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Decay: A problem in both young and old trees

By Dr. Alex L. Shigo

DECAY is a major cause of damage to trees throughout the world. Most tree owners learn about decay after it is too late—when a tree falls on a car, a power line or, worse yet, a person.

When a tree does fall during a storm, the broken trunk exposes the rotten interior. Decay is thought to be a problem only of big old trees. Nothing could be further from the truth. Decay is a major problem of young small trees, too. The decay seen in some of the big old trees that fall during a storm is the result of a long accumulative problem that started when the tree was young and small.

There is much that can be done to prevent and to minimize the impact of decay on trees. The best way to help the tree is to understand the problem. What is decay? How does it start? What can be done about it? Here are some answers that have come from my 17 years of research on decay, during which more than 5,000 trees—conifers, hardwoods and tropical trees—were dissected and studied carefully.

Dr. Shigo is chief plant pathologist, USDA Forest Service, Northeastern Forest Experiment Station, Durham, N.H.

Understanding Decay

Decay is a condition of the wood that results from digestion of the cell walls by microorganisms. The strength of the wood is reduced. The dry weight of the wood is decreased.

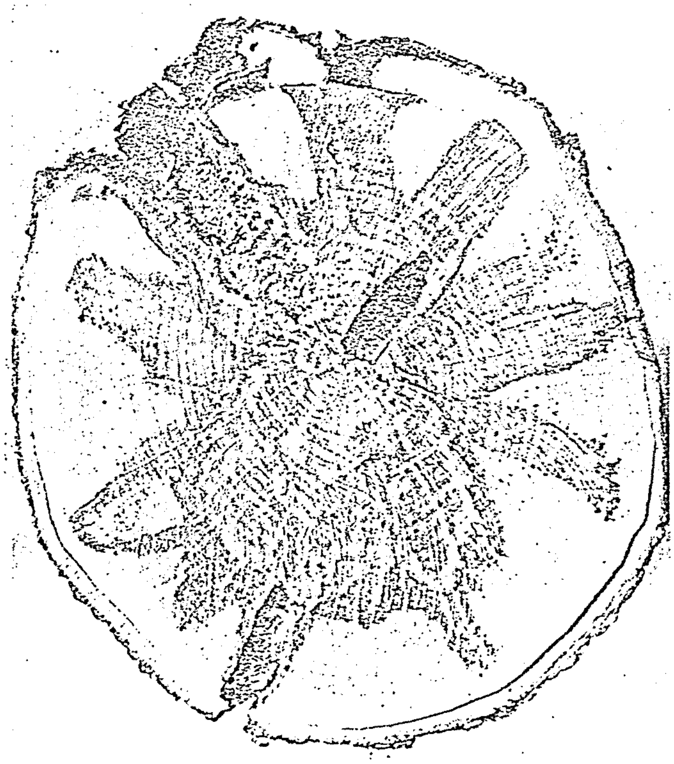
Wounds start the processes that can lead to decay, but it must be emphasized that not all wounds lead to decay. Most wounds heal. If this were not so, there would be no trees today.

A wound is any break in the bark that exposes the wood. Wounds can be caused by animals, birds, insects, fire, storms and man and some of hi[s] activities. A branch that is cut o[r] ripped off also constitutes a wound.

After a tree is wounded, the woo[d] around the injured and exposed woo[d] reacts. The tree sets up a stron[g] chemical barrier that keeps out mos[t] microorganisms. But some micro[-] organisms are able to surmount th[e] protective chemical barriers, and the[y] begin to interact with the tree.

When the invasion force of th[e] microorganisms begins to overcom[e] the protective force of the tree, th[e] microorganisms begin to move slowl[y] into the wood around the wound. Th[e] tree may later stall this invasion, be[-] cause, as the microorganisms move i[n] deeper, they come in contact wi[th] more living cells of the tree. Th[e] major point is that the tree still ha[s] many opportunities to stall the in[-] vasion.

When the microorganisms are abl[e]



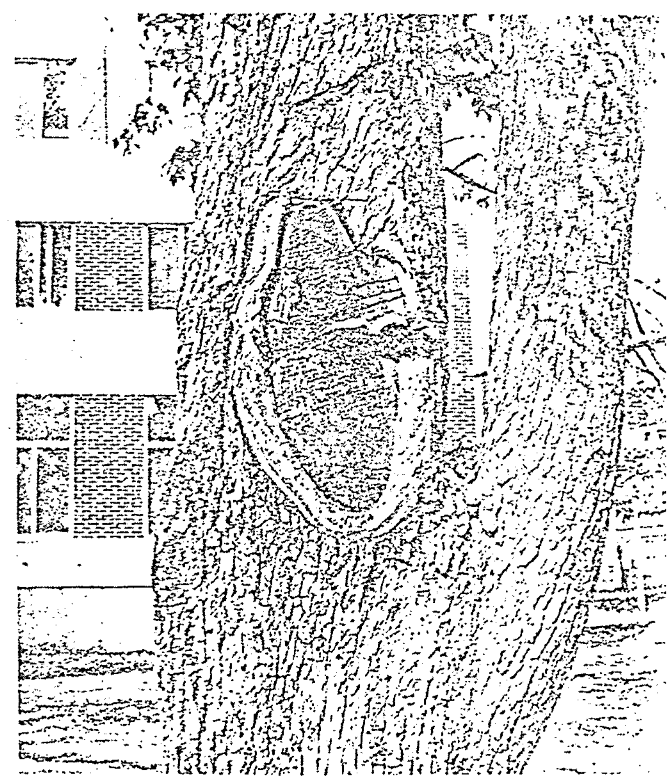


Fig. 1. (left) Decay associated with drill wounds on a young sugar maple. Trees can take only so much wounding befo[re] serious internal injury starts. Such weakened trees can be broken easily in a storm or attacked by aggressive insects or pathogen[ic] microorganisms that would kill it. Fig. 2. (right) Decay associated with this well-painted wound is indicated by the large fung[us] fruit body. Some wound dressings may stimulate callus formation, but they have little beneficial effect for preventing intern[al] decay. The painted surface may look good, but, too often, the decay microorganisms are already well-established and ev[en] protected behind the dressing.

to continue their invasion, the tree still has another built-in system for protection. The tree walls off or compartmentalizes the invaded tissues.

A tree is a highly compartmented plant. After wounding, the tree confines the injured and invaded tissues to the least number of compartments. In a sense, each growth ring can be thought of as a tree. Every year, a new tree envelops all the other trees inside it. Of course, there are radial connections between the trees, mainly through medullary rays.

Compartment Walls

Each growth ring, or tree, is divided into compartments. A compartment is a room with radial side walls made up of sheets of ray cells and tangential side walls made up of the last cells that formed in each growth ring. The top and bottom of the compartment have openings in them because of the elements—vessels, tracheids—that conduct liquids in the wood. One of the first events that happen after wounding is a plugging of the liquid transport system. Tops and bottoms then begin to form on the compartments.

When a microorganism invades, it moves from compartment to compartment. The weakest walls are the tops and bottoms. The microorganisms usually move upward and downward first. Then the microorganisms move inward through the tangential back walls. If the invasion force is still active, the microorganisms begin to move through the radial side walls.

(In this description, my intent is to give a mental picture of the inside of a tree, and the terms used are those that are easiest to picture. Of course, in a tree, there are no anatomical features that can be accurately described as walls.)

Barrier Zone

If the invading microorganisms are able to move through many compartments, the tree still has a second system of compartmentalization. The cambium injured by the wound begins to form cells that are different in many ways from those formed normally. The newly formed cells create a barrier zone that separates the tissues present at the time of wounding from the new trees that will continue to form later.

The barrier zone is very effective as a major wall that confines the invading microorganisms to the tissues present at the time of wounding. For example, if a tree is three inches in diameter when it is wounded and it is not wounded again during its life,

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Fig. 3. Compartmentalization of injured and infected wood.

(A) The diameter of the hollow was the diameter of this birch when it was wounded 50 years ago. The arrows marked (4) indicate the position of the barrier zone that was formed by the tree after it was wounded.

(B) The wound on the maple was walled off from the three directions: (2) By back tangential walls, (3) by side radial walls and (4) by the barrier zone that formed after wounding.

(C) The discolored wood associated with a wound on this maple was walled off from two directions: (3) By side radial walls and (4) by the barrier zone that formed after wounding.

(D) Several drill wounds in a maple, showing how they are walled off.

(E) Radial view of a drill hole and associated infected wood in a maple. The arrows and numbers (1) indicate the position of plugged vessels that serve to limit the longitudinal spread of the microorganisms. After the tree is wounded and microorganisms begin to invade, they usually move upward or downward. When walls (1, 2 and 3) fall to the invading microorganisms, the barrier zone (4) usually still confines the injured and infected tissues, and the newly formed cells in the subsequent growth rings are not infected.

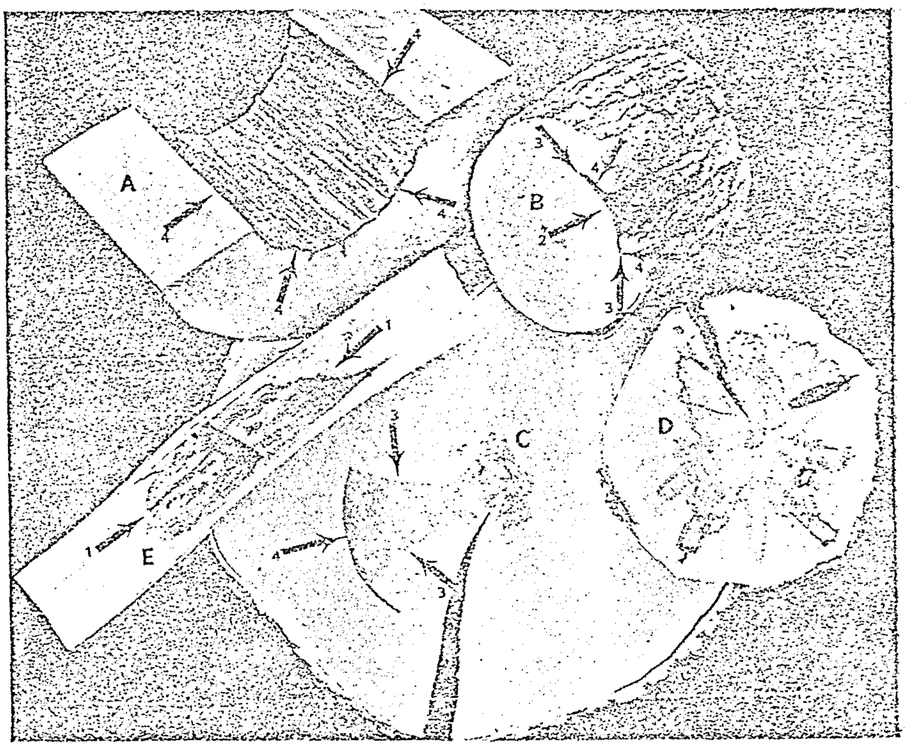
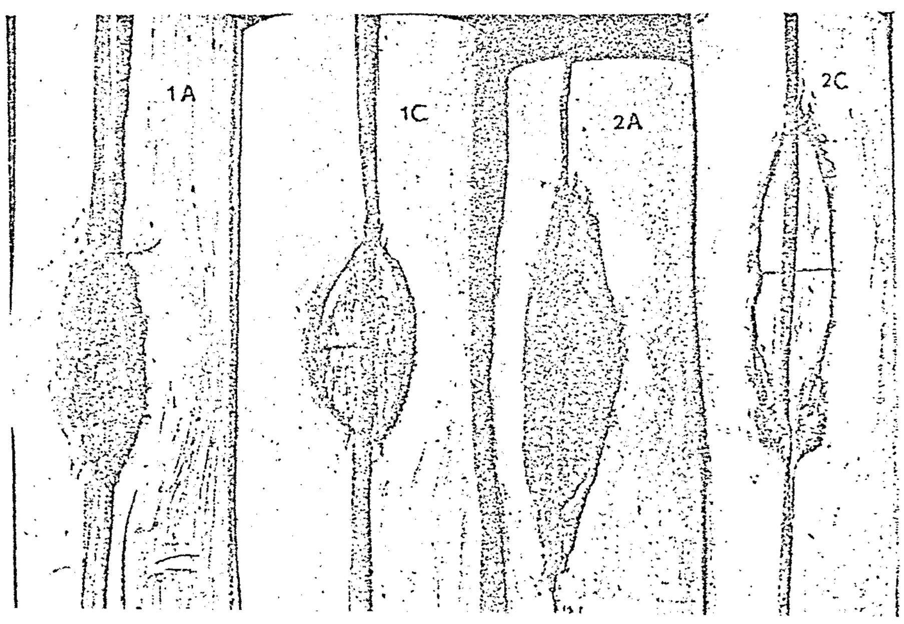


Fig. 4. Some trees of the same species apparently can heal wounds more effectively than others. The two wounds (1A—asphalt—and 1C—control) were on the same tree. There was no dieback around the wounds. The two wounds (2A—asphalt—and 2C—control) were on the same tree. Those wounds had extensive dieback. All wounds were four years old.



TREE DECAY

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the worse that can happen is that there will be a column of decay three inches in diameter inside the tree.

This means that the microorganisms that do invade do not attack the new trees that will form in following years unless new wounds are inflicted at later times. An understanding of compartmentalization is the key to understanding the development of decay in trees.

Understanding Healing

Healing in woody plants is usually thought of as wound closure, related to callus formation. Yet, this is only a minor part of the wound-healing process. Many large wounds on large trees will never close, but they will heal—from the inside.

Healing is a two-part process: External closure and internal compartmentalization. The internal part of healing is much more important than the external part. If wounds close completely, the internal invasion process will almost stop. But, in many trees, new wounds, such as broken branch stubs, continuously open the tree to new infections.

The commonly used wound dressings, especially the asphalt-based materials, do little to stop decay. Some materials, such as lanolin, may indeed stimulate callus formation, but these materials do little to prevent deep invasion by wood-inhabiting microorganisms. Thick coatings of dressing may actually cause more problems as bubbles form on the wound surface, because such bubbles make excellent sites for microorganisms to grow.

Most of the research on wound dressings has been done on the closure phase of healing. Few studies have examined the internal phase. Results of a five-year study on red maple and American elm indicated that the commonly used wound dressings did not prevent decay.

Trade-Offs

A treatment to prevent or stall a disease may involve injection of materials into the tree. The tree would receive some wounds this way. The wounds might cause some decay, but the tree would be saved by the treatment. On the other hand, the decay in the treated tree could increase the hazard potential. In some situations, there is no sure answer.

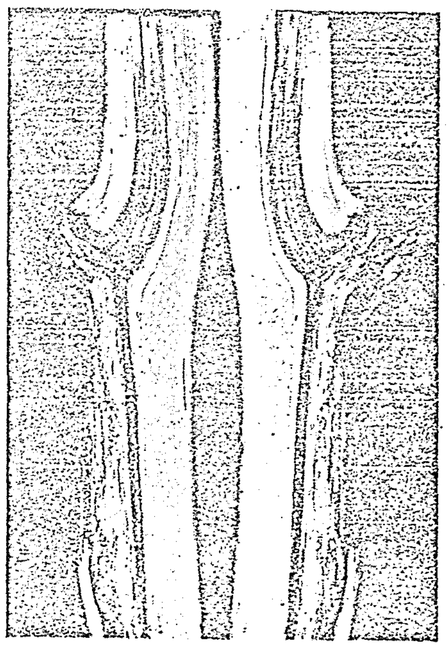

Fig. 5. Decay associated with a branch stub on a small tree. Decay microorganisms can attack young as well as old trees.

Tree owners often determine the course of action for the tree. But many times, and rightfully so, the tree owner puts his or her faith in the professional tree expert. In turn, the tree expert puts his faith in experience and the recommendations coming from the researchers. The researcher must understand the nature of the problem, be aware of work already done on the problem and, most important, must be willing to interact with the tree expert who is faced with the problem directly every day.

But, aside from the technical portion of the problem, other factors must be considered, such as the cosmetic trade-offs that are given high priorities by some tree owners. It may not be so important that the tree is not vigorous, is diseased or is developing decay as it is for the tree to look attractive in spite of its miseries.

Wound paints play an important role here, because they serve to hide the decay. Wound paints also serve to signal to all that the tree owners did everything possible to help their trees. In this way, the wound paints satisfy a psychological need of the tree owner.

Wound Dressings

A common comment about wound dressings is that they are better than nothing. This is debatable, especially when heavy coatings are applied. The major problem in the entire subject of wound dressings is that a low-priority subject keeps getting high-priority attention.

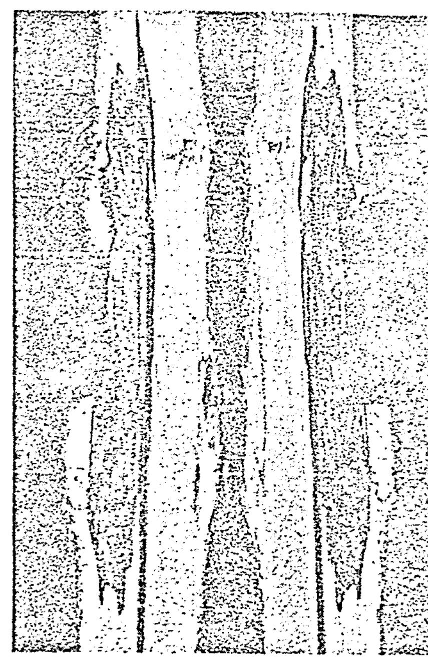

Fig. 6. Decay associated with a wound on a small tree. Wounds start the processes that can lead to decay on all trees.

There are other more important actions that should be taken before a dressing is applied: Removing broken bark, scribing wounds properly and doing everything possible to increase tree vigor—pruning, fertilizing, watering and cutting away competing low-value woody plants. Then, if it is desired, a thin coating of dressing should be applied to the wound.

Help from Research

Research on better wound treatments, on ways to measure the vigor of your trees and on ways to detect decay is also being done. Also, better ways to disseminate information about the decay process are being explored.

New electronic equipment is now available for detecting decay in trees. This will help determine the hazard potential of a tree. One such device, called a Shigometer, delivers a pulsed electric current and measures the resistance in K ohms (thousands). When used properly, the Shigometer will give information on any tree condition that is associated with changes in resistance to a pulsed current. As wood tissues begin to decay, resistance to a pulsed current decreases.

To detect decay, a 3/32-inch hole is bored into the tree with a battery-powered portable drill. Then, a long twisted wire probe is inserted into the hole. The probe is attached to the Shigometer by a long wire. When the probe tip moves through sound wood into decayed wood, there is an abrupt drop in resistance. Details on the technique have been published.

Tree Vigor

Results from preliminary experiments suggest that the meter can also be used to measure relative tree vigor. The resistance of the cambial zone is measured with two small needles. It now appears that, as vigor increases, resistance of a pulsed current in the cambial zone decreases. After some additional research, this method may be of great value to the nurseryman who wants to know the vigor of the tree before it is transplanted, or the vigor of established trees.

Preliminary results of some wound-treatment experiments suggest that agents of biological control may be the answer to some of our wound-treatment problems. With biological control, it must be remembered that we get a little more for our efforts but definitely not all or everything. The use of a common soil fungus on fresh wounds stalled decay in red maple trees for two years.

Recent results from other experiments suggest that the wound-healing process may be under genetic control. If this is so, then the day may come when trees will be selected on the basis of their ability to heal wounds.

Some Conclusions

Recognition of a problem is the first step toward solution. It is difficult to make people aware of the tree-decay problem, because the process goes on deep inside the tree, out of sight. By the time most people become aware of the problem, it is too late to do anything except remove the tree.

We are coming into an age when people are coming in closer contact

with trees. Indeed, man and some of his activities are causing trees some serious problems. But many people still think that trees are so big and strong that they can take anything we can throw at them. This is not so.

To grow healthy trees, sound maintenance programs must be established early in the life of the tree and continued throughout the tree's life-span. A major part of such maintenance programs should include wound prevention and wound treatment. Broken branches and lawn mower basal wounds on small trees can cause serious problems.

Dissections of thousands of trees over a 20-year period have revealed that the insides of most trees show the many scars of wounds inflicted from the time the trees were seedlings. Yes, trees can compartmentalize wood infected by microorganisms, but the accumulation of many small injuries over a long period can weaken a tree so severely that it either breaks during a storm or some pathogenic microorganisms or aggressive insects attack and kill it.

Trees need our help not only when they are large and old, but when they are young and developing, as well.

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