FINE GARDENING

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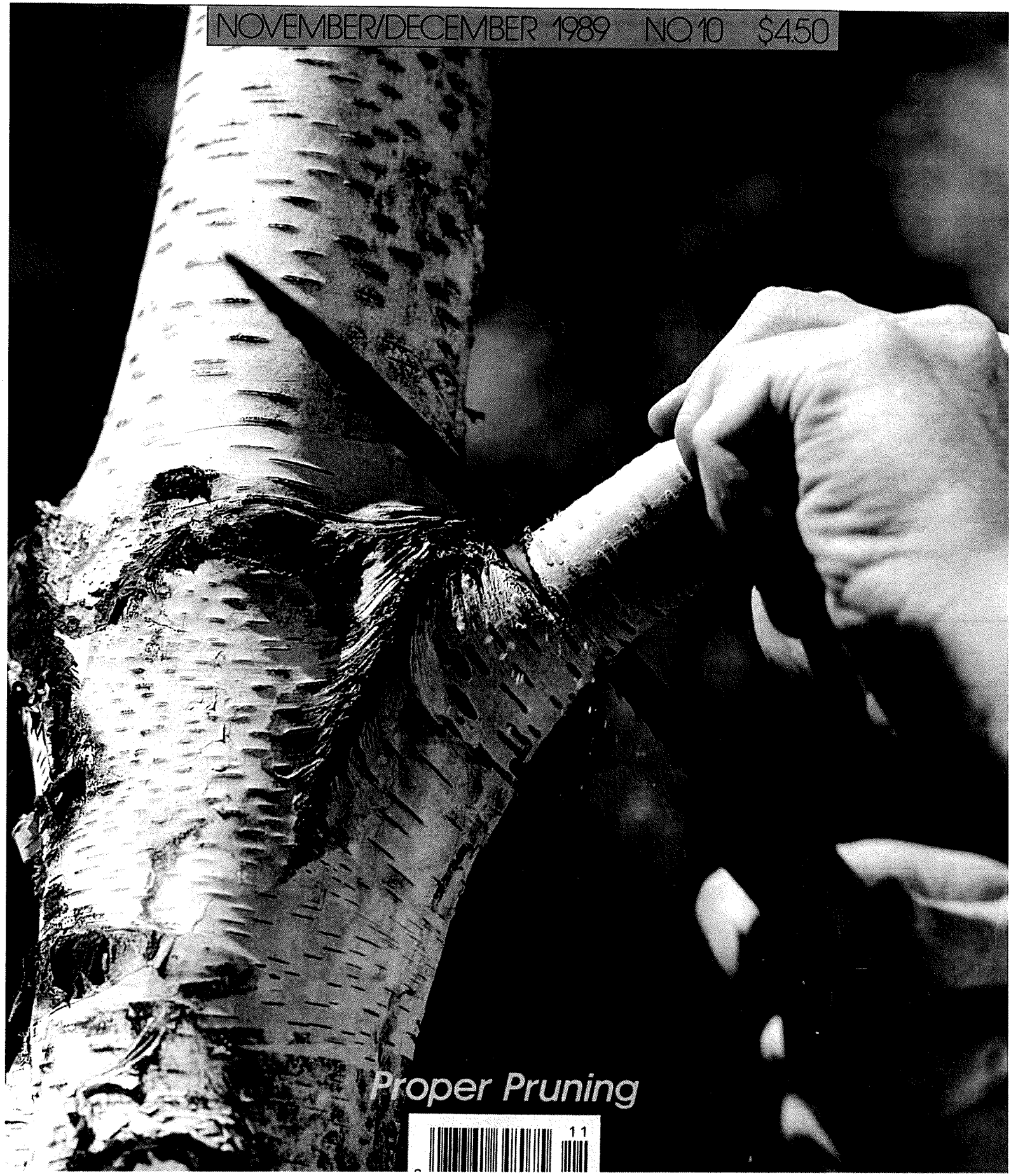


Proper Pruning

Pruning Trees

Make the kindest cut

by Alex L. Shigo

When you remove a branch, the tree must defend an open wound. Whether the outcome is health or decay depends on how you cut. If you prune properly, the tree can readily cope with the injury. If you prune improperly, you threaten the tree's health.

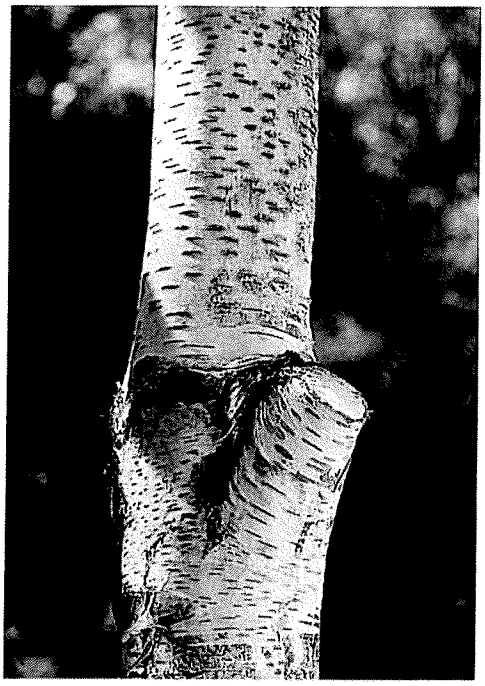
Trees respond to injury by isolating the damage. They do not heal, as people do, by regenerating damaged tissues. Instead, they sacrifice injured wood to protect the healthy. In the vicinity of a wound, trees activate living cells that store oils, starches and other materials. The cells convert their stores into compounds that coalesce around the wound, forming boundaries that restrict the spread of pathogens and insects. The isolated wood dies, but the rest of the tree lives on.

Proper pruning cuts and improper pruning cuts have different outcomes because trees do not produce uniform defenses. While they strongly resist the spread of pathogens and insects across growth rings and across the radial sheets of cells called rays (see the drawing on the facing page), they offer less resistance in the axis of sap flow. When conductive tissues are injured, as they are by improper pruning, rot tends to spread farther above and below the wound than it does to the sides or into the tree. Trees have another defensive zone at the base of branches, where they form a boundary that markedly inhibits the spread of pathogens. Proper pruning preserves the tissues where this protective barrier forms and does not injure conductive tissues.

Times to prune

Energy reserves are the fuel of a tree's defense system. When the cells have ample reserves, the tree forms strong barriers against pests and diseases. If the reserves are low, the barriers are weak.

A tree's energy reserves increase and decrease in an annual cycle. The fine roots start absorbing water and elements in late winter, often with snow still on the ground. Then the tips of the twigs awaken and the buds begin to open. Once the leaves have opened, new wood begins to form in the branches, and then in the trunk. During these phases, the tree draws mainly on stored energy to fuel its growth. By the time leaves have formed, reserves are usually at their lowest. Then, within days, the new leaves begin trapping the sun's energy and the reserves increase rapidly.



Built-in defenses keep rot and insects from invading a tree after pruning, provided the collar-like bulge at the branch base is intact.

I feel strongly that the best time to prune is when the tree has the greatest reserves and is ready to grow. That means during late dormancy, before buds begin to swell. If need be, you can also prune during most of the growing season, but wait until a few weeks after the leaves have opened. The worst times to prune are when leaves are forming, because reserves are low, and when leaves are falling, because new absorption roots develop then and pruning drains energy that would have gone into their formation.

You should also refrain from pruning living branches when you believe for other reasons that a tree has low reserves—during or after a season of severe drought, if the tree has lost a considerable number of leaves to disease or pests, or if it has been harshly pruned in the last few years. Under these circumstances, prune in a year or two, when the tree can defend itself more aggressively. Pruning living branches from a weakened tree invites disaster. Do remove any branch that is waning or dead, regardless of the season or the tree's condition.

The branch collar

In 26 years of research for the U.S. Forest Service, I pruned thousands of branches on many different species of trees, then returned to the trees later (years later in many cases), felled them, and chainsawed the trunks longitudinally through the various pruning cuts to study the trees' defenses. The results were conclusive. Pruning a branch by cutting it flush with the trunk or branch it arises from forces the tree to sacrifice large reserves of energy and considerable amounts of wood. Unfortunately, some tree-care professionals and many books on pruning still advocate making flush pruning cuts.

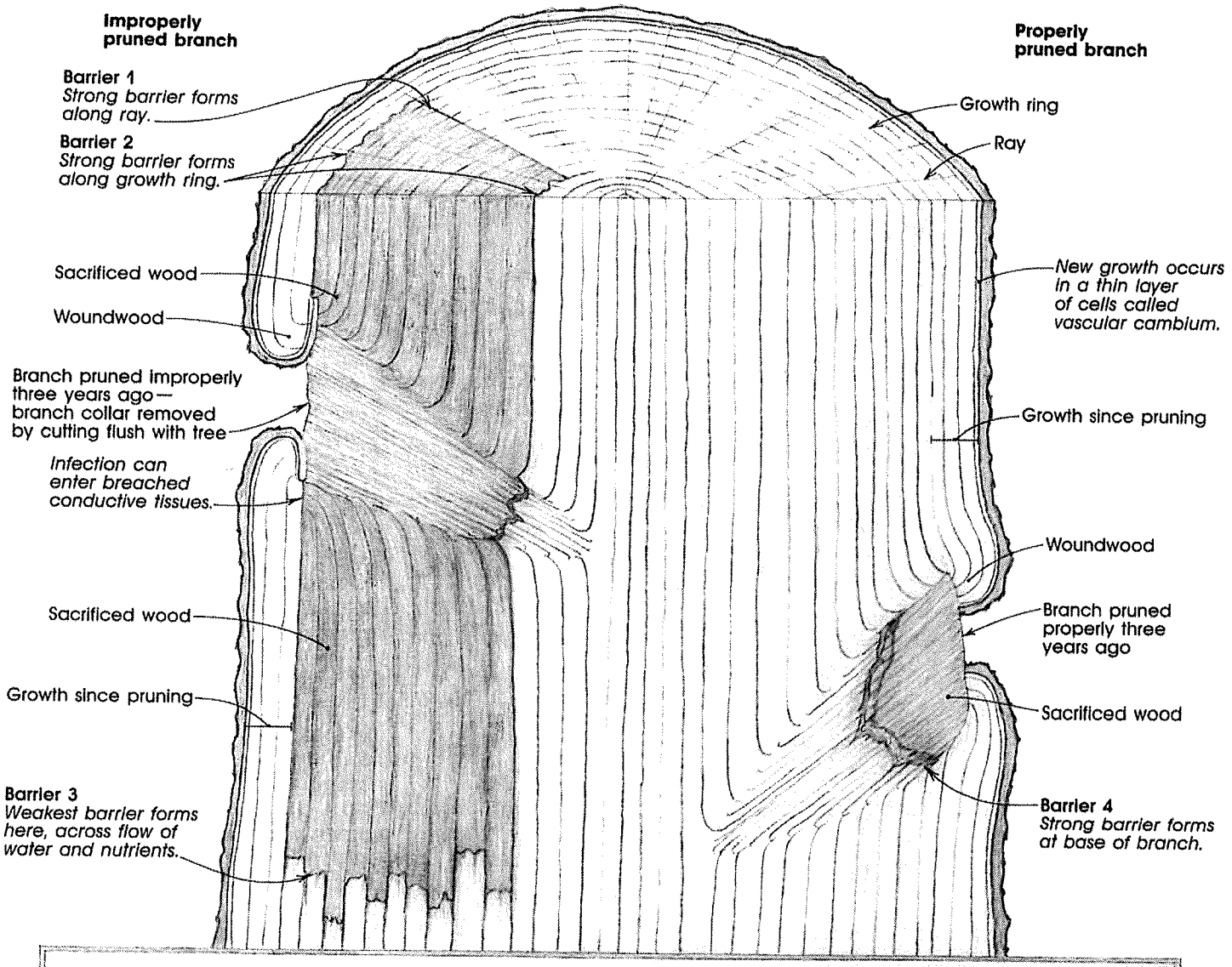
The key to proper pruning is a distinctive bulge at the base of a branch. The wood at the base of a branch is made up of a series of collars (see the bottom drawing on the facing page). In early spring, each branch adds a layer of tissues that circle the branch base to form a collar. Later, after leaves develop, the trunk adds a layer of tissues that circle the new branch collar. (I'll call the whole system collectively the branch collar.) This interlocking system is the most wondrous natural phenomenon I have ever seen. A branch has extraordinary strength and resiliency, and yet it is not one piece with the tree. If you pull a three- or four-year-old branch off with a downward tug, you can actually feel the collars popping past each other.

The kindest cut

When you prune a branch, leave the branch collar intact. That is nature's meth-

A tree's defenses

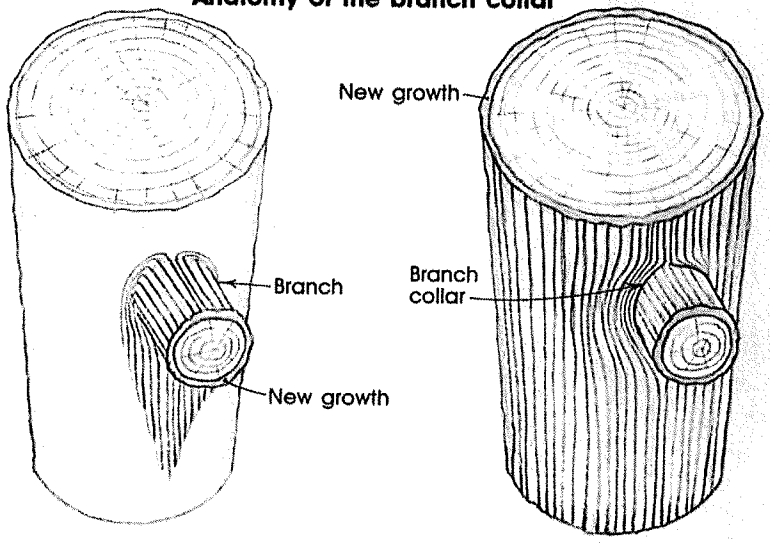
Living cells near an injury produce chemicals that coalesce in four defensive barriers, walling off a portion of wood (here colored dark) that is sacrificed and dies. Improper pruning—cutting branch flush with tree—breaches conductive tissues and tree must wall off a large column of wood, as shown on left. Proper pruning preserves branch collar (see inset below) and tree defends itself at branch base, losing little wood, as shown on right.



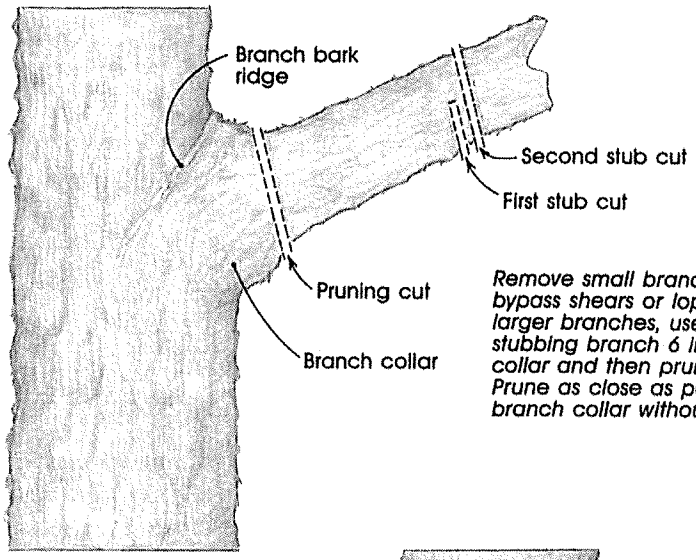
Anatomy of the branch collar

New growth develops first in twigs and moves down branch. At base of branch, new tissues turn and circle branch before falling away below it. Branch tissues join trunk tissues only in tail.

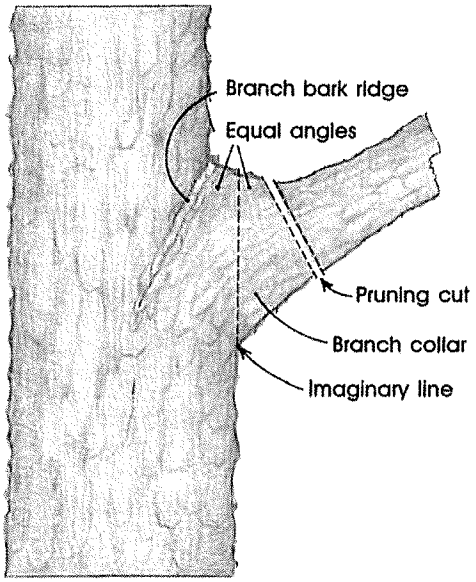
For clarity, new growth is dark-colored and bark is absent.



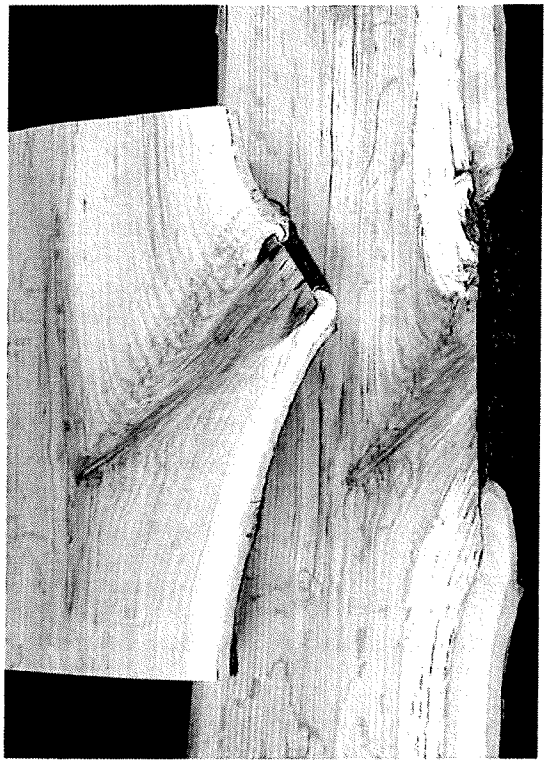
When branch finishes growing, new tissues form on tree, covering base of branch with a characteristic bulge, or branch collar. Each year, cycle repeats, producing a multilayered intersection that clamps branch to tree and shunts water and nutrients both to branch and around it.



Remove small branches with bypass shears or loppers. For larger branches, use a pruning saw, stubbing branch 6 in. from branch collar and then pruning branch. Prune as close as possible to branch collar without injuring it.



When bottom of branch collar is hard to see, determine where to cut by first drawing an imaginary line from top of branch collar to point where bottom of branch joins tree. Next estimate angle between imaginary line and branch bark ridge. Then cut branch at same angle. Start cut alongside top of branch collar.



The results of proper and improper pruning
The author pruned thousands of trees, some properly, some improperly, and observed the aftermath. Here he has sliced longitudinally through portions of two trees, several years after pruning a branch from each. On the right, a flush cut removed the branch collar and led to extensive rot in the tree, visible as columns of pale blotchy wood above and below the wound that extend beyond the sections shown here. A crack has developed at the base of the wound, where the bark has turned under, separating new wood from old. Improper pruning often produces lengthy cracks above and below wounds. On the left, proper pruning left the branch collar intact, and the tree has walled off the base of the branch, confining rot to two small discolored areas at the edge of the wound. New wood is growing over the old without producing cracks.

lack of light, or attack by insects and pathogens. The tree forms a protective barrier inside the branch collar, and the branch rots and falls off, leaving the branch collar intact. Pruning cuts that breach or eliminate the collar destroy the branch protection zone and cut through the interlocking tissues of the collar, leaving conductive tissues open to invasion and infection.

The proper pruning cut starts from the top of the branch collar and ends at its bottom (see the drawing at left). If you take a few minutes to stroll around your neighborhood and look at branch collars, you'll learn that they vary widely. On some species they are thick and prominent; on others they are flat and close to the trunk. Conifers, for example, frequently have nearly flat branch collars. The variations in collars mean that there is no set location or angle for a proper pruning cut. You may cut one branch ½ in. from the trunk and almost vertically, and another branch 4 in. from the trunk and 30° off vertical. What determines a proper cut is the position of the branch collar.

Before sawing larger branches off at the branch collar, shorten them to 6-in. stubs. If you omit this precaution, the branch is liable to tear away from the tree as you near the end of the pruning cut, ripping out the tissues at the bottom of the branch collar and below. Make the initial stub cut on the underside of the branch, 6 in. from the branch collar and about a third of the way through the branch. Start the second stub cut on the top of the branch, outboard from the first cut and ¼ in. or less away from it. Be prepared for the branch to break away suddenly as you near the first cut. Once the branch falls, make the proper pruning cut at the branch collar, removing the stub.

With thick or highly prominent branch collars, many people hesitate to prune properly. They feel that preserving the branch collar leaves the tree with an unsightly volcanolike wound. The temptation to cut through the branch collar is greater still when a branch has been dead for some years and the branch collar has grown like a sleeve around it. On large dying and dead branches, the branch collar may grow outward several feet. But no matter how prominent the branch collar, leave it intact.

Conversely, don't try to safeguard the branch collar by cutting the branch an inch away. Branch stubs are like buffets for pathogens and insects, and once an infestation has gathered strength in a branch stub, it may push past the base of the branch and get into the tree. Proper pruning does not leave a stub.

Branch bark ridge—The branch bark ridge is raised bark between a branch

bark persists on the trunk in a line to each side of the branch. Never cut behind the branch bark ridge. If you have trouble distinguishing the branch collar, you can make a proper pruning cut by taking an angle that mirrors the angle between the branch bark ridge and the trunk (see the drawing on the facing page).

When a branch is not a branch—Trees fork as well as branch. In pruning, the difference matters. When a tree forks, the result is two codominant stems, each connected to half the stem below. Removing a codominant stem opens half the stem below to pests and diseases. What's more, codominant stems have no built-in defense zone as branches do. When they are pruned, the tree struggles to wall off the injury.

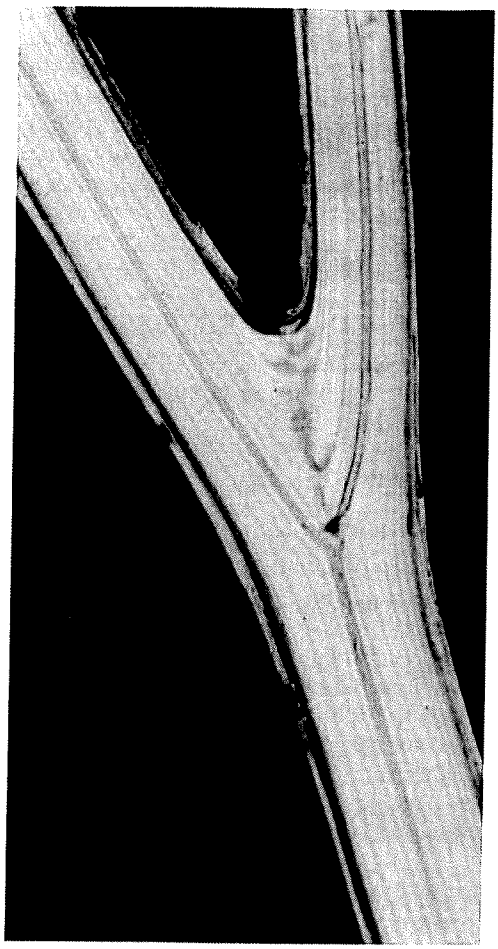
The goal in pruning a codominant stem is to make a wound the tree can defend and eventually close. As with branches, the proper cut varies. But codominant stems do not form branch collars, so take your pruning indications from the stem bark ridge (see the top photo at far right). The cut should start beside the top of the stem bark ridge and end directly across from the bottom of the ridge.

Safety first—I recommend that you prune only what you can reach with hand tools while standing on the ground. Don't work on a ladder and don't climb. For small branches, use sharp bypass shears. They work closer to the branch collar than anvil shears do. For somewhat larger branches, use bypass loppers, and for bigger branches, use a sharp pruning saw. Leave chain saws for the professionals. When the job is too big, hire a tree-care professional—an arborist—who understands proper pruning.

After pruning

In the years after you prune a branch, the branch collar grows over the wound, laying down new wood. First the wound produces callus, which is tissue that is not woody and that can generate buds and sprouts. Then the callus produces woundwood, which is woody and does not form buds. On properly made cuts, the woundwood advances evenly (see the bottom photo at far right). If woundwood fails to grow at the top or bottom of the wound, or grows slowly in those places, it's a sure sign that the pruning cut injured the branch collar. On improper cuts—cuts through the branch collar, or flush with the tree—the woundwood may curl under on itself and grow bark between it and the tree, starting a permanent crack. Even if the wound eventually closes, the flaw remains. Years later, when stress splits the bark, the damage is blamed on frost. No one remembers the pruning mistake.

Don't confuse the growth of wound-



Codominant stems differ from branches in several ways: they have roughly equal girth, are each continuous with the half of the stem below them, and lack branch collars (left). Pruning a codominant stem usually forces the tree to wall off and sacrifice more wood than pruning a branch does. The proper pruning cut (above) starts at the top of the stem bark ridge and ends opposite the end of the stem bark ridge.

Woundwood

New growth slowly closes pruning wounds. When a branch is properly pruned, the new growth advances evenly around the wound. The photo at right shows the development of woundwood several years after proper pruning. On a flush cut, new growth often first advances only at the sides of the wound, a sure sign that tissues have died above and below the wound, as shown above.

conception, and it leads to disaster. It happens that cutting the branch collar usually produces fast-growing woundwood. You can see what comes next—people cut off the branch collar to speed up the woundwood. A tree's injuries never "heal." The tree carries them all its life, safely walled off, if all goes well.

Wound dressings—The concept of wound dressings, like the idea of healing, confuses trees with people. The analogy seems to be that a cut finger needs disinfectant, so a tree wound needs dressing. Over the centuries, innumerable dressings have been concocted, purported to protect trees by barring fungal infections and insect pests. For years, I assumed they worked. Then I began testing them to see which worked best. To my surprise, I eventually found that none had beneficial effects, and what's worse, some actually encouraged pathogens and insect pests. My experiments were straightforward. I pruned branches that were much alike, then dressed half the wounds and left the other half alone. After seven years, there were few differences between the two groups. The trees had isolated and closed most wounds alike. Wound dressings actually harmed some trees, however, such as white oaks, which had more decay than trees with untreated wounds. The experiments changed my mind about wound dressings. If branches are pruned properly, pathogens seldom spread into the tree. If branches are pruned improperly, no dressing will keep pathogens out.

Nature has a wound dressing that resists pathogens. It is the compounds that surround injuries. What we must not do is destroy the only wound dressing that works!

Occasions for pruning

As a general rule, restrict pruning to branches that endanger the health of the tree (see the examples on the facing page). These branches fall into several categories. The easiest to spot are dead, dying or infested branches. Remove them as soon as you see them. The remaining categories cover branches that may eventually fall from their own weight, injuring the tree and endangering people.

Some branches squeeze so tightly against the tree or an adjacent branch that bark is trapped in the crotch year after year, interrupting and weakening the branch collar. The condition is called included bark. As the branch gains weight, it may pull away from the tree, opening a crack along the included bark. Eventually, the branch will tear away from the tree.

Learn to spot included bark, and possible. Branches that ascend from the tree at a steep angle, and codominant stems that grow close together, often develop included bark. So do branches that arise from the tree too close together. Check them. If there is no ridge of bark in the crotch between branch and tree, or in the crotch between codominant stems, you must prune. Start the cut at the bottom of the branch collar, not the top, and cut upward, ending as close to the tree as you can. This is tricky work, and no matter how well you do it, the tree must sacrifice a considerable amount of wood to wall off the wound.

Another sort of weak branch arises from the tree later than—often years later than—neighboring branches. It is called an epicormic branch, meaning "on the trunk," and develops either from a dormant bud that has persisted for many years or from a new bud formed in the callus that follows injury. Shortening large branches—a misguided practice called topping—often provokes the development of epicormic branches. The epicormic branches grow larger while decay spreads below them. Eventually the branches may tear away from the tree. Epicormic branches can also develop from unwounded portions of a tree, and often do when a tree has been overpruned. Most of them are weakly attached to the tree. They grow much like branches that develop included bark. If many epicormic sprouts form, remove the smaller, weaker ones only.

An old tree that has grown all its life in the company of other trees may develop dangerous branches when some of the neighboring trees are removed. As its branches grow into the vacancy, they may get so heavy that they fall off, particularly if they have old wounds near their bases. If you see cracks at the base of suspect branches, ask a professional to look.

REFERENCES

The author has published two books about tree growth and tree care. Both are hardcover, printed on coated paper, and copiously illustrated with photos and drawings. They are available mail-order from Shigo and Trees, Associates, 4 Denbow Rd., Durham, NH 03284.

The New Tree Biology, 1986, 612 pp., $55.00 postpaid. Written principally for tree-care professionals, but scientifically minded gardeners will gain a deep appreciation of tree growth.

Tree Pruning, 1989, 192 pp., $42.00 postpaid. A guide to proper pruning. Not for doing it yourself, except in limited cases, but valuable for using a tree professional knowledgeably.

Pruning from the early stages of a tree's life is the best way to assure the tree's health, size and safety. Removing branches early is far safer for the tree than removing them years later. It is also the only good way to control the size and shape of a tree. You cannot prune a big tree to make it a small healthy tree. You can, however, keep a small tree a small healthy tree for a long time by proper pruning. If you are pruning for convenience—to make mowing easier around a tree in the lawn, or to limit the size of a tree near your house to preserve a view—start early.

Prune young trees carefully. You'll find that their branch collars tend to be quite prominent. Left intact on a slender trunk, they look unsightly to some people. Nevertheless, don't be tempted to remove them. Also avoid pruning several branches that are close together. Prune one branch, then wait a year or two before removing another.

When you buy young trees at a nursery, look closely for signs of poor pruning. Many nurseries, unfortunately, remove branch collars for cosmetic reasons. You'll see woundwood on the sides but not the top or bottom of flush cuts. You may also see a sunken spot above the cut, which indicates damage in the trunk. On some species, such as lindens and elms, you may see sprouts around the wound. When you prune the sprouts, more will appear. Some nurseries let young trees grow with low branches because the extra photosynthesis increases the diameter of the trunk. When sale time is near, the low branches are pruned, which produces closely packed wounds. Avoid these trees.

Responsibility

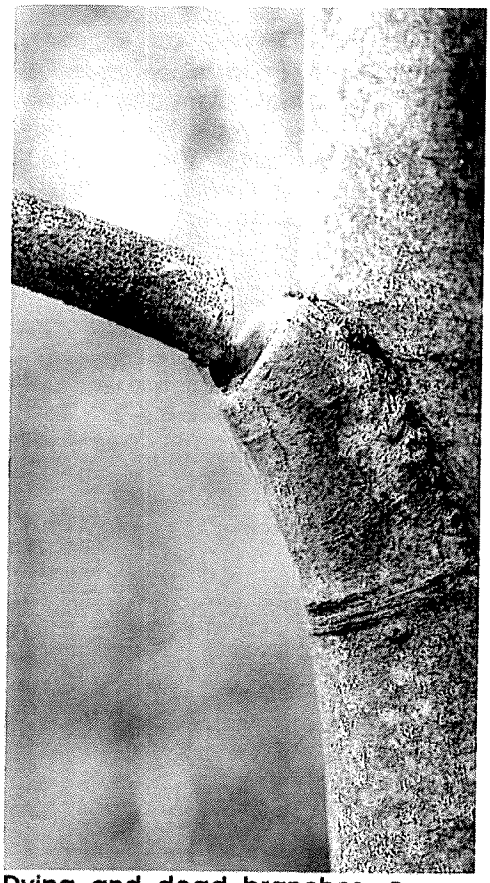
The single most important step you can take to keep a tree healthy is not pruning but rather planting it in the right place. People insist on planting trees where they should not—hemlocks in front of picture windows, for example, or eucalyptus trees under power lines. Then when the trees are too big, whack! they are topped and die a slow death. Trees should die with dignity. If a large tree has to be topped, it is better to remove it. When you plant trees that can outgrow their site, start pruning them early.

We are responsible for trees. I believe what the fox said in Antoine de Saint-Exupery's *The Little Prince:* "Men have forgotten this truth. But you must not forget it. You become responsible, forever, for what you have tamed." □

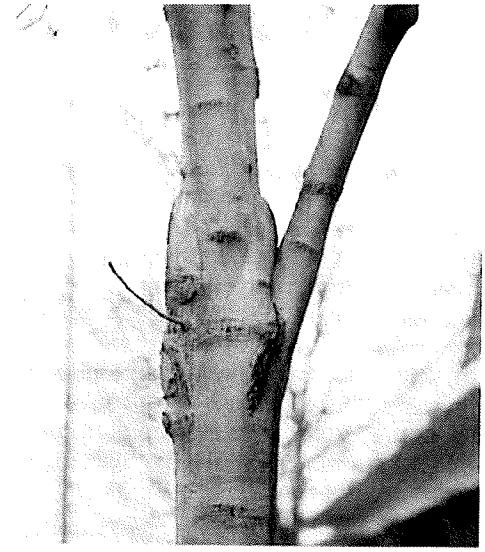
Since retiring from the U.S. Forest Service in 1985, Alex L. Shigo has made a new career of educating people about trees. He lives in Durham, New Hampshire.

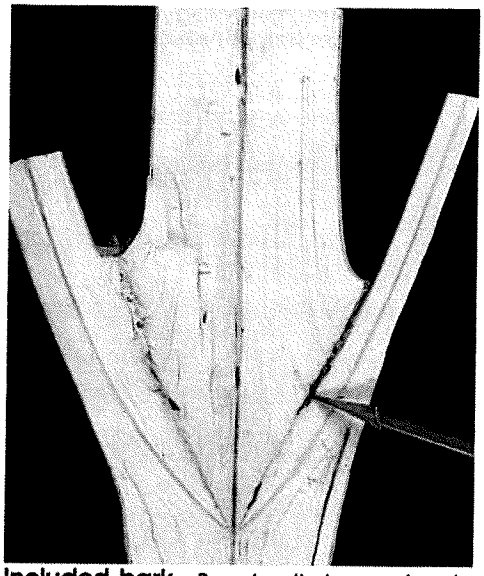
Occasions to prune

The three sorts of branches shown here threaten the health of a tree, and should be pruned as early as possible. Dying and dead branches (photo below) are havens for insects and rot. Branches with included bark (center photos) can tear away from the tree under their own weight. Epicormic branches (photos at far right), which develop around wounds or after heavy pruning, can also be hazardous.

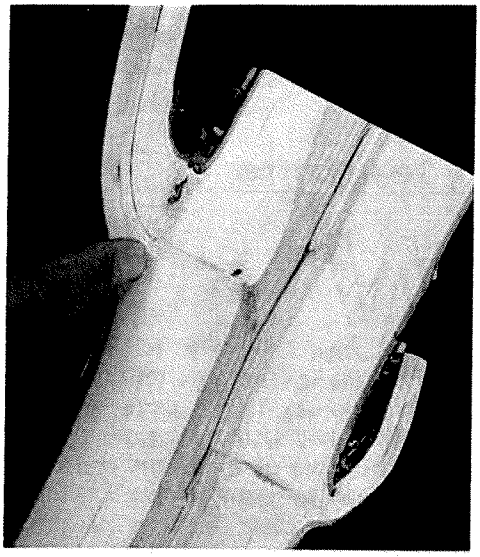


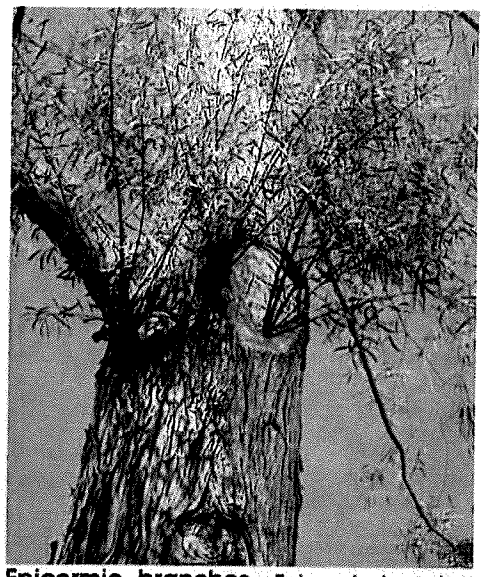
Dying and dead branches—Remove promptly. If a branch has been dead for several years, the branch collar may have grown outward. Nonetheless, preserve it, as shown here.





Included bark—Branches that grow close to the tree may develop included bark, which interrupts and weakens the branch collar (above). The outward sign of included bark is the absence of a branch bark ridge in the crotch (at top). Prune by cutting upward, starting at the bottom of the branch collar and ending as close as possible to the tree.

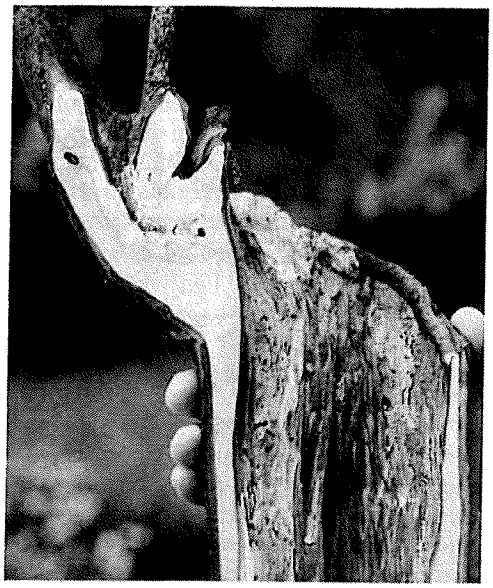




Epicormic branches—Epicormic branches develop when buds that have been carried in the cambium begin to grow, as shown at top, or when new buds form and sprout in the tissues around wounds, like the improper pruning cut above. Epicormic branches are often weakly attached to the tree, due to included bark, and should be removed while small.

Don't top

Don't try to reduce a tree's size by cutting back large branches between limbs, a practice called topping. Topping produces decay and hazardous sprouts. Only early training can control tree size safely. Trees too large for their site should be removed.



Topping—Cutting back large branches, or topping, causes epicormic branches to sprout profusely around the wound. Meanwhile, rot spreads below the wound; note the hole in the tree at right and the decay in the halved branch and sprouts at far right. Weakly attached, the sprouts around topping cuts are prone to tear away from the tree as they gain in size.