VARIATION IN BARK CHARACTERS AND WOOD SPECIFIC GRAVITY OF SUGAR MAPLE[1]

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The external appearance of the bark of sugar maple (*Ater saccharum* Marsh.) has been described as "deeply furrowed," "fissured with long irregular thick plates or ridges," "somewhat scaly," "sometimes curling," and "highly variable." Adjacent trees in natural stands often have strikingly different external bark characteristics.

Gross variability in bark appearance is unusual within a species. In general, bark appearance is relatively constant, and any variability encountered is often a reflection of vigor. Indeed, some researchers consider external bark characteristics to be helpful in log and tree grading and quite reliable as an indicator of tree vigor (Burkle and Guttenberg 1952, Arbogast 1957). Kennedy and Wilson (1954) in studies of smooth and cork-bark alpine fir (*Abies lasiocarpa* (Hook.) Nutt.) show that a strong relationship exists between age and bark type for four diameter classes. The cork-bark type is consistently older.

The objective of this study was to investigate what relationships may exist between bark type, age, diameter, growth rate, and wood specific gravity in sugar maple.

Materials and Methods

Sixty-one trees were selected from an area of about 30 acres on Copper Range Company lands in Houghton County, Michigan. The stand is predominantly sugar maple and had been selectively logged twice. The site is a fairly uniform loamy sand, deep and well drained with no extreme topography. The stand was selected because it has a good diameter distribution, from 12 to 24 inches d.b.h., and considerable bark variation was noted throughout these classes. Measurements and stereophotographs were taken of the bark. Because of the difficulty in quantifying external bark characteristics, qualitative descriptions were also recorded.

One 8 mm increment core, extending to the pith, was removed from each tree at breast height. The position of extraction was random except for leaning trees; in these, the cores were extracted at right angles to the direction of lean. The cores were placed in water and stored frozen until processed in the laboratory.

The characteristics determined from these cores were: (1) Total age at breast height, (2) growth rate, by averaging the rings per inch for the last 3 inches of radial growth, and (3) wood specific gravity based on green volume and oven-dry weight for each inch of core from the pith outward.

Bark Classes

From many field observations and from a study of the bark photographs, four fairly distinct bark classes were defined:

Bark type 1. — This type is termed "platy" (fig. 1). It could be considered as typical and was most common in the sample. The bark plates are relatively flat and are much broader than the furrows. Occasionally the plates curl and the bark is firm. The furrows are relatively narrow and V- or U-shaped in cross-section. The furrows have a prominent vertical pattern and are usually 1/2-inch or less in depth.

Bark type 2. — This type is termed "corrugated" (fig. 2) and usually has a fairly uniform pattern. In large trees the bark resembles that of old-growth red oak (*Quercus rubra* L.). In smaller trees, it resembles white or green ash (*Fraxinus americana* L., *F. pennsylvanica* Marsh.). The bark has ridges and furrows of equal width and is quite firm. The ridge crowns are mostly rounded and the furrow bottoms are rounded or V-shaped in cross-section. The furrows have a prominent vertical pattern and are usually over 1/2-inch in depth.

Bark type 3. — This type is termed "shell bark" (fig. 3) and resembles somewhat the bark of jack pine (*Pinus banksiana* Lamb.) or black cherry (*Prunus serotina* Ehrh.). It is similar to the platy type, but the plates are of various sizes and often

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FIGURE 1. — Type 1 bark ("platy"). Tree is 22.6 inches d.b.h. at 142 years. Rapid growth rate.

FIGURE 2. — Type 2 bark ("corrugated"). Tree is 20.8 inches d.b.h. at 227 years. Medium growth rate.

FIGURE 3. — Type 3 bark, ("shell"). Tree is 14.4 inches d.b.h. at 129 years. Medium growth rate.

FIGURE 4. — Type 4 bark, ("ropy"). Tree is 11.5 inches d.b.h. at 83 years. Medium growth rate.

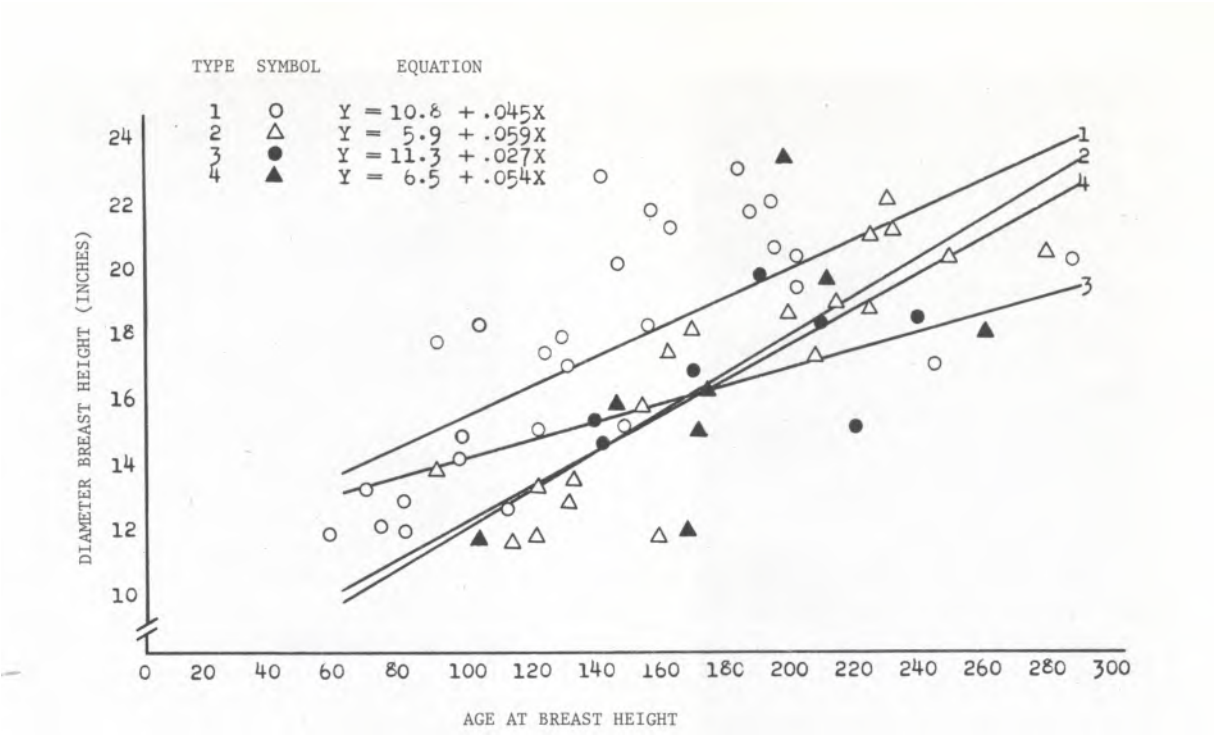

FIGURE 5. — Relationship between diameter breast height and age at breast height for four bark classes.

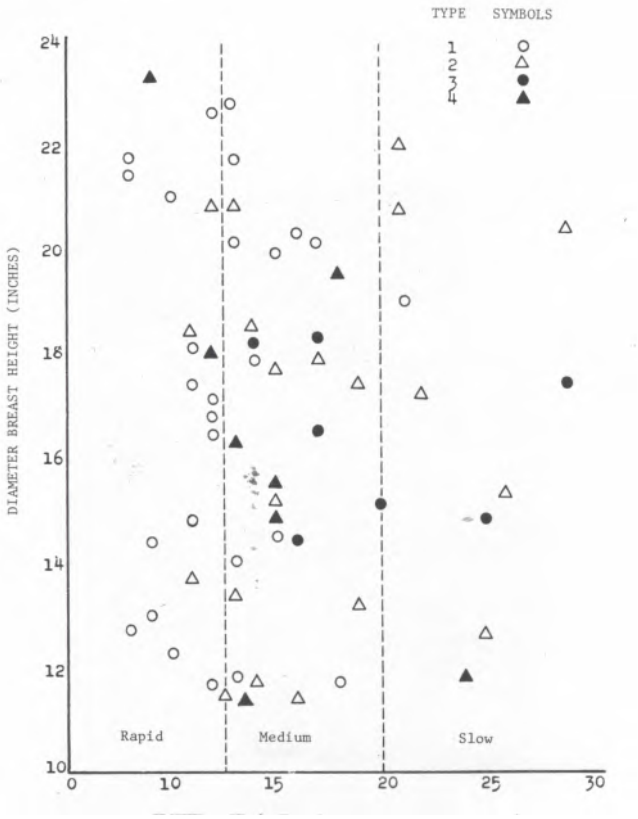

FIGURE 6. — Distribution of sample trees by d.b.h. and growth rate for four bark types. Growth rate is the average number of rings per inch based on the last 3 inches of radial growth.

overlapping. Crossbreaks are common. The furrows are of various depths and have very little vertical pattern.

Bark type 4. — This type is termed "ropy" (fig. 4). It resembles the common hackberry (*Celtis occidentalis* L.). It is similar to the corrugated type except the furrows are very broad and flat in relation to the size of the ridges.

Relationship of Bark Type to Diameter and Age

The relationship of bark type to diameter and age at breast height (fig. 5) indicates that trees with bark type 1 may be the most vigorous. The distribution also indicates that a diameter-limit cut has been practiced in this stand since no trees over 24 inches d.b.h. were found. This practice would tend to remove the more vigorous trees and thus the slope of the regression line for bark type 1 may be lower than in stands with no limit on diameter.

Since nearly one-half of the sample trees are of bark type 1 (N=28), the regression of this type was tested against the combined regression of bark types 2, 3, and 4 (N=34) by covariance analysis. The first step in this analysis is a test of parallelism of the two regression lines. This test was not significant at the 0.05 level. Having found no significant difference in slopes, the next test was to determine whether the regressions differ in level. This test was significant at the 0.01 level.

In figure 6, no relationship is indicated between

bark type and diameter, but a strong relationship is indicated between bark type 1 and the rapid growth rate class. Seventy-five percent of the trees in this class have bark type 1. These data also indicate that some large-diameter trees have a capacity for rapid growth rate.

Specific Gravity

The average specific gravity of the sample trees is .586 compared to .56 as reported in the Wood Handbook (1955) and .585 as reported by Paul (1963) based on samples from 70 trees from 12 stands in 8 states.

Bark type 1 trees tend to have slightly less dense wood (fig. 7); their mean specific gravity is 0.579 while the mean of trees with types 2, 3, and 4 bark is 0.591. Statistical analysis based on the t test for group comparisons indicates this difference is significant at the 0.05 level.

Specific gravity in relation to position at breast height (fig. 8) for all trees indicates a high specific gravity near the pith followed by a decrease, then an increase. This conflicts with reports by Lisboa (1961) and Webb (1964) who showed that in some diffuse-porous hardwoods (black willow (*Salix* nigra Marsh), sweetgum (*Liquidambar styracflua* L.) specific gravity is lowest near the pith, and increases and then decreases with age. In this study, however, variation in specific gravity was recorded by position in inches from the pith and not as a function of age. Variation in number of rings per inch was very large, ranging from 10 to 50 rings per inch for the position nearest the pith and from 4 to 65 rings overall.

Correlation coefficients were computed to determine if growth rate was related to specific gravity by position. At no position was a significant correlation obtained. The amount of variation explained by growth rate (rings/inch) at each position was very small, as shown by the coefficient of determination values (r^2) in table 1. This disagrees with Paul (1963) who found growth rate was related to specific gravity after the first or second inch from the pith in sugar maple.

Some of the differences found between this study and other reports may possibly be due to the occurence of mineral stain. Mineral stain in maple is difficult to differentiate from normal

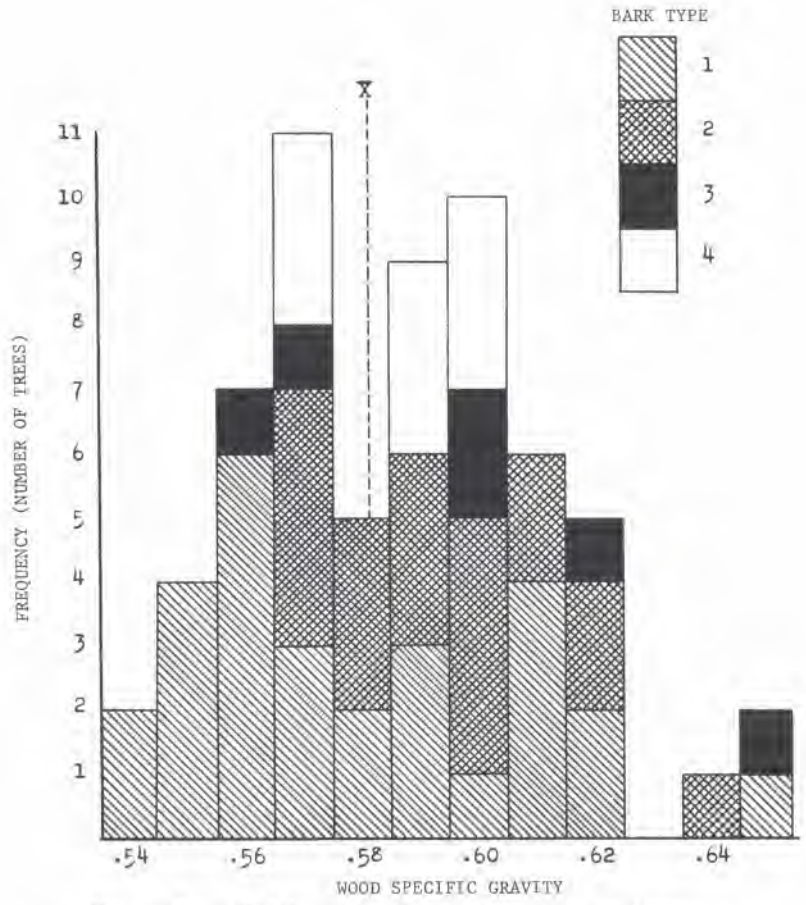

FIGURE 7. — Relationship of bark type and wood specific gravity.

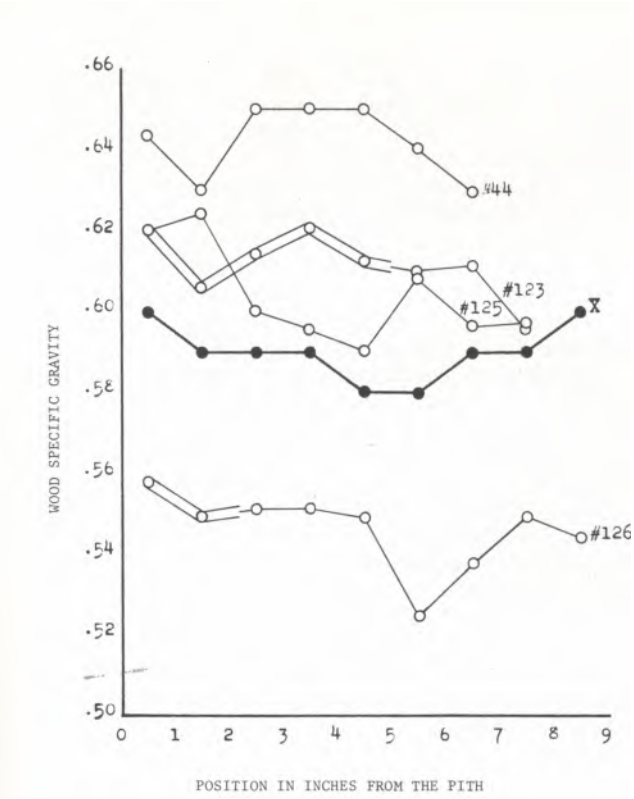

FIGURE 8. — Variation in specific gravity at breast height in relation to position for the average of all trees and for four selected individual trees. The double lines indicate the amount of heartwood.

heartwood. It occurs in the heartwood and in scattered pockets in the sapwood and thus may increase the specific gravity by a significant amount (Good *et al.* 1956, Seidel 1948). Future studies of specific gravity in sugar maple should take mineral stain into consideration, perhaps by ashing the wood and subtracting the weight of ash from the oven-dry weight of the wood.

Summary and Conclusions

The trees in this study, were selected because they had a definite bark 'appearance. It must be stressed, however, that the variation in sugar maple bark is usually continuous; gradations among the four types given here were found on the study area.

The single most consistent indicator of tree vigor as found in bark appearance is the thickness of the outer bark or the depth of furrows. The furrows must be in a prominent vertical pattern and the plates firm.

Bark types are not common to a particular diameter group. Slightly more than one-half the

Table 1. — Coefficients of correlation between specific gravity and rings per inch

Position (in. from pith)	n	r	r^2
1	47	.030	.0009
2	58	.108	.0117
3	58	.145	.0210
4	59	.044	.0019
5	55	.023	.0005
6	45	.078	.0061
7	40	.207	.0428
8	23	.000	.0000

bark type 1 trees are growing at a rate of less than 13 rings per inch as averaged over the last 3 inches of radial growth.

Specific gravity based on the average of 61 trees in a 30-acre stand closely agrees with the average as reported from 12 stands in 8 states. Growth rate and specific gravity are not correlated to a significant degree.

Literature Cited

Arbogast, Carl, Jr. 1957. Marking guides for northern hardwoods under the selection system. U.S. Forest Serv., Lake States Forest Exp. Sta., Sta. Pap. 56, 20 p.

Burkle, J. L., and S. Guttenberg. 1952. Marking guides for oaks and yellow-poplar in the southern uplands. U.S. Forest Serv. South. Forest Exp. Sta. Occas. Pap. 125, 27 p.

Good, H. M., P. M. Murray, and H M. Dale. 1955. Studies on heartwood formation and staining in sugar maple, *Acer saccharum* Marsh. Can. J. Bot. 33: 31-41.

Kennedy, R. W., and J. W. Wilson. 1954. Studies on smooth and cork-bark *Abies lasiocarpa:* I. Fiber length comparisons. Pulp Pap. Mag. Can. 55:7, 130-132.

Lisboa, J. M. B. 1961. Specific gravity pattern of black willow. M. F. Thesis, Louisiana State Univ., Baton Rouge. (Quoted from Webb)

Paul, Benson H. 1963. The application of silviculture in controlling the specific gravity of wood. U.S. Dep. Agr. Tech. Bull. 1288, 97 p.

Seidel, Herbert. 1948. Characteristics of mineral stain in hard maple, *Acer saccharum* Marsh. M.S. Thesis, New York State Coll. Forest., Syracuse, 48 p.

U. S. Forest Service, Forest Products Laboratory. 1955. Wood Handbook, U.S. Dept. Agr., Agr. Handb. 72, 528 p.

Webb, Charles D. 1964. Natural variation in specific gravity, fiber length, and interlocked grain of sweetgum (*Liquidambar styraciflua* L.) in the south Atlantic states. Ph.D. Thesis, School Forest., N. Carolina State of the Univ. N. Carolina, Raleigh, 138 p.