

Wounding and Decay in Trees (Part Two)

Frank Fogliati

Practical Implications of Compartmentalization

In the previous article (*Magnolia*, Vol. 36, Issue 69) wounding and decay were discussed with particular relevance to the process of compartmentalization and the CODIT model. Before discussing how the theory of compartmentalization relates to pruning and other arboricultural practices, we should gain an understanding of how tree branches are attached to trunks, and related aspects of anatomy and physiology.

In looking at trees, you may have observed dead branches sitting in what appears to be "sockets" of live tissue. Sometimes kino, resin, or gum may have been exuded. These sockets or bulges in tissue where a branch joins another branch, or where a branch joins the trunk, are called branch collars (see Figure 1). There is often a ridge of bark in the fork; this is called the branch bark ridge. The size and shape of the collar varies from species to species.

Research work by Shigo helped to clarify how this collar is formed. Early in the growing season, within the cambial zones of a branch and its adjoining trunk, branch tissues are the first to develop. The maturation of these branch tissues proceeds basipetally (top to bottom). The xylem vessels of the branch form a swollen collar around the base of the branch. The collar tissues meet on the trunk below the branch. Later in the growing season, a collar of trunk xylem envelops the branch collar. The xylem in the trunk collar meets above and below the branch.

The branch is structurally attached to the trunk by a series of trunk collars every growing season (see Figure 2). This produces a type of "ball and socket" arrangement.

Conduction into and out of the branch follows the pathway of the branch collar, and there is no direct conduction between trunk xylem above a branch and within the branch. The developing xylem tissues in the fork of the branch have little space to occupy and they are compacted to form a hard zone of tissue between branch and trunk. The bark does not have room to expand, and thickened layers of bark formed in the forks are "pushed" to the sides of the branch to form the branch bark ridge.

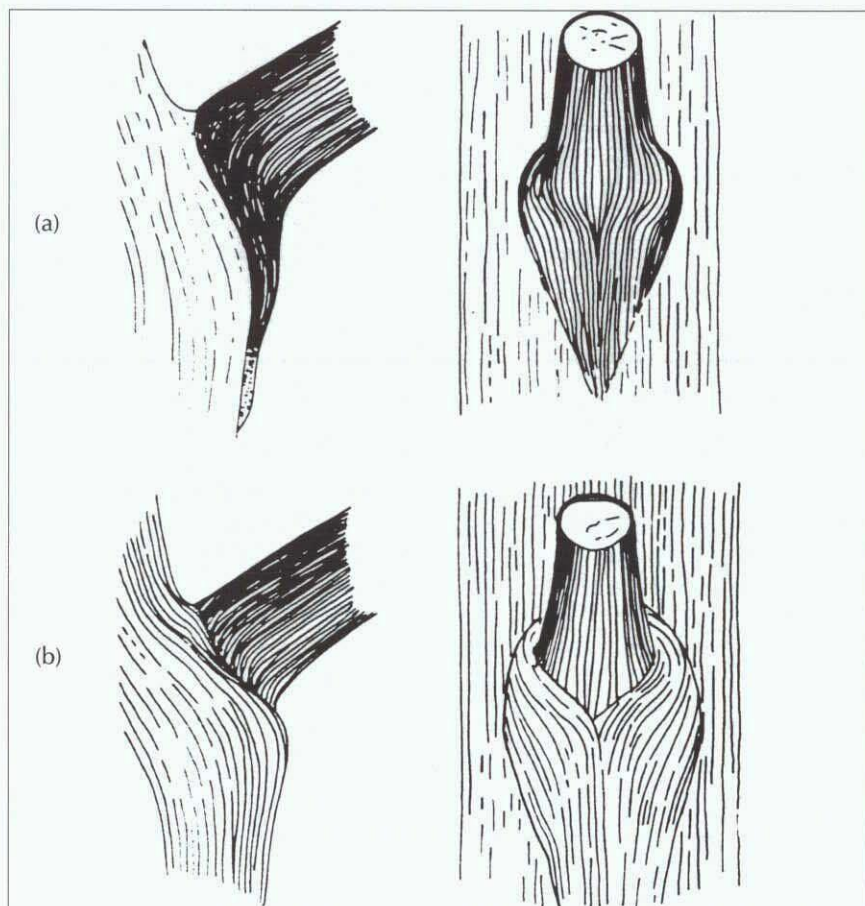


Figure 1 Branch collars. Part (a) shows branch growth early in the season; part (b) shows trunk growth later in the season.

When a branch begins to die, a protection zone develops within the branch base. This zone contains phenol-based antimicrobial substances in deciduous hardwoods, and resin-based substances in conifers. The dead and decaying branches are shed at the position of the protection zone.

So, how does this relate to pruning? Numerous experiments have shown that if the collar is injured or removed during pruning, the trunk xylem above and below the cut can be rapidly and extensively infected and decay may develop. In many older textbooks, flush cutting (cutting the branch as close as possible to the trunk) is shown to be the correct way to prune branches. Ignore this practice, and always prune to the

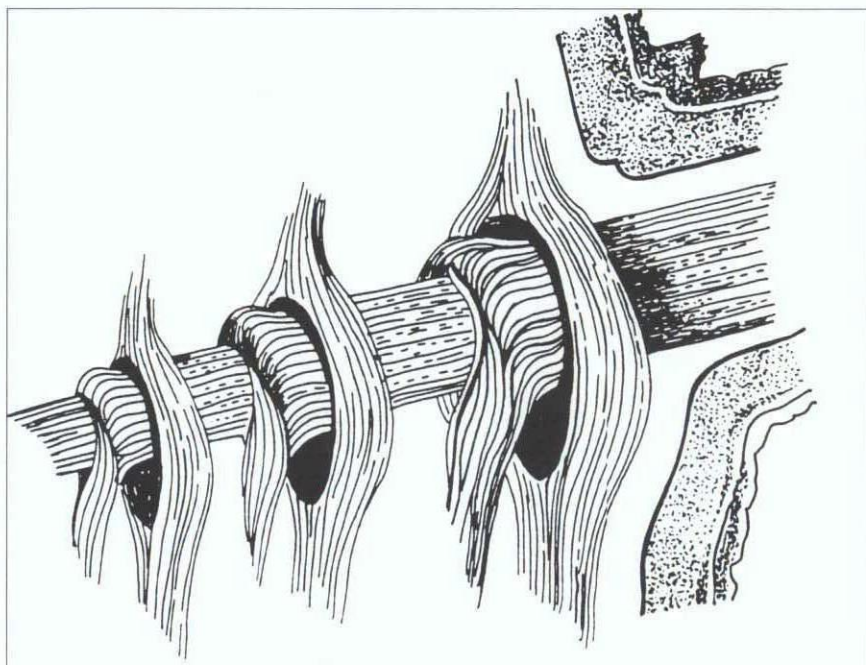


Figure 2 Branch collar development over three seasons.

collar (see Figure 3). Flush cuts remove the branch collar and create large wounds into the trunk. These cuts weaken tissues all around the cut and make them more susceptible to insects, decay, and the effects of temperature extremes. Even though large amounts of woundwood (callus) may be formed after flush cutting, this is not an indication of the internal condition of the tree. Often, the most visible sign of decay in such trees only appears some time later by the presence of a fungal bracket. This is the fruiting body of the fungus, which indicates that the vegetative stage has advanced to the reproductive stage and that some internal tissue has already been destroyed.

As a tree ages, it is less able to cope with large pruning wounds. Therefore, mature trees should be pruned only when necessary and always back to the collar, with care taken to retain the branch bark ridge. Ideally trees are trained and shaped when young and vigorous then allowed to grow "naturally." Always use the step cut or undercut method of branch removal to prevent tearing of the bark and damage to the collar (see Figure 4). (To minimize pruning, select vigorous, well-shaped trees in the first place.)

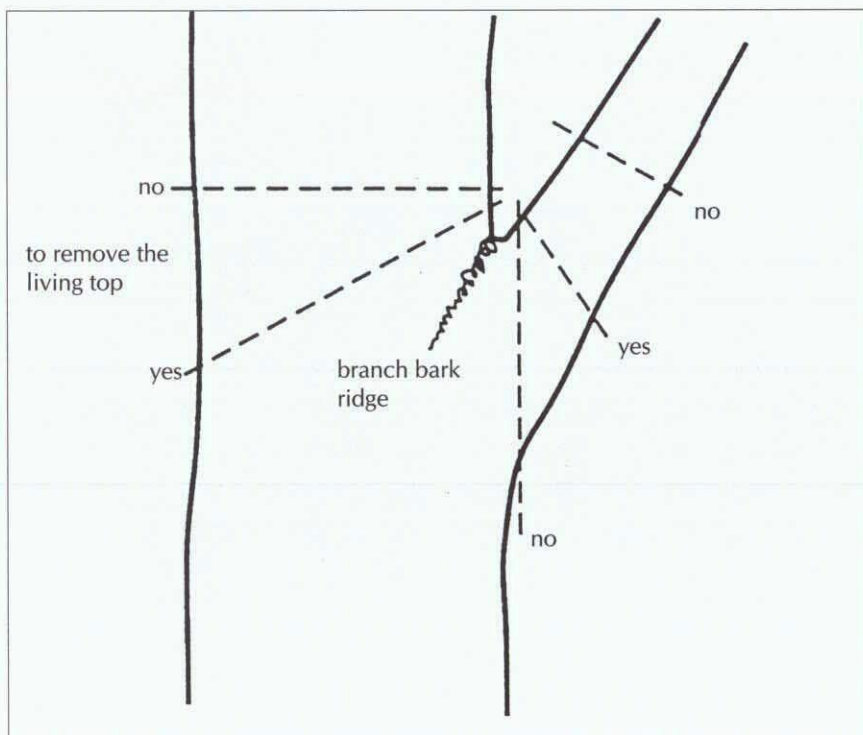


Figure 3 Pruning to the branch collar. To remove a living branch, prune to the branch collar and retain the branch bark ridge. Do not leave a stub and do not flush cut. Note that the size of the branch collar varies from species to species.

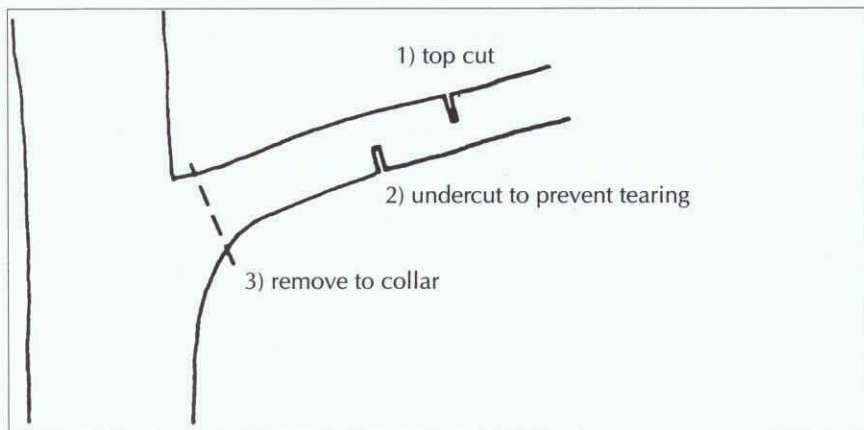


Figure 4 When removing branches, use the step-cut method as illustrated in this figure. Make cuts 1 and 2 5-40 mm apart (0.2-1.6 in) depending on the size and species.

Codominance

The subject of codominance should be briefly covered, as this growth habit frequently occurs in many *Magnolia* spp. Codominant stems refers to the development of two stems or trunks of equal size. There are no branch collars or trunk collars at the base of codominant stems, therefore there is no protection zone at the base. Instead, a stem bark ridge develops between the two stems. If this ridge of bark points upwards it indicates the likelihood of a strong union (see Figure 5, part A). However, if the stem bark ridge turns inward, included bark is likely and a weak union develops (see Figure 5, part B).

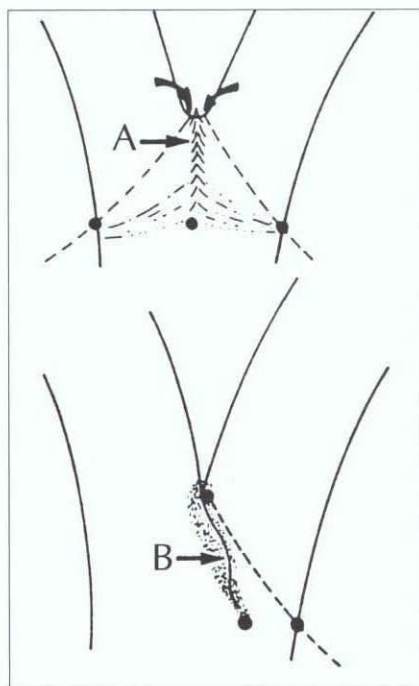


Figure 5 Codominant stems; correct pruning after cuts (after Shigo, 1989)

Trees with codominant stems should not be selected for planting. However if you need to prune a codominant stem, Figure 5 illustrates the correct procedure (the pruning lines are indicated by the dotted lines).

For older trees with codominant stems where branch removal is not desirable, another option may be cabling the branches together. This requires skilled placement of the cables in the trees, and if the risk of branch splitting becomes too great the tree should be removed.

Cavity Treatment

Cavity filling, cleaning, and draining are other traditional practices that need to be reappraised in the light of Shigo's research.

Cleaning and Draining

If a tree has a cavity then Wall 4 (the strongest wall) now separates tissues present at the time of wounding from those produced after wounding. Although Walls 1, 2, and 3 have been formed, the organisms that colonized the wound have succeeded in breaking these walls down and a cavity has resulted. In some cases a cavity may hold water (see Figure 6). Does water cause decay? Wood-decay fungi actually thrive in moist conditions, not the saturated conditions commonly blamed in many books. An incorrect treatment based on this misconception is that

the cavity must be cleaned back to green wood, and then drained by drilling a hole through to the bottom of the cavity (see Figure 7). When a tree is re-wounded by scraping and drilling, the tree's strongest wall is broken, other boundaries are broken, and the tree must initiate a new response: the formation of walls 1 through to 4. Also, decay-causing organisms may be spread into the newer tissues. As a tree ages it is less able to deal effectively with pathogens.

Additional wounding to previously wounded trees dramatically increases wood discoloration and decay. The site of the original wound is depleted of carbohydrates because of the initial wound response. A new wound into these areas means low carbohydrate levels and a poor wound response. In weak-compartmentalizing trees that are re-wounded, Wall 4 may not be strong enough to resist the spread of discoloration from the outside in, even though it may be capable of resisting such spread from the inside out.

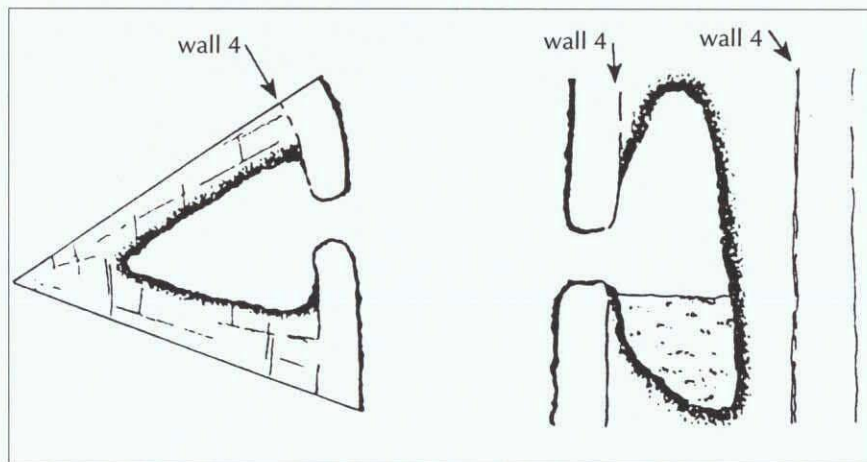


Figure 6 Cavities.

Thus, the boundaries that surround cavities should not be broken. Any damage to this zone will result in more rapid and extensive decay than if the cavities had been left alone.

Filling

Once a cavity is filled it is no longer possible to easily monitor the rate of decay, as opposed to the rate of new tissue growth. It is most important to regularly inspect cavities, as continued decay may result in structurally dangerous trees. In general, cavity filling is unnecessary except possibly with large basal cavities, where vandalism (garbage

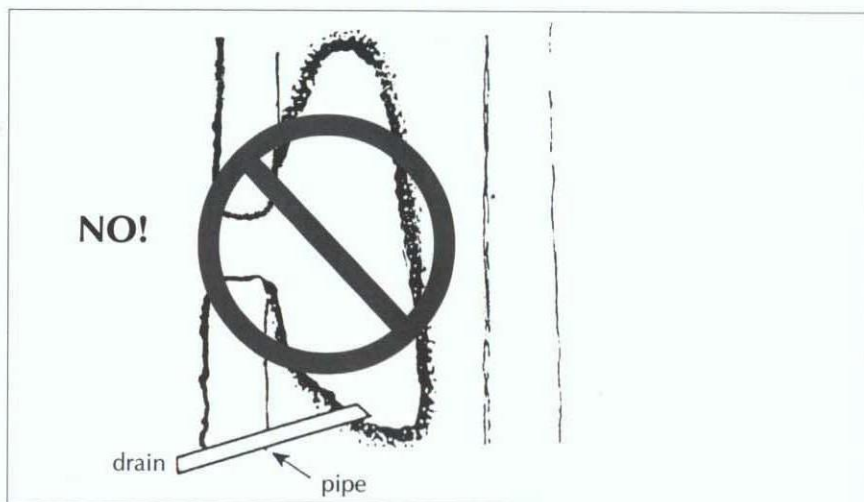


Figure 7 This drawing illustrates an incorrect practice of dealing with cavities.

dumping, fire) may occur. In such cases a piece of semi-flexible board (marine ply) would suffice as a cover. There must be provision of a firm base for callus tissue to roll over and continue the healing process. If a cavity must be filled, do not clean back to healthy green tissue; remove by hand only soft materials, and use suitable filling materials (polyurethane). Filling a cavity is of little or no value in promoting the health and longevity of a tree. Fill material seldom strengthens tree structure as much as the callus roll that develops around an open cavity.

Other Treatments

As discussed above in cavity treatment, any practice that wounds a tree will initiate a stress response by the tree. As this response takes sugars and therefore energy away from other processes, the wounding needs to be carefully considered. Another possible outcome is that decay may result from the wound.

A range of chemicals, including fertilizers, insecticides, and growth regulators, can be injected into trees as treatment. Not only may the injection holes lead to decay, but the chemicals used (especially insecticides) result in further injury. Therefore, the possible damage from injection wounds must be weighed against the possible benefits of the chemical treatment.

Drilling holes into trees to install braces and cables may also encourage decay. It may be best to avoid cabling known decayed trees, or at least to exercise discretion.

Wound Treatment and the Prevention of Decay

One of the traditional approaches to wound treatment and the prevention of decay has been to apply a wound dressing or tree paint, usually bitumastic or latex emulsions. Lonsdale (1984) examined the available treatments and assessed their value in relation to their theoretical roles. His conclusions can be summarized in the following manner:

- **Physical exclusion of fungal spores.** The success of a dressing in mechanically excluding fungi from a wound depends on the tree being initially free of fungi, and the creation of a completely intact coating with long-term persistence. Visual cover cannot be equated with the exclusion of microorganisms as a wound may appear to be covered but fruiting bodies may still appear. Wood-boring insects may break the seal and some compounds crack and peel. The spores of some fungi can be sucked into wounds to a considerable depth, so there is little point in surface sterilizing the wound before sealing.
- **Antifungal activity.** If a fungicide is to be of real value it should be able to eradicate fungal spores already on or beneath the wound. It should provide long-lasting protection against subsequent infection, and it must not be excessively phytotoxic—a problem with some copper compounds and phenolic materials. These particular phytotoxic fungicides, along with mercury compounds, are the ones that have broad enough spectrums of activity to protect the wound against most species of fungi likely to be present. Of the available fungicidal dressings that are neither phytotoxic nor otherwise undesirable, most are lacking in their spectrum of activity against different fungi and in their persistence. Some decay and non-decay fungi have been found to detoxify fungicides. Even if a fungicidal barrier can remain intact in the long term, wood-boring insects may break it. Some fungicidal ingredients such as copper naphthanate can be sucked into open ends of severed xylem but, apart from their phytotoxicity, they can become so diluted in their passage through woody tissue that their concentration falls below a level that is toxic to the target fungi.
- **Promotion of callusing.** Some wound treatments such as lanolin, shellac, bitumen, and latex do encourage callus growth. This is probably due to the protection of the exposed cambium from drying out. However, research (Shigo, 1989) indicates that if woundwood (previously called callus) forms too rapidly and rolls inward, then a wound may never seal and internal cracks may develop. Flush cuts and many types of wound dressings stimulate rapid woundwood formation. The development of decay and the rate of callusing/development of woundwood appear to be two different processes, so the role of wound dressings in this respect is questionable.

- **Cosmetic uses.** Some people may consider pruning cuts look better when painted. This is a matter of personal taste. If tree paints are employed for this purpose they should be thinly applied.

Other researchers have arrived at similar conclusions. Mercer (1983) tested about 30 preparations designed to prevent decay. This work was carried out over six years. Almost all products tested that had a fungitoxic action also had a phytotoxic effect. The only exception was mercuric oxide, but its use is now restricted as it is a biohazard. Bitumastic and latex emulsions do help the tree to produce callus but do little to limit both staining of the wood and decay. One product, Lac Balsom (a latex), was particularly good in encouraging callus growth. The addition of the fungicide copper naphthenate to the treatment increased staining by 2 1/2 times plus it was phytotoxic.

The majority of decay fungi seem to develop in the wake of non-decay "pioneer" microorganisms. This implies that the freshly exposed wound surface is not a good substrate for the growth of most decay fungi, and that the short-term protection given by most wound dressings is of little value. However there are a number of fresh-wound parasites that may be prevented by the application of particular polyvinyl acetate dressings (with or without fungicides). Further research may help to identify situations where short-term protection against such fungi is justified. Such short-term protection must take into account the susceptibility of the tree species, the prevalence of the parasite and the time of the year.

Biological control is an area with potential. Mercer (1979) suggests that if some organisms such as the sugar fungi could be encouraged at the expense of those that cause decay, some benefits could be achieved. That is, an antagonistic organism (either a fungus or bacteria) which would compete with decay-causing organisms but would not damage the tree, could be applied to the wound. Work has been done with the fungus *Trichoderma viride*. It has been found to persist well and to greatly reduce colonization by basidiomycetes in *Fagus* spp. wounds over a four-year period. Obviously more research is required with other tree species but it shows promise.

In conclusion, no real evidence exists in support of the use of currently available wound dressings for the long-term protection of trees against decay. The best advice would seem to be: avoid wounding trees; always prune to the collar; and whenever possible, train trees when they are young and growing vigorously.

References

- Lonsdale D. 1983. "Available treatments for three wounds: An assessment of their value." *Arboriculture Journal*. Vol 8, 97-107.
- Mercer PC. 1979. "Pruning wounds and decay." *Arboriculture Research Note*. Arboricultural Advisory and Information Service. UK.
- Mercer PC. 1983. "Dressings to kill." *G C and H T J*, 8 July.
- OTEN. *Arboriculture Course 0503U Notes*. Sydney.
- Shigo AL. 1985. "How tree branches are attached to trunks." *Canadian Journal of Botany*, Vol 63, 1391-1401.
- Shigo AL. 1989. *Tree Pruning: A Worldwide Photo Guide*. Shigo and Trees Associates. New Hampshire.
- All drawings are courtesy of OTEN unless otherwise noted.



From our Members...

Lola Koerting writes:

To answer questions posed by many members of the Magnolia Society, *Magnolia* \times *brooklynensis* #204 has not been registered and officially named. However, the Spring 2001 catalogue of Fairweather Gardens Nursery offered *M.* \times *brooklynensis* #204 under the name 'Black Beauty.' This name was given by Fairweather Gardens Nursery for their own purposes.

This is a plant that deserves registration. Since the hybridizing was done at Brooklyn Botanic Gardens, their consent to register may be necessary.



Lola Koerting

Also, as a follow-up to the article on the Brooklyn Botanic Garden magnolia breeding program (*Magnolia*, Issue 68), at the left is a photo of *M.* 'Lois.' This magnolia was the last introduction from the now-discontinued BBG breeding program. 'Lois' was named and registered in 1998.

Lola Koerting,
Ridgefield CT