Wood Decay and the Cleanup Crew

By Kevin T. Smith, Ph.D, and Jessie A. Glaeser, Ph.D.

Arborists are encouraged to recognize the wood-decay process as an important factor in tree health and public safety. Technical experts who develop training materials to recognize wood-decay processes in living trees are frequently forest pathologists. Much of the history of forest pathology was to support production of sound, high-quality timber. That heritage is passed on in terms used by arborists today that are derived from timber production, such as "defect" and "degrade." These terms are used for genuinely adverse conditions such as cracks and seams. Unfortunately, the terms are also sometimes applied to positive features that contribute to tree recovery and stability, such as response growth and woundwood formation.

Mushrooms and other fungal fruiting bodies are signs of infection. However, such infections are not necessarily the enemy of healthy and safe landscapes.

Figure 1: The common bricktop mushroom (Hypholoma lateritium) on a stump. Bricktop mushrooms can be readily distinguished from the shoestring fungus by gill color, which is purple-gray in the former and orange to cinnamon in the latter. All images by K.T. Smith and K.R. Dudzik, USDA Forest Service.

Wood decay in nature

Trees and fungi developed together and have coexisted for a long time. For forest ecosystems, wood produced as part of tree growth is a primary storage material for carbon and biological energy. Fungi break down wood structure to release the stored carbon and energy to build their own structures and to fuel their biology. Many other organisms, from bacteria to bears, take good advantage of the wood-decay process and use this flow of carbon and energy to provide for their own nutrition and habitat. Wood-decay fungi and other organisms large and small transform the breakdown products into soil organic matter, which supports the growth of the next generation of trees.

The primary components of wood, such as cellulose and lignin, are polymers (chains) of sugar and amino acid derivatives, respectively. Although the simple components are readily digested by many microorganisms, the polymers resist breakdown by most fungi. Of those fungi that decay wood, most of them participate in only a portion of the pathway that runs from being alive and healthy to being punky but recognizable as wood, through to soil humus. In a tricky piece of chemical engineering, some decay fungi have developed chemical systems that unravel and open up the polymer structure without enzymes. Once the structure is opened, digestive enzymes are able to enter and do their work.

The problem with indicators

Arborists need to be aware that the mere presence of decayed wood or a cavity does not mean that a tree is likely to die in the foreseeable future or to structurally fail. Other indicators such as included bark, cracking or lifting of the root plate, prolonged flooding, or construction injury (Mattheck 2015) are frequently more associated with tree mortality or structural failure. The presence of an active decay fungus does not necessarily mean the tree is severely compromised but does present an opportunity to refine the assessment of tree condition.

Textbooks classify decay fungi as "pathogens" that cause disease and "saprobes" or "saprotrophs" that break down organic matter. In the history of plant pathology, even well into the 20th century, some experts questioned whether wood decay in living trees, particularly decay of heartwood that lacked living cells, could be considered as disease. Conversely, opportunistic fungi that colonized already killed sapwood but did not spread beyond the initial compartmentalization boundaries were considered as pathogens. Of

Decay Fungi Series

This is the fourth article in a series on decay fungi species found in urban trees that will run in *TCI Magazine* this year. The first three parts, all from Christopher J. Luley, included:

March: Part 1: "Berkeley's Polypore"

April: Part 2: "*Ganoderma sessile* (aka *Ganoderma lucidum*) – An Important Root Disease and Butt Decay by Any Name"

May: Part 3: "Burnt-Crust Root and Butt Decay and Canker: *Kretzschmaria deusta*, a Common Decay Fungus You Might Not Recognize"

course, the fungi didn't bother to read the arguments, they simply pursued their survival strategies.

The wood-decay fungi are not always so easy to classify as being pathogens or saprobes. Determining the species can also be difficult, even with good samples of fruiting bodies: mushrooms, conks, brackets or crusts. Reliable identification from photographs is even more difficult in that a single image or two will likely not contain all of the macroscopic characters indicative of a given genus or species, especially when the fruiting body is very young or past its prime. Differences that are striking and obvious to the professional mycologist or the dedicated enthusiast with a microscope may be subtle and missed by the arborist.

Also, key field characteristics such as texture or smell (and even taste!) are not conveyed in a photograph. Still, some species or groups are distinctive enough to be identified by photos supplemented with a little additional information on habitat and non-visual features. That's part of the basis for photo guides that are useful to identify the top handful of decay fungi that most frequently threaten or coexist with urban and community trees (e.g., Luley 2005 and 2017; Glaeser and Smith 2010). Indeed, there are a few decay fungi that should be learned by arborists. Chris Luley's guide (2005) lists several fungal genera, the presence of which should cause concern and likely action, including *Ganoderma, Armillaria* and *Ustulina* (the last referred to as *Kretzschmaria* by some specialists). These are comparatively few and may vary by region.

Dr. Alex Shigo used the term "cleanup crew" to refer to saprobic fungi in living trees that decay wood killed by physical injury, flooding or some other damaging event. As the wood-decay fungi that are not usually associated with serious disease or tree risk greatly outnumber those that heighten risk of structural failure, this article is presenting just a few examples that are especially common in the northeastern and northern midwest of the U.S. and that also occur in other parts of the country. More important than the precise species of fungi in the cleanup crew is to realize that they are active and out in the landscape and commonly encountered by arborists, landowners and managers.

Figure 2: Dead man's fingers (*Xylaria polymorpha*) on buttress root.* Xylaria polymorpha *is a weakly pathogenic fungus that produces clumps of fungal tissues or stroma at the base of a dead face of a living tree or from shallow-buried woody roots. Infection by this fungus should not be an immediate call for removal but should prompt additional attention and efforts to reduce stress.

Stump cleanup

Stumps provide a special habitat that does not occur in the natural forest, but which is readily exploited by some decay fungi, including the potentially serious *Ganoderma, Armillaria* and *Heterobasidion* pathogens. The remaining root system provides intimate contact with damp soil, and the cut surface provides a large surface area. Consequently, the colonized stump provides a range of environmental characteristics of aeration and moisture as well as access to infection from the soil surface.

Saprobic and potentially beneficial fungi also colonize and decay stumps as part of the cleanup crew. The common bricktop mushroom (*Hypholoma lateritium*) and velvet foot or winter mushroom (*Flammulina velutipes*) are superficially similar to the pathogenic shoestring mushroom (several species of *Armillaria*) in that they all occur in clumps on decaying stumps or woody roots of living trees. All three are the classic mushroom shape with gills attached or running slightly down the central stipe or stem. However, the bricktop mushrooms can be readily distinguished from the shoestring fungus by gill color, which is purple-gray in the former and orange to cinnamon in the latter. The spore color of the bricktop is purple-brown, while off-white to cream in the shoestring fungus. Spore color of the velvet foot is also whitish, but the lower portion of the stipe is dark and velvety, unlike that of the shoestring mushroom. Of course, presence of the black "shoestring" foraging structures also indicate the shoestring fungus. The bricktop may have an additional role in moving essential fertilizer elements from the mineral soil into the tree rooting zone.

Natural pruning of branches

As a tree crown increases in size, interior and lower branches become shaded and are no longer useful to the tree. The crowns of neighboring trees meet and compete for sunlight, and the shaded branches die and may become a liability to the tree.

Some major forest pathogens that are infrequent in the urban environment do enter mature stems through branch stubs such as the paint fungus (*Echinodontium tinctorum*) and red-ring rot fungus (*Porodaedalia pini*). Others infect dead, attached branches without much spread in the living portions of the tree and are part of the clean-up crew.

Branch shedding is a necessary part of tree development as forest stands close and become shaded. Even open-grown trees shed branches of all sizes following storm injury, heavy defoliation from insects and fungi, and root damage from human construction and other activity.

Attached, decaying branches provide unique habitat for a variety of plants, animals and organisms and are actively conserved by some landowners and managers, more often in Europe than in the U.S. The decline in vigor, death and decay of branches proceeds at different rates depending on species and the environment. After the branch breaks away at or near the branch collar, the tree has the potential to close over the wound and restore continuity of the vascular cambium, the tissue beneath the bark that produces cells that mature into wood and inner bark.

Figure 3: Milky tooth (Irpex lacteus) on a shed branch. Most often found on dead, attached branches, the Irpex lacteus facilitates the physical breakage of branches or stem tops killed from storm injury or some other cause. Decay and breakage of the branch facilitates closure and restoration of the vascular cambium at the position of the shed branch.

Most often found on dead, attached branches, the milky tooth (*Irpex lacteus*) facilitates the physical breakage of branches or stem tops killed from storm injury or some other cause. Decay and breakage of the branch facilitates closure and restoration of the vascular cambium at the position of the shed branch.

When the milky-tooth is found on wood in ground contact, it is usually due to breakage after colonization and establishment in the tree crown. This fungus is an indicator that the supporting branch is dead, but is likely not the cause of branch death.

*Figure 4: Black jelly drops (*Bulgaria inquinans*) on downed wood. The cup fungi have many members of the cleanup crew that, although common, are not noticed until they are seen in large numbers such as with the black jelly drop.*

Downed wood and root cleanup

The cup fungi have many members of the cleanup crew that, although common, are not noticed until they are seen in large numbers such as with the black jelly drop (*Bulgaria inquinans*). Perhaps due to the odd shape and firm yet jelly-like consistency, homeowners sometimes find these alarming. Present on dead portions of standing trees or within a few years of ground contact, *Bulgaria* usually appears and disappears within a single growing season.

Dead-mans fingers (*Xylaria polymorpha*) is a weakly pathogenic fungus that produces clumps of fungal tissues or stroma at the base of a dead face of a living tree or from shallow-buried woody roots. (Figure 2, page 57) Trees with reduced ability to compartmentalize due to, say, low energy reserves from defoliation are especially vulnerable to the spread of this fungus. Infection by this fungus should not be an immediate call for removal but should prompt additional attention and efforts to reduce stress.

The challenge for decision-making

The challenge for the arborist is that, with increased awareness of the role of wood-decay fungi in structural failure, the guidelines for practice will overreach prudence and the practitioner will overreact and condemn a tree with any amount of decay or presence of fruiting bodies, slating it for removal. We have learned from experts in engineering that even large volumes of decaying wood or even open cavities do not necessarily confer a great degree of risk. The extent of wood decay is important, but not the only important factor to assess tree condition. The challenge for the practitioner is to accurately assess not how much wood has been lost to decay, but to assess 1) the quality and quantity of the wood that remains and 2) the strength of the response growth of the tree to compensate for injury, infection and decay.

For more information:

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Figure 5: Winter mushroom on stump. Velvet foot or winter mushroom (*Flammulina velutipes*) is superficially similar to the pathogenic shoestring mushroom (several species of* Armillaria*) in that they both occur in clumps on decaying stumps or woody roots of living trees. Both are the classic mushroom shape with gills attached or running slightly down the central stipe or stem.