

Restoring the American Chestnut Tree

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Abstract: The American chestnut (*Castanea dentata*) was a dominate hardwood tree in the eastern United States. Its historic range extended from Maine south to the northern parts of Georgia, Alabama, Mississippi, and west to the Ohio River Valley. In 1904, an exotic Asian fungus responsible for the death of American chestnut trees was first identified at the Bronx Zoo (New York City, NY). By 1950, the fungus (*Cryphonectria parasitica*) had spread throughout the range of the chestnut and had functionally removed the chestnut as a canopy tree. The American Chestnut Foundation (TACF) was established in 1983 with the mission of restoring the species to our eastern woodlands to benefit our environment, wildlife, and society. TACF currently operates over 300 breeding orchards representing over 120,000 chestnut trees throughout the range of the species. TACF has begun outplanting and testing their first line of potentially blight-resistant chestnuts. In addition, TACF is developing trees resistant to ink disease, and is using biotechnology to develop blight-resistant chestnut trees and to increase efficiency of its breeding program.

Keywords: American chestnut, *Cryphonectria parasitica*, ink disease, backcross breeding, The American Chestnut Foundation, chestnut blight

Introduction

The American chestnut (*Castanea dentata*) was once the “King of the Forest,” the single most prevalent hardwood tree in the eastern half of the United States. At one time, nearly one out of every four canopy trees was an American chestnut. Some of those trees were giants, reaching heights in excess of 30 m (98 ft) and diameters (at breast height) in excess of 3 m (10 ft). They often were branch-free for the first 15 m (49 ft).

The natural range of the American chestnut extended from Maine south to the northern parts of Georgia, Alabama, and Mississippi, and west to the greater Ohio River Valley and the western end of Lake Erie.

During the first half of the 20th century, an Asian fungus (*Cryphonectria parasitica*) causing a disease known as “chestnut blight” was accidentally imported into the United States. Chestnut blight was first observed on American chestnut trees in the Bronx Zoo (New York City, NY) in 1904. The fungus spread quickly and more than four billion trees were destroyed across nearly 81 million ha (200 million ac) of forestland. Most of the trees succumbed to the blight. Chestnuts that didn’t initially die were often cut down to preserve the timber for future use.

In less than 50 years, the American chestnut was gone from the American landscape as a forest-canopy tree. Chestnut blight is recognized as one of the worst ecological disasters of the 20th century. Although American chestnut trees are still common in our forests today, they exist as small saplings growing from the root system of parent trees originally infected by the blight during the early 20th century; the saplings are continually knocked back by repeated attacks of the disease and rarely reach the canopy.

The American chestnut historically was an important tree for both wildlife and society. The chestnut was a staple in many American households prior to the chestnut blight. Families depended on the nuts as a major food source as well as a cash crop. Millions of bushels of the sweet-tasting nuts were hauled to cities like New York and Philadelphia and sold during the Christmas holidays. Many railroad cars were filled to the brim each year for shipment to urban areas. Farm families in the Appalachian Mountains fattened their hogs and other livestock on the nuts, and children would fill their pockets with chestnuts to snack on at school.

The most important hard mast for wildlife almost assuredly was produced by the American chestnut. Hard mast commonly available to wildlife includes acorns, hickory nuts, beech nuts, and walnuts. Mast provides wildlife with critical nutrients during the fall and winter months when other foods are scarce in the forest. The plentiful, reliable nut crop of chestnuts likely provided more nourishment than any other hard mast.

Many species likely benefited from chestnuts, including white-tailed deer, bear, raccoon, wild boar, squirrels, mice, wood rats, wild turkey, grouse, crows, and blue jays.

The American chestnut crop provided an important alternative food source when mast failure occurred in other nut-producing tree species. Because chestnut trees rely on pollination by both wind and animals, and because they flower in late spring to early summer, chestnut trees can recover from flower (and mast) failures caused by late spring frosts, unlike hickory (*Carya* spp.), oak (*Quercus* spp.), beech (*Fagus* spp.), and walnut (*Juglans* spp.).

Restoring the American Chestnut

The American Chestnut Foundation (TACF) was established in 1983 with one clear mission: to restore the American chestnut to our eastern woodlands to benefit the environment, wildlife, and society.

Since 1983, TACF has been working to restore the American chestnut tree by breeding blight-resistant trees using a backcross tree breeding method developed by Burnham and others (1986) that involves crossing American chestnut and Chinese chestnut (*C. mollissima*). The goal of the backcross breeding program is to develop a population of trees with the growth characteristics of the American chestnut while maintaining the genes from the Chinese chestnut parents that confer resistance to chestnut blight. Burnham and others (1986) predicted that chestnuts should have adequate blight resistance by the third generation of the third backcross (B3F3).

TACF intends to continue breeding beyond the B3F3 level, but considers trees at the B3F3 level of breeding as suitable for the start of a long-term process of testing and reintroduction. As TACF develops more advanced lines of potentially blight-resistant trees, the organization will switch to using these trees for testing and reforestation efforts.

The breeding program of TACF selects for trees that exhibit both American chestnut growth characteristics and enough blight resistance to allow the tree to reproduce sexually; this is a basic requirement for the success of the breeding program. In addition, the program incorporates local germplasm through our state chapter breeding programs as well as blight resistance from multiple types of Asian chestnuts.

Developing a blight-resistant chestnut tree is an obvious and obligatory requirement of TACF's program. TACF, however, is not necessarily developing an "end product" (blight-resistant tree), but rather a population of trees with the necessary set of genes to allow the species to resume evolving through natural selection. This is a critical distinction for TACF. The organization is not developing a "crop" plant, but rather a genetically diverse wild tree species with sufficient blight resistance and American chestnut growth characteristics to be reintroduced successfully into our eastern forests.

To maximize genetic diversity within our chestnut trees, TACF established a network of state chapters throughout the historic range of the American chestnut. The chapters breed American chestnuts indigenous to their states to develop blight-resistant trees that are adapted to the environment peculiar to the state and to increase the overall genetic diversity of trees in the program. The state chapter system has developed more than 300 breeding orchards representing more than 70,000 chestnut trees.

During spring 2009, TACF partnered with the USDA Forest Service (USFS), the USFS Southern Research Station, and the University of Tennessee to initiate testing of our first lines of potentially blight-resistant chestnuts (B3F3). TACF and our partners continue to install additional outplantings and monitor growth characteristics and blight resistance in these trees.

In addition to outplantings with the USFS, TACF has established a number of additional B3F3 outplantings on both private and public lands to secure data on resistance and growth of the B3F3 trees. It is still too early in the testing process to make any meaningful evaluation of our breeding program. TACF, however, does not consider the B3F3 tree as the end of our breeding efforts. On the contrary, the B3F3 represents the beginning of a continual process of additional breeding and testing, both in structured field trials and actual reintroduction efforts.

TACF's backcross breeding program extends beyond breeding blight-resistant chestnut trees. TACF is also engaged in a breeding program designed to develop trees resistant to ink disease. Ink disease is caused by the organism *Phytophthora cinnamomi* and other *Phytophthora* spp. Many chestnut outplantings have failed due to ink disease (Jeffers and others 2007), mainly in the Southeast where this organism is common. Although chemical treatment for *Phytophthora* is effective in orchard situations (Barilovits 2009), this is not a practical approach for reintroducing the American chestnut to the wild. TACF's efforts focus on selecting for chestnuts that have both resistance to blight and ink disease at Chestnut Return Farm (Seneca, SC).

The use of biotechnology is another pathway TACF is using to develop blight-resistant trees. In partnership with the State University of New York (SUNY, ESF), Pennsylvania State University, University of Georgia, North Carolina State University, and USFS, TACF collaborators are experimenting with transgenic approaches to confer resistance, along with identifying markers to allow for more precision in our traditional breeding programs. During spring 2011, TACF's New York state chapter and SUNY, ESF planted their first transgenic chestnuts for testing and evaluation.

Conclusion

The loss of the American chestnut resulted in a tremendous blow to the eastern forests of the US. The mission of TACF is to restore the American chestnut to our eastern woodlands to benefit the environment, wildlife, and society. To achieve this monumental task, TACF and its partners have developed a structured, yet diverse program to accomplish this mission.

TACF's program of restoration will span many generations, but is now at a juncture where trees are being outplanted and closely evaluated. Breeding will continue for many more decades but the organization will expand its scope to include ecological and silvicultural aspects of the restoration program.

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