Measuring resistance to chestnut blight (*Cryphonectria parasitica)* and American chestnut (*Castanea dentata)* morphology of backcrossed hybrids in Lesesne State Forest

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Background

C. dentata filled a social and ecological niche in Eastern hardwood forests rivaled by few hardwood species to date. Restoration of *C. dentata* depends on establishing resistance to *C. parasitica* in the species (Diskin, 2005).

Backcross breeding introduces blight resistance through hybridization with resistant Chinese chestnut (*Castanea mollissima).*

Success of backcross breeding depends on selecting individuals that express blight resistance while resembling their *C. dentata* parent (Westbrook, 2019). Genetic testing or field-based observation indices determine this.
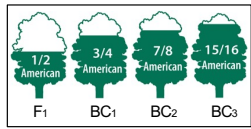

Figure 1: Recapture of *C. dentata* genome through 3 generations of backcrossing.
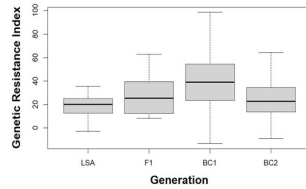Image from PA-TACF Chapter, 2016.

Figure 2: Blight resistance in Lesesne State Forest, 2 generations of backcrossing. Indicative of *C. mollissima* genetic content in hybrids.

Objectives

- Measure phenotypic blight resistance and *C. dentata* morphology in *C. dentata* backcrossed hybrids in Lesesne State Forest.
- Identify correlation between field-based indices and genetic data (genetic resistance index and *C. dentata* / *C. mollissima* genome content)

Methods

Image 1: Lesesne State Forest, BC2 orchard.

Setting: Lesesne State Forest, Virginia. Data collected May-October 2022. Evaluated 600 trees by observable traits indicative blight resistance and *C. dentata* morphology. Genetic data provided by Jared Westbrook.

Image 2 & 3: Examples of *C. dentata* (left) and *C. mollissima* (right) morphology. Leaf serration, shape, and shine shown. Leaf pubescence, petiole angle, and tree form also observed, not pictured. Image 3 by Zhangzhugang (板栗, 杭州植物园), 2018.

Methods, cont.

Image 4 & 5: Cankers caused by chestnut blight fungus, *C. parasitica*. Blight resistance evaluated by canker size, containment, depth, and appearance. Evaluation also included presence of exposed wood, canopy or stem death, stump sprouts, and blight sporulation (not pictured).
Image 5 shows cross section of deep canker with swelling and scar tissue.
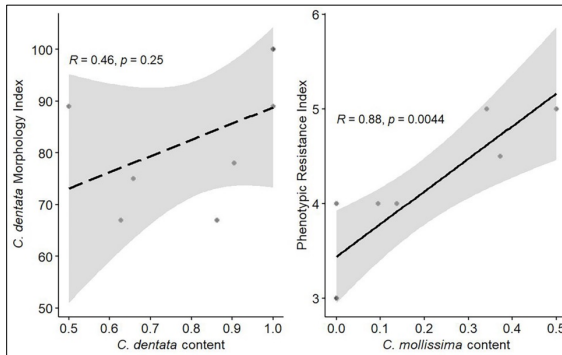
Results

Figure 3: Correlation between *C. dentata* genome content and *C. dentata* morphology index. No significance found.

Figure 4: Correlation between *C. mollissima* genome content and phenotypic resistance index. Strong and significant correlation found.
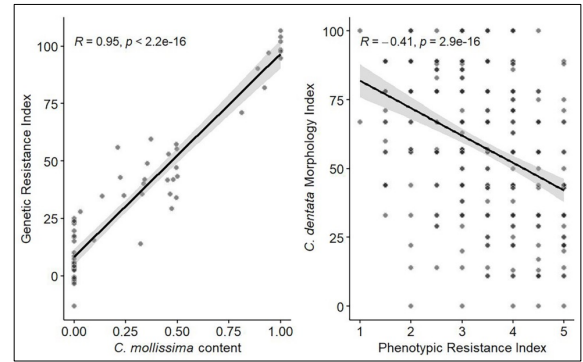

Figure 5: Weak correlation between *C. dentata* morphology and genetic resistance index. Significance found.

Figure 6: Correlation between *C. dentata* morphology and genetic resistance index. Weak but significant.

Results, cont.

Figure 7: Correlation between *C. mollissima* genome content and genetic resistance index. Strong and significant correlation found.

Figure 8: Correlation between phenotypic resistance index and *C. dentata* morphology index. Moderate, significant correlation found.

Conclusion

- The Phenotypic Resistance Index is a successful measure of blight resistance in the field and is correlated with both the genetic-based resistance index and *C. mollissima* genotypic content.
- The *C. dentata* Morphology index is not an effective estimate of *C. dentata* genotypic content in the field.
- The *C. dentata* Morphology index should be improved upon in order to correlate significantly with genetic data.
- This study was limited by the amount of Whole Genome Sequencing data available for the trees evaluated.
- Increasing the correlation between field-based indices and genetic data offers an opportunity to increase the success and progress of the *C. dentata* backcross breeding program without requiring extensive genetic testing.

References

Westbrook, Jared W., et al. Genomic Selection Analyses Reveal Tradeoff between Chestnut Blight Tolerance and Genome Inheritance from American Chestnut (Castanea Dentata) in (C. Dentata x C. Mollissima) x C. Dentata Backcross Populations. preprint, Genomics, 3 July 2019. DOI.org (Crossref), https://doi.org/10.1101/690693.

Diskin, Matthew, et al. "Recovery of American Chestnut Characteristics Following Hybridization and Backcross Breeding to Restore Blight-Ravaged Castanea Dentata." Forest Ecology and Management, vol. 223, no. 1, Mar. 2006, pp. 439–47. ScienceDirect, https://doi.org/10.1016/j.foreco.2005.12.022.

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Zhangzhugang. 板栗, 杭州植物园. 3 June 2018. Own work, Wikimedia Commons, https://commons.wikimedia.org/wiki/File:Castanea_mollissima,_Hangzhou_Botanical_Garden_2018.06.03_15-38-49.jpg.

Acknowledgments