TRUNK WOOD DISCOLORATION AND DECAY FOLLOWING ROOT WOUNDING

by Frank S. Santamour, Jr.

Abstract. *Discoloration and decay of trunk wood following root severance occurred only in trees that exhibited weak Wall 2 compartmentalization of chisel wounds made in the trunks. Furthermore, trunk wood discoloration only occurred when the root cambium died back to, or beyond, the junction of root and trunk. Thus, that trunk wood discoloration induced by root severance may have been the result of trunk injury (cambial death) rather than the root wounding. Other factors such as tree species, root size, and season of severance may also play a significant, but presently unknown, role in this process.*

Compartmentalization of wood discoloration and decay following wounding of tree **trunks** has been shown to be under moderate to strong genetic control (1,4,6). Wounding of the woody **root** system is also a common occurrence in the life of a landscape tree, but we know little about the effects of such wounds. Whereas wounds to the trunks of trees generally occupy only portions of the stem, root wounds frequently involve complete cross-sectional severance of the root.

When trees are dug in the nursery, whether for transplanting or final sale, many roots of various sizes are severed. Trees growing along city streets often have their roots severed as a result of sidewalk relocation or public utility repair and maintenance. Roots may also be severed to allow for the injection or infusion of fungicides, as practiced in Canada for control of Dutch elm disease.

The present studies were undertaken to determine the nature and extent of trunk wood discoloration caused by root wounding, the possible relationship between wood discoloration and compartmentalization resulting from trunk wounds and root wounds, and the possibility of genetic control of the compartmentalization response in roots.

Materials and Methods

Two sets of experiments were designed to simulate (A) root severance of mature street trees such as might occur during sidewalk relocation and (B) root severance that occurs when young trees are dug or transplanted with a tree spade in the nursery.

Mature trees. The oldest plants available for the mature tree study were red maples (*Acer rubrum*) of known parentage in plantations GP-3-46 and GP-4-46 established by the USDA Forest Service in Beltsville, Maryland in 1946. In 1978, these trees were 38 and 39 years old from seed. Some trees in these plantings had been used in a previous study of stem wound compartmentalization (4). Three trees of each of 12 progenies that had shown significant differences in the length of vertical discoloration and Wall 2 (CODIT Model (9), inward spread) compartmentalization following stem wounding were selected for root wounding. In addition, a single tree of each of the female parental clones was also root-wounded. All of the trees had been stem-wounded in 1974 and again in 1979 with chisel wounds.

A single root of each tree was severed within 0.5 m of the trunk with a chain saw on November 16, 1979. Care was taken to insure that no root branching occurred between the point of severance and the trunk of the tree. The diameters of roots severed in the upper 30 cm of soil ranged from 25 mm to 128 mm (most were 50 to 60 mm) and were somewhat positively correlated with the vigor of the tree. Trunk and root diameters were measured for each tree.

The second group of mature trees were oaks in a provenance (seed source) planting at Longwood Gardens, Kennett Square, Pennsylvania. This planting was part of the Michaux Quercetum Project, a joint study of the Morris Arboretum of the University of Pennsylvania and the USDA Forest Service (5). Seed had been collected from individual mother-trees in various localities in the fall of 1953 and sown directly in prepared seedbeds. Thus, in December, 1978, the trees were 25 years old from seed. Five trees from each of two seedlots of black oak (*Quercus velutina* from Illinois and Michigan) and white oak (*Q. alba* from Maryland and Virginia) were selected for root wounding. A single root of each

of the 20 trees was severed with a chainsaw, as with the maples, on June 6, 1979. At the same time, each tree was stem-wounded by making 3 chisel cuts into the sapwood and a drill hole into the heartwood. Trunk and root diameters were measured for each tree.

In November, 1983, all root-wounded oaks and maples were cut down. Cross-sectional cuts were made through the trunk and the roots to allow measurement of the extent of vertical and horizontal discoloration resulting from both stem and root wounds.

Young trees. The young trees used in this study were part of the provenance and progeny tests of the National Arboretum's project in "Cytogenetics, Breeding and Evaluation of Landscape Trees". The sweetgums were first-generation hybrids between known parents of *Liquidambar orientalis* x *L. styraciflua* and the planetrees were control-pollinated hybrid progenies between *Platanus occidentalis* and *P. orientalis* (2,3). Both the sweetgum and planetree crosses had been made in 1968, and the trees outplanted in 1971.

On December 7, 1978, ten trees each of the sweetgum and planetree progenies were root-wounded by a simulated tree digging operation, using a tractor-mounted tree spade with a 30-inch ball capacity. Each tree was lifted slightly with the tree spade, to insure that all roots had been severed, and the ball was lowered back into its original position. The trunk of each tree was also wounded at approximately 1.3 m by chisel or drill wounds on opposite sides of the trunk. The height and diameter of each tree were measured at the time of wounding.

The above procedure was repeated on 10 other trees of sweetgum and planetree on April 25, 1979, after vegetative growth had begun. According to the standards of the American Association of Nurserymen, all of these sweetgums and planetrees were definitely "short-balled" and should have been dug with a larger diameter ball.

All young trees that had been wounded during the dormant or active growth period were dug with a tree spade in November 1983. The soil was washed from the root systems, and each tree was dissected to determine the extent of wound-induced wood discoloration.

We also made chisel wounds on June 27, 1980, in major roots of three mature red maples that had exhibited weak compartmentalization to stem wounding and three that had shown strong compartmentalization.

Results

I differentiate between trees that are strong or weak compartmentalizers of trunk wounds (made by chisel or drill) on the basis of the tree's ability to wall off the progression of discoloration and decay from the wound area into the interior of the tree (Wall 2 compartmentalization). This would also be true for roots wounded by chisel cuts. Complete severance of a root is a far more complicated situation, probably involving several "walls", and the only significant measurement in this study was the extent of root wood discoloration and decay from the point of severance to the base of the tree.

1. All of the mature red maples that had been chisel-wounded in the roots exhibited strong Wall 2 compartmentalization regardless of whether they were strong or weak compartmentalizaers to trunk wounding.

2. None of the 40 saplings of sweetgum and planetree that had been root-wounded by digging with a tree spade showed any wood discoloration or decay in the trunk that could be associated with root severance. This was true whether the trees were strong or weak compartmentalizers of trunk wounds or dug (root-wounded) during the growing season or the dormant season. No tree showed root wood discoloration or decay more than 7 cm from the point of severance and new root branching frequently occurred "above" that point.

3. None of the 36 mature red maples that had a major root severed with a chain saw exhibited trunk wood discoloration or decay that resulted from root severance. Again, this was true regardless of the tree's response to trunk wounding. No root wood discoloration or decay occurred beyond about 6 cm from the point of severance.

4. Only among the 20 mature oaks did we observe discoloration and decay in some of the trunks 4 years after root severance. This occurred in 6 trees, 4 white oaks and 2 black oaks, *all* of which exhibited weak Wall 2 compartmentalization of trunk wounds (Fig. 1). However, there was no trunk wood discoloration and decay in 5 other

weak-compartmentalizing white oaks or 4 other "weak" black oaks.

Trunk wood discoloration and decay was observed **only when the root cambium had died back to, or beyond, the junction of root and stem.**

Furthermore, it appeared that the severance of the tree root was not the key element in causing or allowing decay to enter into the trunk wood. Rather, it was the "injury" or "wounding" of the tree trunk, caused by death of cambial tissue at or above the root-stem junction that was the proximal cause of trunk wood discoloration.

Our observations can best be explained using the following sequence of illustrations. Figure 2 shows the base of an oak tree in which the root cambium is intact at the junction of root and trunk. No trunk wood discoloration was noted in this tree or in other trees with similarly intact cambium at this point. In Figure 3 it is evident that the death of the root cambium did extend to the root-trunk junction. However, even though the entire root cross-section was decayed at the original point of root severance, the area of discoloration and decay in the trunk was limited to the zone where the cambium had not died back. A more graphic demonstration of this similarity in size between the trunk "wound" (zone of cambial death) and the trunk decay is given in Figure 4. Although the "width" of the decay zone in the root measured 7 cm across at its widest point in the root, the width of dead cambium is only about 3 cm where the root joins the trunk. This is reflected in the small area of decay found in the trunk — cut as close to ground level as possible.

The "injury" to the trunk caused by severance of the root of the tree in Figure 5 was obvious even before the duff and soil were removed from around the base of the tree. The lower surface of the trunk cross-section taken just above the visible bark injury (Figure 6) reflects the width of the wound at the trunk-root junction rather than the narrower "point" just below the cross-sectional cut.

The vertical extent of discoloration and decay in the trunk wood 4 years after root severance did not exceed 30 cm when the root cambium had died back only to the root-trunk junction. Even in the tree pictured in Figure 5, where trunk cambium death was obvious above ground level, trunk wood discoloration did not extend beyond 60 cm up the tree. In all cases, the cross-sectional area of wood discoloration became smaller with increasing distance from the base of the tree.

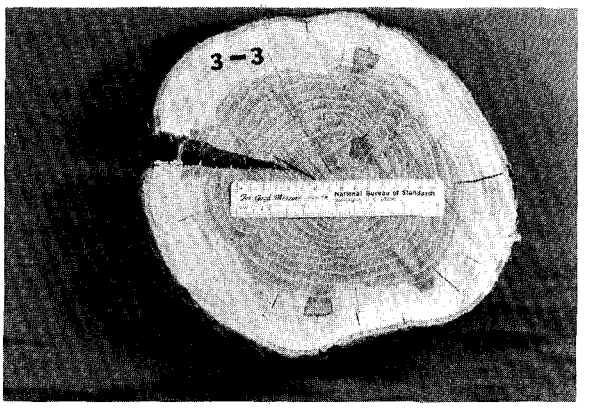

Figure 1. Trunk cross-section of white oak (tree 3-3) showing weak Wall 2 compartmentalization of chisel wounds. The inward spread of discoloration from the wound site is partially obscured by the outward spread of heartwood during the 4-year period between wounding and felling.

Figure 2. Base of a black oak tree showing little dieback of root cambium as a result of root severance.

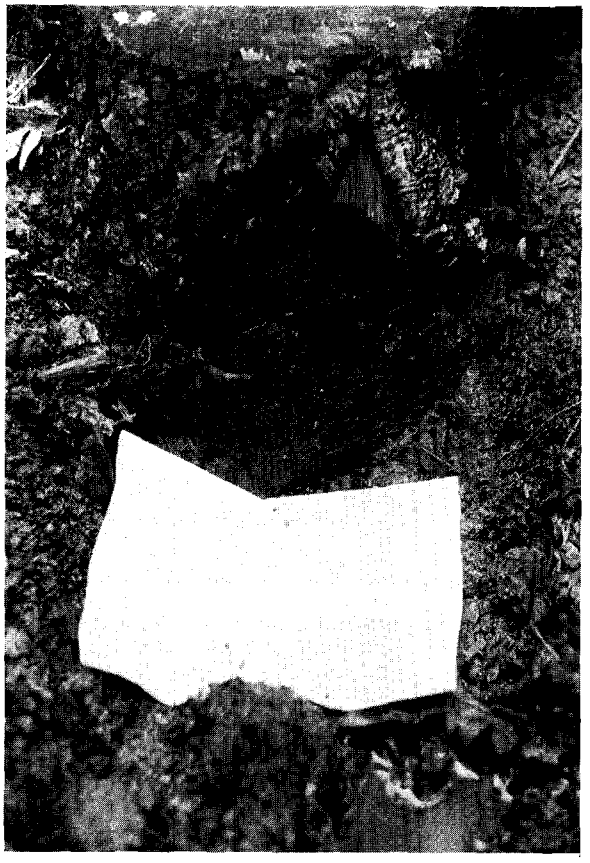

Figure 3. Base of a white oak tree showing root cambium dieback to the root stem junction. Original point of root severance is below white paper.

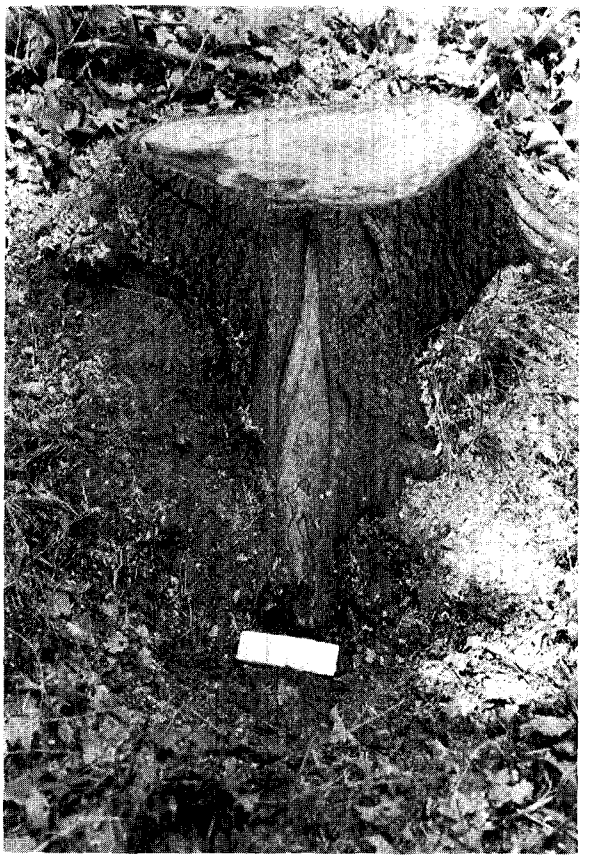

Figure 5. Base of trunk of black oak (tree 28-14) showing extent of cambial death associated with root severance.

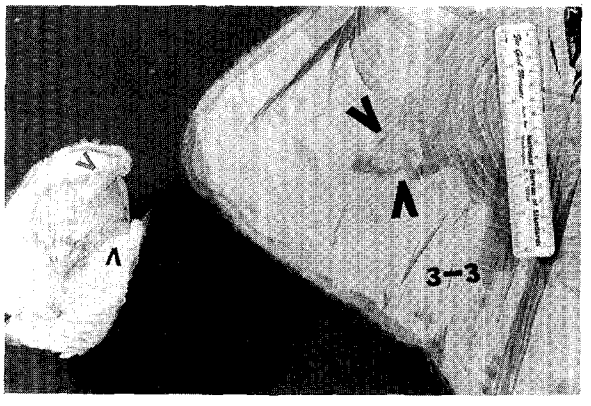

Figure 4. Left: Section of root of weak compartmentalizing white oak (tree 3-3) at junction of root and trunk. Right: Trunk cross-section of same tree showing similarity of decayed area with zone of cambial dieback in root.

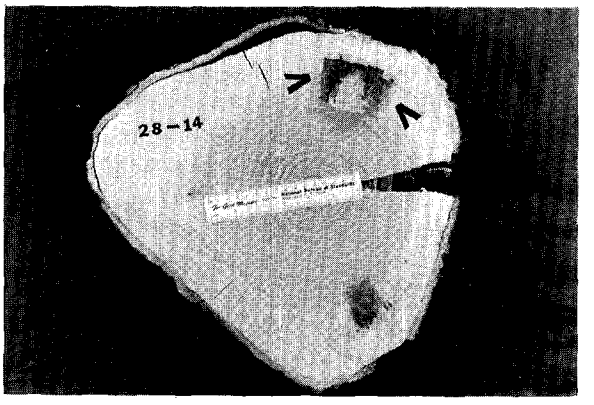

Figure 6. Trunk cross-section of black oak (tree 28-14) taken just above area of cambial death; showing comparability of decayed area in trunk to that at base of tree.

Discussion

Our observations can support certain inferences of potential significance. First, there may be wide differences between species (or genera) in their ability to "resist" trunk decay after root severance. The red maples and oaks were growing on different sites, but the observed differences between genera in trunk decay potential appeared unrelated to site conditions. Likewise, the lack of trunk decay caused by root severance in the spade-dug juvenile trees of *Platanus* and *Liquidambar* would tend to indicate that the roots of these species (genera?) can also be severed with few adverse effects on the soundness of trunk wood. The oaks may be more susceptible than the other species tested. There is, more than likely, a vast pool of unassembled data in the combined experiences of urban tree managers and nurserymen in this regard, even if few persons have actually "dissected" the injured trees.

Second, it may be that there is **some** relationship between strong Wall 2 compartmentalization of trunk wounds and "resistance" to trunk decay following root severance. Our data are far from overwhelming on this point. However, the fact was that trunk wood discoloration and decay occurred **only** in trees with weak Wall 2 compartmentalization in the trunk.

There was also an "apparent" correlation of root size (average diameter) with root cambium death and subsequent decay in the trunk. In the oaks that exhibited trunk wood decay, the diameters of the severed roots ranged from 83 mm to 122 mm, with an average of about 97 mm. The root diameter of those trees that did not show trunk decay averaged 63 mm, and on only one tree was it above 97 mm. Severance of large roots, therefore, is more likely to result in trunk decay in weak compartmentalizing trees.

Would the severance of large roots in strong trunk wound compartmentalizers lead to trunk decay? Of the 36 red maples root-severed in this study, most had root diameters between 5 and 6 cm. Only 4 trees, all strong Wall 2 compartmentalizers, had severed roots in the 8-12 cm range, and none of these trees exhibited any discoloration or decay in the trunk wood, nor did the root cambium die back to the root-stem junction.

Does the season of root severance have any influence on the potential for root and stem decay? There were no differences between groups of sweetgums and planetrees dug during the dormant or growing season. The maples were wounded during the dormant season, but the oak roots were severed in June. However, not all of the oaks showed cambial dieback or trunk wood discoloration and decay. Whether the time of year of root severance would be of more significance than genetic or size factors is problematical.

So, it may be that trees that exhibit strong Wall 2 compartmentalization of trunk wounds would also be less likely to suffer trunk damage and trunk wood decay as a result of root wounding. Can we select trees of this type for future planting? The answer is an unequivocable "yes". Recent research (7) has demonstrated the efficacy of selecting both juvenile and mature trees that are inherently strong Wall 2 compartmentalizers.

Furthermore, it is possible that we already have a great number of strong compartmentalizing trees in our landscape plantings. Santamour (6) has shown that **all** the cultivars he tested (20 cultivars in 7 genera) were strong Wall 2 compartmentalizers and concluded that their ability to be propagated by grafting, which involves wounding, constituted a selection for strong compartmentalization. If grafting is successful only when both scion and stock are strong compartmentalizers, then we also have inadvertently been selecting for strong compartmentalizing rootstocks, and root systems. Research to extend and strengthen these observations is currently underway.

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ABSTRACT

HENSLEY, D.L. and C.F. FACKLER. 1984. **Do water-holding compounds help in transplanting?** Am. Nurseryman 159(3): 93.

A number of water-holding compounds have been introduced into the horticultural market within the past few years. Most of these are starch-hydrolyzed polyacrylonitrile copolymers and acrylamide and acrylic acid salt copolymers. These are sold under a number of brand names. The use of these and similar materials has improved the water status of plants during production. The purpose of this study was to determine if water-holding compounds are useful as transplant aids for ground covers. Root dips with Terra-Sorb had no effect on survival or growth. Root dips also did not help to establish these species. Little benefit is likely where rainfall is adequate or where supplementary irrigation is available.