

**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:** Third year of a continuing 3 year project, 1 January - 31 December 2012

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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 concerned, and there is a need to know its geographic range and 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 studies will enable us to determine where BOB occurs and how it intensifies within trees and stands.

**e. Priority issues.** We will identify the causes of poor crown conditions and address the possible role of climate change. The disease has increased in prominence, 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. americana* causes veinal necrosis on red oaks and other hardwoods. The BOB *Tubakia* is new to science and the only species causing severe disease on bur oak. Another closely-related species causes leaf blight on post oak.

The hypothesized disease cycle follows: Many leaves infected early in the season hang onto twigs 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 (by rainsplash) but infects adjacent expanding shoots in May. The fungus remains latent (endophytic) in these first-infected shoots and leaves. Secondary inoculum (rainsplash-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 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, and this will continue through the 2012 season. 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 upland and bottomland 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, arborists, and numerous collaborators in other states. They provide symptomatic branches 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 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.

**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 2012. New species of *Tubakia* and BOB epidemiology will be described in 2012, and outreach materials will be updated.

**e. Progress/Accomplishments:** We have confirmed that BOB occurs throughout the geographic range of the small-acorn variety of bur oak, *Q. macrocarpa* var. *oliviformis*, which we think is the only seriously-affected variety. The disease is most severe on upland, former savanna sites, where var. *oliviformis* is well-adapted. Monthly and annual sampling of plots in the Ames area is confirming the hypothesized disease cycle, especially the critical infections at bud break. Eradicative fungicide injections in early June reduce disease severity.

There has been substantial outreach activity: a video summarizing what we knew in Feb. 2010, an article published in ISU Extension's *Woodland Owners Newsletter* and *Horticulture & Home Pest News*, a US Forest Service Pest Alert with Jill Pokorny, and the poster prepared as an annual report, all available on my BOB pages ([www.public.iastate.edu/~tcharrin/BOB.html](http://www.public.iastate.edu/~tcharrin/BOB.html)). An extensive formal description of the disease and pathogen (*Tubakia iowensis* T.C. Harr. & D. McNew, sp. nov.) will be published next month in the peer-reviewed *Mycologia*. Presentations on BOB were made at meetings of the North Central Plant Diagnostic Network and the Iowa SAF, and presentations will be made at ISU and at the Northern Green Expo.

**1. Intensive plots in Story Co.** Surveys indicate that all bur oak groves in Story Co. 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. Five permanent plots with 376 mature bur oak were established in Ames in Sept. 2009, and these trees were rated again in Sept. 2010 and 2011, but the 2011 data have not yet been summarized.

**2. Geographic distribution in Iowa.** Extensive trips to the four quadrants of the state were made in 2010 and 2011. These samples and those from cooperators and homeowners have confirmed the BOB *Tubakia* in 65 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, chinkapin and bur oak, but this species does not produce pustules on petioles nor severe blight on bur oak. A manuscript will be prepared in 2012 that will recognize the overlooked *T. americana* and describe three new species.

There appears to be a wide variation in susceptibility of bur oak both within and among stands. Severe BOB occurs in remnant savanna stands, and bur oak adapted to thin, upland soils (i.e., var. *oliviformis*) appear to be particularly vulnerable. Bur oak in dense stands typical of eastern Iowa generally show little or no disease. Even on upland sites, there is typically a wide variation in susceptibility within a stand, with severely affected trees next to healthy trees.

Genetic analyses show a surprising level of genetic variation in *T. iowensis* 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 more than 200 isolates of *Tubakia* from oak trees in Iowa and adjacent states. We have had excellent cooperation from state, federal private interests. Jill Pokorny from the US Forest Service has greatly extended the known distribution of BOB northward in Minnesota. Landowners and arborists have helped extend the known distribution of BOB into southeastern Wisconsin and northeastern Illinois. The known distribution of BOB now includes northeastern Kansas, eastern Nebraska, almost all of Iowa, northwestern to southeastern Minnesota, southern Wisconsin and northern Illinois. We have also confirmed the disease in a few sites just across the eastern and southern borders of Iowa into Illinois and Missouri. The BOB distribution coincides with the distribution of the small-acorned variety of bur oak, *Q. macrocarpa* var. *oliviformis*, which is known to be well adapted to upland sites. The disease is most common on mature trees in remnant savanna forests, but we have occasionally seen the disease in urban plantings, apparently of locally produced material. The BOB *Tubakia* appears to be very specific to this variety of bur oak, but we suspect that there was little selection pressure for disease resistance in this variety when the climate was drier. Unusually wet springs for the last 20 years may be the most important contributing factor for the relatively recent recognition of what appears to be a native disease.

**COSTS: Third year budget, 1 Jan 2012 – 31 Dec 2012**

	FHM	ISU	Total Budget
Administration Salary <i>T. Harrington</i> (2.5 mo)	0	26,189	26,189
<i>Lab Tech</i> (6 mo)	18,900	0	18,900
Fringe <i>T. Harrington</i> (29%)	0	7,595	7,595
<i>Lab Tech</i> (35.4%)	6,691	0	6,691
Overhead (48%)	16,216	16,216	32,432
Travel	2,300	0	2,300
Procurements DNA Sequencing (ISU)	2,000	0	2,000
Laboratory Supplies	3,893	0	3,893
Total	\$50,000	\$50,000	\$100,000