

Hemlock mortality after hemlock woolly adelgid attack: Role of *Armillaria*

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Significant mortality of eastern hemlock, *Tsuga canadensis*, associated with the hemlock woolly adelgid, *Adelges tsugae*, (HWA), has occurred in Connecticut forests since a recent introduction of the insect in 1985. Mortality associated with HWA has also occurred recently in the Delaware Water Gap (PA and NJ) and the Shenandoah National Park (NC). Infestation and crown damage usually begins in the lower portions of the crown and moves upward causing decline and eventually resulting in death several years after the initial infestation. Such stress-initiated mortality is consistent with dieback and decline disease etiology which usually involves secondary disease organisms, insects as well as fungi. The most prominent secondary or stress-induced pathogen in decline diseases is the *Armillaria* root disease fungus. A preliminary study was conducted to assess its presence and significance on hemlocks stressed by HWA infestation and defoliation. The status of *Armillaria* on three trees in each of three health categories, older dead, recent dead, and poor crown vitality, was evaluated in five randomly selected plots in Devil's Hopyard State Park in southcentral CT near Millington. Root collars and buttress roots were excavated and evaluated for colonization by *Armillaria*. Trees were also examined for evidence of Hemlock borer attack by peeling a 1/2 m wide band of bark

from the main stem at 1 to 1.5 m above ground and estimating the abundance of borer galleries. All older dead trees were extensively decayed and had rhizomorphs of *Armillaria* present on and around them. But their deterioration was such that it could not be determined if *Armillaria* had colonized them prior to death. All recently dead trees (crowns still intact with fine twigs and dead needles) were colonized by the fungus heavily at the root collar and on major buttress roots. Only four of the fifteen trees with poor to very poor crowns (> 75% of crown without needles, some living branches or portions in the upper crown) were colonized by *Armillaria*. Three trees were colonized at the root collar and buttress roots, the fourth only on the buttress roots. Colonization on these trees was not extensive suggesting that it had occurred recently. Additional trees with greater than 50 percent living crown or with full living crowns were excavated in these plots and revealed that no colonization had occurred at the root collar or on the buttress roots excavated to a distance of 1.5-2 m. These results suggest that *Armillaria* is acting as a roguer of weakened trees, colonizing them very late in the decline process after significant crown loss had already occurred, and accelerating the rate of death. It is doubtful that these trees would have recovered to any great extent even in the absence of the fungus, but they probably would have lingered on in the canopy for several more years. The pattern for hemlock borer attack was quite similar to that for *Armillaria*.

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