Identifying and Managing Cankers on Landscape Trees

By Marion Murray

Learning Objectives
- Identify a canker based on symptoms and diagnostic practices
- Differentiate between an annual and perennial canker
- Understand the disease cycle of canker pathogens
- Understand how to manage canker diseases

CEUs: A, M, T, Bs, Bp

Sunken, loose bark, or oozing sap on trunks or limbs may indicate a canker, especially if associated with branch dieback. On trees, cankers are areas of localized necrosis of the bark and cambium, caused by a plant pathogen, typically a fungus or bacteria. Some canker-causing pathogens are a minor pest of trees, while others may cause branch failure or even tree death. Management of canker diseases focuses primarily on prevention and sanitation.

General Canker Symptoms

It is important to properly identify whether bark damage is caused by a pathogen or abiotic factor (see "lookalikes" below). This will help to initiate the most appropriate management program. One of the easiest methods to determine whether the visible damage is caused by a canker disease is to scrape the bark away at the edge of the symptomatic area. Canker pathogens will kill the phloem, leaving it characteristically darkened, as opposed to healthy, cream-colored phloem.

Canker-causing pathogens kill the outer and inner bark, turning the phloem a dark tan to black color. The necrotic tissue occurs in stark contrast to the healthy, cream-colored tissue at the canker's edge.

Look-Alike Symptoms

As noted above, if the bark symptoms are caused by a pathogen, not only will the phloem tissue underneath be distinctly necrotic, but the lesion will typically expand

Symptoms and Signs of Canker Diseases

- Shape of the symptomatic area is generally oval to elongate.
- Outer bark may be discolored, ranging from a subtle or obvious shade difference, depending on the host and pathogen.
- Bark may split, crack, flake, and/or appear sunken, sometimes centered around dead twigs or pruning cuts.
- Ooze or pitch may emanate from the center and/or the canker margins.
- Dead inner bark and phloem, with a color ranging from light brown to black, is present often in stark contrast to the cream-colored, healthy phloem tissue at the margin of the canker.
- In some cases, bark is ridged and thick, surrounding a bulls-eye appearance of repeated callus growth.
- Small, raised, dark fruiting bodies may be visible on dead bark killed by fungal pathogens.
- Associated limbs may have chlorotic foliage, followed by wilting, then death.

over time. These factors are not the case with some look-alike causes of bark damage, which include the following:

- *Flatheaded borer* larvae feed in the phloem just under the bark. On young or smooth-barked trees, their feeding damage appears as sunken, cracked bark. But close inspection under the bark will reveal the feeding galleries and callus tissue around the damaged areas.
- Like a canker, damage from *sunscald* (southwest injury) can also cause discolored bark, oozing sap, and cracked, dead bark. However, the newly-dead phloem under the damaged bark will be lighter in color than canker-killed tissue (light tan), and within a few years, a large ridge of callus tissue will be visible around the margins.
- With other *one-time instances of mechanical injury*, such as weed trimmers, mammal damage, vehicular damage, etc., callus tissue typically forms quickly around the affected area, followed by death of bark from within. Again, the discoloration of the dead phloem will be much lighter in color.
- *Slime flux*, or bacterial wetwood, is not a localized disease of the phloem and bark. It is associated with the release of gas pressure within an affected tree due to colonization of bacteria initiating at the roots. In this case, the associated ooze has a distinct fermented odor, is usually associated with a large pruning cut or tight branch crotch, and typically does not enlarge over time.
- *Frost cracks* or *lightning strikes* will appear as a distinct vertical crack surrounded by a ridge of callus tissue, whereas cankers are typically oval in shape and may enlarge both vertically and horizontally over time.
- *Drought-stress* on some trees such as honeylocust can cause gummosis that may resemble a canker. The phloem tissue, however, will not discolor or darken.

Types of Cankers

Cankers can be classified as annual, perennial target, or perennial diffuse cankers.

Annual

Most annual cankers are caused by fungal pathogens and persist with the host for just one season, typically during host dormancy. Termination of fungal growth occurs through natural tree defenses or death of the pathogen. In some cases, the pathogen grows quickly, extending several vertical feet, while in other cases the pathogen may only grow a few inches before being quickly walled off by callus tissue (Bier 1964; Bergdahl and Hill 2016). Typically, these types of cankers have little impact on tree growth, but trees affected by drought or nutrient stress could potentially get hundreds of annual cankers in one

Learning to recognize cankers is important. One symptom is discolored bark.

Some trees, such as peach, apricot, poplars, and nut trees (butternut shown above) respond to cankers by oozing as a defense response.

Mechanical bark injury, such as sunscald, resembles a canker, but the wound is completely callused around the edges.

Nectria canker on birch is an example of a perennial target canker. The target appearance is caused by the repeated formation and death of callus wood. Robert Anderson, USDA Forest Service, Bugwood.org.

season. An example of an annual canker is Fusarium canker (caused by multiple *Fusarium* species) on sugar maple, *Juglans* spp. (walnuts), yellow poplar, and other hosts.

Perennial

Perennial cankers can be considered as "target" or "diffuse" cankers. Perennial target cankers are caused by less-aggressive fungal pathogens, where the fungus and the tree form a years-long cycle of death and healing. While the host is dormant, the fungus grows, killing a small amount of bark and cambium. When tree growth begins, it responds by laying callus tissue around the edges of the fungal-killed areas. This cycle repeats multiple times, and the alternate formation and death of callus tissue results in an oval, target-like appearance of the canker. If less vigorous trees are attacked, the fungus may overcome the resistance response and grow through the callus barrier (Bier 1964), while alternatively, callus tissue may successfully wall off the fungus for good. Although target cankers typically do not kill the associated limb, the cankered area is weakened and susceptible to failure. Some examples of target cankers include Nectria canker (*Neonectria ditissima*) on oak, sugar maple, birch, walnut, and others; Strumella canker (*Strumella coryneoidea*) of red oak, black oak, and shagbark hickory; and Eutypella canker (*Eutypella parasitica*) of sugar, red, and Norway maples.

Perennial diffuse cankers are visually different from target cankers because the pathogens that cause them grow rapidly in the bark and phloem during the growing season, and the tree has little chance to respond. These types of cankers are of the greatest concern, causing sunken and discolored bark, and in many cases, death of the limb in a single season. If the pathogen has not girdled the limb in the first season, growth resumes the following spring as the name implies. Most bacterial-caused cankers, such as fire blight (*Erwinia amylovora*), are diffuse, and a classic fungal-caused diffuse canker is chestnut blight (*Cryphonectria parasitica*).

How Infections Happen

Although some canker-causing pathogens may infect trees through natural bark openings such as lenticels, most are opportunistic, meaning that they do not invade living wood, and that a wound is required for infection. The wound can be the tiniest crack from freeze injury, a narrow branch crotch, insect feeding, a broken twig, animal scratch or rub, or it can be larger, such as a pruning cut, sunscald, or other mechanical injury.

The general life cycle of most canker diseases is similar. First, fungal spores or bacteria (inoculum) from existing nearby cankers are spread to a susceptible host by wind-driven moisture (rain, irrigation, heavy dew), or in some cases by insects or pruning tools (Bertrand and English 1976). Once successful infection of the wound or natural

Hypoxylon canker of aspen causes a characteristic, mottled, black and white checkerboard appearance to the bark. It is one of the most common diseases of aspen in eastern and central North America. William Jacobi, Colorado State University, Bugwood.org

"Bot canker," caused by several genera in the fungal order *Botryosphaeriales*, can be deadly on certain hosts, such as redbud and dogwood, including red-twig dogwood.

Examples of Diffuse Cankers

Cytospora canker is a common fungal disease of stone fruits, poplar, willow, ash, maple, spruce, and dozens of additional woody plants (Biggs and Grove 2005; Kepley et al. 2015). It is caused by several species in the genus *Cytospora* and can be considered the classic model of an opportunistic pathogen, successfully invading trees under stress. Spores are released throughout the year (Grove and Biggs 2006); they readily infect tree wounds (pruning cuts and cold injury); the pathogen translocates via the xylem tissue; and it persists in dead wood for many years. Cankered areas are identified by copious ooze, gumming, or pitch, and cinnamon-brown-colored phloem beneath the ooze. Trunk cankers may kill the tree within three to four years.

Hypoxylon canker, caused by *Hypoxylon mammatum*, is a disease of aspen and other poplars (Sinclair and Lyon 2005). Bark of young cankers is yellow-orange and slightly sunken, while bark of older cankers turns black and crumbles in a characteristic, checkerboard pattern. The bark sloughs away, and gray, fungal fruiting bodies form underneath, providing spores for future infections. In the southwest US, some aspen trees with cankers have been known to survive for many years (up to 50) before death. A related fungal species, *Hypoxylon atropunctatum*, causes cankers on oak in the southeast US.

Botryosphaeria canker is a fungal disease caused by various genera in the order Botryosphaeriales, including *Botryosphaeria*, *Diplodia*, and *Sphaeropsis*. It can affect over 200 different hosts, including broadleaf trees, woody ornamentals, and conifers (Bergdahl and Hill 2016). It is notably severe on redbud, cherry, dogwood, and rhododendron. Infections range from small, cankered areas, to girdled and dead shoots, to extensive cambial death spanning several feet along the trunk. On dead tissue, the fungus forms small, black-colored fruiting bodies called pseudothecia that erupt through the bark. In spring, spores emerge from these structures during persistent wet weather to cause new infections. As noted with other canker diseases, trees affected by drought, winter injury, or other stress factors are most susceptible.

Many canker-causing pathogens, such as *Cytospora* spp., require a wound to cause infection, such as a fresh pruning cut or a small stub cut that does not heal properly.

opening occurs, the pathogen produces toxins that kill tissue ahead of the advancing mycelium or bacteria. Cankers may expand for a single season and die, or they may persist in the tree for many years. In either case, under the optimal weather conditions, the pathogen forms inoculum on the bark surface in the form of bacterial ooze or fruiting bodies that release spores, repeating the disease cycle.

The ability for a new canker infection to become damaging in the host is determined partly by the virulence of the pathogen and partly by the rapidity of the host in forming mechanical and chemical responses to infection. In general, trees under stress from drought, weather conditions, or nutrient deficiency have fewer resources allocated for defense mechanisms, or are slower to react, and therefore less able to prevent canker-pathogen growth and subsequent damage (Worrall et al. 2010; Beresford and Kim 2011; Lamichhane et al. 2014).

General Canker Management

Once established, cankers are difficult to control, and it is important to understand that most woody plants can be affected. Therefore, preventive tree care practices should always be used to avoid issues with cankers.

Proper Pruning Practices

Make every effort to follow best management practices when pruning. Some (not all) canker-causing pathogens can enter trees through poor pruning cuts (stubs or flush cuts) that do not heal properly (Biggs and Grove 2005; Eskalen 2013). When pruning, remove rubbing and crossing limbs to prevent future bark wounding. The use of commercial tree-wound paints and dressings is not recommended, as their effect is largely cosmetic.

Prune at the Right Time

Avoid pruning in wet conditions to avoid the chances of fresh pruning cuts being exposed to fungal or bacterial inoculum that will likely already be present (Sundin and Rothwell 2012). In addition, some pathogens, such as *Cytospora*, cause infection at low temperatures, and pruning susceptible trees during dormancy allows for fresh pruning cuts to be exposed for a longer period of time. Wound-healing only occurs during the growing season, so therefore, pruning these types of trees later in spring allows for more rapid wound-healing and reduced less risk for infection (Biggs and Grove 2005).

Improve and Provide Optimal Tree Vigor

As noted above, winter injury, nutrient deficiencies, and drought stress are the most common abiotic factors for canker development (Worrall et al. 2010; Lamichhane et al. 2014). Select trees and shrubs that are adapted to the site and maintain their health and vigor through proper mulching, irrigation, nutrition, soil management, pruning, and winter protection practices. In colder climates, avoid late-season fertilizer application (typically after mid-August) because it can create a spiral effect of growth stimulation, delayed winter-hardening, and cold-injury wounding, which will be susceptible to infection.

Protect Newly Planted Trees

In colder climates, thin-barked and newly-planted trees are susceptible to sunscald ("southwest injury") where the bark is killed by thawing/freezing events in late winter. This newly-killed bark can be susceptible to infection. In these regions, apply white wrap to tree trunks in early winter (remove it by early spring) for the first few years after planting. White latex paint (diluted to 50% in water) can also be used.

Sanitation—Remove Cankers Immediately Once They Are Found

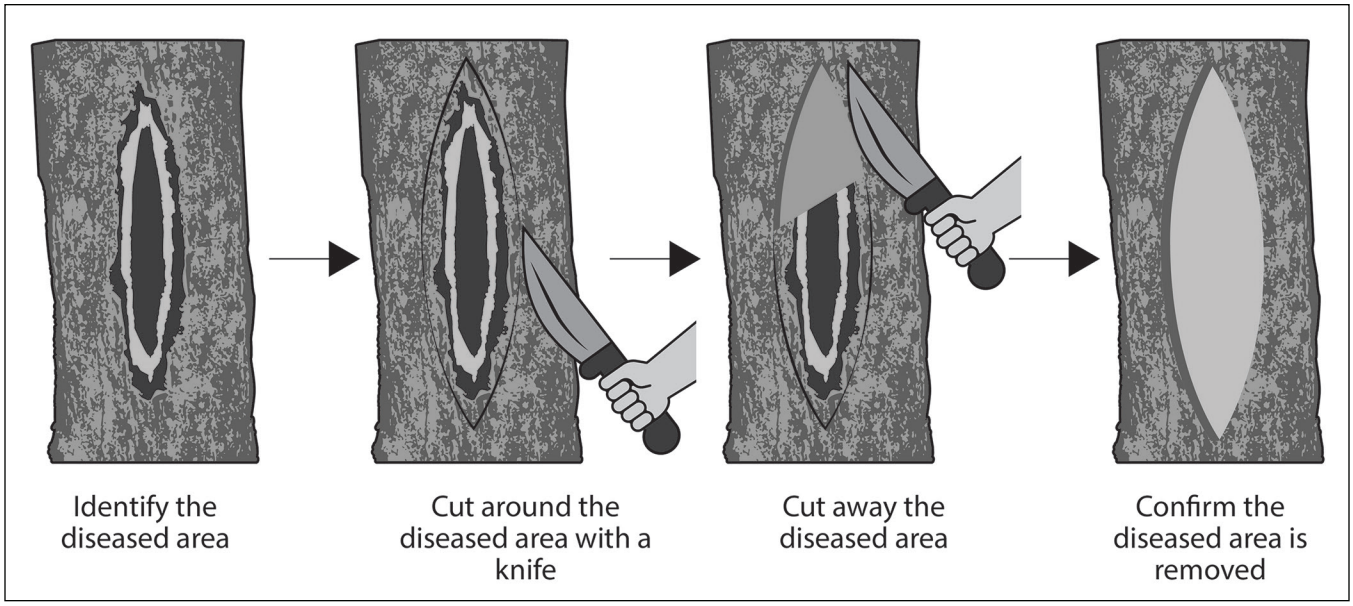
It is important to prune out infected branches, since some canker pathogens can survive on dead wood for many years, contributing to spread. Do not rely on the bark symptoms to determine the canker margin, as pathogen growth may extend beyond what is visible. Use a knife or hand pruners to cut the bark away and expose the leading edge of the canker against healthy tissue. For

fungal-caused cankers, plan the pruning cut to be four to eight inches beyond this edge into healthy tissue, which may mean taking off more wood than planned. Cankers caused by bacterial pathogens, such as bacterial canker (*Pseudomonas syringae*) or fire blight (*Erwinia amylovora*), should be pruned at least 12 inches beyond the visible necrotic tissue to remove all traces of bacteria that extend into healthy-appearing wood (Sundin and Rothwell 2014).

Regarding sterilizing tools between pruning cuts, there is some conflicting information, and much of the recommendations depend on the canker type being pruned and the time of year (Bergdahl and Hill 2016). To be on the safe side, when pruning during the growing season, tools should be sterilized with bleach wipes or a dip of 10% bleach or 70% alcohol (be sure to oil pruners at the end of the day to prevent corrosion). Sterilization of tools is not needed when pruning cankers during the dormant season.

If a canker occurs on the main trunk, it cannot be pruned out. For young or small cankers, "bark tracing" may reduce damage and slow further spread (Pscheidt and Ocamb 2017). The method is done by cutting out the bark and phloem of the entire cankered area and exposing a small ring of healthy tissue surrounding the canker. Extreme care must be taken to avoid infection of this fresh wound area by sterilizing the tool between cuts (see above). The excised area should then be monitored over the next year for proper callus healing. If healing has not occurred, either the canker pathogen survived or wood decay set in. This technique should only be conducted by a skilled arborist that can successfully find the

Pruning out cankers is an important sanitation practice. Pruning cuts that do not heal with callus tissue indicate that the canker that occurred on the pruned-out limb likely extended beyond the pruning cut.



Excising a tree canker should only be performed by an experienced arborist and is not a guarantee of killing the canker or preventing spread.

canker margins and not cause more harm than leaving the canker intact. Bark tracing is not recommended for large, old cankers, as the pathogen may have spread into the vascular (xylem) tissue.

Chemicals

In general, there are few chemicals that are labeled for treatment of cankers on ornamental trees, and fungicides that are labeled list pathogens that initiate infections on succulent shoots, such as *Kabatina* sp. or *Phomopsis* sp. Although several fungicides have been tested on agricultural tree crops with limited success, applied either as a direct canker spray or foliar spray as wound protection after pruning (Brown-Rytlewski and McManus 2000; Pitt et al. 2012; Twizeyimana et al. 2013; Miller et al. 2018), this practice may not be practical for landscape trees.

Some diseases, such as bleeding canker of maple, beech, and others (caused by *Phytophthora* spp.) and bleeding canker of horsechestnut or birch (caused by *Pseudomonas syringae*) may be suppressed by a foliar, injection, or direct-canker treatment of a phosphite fungicide (also known as phosphonate), with or without a surfactant (Brown and Viveros 2005; Garbelotto et al. 2007; Percival and Banks 2015). These fungicides work by inducing resistance responses in the tree host, including increased lignin production, thickened cell walls, and production of secondary metabolites (Guest and Grant 1991). There are many phosphite fungicides, so it is important to check the label for the host and disease.

Bacterial-caused cankers, such as fire blight caused by *Erwinia amylovora*, and bacterial canker of stone fruits caused by *Pseudomonas syringae*, can be suppressed with the application of copper before budbreak. The copper does not kill the pathogen, but rather slows colonization of bacteria on cankered bark surfaces, reducing spread (Elkins et al. 2015).

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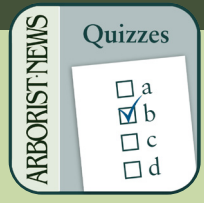
Arborist News CEU Quiz Questions



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A passing score for this quiz, **Identifying and Managing Cankers on Landscape Trees**, requires sixteen correct answers. Quiz results will display immediately upon quiz completion. CEU(s) are processed immediately. You may take the quiz as often as is necessary to pass.

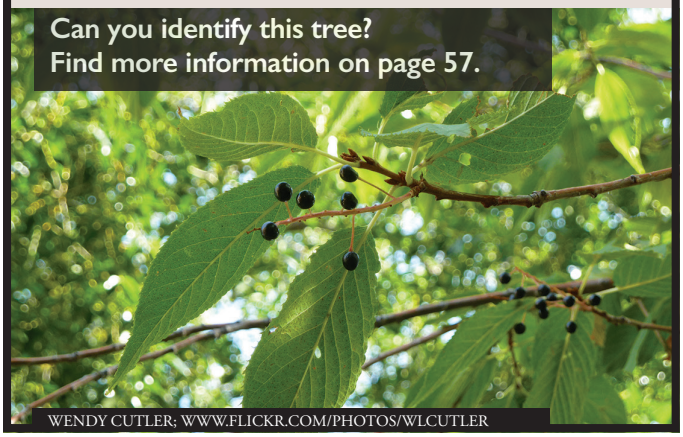
CEU(s) for this article apply to: A, M, T, Bs, Bp

CONTINUING EDUCATION UNIT

1. What are the primary causes of infectious tree cankers?
   a. fungi and bacteria
   b. fungi and viruses
   c. insects, fungi, and bacteria
   d. fungi, bacteria, and abiotic factors
2. Why is it important to properly identify whether bark damage is caused by a pathogen or abiotic factor?
   a. to determine the cause of the damage
   b. to establish a management plan
   c. to prevent further spread
   d. all of the above
3. The inner bark (phloem) of areas affected by a canker is _____.
   a. still conducting nutrients
   b. dead and white to light tan in color
   c. dead and light brown to black in color
   d. an area that constantly oozes pitch or gum
4. An example of an annual canker is:
   a. Chestnut blight
   b. Cytospora canker
   c. Fusarium canker
   d. Hypoxylon canker
5. Target cankers are typically caused by fungal pathogens.
   a. True
   b. False
6. Pathogens that cause perennial target cankers are _____.
   a. aggressive, killing the infected area quickly
   b. slow-growing
   c. only able to infect conifers
   d. bacteria
7. At what time of year do organisms that cause perennial target cankers typically grow?
   a. constantly; they never stop growing
   b. spring only
   c. spring to late summer, when trees are growing
   d. fall to late winter, when trees are dormant
8. The greatest concern for target cankers is _____.
   a. death of the associated limb
   b. failure of the associated limb
   c. tree death
   d. lack of root and shoot growth
9. Which statement below is true about perennial diffuse cankers?
   a. Vigorous trees can permanently wall off (callus over) and kill the pathogen.
   b. The pathogen grows during winter, and the tree walls off the canker during summer.
   c. Pathogens that cause these cankers can be aggressive, girdling a branch or stem in a single season.
   d. Only bacteria can cause a diffuse-type canker.
10. Which is an example of a perennial diffuse canker?
    a. Chestnut blight
    b. Nectria canker
    c. Fusarium canker
    d. Strumella canker
11. An opportunistic pathogen is one that _____.
    a. causes infection through natural plant openings such as lenticels or stomates
    b. has an opportunity to survive for multiple years without a host
    c. does not actively invade living wood, but causes disease when given the opportunity
    d. normally behaves as a parasite, but has an opportunity to becomes a saprophyte to survive
12. What is inoculum?
    a. dead plant tissue killed by a pathogen
    b. infectious structures of pathogens, such as fungal spores or bacteria
    c. the point at which an infection occurs (when the pathogen enters the host)
    d. optimal conditions (weather and time of year) for infection to occur
13. What is required for a canker infection to be successful?
    a. an existing wound or a natural opening on a susceptible host
    b. optimal weather conditions for spore formation and dispersal
    c. loss of vigor in the host due to drought stress
    d. a and b
14. What are three highly common factors contributing to tree susceptibility to cankers?
    a. drought-stress, weather conditions, and nutrient deficiency
    b. drought-stress, soil compaction, and winter injury
    c. drought-stress, girdling roots, and soil compaction
    d. nutrient-poor soil, girdling roots, and soil compaction
15. The best management action for cankers is to rely on prevention through proper tree care.
    a. True
    b. False
16. Which practices below can help reduce the incidence of cankers?
    a. prevent stub and flush cuts
    b. avoid pruning in wet conditions
    c. prevent nutrient deficiencies
    d. all of the above
17. For some cankers caused by bacteria, such as fire blight, the bacteria can reside in healthy-looking tissue up to ___ inches beyond the visible symptoms of the canker.
    a. 4
    b. 8
    c. 12
    d. 16
18. In general, which time of year should pruning tools be sanitized between cuts when removing cankered limbs?
    a. year-round
    b. spring and summer
    c. fall and winter
    d. sanitation is not necessary
19. When conducting bark tracing, what is an important step?
    a. remove the bark around fresh pruning cuts to prevent infection
    b. only cut out the center of a canker
    c. sterilize the tool between cuts
    d. only use the bark tracing practice on large, old cankers that occur on the main trunk
20. Phosphite fungicides have been shown to primarily work against which canker disease?
    a. bleeding cankers caused by *Phytophthora* sp.
    b. Cytospora canker
    c. cankers caused by fire blight
    d. Fusarium canker

Plant I.D.

Can you identify this tree?
Find more information on page 57.



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