

TITLE: Distribution and Intensification of Bur Oak Blight in Iowa and the Midwest

LOCATION: IA, ND, SD, NE, KS, MO, MN, WI, IL, IN, MI

DURATION: Second year of a continuing 3 year project, 1 January - 31 December 2011

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OBJECTIVES: 1. Determine distribution of bur oak blight (BOB) and follow within-tree intensification and spread to new trees in Story County, Iowa. 2. Determine the geographic distribution of BOB in Iowa. 3. Determine the geographic distribution of BOB in the Midwest.

JUSTIFICATION:

a. Linkage. Dramatic, late-season defoliation and poor crown conditions of bur oak in the Midwest have been specifically noted over the last 10 years in annual "Forest Health Highlights" from Wisconsin, Minnesota, Missouri, Nebraska, and Iowa.

b. Significance. The incidence and severity of bur oak blight (BOB) has increased dramatically in central Iowa since 2004. In an area stretching from eastern Nebraska to southern Minnesota and southwestern Wisconsin, the incidence of BOB is spotty, but apparently increasing. It is the major contributor to the decline of bur oak and is a local and regional issue of high priority.

c. Biological impact. The disease is killing many large bur oak. The late-season symptoms are dramatic, and many affected trees die after repeated defoliation. The public is very concerned, and there is a need to know its geographic range, if it is expanding and increasing in intensity.

d. Scientific feasibility. Inoculations have confirmed that BOB is caused by an undescribed species of *Tubakia*, which can be distinguished morphologically and molecularly. Our ongoing studies will enable us to determine where BOB occurs and how it intensifies within trees.

e. Priority issues. We will identify the causes of poor crown conditions and address the possible role of climate change. The disease is increasing, suggesting that either the pathogen is an invasive species, or climate change is responsible for its sudden prominence.

DESCRIPTION:

a. Background: Previously, *T. dryina* was the only recognized *Tubakia* species on oaks and other hardwoods in eastern USA. Through morphological and DNA sequence studies, we now recognize five species on bur oak. *T. dryina* primarily infects white oak. Another undescribed species is a twig endophyte in bur oak. The more common *T. castanicolum* causes leaf spots on red oaks and other hardwoods. The BOB *Tubakia* is new to science and the only species causing severe disease. Another closely-related species causes a leaf blight on post oak.

The hypothesized disease cycle follows. Many leaves infected early in the season hang onto branches through the winter and into the next spring, when the pathogen produces spores (conidia) on the old petioles. This primary inoculum does not disperse well but infects adjacent expanding shoots in May. The fungus may remain latent (endophytic) in these first-infected shoots and leaves. Secondary inoculum (rainsplashed dispersed conidia) from symptomatic leaves (veinal necrosis) is abundant from late July through Sept., when leaf death and defoliation may be dramatic. Trees affected by BOB usually show symptoms first on lower branches, and the fungus progresses slowly upward over the years because of limited dispersal of the primary inoculum. After many years, heavily affected trees may die directly or due to secondary agents.

The spotty nature of BOB suggests that it has not fully expanded its potential range and is not native. However, the disease may be spotty in distribution because of variation in resistance within and among local populations of bur oak. BOB may have just recently been recognized because of the increase in early-season rain events (climate change) over the past two decades.

b. Methods: We began intensive sampling in a grove of 39 bur oak at Brookside Park in Ames in May 2009. Hundreds of isolations from old and new twigs, expanding shoots, and leaves, as well as observations of symptoms, are conducted monthly to determine the disease cycle and follow disease progress within trees. We also survey for BOB in accessible bur oak stands in Story Co. Disease progress on individual trees is monitored each Sept. in permanent plots.

Distribution of the disease in Iowa and the Midwest is determined through samples provided by the ISU Extension, the Iowa DNR, landowners, and contacts in other states. They provide branches from declining trees in August and Sept. We visit Iowa counties and other states that have not been adequately sampled in order to determine the extent of the BOB epidemic.

For all samples, we examine leaves for presence of fruiting bodies, and if *Tubakia* is present, we conduct isolations and morphologically identify the species. DNA is extracted and rDNA is sequenced to definitively identify the *Tubakia* species and evaluate genetic variation.

c. Products: Scientific publications will include the description of the new species of *Tubakia*, the epidemiology studies at Brookside Park and other Story Co. sites, and Midwest survey results. Pest alerts, other publications, and presentations will be made to increase awareness and understanding of this significant forest health problem. Annual progress reports will be made.

d. Schedule of Activities: The Ames epidemiology studies (monthly samplings at Brookside and yearly sampling in eight permanent plots) will continue through 2012. Samples from across Iowa and the other states will be received and we will be filling in gaps with more site visits during 2011 and 2012. New species of *Tubakia* and the BOB disease cycle will be described in 2011.

e. Progress/Accomplishments: We have made excellent progress in the first year, including more travel in Iowa, Missouri and Nebraska than initially proposed. Monthly and annual sampling yielded very useful epidemiological data, and we have a much clearer picture of the disease cycle and BOB distribution. We will continue as planned in 2011 and 2012. We made a video summarizing what we knew in Feb. 2010 (fms.extension.iastate.edu/vod/video/2010BobPresentCIC.html), and an article for ISU Extension's *Woodland Owners Newsletter* is in preparation. We will prepare a manuscript this winter describing the new *Tubakia* species and the disease cycle.

1. Intensive plots in Story Co. Surveys indicate that all bur oak groves in the county have the BOB *Tubakia*, though significantly blighted trees are not always present. We are completing our second year of intensive, monthly sampling of 37 bur oak trees (two were lost in storms) at a bottomland site (Brookside), where disease levels are relatively low. Four different species of *Tubakia* were identified from hundreds of isolations from asymptomatic leaves, petioles, and twigs of bur oak, but only the BOB *Tubakia* was associated with significant symptoms. Ten trees had BOB in 2008 based on overwintering petioles on branches. Nine of these had significant BOB symptoms in 2009 and significant numbers of overwintering leaves on branches in April 2010. These nine trees were the only ones with newly infected fresh shoots (asymptomatic) in May 2010 and the only ones that showed substantial symptoms in Sept. 2010. The other 26 trees had no significant BOB in 2009, few overwintering leaves on branches, no fresh shoots were infected in May, and they had no significant BOB symptoms in Sept. 2010.

Five permanent plots with 376 mature bur oak were established in Ames in Sept. 2009, and these trees were rated again in Sept. 2010. The bottom and top halves of the crown were rated as clean (0) to severe (3); trees were rated from 0 to 6. The Sept. 2010 disease rating for individual

trees was highly correlated with the rating in Sept. 2009. Symptoms appeared earlier in 2010 (early to mid-July) than in 2009 (late July), perhaps due to warmer and wetter conditions in 2010. The average disease rating for the 376 trees went from 1.141 in 2009 to 1.309 in 2010. Four of 11 “severe” trees died. Permanent plots of 105 trees at three sites were added in Sept. 2010, for a total of 481 trees to be monitored through Sept. 2012. The three bottomland sites had an average disease rating of 0.772, compared to 1.922 on the five upland sites.

2. Geographic distribution in Iowa. Extensive trips to the four quadrants of the state were made in Aug. and Sept. 2010. These samples and those from cooperators and homeowners have confirmed the BOB *Tubakia* in 55 of Iowa’s 99 counties. It is one of five *Tubakia* species recovered from bur oak, so each of these samples has required morphological and molecular analysis. The BOB *Tubakia* has only been isolated from bur oak, while the other species have a broader host range. A very closely related *Tubakia* species on post and chinkapin oak now has been confirmed on bur oak in southeast Iowa, where BOB is uncommon.

We found the pathogen to be present throughout Iowa, though there appears to be a wide variation in susceptibility of bur oak both within and among stands. Severe BOB occurs in remnant savannah stands, and bur oak adapted to thin, upland soils appear to be particularly vulnerable. Bur oak in dense stands typical of eastern Iowa generally show little or no disease. The deep, well-drained soils of the Loess Hills have an intermediate level of BOB. There appears to be a very strong host genetic component to the disease. Even on upland sites, there is typically a wide variation in susceptibility within a stand, with severely affected trees next to healthy trees.

A total of 51 *Tubakia* isolates from BOB trees were sequenced. These analyses show a surprising level of genetic variation for a putatively asexual species and strongly suggest that the fungus is native to this region and is not a recently introduced pathogen. A shift in climate is suspected to be the primary reason the disease has become more noticeable.

3. Distribution in the Midwest. We have sequenced 155 isolates of *Tubakia* from oak trees in Iowa and adjacent states. Based on these data and morphological study, we have confirmed the BOB *Tubakia* in Iowa, Minnesota (myminnesotawoods.umn.edu/2010/09/bur-oak-blight-bob-in-minnesota/), Nebraska, Illinois, and Missouri. However, the disease is very limited in Illinois and Missouri. Severely blighted trees can be found commonly in eastern Nebraska, southern Minnesota, and the western two-thirds of Iowa. To date, BOB has been confirmed only in the small-acorned variety of bur oak, *Q. macrocarpa* var. *olivaeformis*, which is known to be well adapted to upland sites. This variety is centered in Iowa, but it ranges from eastern Nebraska to southern Minnesota. We suspect that the BOB *Tubakia* is very specific to this variety of bur oak and that there was little selection pressure for disease resistance in this variety when the climate was drier.

COSTS: Second year budget, 1 Jan 2011 – 31 Dec 2011

	<u>FHM</u>	<u>ISU</u>	<u>Total Budget</u>
Administration Salary <i>T. Harrington</i> (2.5 mo)	0	26,294	26,294
<i>Lab Tech</i> (6 mo)	18,900	0	18,900
Fringe <i>T. Harrington</i> (29%)	0	7,625	7,625
<i>Lab Techn</i> (35.4%)	6,691	0	6,691
Overhead (48%)	16,281	16,281	32,562
Travel	2,500	0	2,500
Procurements DNA Sequencing (ISU)	2,000	0	2,000
<u>Laboratory Supplies</u>	<u>3,828</u>	<u>0</u>	<u>3,828</u>
Total	\$50,200	\$50,200	\$100,400