Interactions between American chestnut establishment, groundcover, and ectomycorrhizal colonization

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The American Chestnut Foundation has partnered with the Appalachian Regional Reforestation Initiative (ARRI) since 2008 in an effort named "Operation Springboard" to use reclaimed surface mines for the planting of TACF backcross chestnuts as a regional and widespread approach to reintroduce the species throughout its original range. As part of the mine reclamation process, sites are usually seeded with low growing plants to control erosion, but these ground covers can compete with the trees for water and nutrients. They can also be beneficial to trees on these challenging sites by providing organic matter, helping to initiate the nutrient cycling process, and acting as hosts for a wide range of organisms both above, and below ground. Of particular importance to trees are the beneficial ectomycorrhizal (ECM) root colonizing fungi. These fungal symbionts are essential for healthy tree growth, and ECM colonization has been found to result in improved chestnut establishment, and a positive correlation with tree growth. An understanding of how different groundcovers influence the growth and mycorrhizal colonization of young chestnut trees will allow us to select species that can be planted along with the trees to maximize chestnut establishment and growth.

This study evaluated plantings of TACF restoration chestnut that were planted in 2008-2009 on restored surface mines in eastern Tennessee. After mining ended, each site was reclaimed using the Forestry Reclamation Approach as recommended by ARRI in which the material most suitable for tree growth is placed on the surface using minimal compaction. Plots on these sites were originally seeded with different groundcovers to test their influence in the early years after reclamation, but over time, differences in soils and in the vegetation surrounding the site had a larger influence on the development of vegetation. Seventy-eight chestnut trees at were sampled in September of 2016, and 142 chestnut trees were sampled in 2017. Chestnut survival and growth, and the density and species composition of vegetation surrounding each seedling were measured. ECM colonization of 96 chestnut root systems was assessed; one hundred root tips per seedling were evaluated to determine the percentage of roots colonized by each species of ECM fungi. Fungal species were initially classified based on their color and texture, and other morphological features, then were identified by DNA sequencing.

Growth was greatest on site B, at an elevation of 2250' on a steep slope with an eastern exposure. Much of this site was quickly colonized from the surrounding mined area by sericea lespedeza (*Lespedeza cuneata*), a non-native, nitrogen fixing legume, which dominates the dense groundcover. Site A is a steep northwestern-facing slope at an elevation of 2950', with slow development of a diverse, native groundcover, and had the poorest growth of chestnut.

Seedlings planted on site C, a steep, west-facing slope at an elevation of 1950', are intermediate in growth. The vegetation on this site is also intermediate in diversity, but rich in legumes with patches of lespedeza and native black locust (*Robinia pseudoacacia*) trees that shaded some chestnut seedlings. ECM colonized between 78% an 87% of the chestnut root systems, with the most common species being *Cenococcum* sp. (39%) followed by *Cortinarius* sp. 1*(15%),* and *Cortinarius* sp. *3 (8%).* Average ECM colonization was similar across sites but the ECM species differed with species richness lowest on the site that also had a low diversity of plant species. ECM diversity was greatest on site A with a moderate plant diversity, higher concentrations of micronutrients in the soil, and intermediate growth of chestnut seedlings. Results show that the groundcover community does influence the species of ECM that colonize chestnut roots, and also suggest that legumes are beneficial to the growth of chestnut seedlings on reclaimed minesites. Although chestnut seedlings in this study had greater growth in a low diversity ground cover more diverse communities are more resilient to changing environments, and it is important to continue to monitor these sites.

Figure 1. A chestnut seedling in the first year after planting on a reclaimed mine site.

Figure 2. Collecting root samples from a 8 year old seedling.

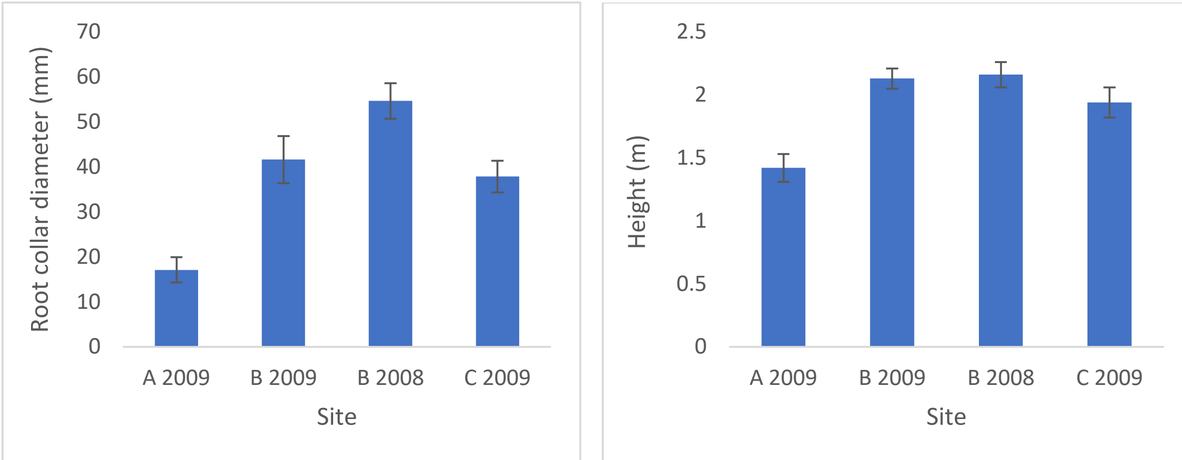

Figure 3. Stem diameter at the base of the stem, and height of seedlings planted in 2008 and 2009, measured in 2017.

Figure 4. Two eight-year-old chestnut seedlings on site B, with a dense cover of lespedeza in the foreground.

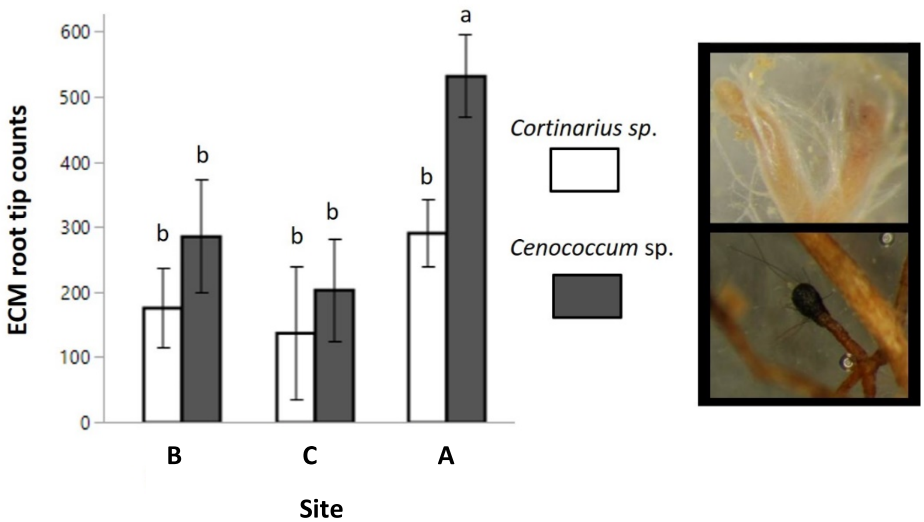

Figure 5. Comparing the two most abundant ECM species across the sites. Cortinarius was evenly distributed, however, Cenococcum sp. significantly more abundant on site A with higher groundcover species diversity.