required, it will be a great advantage to the timber grower. However, if for one reason or another, the wood produced from this rapid growth proves um-suitable for its intended use, then the user will be at a great dis-advantage.

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2/ Underlined numbers in parentheses refer to the list of numbered references at the end of the article.

(This paper was illustrated by slides)

Among the faults recognized in rapid growth of coniferous species under natural conditions are low specific gravity and strength. Another fault that may accompany these is excessive shrinkage along the grain. For some uses weight of the wood, or high strength, are not important. This is true for many uses of white pine, but even in white pine it has been found that when growth rings are as few as 4 to 6 per inch the wood is unsuitable for match stock, one of the important uses of white pine. The reason is that in cutting match sticks from wide-ringed blocks, many of the match sticks contain only the weak springwood portion of the growth ring and, as a result, they lack the necessary strength for striking. Other white pine wood with 12 to 16 rings per inch produced satisfactory match sticks, since in this case some of the stronger summerwood was present in each match stick.

Initially wide-ringed wood *in* young southern yellow pines usually is below average density. It has short fibers, and the fibers themselves are made up of fibrils that lie at a large angle with reference to the axis of the fiber. This anatomical arrangement in the fiber walls gives rise to unusually high shrinkage of the wood along the grain during drying, which results in warping that makes it unsuitable for many uses. If rapid growth is to be an objective in such species, then an effort ought to be made to develop trees in which the fibrils have a small angle to the axis of the fiber. This may take a long time to accomplish, since evolution of wood characteristics may be expected to take place very slowly. According to Arthur Koehler (5), wood is the most conservative part of a tree from an evolutionary standpoint. This is evident in a number of genera, like the oak and pine, in which the wood of a number of species cannot be separated on the basis of its structure, although botanical characteristics of fruit and flowers upon which species classification is based may have significant difference.

In our native species, there are variable widths of growth rings under different conditions of environment. Also, these variations in growth rate may result from changes of a silvicultural nature that take place naturally or as a result of treatment of a stand. Rings may be wide at first and gradually become narrower as the trees become larger and relative growing space of trees becomes less. Along with this change *in* ring width, in the southern pines accompanying changes have been observed in the size of fibril angles. With initial slow growth of trees, the fibril arrangement becomes stabilized at small angles much nearer the pith, although perhaps no sooner in years than in wider. ringed trees. Investigations along this line are in progress.

In breeding trees having maximum diameter growth, the objectionable structural tendencies of the wood need to be overcome. Width of rings also affects appearance of finished lumber, particularly in species with prominent summerwood bands. When considerable areas of summerwood are present on the surface, as in flat-sawed lumber, the paint-bolding capacity is lower than when individual summerwood areas are relatively small, as in quarter-sawed surfaces. Variations in the springwood-summerwood ratios in growth rings likewise vary with environmental conditions. The total amount of summerwood has been seen to be influenced by soil moisture during the growing season. Extremely dry or wet growing seasons give highly contrasting amounts of summerwood. Total springwood seems to be influenced by crown size and, at a given cross section in the tree, by proximity of the green crown when other factors are equal.

In studies of rotary-cut veneer from second-growth Douglas-fir, it was found that wide rings resulted in an uneven distribution of springwood and summerwood that gave an unbalanced sheet (j). The veneer from wide growth rings did not have the fine texture desirable for faces. Production of Douglas-fir timber yielding high-grade veneer logs appears to be a silviculture' problem calling for growth-rate control and also for pruning to rid the trees of persistent dead branches. For this species, not less than 10 rings per inch is recommended for high-quality face *veneer.*

The direction of grain and presence of figure in wood have been considered¬ from the standpoint of developing strains or hybrids that will have high value on account of their attractiveness. H. G. Champion t2) in 1927 grew a large percentage of spiral-grained offspring from seeds of spiral-grained trees. As a result, he claimed that spiraling was hereditary. However, because of the variable occurrence of spiral grain among our native species, there is some evidence that spiral grain develops also from other causes. Sometimes spiral grain will occur only late in the life of a tree. In many cases the degree of spiral changes, or it may spiral first in one direction and then in another. In some released ponderosa pine trees, it was observed that the degree of spiral was reduced by acceleration of growth; and in one of the trees, the spiral reversed its direction. General observations indicate that spiraling is associated with slow growth and becomes intensified with retardation of growth in diameter.

Interlocked grain appears more likely to be hereditary than spiral grain. It is usually characteristic of most trees of a species; for example, sweetgum.

In Finland, the Forest Research Institute (4) tested hereditary tendencies of figure in birch. Four-year-old trees grown from seeds of parent trees having figured wood were planted in 1929. After 6 years, 44.6 percent had developed figure and, after 9 years, 61.7 percent. It was claimed that figure could be detected in trees as young as 2 years in the nursery beds. It was stated, also, that figure formation slowed down the growth of the birch and that the figured trees developed a bushy habit of branching, requiring pruning for the best results. Stakes were used to hold young figured trees upright, since the winding wood fibers caused the stems to become crooked. In Finland, grafting is practiced to reproduce the best racial features of figured birch.

A few years ago curly aspen in Maryland attracted much interest. In a letter from Schreiner (g) (1946) the origin was traded to a hybrid, Populus canescens, resulting from a cross of European white poplar and European aspen. It was distributed in this country as a shade tree. The wood of this particular clone had interlocking fiber, and it is reported that individual trees were sold at high prices ($700 to MO) for furniture and cabinet use.

Black walnut is a species in which occasional trees have figure highly valued for veneer. The cause of figure in walnut, like bird's eye in maple, is not clearly understood. A number of years ago, a highly figured black walnut tree, known as Lamb's walnut (1), was propagated by grafting. A specimen thought to have originated from that tree, sent to the Forest Products Laboratory recently, showed no tendency toward a figured grain.

Pillow (1), a number of years ago, examined sugar maple for the presence of bird's eye. He discovered a tendency toward the formation of dimples -- supposedly the forerunner of bird's eye -- in young suppressed advance reproduction. If bird's eye can be recognized in small trees, then they could be marked and favored in making thinnings and the proportion of bird's eye increased in a maple forest.

Wood from only two hybrids from the Institute of Forest Genetics has been tested at the Laboratory; a natural hybrid of Jeffrey and Coulter pines and a hybrid of knobcone and Monterey pine. Both trees were of relatively rapid growth. They were tested for specific gravity and shrinkage. These trees did not show any outstanding wood characteristics in their favor over those of the parent species other than rapid growth. The wood, however, was characterized by abnormally high longitudinal shrinkage, although not equaling high values obtained previously in the wide-ringed wood of several other coniferous species.

Objectives in tree breeding, therefore, should include the important factors that control the use requirements of the final product. Accentuation of a single phase of development may be insufficient. The apparent advantages in volume growth per tree may lead to a disadvantage in the usefulness of the lumber from it. A well-rounded background knowledge of environmental influences upon wood quality is basic to the formulation of objectives in tree breeding. A test of the quality of wood resulting from experiments in forest genetics needs to be made at the earliest possible opportunity in order to find out whether new types of wood structure exist and, if so, which ones are most suited for further development. The selection and propagation of trees that produce figured wood of above average value for a species appears to have rather definite possibilities.

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