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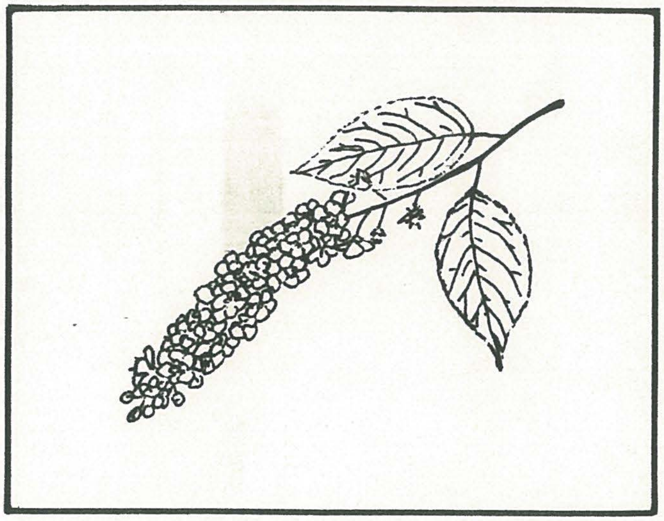

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SELECTIONS OF MAPLE AND BIRCH TREES WITH HIGH RESISTANCE TO SPREAD OF DECAY ASSOCIATED WITH WOUNDS

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ABSTRACT. Sugar maple, paper birch, and yellow birch trees selected as superior for form on the White and Green Mountain, Allegheny, Monongahela, and Nicolet National Forests were wounded with drill holes. After one and two growth seasons, the columns of discolored wood associated with the wounds were determined with the twisted-wire electrode and the Shigometer. Double-needle electrodes and the Shigometer were used to determine cambial electrical resistance of the superior trees, comparison trees, and from 15 to 30 neighboring trees of the same species. From these data, trees with the smallest columns of defect and the highest vitality were selected as superior for form, growth rate, and resistance to decay.

TO MOST PEOPLE, superior trees are those with rapid growth or good form, or both. We believe that to be superior a tree also should be superior on the inside. Trees with few or small internal defects yield more high-quality wood and more high-quality products.

Research on several tree species indicates that resistance to the spread of decay associated with wounds is under moderate to strong genetic control (Garrett and others 1979, Santamour 1979, Armstrong and others 1981, Lowerts and Kellison 1981). Other studies provide information that supports this view (Shigo and Sharon 1970, Garrett and others 1979, Shigo and Wilson 1977, Walters and Shigo 1977, Shigo and others 1977a, Shigo and others 1977b, Schmitt and others 1978, Eckstein and others 1979, Bauch and others 1980, Shigo 1982).

The rationale for selecting decay-resistant trees is not based on the tree's ability to resist infection, but on the tree's ability to rapidly and effectively set boundaries to resist the spread of decay. This boundary-setting, wound-response process is called compartmentalization. A model of the process is called CODIT, an acronym for Compartmentalization Of Decay In Trees. An understanding of CODIT makes it possible to begin selecting trees resistant to the spread of decay. Details on compartmentalization and CODIT are discussed in detail in a number of published studies (Shigo and Marx 1977, McGinnes and others 1977, Shortle 1979, Shigo and Shortle 1979, Shigo 1979, Shigo 1979, Shigo and Tippett 1981, Shigo and Hillis 1973).

On the basis of this information, and discussions with geneticists--Dr. Peter Garrett, Dr. Richard Miller, and John Murphy--we initiated a field wounding test on trees that already had been selected as superior on the basis of form, as given in United States Forest Service Guidelines R9-2470-22, June 22, 1966, as revised November 1977. Our objective was to determine which of the individual superior sugar maple, *Acer saccharum* Marsh., paper birch, *Betula papyrifera* Marsh., and yellow birch, *Betula alleghaniensis* Britt. trees also were superior on the inside to resist the spread of decayed wood associated with the drill wounds.

MATERIALS AND METHODS

Shigo (1978) includes detailed information on materials and methods for such a study. The following summary includes slight changes in the procedure.

Wounds were drill holes 2 cm wide and 5 cm deep, 3 per tree at 1.4 m aboveground. Care was taken not to wound areas near other wounds or bark distortions.

Cambial electrical resistance (CER) was measured at two positions on the trunk with double insulated electrodes attached to the Shigometer[1/] (Wargo and Skutt 1975, Shortle and others 1977, Davis and others 1980). Comparison trees and from 15 to 30 neighboring trees of the same species also were measured at two positions.

Wounding and CER measurements began in the spring of 1979 with 34 yellow birch and 81 sugar maples, and 18 paper birch were wounded and measured. The tests were conducted on the White Mountain, Green Mountain, Allegheny, Monongahela, and Nicolet National Forests.

1/ The use of trade, firm, or corporation names in this paper is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the U.S. Department of Agriculture or the Forest Service of any product or service to the exclusion of others that may be suitable.

Measurements for column length began in fall of 1980 with 83 sugar maple. In fall of 1981, 5 yellow birch, 2 sugar maple, and 16 paper birch were measured for column length.

For sugar maples, a 2.4-mm hole was drilled to 5 cm deep at 10 cm above each old drill wound. Another 2.4-mm hole was drilled lateral to the first hole by 5 to 8 cm. The ER of the wood above the old drill hole was compared with the ER of the sound wood lateral to the old drill hole. If the wood were similar at the two measuring points, the ER reading would be the same. If discolored wood were above the old drill wound, the ER would be lower than the wood in the control hole.

The double-needle electrodes were positioned vertically between bark fissures to determine the CER. Trees with lower CER usually are more vital than trees with higher CER. CER appears to be best correlated with the width of phloem (Carter and Blanchard 1978).

For birch, the 2.4-mm holes were drilled 20 and 30 cm above the old drill wounds, because discolored wood normally spreads faster in birch. For selections, trees with very short columns and a low CER were the aim--especially when the select trees had a low CER, and the CER at the site was very high.

RESULT AND DISCUSSION

After two growing seasons, highly resistant candidate sugar maple trees were selected from the four national forests in the Northeast (Table 1). Examples of trees not chosen are shown in Table 2. The trees selected for high resistance to the spread of decay also were selected because they had low CER, indicating high vitality. There are several sugar maple trees from the Nicolet National Forest that appear to be strong candidates for high resistance, but additional data, especially CER measurements, are lacking now.

Additional data from yellow birch and paper birch will be available after the 1982 growing season to enable us to make additional selections in these species.

The measurements taken for yellow and paper birch show that a few trees are clearly superior to others with regard to the spread of decay associated with wounds. A few trees had columns of discolored wood less than 20 cm.

In the sugar maple selections we chose 10 cm as the limit because many studies on other trees show that some individuals do limit columns to that length. Also, from other studies (Shigo and Sharon 1970, Walters and Shigo 1977) we know that most of the column length of discolored wood is formed after 2 years. The column will continue to increase, but at a much slower rate after 2 years.

Recent research shows that the CODIT model also is applicable to root decays (Shigo 1979, Shigo and Tippett 1981, Tippett and Shigo 1980, Tippett and Shigo 1981). This means that selection may be able to be made for resistance to the spread of decay in roots.

CODIT also is applicable to vascular wilts (Shigo and Tippett 1981, Tippett and Shigo 1981), which extends the possibility of using wounding studies to identify trees with a high ability to compartmentalize injured and infected tissues to small volumes.

Results from other studies by geneticists continue to show that the ability to compartmentalize is under moderate to strong genetic control. The trees we are selecting will be prime candidates for seed collection and for possible breeding experiments in the future. Our future forests depend on healthy trees that will produce high-quality wood products. Through programs of genetic selection and breeding we will be able to assure the high quality of future trees.

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Table 1.--Profiles of sugar maples selected as highly resistant to spread of decay associated with wounds after two growing seasons

National Forest	Tree No.	CER[1] selected tree	CER[2] Site Mean	CER site[3] Highest tree	Lowest tree	ER discolored columns[4] Above[5] Hole C	Above Hole C	Above Hole C	dbh (inches)	Age
White Mountain	131	8-11	13.8	25-19	8-11	500-500	500-500	500-500	14	82
White Mountain	122	11-8	12.3	17-18	6-7	500-500	500-500	500-500	13.5	66
White Mountain	118	7-9	8.8	11-14	6-6	500-500	500-500	500-500	17.5	105
Green Mountain	79	6-6	8.5	12-12	5-6	500-500	500-500	500-500	14.9	81
Green Mountain	78A	9-9	10.1	12-11	9-9	500-500	500-500	500-500	14.5	77
Green Mountain	76	8-8	10.4	11-15	8-8	500-500	500-500	500-500	16.9	98
Green Mountain	73	8-8	8.8	16-16	6-6	500-500	500-500	500-500	21.3	117
Green Mountain	55	8-8	13	17-15	8-8	30-30	40-40	30-50	13.7	67
Monongahela	116	7-7	10.4	16-12	7-7	500-500	500-500	500-500	14.3	80
Monongahela	118	4-8	11	17-15	8-8	500-500	500-500	500-500	13.8	70
Allegheny	M49	5-4	6.5	9-9	5-4	500-500	500-500	500-500	14.5	78
Allegheny	M46	7-7	8.8	15-11	6-7	500-500	500-500	500-500	11.7	59
Green Mountain	S40	7-8	9.4	12-12	6-8	500-500	500-500	500-500	15.1	75

1/ CER at 2 positions on trunk.

2/ CER mean of 15 to 30 trees--measurements per tree--of the same species in same area.

3/ CER of tree with highest and lowest measurement in area.

4/ ER with internal electrode of wood 10 cm above hole, and in control wood 5 to 8 cm lateral to the hole.

5/ Above hole = ER above large wound hole; C = ER of healthy wood above and lateral to old, large, wound hole.

Table 2.--Examples of profiles of sugar maples that were not selected as highly resistant to spread of decay associated with wounds, after two growing seasons

National Forest	Tree No.	CER[1] selected tree	CER[2] Site Mean	CER site[3] Highest tree	CER site[3] Lowest Tree	ER discolored columns[4] Above Hole C[5]	ER discolored columns[4] Above Hole C	ER discolored columns[4] Above Hole C	dbh (inches)	Age
White Mountain	123	9.7	12.4	24-24	9-7	300-500	150-280	220-500	15.7	85
White Mountain	115	14-12	13	18-22	8-8	48--420	420-500	310-440	15.1	88
Green Mountain	80	15-13	14.6	25-21	8-10	190-260	80-500	500-500	12.9	75
Green Mountain	84	8-9	11	15-13	7-8	190-170	190-310	230-280	18.1	90
Monongahela	120	12-9	13	24-26	8-9	290-500	500-500	400-500	12.6	62
Monongahela	115	13-10	11.7	14-17	9-8	260-500	50-60	500-500	12.1	65
Allegheny	M48	5-4	7.3	10-9	5-4	250-500	500-500	180-480	18.0	88

1/ CER at two positions on trunk.

2/ CER mean of 15 to 30 trees-measurements per tree--of the same species in same area.

3/ CER of tree with highest and lowest measurement in area.

4/ ER with internal electrode of wood 10 cm above hole, and in control wood 5 to 8 cm lateral to the hole.

5/ Above hole = ER above large wound hole; C = ER of healthy wood above and lateral to old, large, wound hole.