Restoring the American Chestnut

Modern advances in molecular genetics have opened up new possibilities for the restoration of the American chestnut to its natural range. One promising area of biological control is hypovirulence where the chestnut blight fungus is infected by a virus, making the pathogen less virulent or damaging to the tree (Dawe and Nass, 2001). Normally, the fungus grows too fast for the tree to produce enough callus tissue to wall off the canker. However, the virus-infected fungus grows at a much slower rate, allowing the tree's natural defenses to build a barrier to the infection and stave off mortality.

In 1965, Dr. Jene Grente discovered and later isolated chestnut blight fungus infected with a virus from the *Hypoviridae* family on a recovering European chestnut (Barakat, 2009). Mass treatment in Europe with this hypovirulence greatly reduced the mortality rate of European chestnuts, especially in orchards where virus transmission between closely packed trees is readily achieved. Attempts to inoculate American chestnuts with the virus have had very limited success due to the genetic incompatibility between the European and American chestnuts restricting virus transmission (Milgroom and Cortesi, 2004). However, ongoing genetic research in fungal and viral strains holds promise in finding the right combination to resolve the dispersal problem.

Along similar lines, researchers are trying to isolate the defensive genes in the blight-resistant Asian chestnuts and surviving American chestnuts that have not been infected. With hypovirulence, the trees are still infected usually multiple times from a weaken pathogen that manages to damage but not cause mortality. Widespread restoration of infected and damaged trees that require multiple treatments over the years is neither a practical nor economically viable forest management strategy.

Researchers have identified several candidate genes that may explain the response to the pathogen between Asian and American chestnuts (Barakat, 2009). Once properly mapped, the defensive genes could theoretically be represented in future generations of American chestnuts through gene therapy, although the complexity and economical requirements of this approach are extremely daunting. More practical but not necessarily more likely, these genes could be found naturally in surviving American chestnuts due to random genetic recombinations. These naturally blight-resistant trees could then be selectively bred to retain their genetic defenses in future generations and present an avenue for restoration.

Since neither hypovirulence nor genetic pathways will be ready for implementation on a landscape level any time soon, more aggressive approaches in crossing Asian chestnuts with American chestnuts are underway to produce a viable blight-resistant hybrid. The most promising and long-term effort has been managed by the non-profit organization, the American Chestnut Foundation, using a well-established plant breeding technique known as backcrossing.

Through controlled pollination, healthy, blight-resistant trees are crossed under a strict breeding program. Trees in the program are inoculated several times with the fungus to determine their resistance and those that have little or no resistance are removed. The ultimate goal is to eventually produce a viable hybrid through successive generations that has all the characteristics of the American chestnut while retaining the blight-resistant genes of the smaller, less winter-hardy Asian chestnuts.

The American Chestnut Foundation hopes to start restoring the American chestnut range with this hybrid. It should be clear though that the final cross does not produce an American chestnut but a 15/16ths crossbreed (BC_3F_3 hybrid) by their account that seemingly has all the characteristics of a pure species. These characteristics have neither been mapped nor confirmed

by genetic analysis so their determination must be highly suspect. Despite this, the organization has begun field testing on their final cross to determine its viability as a restoration candidate.

References

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