# EVALUATION OF THE 24-YEAR OLD TABLE ROCK (S. CAROLINA) CHESTNUT PLOT FOR GROWTH AND DISEASE RESISTANCE AND A PROPOSED BREEDING PROGRAM FOR ITS USE

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The American chestnut (Castanea dentata (Marsh.) Borkh.) has been almost completely killed throughout its native range in the United States by the chestnut blight fungus (Endothia parasitica (Murr.) A. & A.). Beginning in 1925, several state, private, and government agencies have been involved in breeding attempts to find a chestnut tree that is resistant to the fungus. The story has been reported elsewhere (Beattie and Diller, 1954; Diller and Clapper, 1965; Diller and Clapper, 1969; King, 1970) and will not be repeated here.

Beginning in 1947, a series of plots was established under the leadership of Dr. Jesse D. Diller of the Division of Plant Pathology, U. S. Dept. Agriculture. During the period, 1947-1955, 15 plots were established in 13 states throughout most of the range of the American chestnut. Southern states included in the test plantings were Arkansas, Alabama, Tennessee and South Carolina. The plots consisted of chestnut hybrids of various pedigrees and some of the Chinese chestnut (Castanea mollissima B1.). A recent evaluation of the 15 plots was made by Diller and Clapper (1969).

## THE TABLE ROCK PLOT

The South Carolina State Commission of Forestry cooperated in this study by establishing a one-half acre plot in April 1948 at Table Rock State Park in upper Pickens County, South Carolina. The plot lies at 1100 feet elevation and is considered above average for hardwoods in the area, having fertile and well-drained soil. The site has a low southwest exposure and before planting supported a mixed stand of yellow poplar, sweetgum, red maple, red oak, white ash, and dogwood. The dominant yellow poplar averaged 4-6 inches dbh. After planting all trees and shrubs over three feet in height were cut or girdled.

The 1-0 seedlings obtained for planting were grown by the U. S. Dept. of Agriculture at Glenn, Dale, Maryland, and by the Connecticut Agr. Expt. Station at Hamden, Connecticut. A total of 125 seedlings were planted at an approximate spacing of 10 x 10 feet on April 12, 1948. Of the seedlings planted, 68 were hybrids developed by Arthur H. Graves at Hamden. The Glenn Dale trees were developed by Russell B. Clapper and consisted of 19 hybrids, 16 Chinese chestnut (Nanking strain), P. I. 58602, and 19 open-pollinated American X Chinese chestnut hybrids. Three trees could not be identified with certainty because one of their two tags was missing. The other set of tags had numbers that indicated they were Connecticut hybrids and are so treated here. The planting site was an irregular area fitted into a mountain cove. Eight rows consisting of 5 to 26 seedlings per row made up the plot. The seedlings were assigned to the space in a pre-arranged randomized manner.

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Since planting the plot has been maintained by periodically girdling edge trees and removing sprouts and understory vegetation competing with the chestnut trees. The plot is in good condition at the present time.

## COLLECTION OF DATA

On January 29, 1971, the authors made a detailed survey of the plot. Data were obtained on survival, diameter, height, blight resistance, and tree form of all chestnut trees on the plot. Diameters were measured with diameter tape and recorded to the nearest 0.1 inch. Heights were obtained with a Haga and recorded to the nearest foot. Blight resistance was assessed as noted by large number of cankers and dieback. Tree form from a timber type point of view was also gauged in five categories ranging from excellent to valueless.

## ANALYSIS OF RESULTS

1. Survival (Table 1)

First year survival was 77 percent. Losses since 1949 have further reduced the number of surviving trees to 71 (57 percent) as of January 1971. The age of the trees at that time was 24 years. Earlier losses can be attributed to damage in planting, and competition from edge trees and sprouts. Animal damage was minimal. The onset of blight on the plot was not noted in the old records but it was obvious that some trees had succumbed to the disease. The Chinese chestnuts and open-pollinated hybrids survived somewhat better than the controlled hybrid crosses.

Table 1. Number Planted and Survival of Four Groups of Chestnut Trees at Table Rock State Park, S. C. (Age - 24 yrs.)

| Group | Number Planted | Number Surviving | Percent Surviving |
|---|---|---|---|
| Chinese-Nanking 58602 | 16 | 11 | 69 |
| American-Chinese OP | 19 | 13 | 68 |
| Maryland Hybrids | 19 | 11 | 58 |
| Connecticut Hybrids | 71* | 36 | 50 |
| | 125 | 71 | 57 |

* Including 3 trees whose identity is not certain but most likely belonged to this group. See text.

2. Size of trees (Tables 2 and 3)

The data are grouped into ten, one-inch diameter classes and six, ten-foot height classes. Means were computed from a weighted value depending on the number of trees in each class. As a group the American-Chinese OP hybrids were clearly superior to the others **in** both diameter and height.

Table 2. Number of Trees by One-inch Diameter (DBH) Classes for Four Groups of Chestnut Trees at Table Rock State Park, S. C. (Age - 24 yrs.)

| | Inch - Diameter Classes | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Group | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Totals | Means |
| Chinese-Nanking 58602 | 2 | 0 | 1 | 2 | 2 | 2 | 1 | 0 | 1 | 0 | 11 | 4.6 |
| American-Chinese OP | 0 | 1 | 2 | 0 | 1 | 3 | 3 | 1 | 2 | 0 | 13 | 6.0 |
| Maryland Hybrids | 2 | 1 | 0 | 3 | 2 | 0 | 1 | 1 | 0 | 1 | 11 | 4.6 |
| Connecticut Hybrids | 4 | 3 | 1 | 7 | 8 | 8 | 3 | 1 | 0 | 1 | 36 | 4.7 |
| Totals | 8 | 5 | 4 | 12 | 13 | 13 | 8 | 3 | 3 | 2 | 71 | 4.9 |

Table 3. Number of Trees by Ten-foot Height Classes for Four Groups of Chestnut Trees at Table Rock State Park, S. C. (Age - 24 yrs.)

| | Ten-foot Height Classes | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Group | 0-9 | 10-19 | 20-29 | 30-39 | 40-49 | 50-59 | Totals | Means |
| Chinese-Nanking 58602 | 0 | 2 | 2 | 4 | 2 | 1 | 11 | 33 |
| American-Chinese OP | 0 | 1 | 1 | 3 | 6 | 2 | 13 | 40 |
| Maryland Hybrids | 1 | 2 | 1 | 4 | 1 | 2 | 11 | 32 |
| Connecticut Hybrids | 1 | 3 | 6 | 16 | 8 | 2 | 36 | 34 |
| Totals | 2 | 8 | 10 | 27 | 17 | 7 | 71 | 35 |

3. Blight-resistance (Table 4)

The categories were determined on the basis of evidence of blight. Such evidence consisted in number of cankers present, presence of sprouts where the main stem had died, and dieback of tops. The categories, though not as precise as the numerical data obtained from tree size, are believed to be reasonable ones. It was seldom difficult to place a tree in one of the five categories. A surprisingly large number of trees (40 %) were placed in the blight-free category. The American-Chinese OP hybrids and Connecticut hybrids showed slight superiority in blight resistance to the other groups.

Table 4. Number of Trees by Blight-resistance Categories for Four Groups of Chestnut Trees at Table Rock State Park, S. C. (Age - 24 yrs.)

| | Blight-resistance Categories | | | | | | |
|---|---|---|---|---|---|---|---|
| | 5 | 4 | 3 | 2 | 1 | | |
| Group | None | Light | Moderate | Heavy | Severe | Totals | Means |
| Chinese-Nanking 58602 | 4 | 0 | 3' | 4 | 0 | 11 | 3.4 |
| American-Chinese OP | 5 | 6 | 0 | 1 | 1 | 13 | 4.0 |
| Maryland Hybrids | 3 | 2 | 2 | 2 | 2 | 11 | 3.2 |
| Connecticut Hybrids | 17 | 7 | 6 | 2 | 4 | 36 | 3.9 |
| Totals | 29 | 15 | 11 | 9 | 7 | 71 | 3.7 |

4. Tree Form (Table 5)

From a timber tree point of view, the trees were rated in five categories ranging from excellent to valueless. Means were again determined by giving the categories numerical values. The table shows that the American-Chinese OP trees were superior to those of other groups.

Table 5. Number of Trees by Tree Form Categories for Four Groups of Chestnut Trees at Table Rock State Park, S. C. (Age - 24 yrs.)

| | Tree Form Categories | | | | | | |
|---|---|---|---|---|---|---|---|
| | 5 | 4 | 3 | 2 | 1 | | |
| Group | Excellent | Good | Average | Poor | Valueless | Totals | Means |
| Chinese-Nanking 58602 | 0 | 1 | 3 | 6 | 1 | 11 | 2.4 |
| American-Chinese OP | 1 | 4 | 6 | 1 | 1 | 13 | 3.2 |
| Maryland Hybrids | 1 | 2 | 2 | 5 | 1 | 11 | 2.7 |
| Connecticut Hybrids | 1 | 7 | 15 | 10 | 3 | 36 | 2.8 |
| Totals | 3 | 14 | 26 | 22 | 6 | 71 | 2.8 |

5. Summary of Results (Table 6)

In four of five categories, the open-pollinated American-Chinese hybrids were superior to the other chestnuts. This superiority might be attributed to the following: (1) There appears to be a higher percentage of American chestnut genes in these trees than in most of the others. In the Glenn Dale hybirds, Clapper used many Chinese-American hybrids backcrossed to Chinese chestnut; and in the Connecticut hybrids, Graves also used the Japanese chestnut (Castanea crenata Sieb. & Zucc.) extensively (see Diller, Clapper, and Jaynes, 1964 for a partial pedigree list of these hybrids). This species is a smaller tree than the Chinese chestnut and generally less vigorous when grown in this country (Wyman, 1965). (2) The proportion of inbreeding may have been higher in the Glenn Dale and Hamden hybrids due to heavy use of a few selected trees. The pedigrees of many hybrids are not known.

Table 6. Summary Values for Four Groups of Chestnut Trees at Table Rock State Park, S. C. (Age - 24 yrs.)

| | Rankings | | | | | | |
|---|---|---|---|---|---|---|---|
| Group | Survival | Diameter | Height | Blight | Form | Sum of Ranks | Final Ranks |
| Chinese-Nanking 58602 | 1 | 3 | 3 | 3 | 4 | 14 | 3 |
| American-Chinese OP | 2 | 1 | 1 | 1 | 1 | 6 | 1 |
| Maryland Hybrids | 3 | 3 | 4 | 4 | 3 | 17 | 4 |
| Connecticut Hybrids | 4 | 2 | 2 | 2 | 2 | 12 | 2 |

## A PROPOSED BREEDING PROGRAM

### 1. Selection

In selecting trees for a breeding program from this plot, all categories of species and hybrids will be considered. On a combination of growth, form, and disease resistance patterns, three of the 71 trees were rated superior to all others. These are:

F-28, an American-Chinese OP, 6.9 in. dbh, 51 ft. tall, excellent form, blight-free;
F-31, a Glenn Dale Hybrid, 10.0 in. dbh, 58 ft. tall, excellent form, blight-free - this is the tallest tree on the plot;
F-65, a Hamden Hybrid, 7.6 in. dbh, 44 ft. tall, good form but with some heavy limbs, blight-free;

Several others including F-67 (a Hamden hybrid, 11.2 in. dbh (largest), 56 ft. tall, form fair but with heavy limbs, blight-free, best seed producer in 1969 and 1970) could be rated very good and may be acceptable in a breeding program.

In their 1964 evaluation, Diller, Clapper, and Jaynes recommended that vigorous trees averaging two feet or more of height growth per year should be evaluated for their forestry potential. On this basis ten trees of the 71 present (14 percent) would be considered. However, form and disease factors reduce this number so that the number of fully acceptable trees is much fewer. For example, Tree F-26 is 9.7 in. dbh and 54 ft. tall, but it displays many cankers despite its present vigor, and would not be acceptable in a breeding program.

### 2. Propagation

Vegetative propagation, including grafting and the rooting of cuttings, and seed propagation will both be attempted for the better trees. Grafting of chestnut scions unto suitable rootstock is a well-known technique and has been practiced for many years (Jaynes and Graves, 1963). Rooting of cuttings has not given consistent results although certain clones may root quite well. Seed propagation is easiest and may well be the best method. Mass planting of 0-P seed from the better trees would assure a broad genetic base and allow a greater choice for selecting superior trees. Crossing desirable clones, such as those listed above, will also be attempted.

The development of superior, disease-resistant chestnut trees for forestry purposes is still a task for the future. From plantings, such as those at Table Rock and others established over the past 25-30 years, tree breeders have hopes of bringing the chestnut back. That hope seems brighter now than ever before.

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