

RESTORING THE AMERICAN CHESTNUT TREE

Background: Early research

Beginning in the 1920s and for decades thereafter, the U.S. Department of Agriculture and the Connecticut Agricultural Experiment Station (CAES) attempted to breed blight-resistant chestnuts by crossing Chinese and Japanese chestnuts, with the American species. Their efforts were unsuccessful: none of their crosses were fully blight-resistant while having characteristics closely resembling American chestnut in nut or timber quality.

TACF's early efforts

In the late 1970s, TACF's founder Dr. Charles Burnham proposed a methodology of breeding to incorporate blight resistance into the American chestnut tree. By using a well-established plant breeding technique known as "backcrossing," Dr. Burnham hypothesized that one could marry the best characteristics of both the American and Asiatic species.

Biology of the Tree: Controlled Pollination

The first step to making TACF's breeding stock is to find American chestnuts with which to cross Chinese and advanced backcross pollen. Whenever a proper tree is found, great efforts are made to incorporate that tree into TACF's national breeding program through the process of controlled pollination. Pollen from the male flower (called a catkin) of one tree is crossed with the female flower (called a bur) of another tree.



A large surviving American chestnut tree is covered in bags during the controlled pollination process. Some of the larger trees can produce several hundred nuts in a season.



THE
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Massachusetts members of TACF not only discovered, but arranged and performed the pollination of this 65-foot tall tree on the Prescott Peninsula of the Quabbin Reservoir. Shown here are the male flowers known as catkins.

Biology of the Tree: Genetics and Incorporating Native Diversity

Based on the work of the early researchers at CAES, it was determined that blight resistance was controlled by two or three genes acting in an incompletely dominant fashion. This means that when a fully-resistant Chinese tree (RRRRRR) is crossed with a fully susceptible American chestnut (rrrrrr), the resulting F₁ progeny would be moderately resistant to the blight (RrRrRr). With the exception of the intercross (*BC₃,F₂* and *BC₃,F₃*) generations, the most resistance possible is moderate resistance. In order to select which trees have the best resistance of those planted, TACF grows the trees for about 5-8 years and then challenges (inoculates) the trees with the blight fungus.

In order to avoid inbreeding over the long term, TACF seeks to perform the backcrossing process with as many surviving native American chestnut parents as possible. To date, over 500 American chestnuts have been incorporated into various generations and more are added to that tally every year.



Biology of the Tree: Planting and Growing

TACF has been able to make great advances in the standardization of planting and growing all matter of chestnut stock. After pollination in the summer, the resulting nuts are ready for harvest in the fall.

Chestnut nuts require a period of dormancy of approximately 1-3 months. Seed are refrigerated until planting time. The seed are typically planted directly in the ground and protected from rodents and deer using several methods, depending on the site and resources available. The trees are grown for about 5-8 years until they are inoculated and selected for resistance and American character.

This 65-foot specimen grows in one of the outermost parts of the natural range of the American chestnut – Talladega National Forest in Alabama. The tree is now used in TACF's national breeding program and will help increase regional adaptability for the American chestnut.

Biology of the Tree: Inoculation and Resistance

Once the trees reach a proper size for the technique (usually 1.5" diameter at breast height), the trees are inoculated with the blight fungus. Two different strains of the fungus, one relatively weak and one very strong -- one of the strongest known -- are inserted into small wounds created in the tree. The trees are then rated for resistance after five months and again after 11 months. Those trees that have little to no resistance are removed from the planting. Only those that have the highest degree of resistance of those planted will be bred into subsequent generations. This continues for a minimum of six generations. With excellent care, TACF is able to complete a generation in six years or less.

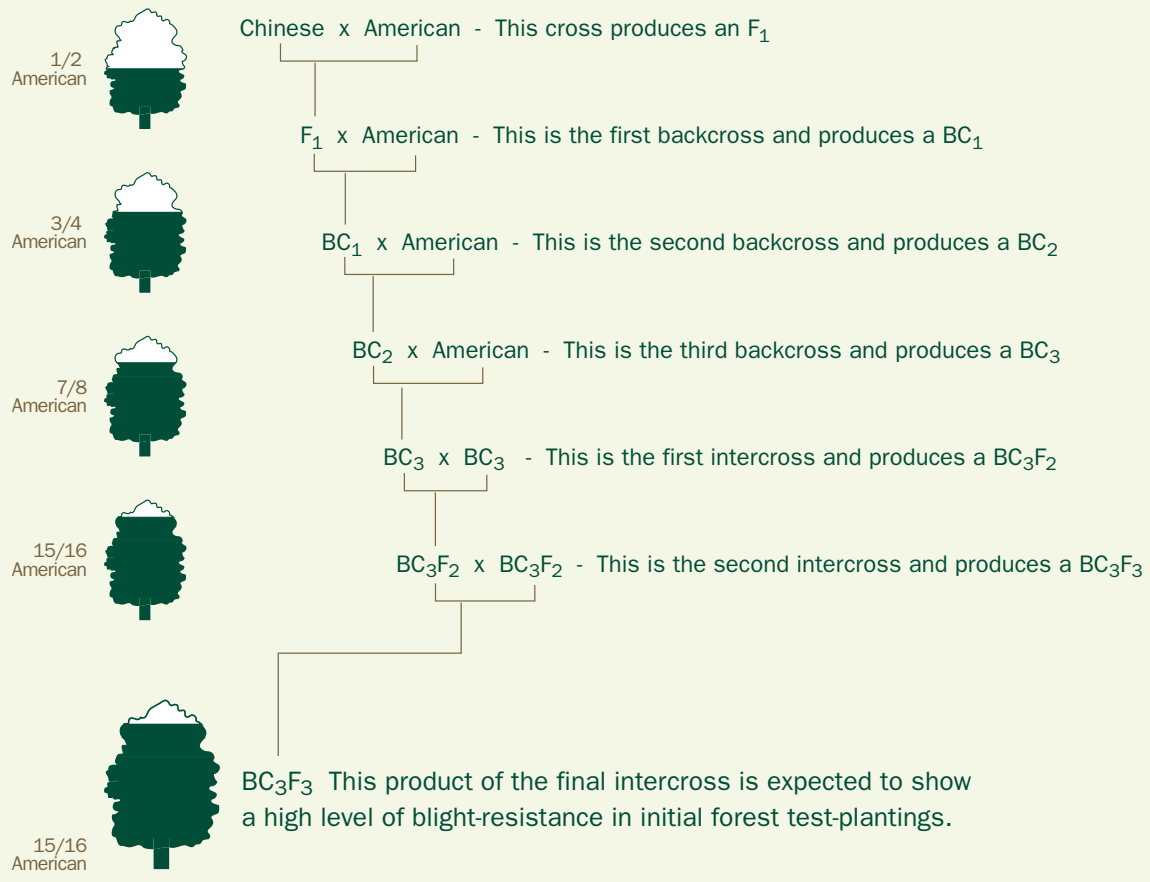
Testing Ourselves

By consulting with a diverse network of colleagues, TACF increases the strength of its scientific focus and methodologies as part of its overall mission and enhances its ability to partner with high-profile organizations throughout the country. In 1999, and again in 2006, TACF contracted with nationally and internationally-recognized scientists for an independent audit of its science program. In each of these years, TACF's national breeding program received high marks indicating an excellence in scientific procedures.

Figure 1.

THE AMERICAN CHESTNUT FOUNDATION BACKCROSS BREEDING PROGRAM

With each cross, additional American chestnut characteristics are regained. Only at the final cross, however, does blight resistance approach that of the Chinese parent



Note: In each step, the Backcross is selected for resistance through the process of inoculation and for American characteristics by visual observation.