

Forest Health Cooperative Annual Meeting - FY2021

Pine Needle Study Update

Presented By

Debit Datta, MS Student

Committee Members

Dr. Lori G. Eckhardt, School of Forestry and Wildlife Sciences, Auburn University

Dr. Scott A. Enebak, School of Forestry and Wildlife Sciences, Auburn University

Dr. Jeffrey J. Coleman, Department of Entomology and Plant Pathology, Auburn University

Motivation for the Study

Loblolly pine in the southeastern U.S.

- Important timber species
- Periodic defoliation and mortality
- Thousands of hectares infected
- Increasing annual reports

Disease symptoms

- Yellowing, browning and defoliation
- Completely empty tree crown
- Current year needles infected

Support for the study

- No evidence of exposure to CFC's and SO_2
- Nutrient deficiencies



Introduction

Pine forests and industrial wood plantations in the southeastern U.S.

- More than \$11 billion
- Sustainability and profitability
- Non-native insect pests and pathogens
- Movement of native forest pests
- Damage approximately \$4.2 billion annually

Introduction

Needle diseases

- Temperature and moisture
- Reproduction, fungal spread and infection
- Fungal richness and abundance

Climatic stressors

- Increasing temperature and precipitation
- Changing interactions
- Changes in disease impacts

For example,

- *Phytophthora pluvialis* in Chile
- *Phytophthora pinifolia* in New Zealand

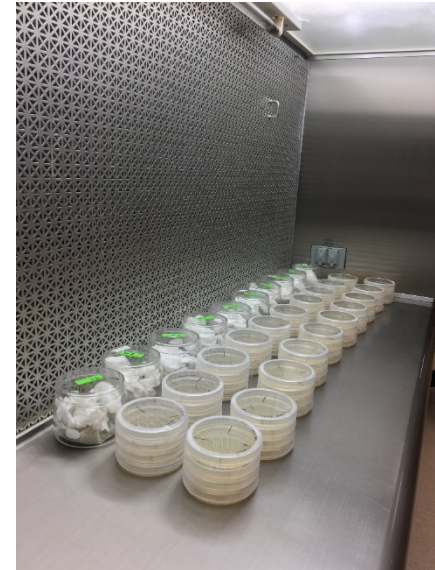
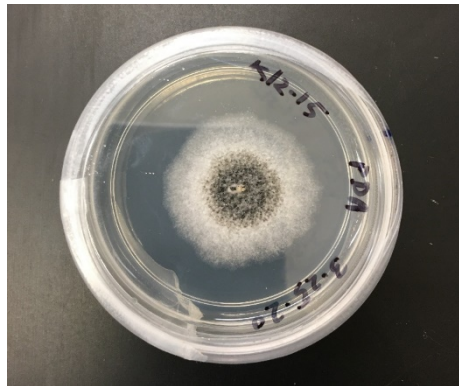


Phytophthora needle disease in Chile



Phytophthora needle disease in New Zealand

Isolation and Identifying of Fungi associated with Loblolly Pine Needle Damage and Mortality in the Southeastern U.S.



Introduction

Loblolly pine defoliation and tree mortality

- First contacted the FHDL in 2013
- Successive defoliation
- Needle mortality and mature tree death
- Chlorosis, necrosis and premature defoliation
- Spread to adjacent areas
- Widespread mortality by summer 2018
- Disease patterns were ambiguous
- Not all adjacent loblolly stands are infected
- More than 25,000 hectares were reported

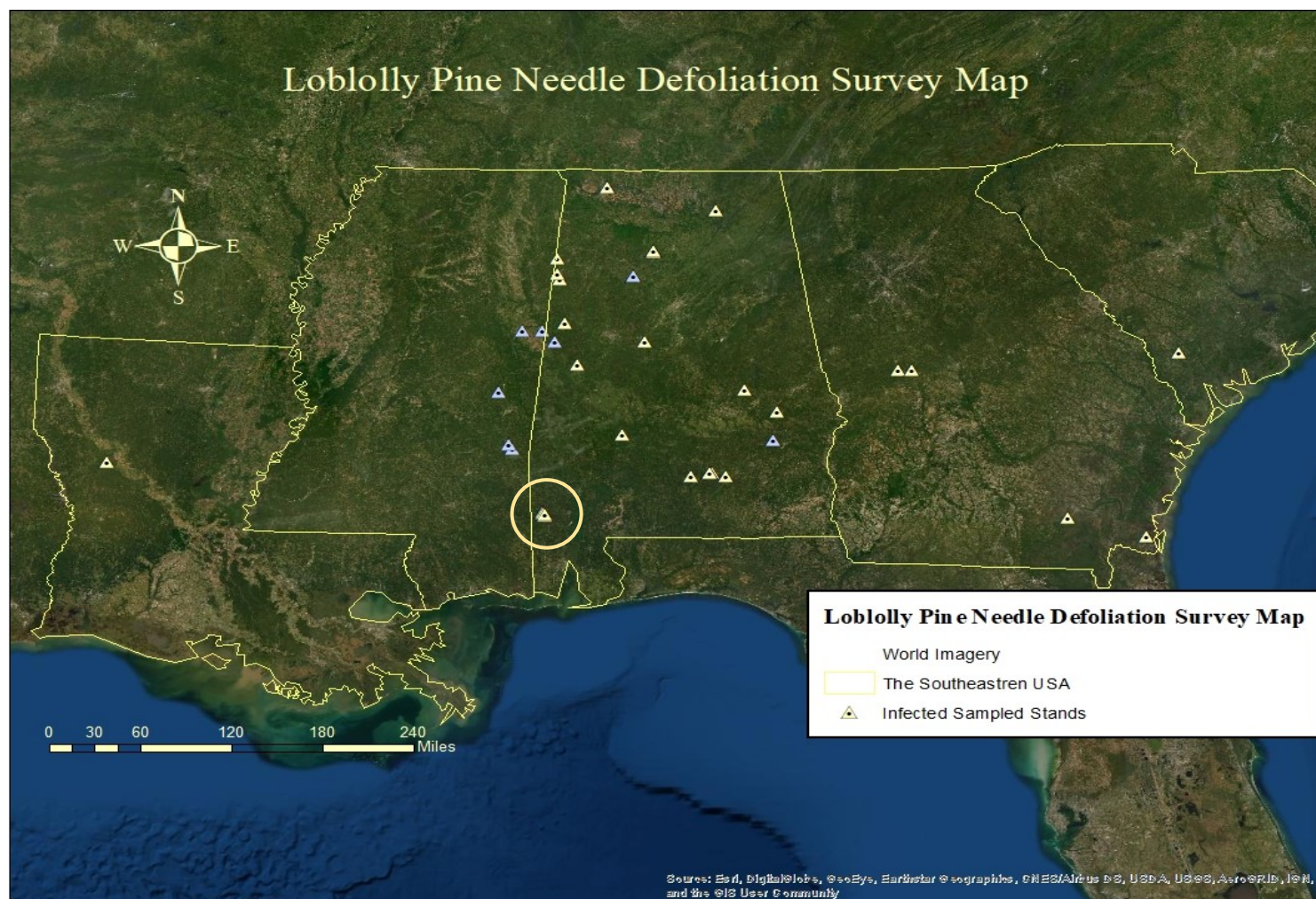


Objectives

To isolate and identify the causal agent(s) associated with loblolly pine defoliation and mortality in the southeastern U.S.

To identify morphological and genetic diversity of fungi associated with loblolly pine defoliation and mortality in the southeastern U.S.

Study Area



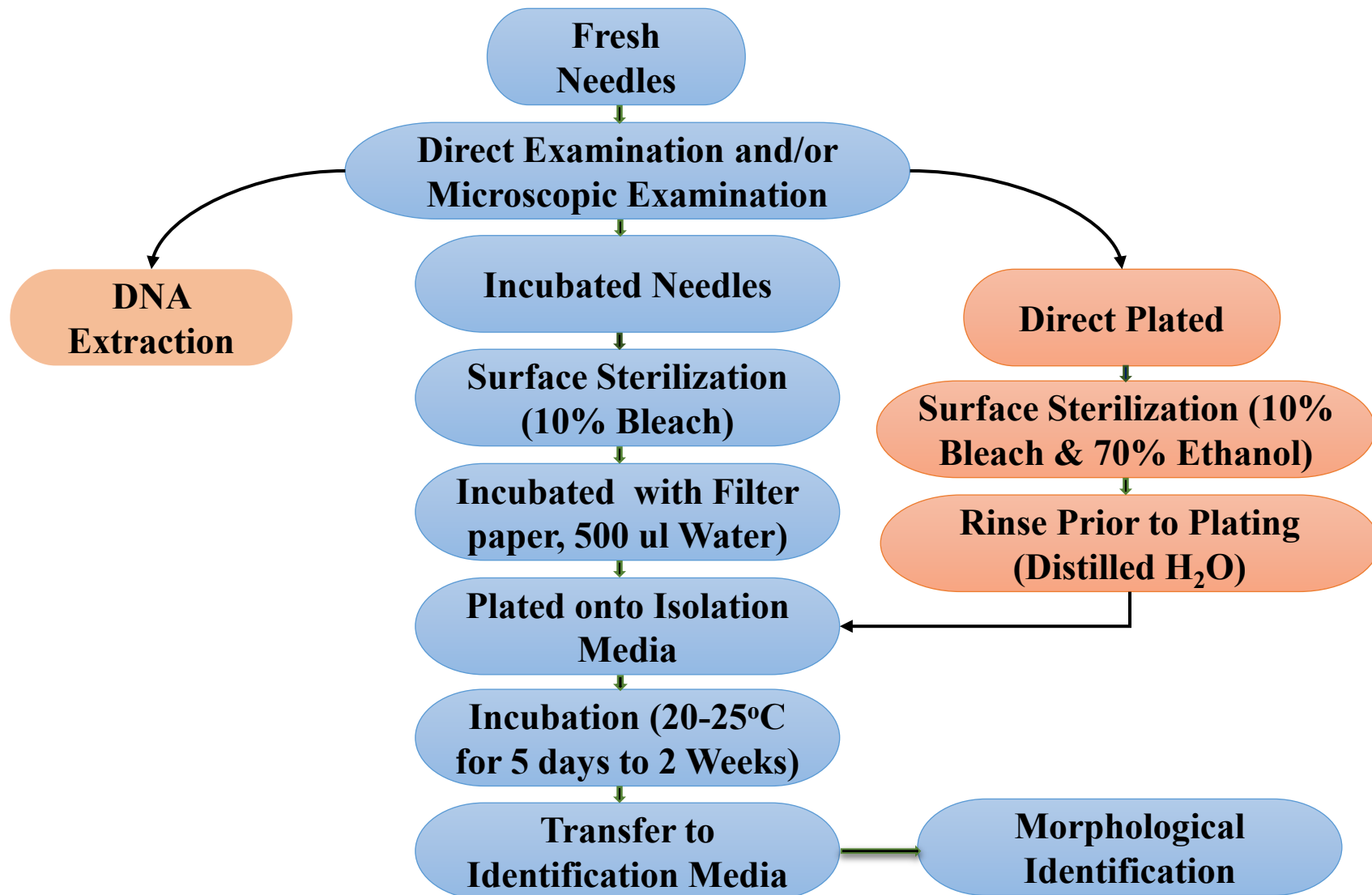
Map showing permanent and surveyed stands in South Carolina, Georgia, Alabama, Mississippi, and Louisiana from 2019 to 2021 from surveys and the permanent study area

Study Area

Sporulation period of five needle pathogens

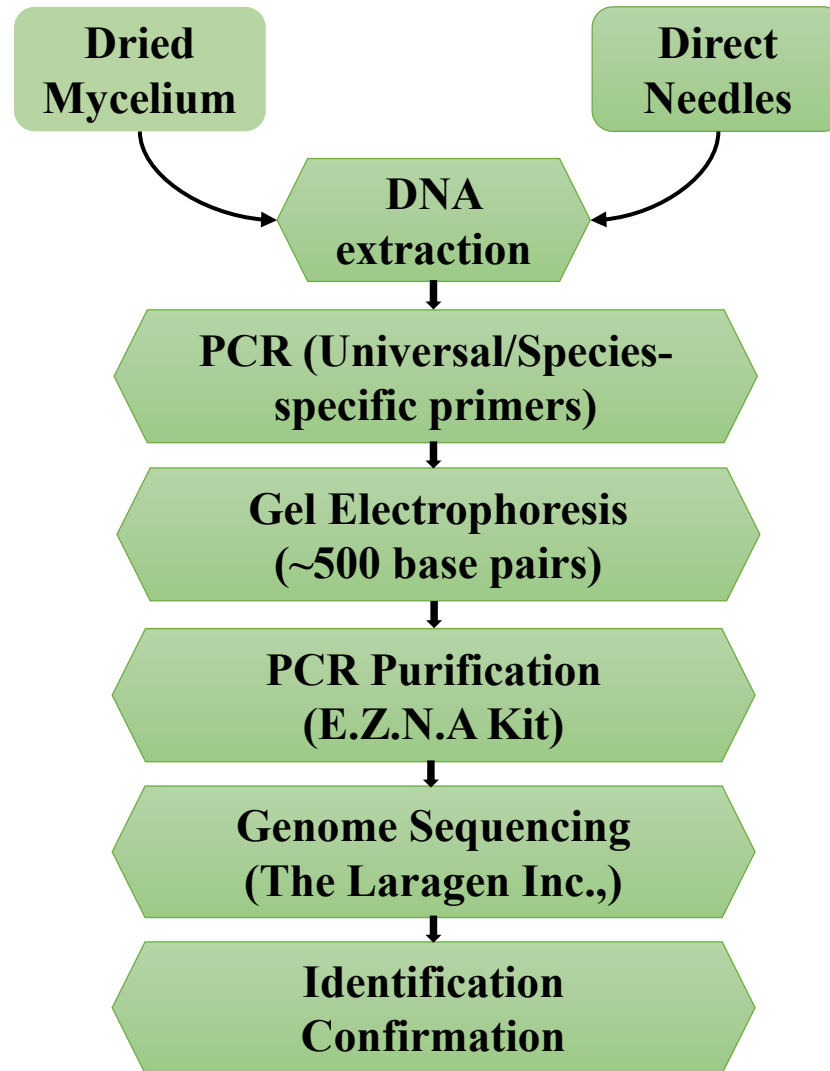
Needle Disease	Causal Agent	Host	Sporulation Period
Phytophthora needle blight	<i>Phytophthora</i> spp.	Pines, Oak, Douglas fir,	May to November
Brown spot needle blight	<i>Lecanosticta acicola</i>	Over 53 different pine species	March to October
Dothistroma needle blight	<i>D. septosporum</i> <i>D. Pini</i>	82 Pinus taxa	Late summer to fall (August-October)
Lophodermium needle cast	<i>L. seditiosum</i> <i>L. spp.</i>	Scots, Austrian and Red pine	Late summer (August-September)
Coleosporium needle rust	<i>Coleosporium</i> spp.	2 or 3-needled Pines	Spring (March-May)

Materials & Methods



Cultural methods for fungi identification

Materials & Methods



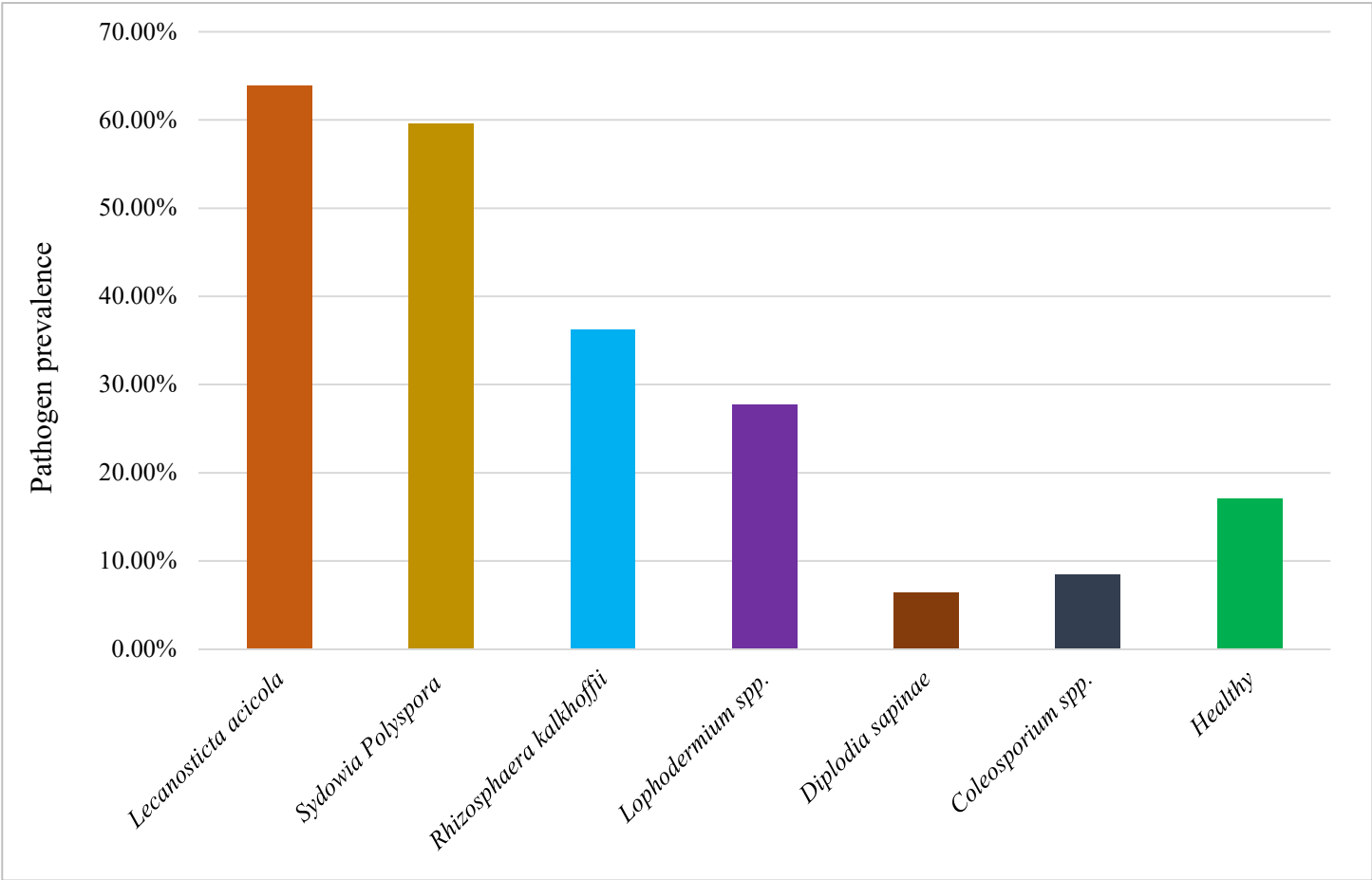
Molecular methods for fungi identification

Materials & Methods

Phylogenetic analysis

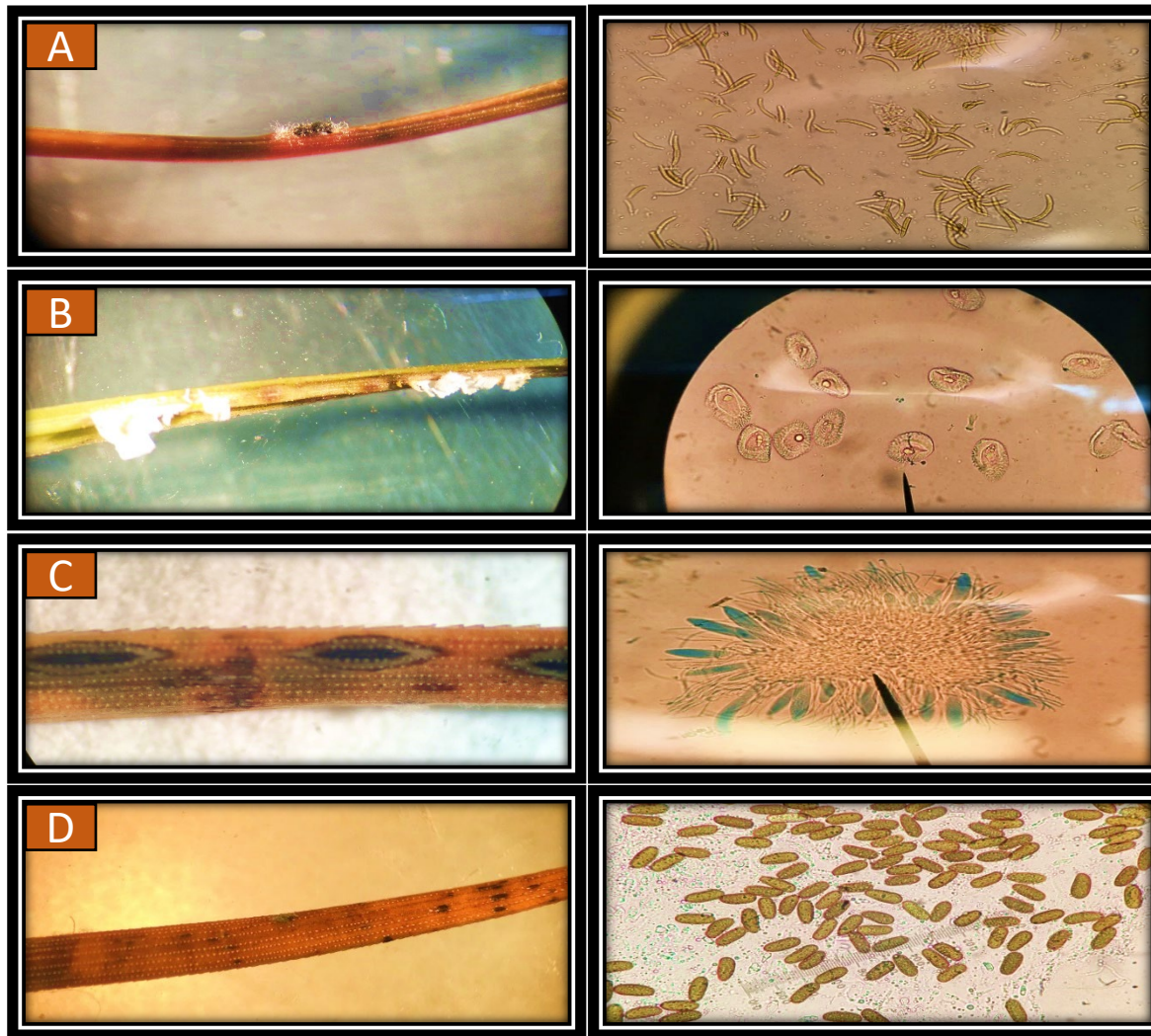
- Laragen Inc., Biotechnology for sequencing
- Raw sequences were edited and adjusted
- Bioedit software and deposited in GenBank and BankIT
- MEGA version 4.0 software
- Alignment were completed
- Neighbor Joining (NJ) and Maximum Likelihood (ML) methods
- 1000 bootstrap replications were performed

Results



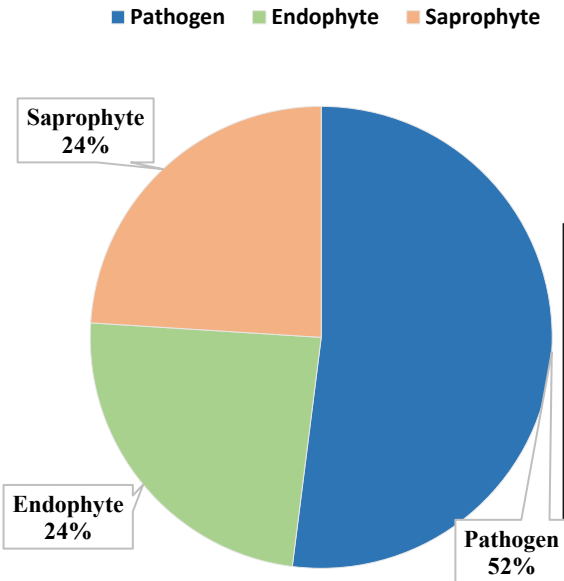
Pathogen prevalence of *Lecanosticta acicola*, *Sydowia polyspora*, *Rhizosphaera kalkhoffii*, *Lophodermium spp.*, *D. sapinae*, *Coleosporium spp.* and healthy sites

Results

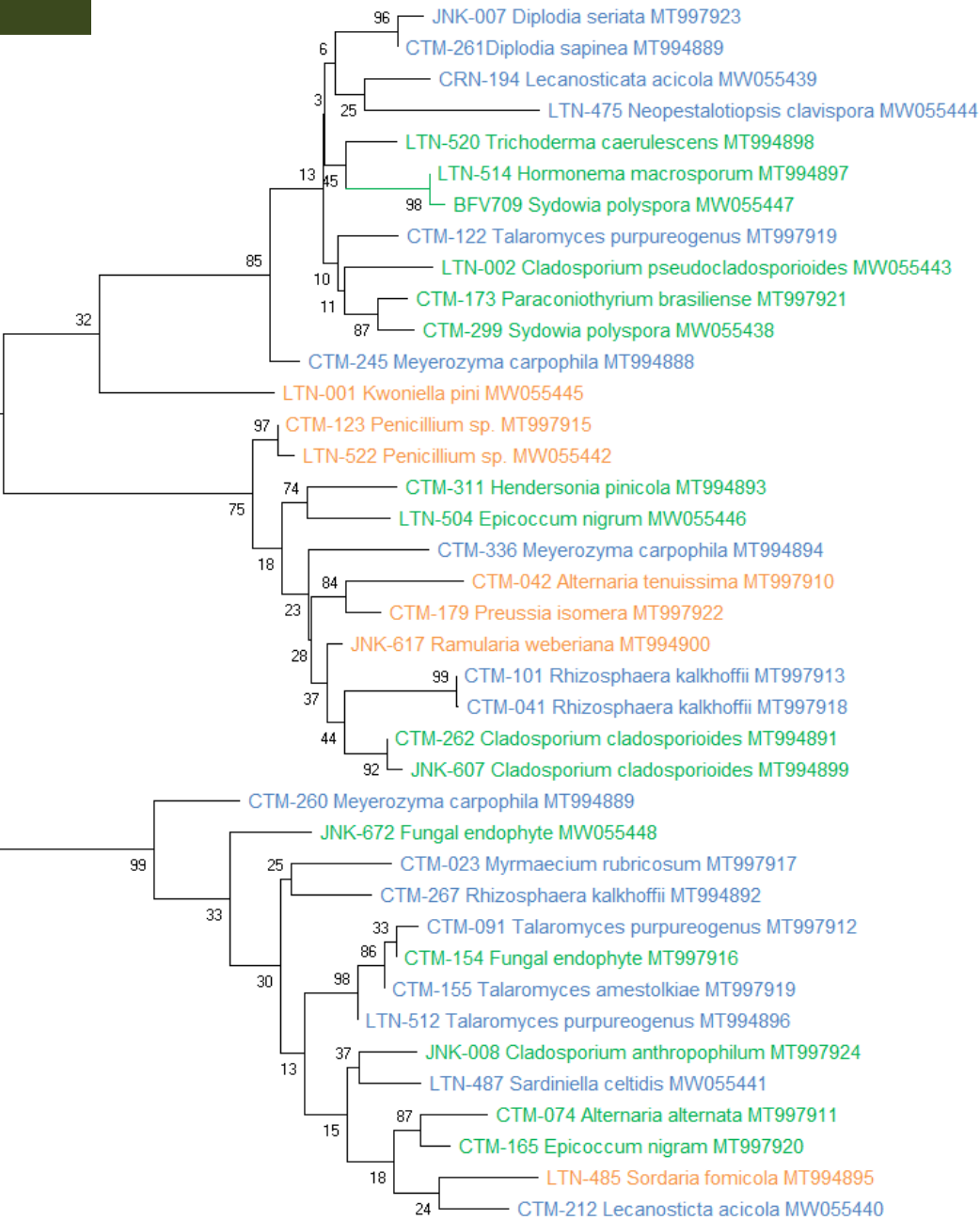
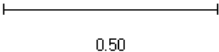


Disease symptoms and reproductive structures of (A) *L. acicola* (B) *Coleosporium* sp. (C) *Lophodermium* sp. & (D) *D. sapinea* on loblolly pine

Results



Neighbor-joining phylogenetic tree based on ITS1 and ITS4 sequences of fungi recovered from loblolly pine needles in the study



Results

Maximum likelihood
phylogenetic tree representing *L.*
acicola and its associated
lineages



0.050

- 62 CTM277 *Lecanosticta acicola* MW030672
- 62 CTM295 *Lecanosticta acicola* MW030675
- 62 LTN-DN-003 *Lecanosticta acicola* MW030671
- 62 LTN-DN-002 *Lecanosticta acicola* MW030670
- 62 LTN-DN-001 *Lecanosticta acicola* MW030669
- 61 CTM-DN-56 *Lecanosticta acicola* MW030668
- 61 CTM-DN-54 *Lecanosticta acicola* MW030667
- 61 CTM-DN-53 *Lecanosticta acicola* MW030666
- 61 CTM-DN-52 *Lecanosticta acicola* MW030665
- 61 LTN018 *Lecanosticta acicola* MW030663
- 63 LTN013 *Lecanosticta acicola* MW030662
- LTN002 *Lecanosticta acicola* MW030661
- CTM631031 *Lecanosticta acicola* MW030660
- CTM217 *Lecanosticta acicola* MW030659
- CTM216 *Lecanosticta acicola* MW030658
- CTM215 *Lecanosticta acicola* MW030657
- CTM214 *Lecanosticta acicola* MW030656
- CTM213 *Lecanosticta acicola* MW030655
- CTM211 *Lecanosticta acicola* MW030654
- Lecanosticta acicola France KT737239**
- Lecanosticta acicola Spain KC013002**
- CTM-DN-51 *Lecanosticta acicola* MW030664
- CTM283 *Lecanosticta acicola* MW030673
- CTM292 *Lecanosticta acicola* MW030674
- 63 CTM296 *Lecanosticta acicola* MW030676
- 63 CTM297 *Lecanosticta acicola* MW030677
- 84 CTM333 *Lecanosticta acicola* MW030678
- Lecanosticta aciicola Northern United States KT007127**
- 100 CTM631031 *Lecanosticta acicola*
- 100 CTM217 *Lecanosticta acicola*

Results

Brown spot needle blight (BSNB) fungus, *Lecanosticta acicola*

- Predominant pathogen in the southeastern U.S.
- Three distinct lineages
- Asexual state recovered (Alabama and Mississippi)
- Black to olive green mucilaginous conidiomata
- Fusiform to cylindrical with straight to curved conidia
- Septation 2-4 with truncate base and rounded apex
- Positive for a single mating type loci, MAT-1-1

Discussion

Brown spot needle blight emergence and spread

- Changing climatic conditions
- Site conditions
- Monoculture
- Genetic factors
- Edaphic Factors

Conclusions

First report of *Lecanosticta acicola* associated with loblolly pine defoliation and tree mortality

- Central, Southern, Northern, and Southwestern counties
- Less genetically diverse

Sydowia polyspora

- Endophytic to pathogenic
- Disease severity in the infected stands

Genetic and environmental factors

- Further investigation

Acknowledgements

Committee members

Dr. Lori Eckhardt
Dr. Scott Enebak
Dr. Jeffrey Coleman

&

Dr. Brian Via
Dr. Beatriz Vega
Dr. Mary Anne Sword
Dr. Emily Carter



Forest Health State
Cooperative

Lab managers

Jessica Baldwin
Tina Ciaramitaro
Angelica Baker

Needle Shooters

Dr. Lori Eckhardt
Kris Bradley
D.R. Stallworth
John Gunter
Nathan Baker
Micah Walker
Forrest Fay
Mark Estrada

Undergraduates

Ashton Newman
Mark Estrada
Abigail Beech



Graduate Students

Sylvester Menanyih
John Mensah
Jessica Ahl

Facilities

Forest Health Dynamics Lab
Molecular Mycology Lab
USDA Forest Service Lab
Waypoint Analytical Lab
Forest Products Lab



