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EFFECT OF SOIL TYPE ON SUSCEPTIBILITY TO THE SUGAR MAPLE BORER AT THE RAYSTOWN FIELD STATION

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ABSTRACT

I examined the relationship between three soil types, Ernst Silt Loam, Blairton Silt Loam, and Berks Shaly Silt Loam to the number of sugar maple trees (*Acer saccharum)* infected with the sugar maple borer (*Glycobius specious*) at the Raystown Field Station. Total mean infection rates in Ernst (16.7%) and Blairton (6.5%) was greater than that in Berks (0%) (F = 2.35, df = 8, P = 0.117). I also found that the density of trees within each soil plot had no significant relationship to the frequency of trees infected (r^2 = 13%). Overall, Berks soil had the lowest relative density of sugar maples. My findings show that there is no correlation between infection rates to tree density, but that infection rate is slightly significantly different among soil types.

Keywords: Acer saccharum, Glycobius speciosus, *sugar maple borer, sugar maple, stress*

INTRODUCTION

Sugar maple (*Acer saccharum)* mortality has reached unusually high levels across northern Pennsylvania since the mid-1980's (Horsley et al. 2000). Previous studies have indicated that the decline of sugar maples can be linked to soil acidification. The nutrient factors associated with dieback disease include the interaction of Mg and Mn (Horsley et al 2000). The roles of Mg and Mn nutrition and defoliation stress in plant carbohydrates suggest that root storage carbohydrates may be an integrating factor in sugar maple decline. Other significant factors include insect defoliation, drought, late spring frost, and midwinter freeze-thaw cycles (Horsley et al 2000). Stressed sugar maples are a common occurrence on soils with a low pH.

One specific factor associated with maple decline is the sugar maple borer, *Glycobius speciosus*. The sugar maple borer is a long horned wood-boring beetle that thrives on stressed sugar maple (Forest Service 2002). Although the borer rarely kills sugar maples, small populations can cause substantial damage by laying eggs into cracks or under bark scales. Once hatched, the larva makes a winding mine beneath the bark. Within the first year, the larva makes a deep, horizontal, groove in the sapwood that partially encircles the bole or branch as it spirals upwards. By the second year, a J-shapes tunnel (Fig. 1) forms deep within wood where the borer remains until emerging as an adult (Forest Service 2002). Within this J-shaped bore decay is more likely to develop compared to horizontal bore cuts (Sendak et al. 1997). The maple borer destroys portions of the translocation tissue in the trunk and large branches, resulting in crown dieback. This restricts photosynthesis causing sap flow to reduce (Newton and Allen 1982). The sugar maple borer usually invades stressed trees or ones that are located near a supply of dead wood (Greifenhagen 2000).

The goal of my study was to compare the frequency of maple borer infections among three soil types and to examine the relationship between tree density and maple borer infection rate.

Figure 1. The J-shaped cut in a board sawn from a borer-infested tree.

FIELD SITE

I conducted this study at the Raystown Field Station, Entrikin Quadrangle in South Central Pennsylvania (Fig. 2), in a sugar maple grove located on three soil types: Ernst Silt Loam, Blairton Silt Loam, and Berks Shaly Silt Loam (Fig. 3).

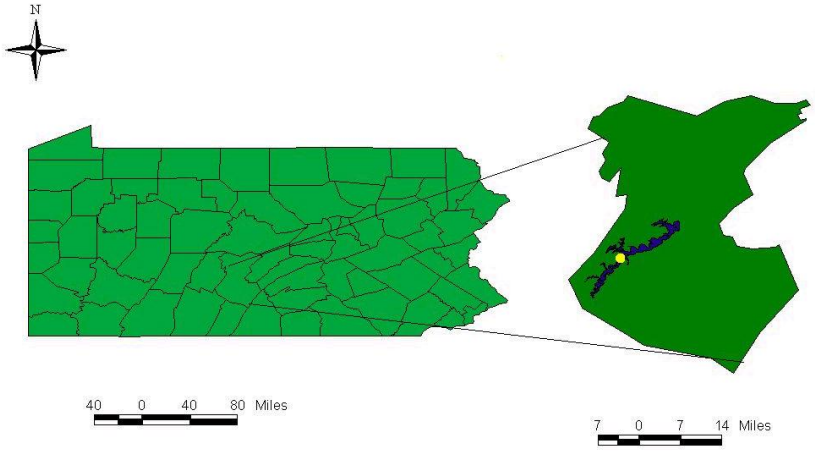

Figure 2. The location of the Raystown Field Station (dot) in relation to Huntingdon County, PA.

These soil plots are located between the Juniata College field station house and Raystown Lake. Ernst Silt Loam is a gently sloping soil with medium runoff and a moderate hazard to erosion in disturbed or cultivated areas. Areas of Ernst Silt Loam have a seasonal high water table. Blairton Silt Loam consists of moderately deep and poorly to moderately well drained soils. These soils formed in weathered shale, siltstone, and fine-grained sandstone. Blairton Silt Loam is moderately low in permeability with available water capacity at low to moderate. Berks Shaly Silt Loam has medium runoff and moderate hazard to erosion (Soil Survey of Huntingdon County 1983).

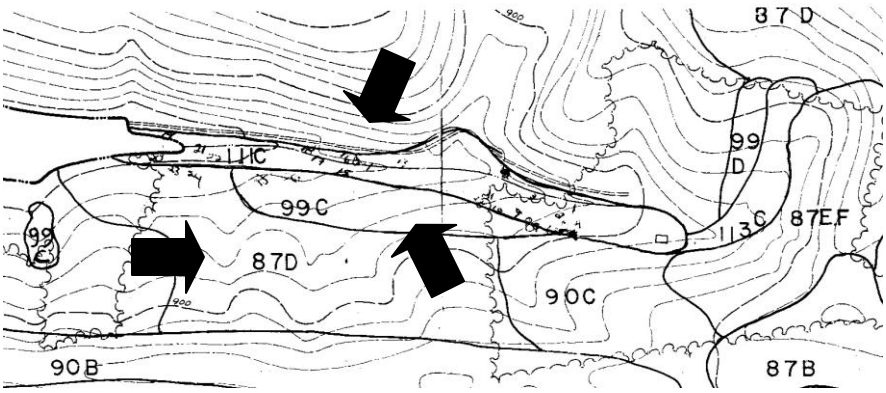

Figure 3. Locations of soil types Ernst Silt Loam (111C), Blairton Silt Loam (99C) and Berks Shaly Silt Loam (87D) at the Raystown Field Station, Entrikin PA.

METHODS AND MATERIALS

I surveyed sugar maple trees at the Raystown Field Station during late October through early November 2002. I randomly selected three, 20m x 20m quadrants, in each soil type Ernst Silt Loam (Ernst), Blairton Silt Loam (Blairton), and Berks Shaly Silt Loam (Berks). For each tree (dbh > 7.5 cm) I recorded the dbh in centimeters, using a dbh-measuring tape, and the number of unhealed and healed sugaring tap holes. I also made observations of the canopy, forest floor covering, and amount of dead wood in each quadrant.

I compared infection frequency among the 3 soil types using a One-Way Analysis of Variance (Introductory Biological Statistics) and compared the density of trees to the infection rate with a linear regression (Introductory Biological Statistics). I considered differences to be significant if $P \leq 0.05$.

RESULTS

The mean infection rates in Ernst (16.7%) and Blairton (6.5%) was greater then that in Berks (0%) ($F = 2.35$, $df = 8$, $P = 0.117$) (Fig. 4). I also found that the density of trees within each soil plot had no significant relationship to the frequency of trees infected ($r^2 = 13.0\%$) (Fig. 5). Soils Ernst and Blairton had more sugar maple trees compared to the total of all other species combined (Fig 6). Berks soil had fewer sugar maples compared to all other tree species combined.

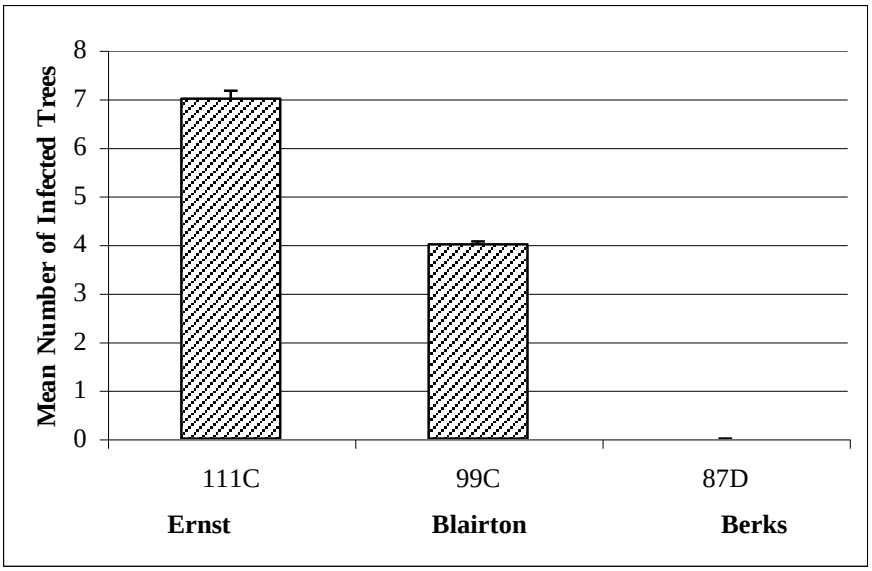

Figure 4. The number of trees infected with the Maple Borer among three soil types during fall 2002 at the Raystown Field Station.

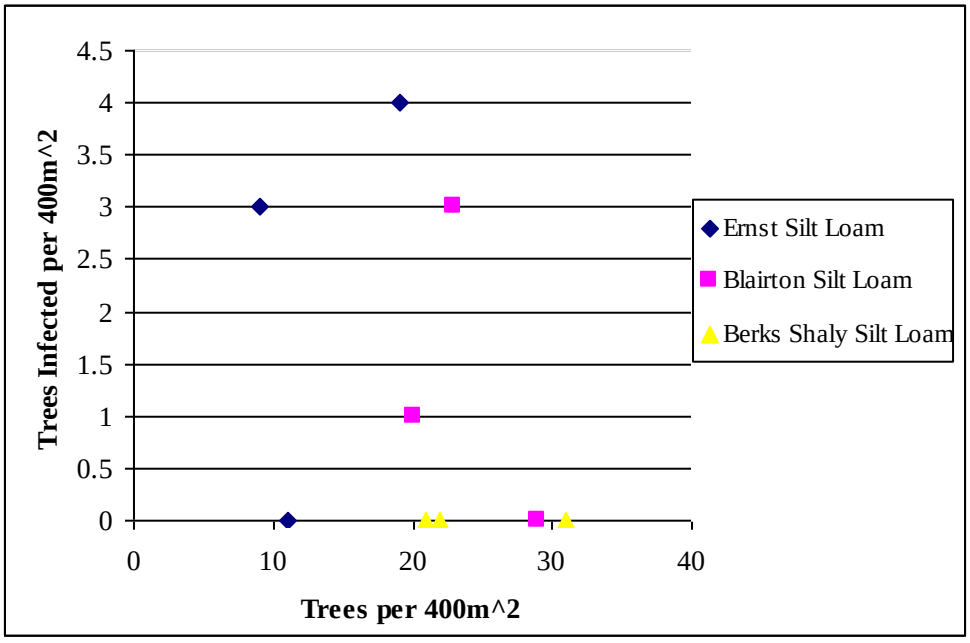

Figure 5. The number of trees infected with Maple Borer compared to the total tree density in three soil types during fall 2002 at the Raystown Field Station.

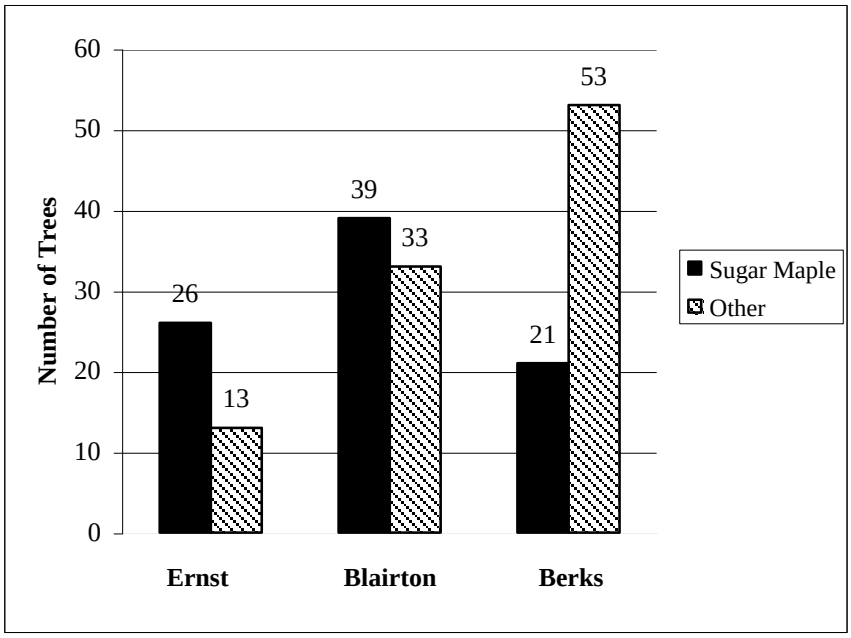

Figure 6. The number of sugar maple and other tree species located within soil types Ernst Silt Loam, Blairton Silt Loam, and Berks Shaly Silt Loam during fall 2002 at the Raystown Field Station.

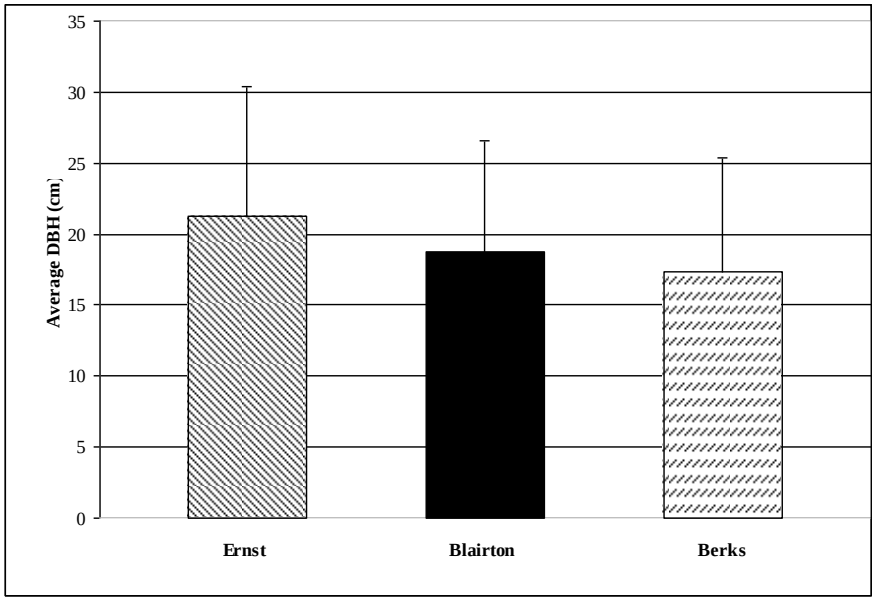

Figure 7. The Average DBH (diameter at breast height) for each tree species located in soils Ernst Silt Loam, Blairton Silt Loam, and Berks Shaly Silt Loam during fall 2002 at the Raystown Field Station.

DISCUSSION

One reason why Ernst and Blairton soils have higher infection rates may be because they are Ultisols (Molesevich, 1977). Ultisols soils are commonly found on unglaciated land and are characterized by having fewer weatherable minerals within the rooting zone and containing low base cations (Ciolkosz et al 1989) than Inceptisols, possibly limiting nutrient supply (Horsley et al. 2000). Long et al. reported that symptoms of maple decline appear to be concentrated on upper slopes of unglaciated sites. Unglaciated soil appears to have inadequate base cation supply where sugar maples may be vulnerable to other stresses (Horsley et al 2000).

Low base cations and low percentages of clay within soil types has also been related to maple decline (Drohan et al. 2002). Mineral availability becomes a problem to trees growing in unglaciated slopes because weatherable minerals are located well below the rooting zone or in the bedrock (Horsley et al. 2000). Glaciated soils, like Berks, have derived from material more recently exposed by glacial erosion, which might be why Berks shows the lowest infection rate. Berks soil falls into the order of Inceptisols, containing weatherable material within the rooting zone making it available to trees (Horsley et al 2000). Sugar maples on Berks soil may show no signs of infection because its soil is composed of minerals that limit stress rates.

When comparing the number of sugar maples to other tree species, Berks has fewer then both Ernst and Blairton. The relatively low number of sugar maples in these plots may contribute to why Berks showed the lowest infection rate. Ideally, Berks soil does not favor sugar maple growth or species quality because of seedling morality and erosion hazard (Huntingdon County Soil Survey, 1983). Therefore, even though the soil limits stress and infection rates it does not support high growth rates for sugar maples. The density of trees within each soil plot had no significant relationship to the frequency of infection, which suggests that it does not contribute to trees stress.

The size of sugar maples could have an effect on their susceptibility to infection. On average, the dbh of sugar maples within Berks soil measured lower compared to Ernst and Blairton. Ernst and Blairton both had higher infection rates than Berks, which suggests that larger sugar maples may have a greater risk of infection then smaller ones (unpublished data).

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