

FOREST PRACTICE

DECAY IN TREES

ALEX L. SHIGO
Chief Plant Pathologist
USDA, Forest Service
Northeastern Forest Experiment Station
Durham, New Hampshire

Decay is now and always has been one of the major problems affecting the quality of wood in all species of trees and in all types of wood products throughout the world.

Decay begins with the events that follow wounding of a tree. A tree reacts with a protective chemical response in the living wood tissues exposed by the wound. The chemical changes form a protective barrier against invasion by microorganisms. This barrier is effective against most microorganisms most of the time.

Bacteria and fungi that do not cause decay are usually — but not always — the pioneer microorganisms that are able to surmount this chemical barrier and invade the tree. The tree then responds further in a chemical way to the invasion. Most of the time the protective responses in the wood are effective in preventing invasion; but not always.

Other species of microorganisms continue to invade, in a wave action — a *succession*. After the living wood cells are killed, decay microorganisms invade and digest cell walls. To say it another way, the decay microorganisms are the “clean-up crew”. They do their job effectively.

A second line of defense occurs after

the microorganisms have invaded the tree. The tree walls off the invaded tissues. They are *compartmentalized*.

The new cells formed by the cambium after a wound has been inflicted are different in many ways from those cells formed normally. These altered cells act as a physical barrier to the invading microorganisms. After compartmentalization, the cambium begins to form normal tissues; and these new wood tissues are not affected unless other wounds occur.

Compartmentalization of invaded tissue has been observed in deciduous hardwoods, conifers, and tropical hardwoods. It is because of compartmentalization of invaded tissues that you will often see a tree that has a hole in it surrounded by clear, healthy wood. The diameter of the tree when it was wounded was the diameter of the defect.

The Decay Model

The succession of events that occur after a tree has been wounded can be depicted in this model:

THE WOUND —

Stage I

Tree response to wounding: slight wood discoloration.

Stage II

Infection & invasion processes. Tree and microorganisms interact. Intense discoloration of wood.

Stage III

Decomposition of cell walls. Wood decay organisms interact with other microorganisms.

– TOTAL DECOMPOSITION OF WOOD

The wood in the living tree that is altered only slightly after wounding may be difficult to detect in green timber. But these tissues will be different from healthy tissues after the wood has dried. In most cases the tissues in Stage I of the decay process – those altered primarily as a result of host response to wounding – will dry to a color slightly different from the healthy wood. In sugar maple and birches the tissues in Stage I dry to shades of pink, while healthy wood will remain white.

Tissues that are in Stage II present more severe problems during drying. They have been invaded by pioneer microorganisms. These microorganisms digest the remains of the living cell contents, and it is thought that they may also digest some of the materials in the cell walls. The action of the pioneer microorganisms may cause the tissues to collapse or honeycomb after drying.

Discolored tissues in Stage I and the early part of Stage II can add value to some wood products. The wood may be colored, though the strength is not reduced. The colors also add figure to the wood. But where does valuable discolored wood in the early period of Stage II end, and where does valueless discolored wood in the later part of Stage II begin?

Too often valuable wood in Stage I and II is rejected because it is considered defective. An example is “redheart” in birch. The pink wood in Stage I is valuable, but “redheart” in Stage II is valueless. One of the major problems here is old terminology. “Redheart” in birch is often used to describe any discoloration, and sometimes even decay. The same can be said for “wetwood.” Here we have Stage II tissues but only slight color changes.

A great saving can be made in time,

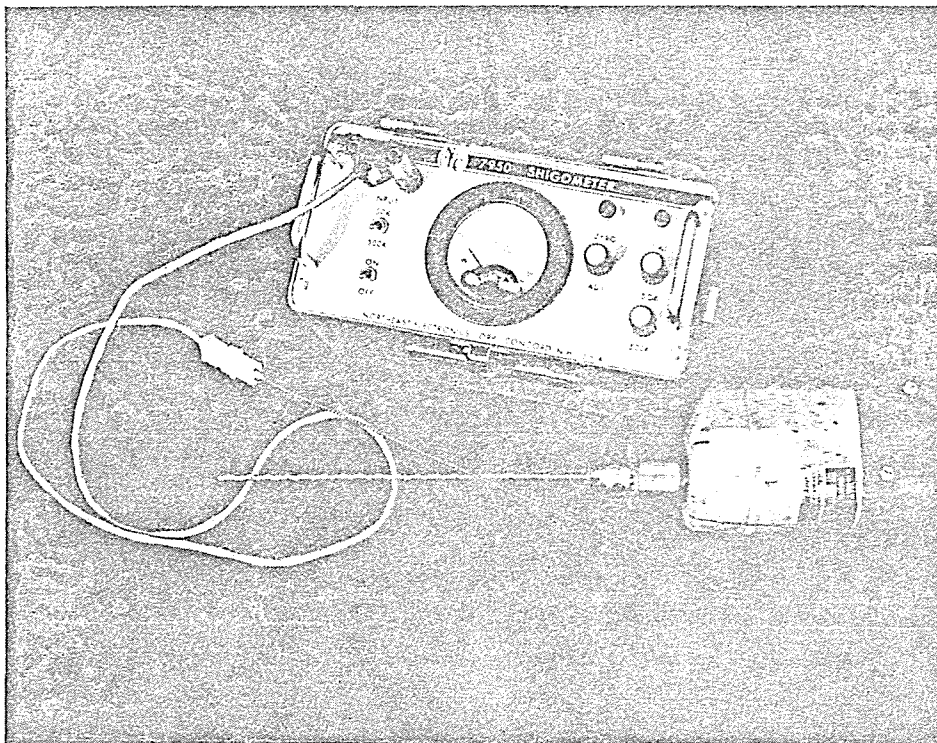


Figure 1. The Shigometer for detecting discolored wood and decayed wood in living trees and utility poles consists of a portable battery-operated drill with a long narrow drill bit, a twisted-wire probe that is inserted into the hole made by the drill bit, and a meter that produces a pulsed electric current and measures resistance to 500 K ohms. When the probe tip passes from sound to unsound tissues an abrupt decrease in resistance is indicated on the meter.

labor, and money by recognizing many of these small but very important defects in the living tree, cut log, or even in the freshly sawn board, by diverting the wood before it is made into a product that must be discarded because of the defect. The earlier the defect is detected, the greater the saving in time, labor, and money.

A NEW TECHNIQUE FOR DETECTING DISCOLORED AND DECAYED WOOD IN TREES

An electrical device has been developed for detecting discolored and decayed wood in living trees (fig. 1). Called a *Shigometer* by the manufacturers (Northeast Electronics Corporation, of Concord, New Hampshire), this device measures the resistance of the wood to a pulsed electrical current. (Mention of products is for information only, and

should not be considered an endorsement by the Department of Agriculture or the Forest Service.)

As invaded tissues die, discolor, and decay, concentrations of minerals increase; and as mineral concentrations increase, resistance to a pulsed current decreases. This method for detecting discolored and decayed wood is very simple, and it has been field-tested on many trees during both winter and summer conditions.

First a small hole, 3/32 inch in diameter, is drilled into the tree. Drill bits 8 and 12 inches long have been used. It takes less than a minute to drill such a hole in an oak tree. The drill bits are mounted in light-weight portable battery-operated drills. Then a long twisted wire probe, which is attached to the meter, is inserted slowly into the hole.

As the probe tip passes through healthy wood, the resistance of the

tissues to the pulsed current is fairly constant. The ohmmeter on the meter indicates only very slight changes. But when the probe tip passes from healthy tissues to discolored or decayed tissues, there is an abrupt decrease in the resistance. The needle on the meter swings to the left.

The magnitude of the decrease in resistance indicates the degree of tissue deterioration. The position or depth of the probe tip in the hole at the moment the needle begins to swing to the left indicates the exact position of the defect column. Because of compartmentalization, most—but definitely not all—columns in the tree are fairly uniform in diameter so that two probes from opposite sides can detect the diameter of the defect columns.

Experiments on wounds made by the drill bits show that the slight injuries heal very quickly, and very little or no columns of discolorations develop.

SOME KEY POINTS

Here is a brief summary of some key points that could help to minimize damage caused by discoloration and decay in living trees.

1. When thinning, favor trees with well-healed branch stubs. Remove cankered trees.
2. Prevent wounds; use every possible means to minimize logging injuries. Impress on logging crews the damage that can result from wounds.
3. Learn to recognize the early signs of internal defects: sapsucker wounds, sugar maple borer wounds, branch cankers, etc.
4. Shakes—ring and ray—are associated with wounds, but not all wounds form shakes.
5. Shakes in hemlock are commonly associated with sapsucker wounds.
6. Seams—especially basal seams—start from wounds, often old basal fire wounds.
7. Know that healthy maple and birch trees have no colored heartwood cores. Trees with many poorly healed branch stubs will have large central cores of discolored wood.
8. Mineral streaks and stains start from small wounds, usually sugar maple borer wounds and sapsucker wounds.
9. Cambium miner defects can be seen on the cut ends of the logs or on the freshly cut stump.
10. Pink wood in birch—Stage I—is different in many ways from “red-heart”—Stage II. Redheart has a foul odor.
11. Wetwood may not be darker in color than healthy wood; wetwood is associated with wounds.
12. Wood in Stage I will dry to a color slightly different from that of unaffected wood.
13. White, hard wound faces are usually associated with less decay than dark, soft wound faces.
14. Defects associated with stem stubs are the diameter of the stubs, and they go downward.
15. Cut the suppressed sprouts out; let the dominant ones with the well-healed branch stubs remain.
16. Minute insect holes in lenticels of paper birch indicate internal columns of discolored wood.
17. Discolored heartwood can form in oaks, pine, walnut, cherry, and other species that have a heartwood.
18. Prune dead and dying branches as well as low live branches from trees selected for pruning.
19. With the Shigometer it is possible to know with certainty the internal condition of the tree. 