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Southern Pine Beetle in Northeastern U.S.

Southern pine beetle (*Dendroctonus frontalis* –SPB-) and its associated fungal pathogens (see below) have been recently found in Connecticut. Historically, the range of SPB extended throughout the southern and southeastern United States, north to New Jersey, Delaware, Pennsylvania and Ohio. However, it appears that a warming climate has allowed this insect to expand its range into northern areas where beetles had previously been precluded by cold temperatures. Adults can survive temperatures down to 10˚F and larvae to temperatures below 0˚F. The expansion of these beetles into northern areas is not surprising since our summers are becoming dryer and hotter and winters warmer. The beetles recently expanded from New Jersey to Long Island, NY in 2014 infesting approximately 3,500 acres and further north into Connecticut in 2015 (Fig. 1).

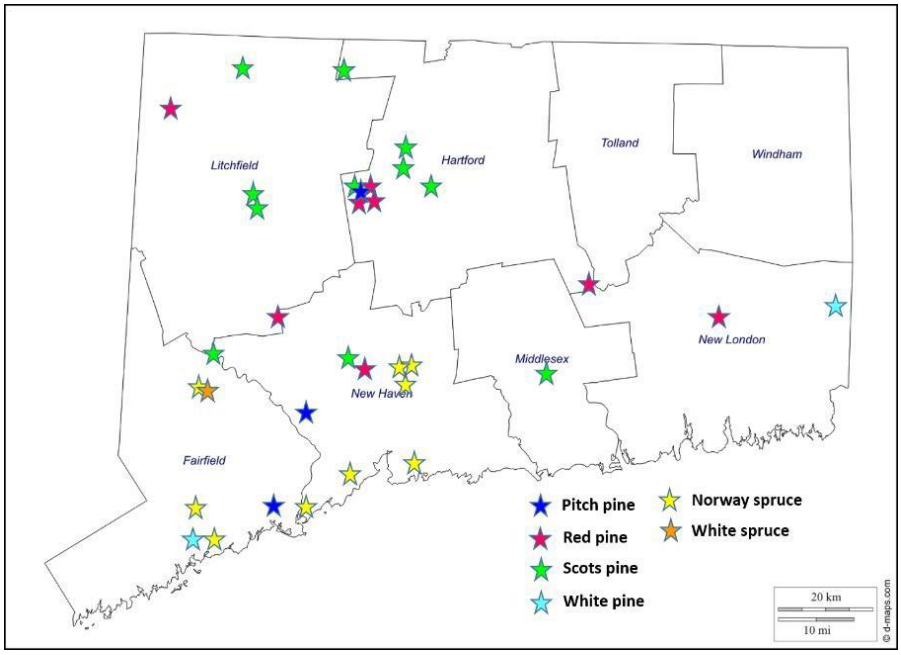

Figure 1. Southern pine beetle distribution for Connecticut in 2015. Stars denote either single or several trees of pitch, red, scots, and white pines, and Norway and white spruces where we found SPB.

Interaction hosts, beetle and fungus

Southern pine beetle is an aggressive bark beetle and is one of the most important damaging agents of pine forests. The initial attack is done by females who are attracted to volatiles released by the tree or by olfactory pheromones released by other beetles. These beetles are never alone, they carry a complex of other organisms such as mites, several fungi and bacteria. The beetle's success depends on both the physiological status of the hosts and beetle population. This species can thrive in suppressed, old and/or highly stressed pine trees at low beetle populations (endemic); colonizing alongside other secondary bark beetle species. The potential for these beetles to attack large-diameter healthy trees is more likely when beetle populations are high (epidemic). If climatic conditions remain favorable for beetle survival, individuals may spread rapidly across the forest landscape.

During the outbreak phase, the population can range from thousands to millions of beetles in a single area where they occur as multiple local aggregations scattered through the forest. Each tree may contain beetles in one or more stages of development. The initial tree response to beetle attack consists of the release of a resin, composed primarily of terpenes (volatile aromatic molecules), that provide physical and chemical defenses to deter the beetles (Fig. 2). Despite the tree's response, female beetles can use resin terpenes as precursors for aggregation pheromone components that attract members of both sexes to the tree.

This aggregation pheromone facilitates a rapid increase in the beetle population, overwhelming the tree and decreasing its defense mechanisms.

Beetle habitat (feeding sites) on the tree is temporary because nutrients become mostly exhausted after one generation. Therefore, emerging adults must locate new host trees for feeding and reproduction purposes. During this migratory phase, these bark beetles often disperse in the absence of olfactory cues by other beetles, landing in nearby trees.

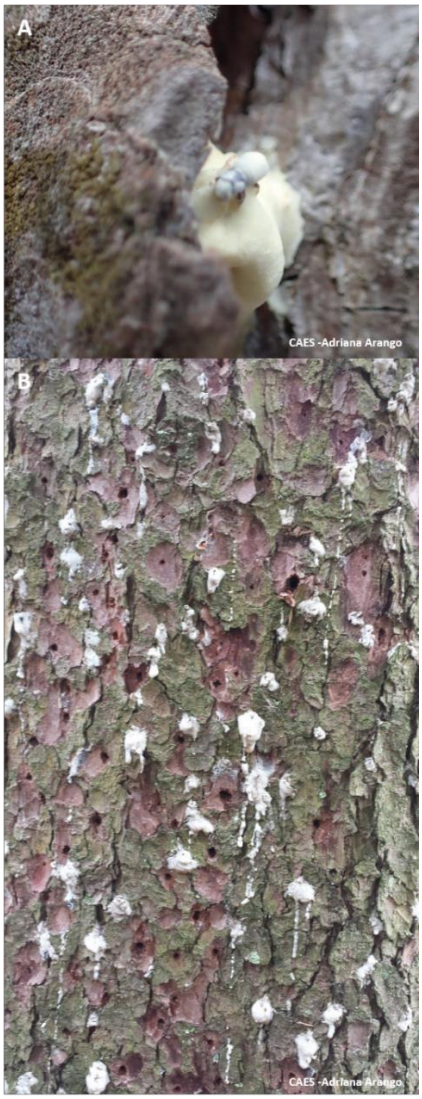

Figure 2. A. Adult beetle "pitched out" by tree produced resin. **B.** Visible resin along the tree trunk, and holes made by wood peckers in search of beetles.

Once the beetles overcome the tree defense responses and bore under the bark, they proceed to feed and reproduce on the phloem, introducing the complex of microorganisms (fungi and bacteria) and mites. As they advance into host tissue, beetles disseminate these microorganisms along with a pathogenic[1] fungus (blue stain). At the same time, female beetles deposit numerous eggs along the sides of the galleries (tunnels in the inner bark). Larva feed outward into the phloem; completing their development inside the tree (Fig. 3A-D). To increase the probability of beetle population survival, female beetles exit the host and attack a nearby tree to lay additional eggs. SPB infestations are initiated in spring by dispersing beetles and can last through the remainder of the year until temperatures become too low (about 10˚F). Beetles may have 3-6 generations per year, though 1-2 generations per year are most common in Connecticut. Parallel to beetle development, fungal growth occurs in the inner bark and sapwood ray cells causing desiccation, disrupting water transport, and eventually killing the tree (Fig. 3E-F).

Figure 3. A: Eggs laid in niches along the galleries, **B**. I, II and III larval stages, which feed in the cambium until they are grown and then excavate areas near the bark surface to pupate. **C**. Adult beetle. **D**. SPB galleries, larval chambers and development of blue stain along the inner bark. **E**. Blue stain in the late wood of red pine (*Pinus resinosa*). Photos: Adriana Arango

[1] Pathogenic - capable of causing disease

The complex of fungi introduced into the tree by SPB includes several species of *Ceratocystis, Ophiostoma* and *Entomocorticium* sp. with different degrees of pathogenicity. These fungi are ascomycetous carried on the exoskeleton of the SPB. Associated mites also play an important role in fungal abundance through dissemination of fungal ascospores[2] within the tree. These mites can influence the presence of blue stain in conifer trees. Furthermore, fungal development causes the tree to produce a diagnostic blue stain coloration within the inner bark. The rate at which sapwood obstruction extends radially, toward the tree center depends on both fungal abundance and pathogenicity. If fungal populations are high, a tree can be killed within 30 days without the influence of SPB colonization. Similarly, observations in SPB attacked white pine and Norway spruce, but unsuccessfully colonized by the beetle, declined in the presence of blue stain, raising the question of pathogenicity of this fungus without SPB presence. In other words, while SPB may not be able to successfully colonize these species, the beetles may be able to infect trees with a tree-killing fungus.

Changes in climatic conditions that have occurred over recent decades have likely affected the distribution and ecological dynamics of many invasive species, including SPB, allowing them to expand into New England. A shift toward warmer summers and winters is increasing the likelihood of SPB range expansion into areas previously deemed unsuitable for this beetle. Their arrival and dispersion has the potential to negatively impact several of our economically and ecologically important conifer species in both forest and urban areas (Fig 1.). Our ability to predict whether SPB will further expand is limited, but any information about SPB presence in the mentioned conifer species could lead us to better quantify and geographically identify where this beetle is moving in northeastern U.S.

For beetle identification and more information please contact the insect information office at CAES (http://www.ct.gov/caes/cwp/view.asp?a=2834&q=376958)
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[2] Ascospores – fungal spores formed within an ascus (membranous structure)