Contents Vol V, #1

ACF Receives Major Grants

The Foundation is continuing to broaden its base of support. Not only is our general membership steadily increasing, but we are now increasingly able to attract major gifts from private foundations and persons.

For the last three years, the Merrill G. and Emita E. Hastings Foundation has supported us to the maximum their guidelines will allow, in spite of the fact that their usual policy is not to fund any particular organization for more than two years in a row.

Mr. Brad Stanback, benefactor of many environmental causes in the Appalachians, and a major supporter of the Longbranch Environmental Education Center in North Carolina, last year responded to our request for special help with a gift of $40,000 for our general operations fund. This gift was tremendously important to us, and among other things, made President Rutter's search for germplasm in China possible by freeing him (temporarily) from fundraising chores.

Most recently, the hiring of our new Executive Director was made possible by a special gift from Mr. Wallace Dayton of $20,000. Mr. Dayton is a dedicated and honored conservationist. He has served in many ways, among them as a Trustee of the National Audubon Society, Chairman of the Board of Governors of the national Nature Conservancy, and as Chairman of the Minnesota Nature Conservancy. A few of his many awards are the 1985 Nature Conservancy Land Guardian Award, and the 1986 Garden Club of America Cynthia Laughlin Medal.
We are very proud of the trust placed in the American Chestnut foundation by these eminent conservationists.

Letters to the Editor

Sir-

We have read with interest the FaII/ Winter, 1989-90 issue, Vol. IV, No. 1 of the *Journal of the American Chestnut Foundation,* but note the need for better proofreading in its production. There are a number of typographical errors that detract from the message that the articles are intended to transmit.

Furthermore, the article on page 23 seems to have no author, and it does not appear in the Table of Contents.

The illustration on page 24 has the word *canker* misspelled and the root connection between the multiple stemmed growth form at the left should be shown to illustrate the origin of the larger tree. The sketch should be drawn in such a way that the dead portion of the crown can be distinguished by the reader at a glance.

It seems to me that pages 10 through 13 ("Service of Dedication" - Ed.) are out of place in this journal.

Sincerely,
Donald B. Lawrence
Minneapolis, MN

Frederick L. Paillet *of the Department of the Interior, Denver, made the drawings and accompanying texts in the last issue. Dr. Pail-let also drew the illustration on the covers of the last issue and this. Acknowledgment was inadvertently omitted during the production process. We apologize to our readers and to Dr. Paillet, and look forward to publishing more of his helpful work in future issues.* Ed.

Sir-

You have sent me my first copy of your journal, and my curiosity is aroused. Since all of us who subscribe have an interest in growing good chestnuts in America, it seems a foolish waste of your excellent paper to recite again the fall of the American Chestnut. Surely there are more substantial subjects to be discussed than the glory of the split-rail fence.

You list some producers of Chinese Chestnuts. Would it be feasible to discuss with some objectivity the flavors and size of the nuts from the various cultivars? Even the Chinese Chestnut is not perfectly immune to the blight; is there someone who could discuss the early signs of infestation with E. *Parasitica?*

Thank you for your interest.

Wallace C. Bedell
Free Union, VA

Editor's Notes

Chestnut growers and supporters have accurate and discerning eyes. Many members have written or called to observe that *The Journal of the American Chestnut Foundation* has appeared irregularly since it began publication. *The Journal* depends upon a constant stream of Notes, Memories & Observations, and Scientific articles for its existence and frequency. On the editorial side, we are still experimenting with procedures and format. Our goal is two issues per calendar year to keep our membership up to date on scientific and organizational progress. This issue is "less late" than earlier issues have been, and we will exert every effort to be increasingly regular in the future.

Although back issues of *The Journal* are rare, we include in this issue an index of Volumes I through III. If there is sufficient interest from libraries, photocopies or microfilm of back issues might become available. Those who own early issues of *The Journal* are permitted - even urged -to make reasonable numbers of photocopies for colleagues in pursuit of the goal: *"Toward the Restoration of an American Classic."*

Angus W. *McDonald,* Jr.

President's Message

July 1990

Philip A. Rutter

Whenever I sit down to write one of these messages, I have to struggle to narrow the possible topics down to a sensible number. This time is no exception. So many things are happening for the ACF that our already overloaded volunteers just can't handle the volume of communications. And it's all good news! It's just that there is so much of it we are getting frustrated trying to keep you up to date. So, please forgive me if I hit several topics briefly rather than talking about one thing in detail; it seems to be necessary.

Item 1: *National Geographic Magazine*

In case you somehow missed it, the article on chestnuts appeared in the February 1990 issue. It was well written and beautifully photographed. Since our Foundation's activities are prominently featured, it is not surprising that it is proving to be a tremendous boost for us. It has resulted in many new contacts and possibilities; we'll be telling you about them as they become realities.

I find that one of the most important side effects of the article is credibility. For years, we have had to struggle to explain to potential supporters just *why* working to restore the American chestnut was not foolish and quixotic, but absolutely reasonable in terms of solid science, ecology, and cold hard cash. The *Geographic* allows conversations to move quickly to questions of action.

You can get copies of the February *National Geographic* by telephoning this toll-free number: 800-638-4077, and simply placing an order. The cost is $2.65 per copy, post-paid, and they will send you a bill with the magazines. Buy several for your friends, and brag about the great organization you belong to!

Item 2: China

I had hoped to be able to present you with a complete report in this issue of the *Journal* on my experiences in China and the results of the investigations there. Because so many things are happening, however, it has simply not been possible to complete it. The China expedition is easy to summarize, however. Absolutely everything I saw in China makes me *even* more confident that our effort to restore the American chestnut will be successful. There is blight everywhere in China, and it is simply unimportant.

I brought back some writings from the Ming Dynasty about the history of chestnuts in China, which we are in the process of translating now. I was also successful in bringing back seed from wild chestnut trees, as well as orchard trees. The seeds have resulted in more than 450 seedlings, now in the care of Dr. L. J. Grauke of the USDA Clonal Germplasm Repository system; he tells me some of them are already more than 3 feet tall. As soon as we can satisfy all the quarantine requirements, we will be planting them out in permanent locations, so they can be tested for the possibly improved blight resistance they may he carrying.

The next issue of the *Journal* will have a complete report on my experiences in *China. Also,* if you come to the Annual Meeting, I will be giving a slide presentation-report there. You will probably also have a chance to meet my Chinese host, Professor Huang Hong-wen; he is spending a year in the USA working at Auburn University.

The Chinese are very interested in chestnut, and very interested in The American Chestnut Foundation. I am currently trying to arrange for three officials of the Hubei Provincial Science and Technology Commission to visit the U.S. this fall, to tour some of the various chestnut research projects with an eye towards long-term cooperation. We have a considerable amount to gain. Chestnut is an important commercial crop in China; they have many scientists who know a great deal about the trees, a tremendous amount of genetic diversity, and a serious interest in cooperation.

Item 3: The Annual Meeting

Speaking of the Annual Meeting, it will be held in Carlisle, Pennsylvania, October 20-22. Details can be found on page 7 of this issue. We really hope you can come; it promises to be an excellent meeting, at a beautiful location, at a beautiful time of the year. We will be going to see our young hybrid chestnut

planting, being maintained by the Natural Lands Trust at their Blue Mountain preserve. Please come!

Particularly those of you from Pennsylvania-there is a very serious effort underway in Pennsylvania to establish a state Chapter of the ACF, similar to the one already operating in New York. We hope our Pennsylvania members will be able to come to Carlisle and together finalize some of their decisions about details.

Item 4. State Chapters

The New York Chapter of The American Chestnut Foundation is incorporated, and is a reality! Groups in other states are starting to work hard at getting chapters going. Efforts are seriously underway in Connecticut, Pennsylvania, Maryland, Virginia, North Carolina, and Tennessee. If you live in one of these states, you can expect to hear from your state group *before too long*.

Item 5. The Endowment

The American Chestnut Foundation has now taken an extremely important step, by establishing an endowment for the Foundation.

Our project of restoring the American chestnut tree is going to take time. Even though we expect to have significantly blight resistant trees growing and being tested in 10 years or less, the long-term tasks of testing, further improvement, finding resistance to other pests, and the re-establishment of the species back into the forest, will take much longer. The best way to ensure that the Foundation will continue to function in coming years is to begin now an endowment to provide the funding that is going to be necessary for the education and projects.

The endowment exists. I am proud to say that I made the first contribution to it myself. It was only $250, but it is extremely satisfying to know that this small sum should provide at least $2O per year for chestnut research, every year, for as long as it takes to bring our tree back. The President of the New York Chapter, Herb Darling, has handsomely added $1,000 more, and other contributions are starting to come in.

This is a way in which you can make a gift that will continue to give for years to come. Contributions to the endowment actually help to reduce our operating costs, since income generated by the endowment is essentially "free"; we don't have to spend money on fundraising to find it. Many people consider a gift to an endowment particularly appropriate for bequests or memorials; if you have been thinking about such a possibility, please remember the many benefits a restored American chestnut tree will bring to our country and our future, and be generous.

Item 6. Professional Staff

In past President's Messages, I have written apologies to those people whose letters I have not been able to answer. Such an apology belongs in this message too, because I am still not able to answer all the letters I receive. If I owe you a letter, perhaps you can take comfort from the fact that it is often the especially interesting letters which don't get answered, because they tend to be set aside for careful personal attention in that mythical future when there will be "more time."

This is no way to run a railroad; and the Directors have decided that the time has come for the ACF to establish a professionally run office. We are in the process right now of hiring an Executive Director with experience in running a non-profit corporation. We expect this will go a long way towards regularizing the day-to-day functions of the Foundation. As always, however, hiring people is expensive. The experience of every other non-profit organization is that a good executive will pay for himself or herself many times over. But getting over the initial hurdle of finding the necessary money continues to be a difficulty. While we actually have several candidates in the final stages of selection, we do not yet have all the money we need to support such a person in the best possible way. If this is something you would like to see happen; if you would like to have your letters answered faster, the *Journal* published quicker, our news kept up to date, and better fundraising for our expanding projects, then please consider making a special extra contribution now, to help put us on a sound, professional, footing.

As always, we must have your help in order to move forward. The American chestnut is no longer a "lost cause"... but without your help, it would have been.

Meadowview Notes

Dr. Frederick Hebard

My wife, Dayle, and our children, Kyla and Paige, have been here on the farm in Meadowview for almost a year. For me, it has been an exciting time, being able to get started on a full-scale program of breeding for blight resistance. It is a program that I know will be continued by the Foundation until it is completed. It is something I have been preparing for a long time.

> Some of my memories from the first year: Digging 300 holes through the turf by hand to plant our first trees - that was hard work. Buying a tractor at auction. Tracking aluminum shavings through the house when building the base for our pollination ladder. Pollinating in Connecticut with Larry Inman and Sandy Anagnostakis. The excitement of harvesting nuts from the pollinations Building the fence - three words to describe more than a month of hard work. Plowing ground for February nut planting. Getting swamped with mail and phone calls after the *National Geographic* article. Helping arrange Earth Day festivities in Washington. DC, with Congressman Hunter, then driving there and to Scientist's Cliffs, MD, and back to Meadowview in one day.

At this time, we have about 300 saplings growing at the farm. Most are breaking bud now. About 1,000 nuts have been planted this year. The first are starting to emerge.

Finally, as some of you may know, Anna Belle Wagner passed away this past February. She made this farm possible. Her sparkle and drive will be missed by all of us.

May 1990

Chestnut Tree Planted at Walden at Earth Day Celebration

Mary P. Sherwood

WEW planted a Dunstan hybrid chestnut tree at Walden on Earth Day, April 22.

Ever since the chestnuts of the hard-wood forests of the east were killed by the blight from Asia in the early 1900s, re search has been carried on by forest geneticists to try to develop an immune form of the American chestnut *Castanea dentata* mainly by crossing some of the few surviving trees with the immune Chinese chestnut...

In Thoreau's time the American chestnut was found all through the Concord woods. He often took the town children on chestnutting walks to the Estabrook woods and to the Walden area, then helped the children roast the nuts by their family fireplaces in the evening. I myself had to pass under a huge chestnut tree to get to school and was given the task of collecting the nuts for Thanksgiving stuffing.

The chestnut not only afforded abundant food for the wildlife of our eastern forests but was the most rot-resistant wood. It was used for fence posts, post poles, or anywhere that wood had to be in contact with the soil. It was also the standard wood used for railroad ties and at least one story has it that the ties of the tracks at the west end of Walden were chestnut.

> When I first saw Walden in 1958 there were still a few very large chestnut trees standing behind the cairn site. Such tall, gaunt trees - most of them were two feet or more through - were common throughout the woods of New England until the CCC was given the chore to cut them down and saw them into lumber in the 1930's.

By then however the wood, while still not rotted, had been invaded by wood borers, which produced what became known as "wormy chestnut." This was considered so decorative that lumber companies deliberately punched holes in other woods to emulate the wormy chestnut. The tables and walls of the small forest museum in the Connecticut State Peoples Forest are made of wormy chestnut, all cut there in the forest by the CCC.

The non-rotting quality of this tree has resulted in chestnut sprouts coming up from the stumps of the downed trees, many of which can be seen all over the Walden reservation today. These never attain blossoming size because the blight spores remain viable in the soil and kill the young trees before they mature... In the 1960s I knew of a chestnut in Carlisle which produced blossoms, then nuts, for four or five years before it too succumbed to the blight. A similar one existed in Wayland on Rte. 126. However, although I have checked the sprouts at Walden for the last 30 years, not has approached blossom size.

sent by Ed McGarrity

Reprinted from *Walden Forever Wide Newsletter,* Number 27, Spring 1990

[The Dunstan hybrid chestnut tree is largely of Chinese ancestry.-Ed.]

Chestnuts

Kurt Rheinheimer
Editor, Blue Ridge Country

The blight was too far along for them to have been American chestnuts, but there's a boyhood memory of my parents pulling a cookie sheet of hot chestnuts out of the oven and then trying to talk us children into tasting one. I remember the nuts as visually appealing- maybe just because my mother's hand *always* meant some thing good. And the shape - the split brown casing around something steaming and soft-looking - must have added to the initial enticement.

But they just weren't a children's delicacy. The taste to me was as much like warmed-up, waterlogged chalk as any-thing else, so we left the full sheet for our parents to enjoy. I guess in our youth and ignorance we'd have had no problem if we never saw them again. And while those were Italian chestnuts from the grocery store, the disappearance of our own native trees has continued unabated since those days back in the 195Os.

The blight was first noted in New York state in 1904, entered the Blue Ridge region from the north by 1908, and by 1945 was present in all areas of the tree's natural range - from Maine south along and to either side of the Appalachians south into Alabama and even eastern Mississippi. Before the march of the disease, about one in every four trees in that huge 17 state area was a chestnut. Now there are just a few survivors per state, and a great American resource - not just for food, but for lumber, fences, landscaping, shade, and more - has virtually disappeared. A parallel event in the animal kingdom might involve the rabbit or the deer, but the impact on our culture of the disappearance of the tree which has been called the most useful hardwood species in the eastern United States has caused more disturbance in the fabric of our society. Try to think of a town without a Chestnut Street. Or recall, albeit out of season, one of the most recognizable lines in American music - the one about the open fire and the chestnuts roasting.

Maybe it's that kind of entrenchment of the chestnut in our psyches that has helped to spawn a resurgence of efforts to develop a blight resistant tree. Efforts in the 192Os, '3Os, and '4Os - for the most part attempting to breed a more resistant tree - ended in general failure. But a new generation of researchers in the Southern Appalachians (along with a national organization begun in Minnesota but now based in West Virginia) is at work trying to return the chestnut to its proper place in the Appalachian forest and the home landscape. Biologists and arborists at Virginia Tech in Blacksburg, Virginia; at Concord College in Elkins, West Virginia; and at the universities of West Virginia, Kentucky, and Tennessee are exploring several distinct tracks toward eradication of the blight.

Trees infected with a hypovirulent (low) level of the blight fungus have in isolated instances recovered. Though the early hope of these trees providing a 'vaccination' for other trees has ebbed, researchers still see hypovirulence as an important step toward recovery.

Promise has also been shown with a breeding technique using non-blight resistant American chestnuts in initial hybridization with fully blight resistant Chinese chestnuts. Subsequent generations are then back bred to be more and more American (there are some 16 million different gene combinations in the chestnut) and at the same time carry the resistance from the Chinese strain.

There is also an attempt to use genetic material from several large, surviving American chestnuts through grafting.

Irradiation of nuts is being carried out with the hope that resulting mutants will produce a resistant strain.

The people doing the work - people like Gary Griffin at Virginia Tech - carry a quiet, passionate patience about what they do. The work is slow. It takes years to grow a tree to the point that it will produce nuts, but the overall attitude seems to be that the task will be accomplished.

If the job does get done - Griffin says the chestnut could be restored to economic significance within SO years - then the great Appalachian forest would be r~ transformed. Not to the extent that some might dream - the virgin forest that covered these hills for thousands of years, and as late as the 1700s still encompassed the whole of the Blue Ridge region, had already been almost fully destroyed by the 194Os - but perhaps at least to the point where it stood before the advent of the blight, when the chestnuts reached 120 feet into the blue mountain sky, with trunks up to 13 feet in diameter. The oldest of the trees had stood for 500 years on the Appalachian forest floor, well anchored in their preeminence before the blight brought them down.

The battle will be long and slow, and probably won't be won in the lifetimes of most of us. But part of our

ties to this beautiful land are to the forests that give the mountains their life and shape and majesty.

Among the many things we must preserve and present to the generations that come after us, those things that grow around us are surely among the most important.

And besides, every little boy of 10 or so should have to taste a roasted chestnut. An American chestnut.

Reprinted with permission from Blue Ridge Country

Chestnut Breeding in New England

A Midwesterner's Observation

Larry Inman

[Products of long abandoned chestnut research are being used to breed blight resistant trees in Connecticut. Breeding methods for field and garden crops can be adopted for chestnuts, making it likely that the minimum time per generation of breeding (seed to seed) can be reduced to three or four years, considerably shortening the time required to breed locally adapted varieties of blight resistant forest type American chestnuts. -Ed.]

With the encouragement of Dr. Charles Burnham I neglected my Minnesota farm for several weeks last June in order to assist with the crosses made for the American Chestnut Foundation at the Connecticut Experiment Station.

Years ago as a graduate student, I read about the chestnut breeding research, so the area is of historical interest. My trip was an opportunity to see the old plantations of hybrid chestnut trees from the early chestnut breeding research by Graves and the USDA.

There was a Clapper clone which I have used to pollinate American chestnut trees growing at the University of Minnesota Landscape Arboretum. Other selected hybrids from the abandoned chestnut breeding research are being used as a source of resistance to chestnut blight for the current backcross program to breed blight resistant forest-type American chestnuts.

Time was too short to meet all of the cooperators on the long list that had been provided for me. Those I did meet were most hospitable in the way they showed me around and explained their unpublished work.

The best flowers for crossing chest-nuts are too high for an orchard ladder, and they cannot be reached by climbing the tree. Fred Hebard has designed a ladder for such situations. it is an extension ladder mounted on a broad base. He can extend it vertically to a greater height than an orchard ladder without leaning it against the tree.

Philip Gordon is one of the most enthusiastic supporters of the efforts to restore the American chestnut. He has been scouting the woods in southern Connecticut to locate large survivors, sprouts and pre-blight seedlings that can be used as a source of locally adapted germplasm for chestnut breeding. As parents for chestnut breeding, suppressed seedlings are genetically equivalent to the magnificent trees in the original forest before the devastation of the chestnut blight.

Due to their smooth bark, suppressed seedlings are not invaded by the fungus for chestnut blight. But the American chestnuts are rarely reproducing naturally from seeds within their natural range because the sprouts and suppressed seedlings are killed back by the successive waves of chestnut blight reinfection before they are mature enough to produce quantities of seed.

However, the suppressed seedlings can be induced to flower and produce seed by grafting them onto suitable root

stock. By marking the suppressed seedlings with colored flagging, they can be easily recognized for the collection of cuttings when the leaves are off the trees. When propagating fruit trees, a highly skilled nursery laborer can bud about 2000 trees a day.

Apple and pear trees grafted on dwarf root stock flower and produce fruit while they are still growing in pots. Dr. Sandra Anagnostakis has dwarfed American chestnuts by grafting them onto related chestnut species. She has dwarfed chestnut trees that produce pollen and seed in quantity the second year after the graft. With the dwarfed trees which grow like bushes, it may be that the time per generation for backcross breeding chestnuts can be reduced to three or four years. More-over, dwarfs are a convenient height for crossing while sitting on a high stool.

Paul Galloway is a tree farmer in New Hampshire with considerable experience as a contractor. Like Fred Hebard, he is ingenious in his development of techniques to reach the flowers of trees that are too high for an ordinary extension ladder.

He has located an outstanding American chestnut tree on his farm. It appears to be a young, fast-growing tree that has escaped infection by chestnut blight. I do not have the measurements, but it is tall, straight, and free of branches to an impressive height.

His tree is a convincing demonstration of the commercial potential of the species. The wood of the American chestnut is as durable as redwood. Thinnings from a pole stand with a comparable form would be ideal for telephone poles. When grown to sufficient maturity, similar trees should produce several logs that would cut out with a high percentage of clear lumber.

The observations on my trip to New England have reinforced my conviction that adaptations of the breeding

methods for the field and garden crops can be used effectively for breeding chestnuts. Due to demonstrated technique, it is likely that the minimum time per generation of breeding can be reduced to three or four years from seed to seed. Now the estimated time required to breed locally adapted varieties of blight resistant forest-type American chestnuts is shorter than originally considered to be necessary.

A Case of Hypovirulence in the Wild

Text and Drawings by Fred L. Paillet
U.S. Geological Survey

Hypovirulent chestnut blight has been established for nearly a decade at several locations where hypovirulent blight strains appear to have arisen spontaneously, and at many others where hypovirulence was deliberately introduced in an effort to control blight. My first drawing (page 19) shows a large chestnut sprout I have been following over the years. This tree seems to have had at least one hypovirulent canker and is now developing a second almost a decade after the first infection. One tree is not a very scientific sampling, but the data being patiently accumulated by researchers will comprise the results of many such stories. My example illustrates some of the most optimistic results to be expected when hypovirulence becomes widely established in eastern forests.

This chestnut tree first caught my eye when I was traveling along the Dulles access highway on my way to our nation's capital. From the window of a rental car, I noticed new construction carved out of an old woodlot and stopped to take a look. This was old second growth woodland established on former tobacco fields and now dominated by. white, southern red, and chestnut oaks. Only a few ancient-looking pines and cedars were left to indicate the first stages of succession. The woods themselves must have been at least 120 years old, and were clearly full of mature trees when chestnut blight first reached the area about '~920. My inspection showed only a few stumps from big, blight-killed chestnut, but lots of chestnut sprouts. The size and distribution of chestnut sprouts showed the familiar characteristics: lots of both multi-stemmed little "shrubs" and saplings as much as three or four inches in diameter and reaching up into the subcanopy. The biggest of these chestnut saplings was about six inches in diameter and more than 30 feet tall, but a large canker on the lower stem and stunted leaves in the crown made me write off this tree for the future. Here was just another blight statistic included in my rough estimate that about 3% of the sprout clones in this woodlot had an active blight infection, which was yet another example of how relatively unimportant blight can be in an undisturbed woodlot where chestnut sprouts are stagnating in the understory.

Much,to my suprise, this particular tree was still alive and well over two years later, with a now healthy crown of leaves. This prompted further investigation. My figure shows the partially healed canker (inset A). This canker has the typical appearance of a hypovirulent infection - a massive "bulge" of rapidly growing woody tissue on one side of the stem, and an oval area of dead cambium on the other. The whole mess was made even more unsightly by the straps of dead bark clinging to the wound. A core taken from the tree shows both the effects of canopy opening during road construction (about 1968) and the dramatic slowdown growth after blight infection started about 1983. Since then, the growth rate has in-creased. In addition, I found the crown filled with maturing burs during the summers of 1987-89. I estimate the chestnut clone density is in the range of 10-30 per acre when averaged over the entire wood-lot, and at least a few of these clones have stems that are not big enough to be producing male catkins. However, there just does not seem to be enough pollen production to provide cross-pollination. None of the burs I have collected from this location have ever contained fully developed, fertile nuts. The infertile burs form and develop because the chestnut is not self-fertile, and the only significant local source of chestnut pollen is this one tree.

As of the summer of 1989, the old canker seemed completely healed over. All that was left was an oval patch of bare, exposed wood in which the interior oval of discoloration shows the general outline of the original blight infection. Two seasons of rapid diameter increase have done a lot to subdue the ugly, swollen appearance of the bulge of callous tissue on the opposite side of the trunk from the exposed dead wood. What about the future? A second hypovirulent canker is developing at the base of this tree (inset B). In principle, this second canker may cause no more of a problem than the first. However, the number of cankers can severely distort the shape of the tree, and their cumulative effect can be serious indeed. My second drawing (page 21) shows a large chestnut sprout pointed out to me by Phil Gordon of Yale University near his home in Old Lyme, Connecticut. This particular tree had nearly a dozen separate cankers on the main stem, and a few more in the largest branches. At the time I made this sketch only part of the crown was leafing out, and Phil reports that the tree has since died (although the root crown is actively resprouting). So, establishment of hypovirulence in the wild is an important step, but may not be the complete answer to chestnut blight.

A Simplified Key to Chestnut Species

Primarily for Identification of The American Chestnut in its Original Native Range

Philip N. Gordon
Institute of Economic Botany, New York Botanical Garden

Castanea Species

Class I: Leaves hairless or with only a few hairs on the veins beneath.

C.dentata: American Chestnut. E NA. Before the blight, a tree 30-40 m., now rare. Usually a shrubby sprout cluster 1-5m. Leaves hairless beneath, margins well toothed. Catkins 15-20 cm. Fruit with 1-3 small nuts.

Class II: Leaves hairy on the lower surface. Fruit usually with a solitary nut.

C.pumila: Chinquapin. E USA. A shrub or tree to 20 m. Hairs on leaves whitish.

C.alnifolia: SE USA. Shrub less than 1m. Hairs on leaves brownish. May be a variant of *C. pumila.*

Class III: Leaves hairy on lower surface. Fruit with 1-3 nuts.

C.mollissima: Chinese chestnut. China, many in USA. Apple-like orchard tree to 20 m. or tall straight forest tree 20-30 m. with whitish bark. Young twigs remaining hairy. Leaves underneath may be heavily felted, but sometimes completely hairless. Upper leaf surface shiny, often leathery. Fruit small to large.

C.sativa: Sweet, Spanish or European chestnut. S Europe, N Africa, Asia Minor, occasionally USA. Tree to 40 m. Apple-like orchard tree or forest tree like Am. chestnut. Young twigs soon losing their downiness. Leaves with scaly glands below, margins with pointed small to coarse teeth. Fruit small to large.

C.crenata: Japanese chestnut. Japan

Korea, many in USA. Tree to 15 m., rounded and broad. Young twigs soon losing their dowrnness. Leaves with scaly glands and mixture of single and branching hairs beneath; margins with pointed but small teeth. Fruit medium.

This key is a synthesis of literature data and personal observation, and is designed to "see" American chestnut by exclusion of the other species and of hybrids that may be found. Hybrids cannot adequately be classified since we can't yet predict how the progeny of genetic crosses will look. Japanese and Chinese chestnut trees and hybrids are not uncommon in yard plantings, in orchards or in the forest. European chestnuts are less common. Chinquapin are common in their range. In deciding what you have, keep in mind the admonition of Arthur H. Graves on chestnut identification: "In the use of keys, one must not depend too much on any one character. Variation is the most invariable thing in the world. All characters must be taken into account; it is the combination of these on which one must depend in the identification of the species. Also, one should not examine only one leaf or one twig. Look carefully at several before making a decision. Nature is *not* always consistent; variation is the rule."

The Other American Chestnut and Two West Coast Cousins

Frederick Paillet

The American chestnut is the most familiar *Castanea* species in North America. This is the tree we hear about in the forest literature - the old forest giant with the valuable wood and useful nut crop. But the great chestnut has a lowly nephew in eastern forests, and a couple of distant cousins on the west coast. I first met the Allegheny chinquapin *(Castanea pumila* var *pumila)* in the dry oak forests of northern Virginia during my chestnut research. At one time there were a number of named chinquapin species. But taxonomists now recognize only a single species with two varieties *(pumila,* the Allegheny chinquapin, and *ozarkensis,* the Ozark chinquapin). I had originally worried that the chestnut and chinquapin would be difficult to distinguish, but experience showed there wouldn't be a real problem. Chinquapin leaves are slightly smaller, with much smaller teeth than chestnut leaves, and don't have the long, pointed chestnut tip. The leaves also have their widest part two-thirds to three-quarters of the way to the tip, while chestnut leaves are broadest in the middle. At the same time, chinquapin leaves are decidedly fuzzy, and chinquapin twigs have a distinctive orange-brown color. Taxonomists have much more technical terms for these characteristics, but the bottom line is that the two species are easy to distinguish in the field in spite of the great variation in chinquapin leaf shape and stem growth form.

I found chinquapin a pretty small shrub in the open forest in Virginia. My illustration (page 26) shows one of the biggest forest-grown chinkapins I could find. My surveys of the forest in this area indicated that there were on the average about 40 chestnut sprouts and 50 chinquapin shrub clones scattered over each acre of wood-land. Almost all of these chinquapin shrubs were much smaller than the one I show in my drawing - some less than six inches tall and bearing no more than three or four leaves. But the plant looks much more like a real member of the chestnut family when exposed to nearly full sun at the edge of a field. On some open-grown chinkapins I found stems with up to six burs, each holding a single acorn-like nut - without the flat sides one associates with chestnuts at the supermarket, and nearly black in color. From the literature chinquapin is known to hybridize with chestnut, so one wonders why natural hybrids are so rare. The answer seems to be that chinquapin flowers almost a month earlier than chestnut. I found chinquapin blooming in Virginia in late May, while chestnut was flowering in late June.

The chinquapin is a very close relative of the American chestnut, but there are several other chestnut relatives of more distant relationship in the mountains of California. (See drawings, page 27.) The golden chinquapin *(Castanopsis chrysophylIa)* is known to become a small tree in Oregon, but I found it growing as a low shrub on sparsely forested, rocky hillsides above Bear Lake in the San Bernardino mountains about 9,000 feet in elevation. The evergreen leaves and dense thickets of low shrubbery make one think of rhododendron, as do the dark green leathery leaves. Most stems were less than three feet tall, with a few approaching twice that stature in protected places. The clusters of very chestnut-like burs were just maturing in mid-July, while new flowers were still present on the tips **of** this year's growth. This "tree" seems to he the exact opposite of the great chestnut growing as it does in the form of a knee-high shrub underneath the immense jeffrey and sugar pines of the southern California mountains.

I met the other California cousin of American chestnut in the famous Muir Woods, growing in the understory beneath magnificent redwoods. The tanoak *(Lithocarpus densiflora)* grows to a much more respectable size than the golden chinquapin, but still doesn't make much of an impression underneath those redwoods. The evergreen leaves would seem to bear some resemblance to chestnut, except that they are so tough and leathery, and the edges tend to curl under hiding the teeth. The fruit are really just acorns, except that the acorn cap has something like spines rather than simple scales.

Nonetheless, I was somewhat startled to see young tanoak saplings growing up into openings in the evergreen canopy with much the same shape and appearance as chestnut saplings in New England. The trees had the same conical crown shape and branching pattern, and the semi-glossy texture of the bark reminded me of chestnut, too. One tends to think of the great forest trees such as chestnut, beech, and oak as well-defined species that have been around much as they are for all time. The distant and not-so-distant cousins of American chestnut suggest that there have been many different forms of these species over the 40 million or so years since oaks and chestnut first appeared on the earth. How many other interesting chestnut and chestnut-like trees have existed in habitats that we will never know, or became extinct in forests that no one ever saw?

Projects to Control Chestnut Blight in Connecticut

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ABSTRACT

Several projects to aid in the restoration of the American chestnut (Castanea dentata) in eastern North America were completed in the summer of 1989 at the Connecticut Agricultural Experiment Station and nearby chestnut plots. These projects included crossing American trees with Asian trees, trapping the clear-winged chestnut moth, and planting and maintaining chestnut seedlings. The results of these projects could hasten the recovery of the American chestnut as a dominant species in the eastern hardwood forest.

INTRODUCTION

Although the American chestnut (Castanea dentata) has been devastated by blight in its natural range in the northeast, luckily the trees have not been completely eliminated. This is due to the chestnut's ability to sprout again from the root collars of dead trees, and because of the use of hypovirulent forms of the blight fungus (Cryphonectria parasitica) which arrest the death of the trees (Anagnostakis, 1987).

Because some American chestnuts have been able to be kept alive long enough to mature and flower, scientists have been able to learn more about why the American chestnut is so susceptible to blight, and what steps should be taken to decrease this susceptibility. One of the most promising methods involves crossing American trees with the more resistant Chinese and Japanese chestnuts (C. mollissima and C. crenata) (Burnham, 1988). During the summer of 1989, I was fortunate enough, because of a grant from the American Chestnut Foundation, to work with Dr. Sandra L. Anagnostakis at the Connecticut Agricultural Experiment Station on several projects, including crossing different chestnut tree species, to aid in the recovery of the American chestnut. This paper elaborates on the projects with which I was involved.

METHODS

My responsibilities as Dr. Anagnostakis' research assistant varied widely, ranging from setting insect traps, to planting chestnut seedlings, to pulling weeds from around the small trees. By far, the most important job I had was crossing the American chestnut trees at Lockwood Farm in Hamden, Connecticut, with various Asian trees and hybrids. In mid June, developing female flowers on American trees were isolated by trimming off surrounding leaves and male flowers and covering them with waxed paper bags to prevent them from being pollinated naturally by unidentified sources. From July 2 to 11, the isolated female flowers were pollinated with pollen from specific trees. Branches containing mature catkins were collected from several Asian trees and hybrids of Asian and American trees to be used as pollen sources. The branches were kept on ice during the pollination to maintain the viability of the pollen. The catkins were first broken off and then brushed across the isolated flowers. The bags were then put back on the pollinated flowers and labeled with the pollen source as a record of the nuts that would later be produced.

In addition to the crosses made at Lockwood Farm, three trees at Sleeping Giant Plantation, male sterile *(dentata X mollissima)* hybrids, were crossed with various *dentata* A total of 474 bags were put onto female flowers on chestnut trees at Lockwood Farm and Sleeping Giant Plantation.

Another project with which I was involved was the collection of the clear-winged chestnut moth *(Synanthedon castaneae)* at Lockwood Farm, Goodwin State Forest, and Rocky Hill. This insect has been found to cause serious damage in chestnut trees with hypovirulent cankers and could possibly aid in the spread of the chestnut blight (Anagnostakis personal communication). Sticky traps and water pan traps, both baited with pheremone lures supplied by J. W. Snow (USDA, ARS, Byron, GA), were set at Sleeping Giant chestnut plantation, Lockwood Farm, Rocky Hill, and at the chestnut plots in Goodwin State Forest. Funnel traps without pheremone lures were also used in addition to the baited traps. The insects caught in each water trap were collected and stored in jars containing alcohol and labeled with the trap's location and date of collection. The insects caught on the sticky traps were stored on the traps in a refrigerator and were labeled the same as the water traps. The insects from each location were then identified and counted.

To make the number of chestnut trees similar in the two experimental plots at Goodwin State Forest, we planted additional American chestnut seedlings there. 100 seedlings were also planted at Lockwood Farm, half of which

were covered with a hoop frame and shade cloth. Because weeds compete with the seedlings and can kill them, the survival of the newly planted seedlings depended on the area surrounding each seedling being weed free. This was accomplished essentially by hand pulling weeds and putting Hortopaper around the seedlings to inhibit re-growth of weeds.

In addition to pollinating, trapping insects, planting seedlings, and pulling weeds, I also checked A. H. Graves records of the trees at the Sleeping Giant chestnut plantation against the trees that are currently alive there. Using Graves' grid-like layout of the originally planted trees as a guide, I was able to update the records by adding to them the current status and condition of each tree. This task was somewhat difficult since the trees were not planted exactly in a symmetrical grid, but luckily many of the trees still had identifying tags on them.

RESULTS

The results of the crosses are as follows: Lockwood Farm C. *dentata X C. mollissima* yielded 86 nuts.
Lockwood Farm C. *dentata X (crenata X mollissima)* hybrids yielded 31 nuts.
Lockwood Farm C. *dentata X (mollissima X seguinji)* hybrid yielded 5 nutS.
Lockwood Farm C. *dentata X C, crenata* from Cheshire, a, yielded 36 nuts.
Sleeping Giant Plantation hybrids *(dentata X mollissima) X* various *dentata* yielded 81 nuts.

The results of the insect trapping showed that *Synanthedon castaneae* is found abundantly in the Sleeping Giant Plantation, moderately at Lockwood Farm and Goodwin State Forest, but not at all at the Rocky Hill plot.
From weeding around the young trees we found that putting Horto-paper around the trees after they were weeded significantly inhibited the regrowth of weeds and therefore helped the small trees establish themselves.

CONCLUSION

Although the restoration of the American chestnut as a dominant species in the northeastern forest is still a while away, hopefully the projects I worked on in the summer of 1989 will help in speeding up the American chestnut's recovery. By planting new seedlings and maintaining older trees, we have been able to perform interspecific crosses which eventually could lead to the development of an essentially American tree with the blight resistance of its Asian cousins. The success of these crosses supports our belief that the American chestnut can make a comebac~ With continued research this hope can become a reality.

ACKNOWLEDGEMENTS

I would like to thank the American Chestnut Foundation for providing the Connecticut Agricultural Experiment Station with funds to hire me for the summer. I would especially like to thank Dr. Sandra L. Anagnostakis for giving me the opportunity to work with her for the summer, thereby giving me the chance to participate in the restoration of the American chestnut.

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An Historical Reference for Chestnut Introductions into North America

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When people find chestnut trees of any size growing in the New England woods they frequently call The Experiment Station, sure that they have found an American chestnut tree resistant to chestnut blight. It usually turns out that this tree is Asian or an Asian hybrid. In previous centuries, chestnut trees were very important to the people on this continent. They took advantage of "new and different" material much more than is generally realized, and were planting Asian species long before chestnut blight was discovered in New York City in 1904. The species of chestnut are listed in Table 1. Since I am often faced with the problem of telling an enthusiast that some nice tree is not *Castanea dentata* I have started compiling some information about the history of chestnut importations into North America. In Fig. 1 a time line with some of the important "chestnut events" puts this into perspective.

European Chestnut Trees

The first recorded importations were those of Eleuthere Irenee DuPont de Nemours, who in 1799 moved from France to Bergan Point, NJ and then to Brandywine, DE. He brought many European chestnuts *(Castanea sativa)* with him, imported more later, hybridized lots, and planted them all over the area. By 1889 some of the popular varieties of *C. sativa* and *sativa X dentata* hybrids were "Anderson," "Bartram," "Comfort," "Cooper," "Corson," "Dager," "Darlington," "DuPont," "Miller," "Moncur," "Numbo," "Paragon," "Ridgely," "Scott," "Spanish," and "Styer."

Japanese Chestnut Trees

In 1876, S. B. Parsons of Flushing, NY imported a few trees of *Castanea crenata* and sold them as "Parson's Japan." Two of these are still growing very well in Connecticut; one in Old Lyme on the grounds of the Bee and Thistle Inn, and one in Cheshire behind the Congregational Church, Major importation of Asian chestnut trees began in 1882 when William Parry, of Parry, NJ imported 1000 grafted *C. crenata* trees. Parry selected "Parry" as his best, but sold several other varieties as well.

In 1886 Luther Burbank imported 10,000 nuts from Japan for selecting and hybridizing. In 1893 his "New Creations" catalog advertised his "New Japan Mammoth" chestnut and he sold three seedlings to Judge Andrew J. Coe of Connecticut. These were sold in 1897 to J. ~. Hale of South Glastonbury, Connecticut who named them "Coe," "Hale," and "McFarland" and sold them from his nursery and through catalogs starting in ~S98.

There were 21 varieties of Japanese chestnuts listed in T. H. Powell's 1898 Bulletin (#42, Delaware Agricultural Experiment Station). These were discussed in gardening magazines such as *The Rural New Yorker,* and advertised in plant and seed catalogs. Mail order spread these Asian trees all over the country. By the turn of the century Asian and European chestnut trees were available by mail from many nurseries such as Burbank (CA), Parry Bros. (NJ), Hale (CT), Kerr (MD), Biltmore (NC), Boehmer (Japan), and Yokohama Co. of New York and Tokyo.

Chestnuts were being grown as a crop in many places, and some of the Eastern U.S. companies in business by 1900 were:

The Albion Chestnut Company, Clementon, NJ

150 acres of stump land grafted with *sativa* ("Numbo") and *crenata.*

J. W. Beecher, Pottsville, PA

80 acres with 18,800 grafted trees.

Arthur J. Collins, Moorestown, NJ

30 acres, mostly with grafted "Alpha" *crenata,* and "Paragon"sativa.

Henry W. Comfort, Fallsington, PA

56 trees on one acre, mostly "Numbo."

J. T. Lovett, Emilie, PA (near Trenton, NJ)

about 22 acres with 1,200 grafted "Paragon" and 25,000 seedlings.

The Mammoth Chestnut Company,
Clementon, NJ
about 150 acres, mostly grafted "Numbo."
Samuel C. Moon, Morrisville, PA
originator of "Numbo" = Magnum Bonum *sativa*.
Parry Brothers Nursery, Cinnaminson, NJ
many *crenata* seedlings and selections.
Coleman ~ Sober, Lewisburg, PA
300 acres, sprouts grafted with Paragon.
Joseph Williams, Riverton, NJ
7,500 dentata seedlings planted, many grafted with *crenata and sativa* scions.

Chinese Chestnut Trees

Chinese chestnuts are not mentioned in the early catalogs that I have seen, but plant explorers were sending seed to the U. S. In 1903 Dr. Charles Sprague Sargent sent C. *mollissima* seed to The Arnold Arboretum near Boston, Massachusetts for their collection. No trees from this seed lot have survived. In 1908 E. H. Wilson sent them seeds of *Castanes henryi* from Western Hupeh, China. This was planted in their collection as tree #6849, which survived better than most imports of this species, but finally died in 1934. Cuttings were sent to the U. S. Plant Importation office.

Around the turn of the century several plant explorers were traveling around the world collecting things not found in North America. These people were often careful observers of plant ecology and their notes make fascinating reading. When the defeat of the Boxer Rebels (1901) opened China to exploration, several expeditions were made. The most famous explorers are probably Ernest H. "Chinese" Wilson, who collected for an English Nursery and later for the Arnold Arboretum, and Frank N. Meyer, who was hired by David Fairchild to explore for the U. S. Plant Introduction division of the U. S. Department of Agriculture. The two had very different personal styles, and their travels resulted in vast numbers of importations. I have found only one certain survivor of Frank Meyer's chestnut imports. The Rochester, NY Parks Department has a specimen of PI 36666 growing in their Durand Eastman Park as #G 25.

Chestnut Blight

Chestnut Blight, or Chestnut Bark Disease, is caused by the fungus *Cryphonectria parasitica,* formerly called *Endothia parasitica.* Cankers were found on American chestnut trees lining the Avenues of the Bronx Zoo in New York City in 1904. In

1907 and 1908 the fungus attacked other species of chestnut in the New York Botanical Garden. Rapid spread of the disease followed, and within 50 years the fungus was present throughout the native range of *C. dentata* from Maine to Georgia, and west to the edge of Michigan.

In 1913 David Fairchild asked Frank Meyer to look for the disease in China, and Meyer reported that he had found it in early June. He wrote:

"This blight does not by far do as much damage to the Chinese chestnut trees as to the American ones. Not a single tree could be found which had been killed entirely by this disease, although there might have been such trees which had been removed by the ever active and economic Chinese farmers."

Shear and Stevens grew cultures from Meyer's samples, and in July they inoculated the Chinese fungus into American trees near Washington, D. C. Rapid death of the sprouts confirmed that this similar-appearing fungus caused chestnut blight.

Meyer went to Japan in 1915 and was again first in finding chestnut blight. He wrote that the Japanese chestnut trees were generally more resistant to the blight disease than the Chinese chestnut trees that he had seen, and suggested:

"This Japanese chestnut, Castanea japonica might be used as a factor in hybridization experiments together with American, European, and Chinese species to create immune or nearly immune strains of chestnuts."

Hybridization

Many people took up Meyer's suggestion, and hybrids made earlier to improve the orchard qualities of chestnut trees were examined for their resistance to chestnut blight.

Arthur H. Graves, of the Brooklyn Botanical Garden, started planting chestnut trees and making hybrids in the early 1930s. Trees were planted on his property? in Hamden, Connecticut, and on land owned by the Connecticut Agricultural Experiment Station. His work was aided by Hans Nienstaedt and Richard Jaynes, who both did their doctoral research on chestnut at Yale University and the Connecticut Agricultural Experiment Station. Now that we can keep American chestnut trees alive with biological control by hypovirulence, breeding can continue.

Species and hybrids of chestnut were distributed by the Experiment Station to home owners all over the Northeastern U.S. Often records of origin are lost, tags are unreadable, or row lines are confused by the planting efforts of squirrels. I try to identify the trees found by citizens, using leaf and twi g characteristics. The pure species are easy, but the complicated hybrids must sometimes be a case of "best guess."

My file on chestnut history gets larger every year, as I find yet another catalog or letter from the early days of this century. Many fine Asian trees have withstood 50 to 120 years of New England winters, bugs and blight. We can use these in present and future breeding programs, as long as we remember to *write it down for* the people trying to puzzle this Out 100 years from now.

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TABLE 1

CHESTNUT SPECIES

Section *Castanea*
[three nuts per bur l

Castanea dentata (Marshall) Borkhausen	American Chestnut
Castanea sativa Miller	European Chestnut
Castanea mollissima Blume	Chinese Chestnut
Castanea crenata Siebold and Zuccanm	Japanese Chestnut
Castanea sequinh Dode	Chinese Dwarf Chinquapin

Section *Balanocastanon*
[one nut per bur]

Castanea pumila (Linnaeus) Nijiler variety pumila	Chinquapin, Bush Chestnut
variety ozarkensis (Ashe) Tucker	Ozark Chinquapin
Castanea X negThcta Dode	hybrid (?)between *dentata* and pumila in the wild

Section *Hypocastanon*
[one nut per bur l

Castanea henryi (Skan) Rehder & Wilson	Chinese Timber Chinquapin Henry Chinquapin

FIGURE 1
A time line with some of the important events in the history of chestnuts in North America.

- 1972 Hypevirulent strains of chestnut blight imported by the Connecticut Agricultural Experiment Station

- 1930 A. H. Graves starts making hybrids in Hamden, Connecticut

- 1913 Blight found in Japan by Meyer

- 1913 Blight found in China by Meyer

-1904 Blight found in New York City by Merkel

- 1903 First Chinese chestnuts imported by Sargent

-1886 Japanese chestnuts imported by Burbank

-1882 Japanese chestnuts imported by Parry

-1876 First Japanese chestnuts imported by Parsons

-1799 European chestnuts imported by DuPont

Noteworthy Chestnut Trees In Connecticut

Sandra L. Anagnostakis

The recent renewed interest in chestnut tree breeding, due primarily to the efforts of Charles Burnham, has raised questions about the availability of valuable germplasm. Chestnut trees of several species have been available in this country for a long time (see "History" by Anagnostakis), and the Connecticut Agricultural Experiment station and a few private land owners have many very fine trees. Some of my favorites are listed here to illustrate the richness of the resource. Trees are in Experiment Station plantings (which includes over 750 trees) unless otherwise noted.

SPECIES

Japanese

Catanea crenata

1. Two trees planted in 1876, probably "Parson's Japan," both on private land.
2. USDA-PI #78626, seed from wild trees in Oguriyama, Amori Ken, Japan, planted 1933.
3. USDA-PI #104015, Noveka Eirinsho, Miyasaki-Ken Japan, planted 1935.

Sequine

Castanea sequinii

1. Three trees of USDA-PI #70317, "Mojut-tsz" Chiuhwashaan, Anhwei, E. Central China, planted 1929.

Henry

Castanea henryi

1. USDA-Pl 4101587, "Chu-Lee" or "Chun Lee" "Pearl chestnut," Hsiaofeng, Chekiang, China planted 1935.

Chinese

Castanea mollissima

1. Two trees of USDA-PI #70315, "hardy trees native to North-eastem China" planted 1r929.
2. USDA-PI #78744, "Tiger Paw" from the Fa Hua SSu Temple near Beijing, planted 1932.
3. Six trees of USDA-PI #104061 and #104063 from Chekiang Province, China, planted 1935.
4. At least three trees of USDA-PI #39721 from Tientsin, China, planted 1916 at the Bartlett Arboretum

American

Castanea dentata

1. About 300 trees, seedlings from Michigan, Wisconsin, New York and Connecticut, kept alive by hypovirulence in the blight fungus population

Chinkapins

Castanea pumila

1. Var. *pumila,* four trees
2. Var, *ozarkensis,* eight trees

HYBRIDS

crenata X dentata

1. Two trees planted 1931

mollisima X dentata

1. Four trees planted 1960

dentata X mollisima

1. Two trees planted 1936

(mollisima X dentata) X dentata 1. two grafts of the "Clapper" tree and one tree from seed planted 1955 called

"Graves"

These trees have been used by American Chestnut Foundation scientist Fred Hebard, Experiment Station staff, and others for crosses and experiments for several years, and are likely to be here for future use as well.

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