SOUTHERN REGIONAL EXTENSION FORESTRY
FOREST HEALTH

SREF-FH-009
February 2018

Biology, Ecology, and Management of Biscogniauxia (Hypoxylon) Canker in the Southeastern U.S.

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Biscogniauxia (pronounced BISK-o-nee-OX-e-a) canker (formerly called hypoxylon canker) is a disease of hardwood trees that results in cankers on branches and trunks. The cankers, caused by growth of fungi in the genus *Biscogniauxia* (formally *Hypoxylon*) in the sapwood of the tree, can result in dieback of branches or tree death when the trunk becomes infected. *Biscogniauxia* species are secondary invaders[5] that affect trees already highly stressed or damaged by some other factor (e.g. drought or physical injury). If a tree's health has already been compromised, the disease can progress rapidly and act as the final lethal factor for a tree[10].

Biscogniauxia fungi cause cankers all over the world, and combined with drought, are a central factor in widespread tree decline and mortality in many areas[3,8]. In North America, *Biscogniauxia* canker is most frequently observed on oaks in the southeastern U.S. Biscogniauxia canker commonly contributes to the death of shade trees in urban settings, especially those that do not get proper care or are under stress (e.g. near new construction, Fig. 2). This canker can also be an issue in forests, woodlands, and other natural areas. Severe stress can weaken even large trees, which can rapidly succumb to *Biscogniauxia* canker. Cumulative years of drought tend to add to the collective stresses in urban and natural forest areas. Recovery from these conditions is difficult and can take several years, or in some cases trees may not recover at all.

Figure 1. This tree was infected with Biscogniauxia (Hypoxylon) canker near the base (note the large, gray area on the stump), and was subsequently cut down. The tree was likely infected prior to the house construction and yard grading (when the tree was still healthy), but the stress likely compromised much of the tree's root system and allowed the fungi to grow and produce cankers.

Figure 2a,b. Construction near this tree (a) likely compromised it and allowed Biscogniauxia canker to grow and prodce cankers (b).

Biology

The *Biscogniauxia* fungi that cause Biscogniauxia cankers are opportunistic pathogens that usually live as endophytes in the sapwood and bark of living, healthy trees. But, when trees are severely weakened or damaged, these fungi can begin growing into the sapwood and cause damage to the tree[1]. Biscogniauxia cankers are frequently observed on downed logs or as a part of the self-pruning of dead or damaged branches (Fig. 3). However, it is important to remember that if these cankers are present, some other underlying issue is likely harming the tree and reducing its health, or the site suitability is inherently poor[8]. Biscogniauxia canker can be an indication of cumulative stresses in the landscape. Examples of these combined stresses can be environmental (freezing, storm damage, cumulative years with drought or hail), mechanical (compacted soil or construction damage in root zone), pests (repeated defoliation from insects such as gypsy moths or tent caterpillars), or any combination of these factors[2]. These stress factors predispose the tree to damage from *Biscogniauxia* fungi already living in or on the tree which, once the tree is stressed, are no longer kept in check by tree defenses[6,10].

Biscogniauxia canker on oak in North America is most frequently caused by *Biscogniauxia atropunctata* (formerly *Hypoxylon atropunctatum*)[4]. This species can also infect hickories, maples, beech, basswood, pecan, and other hardwood tree species. *Biscogniauxia atropunctata* has been reported as especially virulent on red oaks[1], perhaps due to red oak's relatively poor ability to tolerate environmental stress. In the Southeastern U.S., several other *Biscogniauxia* species can cause cankers on oak and other tree species (e.g. *B. tinctor* affects sycamores and London plane tree).

Figure 3. This dead branch has a large Biscogniauxia canker near the base (at arrow), and the rest of the branch is also riddled with cankers as evident by the lighter color.

Biscogniauxia spores survive in the bark and sapwood of trees. On healthy trees, the fungus is kept in check by the tree's defenses. However, when a tree is weakened, the tree is no longer able to prevent fungal hyphae (thread-like growths that make up the body of the fungus) from growing into and infecting the tree. In weakened trees, the fungus is able to grow more vigorously, and in the process it cuts off the flow of water and nutrients.

The fungus produces a hard mycelial mat called a stroma in order to reproduce and spread to new hosts. Initially, the fungus produces powdery light-colored asexual spores (conidia) that are primarily dispersed by wind (and sometimes by water, insects, or other animals). In a later stage, the fungus produces black sexual spores (ascospores) that are transported through a variety of methods including wind, water, or animals. Spores can be present throughout the growing season: asexual spores are generally produced during the spring or early summer, and sexual spores are produced in summer and fall. Both types of spores can cause infections.

Signs and Symptoms

Trees that have been colonized by *Biscogniauxia* fungi typically remain healthy until some other stress occurs. Early symptoms can be minor and hard to distinguish from general

Figure 4a,b. Bark has flaked off, revealing canker on one of this tree's main stems (a). Piles of bark are often evident on the ground under infected trees (b) although other things can also cause this to occur.

stress symptoms. Initial symptoms of Biscogniauxia canker, such as leaf yellowing and wilting, overlap with those caused by drought stress and makes distinguishing Biscogniauxia infection from the contributing environmental stresses very challenging. This stage may go unnoticed or it can progress slowly as a gradual dieback of the canopy as branches are individually girdled. In other cases, when the canker has initiated in the trunk, a tree may suddenly turn brown, girdled by the fungus, with few other warning signs.

After a branch or trunk is dead, more distinctive Biscogniauxia canker symptoms appear[9]. After a major stress, the fungus can form stromata (fungal mats) under the bark. The bark over the stroma thins and eventually a combination of the bark thinning and pressure from the stroma causes the bark to flake away (Fig. 4) revealing a dusty spore-covered surface (Fig. 5).

Initially, the stroma is light in color (white to brown) and covered with dusty dry asexual spores. Over time, however, the stroma darkens to a smooth gray or black and sexual spores are produced. These grey and black patches are often the most easily observed and characteristic sign of Biscogniauxia canker (Fig. 6)[7]. Different species of *Biscogniauxia* can be distinguished microscopically by their stromata and spore morphology.

The wood of trees with Biscogniauxia cankers often turns brown to yellow to white, likely from a combination of the fungus and the tree's defenses. Even aboveground portions of large woody roots can be infected (Fig. 7). Black lines, called demarcation lines, form between zones of decayed and unaffected wood. However, presence of the demarcation lines alone is not a distinguishing feature as many other wood-decay fungi also form these lines.

Figure 5. The light brown areas are powdery asexual spores (conidia).

Figure 6a,b,c. Older cankers showing both gray and black coloration. Note how the bark has flaked off the fungal mats.

Figure 7. Large woody roots can be infected with Biscogniauxia canker, such as on this dead tree, although this is uncommon.

Management

There are no chemical management approaches directly targeting the fungi that cause *Biscogniauxia* cankers. Since *Biscogniauxia* fungi live ubiquitously in healthy trees, the best management approach is to reduce tree stress and keep trees healthy.

In an urban setting, it may be worthwhile to prune out infected branches (i.e. sanitation). This can reduce the amount of overall inoculum present, as well as remove potential hazards. When doing this, it may help to disinfect pruning tools to avoid inadvertently spreading *Biscogniauxia* spores to other woody plants. Dead wood with Biscogniauxia cankers is brittle and highly likely to fail, creating a potentially dangerous situation that should be carefully monitored. Some sources recommend that if over 15 percent of the crown area shows Biscogniauxia canker symptoms it may be worth removing the tree, as it is unlikely to recover. Since the fungi will continue to grow and produce spores on dead wood, it has been recommended in urban settings to remove or burn infected wood; however, the efficacy of this approach has not been measured.

For urban trees with no or minor symptoms, any steps taken to improve tree health, including reducing compaction, proper mulching, irrigation and fertilization when appropriate, and reducing potential damage to roots during construction, can minimize the risk of future Biscogniauxia canker damage. Appropriate site selection, tree selection, planting, and maintenance in the early years of a tree's life can play a major role in tree health in later years.

In a forest setting, management options are more limited. However, any management approaches aimed at improving overall forest health

are a good starting place. Removing infected trees will likely be ineffective as a control mechanism as spores of *Biscogniauxia* fungi are already widespread, are generally present in healthy trees, and will readily produce spores on downed dead limbs and trees. There are a variety of forest stand improvement techniques, from crop tree release to invasive species removal, to improve stand health.

Forest and woodland management plans should take the potential for Biscogniauxia canker development into consideration, particularly in areas on marginal soils or on south or southwest facing slopes, experiencing drought, severe defoliation due to insects, or other widespread stresses.

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SREF-FH-009 | www.sref.info
A Regional Peer Reviewed Technology Bulletin published by Southern Regional Extension Forestry

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ACKNOWLEDGEMENTS:

We thank David Appel, Chandler Barton, Michelle Cram, Katlin Mooneyham, Dieter Rudolph, Jean Willams-Woodward, and Alan Windham for earlier reviews of this document.

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Resources

For the location and phone numbers of state agencies in the southeastern U.S. providing forestry assistance and information, see the following websites:

Alabama Forestry Commission: http://www.forestry.alabama.gov/

Arkansas Forestry Commission:
http://forestry.arkansas.gov/Pages/default.aspx

Florida Forest Service: http://www.floridaforestservice.com/

Georgia Forestry Commission: http://www.gatrees.org/

Kentucky Division of Forestry:
http://forestry.ky.gov/Pages/default.aspx

Louisiana Department of Agriculture and Forestry:
http://www.ldaf.state.la.us/

Mississippi Forestry Commission: http://www.mfc.ms.gov/

North Carolina Forest Service: http://www.ncforestservice.gov/

Oklahoma Forestry Services: http://www.forestry.ok.gov/

South Carolina Forestry Commission:
http://www.state.sc.us/forest/

Tennessee Division of Forestry:
https://www.tn.gov/agriculture/section/forests

Texas A&M Forest Service: http://texasforestservice.tamu.edu/

Virginia Department of Forestry: http://www.dof.virginia.gov/

For the location and phone numbers of University Extension personnel in the southeastern U.S. providing forestry assistance and information, see the following websites:

Alabama Cooperative Extension System:
http://www.aces.edu/main/

University of Arkansas Cooperative Extension Service:
http://www.uaex.edu/

University of Florida's Institute of Food and Agricultural Sciences (UF/IFAS):
http://solutionsforyourlife.ufl.edu/

University of Georgia Extension: http://extension.uga.edu/

Kentucky Cooperative Extension Service:
https://extension.ca.uky.edu/

Louisiana Cooperative Extension Service:
http://www.lsuagcenter.com/

Mississippi State University Extension Service:
http://extension.msstate.edu/

North Carolina Cooperative Extension:
https://www.ces.ncsu.edu/

Oklahoma Cooperative Extension Service:
http://www.oces.okstate.edu/

Clemson Cooperative Extension (South Carolina):
http://www.clemson.edu/extension/

University of Tennessee Extension:
https://extension.tennessee.edu/

Texas A&M AgriLife Extension: http://agrilifeextension.tamu.edu/

Virginia Cooperative Extension: http://www.ext.vt.edu/

To locate a consulting forester:

Association of Consulting Foresters:
http://www.acf-foresters.org/acfweb.

Click on "Find a Forester", then select your state in the "People Search – Public" search page.

For more information on how to select a consulting forester, go to:

http://msucares.com/pubs/publications/p2718.pdf

http://texashelp.tamu.edu/011-disaster-by-stage/pdfs/recovery/ER-038-Selecting-a-Consulting-Forester.pdf

http://www.uaex.edu/environment-nature/forestry/FSA-5019.pdf

Additional information on Biscogniauxia canker is available at:

http://southernforesthealth.net

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Figure 6c: USDA Forest Service – Region 8, Bugwood.org

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