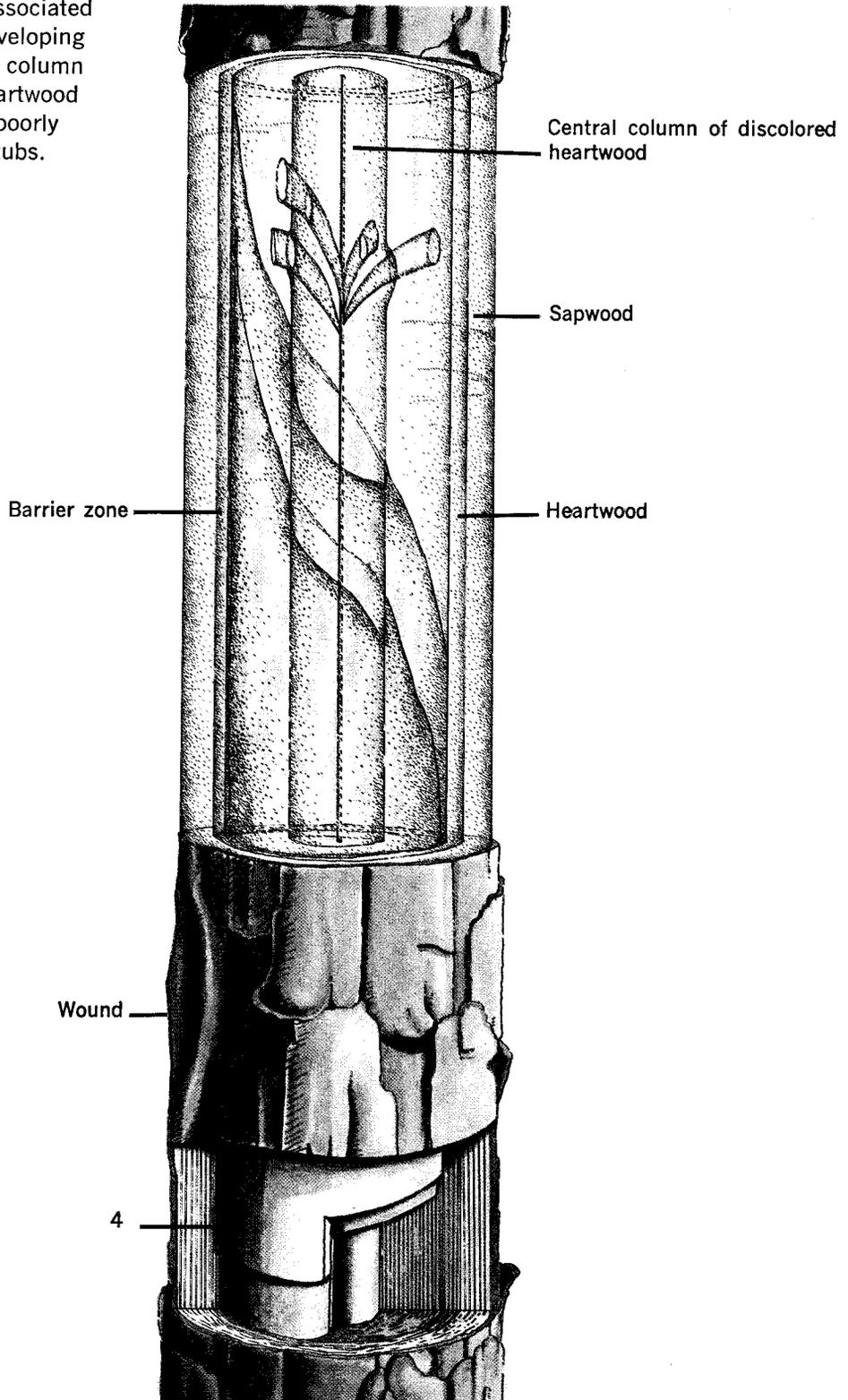
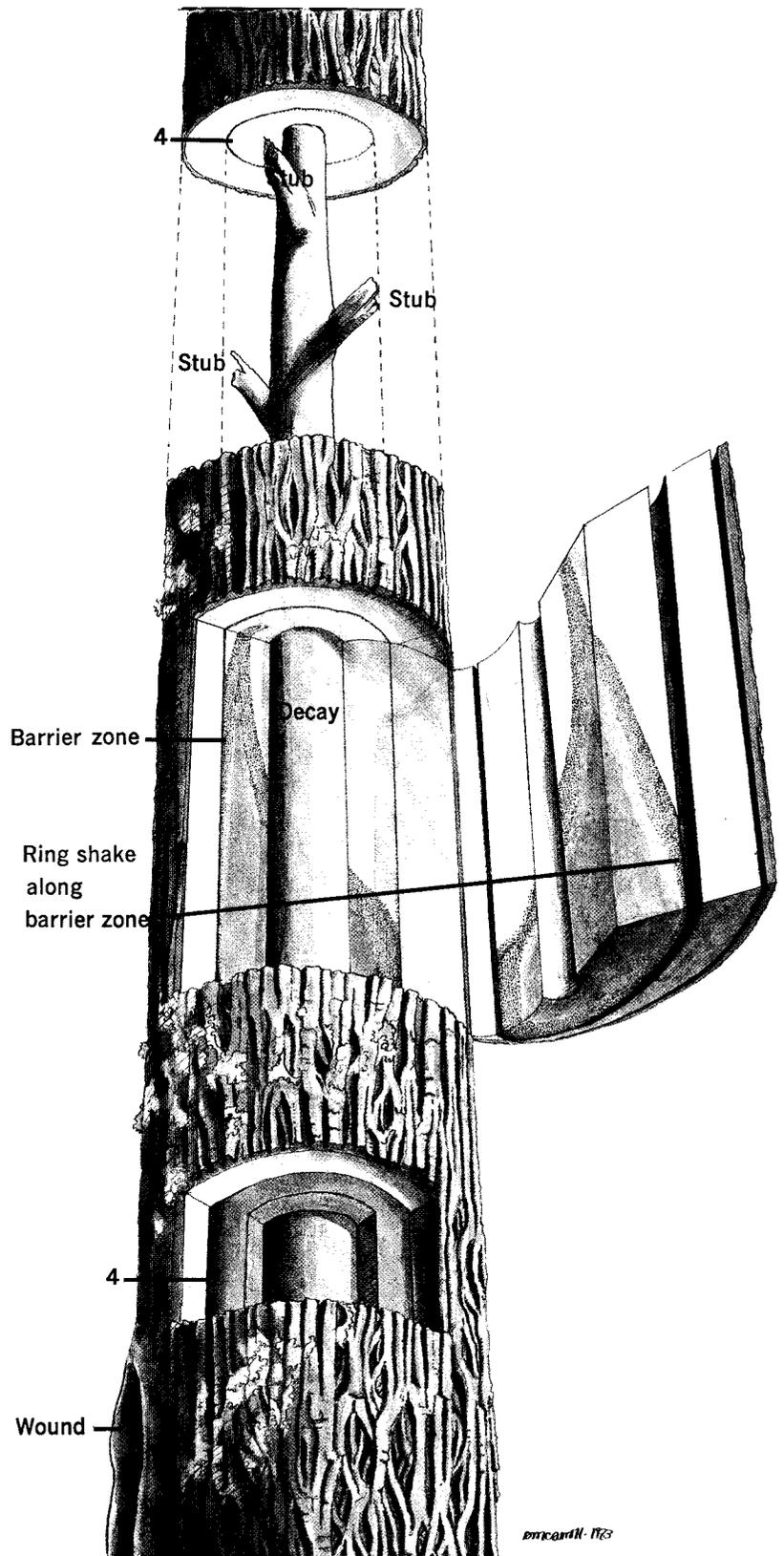


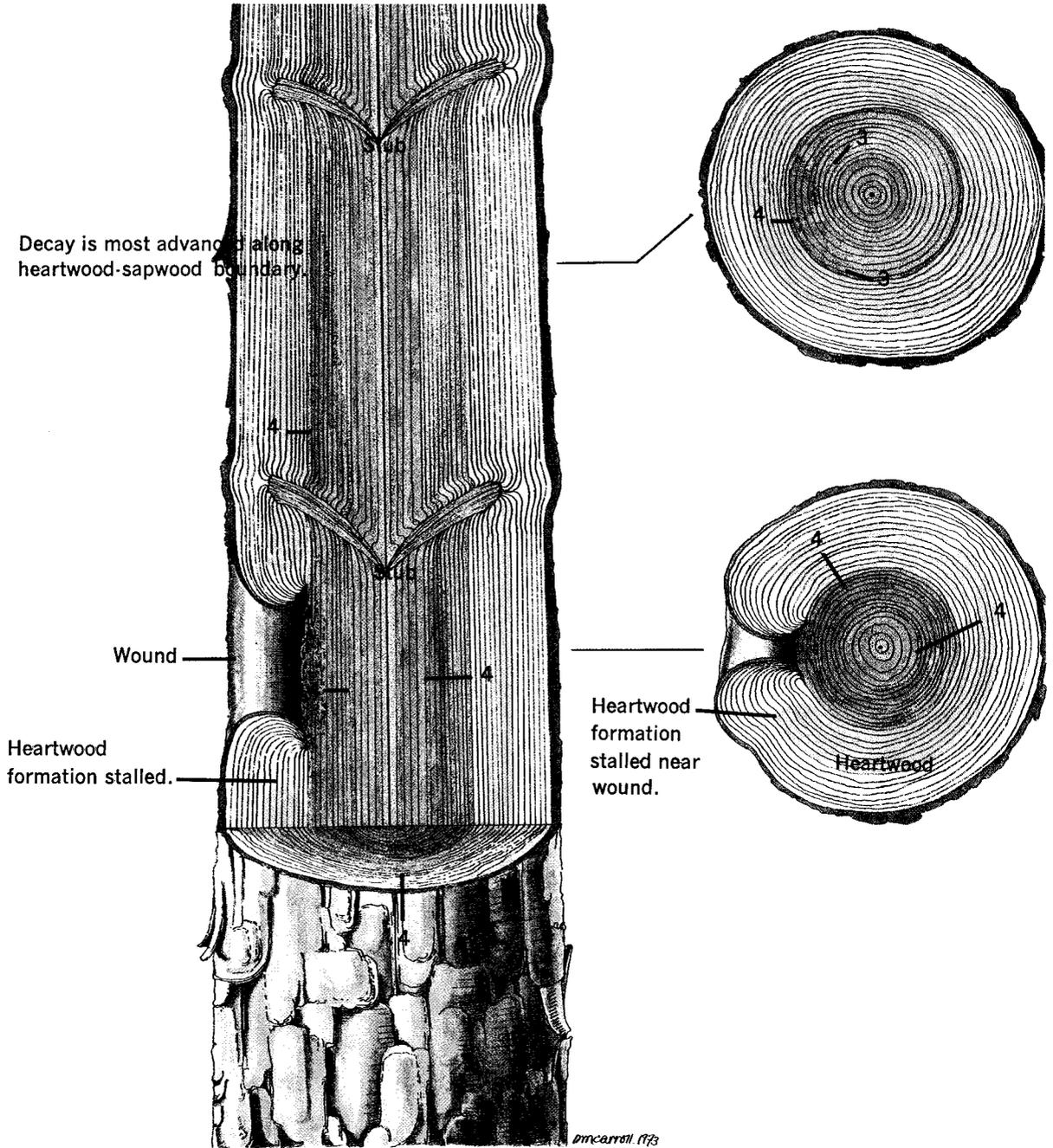
Pine—Column of discolored and decayed wood associated with a wound developing around a central column of discolored heartwood associated with poorly healed branch stubs.



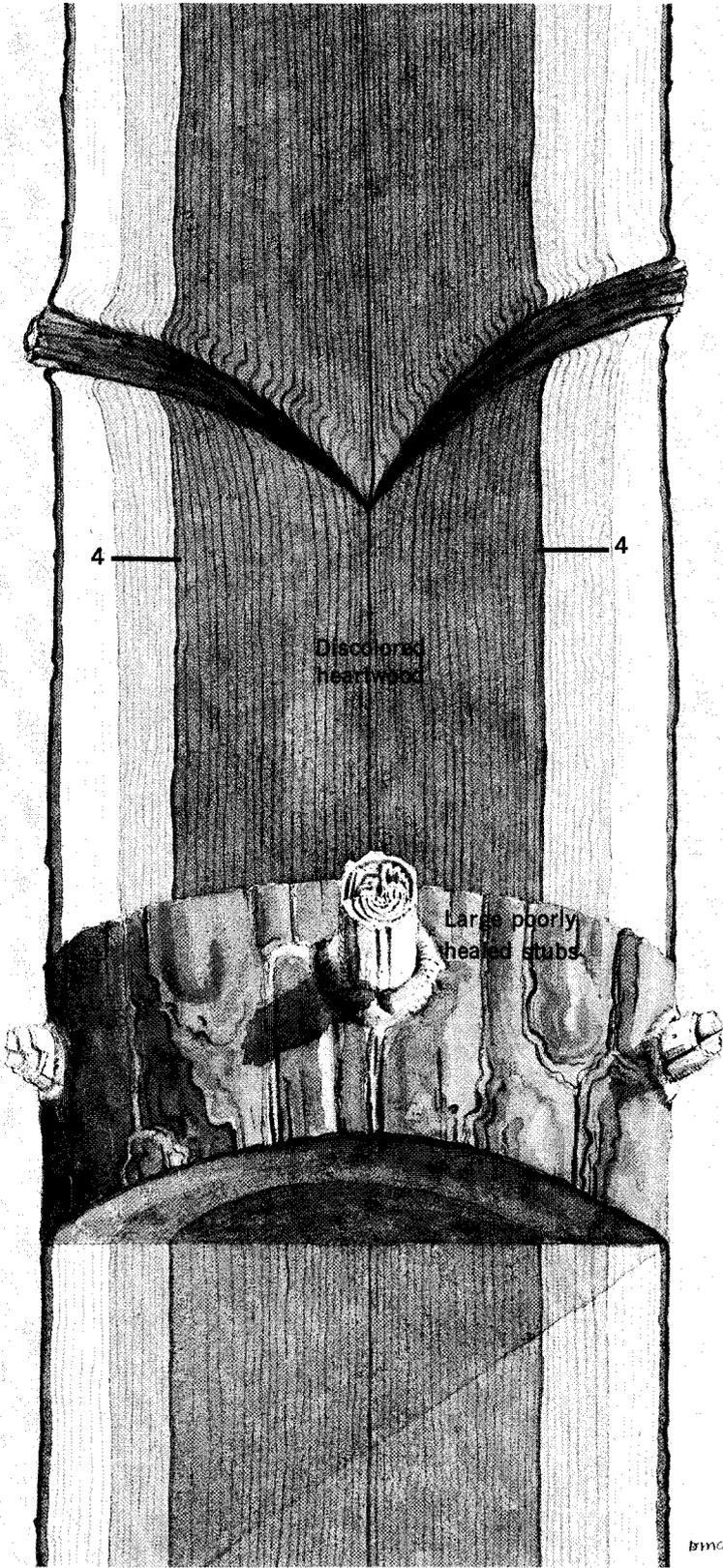
Ash—Column of discolored and decayed wood associated with a wound developing around a central column of decay associated with old, poorly healed branch stubs. The barrier zone is the ring shake boundary.



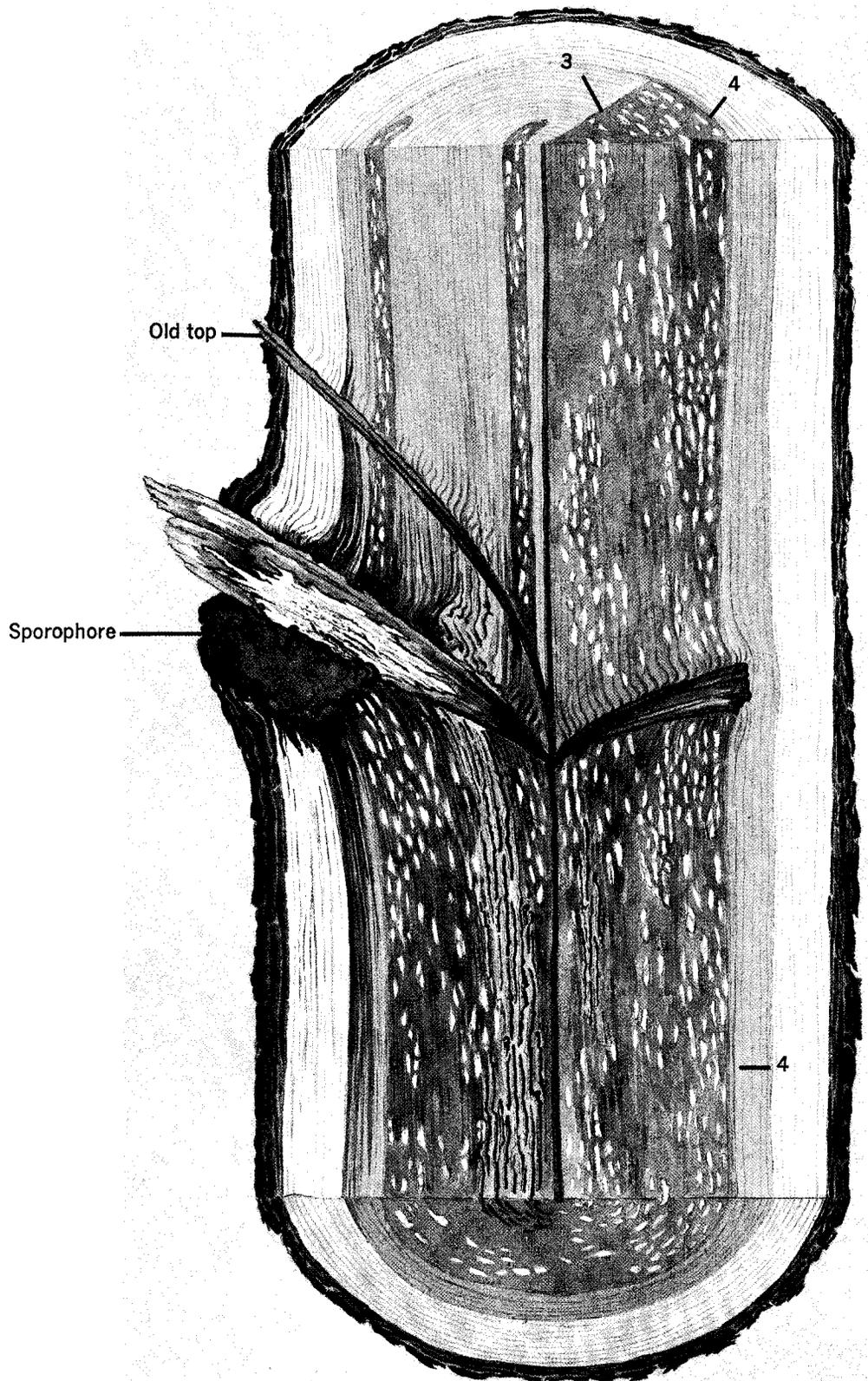
Slightly altered columns of compartmentalized wood associated with wounds in pines are sometimes difficult to see. Some ring patterns of defects in pine form when mechanical wounds are inflicted on trees that already have discolored heartwood.



Another explanation for ring rots in pine and related genera is that some of the decay fungi, such as *Fomes pini*, first get established in the center of the trunk through branch infections. After establishment, new columns of decay form at the boundaries of the sapwood and heartwood. The new columns are compartmentalized and appear as rings.

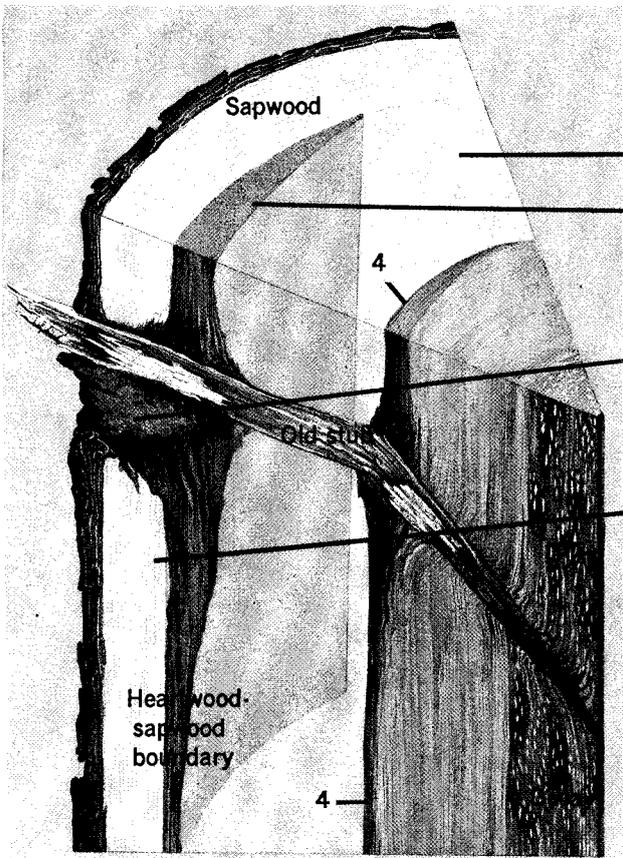


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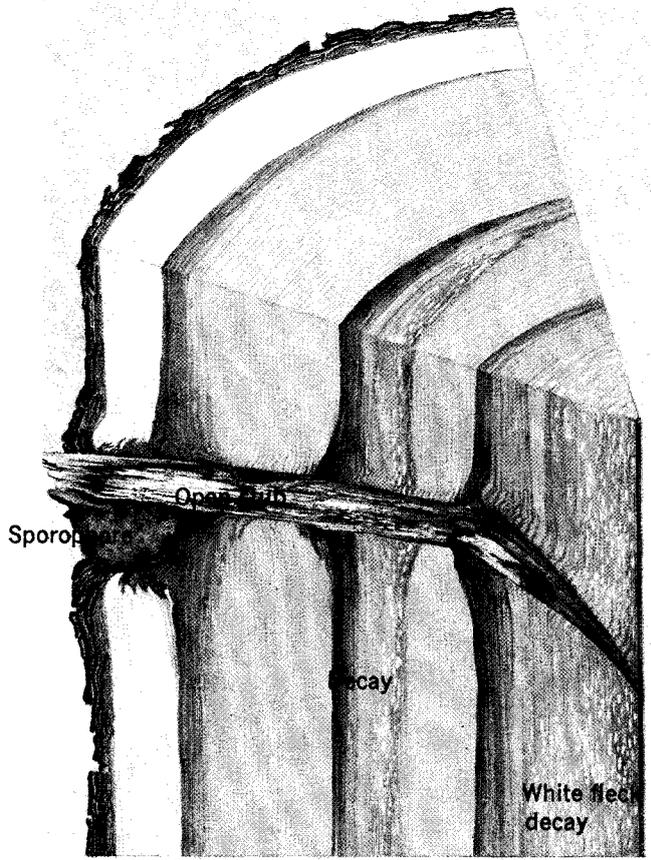
Fomes pini



Heartwood
 Discolored heartwood
 Sporophore of
Fomes pini
 New column of defect not in
 sapwood

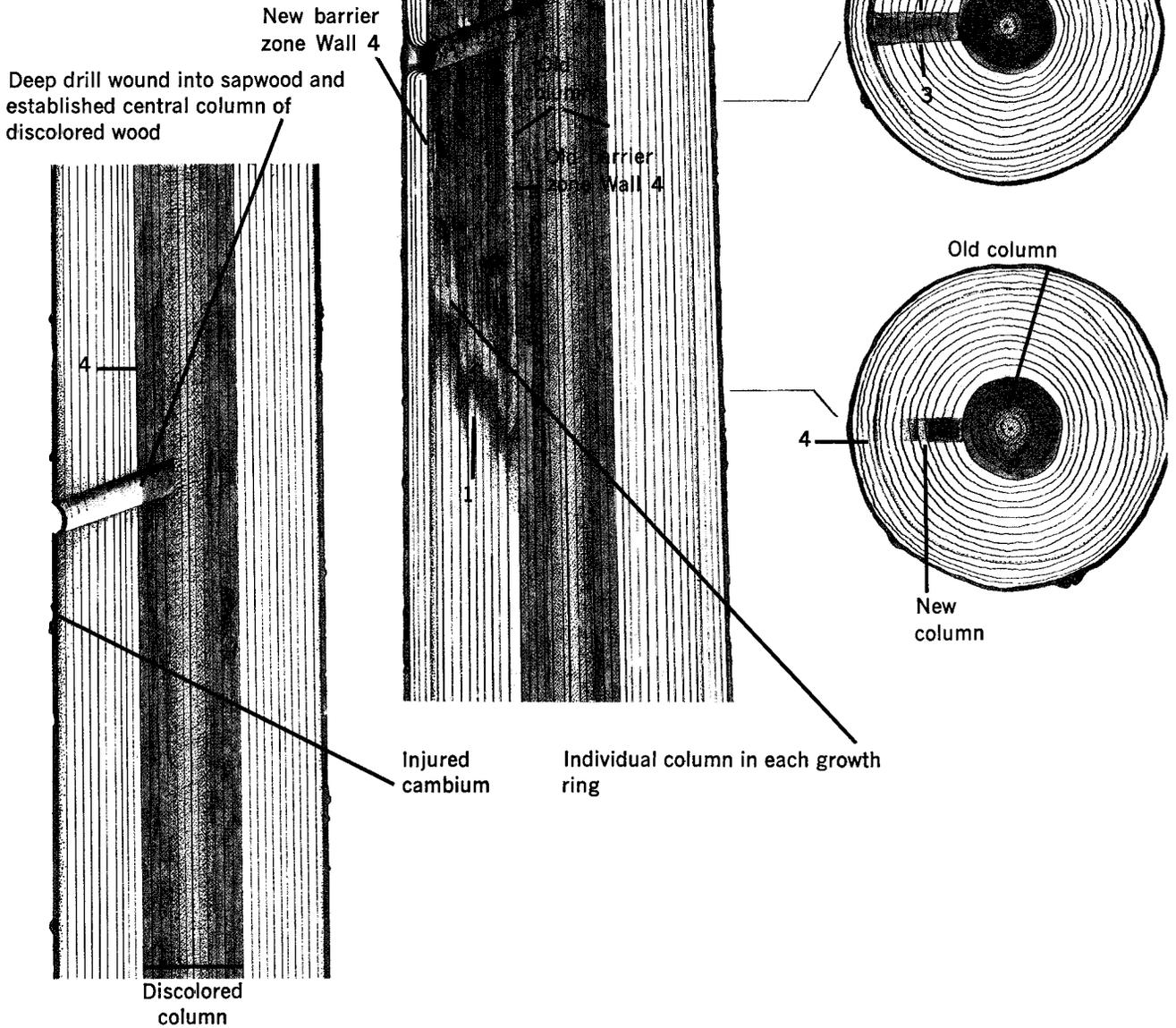
Heartwood-
 sapwood
 boundary

White
 pine



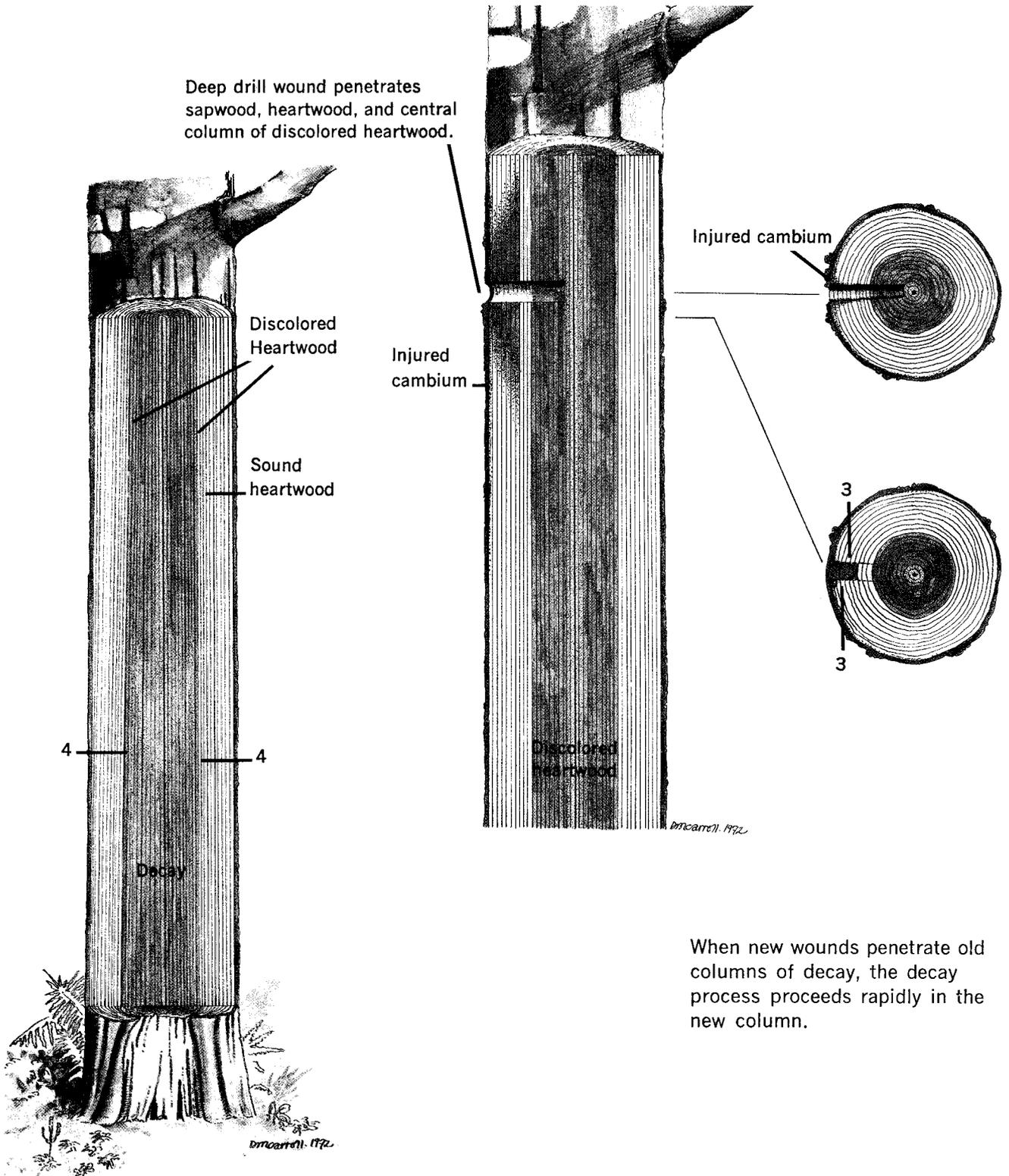
Open wound
 Sporophore
 Decay
 White fleck
 decay

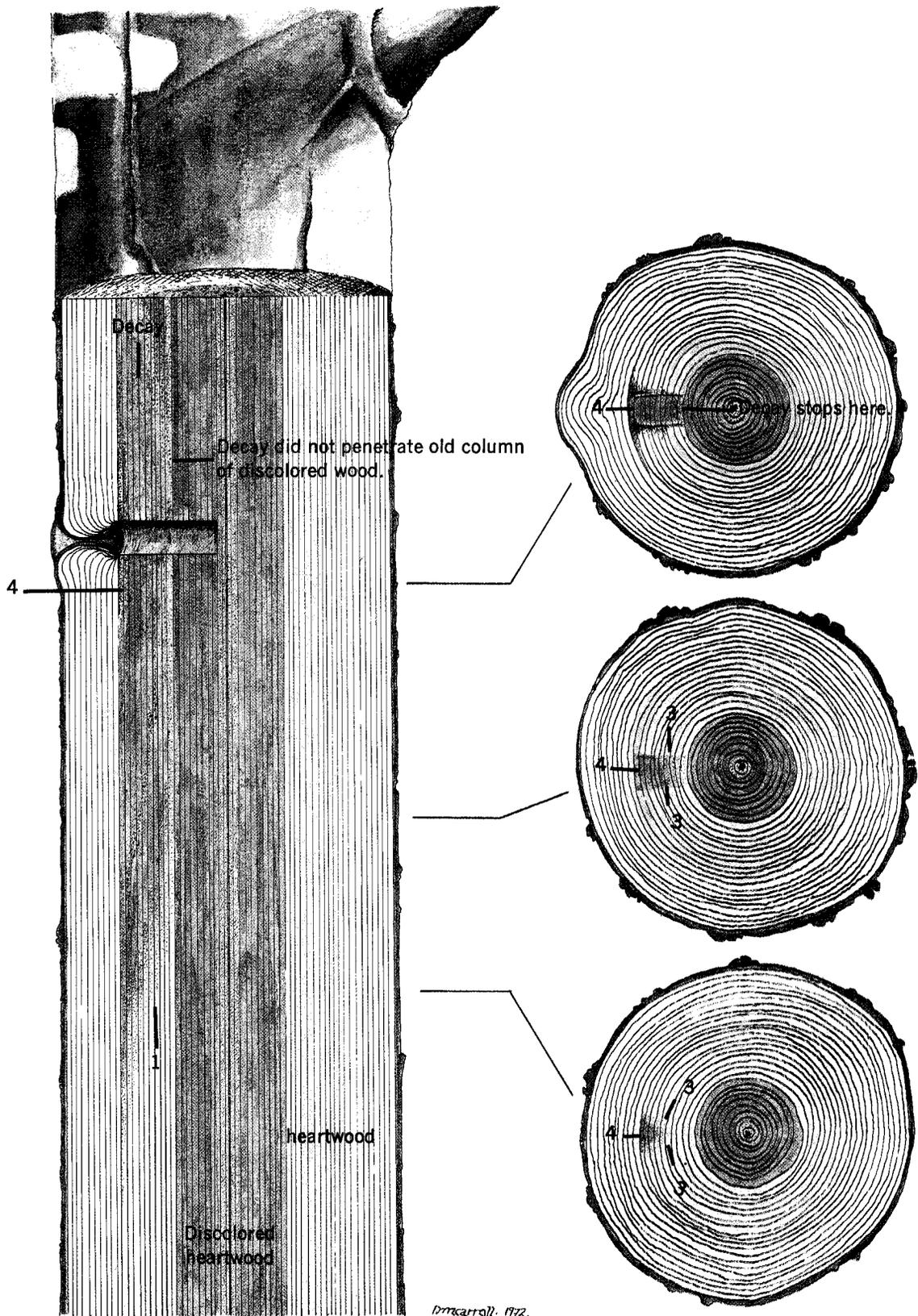
The "holding power" of columns of discolored wood can be shown by wounds that penetrate the columns. The new column that forms remains separate from the inner columns. When the second wound is severe, decay may develop in the new column. This occurs in nonheartwood-forming trees.



Nonheartwood-forming tree

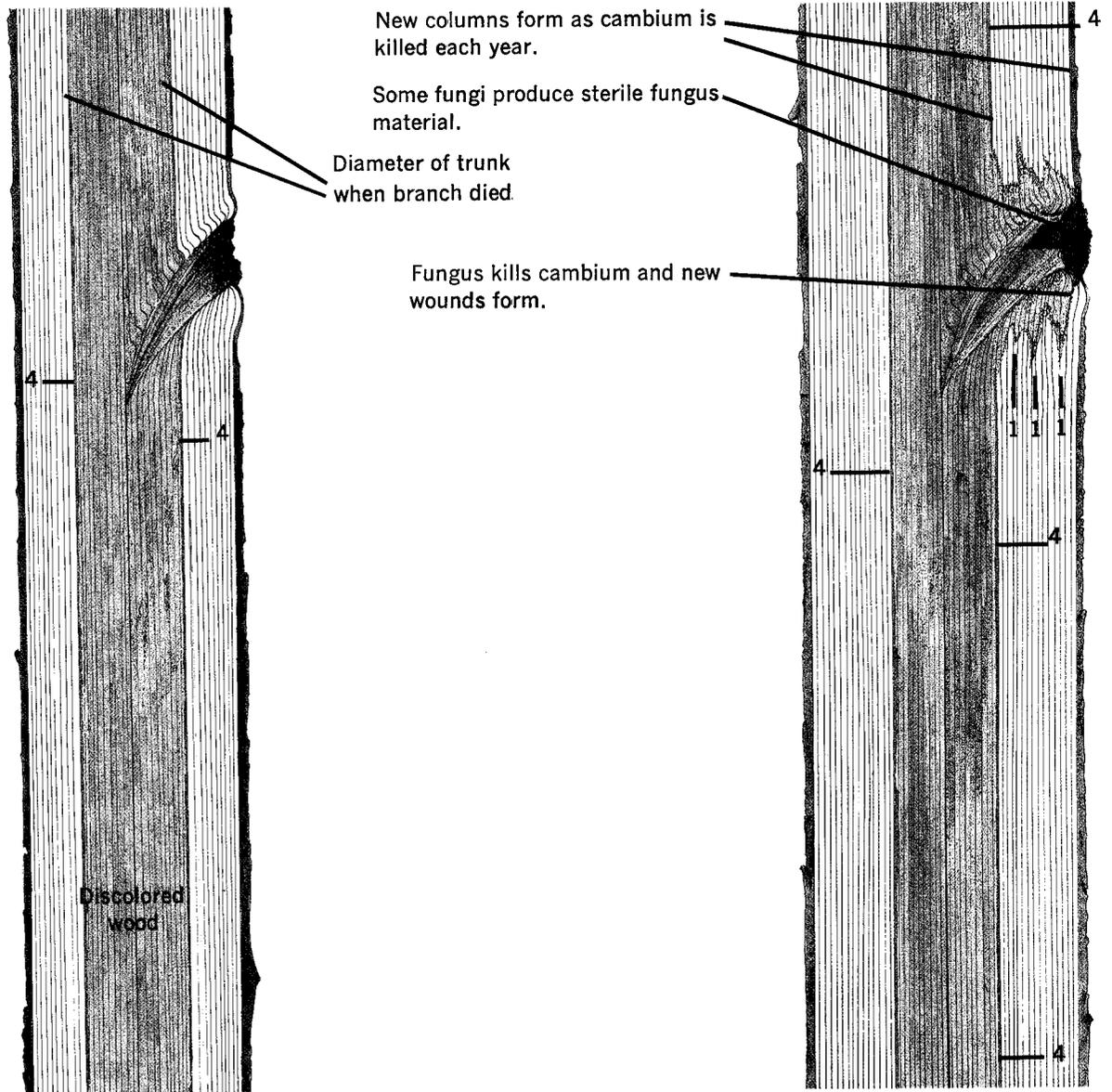
And in heartwood-forming trees.

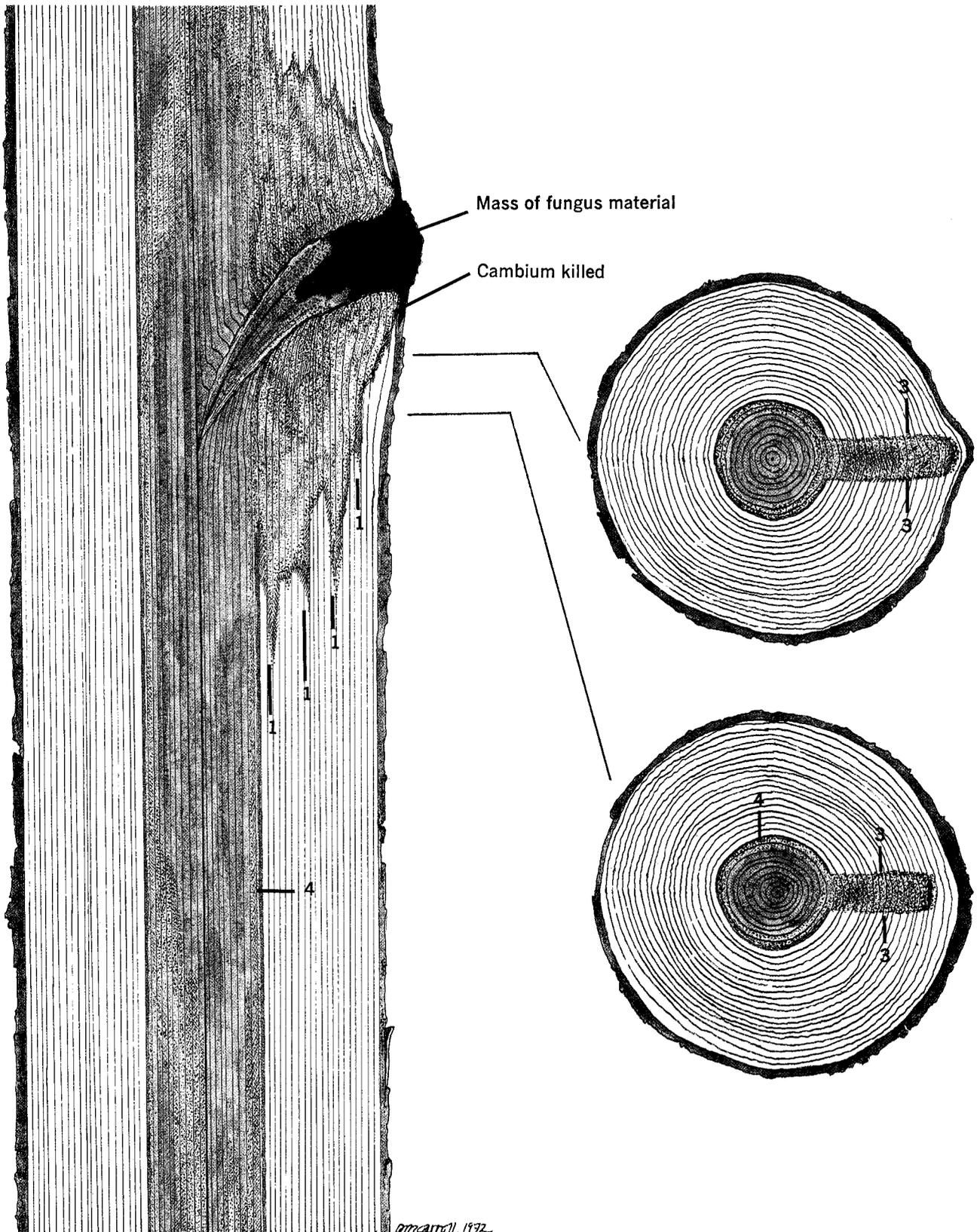




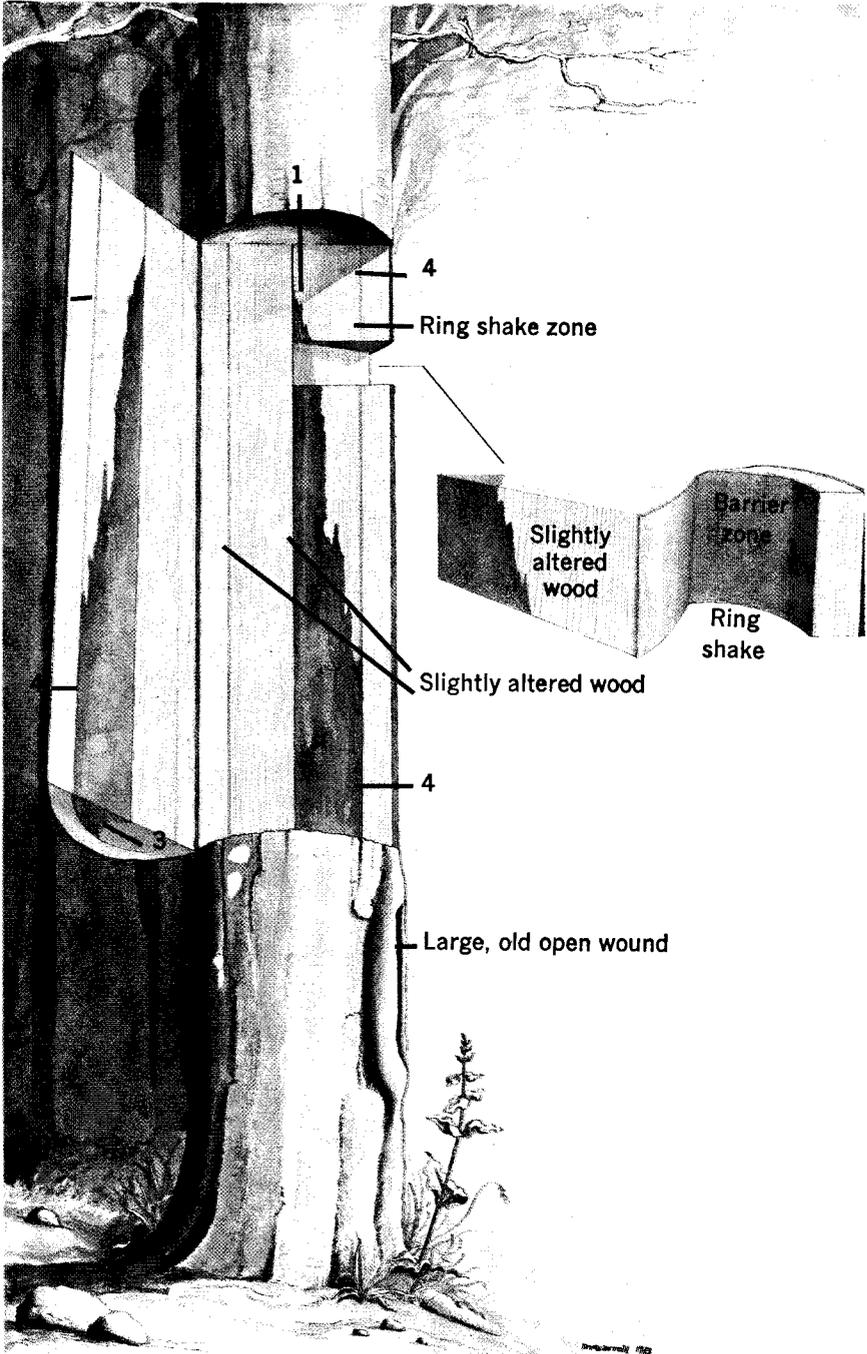
There are some patterns of defects that on first inspection do not appear to fit the concept of compartmentalization. However, they do. The most notable are the defects associated with canker rots. Canker rot fungi, once established in a tree, keep the wound open by slowly killing some living tissues around the wound. This process is the same as re-wounding. And, when the new wound is made, a new

column begins to develop. An intricate pattern of multiple columns is associated with canker rot.

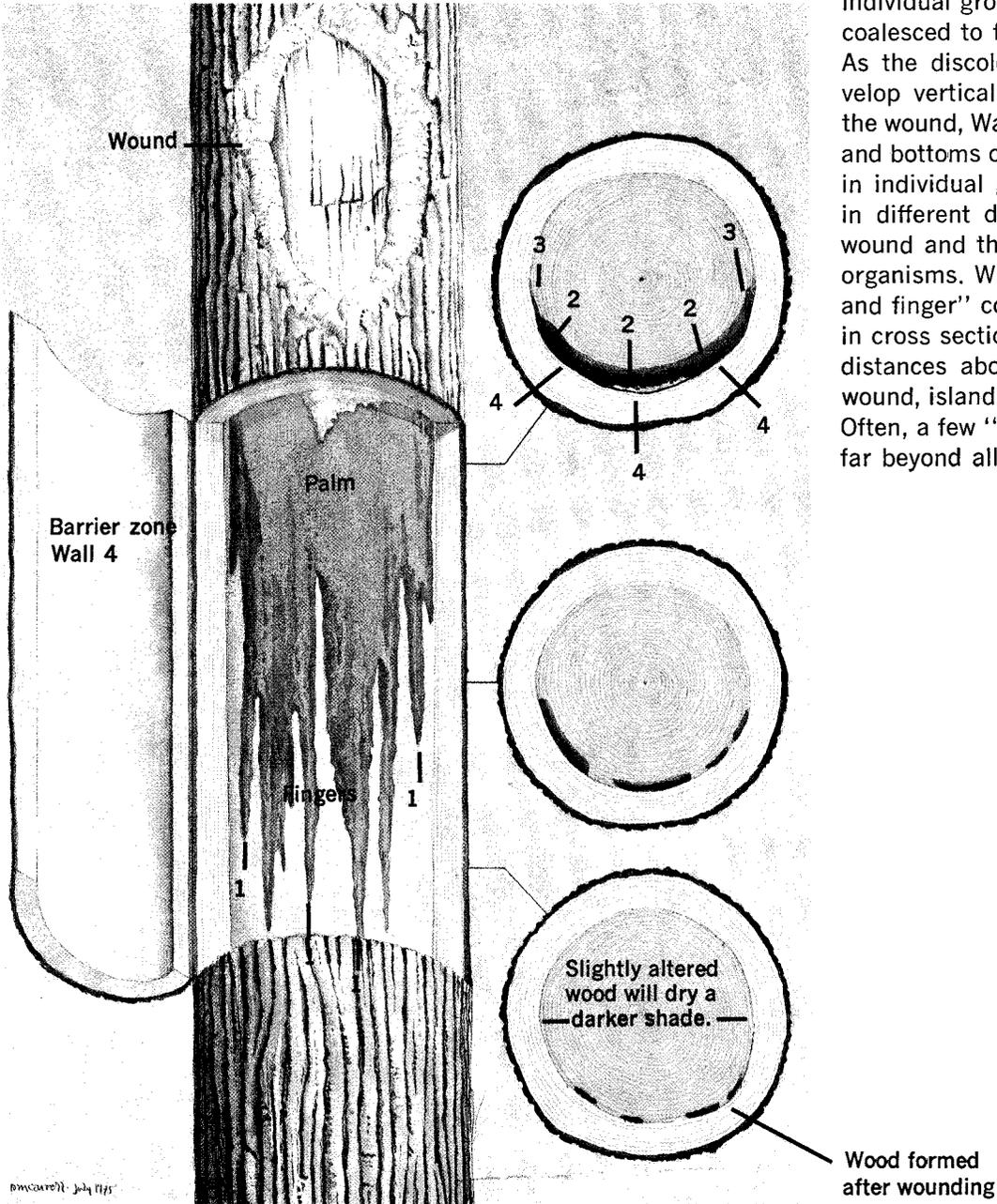




Another type of defect that does not appear to fit the concept are ring shakes—separation of the wood along the rings. The problem here is that the barrier zone associated with the wounds often forms far beyond the visible column of defect. The barrier zone acts as a partition between the wood present at the time of wounding and the new wood formed after. When growth stresses or other stresses are applied, the wood sometimes pulls apart along the barrier zone. Most shakes are associated with wounds, but not all wounds result in shakes.

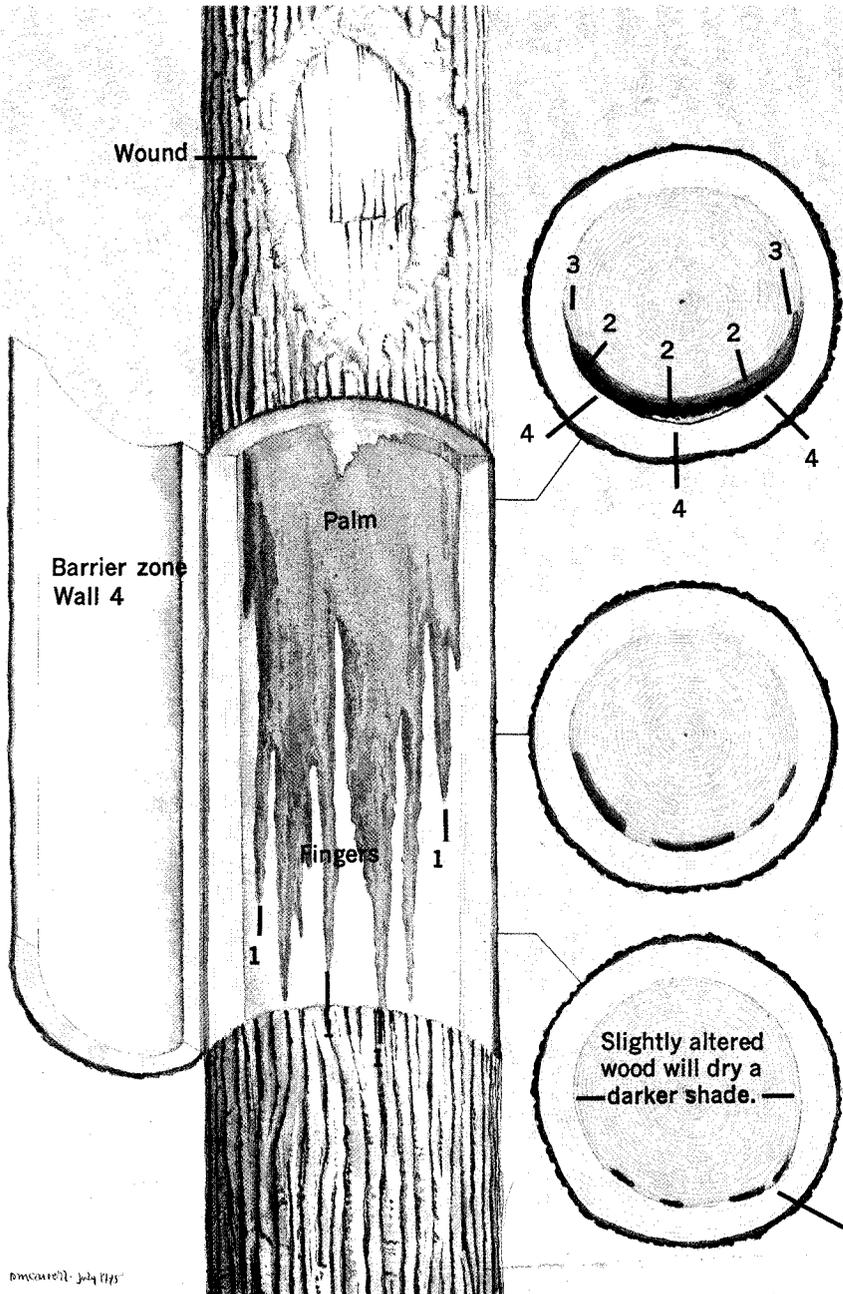


And, yet another type of defect pattern that appears not to fit the compartmentalization concept is the "island" pattern or streak pattern often spoken of as mineral streak. Wounds indeed start these processes. A pattern type that can be termed "palm and fingers" develops. Near the wound all the columns in the individual growth ring are coalesced to form the "palm." As the discolored columns develop vertically above and below the wound, Walls 1, or the tops and bottoms of the compartments in individual growth rings, react in different degrees to the wound and the invading microorganisms. When such a "palm and finger" column is viewed in cross section at increasing distances above and below the wound, islands of defect appear. Often, a few "fingers" will develop far beyond all the others.



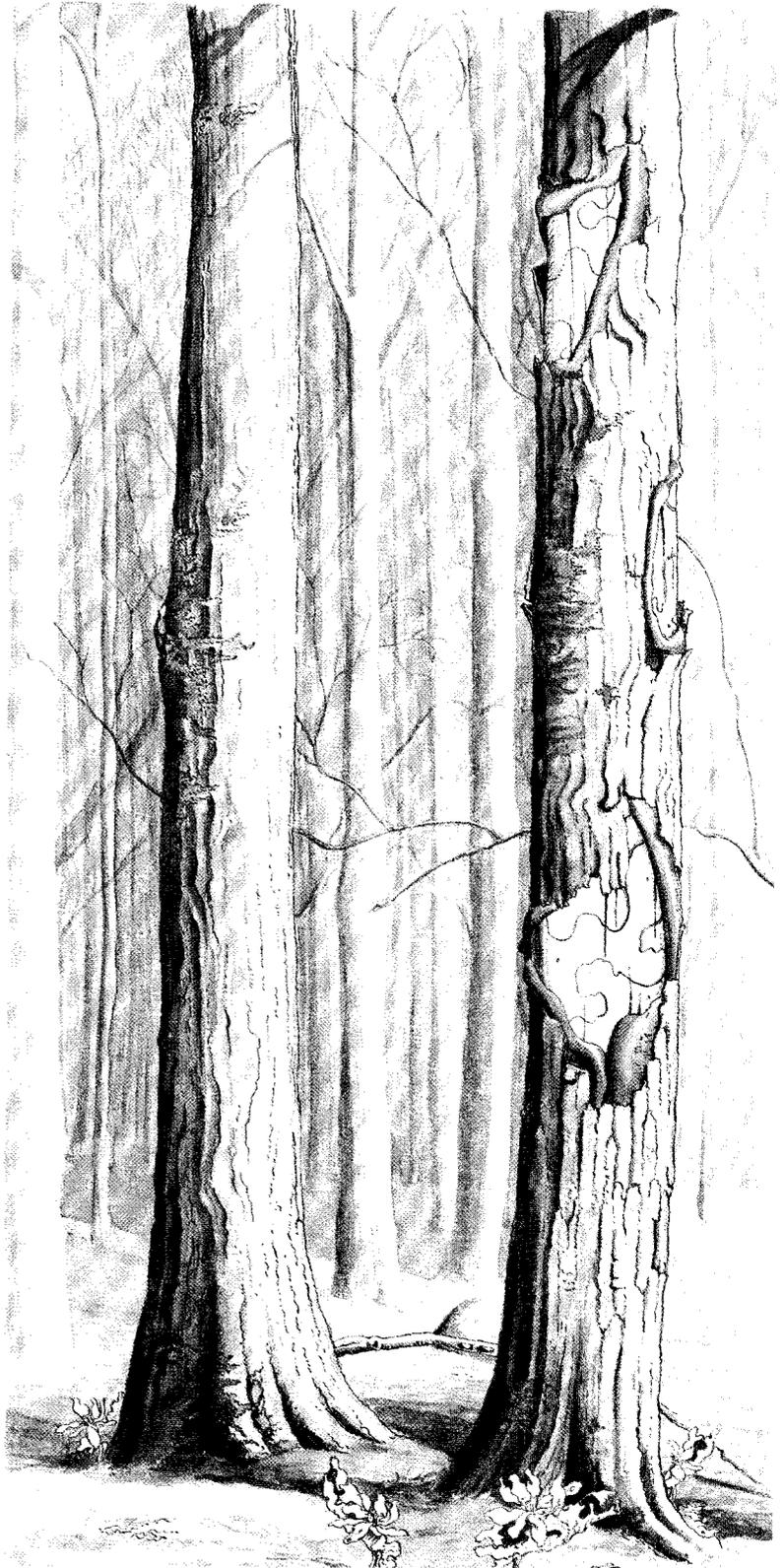
© 1975, J. G. Cameron

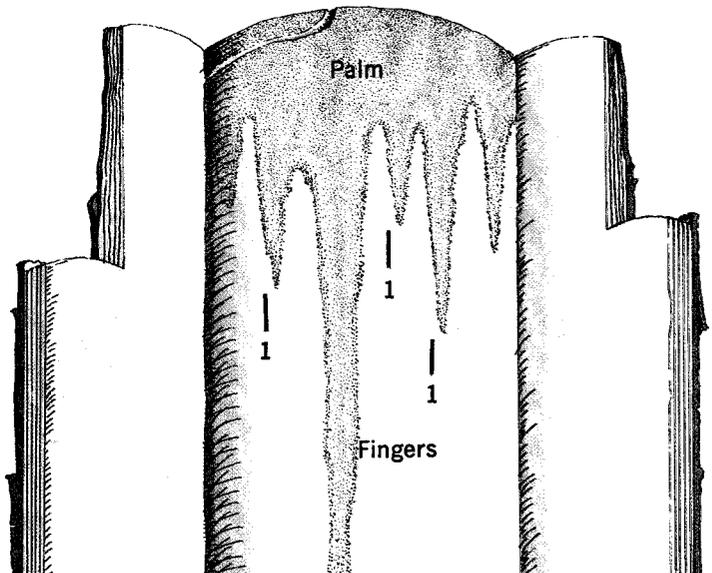
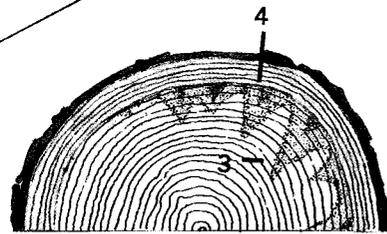
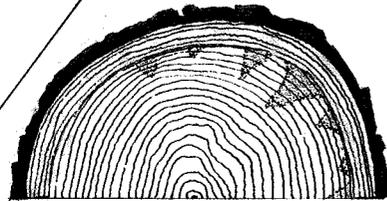
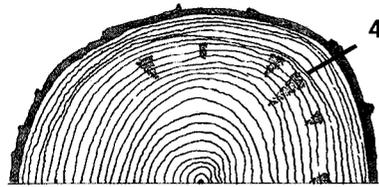
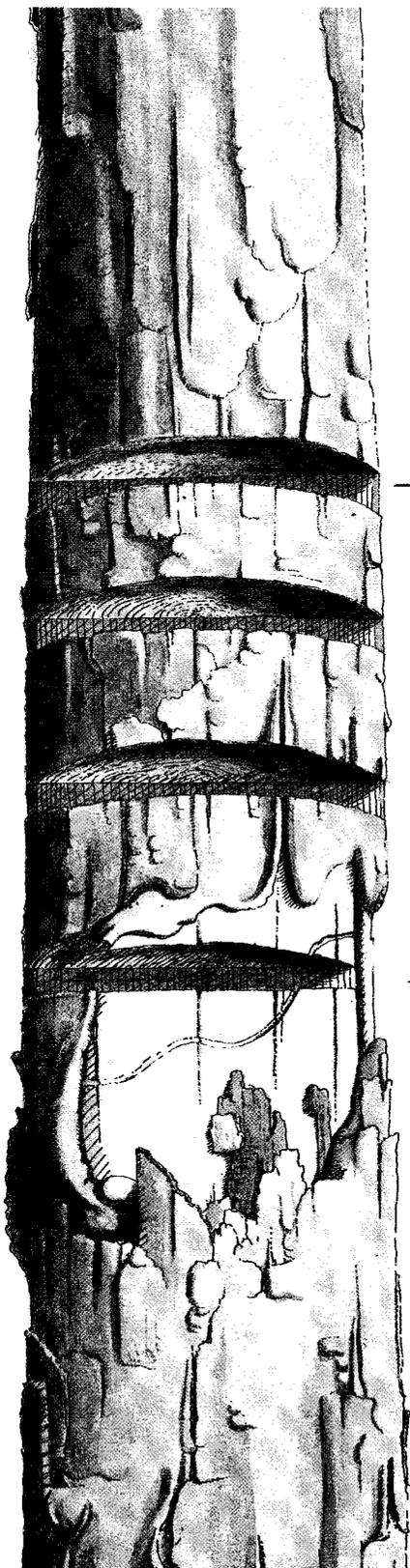
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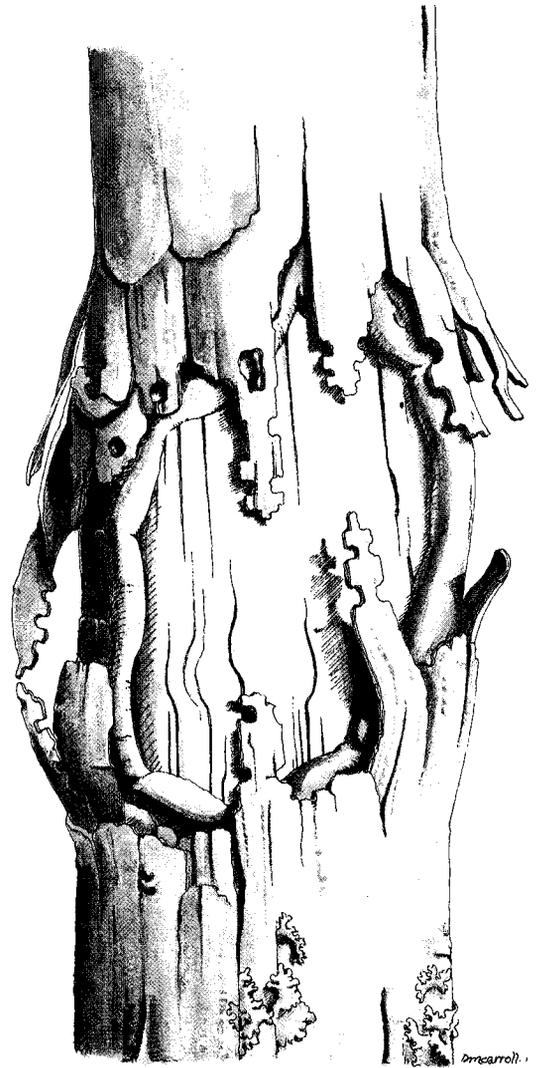
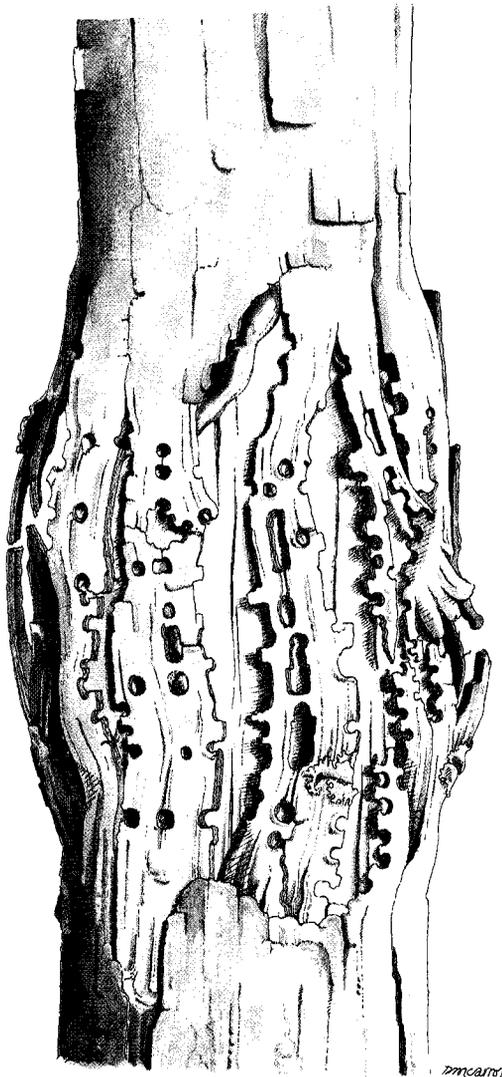
Wood formed after wounding

In sugar maple, for example, the “palm and finger” pattern is the mineral streak pattern associated with sugar maple borer wounds. This insect is a major cause of mineral streak in sugar maple.

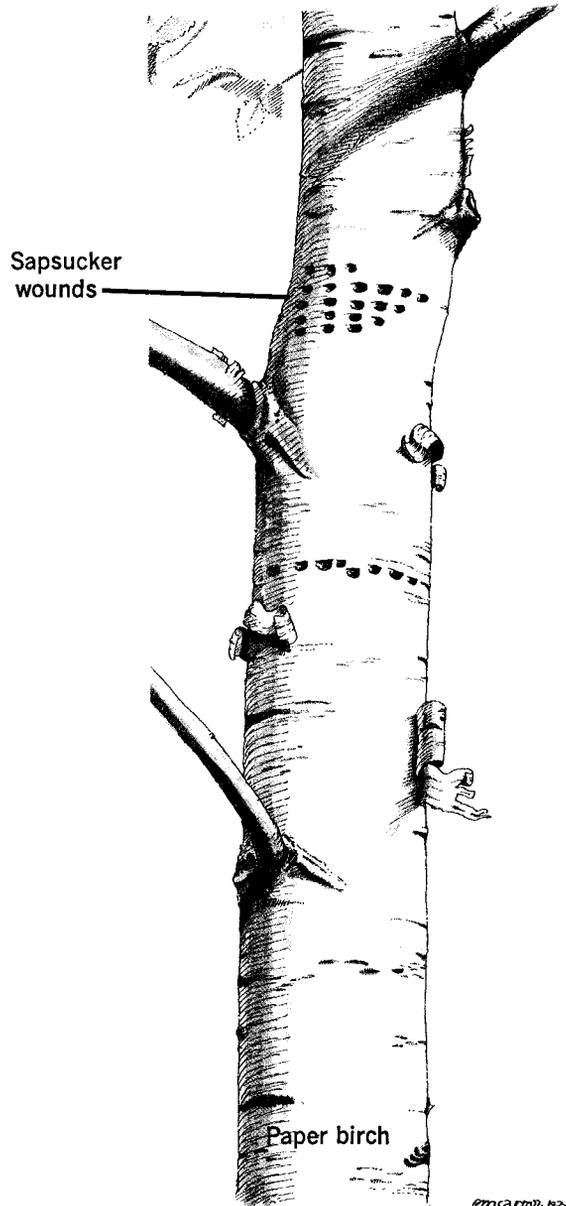
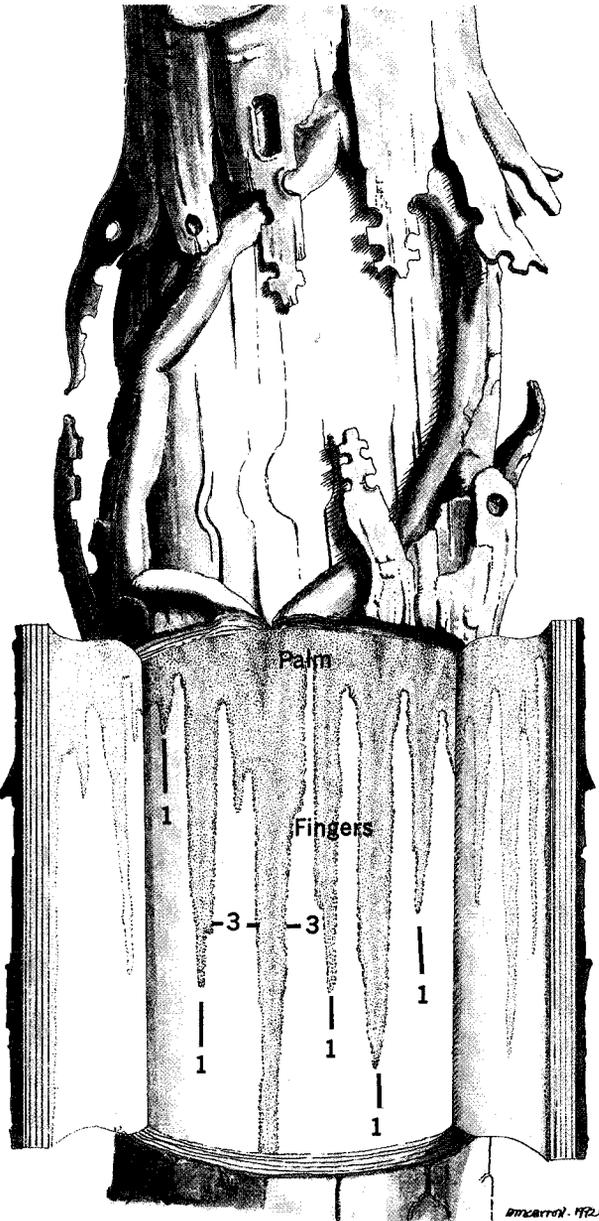




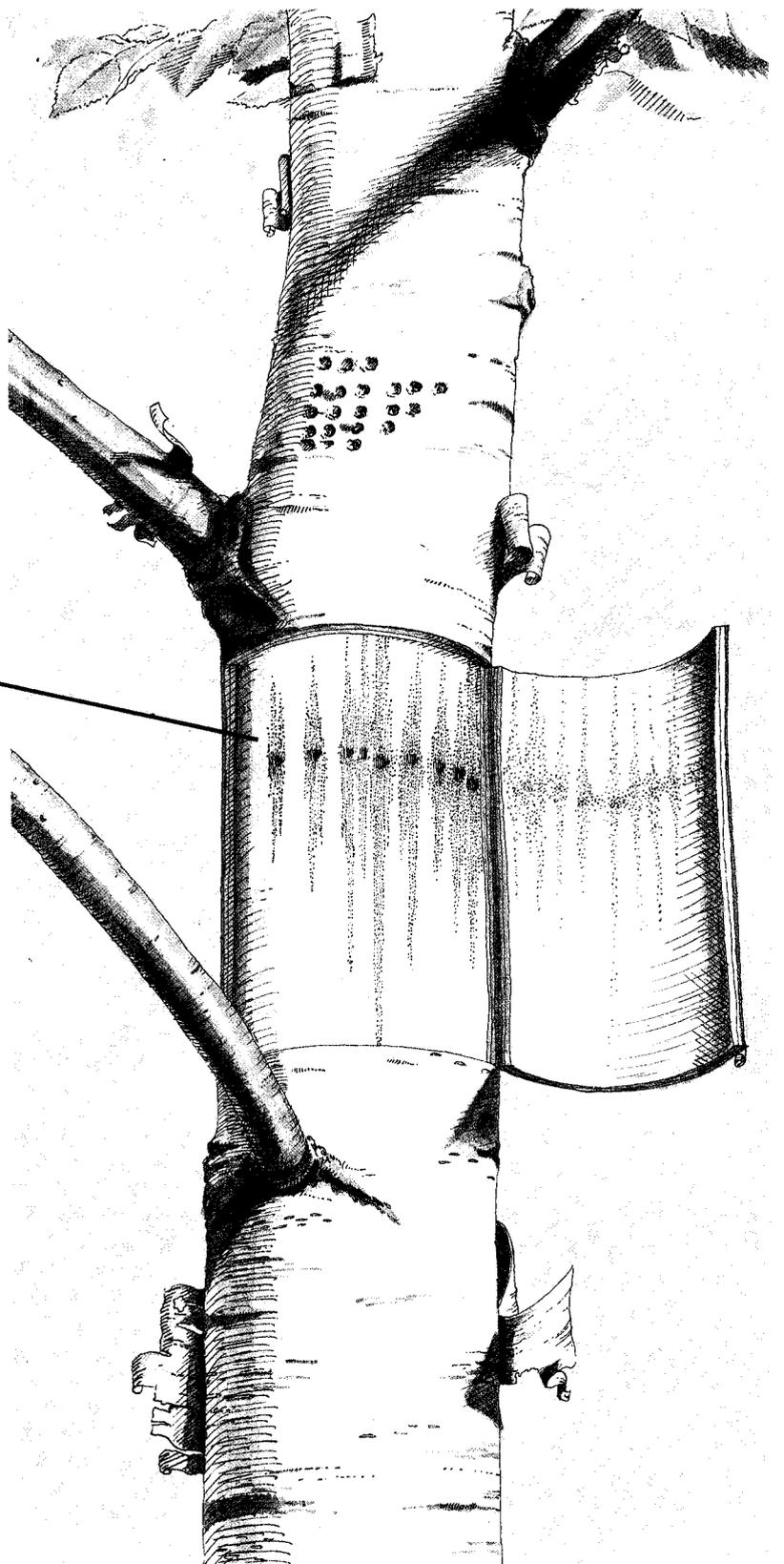
The yellow-bellied sapsucker (see page 7) inflicts several types of wound patterns on many species of trees. In one type of wound pattern a large wound is the result, and the "palm and finger" defect pattern develops. Again, the "fingers" may extend great distances above and below the wound. And cross sections of trunks made through the "fingers" will show islands of defect, or mineral streaks.



The "palm and finger" defect pattern is also associated with some other wounding patterns made by the sapsuckers.

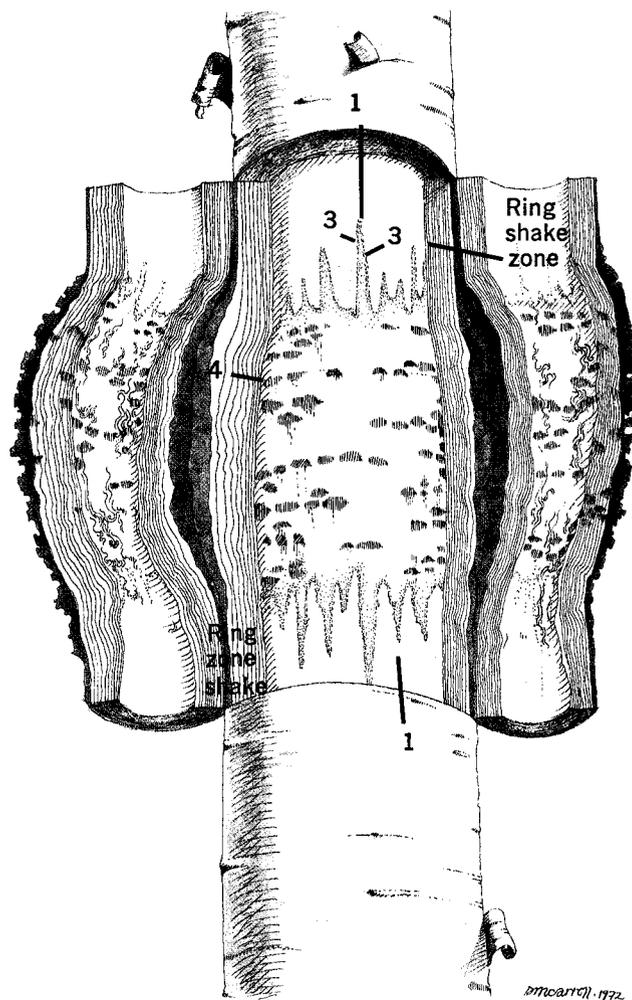
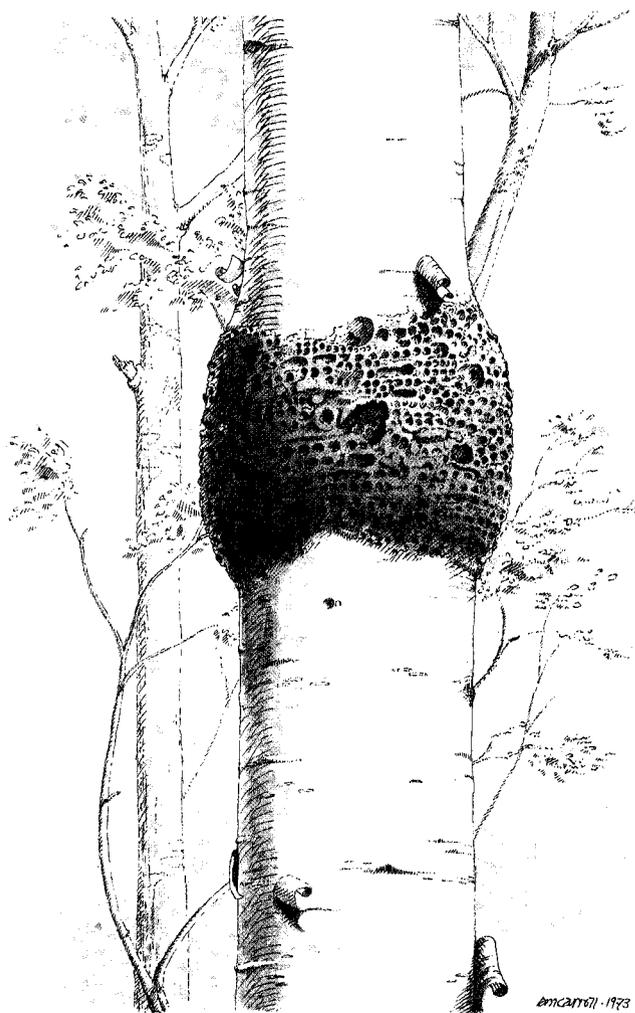


Palm and finger



Sapsuckers will often wound one area on a trunk. On paper birch a swollen black band will form at these sites.

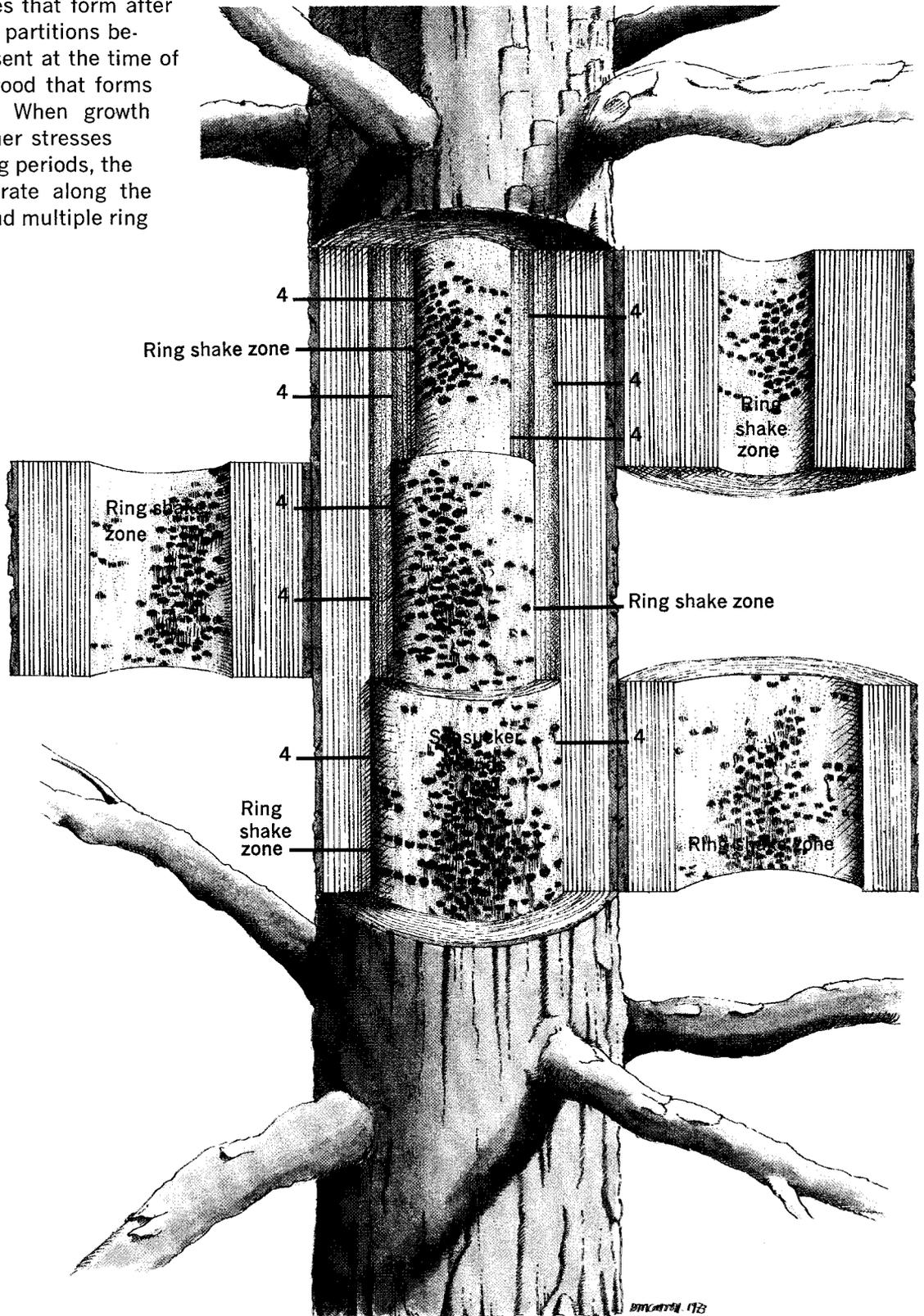
Not only will discolored streaks of the "palm and finger" pattern develop from such wounds, but the barrier zone that develops after wounding may pull apart from the inner rings to form a complete ring shake which is sometimes called cup shake or loose heart.



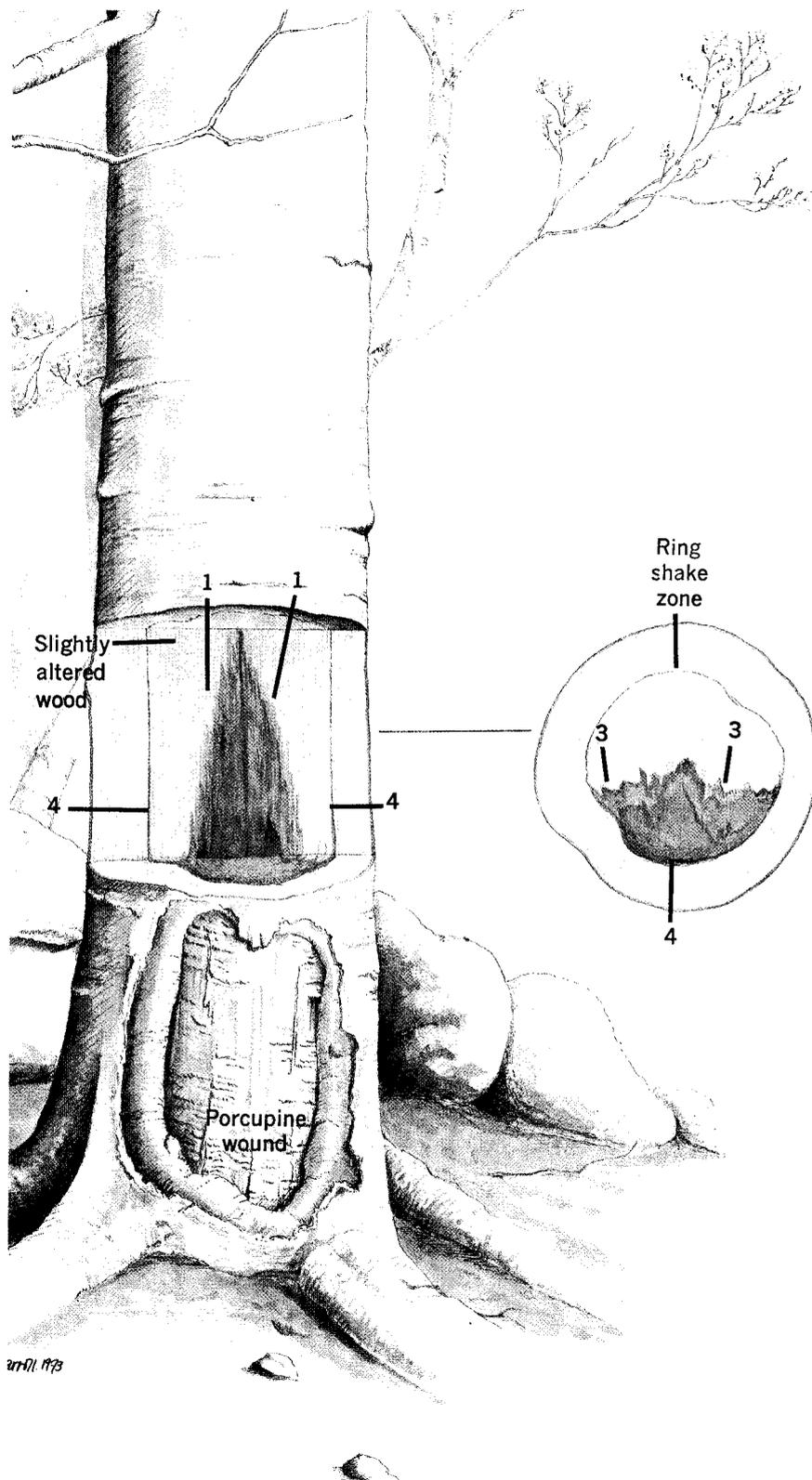
On some trees, such as eastern hemlock, the yellow-bellied sapsucker inflicts many wounds over large areas of the trunk.



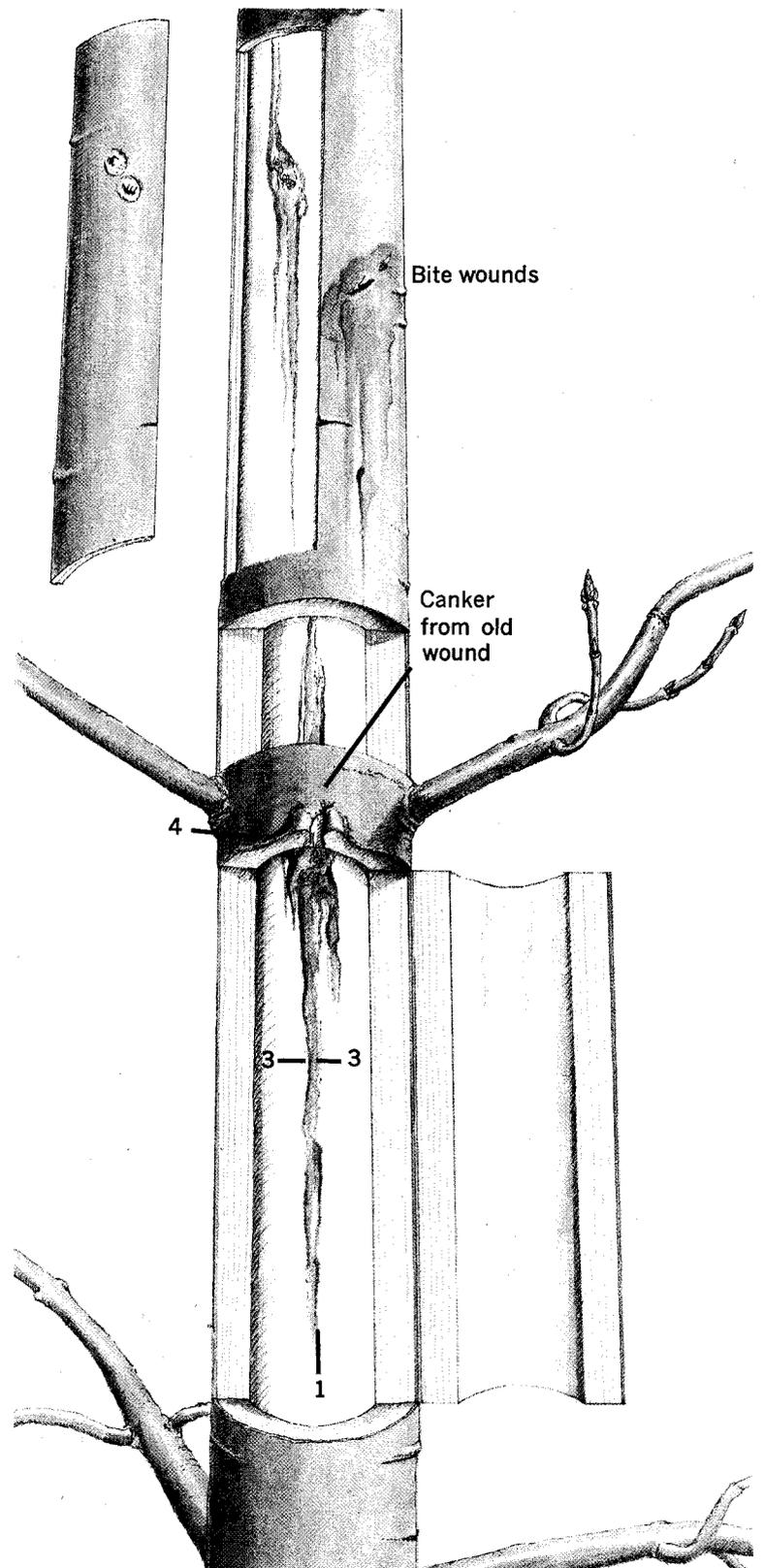
The barrier zones that form after wounding act as partitions between wood present at the time of wounding and wood that forms after wounding. When growth stresses and other stresses develop over long periods, the wood may separate along the barrier zones, and multiple ring shakes form.



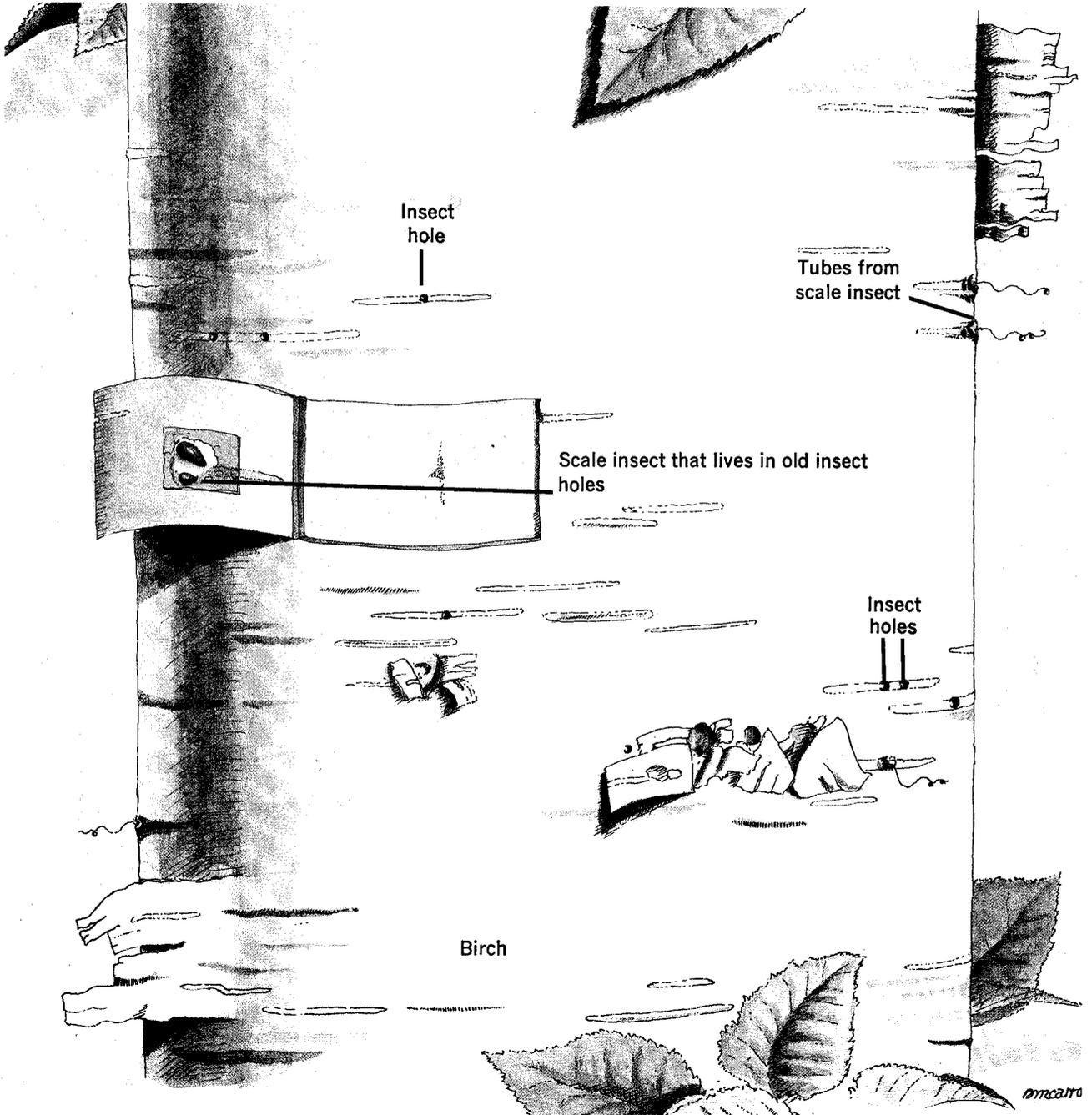
The "palm and finger" pattern of defect and barrier zones that form shake are commonly associated with wounds made by larger animals such as beavers and porcupines (see page 9). When wounds are severe, Walls 1 and 2 may fall to invading microorganisms.



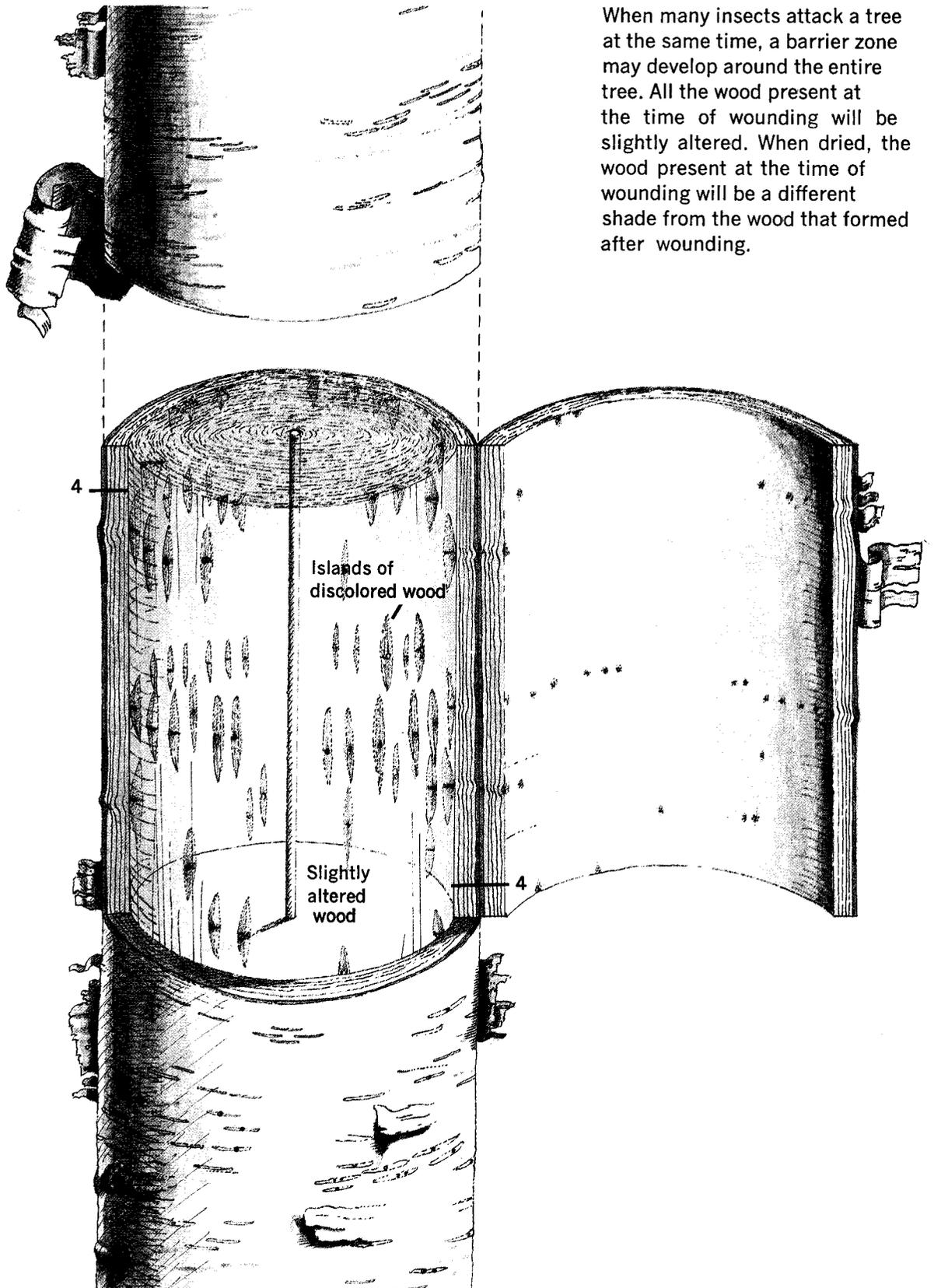
Squirrels wound young, smooth-barked trees in several genera (see page 8). The typical "palm and finger" defect pattern results. In some species these defects are called mineral streaks.



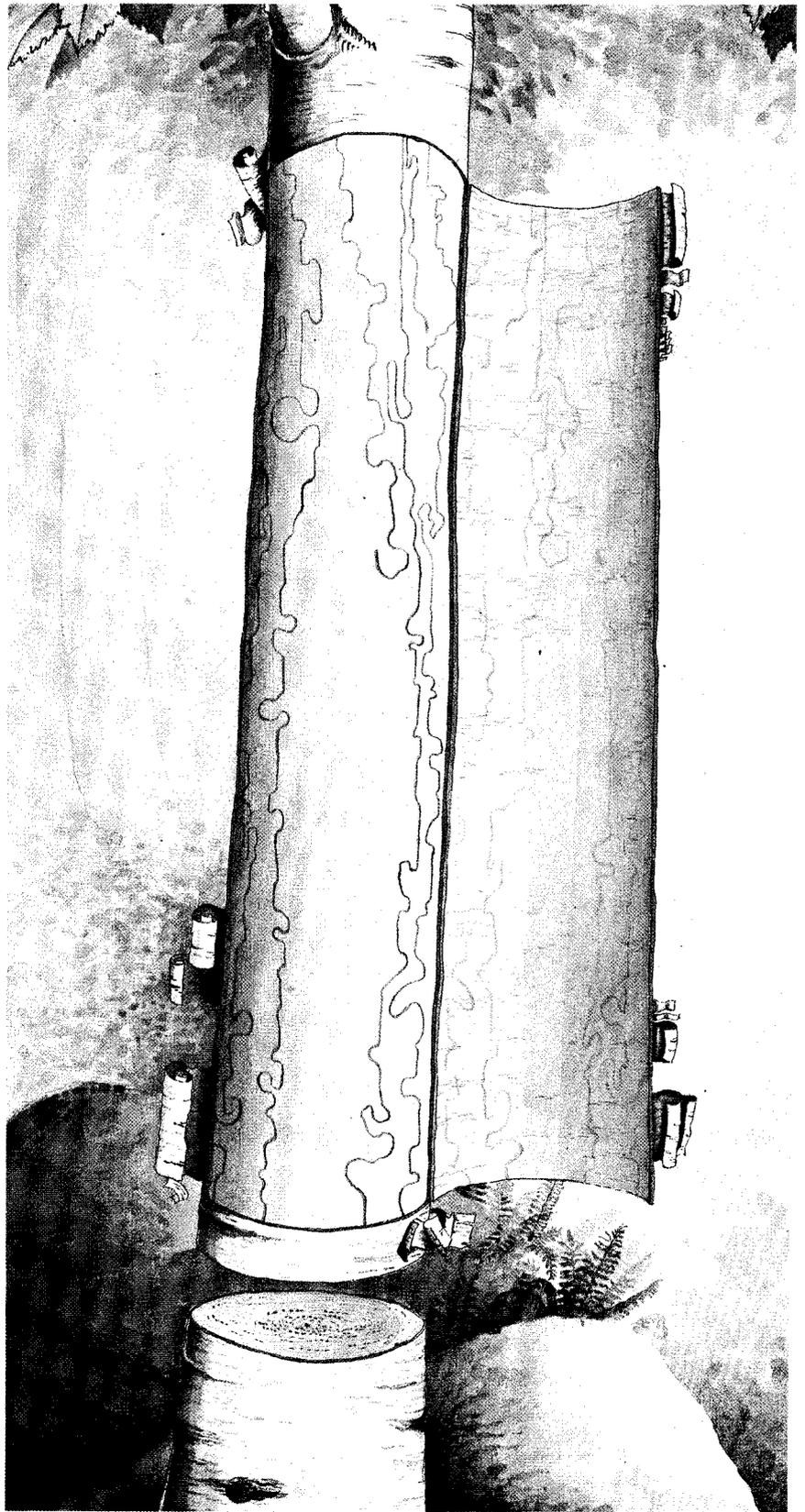
Insects wound trees (see page 8) and small islands of defects form. Each island of defect is a small "palm and finger" column. The columns usually penetrate only to the depth of the hole made by the insect.



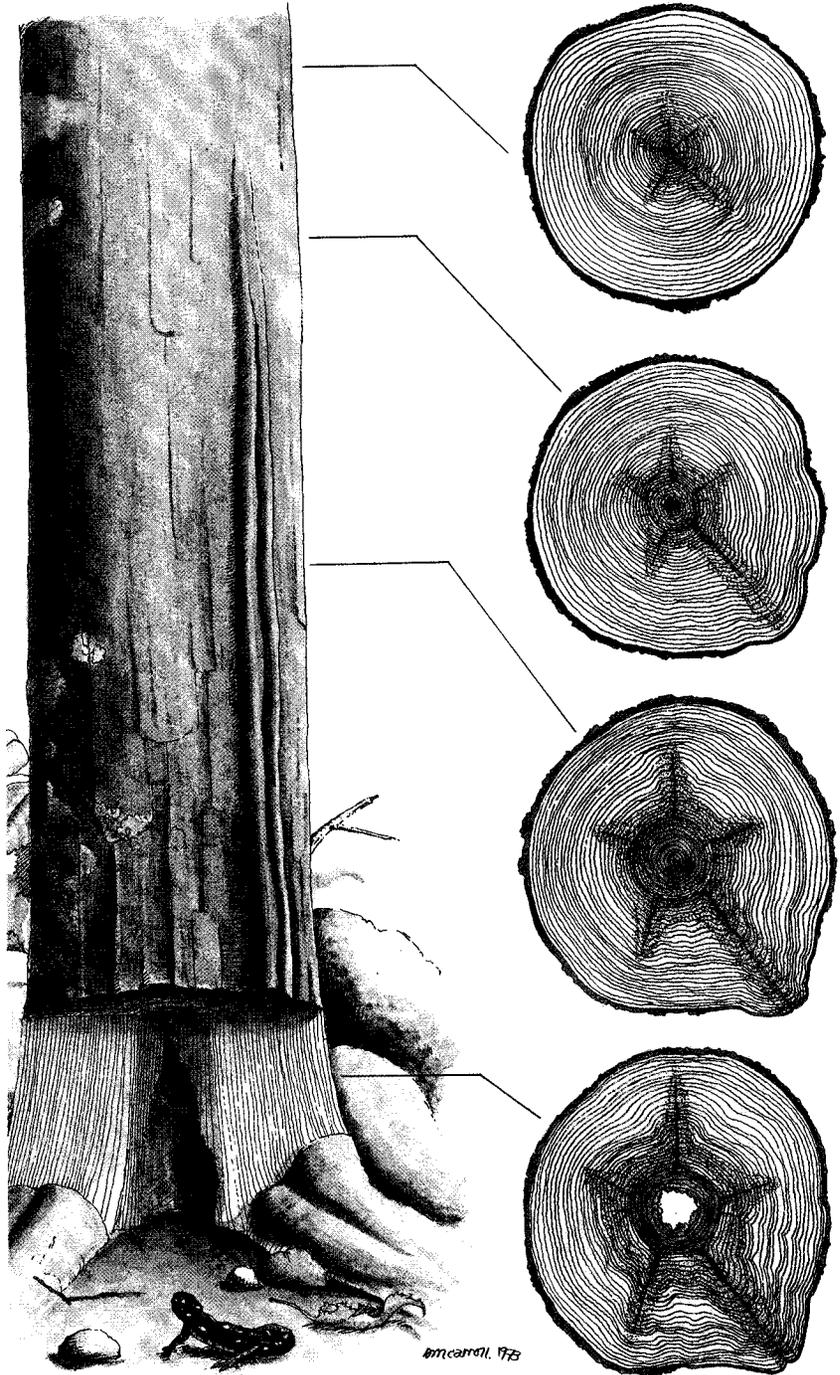
When many insects attack a tree at the same time, a barrier zone may develop around the entire tree. All the wood present at the time of wounding will be slightly altered. When dried, the wood present at the time of wounding will be a different shade from the wood that formed after wounding.



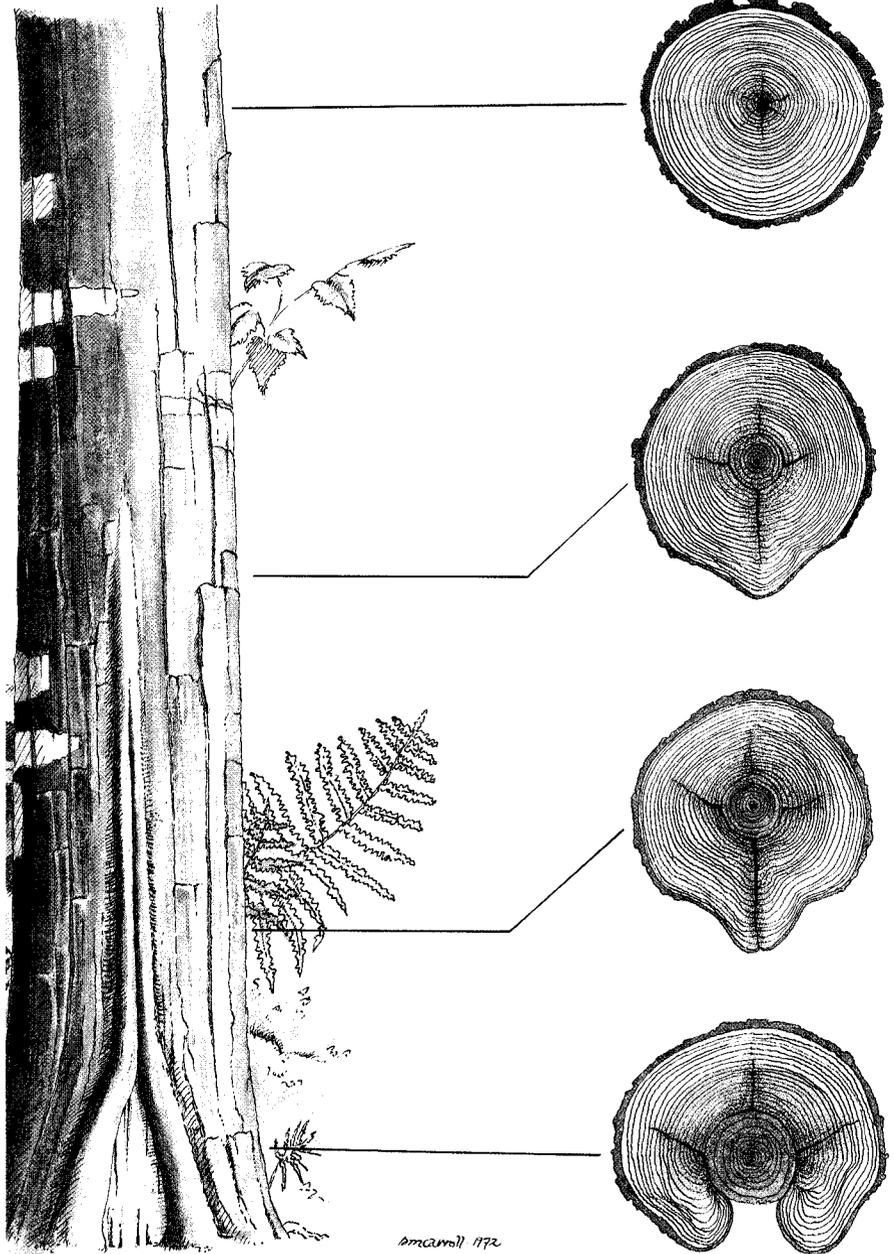
The cambium miner is a small larva of a type of fly that eats its way down the cambial region of some trees. The "tracks" of the larvae are compartmentalized as very long narrow streaks of discolored wood within growth rings.



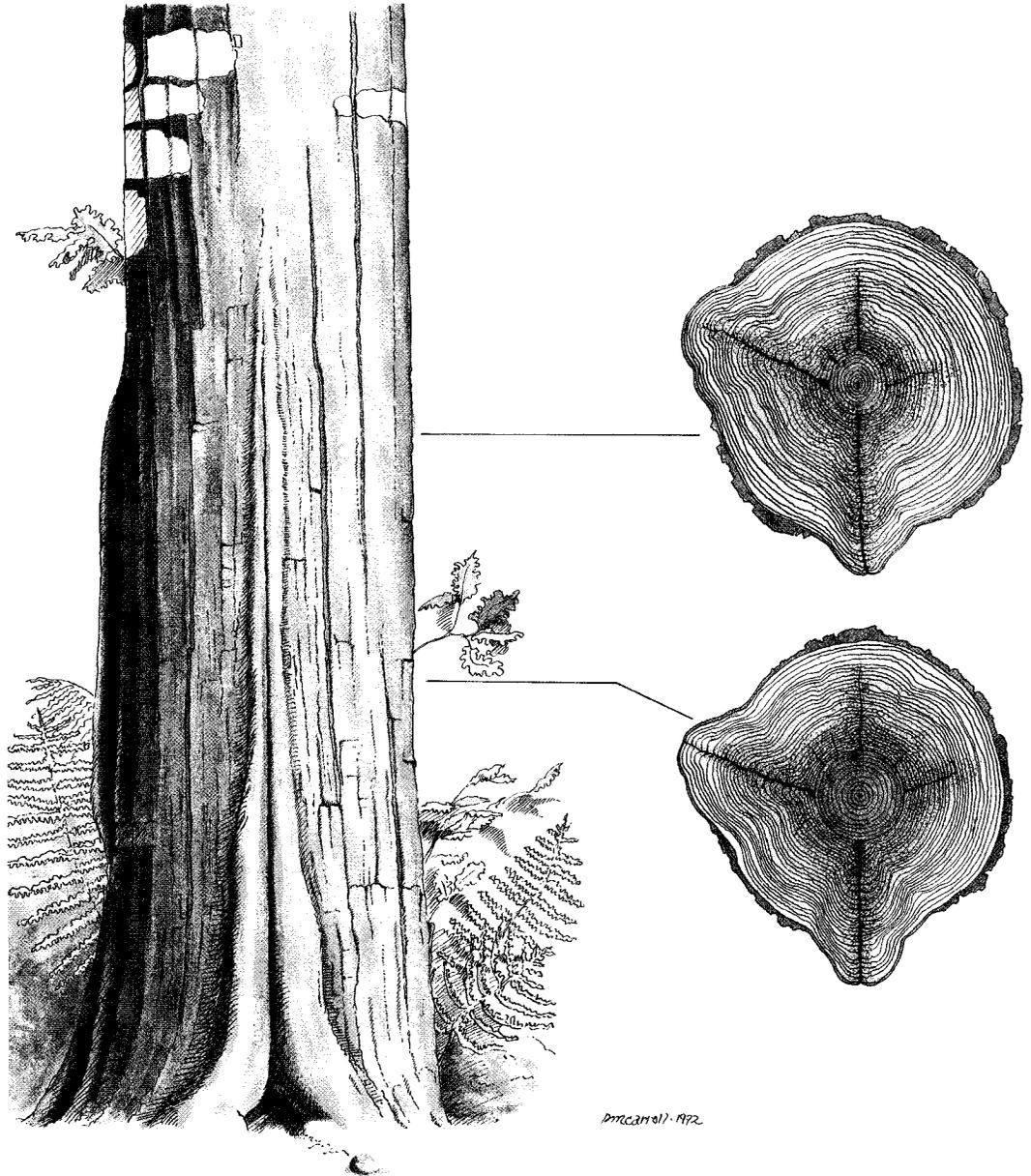
On some trees the wounds are not visible. This is common with small basal wounds, especially those caused by fire when the tree was very young and now the healed wound is hidden by forest litter. The barrier zone still forms around such wounds and often results in ring shake. Also, the inrolled callus serves as a weak spot on the tree that may continue to split vertically. Additional cracks may form from the barrier zone outward into the wood that forms after wounding. When the cross section of a trunk with such a pattern of internal defect is viewed above the base, a star-shaped pattern of cracks radiating out from the center will be seen.



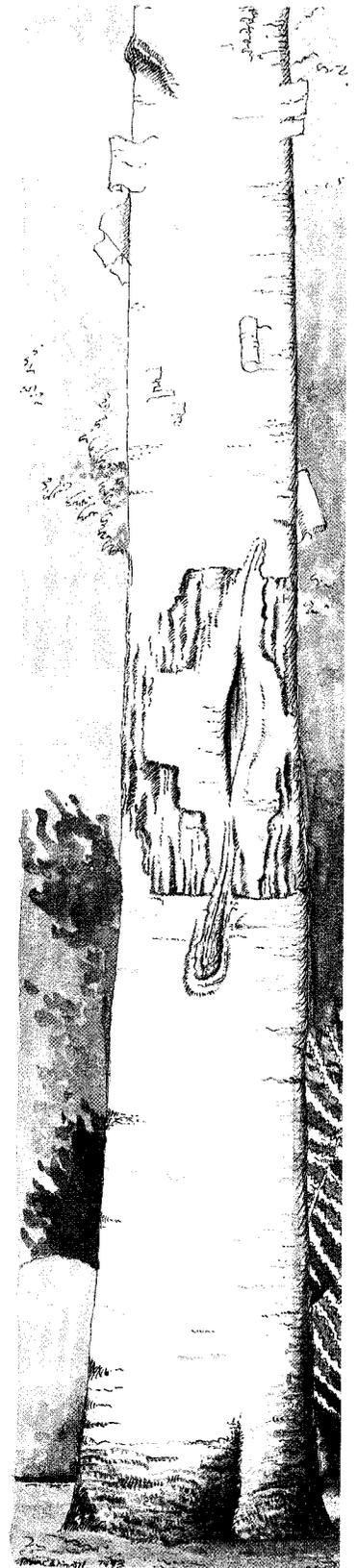
With some basal wounds, long internal cracks, called seams, form at right angles to the wounds at the points where the callus inrolls.

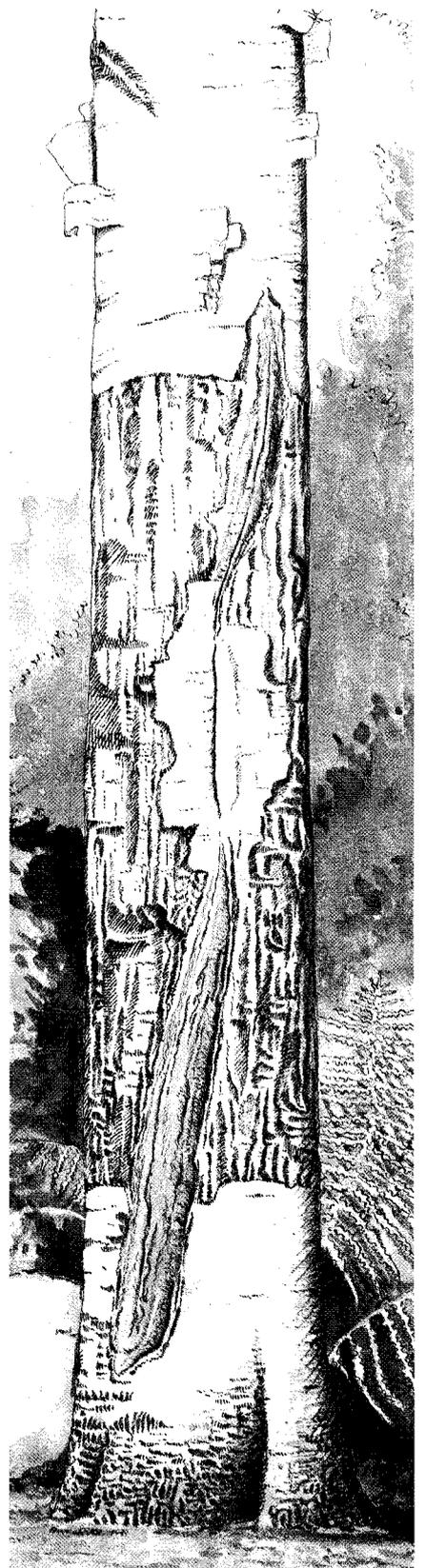
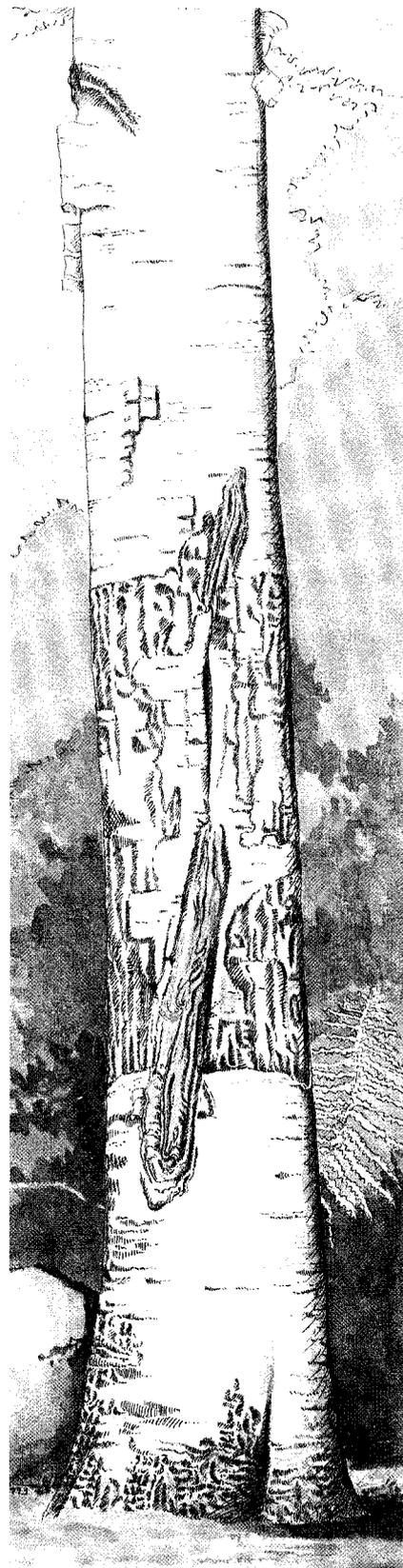


As these cracks continue to enlarge and get closer to the edge of the trunk, they may suddenly split out to the bark. These secondary seams will be at right angles to the main seam. Most large seams start from old wounds and move outward.



Seams will also form from mechanical wounds on trunks. Once a seam begins to form, it will usually continue to enlarge throughout the life of the tree.





In summary, the compartmentalization of defects in trees is a survival system that is effective most of the time—not all of the time! And after the tree dies,

the powerful decay processes continue to decompose the wood. The decaying wood provides nourishment for a wide variety of organisms.



The decomposed wood provides
nourishment for new trees.

