Preliminary Report on the Ecology of Armillaria in the East Cascades of Oregon

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ABSTRACT

As part of a larger effort to assess the distribution and ecology of *Armillaria* species throughout western North America, we present preliminary survey results for the East Cascades of Oregon. Surveys and sampling were conducted on 260 0.04-ha plots, which were randomly located across diverse environments and geographic locations. Using DNA-based techniques for the identification of *Armillaria* spp., we identified three genetically-distinct species groups that comprised the ca. 450+ Armillaria samples. The association of *Armillaria* species groups with habitat is summarized based on detailed vegetation data. When we understand habitats in which *Armillaria* species can potentially occur, forest management prescriptions can be developed to improve forest health at the stand level by reducing impacts of Armillaria root disease. These data also provide critical baseline information for evaluating larger-scale impacts in forest ecosystems as trees are subjected to climate-change induced stress.

INTRODUCTION

The impacts of Armillaria on forested ecosystems are expected to generally increase under climate change (Sturrock et al. 2011, Kliejunas et al. 2009), but methods are needed to predict impacts at local and regional levels. Techniques are available to estimate climate data across the landscape. Climate data coupled with powerful statistical methods, such as maximum entropy (Maxent), can determine probable suitable climate space and potential distribution for a species, even with minimal presence data (Phillips et al. 2006, Pearson et al. 2007). Predicted potential distributions of both pathogens and host species under current climatic conditions can then used to predict potential future distributions, based on various climate-change scenarios (Rehfeldt et al. 2006, Klopfenstein et al. 2009).

Previous studies of the ecology of Armillaria root disease in the inland northwestern U.S.A. and Utah demonstrate that Armillaria distribution can be characterized with environmental parameters, exemplified by plant species coverages as indicators of environmental conditions such as climate (e.g., temperature and moisture) (McDonald et al. 1987, McDonald 1998). This method is well suited for predicting Armillaria presence at the stand level, which can perhaps be adapted for assessment at larger scales. One objective of the current study is to determine the relationship of plant coverages (vegetation subseries/potential vegetation groups) to the distribution of *Armillaria* species in the East Cascades of Oregon. A larger goal of this study is to determine the potential influence of climate and climate change on *Armillaria* spp. distribution, as reflected by plant coverages.

METHODS

Two hundred and sixty 0.04-ha plots (FY2007-FY2010) were established across climatically diverse sites in Oregon's East Cascades. (e.g., Warm Springs Indian Reservation, Fremont-Winema NF, Deschutes NF, Mt Hood NF, and Ochoco NF). The majority of plots were selected based on climatic diversity and spatial separation across gridded sections (ca. every 7'30" N and 1° 52'30" W). For each tree and shrub species present, primary root systems and butts of three individuals were thoroughly examined, and samples (i.e., rhizomorphs, mycelial fans, rotten wood) of *Armillaria* spp. were collected along with precise location. Isolates were established in culture then identified with DNA-based techniques (Kim et al. 2006).

In: Fairweather, M. Comp. 2011. Proceedings of the 58th Annual Western International Forest Disease Work Conference; 2010 October 4-8; Valemount, BC. US Forest Service, AZ Zone Forest Health, Flagstaff, AZ.

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Figure 1—Cedar Hemlock/Moist Herb potential vegetation group, a highly suitable site for Armillaria.

The plant coverages on each plot were classified into vegetation subseries/potential vegetation groups. Each subseries/group represents several ecologically similar plant associations/habitat types based on the percent coverage of key indicator plants (McDonald 1998).

RESULTS

Armillaria spp. were found on 146 plots (56.1 percent) of the 260 plots surveyed. *Armillaria solidipes* (= *A. ostoyae*) was found on 33 plots (12.7 percent), North American Biological Species (NABS) III-V-VII (*A. calvescens-A. sinapina-A. gallica* complex) was found on 73 plots (28.1 percent), and NABS X (including NABS X hybrids with NABS III/V/VII) was found on 67 plots (25.8 percent).

KEY FINDINGS

(1) *Armillaria* spp. are common in the East Cascades of Oregon, occurring on 56 percent of 260 sampled plots. Armillaria incidence increases to 73 percent, when 95 of the driest, wettest, warmest, and coolest plots are excluded (table 1).

(2) Among the three *Armillaria* species groups identified, NABS X group was collected from the greatest range of climates as inferred from vegetation subseries. *Armillaria solidipes* group was rarely found on the warmest sites and the NABS III-V-VII (*A. calvescens-A. sinapina-A. gallica*) complex was rarely found on the coolest sites (tables 2-4).

DISCUSSION

Ecological assessments of Armillaria are critical to address forest management needs. Habitat-based predictions of Armillaria distributions are useful for stand-level Armillaria risk assessments, such as the Armillaria Response Tool (ART) (McDonald et al. 2005). These stand-level indicators can be combined with climate-based predictions of Armillaria distributions at a much larger scale (Klopfenstein et al. 2009), which can be adapted for future predictions under various climate-change scenarios. Future predictions of both pathogens and hosts can provide information for National Insect and Disease Risk Maps. Climate-based predictions will continue to improve as higher resolution grids are developed that include influences of slope, aspect, and soil types. In addition, molecular techniques will also continue to improve species identification and allow classification of genetic diversity at the subspecies level, which will allow further refinements in predictions of environmental influences (Kim et al. 2006, Hanna et al. 2007, Ross-Davis et al. this volume).

Table 1—Occurrence of all *Armillaria* spp. in the East Cascades of Oregon.

	Dry Grass	Dry Shrub	Dry Herb	Moist Herb	Wet Herb	Wet Forb	West Shrub
Pinyon Juniper	0/1						
Ponderosa pine	4/42	3/15	0/0				
Douglas-fir	0/0	0/3	5/7	0/0			
Cool pine	0/5	3/3	1/1	0/0			
Cedar Hemlock			0/1	2/2	0/0	0/0	0/0
Cool fir	0/0	72/105	35/46	7/7	0/0	0/0	
Cold fir	1/2	5/9	6/7	2/3	0/1	0/0	0/0

Table 2—Occurrence of *Armillaria solidipes* in the East Cascades of Oregon.

	Dry Grass	Dry Shrub	Dry Herb	Moist Herb	Wet Herb	Wet Forb	West Shrub
Pinyon Juniper	0/1						
Ponderosa pine	1/42	0/15	0/0				
Douglas-fir	0/0	0/3	0/7	0/0			
Cool pine	0/5	1/3	1/1	0/0			
Cedar Hemlock			0/1	1/2	0/0	0/0	0/0
Cool fir	0/0	10/105	12/46	2/7	0/0	0/0	
Cold fir	1/2	3/9	1/7	0/3	0/1	0/0	0/0

Table 3—Occurrence of North American Biological Species (NABS) III-V-VII (*Armillaria calvescens*, *A. sinapina*, *A. gallica*) in the East Cascades of Oregon.

	Dry Grass	Dry Shrub	Dry Herb	Moist Herb	Wet Herb	Wet Forb	West Shrub
Pinyon Juniper	0/1						
Ponderosa pine	1/42	2/15	0/0				
Douglas-fir	0/0	0/3	4/7	0/0			
Cool pine	0/5	0/3	0/1	0/0			
Cedar Hemlock			0/1	1/2	0/0	0/0	0/0
Cool fir	0/0	44/105	19/46	1/7	0/0	0/0	
Cold fir	0/2	0/9	1/7	0/3	0/1	0/0	0/0

Table 4—Occurrence of North American Biological Species (NABS) X or hybrids of NABS X with NABS III-V-VII (*Armillaria calvescens*, *A. sinapina*, *A. gallica*).

	Dry Grass	Dry Shrub	Dry Herb	Moist Herb	Wet Herb	Wet Forb	West Shrub
Pinyon Juniper	0/1						
Ponderosa pine	2/42	1/15	0/0				
Douglas-fir	0/0	0/3	1/7	0/0			
Cool pine	0/5	2/3	0/1	0/0			
Cedar Hemlock			0/1	1/2	0/0	0/0	0/0
Cool fir	0/0	29/105	16/46	6/7	0/0	0/0	
Cold fir	0/2	2/9	5/7	2/3	0/1	0/0	0/0

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