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: 3 years, January 1, 2010 to December 31, 2012

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PROJECT 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. Unexplained declines of oak species have been of major concern in the eastern USA for decades. 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. This proposal addresses a significant concern of FHM and will elucidate a phenomenon that **has already been observed**.

b. Significance. The incidence and severity of bur oak blight (BOB) has increased dramatically in central Iowa since 2004. In 2009 there was substantial mortality of bur oak trees with BOB, and many trees have shown symptoms for the first time. In an area stretching from eastern Nebraska to southwestern Wisconsin, the incidence of BOB is spotty, but 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, and the **biological impact** of BOB is locally very high. It could become the most important disease of bur oak throughout its range. Symptoms are dramatic from August through October, and many affected trees die after repeated defoliation. Bur oak is the state tree of Iowa and a major species in the Northcentral Region, particularly in former prairie regions, where bur oak groves over 100 years old may dominate the landscape. The **public concern** for the defoliation and death of these mature bur oaks in Iowa is also very high. It is imperative that we determine the current geographic distribution of BOB, if it is expanding its range, and if it is increasing in intensity.

d. Scientific feasibility. Inoculations have confirmed that BOB is caused by an undescribed species of *Tubakia*. We identified its unique disease cycle through an intensive epidemiological study at a site in Ames. Two seasons of sampling in Iowa and adjacent states have enabled us to distinguish the new BOB *Tubakia* from other species of *Tubakia*. Our ongoing studies and a long list of contacts give us confidence that in 3 years we will be able to determine the geographic extent of BOB, if it is distributed spottily or evenly, and if it is increasing in intensity.

e. Priority issues. Because symptoms are not fully expressed until August, we have only a narrow window for surveying, and the most intensive work will take place in Iowa. However, the study is designed to extrapolate our findings across a **broad geographic scale**. We will identify

the **causes of poor crown conditions** and address the possible role of **climate change**. The disease is increasing in both urban and natural forests, suggesting that either the pathogen is an **invasive species**, or **climate change** is responsible for its sudden prominence.

DESCRIPTION:

a. Background: Previously, pathologists had considered only one species of *Tubakia, T. dryina*, as a leaf pathogen on oaks and other hardwoods in eastern USA. Now we recognize that *T. dryina* infects white oaks as a leaf pathogen and twig endophyte (infection without symptoms) in central Iowa, but it does not cause death of bur oak leaves. The more common *Tubakia* that causes leaf spots on red oaks and other hardwoods in North America is *T. castanicolum*, which may cause limited veinal necrosis, but not death, of bur oak leaves. The *Tubakia* constantly associated with BOB is new to science. Inoculations of bur oak leaves with the BOB *Tubakia* causes death of the leaves, and the fungus moves up the stem and causes symptoms in leaves above. Another closely-related *Tubakia* species causes a blight of post oak in Missouri and Arkansas. Thus, we have at least four species of *Tubakia*, but only one causes BOB.

The new disease on bur oak has been reported since 1999 but was probably present much earlier because affected trees may not show dramatic symptoms for several years. Spores (conidia) are dispersed by rainsplash, and lateral dispersal is limited, so the pathogen appears to be spreading slowly to new trees and new stands. Partially affected trees usually show symptoms first on the lower branches, and the fungus progresses upward in the tree in subsequent years. A unique feature of BOB is that many of the killed leaves hang onto the tree through the winter and into the spring, when the pathogen produces spores on petioles from the previous year. This primary inoculum infects extending twigs and leaves of the same tree. Secondary inoculum from symptomatic leaves is abundant from late July through September, when symptoms are most dramatic. Heavily affected trees are completely defoliated and may eventually die directly from BOB or due to attacks by the two-lined chestnut borer.

The disease in Central Iowa is increasing in severity year-to-year in individual trees, and newly-infected trees appear each year. The spotty nature of BOB in Iowa and elsewhere suggests that the fungus has not fully expanded its potential range and is not a natural component of bur oak forests. The pathogen infects healthy acorns, and we have isolated it from seedlings grown in the nursery, so dispersal in acorns and nursery stock may explain the spotty distribution of BOB.

b. Methods: We began intensive, monthly sampling in a grove of 39 bur oak at Brookside Park in Ames in May 2009. Isolations from old and new twigs, leaves, and acorns, as well as observations of leaf symptoms and overwintering leaves, have given a clear picture of the disease cycle and provide a solid basis for monitoring disease progress through 2012. Permanent plots in two stands (70 and 80 bur oak trees, respectively) were assessed in Sept. 2009. We will survey for BOB in all accessible bur oak stands in Story Co. in 2010, and permanent plots will be established in at least 7 more groves to follow disease progress through 2012.

Distribution of the disease in Iowa and the Midwest will be determined initially through samples provided by the ISU Cooperative Extension service, the Iowa Department of Natural Resources, the Diagnosticians Network, and the same contacts that were used in another successful Base EM study that is determining the distribution of bacterial leafscorch of hardwoods in the Northcentral and Plains States. Our contacts will be asked to provide symptomatic leaves from declining bur oak trees in August and September of 2010-2012. In 2011 and 2012, we will 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 will examine leaves for presence of fruiting bodies, and if *Tubakia* is present, the species will be identified by morphology of the spores and fruit bodies and/or cultures. When necessary, DNA will be extracted from fruiting bodies or cultures, and sequencing of the ITS region of rDNA will definitively identify the species.

c. Products: Scientific publications will include the description of the new species of *Tubakia*, the epidemiology study at Brookside Park and other Story Co. sites, and 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 will continue through 2012. New plots in Story Co. will be established in 2010 and followed annually through at least 2012. Samples from across Iowa and the other states will be received in all three years, but we will be filling in gaps in 2011 and 2012 with site visits. Progress reports will be made each year.

COSTS:

First year budget, Jan 1, 2010 - Dec 31, 2010		FHM	ISU	Total Budget
Administration Salary	T. Harrington (2.5 mo)	0	24,735	24,735
	Lab Tech (6 mo)	18,000	0	18,000
Fringe	T. Harrington (28.2%)	0	6,975	6,975
	Lab Techn (34.5%)	6,210	0	6,210
	Overhead (48%)	15,220	15,220	30,440
	Travel	2,000	0	2,000
Procurements	DNA Sequencing (ISU)	1,500	0	1,500
	Supplies (media, reagents, etc.)	4,000	0	4,000
Total		$46,930	$46,930	$93,860

Second year budget, Jan 1, 2011 - Dec 31, 2011		FHM	ISU	Total Budget
Administration Salary	T. Harrington (2.5 mo)	0	26,460	26,460
	Lab Tech (6 mo)	18,900	0	18,900
Fringe	T. Harrington (28.2%)	0	7,460	7,460
	Lab Techn (34.5%)	6,520	0	6,520
	Overhead (48%)	16,280	16,280	32,560
	Travel	2,500	0	2,500
Procurements	DNA Sequencing (ISU)	2,000	0	2,000
	Supplies	4,000	0	4,000
Total		$50,200	$50,200	$100,400

Third year budget, Jan 1, 2012 - Dec 31, 2012		FHM	ISU	Total Budget
Administration Salary	T. Harrington (2.5 mo)	0	27,840	27,840
	Lab Technician (6 mo)	19,845	0	19,845
Fringe	T. Harrington (28.2%)	0	7,850	7,850
	Lab Techn (34.5%)	6,845	0	6,845
	Overhead (48%)	17,130	17,130	34,260
	Travel	3,000	0	3,000
Procurements	DNA Sequencing (ISU)	2,000	0	2,000
	Supplies	4,000	0	4,000
Total		$52,820	$52,820	$105,640