



Assessment and Etiology of Hickory Decline (NC-EM-07-01) Third Year Results

Jennifer Juzwik¹, Ji-Hyun Park², Paul Castillo¹, Linda Haugen³

¹ Northern Research Station, U.S. Forest Service, St. Paul, MN

² Department of Plant Pathology, University of Minnesota, St. Paul, MN

³ Northeastern Area State & Private Forestry, U.S. Forest Service, St. Paul, MN



INTRODUCTION

Within the past decade, hickory decline and mortality have been reported occurring at higher than expected levels in several states in the north central and northeastern USA (USDA Forest Service 2004) (Fig. 1). Widespread mortality has historically been linked to outbreaks of the hickory bark beetle (*Scolytus quadrispinosus*; Hbb) during or immediately after multiple years of drought. In the early 1990's, a newly discovered fungus species (*Ceratocystis* sp.) was linked to sunken cankers and discolored sapwood on hickory bark beetle-attacked hickories in Wisconsin. Since then, two *Ceratocystis* species have been characterized, and one of those (*C. smalleyi*) along with a number of other biotic and abiotic factors, has been associated with the decline and death of hickories (Fig. 2).

Closer examination of these factors has been conducted through field surveys and study of organisms obtained from samples collected from each site. Summaries of these efforts were presented at the 2008 and 2009 Forest Health Monitoring Workgroup Meetings. The second objective of the overall project is to determine the role of the newly described *Ceratocystis* spp. in the decline and mortality of affected hickories. Results of those investigations are presented here.

Figure 1. Dead and declining bitternut hickory.



Figure 2. *Ceratocystis smalleyi* caused lesion.



ASSOCIATION OF *Ceratocystis smalleyi* AND HBB

Materials and Methods

C. smalleyi on attacking beetle

- Felled trees with decline symptoms.
- Used draw knife to access beetles in entry tunnels.
- Removed beetles with forceps (Fig. 3).
- Placed beetles individually in microtubules and stored at -10 C.
- Conducted serial dilution plating to detect presence of *C. smalleyi* on insects.

Lesion size on bitternut logs

- Felled trees with decline symptoms and cut tree into one meter long sections.
- Placed in poly bags and stored in 2 C cooler.
- Used draw knife to remove bark to cambium.
- Measured lesions and recorded data (Fig. 4).

Results

Table 2: Isolation of *C. smalleyi* (Cs) from hickory bark beetles attacking declining, poletimber and sawtimber sized bitternut hickory, late August-early September 2009

Collection Location	Tree No.	Number of hickory bark beetles			Range of stem heights w/ lesions (m)	Lesions Observed						
		Collected	Assayed	Yielding Cs		Pct. Decline	Stem Cutting Date (2009)	No. logs w/ lesions	Total No.	Avg. Length (cm)	No. Assoc. with Hbb	
Olmstead Co., MN	1	19	19	2	T-2	Bloomer, WI	85 Jun-19	7	0.3-9.2	113	7.1	105
Marathon Co., WI	1	41	30	28	T-3	Hatley, WI	50 Jun-23	15	0.3-8.3; 11.2-12.2; 13.2-17.2	555	5.1	551
Shawano Co., WI	1	57	30	28	T-4	Hatley, WI	50 Jul-13	6	2.2 - 3.2; 9.2 - 14.2, 18.2 - 19.2	27	8.2	24
	2	49	30	25								

BNH RESPONSE OF *C. smalleyi* INFECTION: PHYSIOLOGICAL

Materials and Methods

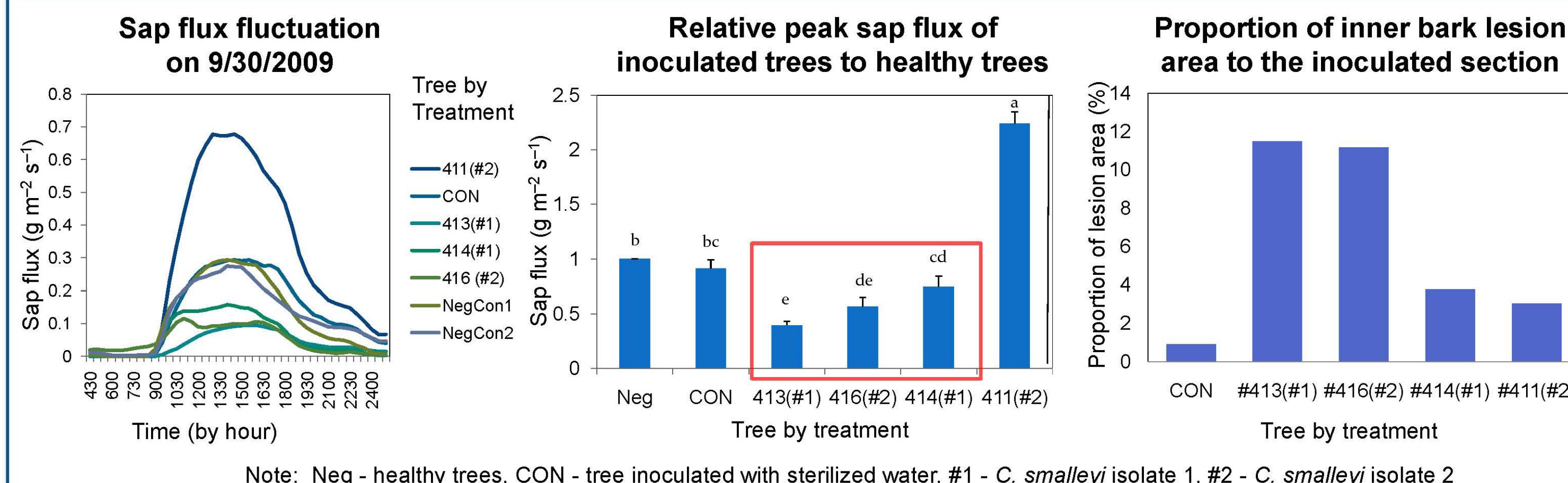
Study trees and treatment

- Three healthy trees (13 – 28 cm DBH) were inoculated with one of two local *C. smalleyi* isolates and control, respectively, in Olmstead county, MN (July 2008) and Chippewa county, WI (July 2009).
- Ascospore suspension (0.1 ml of 1.0x 10⁴ spores/ml) or sterile dH₂O (0.1 ml) were placed in 50 drilled holes on four aspects of a main stem (between 2 – 4 m height), covered and sealed.

Sap flux measurements

- Five treated trees (two of each isolate inoculum and one control) and two healthy trees were examined for sap flux in Olmstead Co., MN (9/18/2009 – 10/05/2009); similar evaluation will be conducted in Chippewa Co., WI (summer 2010).
- Dynamax TDP system was set up to monitor the sap flux of each tree (3 probes for each tree, 10 sec monitoring, 30 min average recording).
- Sap flux was calculated by Granier equation (corrected by sapwood depth).
- Crown volume was estimated prior to harvesting.
- Trees were harvested to measure inner bark lesion size, sapwood discoloration, vessel diameter and tylosis frequency.

Results



CONCLUSIONS TO DATE

- We verified the ability of *C. smalleyi* to cause a newly described canker disease on poletimber sized BNH.
- Hickory bark beetles attacking BNH infrequently to commonly carry *C. smalleyi* on their bodies and are likely responsible for initiation of cankers and lesions on beetle-colonized hickory stems.
- Hundreds of stem lesions, commonly associated with bark beetle colonization, can be found on main stems of declining BNH.
- We hypothesize that coalescing of the very abundant sapwood lesions (and associated bark cankers) is a major contributor to crown decline and death of BNH in north central and northeastern USA.

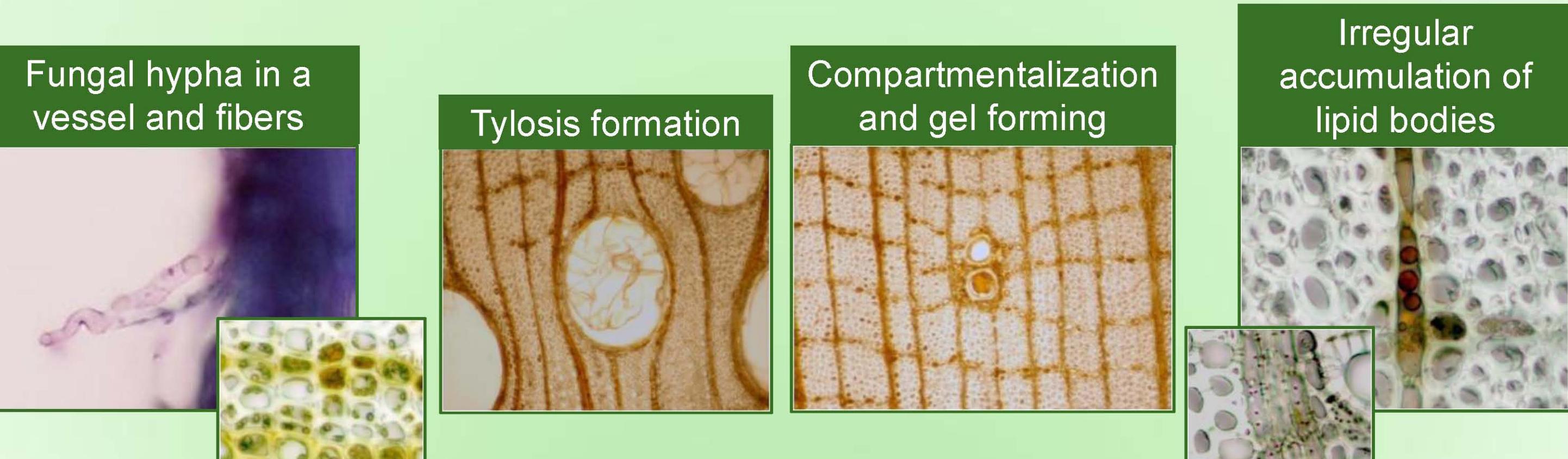
Our remaining work will focus on:

- The mechanisms by which *C. smalleyi* contributes to crown decline, e.g. plugging of vessel elements with tyloses and gums, and
- The relationship between multiple *C. smalleyi* infections and relative sap flow in diseased trees.

ACKNOWLEDGEMENTS

- Numerous individuals, including landowners, who made these studies possible: Mike Boll, Jeannine Cavender-Bares, Tom Harrington, Dennis Haugen, John Hickey, Emily Peters, Andrew Klein.
- County, state, tribal, and federal agencies who contributed assistance and provided study sites: Doyle Richardson, Chippewa County Forest, WI; Shawn Fritcher and Ed Hayes, Minnesota Dept. of Natural Resources; Jack Hieptas, Stockbridge-Munsee Tribal Community, WI; and Brett Stempa, Bureau of Indian Affairs, WI.
- Funding for this project was received from: Forest Health Evaluation Monitoring Program, US Forest Service; and Dept. of Plant Pathology, University of Minnesota.

Results to Date



Experiment location	Inoculum type	Treatment	Inoculated Trees		Monthly/year of:		Observation of:			
			Number	Points/tree	Inoculation	Evaluation	No. cankers / no. inoc'd points	Inner bark lesion (cm ²)	Sapwood discoloration	Reisolation per total inoc. pts.
Allamakee Co., IA	mycelial plug	C. smalleyi	10	1	May-07	Apr-08	9/10	22.4	ellipsoidal reddish brown (38.1 cm ²)	5/10
		Control					0/10	4.0	ellipsoidal brown (7.2 cm ²)	0/10
Chippewa Co., WI	water suspension	C. smalleyi	6	4	Jun-08	Aug-08	16/16	49.7	elongated reddish brown	16/16
		Control					0/8	0.6	none	0/8
Olmstead Co., MN	water suspension	C. smalleyi	9	4	Jul-08	Sep-09	24/24	22.3	elongated reddish brown	21/24
		Control					0/12	2.1	none	0/12