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CHESTNUT BREEDING IN THE UNITED STATES

The appeal of chestnut, both for timber and for nut production, has prompted importation and experimentation in the U.S. for many years.



Fig. 1. A timber-form chestnut tree on the left and an orchard-form tree on the right.

In 1773, Thomas Jefferson grafted European chestnut cuttings (*Castanea sativa* Mill.) onto American chestnuts (*C. dentata* (Marsh.) Borkh.) at his home, Monticello, near Charlottesville, Virginia (2). When E. I. Du Pont de Nemours moved from France to Bergen Point, New Jersey (in 1799) and then to Brandywine, Delaware (in 1802) he

planted European chestnuts for himself, and gave them to friends (11).

G. Harold Powell's 1900 report from the Delaware Agricultural Experiment Station discusses the early history of Japanese chestnut trees (*C. crenata* Sieb. and Zucc.) in the United States. They were first imported by S. B. Parsons of Flushing, New York, who obtained seed from plant collector Thomas Hogg in 1876. The seeds were planted at a CT farm and the resulting trees were called "Parsons' Japan." Three of these (planted in Old Lyme, Cheshire, and Bridgeport, Connecticut) are still alive and well.



Fig. 2. 1876 Japanese chestnut tree at the Bee and Thistle Inn in Old Lyme, CT.

William Parry of New Jersey imported 1000 grafted trees from Japan in 1882, and selected many of the early named varieties. In the West, Luther Burbank imported 10,000 nuts from Japan in 1886, and sold

selected seedlings by mail-order, and to other nurseries.

Our first records of crosses between chestnut species typify the whole history of chestnut breeding in the U.S. The first crosses were done by an interested amateur and by a professional botanist. George W. Endicott of Villa Ridge, Illinois, was growing ‘Japan Giant’ at the end of the last century, and used pollen from an American chestnut tree to produce Japanese X American hybrids in 1895. One of these hybrids produced six burs in its second year, and was named ‘Daniel Boone’.



Fig. 3. A drawing of a bur of the Boone chestnut from W. A. Taylor and H. P. Gould. 1914. Promising New Fruits. Pp. 122-123 IN: Yearbook of Agriculture for 1913. USDA, Washington, D.C.

This variety was strongly self-fertile, which is rare in chestnut (12). The other early hybridization work was done by Dr. Walter Van Fleet, then an associate editor of the Rural New Yorker Magazine. In 1894, he used pollen of American chestnut on flowers of the European (or European-American) cultivar ‘Paragon’ and planted the progeny in Little Silver, New Jersey (13). Van Fleet went on to make thousands of crosses, using many species, between 1900 and 1921. For his early crosses he used the native chinquapin, *C. pumila*, and European and Japanese cultivars.



Fig. 4. A branch of Van Fleet’s hybrid growing in Bell, Maryland, in 1943.

In his later work, he included Chinese chestnuts, *C. mollissima* Bl. Wild seed of *Castanea* species collected in Tientsin, China, were imported by the US Department of Agriculture (as PI#34517) and planted in 1912 at their Bell (Maryland) Experimental Plot. Van Fleet had over 900 of these trees to observe and use there, in addition to subsequent importations made by the USDA plant explorer Frank N. Meyer. An open-pollinated seedling of Van Fleet’s S-8 (its row and tree location in the nursery) was crossed by Arthur Graves in Connecticut with a forest-type Japanese to produce the cultivar ‘Essate Jap’. Van Fleet’s records on the parents of S-8 are not entirely clear, but the female parent was given as *C. pumila* from Virginia (or Washington) and the male parent as pollen from “several named varieties of Japan chestnut including ‘Parry’s Giant’, ‘Killen’, and ‘Hale’.” H. Nienstaedt concluded in his 1948 thesis that it looked more like *C. crenata* X *C. pumila*, based on the results of other crosses of these two species (10).

The USDA Yearbook of Agriculture for 1937 carries an article by H. L. Crane, C. A. Reed, and M. N. Wood in which they discuss nut breeding in the U.S. Their work at Beltsville, Maryland, and the work of R. B. Clapper and G. F. Gravatt at Glenn Dale, Maryland, and A. S. Colby at the Experiment station in Urbana, Illinois,

involved making and testing hybrids for their resistance to chestnut blight and their fitness throughout the US.



Fig. 5. R. B. Clapper with seedlings from 1931 and 1932 crosses of Japanese and American chestnuts (photo 1938).

The USDA work was continued by J. D. Diller and F. H. Berry until the project was terminated about 1960.

The contribution of many interested nut growers has been very important, both in spurring on the scientists and in educating the public. In Connecticut, physicians R. T. Morris and W. C. Deming planted many kinds of chestnuts and experimented with crosses and culture. Fred Ashworth in New York and Alfred Szego on Long Island, and many other faithful members of the Northern Nut Growers have contributed immeasurably.

The Experiment Station studied chestnut management for optimal timber production before chestnut blight engulfed Connecticut, and resistance to the disease after it arrived here. The longest-continuing chestnut breeding program in the United States is that in Connecticut. Dr. Donald F. Jones began getting imported chestnut trees from the USDA in 1929, planting them on Experiment Station property, at his home, and on private land that subsequently became the Collis P. Huntington State Park.

Arthur H. Graves planted trees on land that he owned in Hamden, Connecticut, and started making crosses in 1930.



Fig. 6. Arthur Graves with one of his hybrid chestnut trees in 1952.

He soon began an association with Donald Jones, and together they supervised two graduate students, Hans Nienstaedt and Richard A. Jaynes, who maintained trees, made crosses, and contributed greatly to our knowledge of chestnut in general. In 1950, Graves deeded his land with the Sleeping Giant Chestnut Plantation to the State of Connecticut, to ensure that the work would continue. Since then, the Plantation has been maintained by The Connecticut Agricultural Experiment Station. This is probably the finest collection of species and hybrids of chestnut in the world.

The early Connecticut breeding work focused on making hybrids that were combinations of species, looking for single ideal progeny that could be propagated clonally. R. A. Jaynes joined the Experiment Station staff in 1962, and with A. H. Graves (who died in December of that year) published a bulletin on Connecticut hybrid chestnuts and their culture. Jaynes cooperated with the Virginia Division of Forestry to plant over 10,000 hybrid chestnut seedlings in the Lesesne State Forest in Virginia. These are still being observed by T. Dieroff, so that promising trees can be selected.

With Jaynes' retirement in 1983, responsibility for the chestnut breeding

program fell to me. At the urging of Charles R. Burnham, a prominent geneticist, records were searched for hybrids that were products of resistant X susceptible trees, and any that were back-crossed again to the susceptible parent species.

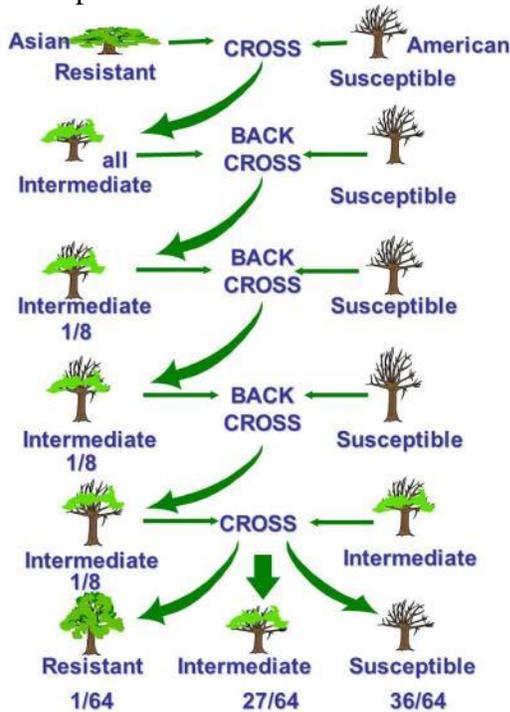


Fig. 7. Diagram of the CAES back-cross breeding plan to produce blight-resistant chestnut trees.

Burnham felt that a few generations of back-crossing and selecting, followed by crosses of those selected trees would result in chestnut trees that had the form and nut quality needed, combined with resistance to chestnut blight (3). These trees would produce “true to type” offspring, and allow reforestation with chestnut.

Because of the long-term commitment of The Connecticut Agricultural Experiment Station to maintain records and valuable trees, this project is proceeding smoothly. Many Asian trees in Connecticut have been evaluated for survival in our climate (some for 138 years, by 2014), resistance to chestnut blight, timber form, and nut quality. Selected trees have been used to make new hybrids with

American chestnut trees kept alive using biological control by hypovirulence (a virus disease of the chestnut blight fungus).



Fig. 8. American chestnut trees, 40 years old, kept alive with biological control by hypovirulence.

Experiment Station trees are also being used by Dr. F. V. Hebard, chestnut breeder for the American Chestnut Foundation. Two of our first-generation-backcross trees [(Chinese X American) X American] are now 68 and 61 years old. The hybrid made by Diller in 1946 was called ‘Clapper’ (7), and although the original tree has died, two grafts survive at the Connecticut Experiment Station farm. Our other old BC1 tree was made by Graves and Nienstaedt in 1953, and we call it ‘Graves’. Both of these have timber form, good blight resistance, and acceptable nuts.

Timber-form hybrids have been planted in forest clear cuts in Connecticut and on Long Island to test their ability to survive in the “real world” with pests and diseases and the climate of Southern New England.

Selections are being made now for orchard as well as timber trees. Some of the complex hybrids made by Jaynes have the Chinese shrub *C. seguinii* in their background, and are compact dwarfs. I have used these in crosses with chestnut trees with exceptional nut quality to select short, reliable nut producers. The levels of nutrients in the nuts are clearly influenced by which pollen parent is used, so studies of “ideal” combinations of nut tree and pollinizer are underway, as well.



Fig. 9. Forester Douglas Ramey and Dr. Cornelia Pinchot examine a 5-year-old hybrid chestnut on Greentree Foundation land on Long Island (NY).

Our latest challenge is the recent arrival of the Asian chestnut gall wasp (*Dryocosmus kuriphilus*) in Connecticut. This pest lays eggs in leaf and flower buds, and when the eggs hatch, a gall is formed. When the wasp emerges, all the galled tissue with attached distorted leaves dies. Orchards of chestnuts in Ohio have had severely reduced nut yields as a result of infestation. Fortunately, the large collection of species of *Castanea* at CAES has allowed us to determine that Ozark chinquapins (*Castanea ozarkensis*) are resistant to infestation. Crosses are now underway to move wasp resistance into the important nut cultivars grown in the U.S.



Fig. 10. Galls of Asian chestnut gall wasp on an American chestnut in Connecticut.

The work at The Connecticut Experiment Station will continue, and the renewed interest in chestnuts should allow cooperation with many people—amateurs and scientists—to speed our progress toward usable chestnut timber stands and a new nut market in the United States.

REFERENCES

1. Anagnostakis, S. L. 2012. Chestnut breeding in the United States for disease and insect resistance. *Plant Disease* 96:1392-1403.
2. Bailey, L. H. 1900. Chestnut. Pp. 294-297 IN: *Cyclopedia of American Horticulture*, Vol. C, MacMillan Co., New York.
3. Burnham, C. R. 1988. The restoration of the American chestnut. *American Scientist* 76:478-487.
4. Crane, H. L., C. A. Reed, and M. N. Wood. 1938. Nut Breeding. Pp. 827-835 IN: *Yearbook of Agriculture for 1937*. USDA, Washington, D.C.
5. Corsa, W. P. 1896. The Chestnuts. Pp. 77-91 IN: *Nut Culture in the United States*. USDA Division of Pomology, Washington, D.C.
6. Fuller, A. S. 1896. The Chestnut. Pp. 60-117 IN: *The Nut Culturist*. Orange Judd Co., New York.
7. Diller, J. D. and R. B. Clapper. 1969. Asiatic and hybrid chestnut trees in the eastern United States. *J. Forestry* 67:328-331.
8. Jaynes, R. A. 1979. Chestnuts. Pp. 111-127 IN: *Nut Tree Culture in North America*. R. A. Jaynes, ed., Northern Nut Growers Association, Inc., 466 pp.

9. Jaynes, R. A. and A. H. Graves. 1963. Connecticut Hybrid Chestnuts and Their Culture. Bulletin 657, The Connecticut Agricultural Experiment Station, New Haven, CT, 29 pp.
10. Nienstaedt, H. 1948. Notes on the Chestnut: Breeding, Culture, and Botanical Characters of Species and Hybrids. Master's Thesis, Yale School of Forestry, 104 p + XIII.
11. Powell, G. H. 1899. The European and Japanese Chestnuts in the Eastern United

States. Bulletin XLII, Delaware Agricultural Experiment Station, Newark, DE.

12. Taylor, W. A. and H. P. Gould. 1914. Promising new fruits. Pp. 122-124 IN: Yearbook of Agriculture for 1913. USDA, Washington, D.C.

13. Van Fleet, W. 1920. Chestnut work at Bell Experiment Plot. 11th Annual Report of the Northern Nut Growers Association, pp. 16-21.

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