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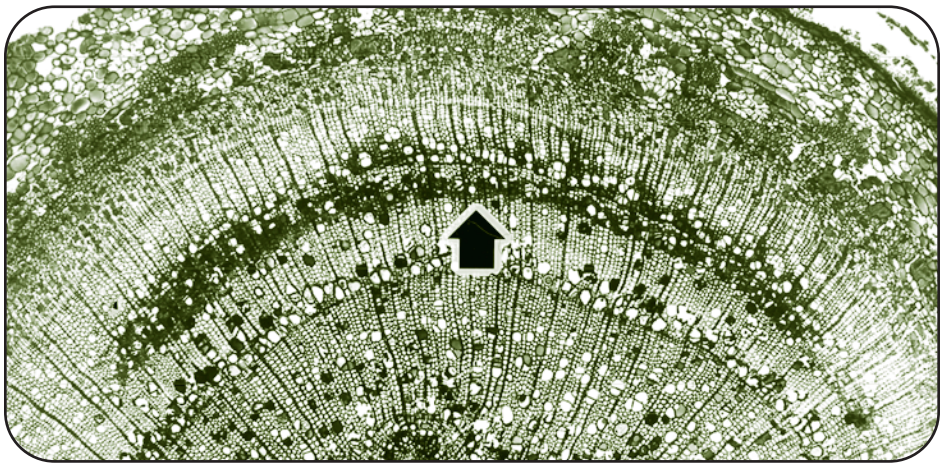
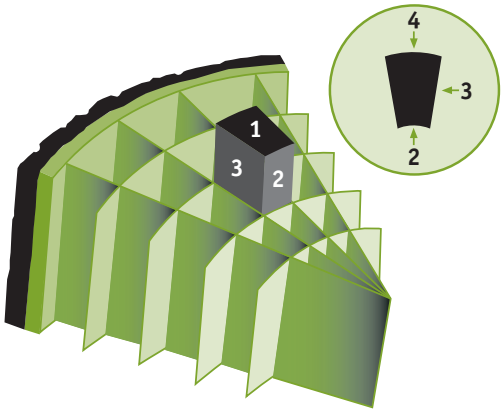
THE NATURAL DEFENCES OF TREES AGAINST INJURY AND DISEASE

Trees are constantly exposed to a multitude of micro-organisms, but only a few are capable of causing disease. When trees come under attack from micro-organisms, their primary line of defence is a mechanism called compartmentalization. Researchers at the Laurentian Forestry Centre of the Canadian Forest Service are studying the compartmentalization process in trees that have sustained different types of damage.



Wall 4 (arrow) observed in a balsam poplar after it was inoculated with the causal pathogen of Dutch elm disease.
Photo: D. Rioux

To gain insight into this natural process and its characteristics, it is helpful to refer to the CODIT model[1], which depicts compartmentalization as a series of anatomical changes initiated by injury or infection. The process involves the formation of four protective boundaries, or walls, that seal off the affected area of the tree, creating separate compartments. Wall 1 forms through a process that involves plugging the conducting elements of the wood. Wall 2 owes its effectiveness to the thick walls of the last cells to form in each growth ring. Wall 3 is made up of sheets of ray cells (forming a discontinuous wall). Wall 4 forms after the tree is wounded or infected; it consists of a band of cells that varies in width and often contains antibiotic compounds that strongly inhibit micro-organisms. This wall separates the affected tissues from the healthy wood.



CODIT model showing the location of the four walls in wood (adapted from Shigo and Marx 1977).

1 CODIT: *Compartmentalization of decay in trees*, Shigo and Marx (1977).

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Other studies have shown that it is the presence of air in the woody tissues, rather than the presence of micro-organisms, that triggers the compartmentalization process. Since fungi do not grow well in a water-saturated, low-oxygen environment[2], trees sometimes wall off tissues into which air has penetrated in order to protect adjacent water-filled tissues.

Overtapped maple showing tapholes that have breached (arrows) compartmentalization barriers.
Photo: A.L. Shigo

Knowledge about compartmentalization and tree defence mechanisms is harnessed in studies aimed at enhancing understanding of tree diseases and evaluating treatments for tree wounds, including tapholes in maple trees and pruning. Research is also carried out on the hormones that play a role in the compartmentalization process and on ways of stimulating the defence responses of trees.

COMPARTMENTALIZATION IN PRACTICE

Scleroderris canker

Scleroderris canker (*Gremmeniella abietina*) is a disease that affects mainly pines, causing major losses in nurseries and plantations. Two races (or strains) of the causal pathogen, the American race and the European race, are implicated in the damage. Whereas red pine is vulnerable to both races, jack pine is resistant to the European race, but susceptible to the American race. In jack pines infected with the European race, colonization by the fungus is stopped primarily by the barriers that form during compartmentalization.

Dutch elm disease

Some non-host (resistant) species were artificially inoculated with the fungus that causes Dutch elm disease. In these studies, researchers compared the trees' response to the reactions seen in American elms. Balsam poplar responds by compartmentalizing the entire area. In elm trees, however, wall 4 is almost never present and when this barrier does form, it is often discontinuous, which allows the fungus to propagate and kill the tree.

Tapping of maple trees

In general, maples are very effective at walling off taphole wounds. Sometimes, however, when tapholes are made, they breach compartmentalized zones—many of which formed in response to earlier tapholes—leading to a more extensive area of discoloured and decayed wood. CFS–LFC researchers can use findings such as these to provide advice for the development of new tapping standards.

FOR FURTHER INFORMATION, PLEASE CONTACT:

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2 This explains why entire forests submerged during the construction of hydro-electric reservoirs have, many years later, been found to be almost perfectly preserved.

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