

Nienstaedt

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MF

**Notes on the Chestnut:
Breeding, Culture and Botanical Characters
of Species and Hybrids**

Acknowledgments

By

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INTRODUCTION

GENERAL DESCRIPTION OF THE GENUS *Leptocryptus*

- External characters
- Coloring
- Male genitalia
- Parasitoid habits
- Life history

DESCRIPTION OF THE INDIVIDUAL SPECIES AND VARIETIES

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INTRODUCTION

More than forty years have now elapsed since the forester at the New York Zoological Garden, Mr. H. W. Merkel in 1904 (85) as the first in the United States realized the seriousness of the new epidemic fungus disease on the American chestnut, Castanea dentata. In an article in the "Tenth Annual Report of the New York Zoological Society" January, 1904 he drew public attention to the matter.

Since then the fungus, now known as the fungus of the chestnut blight Endothia parasitica has spread over the range of the American chestnut with great rapidity. In 1911, only seven years after Merkel found the blight in New York City, the disease had spread over an area from New Hampshire through southern New England and eastern New York to western Pennsylvania, Virginia and West Virginia. (2). In 1925 about 3/4 of the commercial range of the chestnut had been covered (44) and in 1931 Baxter (15) expressed the opinion that most of the virgin chestnut timber would be killed by the blight within 10 or 15 years.

The seriousness of the blight, the most fatal forest tree disease known, (80) called forth a large amount of work in the field of control of the disease and study of the fungus. The initial problem facing the scientists was whether it was an introduced or a native fungus. If the latter was the case and only extreme climatic conditions had caused the sudden epidemic outbreak, the future would not be too grim, and there was a possibility that the fungus would go

back to its saprophytic condition of itself. (28). After the fungus was found in China and Japan (99,100) it was, however, obvious that the fungus was introduced from those countries and it had to be expected that the spread would continue regardless of the climatic conditions, as long as the native chestnut tree did not show any resistance to the disease.

The trend of the control of the disease in the early days, while control still was considered possible, was that of elimination of advanced spot infections, extensive examination of nursery stock before shipment, injection of chemicals in the tree trunks to make them resistant to attack, spraying with Bordeaux mixture and cutting out of the infected spot on the trees, etc. Leading in this type of work was the Pennsylvania Chestnut Tree Blight Commission, which was established in 1911. The work of this organization was short, however, and since 1913 no attempts have been made to check the spread of the disease.

With the discovery of the presence of the fungus in China and Japan and the relative resistance of the chestnut species found there, the Japanese chestnut Castanea crenata, the Chinese chestnut Castanea mollissima Chinese chinquapin Castanea sequinii and the Chinese timber chinquapin Castanea Henryi, new hope was aroused with regard to the possibility of bringing the chestnut back to the American woods. This could be done by the breeding of a new resistant strain of chestnut by crossing the above mentioned Asiatic species with

the susceptible Castanea dentata.

The earliest hybridization work carried out with chestnut was started in 1888 by George W. Endicott of Valley Ridge, Ill. He was working only for the improvement of the nuts in the Japanese chestnut and his work resulted in the variety Boone, which he developed in 1894. (33).

In 1894 Walter van Fleet started his first breeding work also with nut improvement as the main purpose. Van Fleet was working mainly with the crossing of American chinquapin Castanea pumila with the leading European varieties and with Japanese chestnut. He developed one important hybrid the so-called S-8 C.pumila x C.crenata, which since his death has been used in further crossing by the Division of Forest Pathology of the Bureau of Plant Industry, Soils and Agriculture Engineering, United States Department of Agriculture.

The Division of Forest Pathology extended Van Fleet's work beginning about 1928 so that it now includes not only the breeding for better nuts, but also the breeding of a tree of timber type, which can take over the position of the old American chestnut in the forest areas in the eastern United States.

In 1930 Dr. A. H. Graves, then curator of the Brooklyn Botanical Garden, started breeding work with the chestnut. Dr. Graves had since the very beginning of the epidemic been interested in the subject, and had constantly been on the lookout for resistant strains of the American chestnut, which

might have developed, as the blight swept the country--a thing of great importance also in the present breeding work. But not until 1930 did his actual breeding work start. In this year he made his first crosses between C. crenata, which he found as large trees on several estates on Long Island, and C. dentata, hoping that this hybrid would have the resistance of the Japanese parent and the tall, erect growth of the American. These first crosses yielded 10 nuts, but in spite of great care all the nuts molded and not a single plant was obtained. This initial very discouraging result, however, did not prevent the starting of new crosses again the next year, this time with better results, and from this year and up to the present time new crosses have been made every year.

The first crosses made were, as said above, C. crenata x C. dentata, but since 1934 other species of the genus *Castanea*, both the chestnut proper and the chinquapin, have been used to a large extent. Especially the C. mollissima has, because of its high degree of resistance, been used in many of the most important hybrids developed.

This paper is an attempt to give a botanical description of some of the more important species and hybrids. The native range of the species will be given and in the Chinese and Japanese chestnut the climatic conditions over their native range as determining the area in which they can be introduced in the United States will be discussed. The raising of chestnut trees from the germination of the nuts

to the care of the older plantation will be taken up for consideration including such factors as germination, temperatures required, care of the young seedling, establishment of a plantation under forest cover with requirements of light and site, pruning, cultivation, fertilization, etc. Finally, injuries of the chestnut caused by animals or climate will be described, and means of control considered.

In an appendix the results from an experiment designed to find a way to hasten the germination of the nuts and involving some 1500 nuts of Chinese and Japanese parents will be given.

slightly cordate. The margin is more or less markedly serrate. The veins are thin and run to the slender teeth at the end of the serration. Stipules are present but deciduous. The leaf-scar is semi-circular with 3 or more bundle scars forming an irregular row.

A somewhat more thorough description of the flowering habit of the chestnut may be of interest at this place, it being rather complicated and of great importance in the breeding work.

The chestnut is monoecious. The flowers are borne on the present year's growth in long aggregated catkins. Near the base of the flowering branch the catkins are unisexual and bear male flowers only; these are found in clusters of 3-7 and the individual flowers consist of a 4-5 lobed calyx with 10-20 yellow stamens with long filaments. Nearer the apex of the branch the much shorter bisexual catkins are

GENERAL DESCRIPTION of the GENUS CASTANEA (Adams) Mill.

The genus *Castanea* is a small genus of about 13 species found in southern Europe, eastern United States, southwestern and eastern Asia.

It is composed of deciduous trees or shrubs with furrowed bark. The twigs are usually stout, terete and without true terminal buds. The buds are covered with two or more pairs of slightly imbricated scales. The leaves are ovate, elliptical or obovate in shape with acuminate apex and cuneate to rounded or slightly cordate. The margin is more or less markedly serrate. The veins are thin and run to the slender teeth at the end of the serration. Stipules are present but deciduous. The leaf-scars are semi-circular with 3 or more bundle scars forming an irregular row.

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found. They consist of staminate flowers similar to the ones just described, and at the base the pistillate flowers are found, either solitary or in clusters of 2-3 (occasionally 5 or 7) surrounded by the involucre which later forms the characteristic spiny bur. One or several such clusters of pistillate flowers may be found at the base of the bisexual catkins. (75.93.95.101.103.).

The shedding of the pollen falls into two distinct periods. First the unisexual staminate catkins at the base of the flowering branch shed their pollen, and not until several days later do the male flowers on the bisexual catkins mature. The pistillate flowers may begin to bloom either before or after the shedding of the pollen from the basal unisexual catkins. (101.103). This has been called duodichogamy as opposed to dichogamy, where there is only one time of pollen shedding and one for blooming of the female flowers, the two periods occurring at different times. The pollen from both types of catkins has been proved to be fertile. (103).

As stated above, the pistillate flowers may start to bloom either before or after the pollen shedding of the unisexual basal catkins, thus being either protandrous (♂ flowers developed first) or protogynous (♀ flowers developed first). Some trees are almost synacous, (♂ and ♀ flowers maturing at the same time). The protandrous trees usually have a long period of staminate blooming and a relatively short period of blooming of the pistillate

flowers; in the case of the protogynous trees the situation is reversed. The protandrous trees are the most common..(103).

The chestnut is well known for its almost complete self sterility and the question is then, how does the above described habit of flowering influence this, and are there any other factors affecting the result. The duodichogamy involved has the effect, that the period in which close pollination or self-fruited can occur is limited. If we consider a protandrous tree, it is obvious that no close pollination can occur in the beginning of the period of blooming when only male flowers are mature. In the mid-period of blooming, however, both male and female flowers are developed and close pollination is possible; thereafter, at the end of that period the pistils have ceased to be receptive, and although pollen still is produced, no close pollination can occur. In the protogynous tree it is again (due to the long period of pistil blooming and the short period for pollen production) the two end periods in which close pollination is impossible and a cross pollination necessary for the production of fruits. (103).

It is thus obvious that although the condition of duodichogamy shortens the period in which close pollination can occur another factor must be present to obtain self-sterility. (103).

Vilkomerson (103) made several controlled close pollinations (a total of 464 flowers) and obtained only 4 nuts..

The fruit is a light to dark brown (sometimes with dark spots). Stout examined 2 separate chestnut trees in California and found that although the burs reached full size, not a single fertile nut developed. A similar example was noted by the writer this fall in Cheshire, Conn. Here a big Japanese chestnut tree bore a heavy crop of burs, but only one nut was found; this has been the case with this tree also in the past. Apparently the pollen from the same tree is incompatible, so that this and duodichogamy are the two factors resulting in the self-sterility of the chestnuts.

Cross pollination takes place with ease. An examination of our pollination records from 1935 to 1946 showed that of 169 different combinations tried, 130 or 77% were successful at least once. The 23%, which were unsuccessful, are in all cases, combinations which only have been tried a few times, and not enough to prove definitely that the pollen is incompatible.

Finally it may be stated that parthenogenetic development of nuts has been found in the case of C. pumila by Morris. (87). After removing the staminate flowers of the bisexual catkins the pistils were bagged and although no pollen was applied, he obtained fertile nuts, which however showed certain peculiarities, such as chlorophyll in the cotyledons which were protruding through the seed coat before the nuts were fully developed. Also the plants which developed differed from normal, some having much larger, others much smaller leaves.

The fruit is a light to dark brown (sometimes with darker stripes) nut, glabrous or tomentose, ovoid in shape, acute and with a pointed apex which bears the remnants of the style. The hilum is a large pale scar which more or less completely covers the base of the nut. The nuts are borne solitary or in clusters of 2-3 in a 2-4 valved involucre. The involucre, which later forms the bur, is globose or short oblong; the insides of the valves are more or less tomentose, and the outside pubescent or tomentose and covered with rigid hairy or glabrous often much-branched spines. The cotyledons are large and fleshy, more or less sweet, and have a high food value, containing a large proportion of starch.

Studies of the chromosome number have been carried on by Wetzell. (104). He found a haploid number of 11* in the species C. sativa and C. crenata. Moreover, he found that in the order Fagales the number was constant within the various genera; it thus seems justifiable to assume that the same number will be found in all species of the genus Castanea.

* After this thesis was written a reference (Richens, R.H.: Forest Tree Breeding and Genetics. Imp. For. Bur. Oxford, England, 1946) was found, which gives the haploid number for C. dentata and C. sativa as 12

* Computed by the writer.

