

Thousand Cankers Disease – What Have We Learned

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Thousand Cankers Disease (TCD) represents a serious threat to black walnut, an important nut and timber tree in the eastern United States. TCD was first described as a lethal disease for most walnut species in 2009. A webinar sponsored by the USDA Forest Service State & Private Forestry and Forest Health Protection, the Walnut Council, and the Purdue University Department of Entomology on March 28, 2013, suggests we are making progress toward knowing the causes of the tree disease, detection of diseased trees and causal organisms, origin of the beetle and fungus, and treatments to permit transport and sale of products from infested wood. In the first part of the webinar, Simeon Wright, Andrew Graves, Bruce Moltzan, and Julie Spaulding provided information about the disease, and, in the second part, Dana Rhodes, Norm Dart, Paul Merten, and Dan Kenny spoke about their experiences with TCD in their respective states. The webinar was recorded and the entire four hours of presentations are available at the national TCD website at: <http://www.thousandcankers.com/webinars.php>.

TCD is the result of the walnut twig beetle, *Pityophthorus juglandis*, feeding in the phloem and subsequent canker formation by the pathogenic fungus, *Geosmithia morbida* within the inner bark around these galleries.

Walnut twig beetles are attracted to walnut trees by host tree volatiles and sexual chemicals released by the male. The fungus is carried on beetle bodies and is introduced into walnut trees when walnut twig beetles probe the inner bark, which may or may not be followed by construction of egg galleries. The fungus induces the formation of small round to elliptical shaped cankers depending on susceptibility of the walnut species (**Figure 1**). When cankers are numerous enough, movement of nutrients within the phloem or inner bark is blocked causing branch decline and eventually tree death. Dusty, white spores produced by the fungus are formed in egg galleries and become attached to the bodies of most young beetles prior to their emergence from the canker and bark.

Black walnut and butternut are the most susceptible *Juglans* species. Species such as northern California, southern California, Persian (English), and little walnut have some resistance while Arizona walnut is the most resistant. Hickories and pecans are immune to the disease. Although black walnut is susceptible to *G. morbida*, genes for resistance may be present in the black walnut species. Variation in susceptibility has been found among half-sib families (seedlings from a single mother tree) and among nut cultivars. In addition, regional differences may

also exist with preliminary studies suggesting Wisconsin walnuts are more susceptible than Missouri and Oklahoma walnut trees.

The resistance of Arizona walnut to the *G. morbida* fungus supports the idea that the fungus is native to the southwestern US and northern Mexico, the native range of Arizona walnut. In addition, the wide genetic diversity found among *G. morbida* samples confirms that the fungus has been present in the US for a long time. The fungus most likely spread from its native range when beetle-infested walnut logs or wood products with bark on were shipped elsewhere.

Confirmation of TCD requires positive identification of the fungus. The fungus is difficult to identify because the shape of the reproductive structure is similar to other fungi. Further, many different types of fungi, including other *Geosmithia* species are found on beetle bodies and in wood. One study found 19 – 56 different types of fungi on the bodies of beetles closely related to the walnut twig beetle. To improve identification, investigators in Tennessee are developing a more reliable technique to identify *G. morbida* using its unique DNA code. The technique is expected to shorten the process used to identify the fungus when it is grown on artificial medium. Future modification of the technique may permit rapid identification of the fungus directly from samples of the

inner bark collected from a suspect tree.

The search for an effective chemical treatment for TCD infected trees continues. In part, finding an appropriate chemical is difficult because walnut produces an edible nut. The location of the beetle galleries in the tree makes chemical selection even more challenging. Several common systemic pesticides have had limited effect on the beetle and fungus, most likely because systemic chemicals move mostly through the sapwood while the beetle and fungus occupy bark tissues. Research continues on evaluating both systemic and non-systemic pesticides for their potential to kill walnut twig beetles and the *G. morbida* fungus.

Progress has been made in determining if infected logs can be a source of TCD and, if so, how can infested logs be treated so they can be safely moved and used. Optimum growth of the fungus on artificial medium is 77 to 90 ° F; but can survive temperatures up to 107 ° F and has been isolated from frozen logs. Bud Mayfield, a researcher at the USFS Ashville office, has shown that the fungus can be isolated from peeled logs; however, the fungus is killed by heat treatments that raise the temperature of the outer 3/8th inch of sapwood to 118 ° F for 30 to 40 minutes (higher temperatures are needed to kill the beetle). Fumigation of infected logs with methyl bromide at 120 micrograms per liter at 40 ° F for 48 hours will also kill the fungus.

The adult walnut twig beetle is quite small, about the size of a poppy seed or same length as

the “l” on a dime (**Figure 2**). Beetle identification requires examination under a microscope for two rows of tubercles on the flattened elytra. Unlike the adult males, females have a hairy brush (pubescence) across the top of their head partially covered by the thorax. The insect is very prolific and as many as 100 exit holes have been counted from a 4 inch square piece of bark. Trapping in Tennessee showed a consistent peak in adult emergence in September and October and another weaker peak in March, April, and May suggesting the walnut twig beetle can complete two life cycles annually.

There is good evidence that the walnut twig beetle is native to the southwestern US. The oldest collections of walnut twig beetle are from Silver City and Paradise, New Mexico dated 1896 and 1917. Historical records suggest it is an insect pest of Arizona walnut on which it can cause death of small branches but does not cause tree mortality. Like the associated fungus, there is wide genetic diversity within the insect indicating it has been around for a long time.

On black walnut, the beetles attack branches 1.5 inches in diameter but prefer larger branches. On smaller branches, attacks are usually associated with old leaf scars. Tests consisting of cut logs placed in infested areas demonstrate that logs remain attractive to beetles for more than two months after a tree has been cut.

A male pheromone has been identified from the headspace volatiles surrounding infected branches. The volatiles are

separated on a gas chromatograph and amount of excitation from insect antenna was measured to detect the most attractive volatiles as they emerge. The lure has been patented and is being packaged in packets that can be attached to insect traps to monitor for the beetles. The recommended traps for monitoring are Lindgren traps that consist of four black funnels with a wet cup attached to the bottom funnel (**Figure 3**). Traps are usually hung on poles made from aluminum conduit set on rebar driven in the ground.

Adult beetles are clumsy fliers. When they hit one of the funnels on a Lindgren trap, they fall into the wet cup. Propylene glycol, the pink antifreeze used in marine or recreational vehicles, is recommended because it will kill and preserve the insects. Ethanol should not be used because it attracts ambrosia beetles. Ethylene glycol should not be used because of its toxicity to animals. Documents and videos describing how to set up and monitor Lindgren traps are available at <http://www.ipm.ucdavid.edu/pdf/pestnotes/wtb-trapping.pdf> and <http://www.ipm.ucdavis/pmg/menu.thousandcanker.html>. In addition, the website at www.thousandcankers.com has a link to the 47- page publication titled *Thousand Cankers Disease Survey Guidelines for 2013* (4.5 MB pdf) that has detailed information on using baited traps and photos for insect and fungal identification.

In an effort to track state efforts, a national database has been created to document monitoring activities and record where walnut twig beetle traps

have been deployed. Bruce Moltzan, national TCD program leader, discussed the resulting map that summarized the extent and results of monitoring in 2012 which is available at <http://foresthealth.fs.usda.gov/portal>. Information as to negative as well as positive finds has been entered into a national database.

During the webinar, landowners interested in helping with the monitoring effort by placing traps on their land and servicing those traps were encouraged to contact their state natural resource or agriculture department directly. However, post webinar conversations suggest most states would prefer that landowners learn to visually recognize symptomatic black walnut trees on their property or in their communities. In these states, landowners can help by sending local authorities digital photos of the entire tree, areas of the crown showing symptoms, and close-up of the leaves. The photos would be used to determine if symptomatic trees should be further evaluated for TCD. Limiting the number of TCD suspect sites prior to deploying traps is important because traps are expensive, trap evaluation is time consuming, and highly trained personnel are needed to accurately identify walnut twig beetles. Regardless of your state, contact your local authorities if you suspect TCD infected trees are present in your area.

States have been able to apply to the Farm Bill for TCD monitoring funds. Julie Spaulding, National APHIS coordinator, indicated \$400,000 was made available through the Farm Bill in

2012 to 17 states. Most states were able to complete their cooperative agreements in time to be part of this monitoring effort. Funds available in 2013 include \$333,000 in the Farm Bill after sequestration and any funds not spent in 2012.

Representatives from each state with TCD positive trees or documented reports of the beetle gave a brief description in the second part of the webinar of how the disease or beetle was found in that state and ongoing detection efforts.

Dana Rhodes, plant protection program specialist for the Pennsylvania Department of Agriculture, provided a history of the TCD infestation in Pennsylvania. On 29 July 2011, an arborist in Plumstead submitted branch samples from declining black walnut trees to the Pennsylvania Department of Agriculture. The presence of TCD was confirmed on 2 August 2011 and Bucks County was immediately quarantined. The property owner is an arborist who also distributes firewood and operates his own sawmill to prepare live edge lumber for artisans. Six to eight years earlier he had shipped in logs from Chico, California for his business. Testing of beetles captured in Chico and in Pennsylvania show similar genetic patterns confirming this shipment was the likely source of the TCD infested material.

In 2011, ten of 56 walnut trees around the edge of his property tested positive for TCD. Working with the local fire department and heavy equipment operators, the owner voluntarily without state funding, had all 56

walnut trees cut, piled, and burned over two days in late February when the beetles were expected to be inactive. TCD has not been eradicated as walnut twig beetles continue to be captured in baited Lundgren traps and declining walnuts on nearby property tested positive for TCD in 2012.

Norm Dart, Virginia Department of Agriculture's plant pathologist, provided a history of the TCD finds in Virginia. In June 2011 Bartlett Tree Service received a call about a declining walnut tree in Richmond and had it checked for TCD. With further testing, additional trees in the surrounding areas were confirmed to have TCD. A second find was confirmed in the summer of 2012 in Fairfax, Virginia. Officials have not been able to confirm the source of the beetles or fungus. Photographs showing little decline of some TCD infected trees during a two-year period confirm that the disease can progress slowly. Current estimates between initial infestation and tree death in Virginia are 5 to 20 years.

Paul Merten, US Forest Service Forest Health Protection, provided a history of the TCD detections in Tennessee and North Carolina. The disease was first found in May 2010 when a friend of employees at the Tree Improvement Center in Knoxville submitted samples of declining and dead walnuts to Ned Tisserat, the Colorado State plant pathologist who originally isolated and named the fungus. TCD was confirmed after a second set of samples was submitted (**Figure 4**). Knox and three adjoining counties were quarantined in 2010. Trapping in 2011 confirmed the presence of

TCD in three additional counties. Trapping in 2012 did not result in the expansion of the known TCD area in Tennessee. The expanded number of counties is thought to be due to better detection techniques and not a rapid natural spread of TCD. Currently seven counties are quarantined, meaning walnut trees or their wood products along with hardwood firewood cannot be moved outside these counties. The eleven surrounding counties are listed as buffer regulated areas, meaning walnut trees and products can be moved between buffered counties and into quarantined counties, but not taken back out again from quarantined counties. In 2013, Tennessee will put out 70 baited traps across the state with one trap in each quarantined county to confirm the emergence pattern and two traps in each buffer county to continue monitoring the extent of the disease.

In 2012, trees infected with *G. morbida* were found in North Carolina's Great Smoky Mountains National Park. North Carolina employees identified 151 TCD-suspect trees. No walnut twig beetles were detected but *G. morbida* was isolated from two suspect trees in late August 2012 and its identity confirmed by molecular testing. These trees are located along the edge of different campgrounds in open woodlands within the park where it borders Tennessee.

Dan Kenny, Ohio Department of Agriculture, described the events leading to trapping of walnut twig beetles in

Ohio. Baited traps were placed at 28 high-risk sites across Ohio including the log yard for a veneer mill in Butler County. In September, eight beetles from collections at the veneer mill were identified. The trapped beetles had been shipped in alcohol for identification, so beetles could not be tested for *G. morbida* to confirm TCD. The mill had received a shipment of walnut burls from western Oregon as late as July 2012. At the time of the quarantine, there were 1516 walnut logs in the yard and under a compliance agreement, 710 of these logs were processed into veneer and the rest fumigated or burned. Detection of the beetles occurred too late in the year for inspection of the fifty walnut trees in areas surrounding the mill, which will be monitored with more than 20 baited traps during the 2013 summer.

In summary, the interest in TCD is high as over 250 people from 26 states and Canada participated in the March 28 live online webinar. The webinar was recorded and can be viewed on the national TCD website at: <http://www.thousandcankers.com/webinars.php>. The follow-up webinar on April 25 described survey protocols, field identification of thousand cankers disease, and an FHTET demo of survey database entry. A third webinar on May 30 will include an update of current research and methods as well as discuss plans for public outreach plans and outreach needs. The latter webinars will also be recorded and made available on the above website.

An alternative to the above

series of webinars is one sponsored by The American Tree Farm System. Simeon Wright, Paul Merten, and Lenny Farlee discussed "Managing the Threat of Thousand Cankers Disease on Your Tree Farm." It was also recorded and can be viewed at: <http://www.treefarmssystem.org/american-tree-farm-webinar-series>. To find the webinar, find "Check on our Archives" and select the April 18th presentation. While at this website, you may also want to view the March 15, 2012 webinar on "Managing for Black Walnut" by Mel Baughman and Lenny Farlee. It is a very good introduction to site identification, establishment and plantation management of black walnut for timber and/or nut production.

Figure Legends

Figure 1. —Exposed walnut twig beetle egg galleries and fungal cankers responsible for TCD in the inner bark of walnut branches. (Photo from Colorado State University TCD Recovery Plan)

Figure 2. —Size of an adult walnut twig beetle compared to pencil tip (Photo by Ned Tisserat).

Figure 3. —Baited four funnel Lindgren trap attached to aluminum conduit (Photo by Steve Seybold, US Forest Service).

Figure 4. —Black walnut tree in Knox County showing TCD symptoms (Photo by Bruce Moltzan, US Forest Service).



TCD - Figure 1.



TCD - Figure 2.



TCD - Figure 3.



TCD - Figure 4.

UPDATE: Dan Kenny reported in early June that walnut twig beetles have been captured this spring in 9 of 26 traps in Butler county most likely from walnut trees around the veneer mill where beetles were captured in 2012. The quarantine has now been expanded to include all of Butler county.