Extension to PLT Activity 76
Tree Cookies

Lesson Summary

The original Tree Cookies teaches students about annual tree rings and their records of changes in tree growth.

This extension to Tree Cookies uses tree trunk cross-sections to reveal a history of injury or disease, and includes details on wound recovery in trees for educators. Tree cookies provide another tool to understand forest health. Unhealthy trees are less able to heal over wounds and infections. Maintaining healthy trees is thus important because it maximizes their ability to protect themselves.

Background

Trees face a continual barrage of attacks from sources such as lightning, hail, insects, fungi, and machinery, to name a few. But instead of replacing destroyed tissues as animals do, trees block off affected areas in a compartmentalization process—the healthy cells immediately surrounding unhealthy ones change their makeup to form an infection barrier. In effect, a tree walls off wounds and disease-causing organisms and tries to grow around them. The affected tissues eventually die and that part of the tree never recovers its previous function.

Trees can compartmentalize wounds because of their tissue organization. A whole tree may be thought of as a Russian nesting doll—each year’s growth like a “new tree” that envelops “older trees” within. The vascular stem vessels that carry water and nutrients are arranged in concentric cylinders, one inside the next. Other cells are arranged in radially oriented rays, like the spokes of a bicycle wheel. The rays, of varying length and thickness, dissect the vascular tissue into a random, maze-like structure.

When a tree is wounded, or if an organism such as a bacterium or fungus penetrates the tissues, both longitudinal and ray cells respond to wall off the threat (Figure 19). There are four kinds of walls. WALL 1 is a plug formed at the ends of each longitudinal vessel to stop an infection from spreading vertically along the tree. New cells, those in the outer rings, respond faster than older cells, those in the inner rings—this is why wounds often seem to have spread further in the inner tissues than the outer ones. WALL 2 prevents infection from penetrating inward—it is formed by the cells that compose the growth ring directly beneath the wound. WALL 3 is made by the ray cells. It prevents infection from spreading laterally around the trunk. WALL 4 is formed by the cambium to seal the surface of the wound or infection. New growth may eventually cover over an old wound, and although the infected part of the tree might rot away as fungi and bacteria digest the tissues, the walls surrounding it will remain.

Different species, and even individuals within a species, show varying ability to compartmentalize damage and disease. Much of this is determined by genetic makeup—such genes are of interest to those who would like to restore threatened or vulnerable trees to their habitat, those who would like to breed trees for forest products, and even those who would like to plant hardy trees in urban forests.

However, there is an environmental component to trees’ resistance and ability to restrict damage and disease. Healthy trees are better able to respond to attack by creating physical and chemical barriers around affected tissues. Maintaining healthy forests ensures that trees are given the best possible chance to compartmentalize wounds and recover from infections that they are exposed to every day.

Doing the Activity

1. Read the original Tree Cookies on page 327 of the PLT Activity Guide, including the Background Information, Getting Ready, and Doing the Activity sections.
Doing the Activity includes two parts, A and B. The following instructions expand upon Part A—Cookie Counting.

2. The Student Page titled “Reading Tree Cookies” on page 331 briefly touches on signs of tree responses to stress, damage, or disease. To help your students better understand the way such tree ring formations are made, you may draw representative cross sections of trees and walk students through the steps involved in compartmentalization and wound closure.

The Background section provides a brief overview of tree physiology in response to wounding. Horizontal and vertical cross-sections help illustrate three-dimensionally what happens within the tree. Consider creating large-scale versions of unwounded cross-sections before class. Then “animate” the wounding and compartmentalization process to students by adding new layers of tree growth as it seals off and grows over a fresh wound, while explaining your changes out loud. See Resources and References for more information.

3. The original activity notes that signs of damage from branch fall, insects, low nutrient availability, and fire can be seen in tree cookies, either as constrictions in annual rings or as pockets of blackened scar tissue. Freeze damage and bacterial and fungal infections also leave detectable signs in tree cross-sections. Prepare copies of the Student Page, also available online, to show students other examples of damage and disease in cross-section. Use the following information to discuss what happened to the trees before they were cut.

a. Heartrot decay in a white oak: Heartrot is a distinctive feature of trees whose heartwood has been degraded by fungi. These fungi are specialized to feed on heartwood but not sapwood and leave trees with hollow centers. As the tree grows, the heartrot expands. Branches do not contain heartwood and so remain resistant to decay, as seen in the picture.

Heartrot-causing fungi are important components of a healthy ecosystem, because the hollowed out trunks they produce become important sites for nesting and shelter by a wide variety of organisms, including snakes, lizards, woodpeckers, owls, raccoons, and flying squirrels. Hollow trees may not be desirable in some situations, however.

b. Sapwood decay in a maple: Fungi are often specialists, evolved to attack certain genera or species of trees, as well as certain tissue types within trees. Sapwood-rotting fungi are restricted to just the sapwood tissue. In the picture, the tree has left a stain in the wood (darkened area) as it restricted the fungus from reaching the phloem tissue (marked off by arrows).

Damaged and decayed trees are sometimes unusable because their wood has been warped by scars, rots, or stains. On the other hand, for wood turners, carpenters, and artists, wood stained by fungi may create interesting patterns to work with.

c. Cracks or radial shakes in a post oak: Trees may contract during freezing weather. During contraction, old wounds may fissure and crack. In the next cold snap, even more strain is put on the cracks from the previous year, expanding them. In the picture, cracks formed at old wound sites extend out toward the bark in a post oak tree.

Tress with structural instabilities such as scars or cracks may break off at these points, providing shelter in the snags for other organisms. However, falling branches and trees can be destructive as well—in urban areas, they may damage cars, power lines, houses, or people

d. Compartmentalized wounds in an oak: New wood tissue may fuse over an old tree wound, just as new bone tissue may seal a cracked bone. But an X-ray reveals traces of the old crack or the swollen portion of newly-healed bone, just as a tree cookie may reveal traces of an old scar that has been covered in subsequent years. Can you tell where the original wounds occurred in the picture? Hint: Look for the abrupt changes in growth rings. The pen and pencil point to where the scar tissue began closing over the wound.

Note that the overall health of an organism determines its ability to recover from wounding or illness. In old people, bones take longer to heal as the cells and tissues do not divide and reproduce as rapidly as they once did. In general, the younger and healthier any organism is, be it tree or person, the faster and more effectively it will recover from wounds.

4. Wrap up the activity by discussing why maintaining overall forest health may be important for individual trees. For one thing, it sustains lower levels of stress-inducing agents like disease-causing fungi. It also increased the trees ability to fight off infections should they occur. Note, however, that damage and decay, as seen above, may also have its uses.

Resources and References

- The University of Florida’s SFRC Extension website has a visual presentation including the pictures used in this activity. Visit http://sfrc.ufl.edu/extension/ee/foresthhealth.html
Tree Cookies

a. Heartrot decay in a white oak
Can you see where the branches used to be on this tree?

b. Sapwood decay in a maple
Where did the tree stop the fungus from growing?

c. Cracks or radial shakes in a post oak
What do you think made the cracks in this tree?

d. Compartmentalized wounds in an oak
How many times was this tree wounded?

Photos: a) Randy Cyr, Greentree, Bugwood.org, b), c), and d) USDA Forest Service – Northeastern Area Archive, USDA Forest Service, Bugwood.org