ADAPTATION DURING NORTHERN RANGE EXPANSION IN THE ELONGATE HEMLOCK SCALE *FIORINIA EXTERNA*

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ABSTRACT

The elongate hemlock scale *Fiorinia externa,* (EHS) an invasive pest from Japan, was first found in the eastern United States in 1908. It feeds on a variety of plants, most notably the eastern hemlock *Tsuga canadensis*, and has been spreading slowly into southern New England. In order to examine the northern spread of EHS and the possibility of local adaptation in this insect, we first performed a field survey in which we resurveyed 141 hemlock stands (first surveyed in 1997-98; see Orwig et al. 2002 for details) in a 7500 km^2 transect from southern Connecticut to northern Massachusetts. In each stand, we measured adelgid and EHS abundance for 50 trees on a 0-3 scale (0=no EHS, 1=1-10 EHS/m branch, 2=10-100 m/branch, 3=>100/m branch). We also assessed overall hemlock canopy vigor in each stand. We found that EHS continues spreading north and east into New England, and has sharply increased in both density and abundance between 1997-98 and 2005. When latitude and hemlock woolly adelgid density are taken into account, however, EHS density did not correlate with hemlock canopy vigor at the stand level. In a separate experiment designed to assess whether northern populations of EHS show greater cold tolerance than do southern populations, we collected EHS-infested hemlock foliage from four Maryland sites (southern population) and four Connecticut sites (northern population) in March 2004. We then used a freezer to expose EHS-infested foliage to one of seven treatments: 0, 6, 12, 18, 24, 30, or 36 hours at -15° C. One week after the treatments were applied, we counted the percent of surviving scales (up to 100 scales/branch) per treatment per site per location (MD or CT). In the absence of cold shock, southern EHS populations had higher survival than did northern populations. Survival of southern EHS decreased significantly as the length of the cold shock treatment increased; in contrast, survival of northern EHS populations was unaffected by up to 36 hours at -15° C. Our finding that northern EHS populations are more cold-tolerant than southern populations suggests that local adaptation has facilitated this species' invasion.