Contents

Editor's Note

Many thanks to those who have written to the Journal with questions, praise, or brick-bats. The scientific progress we are making and the growth of the Foundation's organizational strength are quite encouraging, but members' letters help to put a human face on the work we do.

Special appreciation must be expressed to Wharton Sinkler for his assistance with this issue.

Angus McDonald

Letters

The American Chestnut Foundation encourages members to write to this section of its Journal with questions, comments, and observations. Where appropriate, this section may answer members' questions at considerable length.

Sir-

I am a new member of the ACF, having joined last April 27 at the Field Day of the New York Chapter. The last *journal* was most interesting and you are to be commended. It made me wish I could read some of the previous *journals*, as reference is made to articles in older issues. Is it possible to acquire any of the older *journals*, and whom could one address to get them? Also their cost.

Alan W. Rand
Clinton, NY

Back issues of the journal of the American Chestnut Foundation are not plentiful, but we offer photocopies at $10 per issue. Write to the journal indicating issues you desire. Sorry, only complete issues - no single articles.

Issues to date:

1:1 (1985)	IV:1 (1989-90)
1:2 (1986)	V:1 (1990-91)
11:1 (1987)	VI:1 (1991)
111:1(1989)	VI:2 (1991-92)

Members who own earlier issues of the journal may make reasonable numbers of photocopies for colleagues interested in advancing the shared goal "Toward the Restoration of an American Classic." Ed.

Sir-

I would appreciate answers to the following questions. I think some of these questions should be answered in a future publication because many people would like to be informed.

1. Do you have to have more than one chestnut tree because they are cross-pollinated, or are they self-pollinating?

2. Is there anything that can be done to prolong the life of an existing tree? They come up from the roots all the time, but every time one comes from a nut it seems to grow until about the time it starts to produce blossoms and nuts, then it dies. I had one that was close to 40 feet high and 18 inches DBH (diameter at breast height, 4.5 feet from ground) which lived until the first crop of nuts, then it caught the blight....

William E. Rood
Baldwinsville, NY

1. Chestnut trees must be cross-pollinated. However, the wind may carry chestnut pollen a considerable distance.

2. The chestnut blight (Cryphonectria parasitica *formerly called* Endothia parasitica) *is endemic throughout the original range of the American chestnut. The fungus grows on many hosts, including scarlet oaks, white oaks, post oaks, live oaks, sumac, dead wood lying on the ground, and often almost invisibly on Chinese chestnut trees. The blight spreads on the wind and on the feet of insects and migrating birds. Distance offers little protection.*

Ultimately the solution to Cryphonectria parasitica *will be found through the American Chestnut Foundation's programs to produce numerous strains of blight-resistant, forest-type trees. But growing pure American*

chestnuts in the presence of blight is far from being worthless. It is useful to preserve as many specimens as possible for their genetic variation.

There are several ways to tackle the problem of blight while more fundamental solutions are being developed. The following list, arranged according to difficulty and expense involved, is adapted from ***The Chestnut Grower's Handbook,*** *which is provided to members who purchase the ACF seed kit.*

General care. Like most other trees, chestnuts will fight any sort of disease better if they are vigorous to begin with. Chestnut trees grown in full sun, with good weed control and fertilizer, have a better chance of fighting a blight infection - and producing nuts - than trees which are struggling to survive because of poor growing conditions.

Avoid wounding the tree - any wounds you make are potential infection sites. This is important for those working with relatively healthy trees within the blight regions; there is always a chance of starting a new, lethal infection. Chestnut trees are thin-skinned and easily wounded.

The blight fungus can grow on dead wood lying on the ground, so general cleanliness is helpful.

Cluster culture. An important tactic in blight areas is to get your trees to grow as a cluster of several stems, rather than with just one trunk. When one stem gets a girdling blight canker and dies, it is likely that the other stems of the same tree will remain healthy for several more years. The root system is unaffected by the blight. Your tree may come to have several older stems, which should be producing flowers and nuts; one or two

blighted stems; and several young stems growing up to replace those lost.

A tree grown this way won't look like the grand old forest trees, but will survive and regularly produce flowers and nuts.

Chestnuts grow well as clusters. Often seedlings will naturally send up strong suckers from the base of the trunk in response to any kind of stress. If a tree grows as a single stem and you want **to** force it to become a cluster, cut it to the ground in late winter or very early spring (before the buds swell). If you want to thin the sprouts, wait until mid-summer, and pinch the tips off those you don't want; late in the following winter, remove them completely.

Blight Control #1: Soil Compress Method. Some years ago Dr. Wayne Weidlich, an ACF Director, noted that chestnut blight will grow on chestnut roots if they are exposed. He thought to try packing soil over trunk cankers. It works. Apparently there is something in soil that effectively eliminates the blight fungus and allows the tree to heal. This method is inconvenient to use on very large trees. It will not protect your tree from new infections, nor save a tree that is already girdled, but it can cure individual cankers which might otherwise kill a trunk you want to protect.

The basics of the soil compress method are simple: you must keep the blight canker, and the entire trunk all around it at least a foot above and below any signs of blight, covered with moist soil for at least a couple of months. This is usually accomplished by making a black plastic sleeve to fit around the trunk, securing it with weatherproof tape, and filling it at least 2 inches thick with moist soil. You can add water at the top once or

twice if it dries out. Obviously, this will be difficult to carry out when your tree develops cankers in the crown after it gets to be thirty or forty feet tall, but this method is a valuable management tool when appropriate.

Blight control #2: Hypovirulence. Hypovirulence is a condition in which the blight fungus itself gets sick. What usually causes this weakening of the fungus is actually a virus, which can be spread from one fungus to another. Someday soon hypovirulence may be an easy method to use for saving chestnut trees, but right now there are no commercially available preparations of the virus and you are in the area of experimentation. The researchers who work on this problem are seldom able to find the time to go through the long process of matching virus and fungus types to save a specific tree, but that doesn't mean you can't experiment on your own.

"Wild" hypovirulence, occurring naturally, is becoming easier to find. If you want to get hypovirulence established in your plantings, you might try this: Go into your local woods to someplace where you know there are many surviving chestnut sprouts. Look for bigger sprouts with large, swollen cankers on them. If you find a tree that has been surviving with a canker for several years, you may have found a case of wild hypovirulence.

Since this is the realm of experimentation, expect a lot of failures. Getting the weak strains of fungus transferred to your planting will not be easy. You can try several things, all of which may work -or may lead to worse infections. If you have serious infections in your planting already, you will not have much to lose. The object is to transfer some of the sick fungus, still alive, to a serious canker you want to infect. Try cutting out a small piece of the hypovirulent canker, including as much living bark as possible, and grafting it into the canker you want to heal. It may help to do this in several places around the edge of the killing canker. If you are lucky, and the two blight cankers are the same type, you may be able to convert a canker that would have killed the stem into one which will only swell up and look bad. In time, if you keep at it, you may be able to establish many hypovirulent cankers in your planting, and it may then start to spread by itself. Or not. There are still many unknowns when dealing with hypovirulence; but there is no doubt it keeps trees alive, and has spread in several places. (See page 14 of this issue.)

Blight control #3: Chemical. In most cases we do not think of using chemical fungicides to control chestnut blight. Chemicals would be useless in a forest situation, but they can be used if there are one or two trees you particularly want to keep alive. You may have seen elm trees being injected with chemicals to keep them from dying of Dutch Elm disease. The same method can work on American chestnuts. If this is something you want to do, hire a professional tree service to handle the injections. The chemicals used are powerful. It is quite possibly illegal in your area for unlicensed persons to use them. Trees protected chemically have to be re-treated every year, and the treatments are likely to be expensive.

Ed. *(with thanks to Phil Rutter and past issues of this journal)*

Meadowview Notes

Frederick V. Hebard
Superintendent, ACF Wagner Research Farm, Meadowview, Virginia

Summary

The third year of our Foundation's research farm once again was extremely successful with regard to growing trees. There were, however, disappointments in the 1991 nut harvest. Rainfall has been abundant for three seasons, giving good growth to the trees. Several American and Chinese chestnuts, their first hybrid and first backcross to American, flowered two years after being planted! Should this early flowering persist, it will greatly accelerate the breeding program.

Emergence of seeds planted in 1991 exceeded eighty-five percent, and survival through the first year has exceeded eighty percent. There were 2,504 trees growing at the farm in February, 1992.

Cooperators have now established five off-farm orchards in the Meadowview area, and we are continuing to supply seed to the American Chestnut Land Trust in Port Republic, Maryland.

The volunteer group at the farm is in the process of being organized. Tours of the farm for groups and individuals who drop in are growing, and we have a volunteer coordinator and a volunteer secretary to help facilitate visitors' understanding of our projects.

Plantings and Harvest

In 1991 the Meadowview area was again blessed with abundant, well-spaced rain. The spring was especially good for nut germination. Warm temperatures prevailed from early April onward, and there was only a minor frost in late April. This encouraged early sprouting of sown nuts with no setbacks; most of our planted nuts emerged at rates exceeding 80 percent (Table 1).

Table 1

Survival through 1991 of chestnut seed and trees
planted at the ACF Wagner Research Farm In 1991

Orchard*	Number Planted	Number Surviving	Percent Surviving
Graves B2s**	464	375	81
F2s**	932	777	83
F1s**	233	109	47
Americans**	200	177	88
China Acquisitions***	82	61	74
Sequins***	69	52	75
Surviving Americans****	120	57	48
Burbanks****	106	60	57

**All orchards but the Sequins and Burbanks were planted in completely randomized designs.*
***Seed.*
****Bare root plants.*
*****Grafts.*

The one exception was in the F1s, where some crosses germinated but never emerged (the China Acquisitions and Sequins were bare root plants). Overall emergence in 1991 (Table 1) was much better than in 1990 (Table 2). We attribute the improvement to 1991's better weather and to strict control of moisture in the planting medium.

These factors may also have contributed to the improved growth of seedlings in 1991. In the breeding orchards, average seedling height was 23 inches at the end of 1991, compared to 17 inches in 1990. The trees planted in 1990 increased 28 inches in height in 1991, to reach an average height of 45 inches. 1991 was also a good year for survival of trees planted in previous years (Tables 2 and 3). Overall, 2504 trees are now growing at the Wagner Research Farm, as shown in Table 4, which presents the number of trees of various types. (See "An Homage to Dr. Charles Burnham" by D. Mulcahy, page 33, for a sketch of the general plan of chestnut restoration by backcross breeding. Ed.)

The most encouraging result of the year is that several trees started flowering only two years after being planted! The precocious flowering is probably due to the abundant rainfall of the last three years combined with biweekly fertilization with MirAcidTM. The flowering trees included American and Chinese chestnut, their first hybrid (Fl) with Chinese chestnut, and several first backcrosses (B1) of F1s to American chestnut. (See page 33, this issue. Ed.) We were able to advance a first hybrid between 'Nanking' Chinese chestnut and American chestnut to B1 three years after the cross was made.

Table 2
Survival In 1990 and 1991 of chestnut seed
planted at the ACF Wagner Research Farm In 1990.

Orchard	199n Number Planted	1991 Number Emerged	Number Percent	Number Replanted	Surviving
Clapper B2s*	361	237	66	26	248
B1s***	110	28	25		
Chinese B1s*	222	187	84	18	200
F1s***	55	13	24		
F2s*	118	87	43	12	85
Age-Pathogenicity**	36	11	31	25	29
Seedbed	162	24	15	113	82
Tubex test**	24	15	62	9	23
Test plots	20	16	80	0	15

**Planted in a completely randomized design.*

***Planted in a randomized block design.*

****In 1991, the B1s and F1s orchards were incorporated into the Graves B2s orchard (Table 1) because of the low emergence of seed.*

Should this precocious flowering persist, we will begin making third backcrosses (B3) this year. This will enable us to advance a source of resistance from Chinese to B3 in only nine years. To ensure the regular occurrence of precocious flowering, we will need to install an irrigation system to carry us through dry years. Your contributions toward this system would be most welcome.

The precociously flowering trees produced only male flowers; there were no female flowers. We expect female flowers in a few years, but several more years will have to elapse before the trees are large enough to bear 100-200 nuts per year for screening. Thus it will still take six to nine years before we can intercross B3s to complete the breeding program with our most advanced lines, and another six to ten years before the first blight resistant products begin producing abundant crops of nuts for distribution.

We need to caution people that the first products of our breeding program will only be the tip of the iceberg, so to speak. We still need to breed 20 lines in Meadowview alone, and we need at least five additional locations with 20 breeding lines each.

While the early spring of 1991 was good for plant growth, it wreaked havoc on our controlled pollination efforts. Not only did it cause early flowering of most trees, it also compressed the length of the flowering period. Trees at high elevations in the Virginia mountains flowered at about the same times as trees at lower elevations, and trees in Connecticut flowered at similar times to trees in the Virginia mountains.

Table 3

Survival in 1989, 1990 and 1991 of chestnut trees planted at the ACF Wagner Research Farm in 1989.

Orchard	Number Planted	Number surviving 1989	1990	1991
Minnesota B1s*	35	34	28	27
KY-Iowa B1s*	150	100	48***	54
Exotics**	26	26	20	19
grafts****	24	21	3	2
Chinese**	19	19	18***	22
grafts****	13	12	7	10
Test Plots	80	73	37	37

**Planted in a completely randomized design.*
***Planted in a randomized block design.*
****Plants were added to the KY-Iowa B1s and the Chinese Orchards in 1990.*
*****Twenty-four of the planted Exotics were grafted trees, and two were seedlings; in 1990, we lost the grafted scions of 21 trees, but lost only six stocks. Likewise, 13 of 19 of the trees in the Chinese Orchard were grafts; in 1990, we lost the grafted scions of six trees, but lost only one stock.*

Researchers Phil Rutter and Mark Widriechner knew that flowering would be early in Iowa, but nevertheless, by the time they got to their trees, it was too late to bag flowers for controlled breeding. This was true also in Connecticut, but I traveled there anyway. Unfortunately there were so many nuts in the control bags from Connecticut that the entire batch of 610 nuts is useless. In Table 5, which details our 1991 nut harvest, these are the Nut Types "CxB1," "B1xC,' "B1xF1," and the second B1.

There also was severe pollen contamination on some of our higher elevation trees in the Virginia mountains, especially the first Nut Type of "B2" in Table 5. These nuts are still useful, however. The stray pollen was American and the nuts

Table 4

Type and Number of Chestnut Trees at the ACF Wagner Research Farm In 1991, with the Number of Sources of Resistance and the Number of American Chestnut Lines in the Breeding Stock are for breeding, so we will eliminate the contaminated ones when we screen for resistance. By contrast, the Connecticut nuts were solely for inheritance studies in which we cannot tolerate contamination. We also had some contamination in the F1s, but we will be able to detect it by examining morphological characteristics in the seedlings. In sum, despite the disappointments in Connecticut and Iowa, we still managed to harvest 792 usable nuts from controlled pollinations And, most importantly, those nuts were the core of our breeding efforts for the year.

Type of Tree	Trees	Number of Sources of Resistance	Lines
American	399	0	
Chinese	289		
Chinese x American: Fl	76	6	1-7
American x (Chinese x American): B1	140	5	1-3
American x (American x (Chinese x American)]: B2	478	2	
(Chinese x American) x (Chinese x American): F2	249		
(Amer x (Chin x Amer)] x [Amer x (Chin x Amer)]: B1 -F2	426		
Chinese x (Chinese x American): Chinese B1	181		
Castanea seguinii	52		
Japanese	72		
American x Japanese: Fl	3		
Castanea pumila	1		
Chinese x pumila: Fl	5		
Large, Surviving American	58	9	
Luther Burbank cultivars	35		
other	40		
Total	**2504**		

The number of lines varied depending on the source of resistance. We will have to make additional pollinations to complete the breeding of some lines.

Our pollination and harvesting efforts were assisted by a number of people this year. We would like to thank Art Levine, Jack Elliston, Gary Baker, Paul Sisco and Eric Girard. Their assistance was important to this year's nut harvest. Additionally Sandy Anagnostakis once again provided access to trees (and housing for me) without which we would have many fewer nuts in this year's harvest. Finally, the efforts of Paul Galloway added 33 B2 nuts to this year's harvest. He also contributed 30 B2 nuts to last year's harvest. His contribution was important beyond its numbers because it added another breeding line to our efforts. We also would like to thank Tom Jayne for grafting numerous scions and growing them in his greenhouse until they were ready for out-planting. This is the third year he has volunteered his expert services. His efforts have been invaluable to the breeding program.

If you are interested in helping with next year's pollinations, please write me at Rte. 1, Box 17, Meadowview, VA 24361. Our main times for pollination are between June 15 and July 10. Perhaps you too will be able to see a hummingbird working a chestnut flower, as I did this year.

Table 5
American Chestnut Foundation 1991 Nut Harvest
from Controlled Pollinations

Nut Type	Pollinated Female Parent	Pollen Parent	nuts	bags	burs	Unpollinated Controls nuts	bags	burs
B2	American	ClapperB1	175	131	223	8	13	23
B2	American	Graves B1	73	99	124	0	9	7
B1	American	Nanking x American	154	89	213	1	9	16
Fl	American	Mahogany Chinese	44	43	49	1	4	5
Fl	American	Nanking Chinese	44	31	43	0	2	2
Fl	Nanking Chinese	American	128	104	104	10	10	12
Fl	Meiling Chinese	American	103	74	97	1	8	13
B1	Mahogany Chinese	Mahogany x Amer.	129	99	139	12	9	16
CxB1	Mahogany Chinese	Graves B1	138	94	155	5	10	15
B1xC	Graves B1	Mahogany Chinese	89	23	67	5	2	4
B1xF1	Graves B1	Mahogany x Amer.	254	125	372	10	14	28
	American	Large, Surv. Amer.	71	90	115	1	7	6
Totals			1402	1002	1701	54	97	147

American Chestnut Research in Tionesta

Patrick Chamberlain
Independent Grower, Cussewago Chestnut Farm
R.D. #2 Crossingville Rd., Edinboro, PA 16412

The Tionesta area in Northwestern Pennsylvania has long been known for containing an abundance of American chestnut sprouts and small trees. A large tract of land owned by Kane Hardwood near Tionesta has recently had its oak trees harvested due to the invasion of the gypsy moth. Consequently the forest floor has been opened up to direct sunlight exposure. In response, the chestnut sprouts which have been surviving as understory shrubs are suddenly growing very rapidly. In most areas there are only a few sprouts per acre; but in some others there are so many that it is easy to pretend that it was not oak which was recently logged off, but chestnut. Near President Road there are thousands of sprouts or small trees, a small percentage of which flower and bear nuts. With the permission of Kane Hardwood, we are attempting to incorporate this area into the breeding project.

In April, 1991, an initial experiment was undertaken in Tionesta to determine if grafting 3/4 American chestnut scions onto selected native sprouts was feasible. These particular scions are the result of a first backcross to a pure American tree in Crawford County near Crossingville. In the area near President Road 22 grafts were made using plastic wire ties for a good snug union and paraffin wax as the sealant. Most of the grafts took and grew to some extent, although many later died. However, six of the grafts did grow well and will be watched carefully in the coming years. It is suspected that the unusually warm 90 degree temperatures of May prevented a better success rate. In my experience the optimum temperature for grafting chestnut is 76 to 78 degrees. Nevertheless we have shown that grafting onto native American sprouts can work.

The trees from which the 3/4 American chestnut scions were cut had not been tested for resistance. Once their resistance levels are known, sometime in the next two years, my goal is to graft numerous scions from the seven or eight best candidates onto some of the sprouts. When these grafts begin to flower two or three years after that, they will be cross pollinated naturally by nearby American trees to produce the second backcross, a 7/8 American generation which should be strongly adapted to this area of north-western Pennsylvania.

Hypovirulence Experiment

The second experiment in progress at Tionesta involves inoculating selected trees with hypovirulence in an attempt to allow the larger trees to survive despite being infected. (See also page 5 of this issue. Ed.)

Three years ago a tree was found near Hydetown, Pennsylvania, which seems to be infected with hypovirulence This particular chestnut is about 40 feet high and its crown appears to be healthy, but the trunk is badly scarred. It appears to have had the blight for a number of years. Some bark fragments collected from this tree were used as an inoculant on a dying tree close to President Road near Tionesta in the summer of 1990. This tree is about five inches DBH (diameter at breast height, 4.5 feet from ground). At the time of treatment it had two rapidly growing cankers. The leaves in the crown were already turning a sickly pale green and were not quite full size. One eighth inch diameter holes were gouged about an inch apart along each side of the two cankers by twisting a small screwdriver. A small particle of bark from the Hydetown tree was pushed into each hole and the holes were then covered with masking tape and left for about eight months. By the following summer both cankers had stopped growing and callous material was starting to heal back over the edges of the cankers. The blight had disappeared and the entire tree appeared green and healthy again.

This tree has been spared for now, but there is no guarantee that it will remain healthy, since there are active cankers other trees nearby. It will be interesting to see if the hypovirulence which has been established on the one tree will begin to spread on its own to other trees in the area.

In an attempt to speed the process, five more trees were inoculated in 1991. Results so far have been inconclusive. It would be a mistake to expect that all the trees near President Road will be cured and grow happily ever after. Even if hypovirulence were to become established in this area the trees would still bear scars on their trunks which would make them useless for quality timber. But it would be nice if the trees could be afforded the opportunity to survive for many years to produce nuts for wildlife and for dispersal to interested growers.

Big Chestnut Trees in the Wild-Not Quite Gone!

Frederick L. Paillet

Wild-grown American chestnut trees are just about impossible to see anymore because the chestnut blight has so thoroughly infiltrated the natural range of the tree. Those few big chestnut trees we can still see are open-grown specimens planted in parks and botanical gardens at locations far beyond the natural range of the species. Only at a few locations where natural conditions resemble those of the Appalachians have these isolated plantation trees produced a few naturalized trees in adjacent forests. When one thinks about how long it takes for a plantation tree to begin to produce regular seed crops, and then for some of those seeds to become established and grow into large naturalized trees in adjacent forests, one realizes how rare such trees might be. Yet there are a few places where big, naturalized chestnut trees can be seen under conditions that roughly approximate what they must have looked like in the wild. Phil Rutter and I described one such location in the *Canadian Journal (4 Botany*. There are many technical reasons for studying these naturalized chestnut stands, but nothing counts more than just being able to see this magnificent tree as it must have looked to early settlers in old growth forests.

Probably the best example of a large, naturalized chestnut tree we have found so far is shown in Figure 1. This tree was about 70 feet tall and 24 inches in diameter in 1987 when the first sketch was made. Using ring counts from other chestnut trees harvested in adjacent woodlots, we estimated that this tree was about 60 years old, and is now growing at more than a half an inch of diameter increase per year. In fact, we measured a 0.8 inch increase between March and December in 1987.

One of the incidental benefits of our study of the tree in Figure 1 was the opportunity to see how this tree responded to the cutting of adjacent oaks. The cutting was completed in early 1987 in a typical selective harvest of hardwoods. Annual increment widths measured on stumps and conversations with local landowners indicated that woodlots in the area are cut over about every 25 to 30 years to provide raw material for a local quality hardwood industry. When we first saw this tree, it had a narrow upper crown produced in the process of filling a gap between much older white and black oaks. In fact, ring counts from the stumps of the oaks harvested in 1987 showed that they were nearly 150 years old, and already large when growth rates picked up significantly about 60 years ago. We suspect that this increase marks an event - a windstorm or selective cutting - that resulted in the establishment of the big naturalized chestnut tree. In any event, by early 1987, the naturalized chestnut was a tall, straight tree with a symmetric but narrow crown, some dead or dying lower branches, and a number of small, dormant-looking branchlets lining the lower crown and upper trunk. How would this tree respond to canopy opening?

When this tree was revisited in early 1991, the lower crown had filled out substantially. By comparing the two crown profiles, we see that the filled out crown resulted from renewed growth of some of those smaller branchlets and by the generation of new shoots or risers' from the nearly bare parts of stagnant lower crown branches.

One wonders how to interpret this result. The response to canopy opening evidently allows the existing chestnut tree to take advantage of the new light resource before competing stems can move into the open space. This rate of response seems much faster than that of oaks, but one must remember that this big tree is still younger and more 'juvenile" than the stately oaks in the surrounding woods. In fact, this is just another indication of the fast growth and aggressive competition that the chestnut provides in its package of adaptations. Perhaps one can think of strong oaks as out-surviving the competition, while vigorous chestnut outgrows the competition!

The response of the big chestnut tree in Figure 1 can be compared to the response of suppressed chestnut trees growing in the understory in the same stand. Many of these small trees were also released by the logging operations. The comparison of these trees at one and four years after logging in Figure 2 illustrates results reported in some of my earlier studies. In particular, these results show that suppressed chestnut stems respond to release by the rapid growth of existing stems, except where there is injury to the original stem in the logging operations. One of the stems in Figure 2 has simply increased in size while filling out the sparse crown of the sapling present in 1988. The other stem was run over by the logging equipment, so that the original stem has died, and a number of new root collar sprouts have grown up. This demonstrates a principle known long ago by practical foresters and related to me by Prof. David Smith at Yale University: it was common practice to cut small, poorly formed chestnut stems left after logging in order to insure that regeneration occurred as new, straight stems, rather than enhanced growth of crooked saplings.

I consider it a privilege to be able to see something of what the magnificent primeval chestnut trees must have looked like. The strong and straight tree in Figure 1 gives some general feeling for what the trees in Appalachian coves - over 100 feet tall with trunks six feet in diameter -might have been like. The growth rates we have measured on these trees certainly support the contentions in the old forestry literature that chestnut was one of the fastest growing hardwoods.

But even now the naturalized populations of American chestnut in the Midwest are expanding and providing a growing target for blight spores.

In 1987 we found the first signs of blight in the stand adjacent to the tree we are describing here, and initial control measures have not been completely effective. Someday soon we will have the sad duty of sectioning the blight-killed trunk of this tree to salvage whatever information can be obtained from its growth record over the short decades it managed to avoid the blight.

Protecting Young Plant with Brush and Eggs

Chandis L. Klinger
Independent Grower, Middlebury, PA

Anyone who lives in an area with deer will quickly learn about deer damage. Many farmers in Pennsylvania experience the damage every year - some crop fields are essentially stripped. Deer browse also affects the regeneration of forest. Where deer are excluded the more desirable species have a better chance to grow above the deer feeding level. Protecting young trees until they grow above the deer feeding level is a significant problem.

During the spring of 19901 bought and planted 70 walnut trees. In addition I received some 30 Chinese chestnuts from the Pennsylvania Game Commission. The walnuts and chestnuts were planted in areas of young brush, the result of a timber harvest forced ten years ago by gypsy moth infestation. The brush had to be cut to allow sunlight to reach the young plants, but to cut all of it would have been too labor intensive.

Some of the brush was cut and left on the ground in a random pattern. Other brush was piled around the newly planted trees, adapting the "cattle guards" of Western ranchers who use rails across roads to keep cattle from straying. Cattle will not walk over the rails for fear of falling through. Since deer have hooves similar to those of cattle, I wondered if the same practice would work to protect trees. Where birch was growing I cut the brush into short lengths and laid the main stems around the bases of the young plants, then laid on the bushy tops. The total height ranged from knee high to above the waist. Where maple or gum grew, with larger open tops, I simply felled them and made sure that the space above the seedlings was open.

This seemed to work well until mid June. Then disaster struck. The deer were eating the leaves and tender main shoots of my valuable seedlings. Something had to be done! I remembered having read in *Tree Farmer* magazine a year or so earlier about an egg-water mixture to keep away deer, but I could remember only a few details: (1) spraying needs to be done only once a year; (2) cheesecloth was used to strain the beaten eggs; and (3) a typical hand sprayer was used.

No cheesecloth was at hand, and it would cost money to buy it. Perhaps a blender would beat the eggs sufficiently that they would not need to be strained .1 beat six eggs in a kitchen blender for two minutes and then mixed them with two and one-half gallons of water. I sprayed the mixture for four or five feet around each of the young plants ... except for one walnut. This walnut was far from the others and had brush piled around it to a height just above my waist and a diameter of about seven feet. I simply forgot about it when the others were sprayed, so it served as a control.

The result of the spraying was immediate and dramatic. Vegetation beyond the sprayed area was eaten by deer, but in the sprayed area there was NO DEER DAMAGE to the young plants. The young chestnuts and walnuts grew new shoots.

Toward the end of July a few young shoots were browsed. This suggested that a single spraying each year may not be sufficient, so I sprayed again near the end of July. Again deer stopped eating where the egg-water mixture was sprayed. The young plants were observed for the rest of the growing season. Deer did not eat them where the brush was piled waist-high or higher. The lone walnut tree and other vegetation growing up through thick brush seemed safe.

Another observation was the difference in brush. Birch brush quickly degraded and collapsed, but the maple and gum brush retained their shape and height for a longer period of time. The deer nibbled the birch leaves and thoroughly enjoyed the maple and gum leaves. Thus care must be used when surrounding plants with different types of brush.

I discussed my preliminary results with individual members of the American Chestnut Foundation at our annual meeting that fall.

The next year, 1991, I obtained further results. Some of the chestnuts did not make it through the winter: the main stems were simply "dead." So I planted another twenty-five or so in the same area. Some of the chestnuts were intentionally planted in the open and no brush was piled around them. Others were planted near the stumps of previously cut brush, many of which were sprouting new shoots.

It did not take long for the deer to begin browsing they were eating the young plants' new growth by the week before Memorial Day.

I modified the spray program to use only four to five eggs in two and one-half gallons of water, and I sprayed less than two feet around the young plants. I sprayed on May 19, June 16, and July 28. I also cut some more brush and piled it around some of the little walnuts. Other young walnuts were left exposed. In both cases the young plants survived and after the initial spraying there was no deer damage.

The observations of 1990 were con-firmed in 1991. Where the brush was piled at least waist high, the deer did not eat vegetation they normally devour. Where the young trees were sprayed with egg-water mixture and left without brush protection, the deer did not eat. But the deer did eat other vegetation (such as poke-weed and young maple shoots) right up to the sprayed young plants.

John Herrington, the executive director of the American Chestnut Foundation, contacted me to gather further data about using eggs. He told me that after our conversation the previous autumn President Phil Rutter had also begun to use eggs. He had not had the same level of success I enjoyed, but he acknowledged that the egg-water mixture is the most economical way to keep deer away from his chestnuts. He also found that he had to spray about every two weeks to be effective.

The difference in our experiences may be due to the environments we have. My young plants are in the forest where trees and brush must be cut to provide sunlight. His are planted in open areas such as fields, and are more visible to browsing deer.

During the 1991 annual meeting of the American Chestnut Foundation I gave a short talk about my experiences. Two significant comments were offered after the talk. Phil Gordon of Connecticut verified my experience with the piling of brush. Another person, whose name I did not catch, suggested letting the egg-water mixture age a little to develop a good stink before spraying.

Deer are a significant problem for reforestation in many areas of the country. As highly blight resistant American chestnut becomes available in the near future, we have to deal effectively with the problem. Both the brush method and the egg spray method may be useful in the process of restoring the American chestnut to our forest.

A Chestnut Taste Test

Frederick V. Hebard
Meadowview, Vfrginia

Many people say that the American chestnut is better tasting than other types. Personally, I have had difficulty telling the difference between Chinese and American chestnuts. I have been told that this is because I do not have a discriminating palate, but I do recall sharing some nuts of Luther Burbank's early chestnut cultivars with Bernie Moynahan, and many of them were terrible! So perhaps I do know the difference between edible and inedible.

This year, we obtained our first harvest of nuts from Chinese chestnut trees at the Meadowview farm, and I thought it would be nice to share them with Foundation members at the festival in Accokeek. Since there were only a few pounds from four different varieties of Chinese chestnut, this seemed like a good opportunity to compare the taste of the four varieties. There is a grove of fruiting American chestnut trees at the Connecticut Agriculture Experiment Station's farm, but about 20 percent of the nuts are pollinated by Chinese chestnut, so these could be used also in the taste test.

The four varieties of Chinese chestnut were the cultivars 'Meiling' and 'Orrin,' and seedling trees from the Chestnut Hill Nursery in Alachua, Florida and the Waynesboro Nursery in Waynesboro, Virginia.

The nuts were harvested and air dried in paper bags for about a week before being stored in the refrigerator in plastic bags. I did not have time to control the curing conditions strictly. Curing conditions also differed because the nuts matured at different times, so I suspect that the results of the test reflect this variation in curing conditions as much as they reflect any inherent difference in taste. Greg Miller has found that curing conditions strongly affect the percent of sugar in chestnuts *(Annual Report of the Northern Nut Growers' Association 78:81-85, 1987),* and sugar content is undoubtedly a major component of taste.

The nuts were roasted on a charcoal grill at Accokeek, one or two hours before being eaten. Since the nut roasters were primarily concerned with roasting large numbers of Chinese chestnuts to be sold, the nuts for the taste test were squeezed into the roasting process on a catch-as-catch-can basis. Some varieties got burned more than others. The American chestnuts, which were smaller than the Chinese varieties, were most severely burned. They also had to be put on aluminum foil so they wouldn't fall through the grill.

Identifying letters were assigned to each of the five varieties, and people were asked to rank each variety from best to worst. Not all people included all the varieties in their rankings. Unfortunately, I believe some people peeked at the label identifying a variety before assigning a rank! And some could tell the American from the Chinese chestnuts. So, it was not a strictly blind taste test.

The results of this somewhat unscientific taste test are shown in the accompanying table. The 'Meiling' Chinese chestnuts and the American chestnuts got the best mean score. There was a barely significant difference (p=O.05) among the varieties.

My personal opinion was that the 'Meiling' nuts were sweeter than the others, and that this was a reflection of curing conditions.

I do not consider this a valid test scientifically because of the complications outlined above, but it was fun, and I think the people who participated deserve a look at the data. We'll try again next year, although I doubt that most people who can identify American chestnuts will ever rank them as anything but the best!

Counts and mean of preference for five types of roasted chestnuts by 40 people.

Type

Preference	Meiling	American	Waynesboro	Dunstan	Orrin
1'	14	13	6	2	6
2	8	3	10	13	5
3	6	12	5	6	10
4	4	5	10	11	8
5	7	5	8	7	10
Mean Preference	**2.5**	**2.6**	**3.1**	**3.2**	**3.3**

*** A score of 1 was given to the best-liked nut, 5 to the worst.**

The Cannon

A Chestnut Story (not an old chestnut)

Philip Gordon
Connecticut Forest and Park Association

One day in January I was walking amidst snowflakes with 86-year-old Robert (Bob) Brown, a professional forester from Old Lyme, Connecticut, looking at American chestnut trees on a six-acre forest plot. I remarked upon what seemed to be the shell of a two-foot-diameter chestnut trunk lying on the ground. That reminded Bob of a story he had not told to anyone for forty or fifty years.

It happened at Crown Point, New York, around the year 1900.

Bob's uncle was a foreman at an iron works, an expert with dynamite and black powder for the ore mining operation. One day, on a bluff overlooking a road near town, he saw an enormous American chestnut come down with a mass of twisted roots still attached. Perhaps it was a windthrow. It was three- to four-foot DBH (diameter at breast height, 4.5 feet above ground) and the uncle decided to detach the lower trunk from the root mat by drilling holes at the base of the trunk toward the center and packing them with black powder.

When the powder was ignited, the top of the tree was blown off the bluff, across the road, and into the front of a large house on the other side. Fortunately no one was in the house when the chestnut top demolished it.

Yup - the tree was hollow.

As Bob learned years later, when forest-grown American chestnuts get to be about 200 years old a normal physiological development is a hollow shaft which forms in the center of the trunk, and this cavity gets larger with age. Loggers knew this: if a tree was to become lumber, it would be harvested before it reached that stage.

The top of the Crown Point chestnut tree must have been weakened by the fall to become an unexpected projectile from a natural cannon.

Success is Assured: Return of the American Chestnut

William Voigt, Jr.

Note: Bill Voigt's death early last November was a major loss to the community of people working "to restore an American classic." Mr. Voigt was a distinguished conservation leader and a charter member of the American Chestnut Foundation. This article was found in his typewriter after he died.

When - not if - the American chestnut makes its triumphant re-entry into our eastern forests, three heroes not visible to the unassisted eye will deserve the applause. One is the tree's own remarkable root system which is still sending up new shoots where the trees used to be, after up to a century of attack by a fungus that converts into a canker that almost always has been fatal. Another is the chestnut's gene and our still developing understanding of its capabilities. The crucial third element in this is the cast of men and women who collectively constitute the quite young American Chestnut Foundation.

The historical record requires little attention here. It has been told and retold since the blight arrived as a then unidentified part of a parcel of Chinese chestnut shoots that were planted in New York City's Bronx Park. There was no quarantine station in those early 20th Century days, and the unidentified traveler who brought the blight to us was part of what had been a common practice since earliest Colonial times.

Spreading at the rate of twenty to fifty miles a year, the blight moved north as far as southern Maine and south to Georgia and parts of the Gulf Coast. The fungus-caused cankers caused the trees literally to die of starvation. Before mid-century the blight had enveloped most environments in which the tree grew.

My first recollection of the chestnut came in my preteen years, 1910-1912, when we lived on Brown's Mill Road between the Atlanta suburb of Lakewood Heights and Hapeville. Across the road was one tree, huge to my eight- to-ten-year-old eyes, and there was a contest of sorts between us kids and the squirrels, coons, and birds for the harvest.

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Now a quick jump to South Georgia's Pierce County, to a farm at the edge of the Satilla River flood plain, six miles by dirt road from Blackshear, the county seat. The year: 1914. There were no chestnuts nearby, but we youngsters - Mother and Dad had three boys and one daughter -made do with abundant chinkapins that grew in the uncultivated corners of the split rail fences.

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Fast forward to mid-century. The intervening years allowed little time for more than an occasional weekend away from newspaper city room typewriters and copy desks. World War II came with the reverse of my World War I situation: in my teen years I was too young to go; and now I was declared too old. After unfruitful years as an Army Ordinance desk hand I went to the Isaak Walton League of America staff, a job loaded with resource issues, first as assistant under Executive Director K.A. Reid, later (1949-50) as his successor.

In 1951 I was in line to become chairman of the Natural Resources Council of America, and the meeting that October was in a U.S. Forest Service field office at Franklin, North Carolina. The meeting ended at mid afternoon, and Bernard Frank, who had attended as an observer, invited me for a Jeep ride on a shelf road to the mile-high top of Mount Albert in the Alleghenies. We climbed the fire tower to get a bird's-eye view near sunset. From the tower we saw, mingled with conifer greens and deciduous color, many stark chestnut snags, gray to nearly white. Bernie pointed to some of the nearer ones. Some had lower branches with life still in them, and they bore chestnuts.

The Jeep stopped often as we scram-bled to pick those near the road. We used stones to pound away burs that had not yet opened. Bernie and I were oblivious to nearly all else. The sun went down and dusk came on. At dark the lights of a pickup truck came 'round the next bend, bringing a rescue' party that feared we might have had an accident.

Clarence Cottam, Assistant Director, U.S. Fish and Wildlife Service, asked for and got a handful of chestnuts from my jacket pocket**,** to be sent to a brother who was on the faculty of a university in Utah. They were to be planted there, beyond reach of the blight. No report came back from Utah.

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Another temporal hiatus, this time until the early 197Os. My retirement had begun at the end of 1968, and until 1973 my wife and I had divided our time between south central Pennsylvania and our Georgia farm. In October, 1973, a friend asked me to visit his rural home a short distance north of Blackshear. Sure enough, as he had told us, there were chinkapins on his place. His home fronted on a small man-made lake. The geographical area to the rear was typical of much of the Southeast: the winds are usually westerly. Over the millennia they have picked up larger, lightweight grains of sand, carried them across low, wet ground and southward-flowing streams to deposit them in what became low ridges or hills to the east. They have left the heavier, denser clays behind on the westerly banks or rises.

Growing from the sandy loam near the crest of the ridge were scattered chinquapin of shrub size - seldom more than two feet high - but they were mature and bore their miniature chestnut-like crop. This episode had a sad ending after a bank acquired the property. The retired chairman of the bank and I rode to the property in his car in October, 1990. 1 assured him that he would see living native chinkapins and their fruit.

Unease dampened our spirits when we arrived. The bank had hired someone to turn-plow the land and had turned it into something that has become a common sight in the Southeast these days: a "pine plantation": straight rows of uniform height, fast growing pines for pulp and paper. Yes, I could have cried. Those pines are making money, but the plantation custom has sharply constricted the bobwhite quail habitat and has done the same for the chinquapin.

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From the desk in my combination bedroom-office I can take three steps and touch a closet cabinet-counter area about twenty-four inches wide and fifteen feet long, from floor to eight foot ceiling. It has no worm holes. This tale takes us back to Pennsylvania.

In 1968 the Commonwealth decided it needed a new mansion for the governor which would be built on Front Street facing the mile-wide Susquehanna River. On the site chosen stood two manorial dwellings we were told had been built in the turn-of-the-century years, or earlier, by wealthy coal operators. My office was at 2101 North Front Street, just across McQay Street from the new mansion site.

When workmen started razing the buildings I took a look at them. We owned a rental duplex overlooking Yellow Breeches Creek in Bowmansdale, a village near Cona, and I arranged with the village carpenter to come with his pickup and haul the butler's pantry fillings from one of the razed buildings out to the duplex. That evening he phoned me.

"You don't want to put those cabinets in a rental property," he said. "It's solid chestnut, with no worm holes."

I agreed, and out they came: the paneling, the counter (1"x24"x12'), and the cabinets. They are all here, at Rockin' Creek Farmhouse, all because, at the start, an inconspicuous rental property needed kitchen cabinets, and the governor was getting a new mansion.

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William G. Raoul, who lives on the West Brow road atop Lookout Mountain in Tennessee, is one of my new friends in the American Chestnut Foundation. He is eighty and says he won't live to see the resurgent chestnut when it makes its reinaugural entry into eastern America. At eighty-eight I have even less chance of doing so than Bill Raoul. But *someone* will be around. Our population growth, and world population putting people wall-to-wall may be the least of this world's coming problems.

The chestnut, restored to its former homelands through the seeming miracle of breeding and backcross breeding and recrossing again and again, if carried to the successful conclusion that seems so surely in the cards- can and will make the transition to whatever is ahead more pleasant, more tasty, more fruitful, and more livable.

October, 1991

The Curious Case of the Ozark Chinquapin
F.L. Paillet

The old forest ecology literature lists a number of different species of chinquapin which are now lumped into varieties of one species, *Castanea pumila*. But whatever the classification, the old literature also mentions the Ozark chinquapin as a fair sized tree, and an important component of mixed oak forests. This is demonstrated in the tabulated listing of trees on Ozark slopes given in the old classic *Deciduous Forests of Eastern North America* by Lucy Braun. A visit to Ozark chinquapin country had long been on my list of things to do.

The opportunity finally came in 1989. My first encounter with the Ozark chinquapin was arranged by two helpful contacts with the Ozark National Forest, Gary Tucker and Ralph Odegard. Gary and Ralph drove us in the familiar government green pickup to visit a number of thickly forested ridges on a crisp, sunny fall day. We saw a fair extent of oak and pine forest with chinquapin abundant in the understory of many older upper-slope stands. My immediate reaction was that Ozark chinquapin looks almost exactly like chestnut. By this, I mean that chinquapin sprout clones look like the chestnut sprouts we see in the East. They are about the same size, running up to 10 or 15 feet tall, and a few inches in diameter. Ring counts on blight-killed stems show that they get to be 20 or 30 years old. At the same time, all of the anatomical details like leaf size and shape, twig color and hairiness, etc., seem identical to Allegheny chinquapin. I saw chinquapin sterns dominating small clearcuts, looking just like chestnut sprouts overtopping all the competition on similar sites in New England.

One area was especially notable to the foresters. They took me to an area cut over four years previously, now full of broad chinquapin crowns, and the ground littered with burs from the summer's nut crop. The view was impressive, but the impression of massed chinkapins comes from the size of the young trees. They dominate the visual aspect because they have outgrown all of the other stump sprouts - here predominantly red maple; black, white and red oak; and blackgum. A little counting showed that there were really only 10 to 20 large chinquapin clones per acre in the clearcut. A short walk through the adjacent uncut forest showed that a similar number of very inconspicuous chinquapin clones were present here, too. All of this is a very familiar story to chestnut observers.

One of the big Ozark chinquapin surprises was to see the size of some of the old chinquapin trees that had been killed by the original invasion of blight - in the middle 1940s according to my Forest Service contacts. A number of these big dead trees were nearly a yard in diameter and probably more than 70 feet tall. An example of such an old dead tree is compared to a typical example of a living Ozark chinquapin sprout in Figure 1. The old dead tree has a characteristic squat appearance, with large downsweeping branches. Samples of the outer wood from this stump show that this tree was still growing at a good pace even in its old age - about an inch of diameter every five or six years. The inner cylinder of wood on many of the old stems showed early growth rates comparable to those for chestnut. So in spite of the usual classification of chinquapin as a shrub, the Ozark chinquapin was a substantial tree in the forests of northern Arkansas before the blight arrived. At the same time, this peculiar tree must have retained some of its shrublike character, forming a squat profile with characteristic downsweeping branches.

As a final part of my first visit to the Ozarks, Gary took me to what he considered the biggest known living chinquapin in the state of Arkansas. The tree shown in Figure 2 was about 40 feet tall and the trunk had a diameter of about 14 inches. The mature bark was somewhat similar to chestnut bark on larger trees, but the "straps" had more of a parallel orientation and less of the interlacing pattern of chestnut, and the overall color was a darker shade of brown. This tree was growing right on the shoulder of a county road. An increment boring showed that the stem originated about 1940, and had experienced accelerated growth in the early 1960s when the road was improved. The tree has continued to profit from the road since most of the living crown is now centered over the opening above the road. There were a number of burs still attached to the bare branches. Fertile burs are usually shed soon after they open and the nuts drop, while these burs still seemed closed. A few burs on the ground were empty, indicating that female flowers had not been properly pollinated. This did not come as a surprise since this tree is located away from other large chinkapins, and cross-pollination would not be very effective at this location. The separation from other chinkapins serving as a source for blight also probably explains how this tree got to be **so** big. However, blight was clearly present in 1989 because the characteristic orange fruiting bodies of the blight fungus were visible along a "seam" in the trunk about two feet above ground level.

All of these observations show that both the old literature and the recent classifications of Ozark chinquapin are substantially correct - the tree was as big as people remember, while all the anatomical characteristics indicate that this is a variety of C. *pumila.* One wonders, with all of the similarity of Ozark forests to those of the Appalachians, whether the shrubby chinquapin is trying to fill the ecological niche of chestnut. In any event, there is enough chinquapin left in the Ozarks that the species is in no danger of being eliminated from the landscape by blight, clearcutting, or even nut gathering in regenerating forests.

Speeding Restoration of the American Chestnut by Using Genetic Markers in a Backcrossing Program: A Homage to Dr. Charles Burnham

David L. Mulcahy and Robert Bernatzky Departments of Botany & Plant and Soil Science University of Massachusetts-Amherst, MA 01003

One of the most successful techniques of classical plant breeding, backcrossing, gives us the ability to transfer useful genetic material from wild species into crop species. The method has the additional and essential benefit of transferring only the sought-after characteristics, leaving behind the undesirable qualities of the wild species. In fact, the widespread recognition that wild species may contain valuable genetic material is one of the driving forces behind programs to preserve endangered species.

Why has backcrossing not been used to introduce disease resistance to the American chestnut? As all readers of this journal will know, there are blight-resistant species (Castanea mollissima, the Chinese chestnut, and C. crenata, the Japanese chestnut), and these have already been hybridized to the American chestnut. Thus the problem is not a lack of genetic resources. These species display several desirable traits of the American chestnut, such as stature and timber quality. Charles Burnham (Burnham, 1988) first suggested a program to apply back-crossing to the American chestnut (see Figure 1) and here we consider doing just that, but with the additional aid of genetic markers.

Introducing desirable characteristics such as disease resistance into a species by backcrossing is a simple process.

Hybrids are made between the susceptible species and a resistant species. Such hybrids, termed the Fl (indicating the first filial) generation, carry genes for both resistance and susceptibility. The Fl hybrids receive not only the gene(s) for disease resistance but also genes for other, very likely undesirable, characteristics. In fact, virtually all the characteristics of the Fl generation will be 50 percent determined by the susceptible species and 50 percent by the resistant species. In the American chestnut the upright growth and unbranching form will be substantially degraded in Fl hybrids.

In order to reverse these unwelcome changes, members of the Fl generation are hybridized (backcrossed) to a member of the originally susceptible species - in this case the American chestnut (Castanea dentata). The resulting progeny, the BC1 (the first backcross) population, will be 75 percent domesticated on average, or, in the case of chestnut, 75 percent American. The BC1 will also be a mixture of disease susceptible and resistant individuals. For the next step in the program, individuals of the BC1 population which carry the genes for disease resistance are identified (the R1R1R2R2 individuals of BC1, shown in Figure 1) and these are backcrossed to the original (American) species. The resulting BC2 population will be 87.5 percent American and, again, a mixture of susceptible and resistant individuals. One more cycle of selecting and backcrossing will produce a population (BC3) which is 93.75 percent American and, to the casual observer, not easily distinguishable from the original American chestnut. Nonetheless, breeders often backcross for up to two more generations.

When the desired original quality has been restored, at least one more generation is required to produce a population of fully resistant (R1R1R2R2) individuals. The population is then ready for field trials. Certainly, the method is long but it does work.

In annual food crops many generations of domestication and breeding have selected for desired qualities of flavor, milling ability, and edibility. With trees, however, the prospect of at least five generations of crosses beyond the initial inter-specific hybridization is not encouraging! Furthermore, the expense of raising large numbers of backcross individuals in order to obtain a small number of resistant trees (perhaps only 25 percent of each generation) needs also to be considered. Surely we do not criticize any individual or group who sees this project as a daunting one!

Figure 1

A USDA study (see Burnham, 1988) indicated that resistance of Chinese chestnut to the blight is determined by two loci (RI and R2), each possessing two alleles. At each locus the allele for resistance Is partially dominant to that for susceptibility. The American chestnut Is presumed to be homozygous recessive at both loci (indicated by r1 r1 r2 r2) and the Chinese chestnut homozygous dominant at both (R1 R1 R2 R2). (Since the dominance Is Incomplete, the hybrid, R1 r1 R2 r2, is intermediate in resistance to the two parents.) The F1 generation contains only R1 R1 R2 r2 individuals, but the BC1 contains four types.

Castanea dentate ***x*** ***C. mollissima***

(r1 r1 r2 r2)(R1 R1 R2 R2)

Susceptible Resistant
and dies

Fl generation:

R1 r1 R2 r2
Somewhat susceptible
but many individuals live.
(50% American Characteristics)

r1r1r2r2 x R1r1R2r2 (Backcross the **F1** to
C. dentata)

BC1 generation:

R1r1R2r2 :	**R1r1r2r2 :**	**r1r1R2r2 :**	**r1r1r2r2**
Somewhat susceptible	Moderately susceptible	Moderately susceptible	Highly susceptible

(Each of the above four groups is 75% American chestnut.)

In this note, however, we indicate that both the duration and the expense of such a program may be dramatically reduced through the use of genetic markers, markers which were not possible to obtain until two years ago.

Genetic Markers and Their Application in Backcrossing

Genetic markers are characteristics which allow us to follow pieces of DNA from one generation to another. Examples include eye color in our own species and the sweet or starchy taste of corn kernels. There are also molecular markers, not so easily observed as eye color, but much more abundant. Late in ~99O, a new technique for generating molecular markers became available. This method, known as RAPDs (for Random Amplified Polymorphic DNAs) depends on a process called PCR (the Polymerase Chain Reaction). Conceptually and, in fact, technically, both RAPDs and PCR are extremely simple but quite powerful. The great advantage of RAPDs is that they provide so many genetic markers that even small segments of DNA from one species can be followed throughout subsequent generations, and it is this which makes the proposed backcrossing program more feasible.

From Figure 1, we see that the individuals carrying the disease-resistant alleles represent only 25 percent of the backcross populations, and economy requires that these be identified as early as possible. Furthermore, even after we identify the R1r1R2r2 individuals, we still face the prospect of several generations of backcrossing in order to restore the desirable qualities of the American chestnut. Genetic markers should facilitate both processes.

In the BC1 population, genetic markers, in the form of RAPDs, for example, will allow us to identify individuals which carry **both** the R1 and the R2 alleles. We are presently generating RAPDs to mark the entire Chinese and American genetic systems. This work is based on a population which has been raised by Dr. Fred Hebard and sent to us. This population should contain both blight-resistant and susceptible individuals and once these individuals are identified, we should be able to find RAPDs which are associated with the disease-resistance genes. (We have recently applied this method to another plant and demonstrated that it is a very effective approach

[Mulcahy, et al. 1992].)

Armed with these general and disease specific markers, we will be able to examine each backcross population, identify the individuals carrying the disease-resistant genes, and discard the remaining 75 percent of the population, with a significant reduction in cost. Philip Rutter and Drs. Sandra Anagnostakis and Fred Hebard have each developed systems of intensive cultivation which greatly accelerate the flowering of chestnut. If it is possible to concentrate these techniques on a small number of marker-selected R1r1R2r2 individuals, a backcrossing program could move forward far more rapidly. However, even their best efforts will not negate the necessity for several generations of backcrossing. Again, genetic markers promise to be useful.

Consider what is being accomplished during a backcrossing program. The purpose of each backcross generation is to dilute the foreign (resistant Chinese or Japanese) germplasm to one half of what it was in the previous generation, a purely random process. It works, but slowly. Tanksley (1983, 1989) pointed out that, since the distribution of the foreign genes is random, some individuals will, by chance, contain relatively few foreign genes. Others will have very many foreign genes.

Within a population of individuals selected because they each carry the alleles for disease resistance, we want to identify those which carry the smallest portion of Chinese characteristics. To this end, if we have a large number of genetic markers for the Chinese germplasm, we can survey the individuals of each backcross generation and identify those individuals which carry the smallest number of foreign genes. In other words, backcrossing would no longer be random. Tanksley (1989) reports that with marker-aided backcrossing, and only thirty individuals within a generation, three backcross generations could accomplish what would otherwise require six generations! Larger populations and more markers would result in even greater acceleration of the process.

Thanks to support from the American Chestnut Foundation and the University of Massachusetts, we are presently working to generate RAPD markers for the blight-resistance genes, as well as much of the remaining genetic regions of both species. If we are successful, it should be possible to see the restoration of the American chestnut.

To quote Robert Frost...

There is our wildest mount, a headless horse. But though it runs unbridled off its course And all our blandishments would seem defied, We have ideas yet that we haven't tried.

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Sterile Bud Cultures from Field-Grown Chestnut Trees: *An Experimental Note*

John Shafet, Jr.
Logansport, Indiana

Various people who have attempted tissue culture work using buds from field-grown trees have reported difficulty in obtaining sterile cultures from such buds. I faced the same problem with hybrid chestnut trees and was able to solve it in the following way:

Collect green-twig shoots from field-grown trees early in the spring, while the shoots are still growing. At this early age the buds are so young that the bud scales have not been formed; therefore the buds are smooth and easy to sterilize. It is critical that the collection be made before the tip bud has ceased to grow. After that bud has stopped growing, the lateral buds will not grow in culture.

Start cultures with auxiliary buds. It seems to be impossible to sterilize the terminal bud.

Cut a section of the green twig with one bud in the middle of the section. A handy size will have about one centimeter of twig below the bud and five to ten millimeters above the bud. At the same time cut off the leaf blade, but leave about 5mm of the base of the petiole attached to the stem section. Dip this stem-petiole-bud section briefly into alcohol (just to wet it - about one to two seconds), and then put it into a Petri dish containing a six percent solution of Clorox or a similar household bleach, together with one or two drops of detergent. The solution in the dish must be deep enough to allow the section to be totally immersed. With sterile forceps hold the section under the surface of the solution and with a sterile knife cut off all the petiole stub and all of the stem above the bud. Start these cuts as near to the bud as possible, and slant the cuts down from the bud. Be careful not to damage the bud!

It is necessary, in making these cuts, to open up the grooves between bud and stem, and between bud and petiole, so that no contaminating organisms can be trapped in the grooves beyond the reach of the sterilant.

Finally, cut off some of the part of the stem that is below the bud - or all of it, if you wish. I usually leave about a 5-7 mm stub in order to have something the grip with the forceps.

After eight minutes of immersion in the sterilant (start counting when the section is first transferred from the alcohol) transfer the culture piece to the sterile culture medium. Rinsing in sterile water would help but it is not absolutely necessary.

In summary, my culture piece, as put into the culture medium, is a short piece of green stem with a completely exposed bud sitting on its upper end. This method has given me 90-95 percent sterile cultures when used with buds from field-grown hybrid chestnut trees.

The Forest's Response to the Death of American Chestnuts in South-Central New York

Timothy A. Volk
Department of Natural Resources
New York College of Agriculture & Life Sciences
Cornell University

Abstract

The response to the demise of the American chestnut was investigated in one south-central New York forest by comparing the stand composition before and after the arrival of the chestnut blight. The preblight forest was reconstructed by locating chestnut stumps and using incremental cores from adjacent trees. Growth rates from the incremental cores were used to document the adjacent trees' response to the death of the chestnut. Stumps of American chestnut were identified and measured in fifty 40 square meter quadrants, and the vegetation type of each quadrant was determined. Chestnut accounted for 35 to 85 percent of the basal area in the pre-blight forest, and was evenly distributed throughout the stand. No correlation was found between the presence of chestnut stumps and a particular vegetation type, indicating that chestnut neither favored nor promoted a specific vegetation type. An intensive investigation of the trees around two chestnut stumps showed that the surrounding forest responded to the death of chestnuts in three main ways: (1) accelerated growth of large, adjacent trees; (2) establishment of new seedlings; and (3) increased growth rates of smaller, shade tolerant trees. A tree's size and proximity to the chestnut stump were the main factors which determined whether or not its growth rate increased following the chestnut's death. The majority of trees established since the chestnut's death were shade tolerant species which would normally be established under a forest canopy. Very few intolerant species were established under canopy caps created by the chestnuts' deaths. Despite the extensive disturbance created by the chestnut blight, this forest's composition changed relatively little, except for the loss of this highly valuable species.

Introduction

At the beginning of this century American chestnut (Castanea dentata) was the most important hardwood species in the eastern United States. On average, chestnut comprised 40 percent of the overstory trees in these forests (Keever, 1953). By 1950 the chestnut blight fungus (Cryphonectria *parasitica)* had virtually eliminated all chestnuts from the forest canopy. The death of literally millions of trees represented the most severe forest ecosystem disturbance documented in the northeast. Thus, an investigation of the residual forest's response to the demise of this significant species can enhance our understanding of forest ecosystem dynamics.

The blight reached south-central New York in the early 1920s (Smith, 1982). After almost 70 years the canopy gaps created by the death of chestnuts are no longer discernible, but we have not lost the opportunity to study the forest's response. Chestnut stumps can be located easily, positively identified, and measured in the forests today because of chestnut's high tannin content, extremely slow rate of decomposition, and its distinctive wood anatomy. The specific objectives of this study were to assess the former abundance of chestnut in a hemlock-oak forest and to determine how a segment of the surrounding forest responded to the death of two mature chestnut trees.

Method

The study was conducted on Bald Mountain in south-central New York, about 20 kilometers southeast of Ithaca (Figure 1). The site is dominated by Lordstown soils formed from glacial deposits. Lordstown soils are strongly acid, well drained and moderately deep (50-100 centimeters to bedrock) (USDA 1965). The site has a southwest aspect and a slope of eight to ten percent.

Five transects, 100 meters x 4 meters, were laid out in an area where chestnut stumps had previously been identified during a general reconnaissance of the *area*. The transects were parallel to the slope (320 degrees) and were spaced 20m apart. Each transect was divided into ten quadrants, each 10m x 4m. The diameter inside the bark (DIB) of all chestnut stumps in each quadrant was recorded to the nearest 0.1 cm. Taper equations for red oak *(Quercus rubra)* (Wenger, 1984) and records of chestnut bark thickness (Zon, 1904) were used to convert stump DIB to diameter at breast height (1.3 m DBH) outside the bark.

In each quadrant all trees more than 15cm DBH were tallied by species. Any trees less than 15 cm DBH which were outside the plot boundaries, but whose canopy overlapped into the quadrant, were also recorded. The vegetation type in each quadrant was classified using the following criteria based on the number of trees more than 15cm DBH: (1) If more than 60 percent of the trees were of one species, then the quadrant was designated by that species. (2) When no single species comprised more than 60 percent of the stems, but two species combined made up more than 75 percent of the stems, the quadrant was designated by two species. (3) If the conditions in neither (1) nor (2) were met, the quadrant was designated as a mixed stand. (4) If no trees were tallied in the quadrant then it was identified as having no distinct forest vegetation type.

Two representative chestnut stumps were selected to investigate how the surrounding forest responded to the death of the American chestnut in this stand. The DBH, species, and azimuth from the chestnut stump were recorded for each tree more than 10 cm DBH that was within a 12.Om radius from the chestnut stump. Trees near the perimeter of this circle that had one or more large stems between the stump and the tree under question were omitted. Two increment cores were collected at breast height from each living tree that was measured. The increment cores were processed using standard dendrochronology techniques (Stokes and Smiley, 1968). Ring widths were recorded to the nearest 0.01 mm using **a** dissecting microscope and a sliding stage micrometer connected to an IBM-PC. The DBH of each tree at the time of the chestnut's death was determined by back calculation, using these ring widths. The DBH of trees that were dead in 1988 were back calculated using average ring widths from the other trees of the same species.

Table 1

Distribution of quadrants, quadrants containing chestnut and the basal area of chestnut among 7 vegetation types.

Vegetation Type

	Hemlock	Red Oak	Maple	Mixed	Other[1]	Hemlock-Oak	None	Total
No. ofquadrants	13	13	6	6	5	4	3	50
No. of quadrants containing chestnut stumps	10	9	1	2	3	3	3	29
Basal area (m2) of all chestnuts	0.47	0.46	0.18	0.13	0.18	0.17	0.17	1.76

other includes the following vegetation types: Oak-Red Maple, white Pine, Red Maple-Beech. Black Birch, Hemlock-Red Maple. Each type was represented by one quadrant each.

Increased growth rates of trees surrounding the chestnut stumps was usually evident by examining annual growth data. The precise indication of a growth response was defined using a t-test that compared the average growth rate of the tree for five years on either side of initial response. When the t-test was significant at p=.Ol then the year was marked as the beginning of the growth response.

RESULTS

Abundance of Chestnut Stumps

A total of 54 chestnut stumps were counted on the $2000m^2$ surveyed. Thus the density of the chestnuts was 270/hectare. Chestnut stumps were found in 29 of the quadrants (58%) (Table 1). The DBH of the stumps ranged from 4.0 to 55.0cm. Mean DBH was 17.6cm. The basal area of all the chestnut stumps combined was $8.8m^2$/ha. Eleven different vegetation types were identified (Table 1). Slightly more than three quarters of the quadrants were classified into one of four vegetation types: hemlock, oak, red maple, and mixed. The number of quadrants containing chestnut stumps was distributed across the vegetation types in proportion to the number of quadrants in each vegetation type. There was no significant difference in the basal area of chestnut stumps among the vegetation types. (ANOVA, p=.l0).

THE RESPONSE OF TREES SURROUNDING TWO STUMPS

Many of the trees that surrounded the two stumps selected for more detailed study responded in one of three ways following the chestnut tree's death: (1) accelerated growth of large, adjacent trees; (2) establishment of new seedlings; and (3) increased growth rates of smaller, shade tolerant trees in the understory. In addition there were a number of trees that did not respond to the chestnut's death, but simply continued to grow at the same rate.

The Response Around Stump 1

Based on Smith's (1982) records and the timing of increased growth rates of surrounding trees, this chestnut began to die in 1930. At that time it had a DBH of 20.9cm and was surrounded by eight other trees ranging in size from 7.2 to 27.7cm DBH (Figure 2). Four were chestnut oak *(Quercus prinus)*, three were red maple (*Acer rubrum*), and one was hemlock *(Tsuga canadensis)*.

By 1988 there were 11 living trees surrounding the stump. They ranged in size from 13.0 to 37.1cm DBH (Figure 3). Two aspen *(Populus grandidentata)* (#2, #12) and one hemlock (#7) were established at about the time of the chestnut's death. The only other trees that were established in this plot since 1930 were two hemlocks (#1, #11) which appeared in the mid-1940s. (These estimated dates of establishment assume that the trees required four years to reach breast height.) One chestnut oak (#8) and one red maple (#13) were dead in 1988.

The growth rates of three chestnut oaks (#3, #5, #6), one hemlock (#9), and one red maple (#10) increased at the time of the chestnut's death, or slightly thereafter. These trees were 5.6 to 11 .4m from the chestnut stump (Figure 2). In 1930 the size of these trees ranged from 7.2 to 27.7cm DBH. The initial year of growth response varied from 1930 for the red maple (#10) to 1932 for two of the chestnut oaks (#5, #6), which were sprouts arising from a common base. Three of the trees (chestnut oak #2, hemlock #9, and red maple #10) showed **2** to 3 years of slight growth increase before showing substantial acceleration (Figure 4).

Response Around Stump 2

Based on Smith's (1982) records and the timing of increased growth rates of a red oak (#9) and a hemlock (#10) around the stump, this chestnut was blighted and began to die in 1925. At that time the DBH of 14 trees surrounding the chestnut ranged from 8.4 to 25.7cm. Four of these trees were other chestnuts, four were red maples, three were chestnut oaks, two were hemlocks, and one was red oak (Figure 5). In 1988 there were only 12 living trees surrounding the stump (Figure 6). The four surrounding chestnuts (#16-#19) and the three chestnut oaks (#2, #14, #15) had died. One white pine (#3) and four hemlocks (#1, #4, #5, #7) had been established since the chestnut's death. The establishment of hemlocks in 1923 (#1) and 1926 (#6) was followed by a white pine *(Pinus strobus*) in 1928 and hemlocks in 1945 (#5) and 1951 (#7). (These estimated dates of establishment assume that the trees required four years to reach breast height.)

The growth rates of two hemlocks (#10, #11) and one red oak (#9) increased following the chestnut's death. The red oak (#9) and hemlock (#10) were the two largest trees on the plot at the time of the chestnut's death (Figure 5). None of the four red maples around the chestnut responded to the death of the chestnut. The hemlocks (#10, #11) had a small initial increase in growth rate for three years. Then their rates of growth increased dramatically.

Discussion

Chestnut comprised a significant proportion of the basal area in this stand on Bald Mountain in the early 1930s. Although the precise history of this stand is not known, its structure, composition, and age in 1988 were similar to stands on permanent study plots at Cornell University's Arnot Forest, located about 20km away (Figure 1). The basal area on the Arnot plots in 1935 ranged from 15.2 to 25.1m^2/ha (J. Fain, unpublished data). Assuming the Bald Mountain stands had similar basal areas, the present study indicated that chestnut comprised 35 to 58 percent of the stand's basal area before the blight struck in earnest. This estimated abundance of chestnut is consistent with values reported by Zon (1904) and Aughanbaugh (1935).

Based on the frequency of quadrants containing chestnut stumps, it appears that chestnut was evenly distributed throughout the forest and did not favor specific vegetation type. In addition. the demise of chestnut apparently did not promote a particular vegetation type. Rather the trees that occupied the site with chestnut . and other species that normally would become established in the understory. filled the canopy gaps created by the death of the chestnut trees.

It is likely that the sprouting, growth and subsequent death of some trees was not detected by this analysis. Thus the following discussion of changes in growth rates and the establishment of new stems around the two stumps only considers those individuals that have survived since the chestnut's death. It is likely that other seedlings and sprouts were established, grew, and died in the period between the chestnuts' deaths and the time of this study. These stems would have been relatively small and thus would have had relatively little influence on other trees on the plots.

The increase in growth rates of a number of stems (e.g. plot 1 #3, #9, #10; plot 2 # 10, #11) occurred in two stages: a relatively small initial growth increase for 2 to 3 years followed by a more substantial jump in growth rate. A similar pattern has been noted in other studies (Aughanbaugh, 1935; Pail let, 1984; Woods and Shanks, 1959). The pattern was attributed to the gradual demise of the chestnut trees over a two- to ten-year period as the blight slowly did its work. Woods and Shanks (1959) state that the initial period of slight growth increase lasts for six to eight years, whereas this study indicates that the period is much shorter. The differences may be due to their use of larger chestnut trees at the center of their plots. The initial growth increase has been attributed to the expansion of the crowns of the trees surrounding the chestnut, while the subsequent accelerated growth rates were due to the already enlarged crowns and the expansion of these trees' root systems (Aughanbaugh, 1935; Woods and Shanks, 1959).

Response Around Stump 1

The southwest aspect of the plot and its northern latitude resulted in a greater quantity of light reaching the forest floor on the north side of the chestnut after its death (Canham et al, 1990). Root competition was also probably reduced in this area of the plot as well, since there were no other large trees at the north end of the plot. To the south and southeast of the chestnut, the relatively large chestnut oak (#8) and red maple (#10) trees would have created a shady environment in the under-story and strong root competition for potential competitors in the wake of the chestnut's death (Figure 2). Assuming that other site factors such as seed dispersal and site quality were similar across the small plot, these conditions may explain the establishment of different types of trees at the time of the chestnut's death, two shade intolerant aspen trees (#2, #12) north of the stump and one shade tolerant hemlock (#7) to the south (Figure 3). The establishment and survival of only hemlock (#1, #11) after 1940 suggests that the gap in the canopy had been closed and that the environment in the understory was once again only suitable for shade tolerant species.

The chestnut oaks (#3, #5, #6) whose growth rates increased following the chestnut's death were the three largest stems on the plot, after the other chestnut oak (#8) (Figure 2). Canopy expansion and height growth of these stems probably restricted the adjacent and smaller red maple (#4) from capitalizing on the opening created by the chestnut's death. In contrast, the red maple (#10) located immediately adjacent to the chestnut was able to take advantage of the canopy gap and reduced root competition. Despite being shaded by two large trees, the growth rates of a relatively small hemlock (#9) increased substantially following the death of the chestnut. Such response is typical of very shade tolerant species, which can respond to very small increases in light levels (Canham, 1990).

Response Mound Stump 2

At the time of its death this chestnut was surrounded closely by a number of other large trees - in particular a large hemlock (#10) (Figure 5). Thus the chestnut's death may not have created a large enough opening in the canopy to allow shade intolerant species to survive in the understory. This situation is probably responsible for the fact that four of the five trees established when the chestnut died were hemlocks. One shade intolerant tree, a white pine (#3), was established on the southwest side of the chestnut in 1930. The white pine's success was probably related more to the death of three additional chestnut trees (#17, #18, #19) to the south and southwest of the white pine (Figure 5), assuming they died in the mid-to late-192Os, rather than the death of the larger chestnut at the center of the plot.

As was the case with plot 1, the size and distance from the chestnut tree were the main factors that determined whether or not a tree's growth rate increased. Thus, it was expected that the chestnut oak (#2), which was dead in 1988, would have shown a growth response, since it was the third largest stem on the plot in 1925 and was only 3.3m from the chestnut. The three maples (#8, #12, #13) in this stand did not respond to the chestnut's death. These three individuals were about half the size of the chestnut oak (#2) and the hemlock (#10) that were situated between the red maples and the chestnut. Thus the red maples were probably over-topped and unable to benefit from the canopy gap. Similarly, red maple #8 would have been outcompeted by the adjacent red oak (#9) and hemlock (#10) (Figure 5).

The smallest tree whose growth rate increased was a hemlock situated north-east of the chestnut. Its growth rate did not increase until five years after the chestnut began to die. It is not entirely dear why this hemlock (#11) responded while the adjacent red maples (#12, #13) did not, although hemlock's greater shade tolerance may have allowed it to take better advantage of small increases in the light level than the red maple (Canham, 1990). Another factor may have been that the roots and branches of two chestnut oaks (#14, #15) at the north end of the plot competed more with the red maples than with the hemlock (#11).

Although red maple #6 is separated from the chestnut by some larger trees, its lack of response was surprising, especially since there were two other chestnut stumps to the southwest that probably would have died at about the same time, beginning in 1925. This red maple had been growing very slowly, less than 1.0mm per year in diameter, for 36 of the 42 years prior to the chestnut's death. Growth rates for the other five years were more than 1.5mm/year. Thus, this red maple had probably been suppressed for so long that it was unable to respond when the canopy gaps appeared.

This study supports previous studies (Aughanbaugh, 1935; Nelson, 1955; Woods and Shanks, 1959) which indicate that chestnut was replaced primarily by species that were associated with it prior to its death. Chestnut was a major component of the forest stand on Bald Mountain prior to the arrival of chestnut blight, but it was distributed evenly throughout the forest rather than clustered in groups. Thus the blight resulted in the formation of relatively small canopy gaps. The primary response to these gaps was for the largest and nearest trees on the plot to increase their growth rate and fill the gap. In addition small - very shade tolerant -hemlocks were able to benefit from the gaps to increase their growth rates.

The forest's second response was the establishment of new trees, but the majority of these were shade tolerant hemlocks which probably would have been established anyway. The only unexpected trees introduced into the stand were two aspens and a white pine. So, despite the extensive disturbance created by the chestnut blight, the composition of the surrounding forest changed relatively little - except for the loss of a valuable and previously abundant species.

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