Chapter Three
Fungi and White Pine Needle Cast

Forest Watch is delighted to republish a research paper written by Dr. Isabel Munck, a plant pathologist in the U.S. Forest Service's Forest Health Protection, and her colleagues. We abridge the article by omitting several images. Notice that Dr. Munck uses the term one-year old needles. In Forest Watch, we would call these second year needles as of June, one year after they are formed.

Eastern White Pine Needle Damage Survey, 2011 In Maine, New Hampshire, and Vermont, Published May 16, 2012

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Abstract

White pine needle damage is a current concern in New England and eastern Canada where *Pinus strobus* is of great historic, ecological, and economic importance. State natural resource agencies received hundreds of calls from concerned citizens during 2010 when damage was particularly severe following a very wet spring. Foliar damage was attributed to a needle cast (*Canavirgella banfieldii*) and brown spot needle blight (*Mycosphaerella dearnessii,* anamorph* *Lecanosticta acicola*). Both of these fungi cause similar symptoms, thus complicating diagnoses. In 2011, the USDA Forest Service coordinated a survey with Forest Health State Cooperators from Maine, New Hampshire, and Vermont to investigate the cause of the needle damage. Sixty trees from 13 sites with foliar damage the prior year were sampled from April to June by FH State Cooperators and then diagnosed at the USFS Northeastern Area Durham Field Office. The needles were found to be infected with *M. dearnessii* and *C. banfieldii*, and another needle cast causing pathogen, *Bifusella linearis*. At one location these three pathogens were all present and at another site more than one pathogen was found infecting the same tree. Long, dark hysterothecia* fruiting bodies formed by *B. linearis* and *C. banfieldii*, along with browning of the distal parts of the needles, were present in samples collected in May. *Mycosphaerella dearnessii* was the most frequently observed and widely distributed pathogen, also the most consistently associated with chlorosis and defoliation in early July. White pine needle damage will likely remain a problem in years with wet springs which favors development of the fungi.

*Anamorph: A fungus whose sexual reproductive stage has never been observed.
*Hysteriothecia: A mature fruiting body of a fungus that opens by a slit. Inside the hysterothecia, there are sacs containing spores. Fruiting body: Part of the fungus in which spores are produced.

Introduction

During the summer 2010, white pine needle damage was observed frequently throughout New England generating much public concern. Symptoms consisted of yellow and brown discoloration of one-year old needles [Notice, Forest Watch would call these second year needles which were formed in June 2009]. Affected needles dropped causing tree crowns to look thin a year after initial infection . Needles of both mature trees and regeneration were damaged.

White pine foliar damage has been attributed to frost and two foliar diseases, brown spot needle blight caused by the fungus *M. dearnessii* and Canavirgella needle cast caused by *C. banfieldii*. Diagnosing the damage agent is difficult because both fungi cause similar symptoms, although they can be differentiated by their fruiting bodies produced at different times in the growing season. The sexual fruiting structures of *C. banfieldii* are produced through the winter and are visible earlier in the spring, whereas *M. dearnessii* fruits in June (Merrill et al. 1996, Sinclair and Lyon 2005). Consequently, *C. banfieldii* fruiting bodies could be present in infected needles by April and fruiting bodies of both *C. banfieldii* and *M. dearnesii* could be present by June.

White pine foliar damage was mapped during 2010 aerial forest health detection surveys in New England. In Maine alone 60,116 acres were reported damaged. Because several fungi and frost were associated with the foliar damage, coding the damage consistently during the aerial surveys was challenging. There was a need to understand the extent of the damage that could be directly related to foliar pathogens. Consequently, the objective of this study was to determine the causal agent of the observed white pine needle damage.

Methods

Forest Health State Cooperators from Maine, New Hampshire, and Vermont collected samples from at least three to five white pine stands per State that exhibited damage during 2010, along with stand information (Appendix A). Because the pathogens associated with the damage fruit at different times, stands were sampled between April 25 and May 2 and again during June 13 and 22, 2011 [Forest Watch would call the 2010 year needles first year needles in April and May and second year needles in June 2011 if new needles have opened]. At each stand, samples were collected from at least three and up to five symptomatic trees. When available, samples were also collected from one healthy, control tree. Each sample consisted of a quart-size (1 L) bag full of branch tips.

Samples were sent to the Durham Field Office where they were processed for pathogen identification. All branch tips were visually examined for fungal fruiting structures. Disease incidence and severity were recorded. Twenty needles from one representative branch tip per tree were placed in a moist chamber, incubated at 25˚C for 24 to 72 hours, and then examined with

the aid of dissecting and light microscopes. Moist chambers consisted of Petri plates with filter papers moistened with deionized water sealed with Parafilm.

Results

A total of 13 stands were sampled throughout northern New England. Most of these were

Figure 3.1: Necrotic needles (A) from Mast Yard, NH, infected by *Bifusella linearis*, fruiting bodies (B) are shinny and black (x7.5) and the ascospores (C) are constricted in the middle (x400). Spores are stained with methyl blue.

Figure 3.2: Needles (A) with chlorosis and necrosis from Sangerville, Maine, infected with *Canavirgella banfieldii*, fruiting body (B) is embedded in the needle (x20) and ascospores (C) are not constricted in the middle (x200). Spores are stained with methyl blue.

Figure 6. Sample (A) with defoliation and chlorosis from Waterbury, Vermont infected with *Mycosphaerella dearnessii* (anamorph *Lecanosticta acicola*), asexual fruiting body (B) (x35) and spores (C)(x200).

natural stands located in wetland areas, but trees on dry steep slopes in one plantation in Vermont were also sampled. Samples were taken from a total of 60 trees in all age classes. In

May, 729 branch tips and 1,153 incubated needles were examined. Similarly, in June 384 branch tips and 901 incubated needles were examined.

Signs and symptoms of *C. banfieldii* and *M. dearnessii* were frequently observed. A third fungus, *Bifusella linearis*, was identified by Mary Inman, diagnostician for the Connecticut Agricultural Experiment Station. Both *B. linearis* and *C. banfieldii* produce long, dark fruiting bodies (Figure 1 and 2)(Merrill et al. 1996). The fruiting bodies of *B. linearis* are shiny and black (Figure 1B), whereas *C. banfieldii* fruiting bodies are grey and embedded in the needle (Figure 2B). These two fungi can be distinguished by the shape of their ascospores*. *Bifusella linearis* ascospores are constricted in the middle (Figure 3.1C) (Horst and Westcott 2008), whereas *C. banfieldii* ascospores are not (Figure 3.2C) (Merrill et al. 1996). *Mycosphaerella dearnessii* produces *

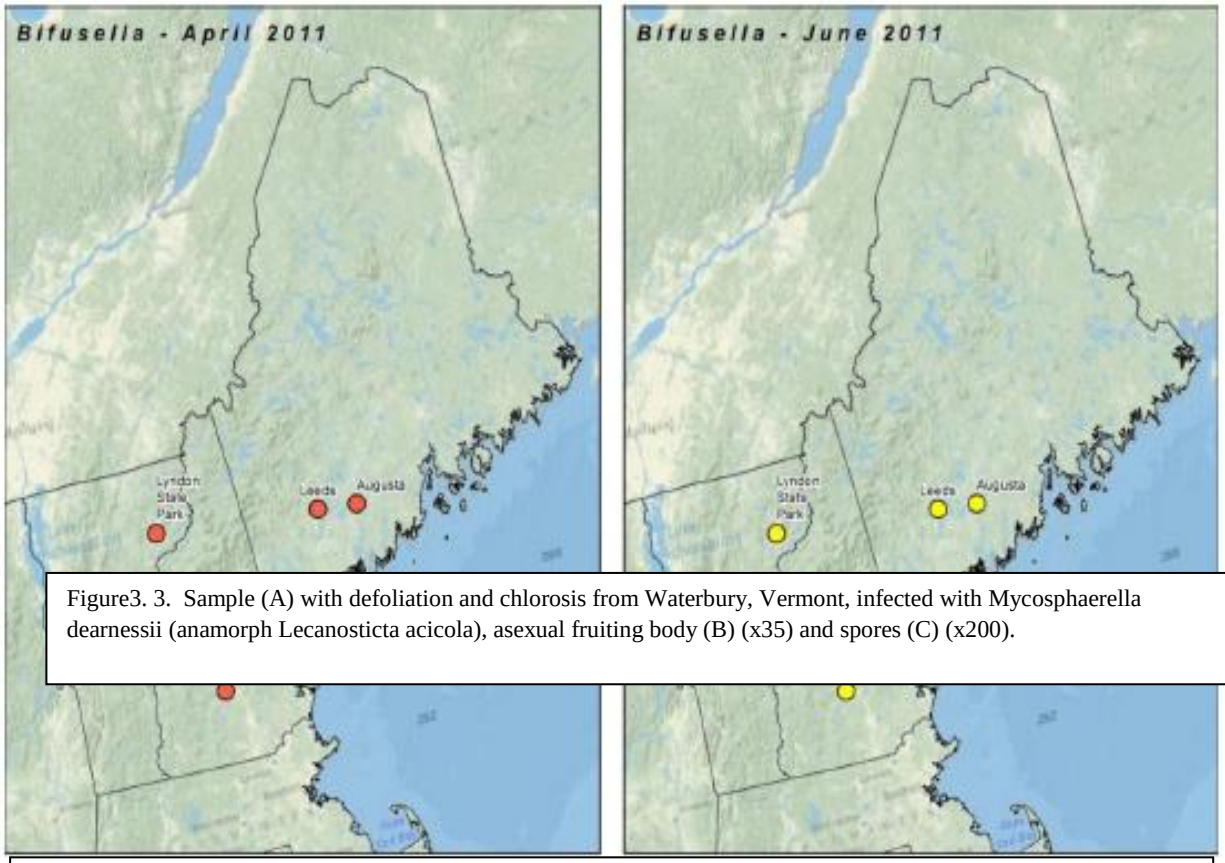

Figure3. 3. Sample (A) with defoliation and chlorosis from Waterbury, Vermont, infected with Mycosphaerella dearnessii (anamorph Lecanosticta acicola), asexual fruiting body (B) (x35) and spores (C) (x200).

Figure 3.4: Location of sites with Bifusella linearis. Infected white pine samples were collected in April and June of 2011.

smaller fruiting bodies (Figure 3.3B) and brown, banana-shaped spores* (Figure 3.3C) (Jankovsky et al. 2009, Jurc and Jurc 2010). Several other fungi were found fruiting on needles

*Ascospores: A sexual spore produced in a sac-like structure.
*Spores: Reproductive structures of fungi and some other organisms, containing one or more cells, similar to a seed for a plant.

but these fungi were not associated with needle blight or needle cast symptoms and appeared to be secondary invaders.

Diagnostic *B. linearis* fruiting bodies were present in samples collected in April and June from the same five sites (Figure 3.4). Similarly, *C. banfieldii* fruiting bodies were observed in samples collected in April and June from the same three sites . Both these needle cast fungi produce sexual fruiting structures that take a year to develop. In contrast, *M. dearnessii* was only found fruiting on four sites in April; however by June it was fruiting in samples from ten sites. Unlike the needle cast fungi, *M. dearnessii* produces asexual fruiting structures that result in more than one disease cycle though the growing season.

Samples were disease free from only one site, Clough State Park, which is in New Hampshire. *Mycosphaerella dearnesii* was the most widely distributed fungus as it was present in most sites alone or co-occurring with the needle cast fungi. All three fungi were present in one tree at one site, Lyndon State Park in Vermont.

In April, fruiting structures of all three fungi were found in less than 20% of the trees sampled (Figure 3.5). By June, 48% of the trees yielded samples with signs of *M. dearnessii*. Between April and June the proportion of trees with symptoms of chlorosis and defoliation increased from 25% to 50% and 0% to 45%, respectively (Figure 3.5). In April 68% of the trees yielded

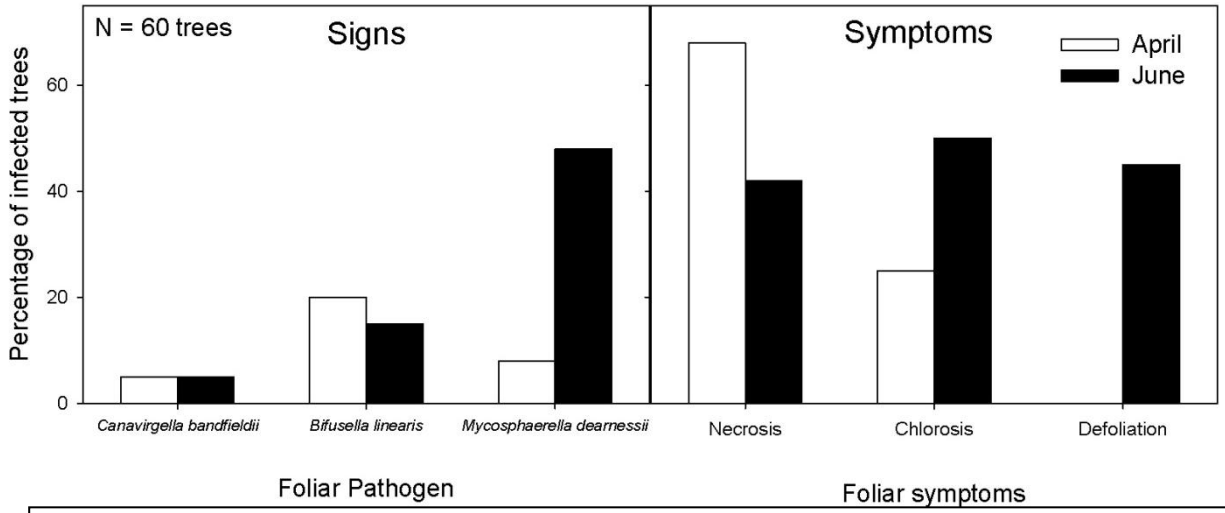

Figure 3.5. Frequency of foliar disease signs and symptoms on infected trees.

samples with necrotic needles, although the necrosis was limited to less than one third of the needle. In contrast, the chlorosis of samples collected in June exceeded more than two thirds of the needle. It is possible that the proportion of necrotic needles decreased due to the needle drop in June.

Conclusions

At one site all three pathogenic fungi were present and multiple pathogens were found on the same tree at another location. *Mycosphaerella dearnesii* was the most frequently observed, widely distributed pathogen, and most constantly associated with chlorosis and defoliation in late June. It is likely that wet spring weather, favorable to disease development, during several consecutive years has led to an outbreak of foliar diseases. Trees in a variety of sites across northern New England were affected. Thus, the observed foliar damage is probably not site related.

Prior to this outbreak, damage caused by *Canavirgella* needle blight was reported on less than 0.1% of eastern white pines (Merrill *et al.* 1996). Similarly, although brown spot needle blight is common on 2 and 3 needle pines, it typically is not associated with white pine. In addition, *Bifusella* needle cast is rarely reported in northeastern North America; however, this disease may have been misdiagnosed or overlooked in the past. The consequence of repeated defoliations by these pathogens is unknown. These fungi are expected to continue to cause damage in years following unusually wet springs. Thinning damaged trees during these conditions is not recommended as these trees are already stressed by repeated defoliations.

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