Reflections

Richard Jaynes

Broken Arrow Nursery, 13 Broken Arrow Rd, Hamden, CT 06518, USA

The following are reminiscences of some of the people and reflections of the diversity of problems and projects one can get involved in while working on chestnut and chestnut blight. A review of chestnut breeding and my involvement in some of the early hypovirulent work in this country are largely excluded because most of that is well documented with original reports and reviews in the literature.

Forty years ago, after my junior year in high school, my involvement with chestnut began as a summer job, working on the farm crew at the Connecticut Agricultural Experiment Station. I learned about chestnuts and corn and weeding, and liked it enough to return two more summers.

Under the guidance of Drs. Hans Nienstaedt (forest geneticist and present at this conference), Arthur Graves (taxonomist and chestnut breeder) and Donald Jones (geneticist of hybrid corn fame), I assisted with the pollinating of corn and chestnut. After two summers with the U.S. Forest Service in Minnesota and graduation from Wesleyan University, I started graduate work in the Botany Department at Yale University with an assistantship at the Connecticut Agricultural Experiment Station. Dr. Francois Mergen, geneticist in the Forestry School was one of my advisors. My Ph.D. on the *Genetics and Cytology of Castanea* was completed in 1961 and I began full-time employment at the Agricultural Station until 1984, when I left and joined the ranks of the self-employed.

The grand "old" man of chestnut breeders in the U.S. has to be the late Arthur Graves. If you check the literature from the 1920s to 1962, you'll see a continuum of optimistic reports on how the problem is nearly solved and we will have blight resistant chestnuts in the forest again! He was a noble, warm, intellectual who dedicated much of his life to bringing back the chestnut. Never mind that he was actually over 50 when he began making crosses in 1929.

Some of Graves' first work with chestnut was between 1912 and 1920, when he scouted forests of southern New England for infections and monitored the spread of chestnut blight. When I knew him he most always wore a jacket, tie and felt hat. Yet his favorite mode of transportation on those early survey trips was on a motorcycle! He must have been quite a sight.

Inarching, like many kinds of grafting, has probably been done for centuries in one form or another. Graves adapted the technique to maintain blight susceptible chestnut hybrids. Suckers were grafted into the trunk above basal cankers and the crown kept alive and flowering so it could be used in crosses. The technique worked well but was not effective on highly susceptible trees like the American chestnut (1).

I used a form of inarching to obtain roots on cuttings (2). A dominant scion was grafted into a seedling and the base of the scion buried in moist soil. Large fleshy roots were formed, and these were used in cytological studies to count chromosomes. Hypocotyles from germinating nuts supplied better material, but nuts were not available from female sterile trees. A comparison of *Tradescantia* chromosomes with those of *Castanea* indicated the minute size of the latter (3). Of course, this form of inarching could be used to laboriously produce own-rooted clonal stock.

I never experienced the luxury of pollinating from an aerial (hydraulic) bucket. We used ladders; the most common being an A ladder with a center shoot that allowed us to sit on the top rung at about 7 m and reach maybe another 2 m. Its stability was less than ideal on sloping ground, but they were economical and functional.

Storing chestnut seeds is often a problem, whether for germination or consumption. On several occasions we kept nuts in peat moss in plastic bags in a walk-in cooler (approximately 5 C) for 17 mo (i.e. a year longer than usual) and as long as 41 mo (4). Clearly the potential is there to store seed in viable condition under carefully controlled conditions for a few years.

With regard to breeding forest trees, one of the most difficult problems is the assessment of the length of the vegetative period. The longer the tree stays vegetative the more likely the bole will be tall, straight and massive. Of the several chestnut species, American chestnut probably has the longest vegetative phase. An F1 hybrid between *C. ozarkensis x C. seguinii* represents an extreme case of a short vegetative phase with flowering occurring the first growing season.

Breeders unfortunately tend to select trees that flower early in their life cycle and heavily. It is hard, when trying to move on to the next generation to select the tree that is last to flower and/or has the fewest flowers. Even when breeding within *C. dentata,* vigilance is needed not to inadvertently impose negative selection for precociousness and poor form. We may have already done this.

Flippo Gravatt was one of the U.S. Department of Agriculture plant pathologists to work on chestnut blight from the 1930s through the '50s. The chestnut breeding done by Fred Berry and Russell Clapper was directed in part by Gravatt. As a graduate student, I visited Gravatt and Berry at Beltsville in 1959, and I viewed a few large American chestnuts alive on land owned by Gravatt in Maryland. These were the largest, healthy American trees that I had seen within the native range. A 32-year-old graft of one of those American trees is presently growing at the Connecticut Agricultural Experiment Station Farm in Hamden, Conn. The trunk has been blighted and covered with reactive tissue for years, but it is still quite healthy. Abnormal strains of the blight fungus have been isolated

from this cankered bark, but how significant is genetic resistance in this clone? It is the age-old question that crops up with every large surviving infected tree. Inoculations using the chestnut blight fungus indicate that the tree has significant resistance (S. Anagnostakis, personal communication). The understock of this American is a Chinese chestnut (no, I don't believe the stock is imparting resistance), but it is normally an incompatible combination. The isoenzyme pattern is apparently compatible among stock and scion (Anagnostakis, personal communication) (7).

The Ross tree in Amherst, Va., is another impressive anomalous American chestnut. It has grown in an open field for years and has a trunk diameter of about 0.9 m dbh. Of course, numerous other large surviving American chestnut trees also are known to exist within the original range.

All of us involved in chestnut breeding were at various times optimistic about one or more of our progeny. Certainly the Clapper chestnut had impressive statistics; 55 ft (17 m) tall, and 9.9 in (25 cm) dbh at 20 yr. It clearly had a relatively long and productive vegetative growing phase, but eventually succumbed to chestnut blight.

As a chestnut "expert" you get to go out and examine all the large "blight resistant" trees others have found. Never mind that the trees often turn out to be horsechestnuts, beech, oaks, or oriental chestnuts. The former national grand champion American chestnut interestingly had all the characteristics of a European chestnut. The horticulturist who took me to see it in Austen, Ore., diplomatically avoided telling the owner the tree identity. However, we eventually got the American Forestry Association to correct the information in their Register of Big Trees.

I was fortunate to collaborate with many wonderful people. The Virginia Division of Forestry and their personnel (Dr. Tom Dierauf in particular) deserve a lot of credit for their part in establishing and maintaining the Lesesne chestnut planting in Virginia (5). Significant financing came from a private source, Anne Valk. Some of the best hybrid chestnuts for form, vigor and blight resistance are presently in this planting that was installed in 1969.

The Lesesne area had the largest chestnut planting in the eastern U.S. at the time and had some promising trees out of the 12,000 planted. One of the best seed parents of these Lesesne trees is a Chinese hybrid (R13T1) of unknown parentage, growing in a chestnut planting at Redding Ridge, Conn.

We were always willing to try better and more efficient techniques, including starting seed in tubes in late winter and planting them in the nursery after the danger of frost in holes dug with a power drill. It worked, however, it was not much of an improvement over traditional techniques.

Other researchers were instrumental in working with the chestnut blight problem. P.J. Anderson published many early articles in the Pennsylvania Blight Commission Bulletin. John Puhalla was the first to import hypovirulent cultures of *Endothia* into the U.S. from Europe.

Although progress towards growing blight-free (resistant) American or American-like chestnut tress has been painstakingly slow, we always found some interesting diversions to pique our interest. Among these was the observation that shells of nuts from American chestnut trees, growing where blight is prevalent, are often infected with the chestnut blight fungus (6). How these get infected is not known, though it may be through the style.

The idea of screening trees for blight resistance in sterile culture (micropropagation) has been a goal for many years. The potential for micropropagation of selected cultivars is close to being a reality, however, producing a dozen or more plants of one or two clones in the laboratory is often a long way from commercial production.

Of course, there was much more we did and much we published, but those timber chestnuts with blight resistance are still a dream of the future. Sharing and cooperation are vital to making progress on this complex host/parasite problem. This meeting is evidence that significant research is being done and that free exchange of ideas and information is occurring. May your efforts fulfill the dream.

Footnote added to complement some points made by Jerry Payne:

Since I was involved with chestnut research for over 30 years and since I have operated a commercial nursery for more than eight years it is fair to ask if we grow chestnut. We do not, and the following are some of the reasons.

Land values, labor costs, and our cold climate in Connecticut virtually preclude considering chestnut as a money-making orchard crop. However, it certainly has value as a novelty crop for the homeowner. Yet, there are several major obstacles to be overcome:

1. Seedlings are too variable for nut size, productivity, disease resistance, etc.; and economical, vegetative propagation techniques for selected cultivars have not been demonstrated.
2. Chestnut weevils are a guaranteed problem and can be controlled now only with chemical sprays, a particular problem for the homeowner or small orchardist.
3. A local market for trees does not exist and would have to be developed.
4. Chestnuts are coarse rooted and difficult to transplant compared to most fruit trees. Thus they are a difficult product for a mail order nursery.

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