THE AMERICAN CHESTNUT FOUNDATION

BOARD OF DiRECTORS 2003

HONORARY DIRECTORS

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FROM THE EDITOR

It is hard to believe that 20 years have passed since The American Chestnut Foundation began its quest to restore the American chestnut to eastern forests. For some, this may seem to be a long time, but in the history of the tree which started some 13 million years ago, 20 years is a mere blip. And during this blip in tree history, when a tree's tale has transected with human beneficence, a lot of work has been accomplished. Many generations of trees have been grown (over 35,000 trees in all!), in effect speeding up the American chestnut's revival by hundreds, perhaps thousands, of years. And some might argue that this was a necessary step, a duty or obligation of mankind as a proper steward of the forest, because our past meddling with the environment may have lessened or perhaps even destroyed the species' ability to come back naturally.

In this issue of The Joumal, we look at the start of TACF through the eyes of Dr. Charles Burnham in his article, reprinted from a 1991 issue of The Journal. It was through his research, enthusiasm and vision that backcross breeding could bring back the magnificent American chestnut that this organization began.

As we turn to our recent efforts, we realize that we are not far from being able to test nuts, products of TACF's intensive breeding efforts, in a forest setting. Dr. Fred Hebard once again presents us with Meadowview Notes, a summary of the progress made in the past year at TACF's central research facility, Meadowview Research Farms. Despite some minor setbacks, The American Chestnut Foundation program to breed a blight¬resistant American chestnut continues on schedule. Our farms completed planting the first line ofB3 F2 nuts which, when mature, will produce progeny suitable for first phase reforestation trials. The Foundation aspires to produce 350 lines of blight-resistant nuts in the next ten to twenty years and to continue its research of later generations beyond the B3F3 stage.

Our efforts to understand the American chestnut is not limited to pure breeding, but also to specialized studies of chestnuts in natural forest settings. Dr. Frederick Paillet presents his findings from his recent return¬trip to the Caucasus Mountains in the Soviet Union. His research will prove to be instrumental in reestablishing and managing chestnut in our forests.

In terms of managing forests, John Perry and Cecil Ison discuss an issue that has been in the forefront of people's mind throughout this summer season fire. They look at historic and prehistoric data and determine that human use of fire influenced the regeneration of Arnerican chestnut in forests prior to the blight. They argue that for us to conduct successful reintroduction, we must look at this historical interrelationship American chestnut, fire and human intervention.

Finally, Elizabeth Daniels provides an introduction to The Armorica Chestnut Foundation's Oral History Project which seeks to collect and document memories of the American chestnut for future generations. Two of these memories are printed in this issue. Clarence Wherry Brown recalls playing among the chestnut skeletons at a sawmill near to where he grew up, and Robert W. McGowan remembers harvesting chestnuts with a flailing stick as a child around 1930. If you remember the American chestnut or have a relative who does, please submit your story and any appropriate photos to beth@acf.org.

MEADOWVIEW NOTES 2002-2003

Frederick V. Hebard
Staff Pathologist

In the year 2002, Meadowview again was blessed with abundant rainfall from May until mid-August, when hot weather and drought set in and persisted until October, 2002. In October, the pattern of the last few years finally broke, and it became very rainy, enough so that field operations were seriously retarded. With one break from mid-December through mid-January, 2003, the wet weather continued until March, when we finally were able to start plowing for the spring plantings. It was not exceptionally warm on anyone day in April and May, but consistently warm enough that most trees had leafed out fully by the first week in May, about two weeks ahead of time. Cool, wet weather set in again toward the end of April and persisted up through June.

Our current holdings are in Table 1, and changes from 2002 to 2003 are indicated in Table 2. We now have more than 20,000 trees covering more than 70 acres. The most notable changes from last year are the continued accretion of B3-F2 trees, and some reduction in the number of B2 trees. The latter reflects our pending conversion of the Wagner Research Farm into a seed orchard for Graves B3-F2s. We expect to begin the planting of those nuts next winter. The other notable change is the increase in BI-F2s and B2-F2s, earlier generations than the B3-F2s. The B 1- F2s and B2- F2s are intended to provide a foundation for increasing the number of sources of resistance throughout the chapters, as was discussed in last year's Meadowview Notes.

Table 3 presents the current holdings of 'Graves' and 'Clapper' third backcrosses in the various state chapters. Taking the chapters and Meadowview together, TACF now has more than 35,000 trees in the ground. Note that the Pennsylvania Chapter produced their first B3-F2 nuts last year!

The 2002 harvest (Table 4) was a disappointment, in part. We had a late harvest at the farm, perhaps due to persistent heat and drought through September. I was assessing when to begin harvesting in the mountains by visiting a site close to Meadowview. However, that site, and the farms, did not reflect temperature and moisture further up the valley (20-25 miles), where the bulk of our mountain pollinations were located. There, the nut crop was not late, but we were, and many nuts had dropped by the time we went to harvest. We probably lost about 1000 nuts, mostly first and second backcrosses. But, on the bright side, we completed one line ofB3-F2 nuts!

EFFICIENCY OF CONTROLLED POLLINATION

In 2002 we compared the nut yield from pollinations done with fresh catkins to those done using dried pollen, and there was no significant difference between the methods (Table 5). However, dried pollen did give a substantially better yield in one instance. I hope we get an opportunity to repeat this test in the future.

I would like to thank Lou Silveri, Ron Myers, Gene Whitmeyer, and Harry Norford for helping out with pollination this year. They came down on their own and stayed at Emory and Henry College. We also had a group come down under an Elder Hostel program. Sam Fisher, Neil Rich & Chrystle Gates of the Southwest Virginia 4- H Center have been very helpful managing the Elder Hostel program, which would not occur without their initiative. Thank you -this wouldn't get done without your help. If you would be interested in helping polli-nate next year, plan on any time in June after the 10th. (Call 276-944-4631 around June 1). If you would be interested in the Elder Hostel program, call 617 -426-8055 or write 75 Federal St., Boston MA 02110.

A Quick Guide to Chestnut Breeding Terminology

PARENT		OFFSPRING
American x Chinese	=	Fl' "F-one"
F, xF,	=	F2' F-two
F2 x F2	=	F3' F-three
F, x American	=	B" first backcross, or B-one
B, x American	=	B2' second backcross, or B-two
B2 x American	=	B3' third backcross
B3 x American	=	B4, fourth backcross
B, xB, B,-F2'	=	B-one F-two
B,-F2 x B,-F2	=	B,-F3' B-two F-three
B2 x B2 B2-F2'	=	B-two F-
B2-F2 x B2-F2	=	B2-F3' B-two F-three
B3 x B3	=	B3-F2' B-three F-two
B3-F2 x B3-F2	=	B3-F3' B-three F-three

NUMBER OF PROGENY PER LINE TO RETAIN AT B3

Last year I discussed the layout ofB3-F2 seed orchards, and the relative merits of producing B3-F2 seed by controlled or open pollination. Another important consideration in producing B3-F2 seed is the number of straight B3 mother trees to select per line. For open pollination, I originally thought that it would be best to retain only one individual per line, in order to avoid the inbreeding arising from full-sib crosses between two individuals from the same line. However, simulations (Figure 1) indicate that inbreeding in later generations actually is decreased by retaining more than one straight B3 per line, *ifall* the B3-F2 trees are grown in *one* seed orchard, rather than dispersing the seed orchard over more than one location. It is true that there is more inbreeding at B3-F2 when more than one individual is retained per line. But this is outweighed by less inbreeding at B3-F3 when more than one is retained, because there are fewer crosses between sibs at B3-F2, those being replaced by crosses between first cousins.

The greatest reduction in inbreeding occurs when two individuals are retained per line, rather than one (Figure 1). The reduction shrinks rapid1y beyond two. Inbreeding finally starts to increase, erratically in these simulations (data not shown), when more than 10 individuals are retained per line.

Another equally, or perhaps more important reason to retain more than one straight B3 per line is to ensure production of adequate numbers of B3-F2 progeny, partially by ensuring that at least one B3 mother survives long enough to produce adequate numbers of progeny. Single trees can be lost due to random events such as wind throw.

It is still important, however, not to select too many straight B 3 individuals per line, so that fairly stringent selection for American type can be performed. It also is important to try to have equal numbers of selections for each line, so that one line does not become over-represented in the progeny, again leading to inbreeding.

We would like to remind all TACF members that you are welcome to visit the farms at any time. We are in a white house on the northeast side of Virginia Route 80, one-third of a mile southeast of Exit 24 on Interstate 81, the Meadowview Exit. We generally are there during normal work hours, but it might be good to call ahead (276-944-4631).

TABLE 1

Type and number of chestnut trees and planted nuts at TACF Meadowview Research Farms in May 2003, with the number of sources of blight resistance and the number of American chestnut lines in the breeding stock.

	Increase or Decrease* in		
Type of Tree	Nuts or Trees	Sources Resistanc	America Lines
American	2120		187
Chinese	918	41	
Chinese x American: F1	696	25	95
American x (Chinese x American): Bl	1064	11	36
American x [American x (Chinese x American)]: B2	4650	9	96
American x {American x [American x (Chinese x American)]}: B3	6425	6	71
Am x (Am x {Am x [Am x (Chin x Am)]}):B4	86	1	1
(Chinese x American) x (Chinese x American): F2	710	5	5
[Ch x Am) x (Ch x Am)] x [Ch x Am) x (Ch x Am)]:F3	6	1	1
[Amer x (Chin x Amer)] x [Amer x (Chin x Amer)]: B1-F2	688	4	3
{Am x [Am x (Ch x Am)]} x {Am x [Am x (Ch x Am)]}:B2-F2	381	4	5
[A x **(A** x {A x [A x (C x A)]})] x [A x (A x {A x [A x (C x A)]})]:B3-F2	3452	2	8
Chinese x (Chinese x American): Chinese B1	142		
Chinese x [American x (Chinese x American)]	41		
Japanese	3	2	
American x Japanese: F1	14	2	2
(American x Japanese) x American: B1	198	2	2
Castanea seguinii	48	1	
Chinese x Castanea pumila: F1	9		
Large, Surviving American x American: F1	251	13	27
(Large, Surviving American x American) x American: B1	768	7	12
Large, Surviving American x Large, Surviving American: 11	194	6	6
Large, Surviving American: F2 = F1 xF1, same LS parent	703	5	5
Large, Surviving American: Other	59	2	2
Irradiated American x American: F1	41	1	1
Other	26		
Total	**20,693**		

* The number of lines varied depending on the source of resistance. We will have to make additional crosses in some lines to achieve the desired number of 75 progeny per generation within a line. In keeping with past practice, the number of lines for each source of resistance are added separately; thus, progeny from two sources of resistance that share an American parents would be counted as two lines crather than one line (this only occurs rarely).

TABLE 2

Changes between 2002 and 2003 in the number of chestnut trees and planted nuts of different types at T ACF Meadowview Research Farms, including changes in the number of sources of blight resistance and the number of American chestnut lines in the breeding stock.

	Increase or Decrease* in Number of		
Type of Tree	Nuts or Trees	Sources of Resistance	American Lines
American	189		20
Chinese	20	-1	
Chinese x American: F1	45	1	11
American x (Chinese x American): Bl	43	-1	-5
American x [American x (Chinese x American)]: B2	-423	0	-9
American x {American x [American x (Chinese x American)]}: B3	107	1	-1
Am x (Am x {Am x [Am x (Chin x Am)]}):B4	-14	0	0
(Chinese x American) x (Chinese x American): F2	-70	0	-14
[Ch x Am) x (Ch x Am)] x [Ch x Am) x (Ch x Am)]:F3	0	0	0
[Amer x (Chin x Amer)] x [Amer x (Chin x Amer)]: B1-F2	179	1	-3
{Am x [Am x (Ch x Am)]} x {Am x [Am x (Ch x Am)]}:B2-F2	-12	0	-4
[A x **(A** x {A x [A x (C x A)]})] x [A x (A x {A x [A x (C x A)]})]:B3-F2	2178	0	0
Chinese x (Chinese x American): Chinese B1	0		
Chinese x [American x (Chinese x American)]	0		
Japanese	0	0	
American x Japanese: F1	-2	0	-1
(American x Japanese) x American: B1	0	0	0
Castanea seguinii	0	0	
Chinese x Castanea pumila: F1	0		
Large, Surviving American x American: F1	-53	1	-9
(Large, Surviving American x American) x American: B1	183	0	2
Large, Surviving American x Large, Surviving American: 11	132	2	1
Large, Surviving American: F2 = F1 xF1, same LS parent	358	0	-5
Large, Surviving American: Other	-16	0	-5
Irradiated American x American: F1	0	0	0
Other	-33		
Total	**2811**		

* The decreases in B1' B2' B2-F2 and Large, Surviving American F1 &: '1 trees reflects roguing of trees with inadequate levels of blight resistance. The increases reflect further breeding and collecting.

TABLE 3

Number of third and fourth chestnut backcrosses at TACF Chapters in 2003, with the number of sources of blight resistance and the number of American chestnut lines in the breeding stock.

Chapter	Nuts or Trees	Number of Sources of Resistance	American lines*
Maine	1581	2	21
Massachusetts	2328	2	20
Pennsylvania	9338*	2	32
Indiana	2057	1	11
Kentucky	150	1	1
North Carolina	865	2	9
Tennessee	745	5	6
Total	**17,064**		

* Includes B3-F2s!

TABLE 4

The American Chestnut Foundation Meadowview Farms 2002 nut harvest from controlled pollinations and selected open pollinations.

			Pollinated			Unpollinated Checks			Number of American
Nut Type	Female Parent	Pollen Parent	nuts	bags	burs	nuts	bags	burs	Chestnut Lines*
B_1	American	72-211 F_1	3	74	61	0	7	5	2
B_1-F_2	Meiling B_1	Meiling B_1	643	543	1684	5	52	156	8
B_2	American	Nanking B_1	2	27	42	0	5	5	2
B_2	Nanking B_1	American	76	96	159	3	11	17	3
B_2-F_2	Clapper B_2	op	4016	open pollinated				6	
B_2-F_2	R1T7 B_2	R1 T7 B_2	13	8	18	0	1	2	1
B_2-F_2	B2-F2 Clapper	op	320	open pollinated				4	

(Continued on next page)

TABLE 4 *(continued)*

		Pollinated			Unpollinated Checks			Number of American
Female Parent	Pollen Parent	nuts	bags	burs	nuts	bags	burs	Chestnut Lines*
American	Douglas B2	50	71	129	0	6	13	
American	Graves B2	3	41	92	2	3	6	
Graves B2	American	230	527	1316	1	43	107	8
R1T4 B2	American	10	3	9				
American	R1T7 B2	187	223	375	3	31	59	7
Clapper B3	op	2793		open pollinated			5	
Kuling Chinese	American	10	43	85	0	5	8	
Mahogany Chinese	American	61	65	112	0	6	13	4
Nanking Chinese	American	261	132	325	1	16	48	3
Amherst F1	American	24	63	253	1	5	20	
American	OrtF1	310	294	780	9	26	69	5
American	Hill4565	2	55	43	1	4	5	2
Ort F1	Ort F1	816	368	1342	3	44	116	6
opDaresBeach	Ort F1	139	47	104	0	6	14	2
opWeekly	Ort F1	3	13	18	0	2	3	
TOTAL CONTROLLED POLLINATIONS		**2843**	**2693**	**6947**	**29**	**273**	**666**	

TABLE 5

Nut yield from pollinations using fresh catkins and dried pollen on the same tree.

Cross	Pollen Type·	bags	burs	nuts
TM287xTM441	fresh catkins	49	185	47
TM287xTM441	dried pollen	60	107	49
TM328xTM550	fresh catkins	34	173	4
TM328xTM550	dried pollen	33	81	30
TM441 xTM482	fresh catkins	59	42	52
TM441 xTM482	dried pollen	64	49	228
TM482xTM441	fresh catkins	33	30	46
TM482xTM441	dried pollen	18	228	13
TM693xTM550	fresh catkins	20	1	14
TM693xTM550	dried pollen	27	14	125

* There was no significant effect of pollen type on the absolute number of nuts produced or the number of nuts produced per bur.

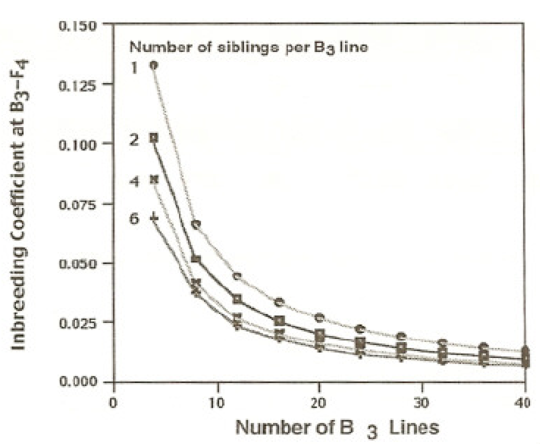
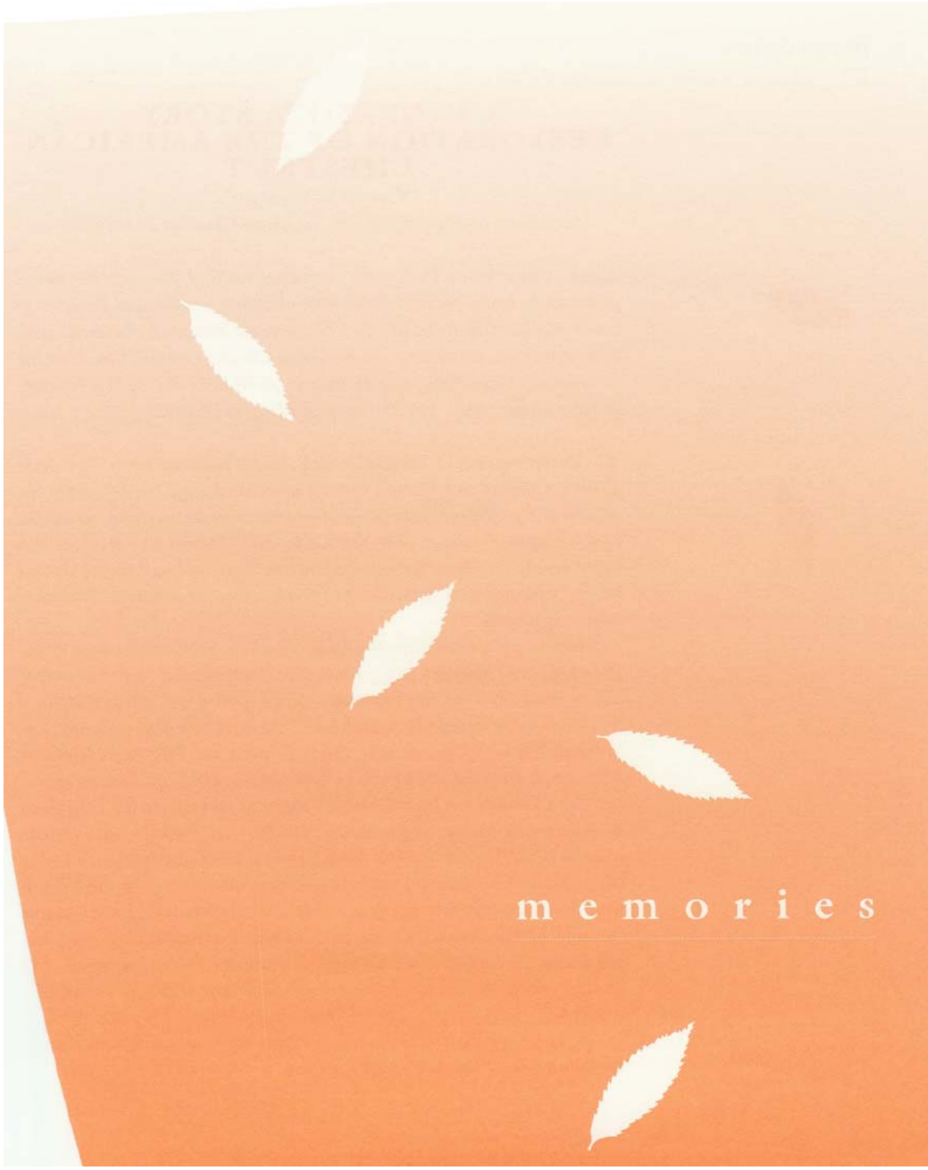


Figure I. Effect of the number of siblings per B31ine on the inbreeding coefficient at B3·F 4 versus the number of B3lines in the founder population, for par· tial dial lei mating at B3 with 4 lines per dial lei, ten B3F2 offspring per line, and for random mating thereafter.


memories

A MINNESOTA STORY: RESTORATION OF THE AMERICAN CHESTNUT

Charles R. Burnham

A memoir by a founder of The American Chestnut Foundation

Editor's Note: When Dr. Charles Burnham realized backcross breeding's potential to bring back the American chestnut, he launched forward to make this possibility a reality. In 1982, *with the assistance of scientists and other supporters, he founded The American Chestnut Foundation. Here, in this reprint of his article from the Summer/Fall 1991 issue of* The Journal, *he recounts the events. Dr. Burnham died April* 19, 1995.

In December, 1980, I found Frank Kaufert's publication on "'Prospects for the American Chestnut in the Upper Mississippi Valley" in the list of University of Minnesota publications in the bulletin room on the St. Paul Campus. I read it over the Christmas holidays and learned that blight-resistant American chestnuts had not been produced by the United States Department of Agriculture (USDA) breeding program. Why not? What happened?

My first job was at West Virginia University in Morgantown (1934-1938), where I had seen large, almost dead American chestnut trees that often produced flowering branches. Hence, pollen was still available.

I knew vaguely that the USDA had a chestnut breeding program, but not until 1959 did I write asking about the program. Fred Berry responded by sending me the 1954 Farmers' Bulletin No. 2068 on chestnut blight, and also a 1955 report on the status of chestnut breeding in the U.S. given at an international meeting in Rome. *The Farmers Bulletin* had a picture of a row of tall 15-year-old H hybrids between the blight resistant Chinese (C) and the American (A) chestnut, with the statement that the hybrids were more resistant than the American but less resistant than the Chinese chestnut parent. Resistance was incompletely dominant, obviously, but not stated. I remember mentioning to someone that in backcrosses to the American chestnut, the moderately-resistant segregates could be selected for the next backcross to American chestnuts, this to be follow by successive selection and backcrossing to American chestnuts. Hence I was surprised to learn about the failure of the program.

The Old Approach, and the Genesis of a New One

I read the references given. I could not believe what I was reading. Others reacted similarly. In the USDA chestnut breeding program, the backcross method had not been used in the manner required to produce American chestnuts with blight resistance.

Most of the backcrosses made were to the resistant parent, though they should have been to the American chestnut. Only a few were from a backcross to the American parent. None were beyond the first backcross. When I explained to Carl Moha in the Forestry Department what had happened, he responded by saying backcrossing should succeed. Colleagues in my department, in Plant Pathology, and Horticulture agreed .

Dr. Charles R. Burnham (1953)

The following is from the 1986 review, "Breeding blight-resistant chestnuts" by Burnham, et al.: "Many pollinations of native species were made at the USDA between 1894 and 1911 using European and Asiatic species then available (Van Fleet, 1914). When the blight disease appeared in their plantings in 1907 and the American chestnut and its hybrids developed the disease, work continued only with hybrids involving the European and Asiatic species and native American chinkapins." Three resistant selections were given Plant Introduction numbers and were used, along with new importations of Chinese and Japanese chestnuts in the breeding program that was resumed in 1922 by the Office of Forest Pathology, Bureau of Plant Industry, USDA. The first crosses were between the blight-resistant Japanese chestnut and the American. When they teamed the Chinese chestnut was more resistant than the Japanese, the JxA hybrids were crossed with the Chinese chestnut. Following a suggestion by D.F. Jones, the Cx(JxA) hybrids from that cross were crossed with the American chestnut.

Thousands of hybrids were produced by hand, controlled, pollination. Most of them were obtained by crossing the various blight-resistant species with each other and with the American chestnut, and then crossing the most promising hybrids. A similar program, begun by Arthur Graves while he was employed at the Brooklyn Botanic Garden was transferred to the Connecticut Agricultural Experiment Station at New Haven in 1947. I realized much later that the goal of both programs was a single tree that would be blight-resistant, and have the desired tirnber-type growth form. It was to be propagated clonally as for apple cultivars. Based on his experience with hybrid corn, D.F. Jones believed it would be a rare combination among thousands of hybrids (see the *Journal of the American Chestnut Foundation* 1:8-11, 1987). Hence their goal was not to restore the American chestnut by adding blight resistance, but to produce a blight-resistant chestnut with timber form that would replace the American chestnut. The USDA program had been terminated about 1960, possibly because they believed that they had attained their goal.

We now realize that a single hybrid clonally reproduced will not restore the American chestnut.

What could be done to put the program back on track? Although I had read that the American chestnut was extinct, I soon learned there are f1owering American chestnut trees growing in the University of Minnesota Landscape Arboretum. Frank Kaufert's publication described additional ones in Minnesota, Iowa, and Wisconsin.

At one time there was also a Chinese X American F1 hybrid at the University of Minnesota Arboretum, but it died back every year due to winter injury. It had finally been removed when Dr. Brierley, the one person in Horticulture interested in nut crops, retired. A European chestnut at the Arboretum still dies back every year. New shoots come from the roots.

THE BEGINNINGS OF A NEW APPROACH

We needed the cooperation of those who had worked on, or were still working on the chestnut problem; hence we had to explain the backcross method and why it should be used. With the help of Drs. David French and Thor Kommedahi, I submitted a Letter to the Editor which was published in the international journal Plant Disease in 1981, describing the backcross method, how it could be applied to produce blight-resistant American chestnuts, and also requesting information on Chinese x American hybrids that might be used for crosses on the American chestnut trees growing at the University of Minnesota Landscape Arboretum.

A news item with similar information was released April 1, 1981 by the University of Minnesota Extension Service. Responses came from several countries. Al Newhall at Cornell University sent male catkins from a chestnut tree at the home of L.H. McDaniels. A year later, at the 75th anniversary of the Plant Breeding Department at Cornell University in 1982, Dr. Will Provine went with me to McDaniel's home. The tree was flowering, but the lowest branches were out of reach.

The tree was at least six inches in diameter. Dr. Provine wrapped his arms and legs around the trunk and pulled and hunched himself up to the branches and cut off several. I brought catkins back for use at the Arboretum. A scion from an American chestnut had been grafted on a Chinese chestnut stock. The graft had died after growing to a diameter of about 6 inches. The living tree. *was* a Chinese chestnut.

Earl Douglass responded to my "plant disease" letter by sending a brochure about his chestnut hybrids in New York, plus some large nuts. They were from a cross between a Manchurian (Chinese) chestnut and the American chestnut. But were they F1s, or from open pollination between the hybrids and other chestnuts growing there? Later, some were identifIed as probable F1s. A few other responses were received, but none with information on usable hybrids.

SEARCH FOR USABLE HYBRIDS

When I explained the backcross method and the reasons for earlier failures, a group of local scientists and others became interested in making an attempt to restore the American chestnut. The recurrent parent would be the American chestnut. A search began for hybrids suitable for beginning the backcross breeding program. The first crosses in this new breeding program were made in 1981. When I wrote to Richard Jaynes in 1981 about the backcross breeding program, he was skeptical about its prospects for success, but sent pollen-shedding catkins from tree WdSL Row 11T7, a [Cx(JxA)]xA cross.

That pollen was used by Harold Petlett and his staff on two American chestnuts at the University of Minnesota Landscape Arboretum. Tree

#58681C produced 2 nuts from the cross. Tree #68242A also produced 2 nuts. (Note: the first two numbers: 58. and 68.. are the years in which the seedlings were planted.)

Tree WdSL Row 11T7 was undoubtedly a promising survivor, but its ancestry is complex. First, three different species are involved. Hybrids from the Cx(JxA) cross would have received half their inheritance from the C parent, but for the other half they received from the JxA hybrid there are many possibilities. Tree WdSL Row 11T7 received half of its inheritance from A, but for the other half there are also innumerable possibilities.

Many of the reports on the breeding work had been published in the Annual Reports of the Northern Nut Growers Association. Most libraries have incomplete sets. Some were missing from the University of Minnesota forestry library. In December 1981, our University library borrowed missing ones for the years following 1925 from the State University of Iowa library at Ames. I photocopied all the pertinent articles on chestnut breeding before returning them. Over the Christmas holidays I read, among others, Dr. John Shafer's 1966 paper that described his results from a planting in Indiana of 100 Chinese X American chestnuts (CxA) F2s he had obtained from Diller in the USDA. He also discussed what might be accomplished if large numbers of F2s were grown in blight areas. Nature would select those that were blight-resistant.

I wrote to him in January, 1982. He replied that a few of the F2s had survived and were producing nuts. These are F3s possibly the first ones ever grown. He also wrote that he had obtained Chinese chestnuts from Arthur Graves, one of those involved in the Connecticut breeding program, had crossed them with the American chestnut, and had flowering Fl hybrids at Logansport, Indiana, and in Tennessee.

Dr. John Shafer received a Ph.D. degree in plant physiology at Cornell University with a minor in plant breeding. He helped Marcus Rhoades at least one summer with corn pollination of the Maize Genetics Cooperation stocks. His first job was at Virginia Polytechnic Institute, Blacksburg, Virginia, but he left it to manage the family lumber business in Logansport, Indiana.

Mr. Philip Rutter (currently President of The American Chestnut Foundation) came into the picture at about that time. Dr. Phil Riegel from the University of Minnesota was visiting my older daughter in Chicago. She told him what I had discovered and what we were doing about the American chestnut. He told her that a friend of his in Southeastern Minnesota was growing chestnuts. I finally obtained Rutter's address and telephone number from Phil Riegel. I convinced Rutter that backcrossing to the American chestnut was the only way to go.

In 1982 pollen from John Shafer's CxA F1 hybrids was used for crosses by Dr. Harold Pellett and his staff on American chestnut trees at the University of Minnesota Landscape Arboretum; and also by Rutter on isolated American chestnut trees that he had located in northern Iowa. The Iowa flowers did not need to be bagged since isolated chestnut trees rarely produce nuts. They are self-incompatible. Pollen from other chestnut trees is required to produce nuts. Also at about that time I told Dr. Lawrence L. Inmen the same story. He had received a Ph.D. degree in 1957 under me with a thesis on a cytogenetic problem in maize. He had a B.S. degree in forestry from Iowa State University (1947) and had prepared a review of the literature on tree breeding for Dr. Arthur Wilcox in Horticulture here at the University of Minnesota. He now says he knew the American chestnut story, but believed he was in no position as a student to do anything about it, and did not know that I had any interest. Inman's first job had been on a Ponderosa pine tree breeding job in Idaho. After completing various foreign assignments, he was operating a farm at Danvers, Minnesota. He became interested immediately. He has helped since then with pollinations at the University of Minnesota Arboretum. Inman's familiarity with the tree breeding literature, his firsthand experience in a tree breeding project, and background training in forestry, genetics, and plant breeding have been a valuable resource. We have had numerous discussions about goals of the chestnut program to establish populations of blight-resistant American chestnuts adapted to different growth zones. Discussions by Inman of strategies to accomplish this are in two issues of the Journal of *The American Chestnut Foundation.* He drove to Connecticut to help Fred Hebard with bagging in preparation for the 1989 crossing and to exchange ideas and information with Sandra Anagnostakis and Philip Gordon. He also visited Paul Galloway who has an excellent American chestnut tree in New Hampshire that is being used for crossing.

The nuts produced in 1982, first backcrosses to A, were all sent to Dr. David Benzing at Oberlin College, Ohio. Dr. John Shafer has provided pollen several times since then. He has also sent us F3 nuts from his F2s.

Rutter and I discussed the possibility of giving a talk at the 73rd Annual Meeting of the NNGA in 1982. Since the meetings are in mid-August, usually at the peak of my corn pollination, Rutter gave the talk we prepared. The published paper is a revision of that talk. The talks aJld other articles are published there without peer review.

THE "CLAPPER" TREE

The USDA (Diller) and CT (Graves) had established forest-type test plantings of chestnut hybrids in 15 sites in 13 states from 1947 to 1955. They had been evaluated several times, the last time In 1978 by Fred Berry. Fred Berry, one of the last workers in the USDA chestnut program, had subsequently moved to Delaware, Ohio, on another program. He had published in 1980 a general summary of his 1978 observations on those plantings. He sent me copies of his field observations on the survivors in those plantings and their pedigrees where available.

One hybrid Berry found in the 1949 Carterville, Illinois, forest-type test planting was from a first backcross made by Diller in 1946. That tree, designated the "Clapper" hybrid, was described as the most promising of all their hybrids, the longsought, rare hybrid with blight resistance and excellent form. Since it was a first backcross (F1), its resistance could have been no greater than moderate, similar to that of the CxA F1 hybrid. In fact, the "Clapper" the tree had survived the blight for about 25 years, but finally developed a large canker at the base and died. Contrary to expectations, it was not widely propagated (Diller and Clapper, 1969). Since these would be clones of a single tree, nuts would be rare. Pollen from other chestnut trees would be needed for nut production. If their recommendation -the planting of an elite Chinese chestnut as pollinator-had been followed, the progeny would have been backcrosses to the Chinese chestnut, useless for the restoration of the American chestnut.

Blight resistance was believed to be dependent on many genes, and the other desired traits were certainly complex in inheritance. In fact, the problem was considered to be so complex there was no chance of success in the breeding program (Jaynes, 1960). Research turned to other means of control. Only a few crosses were made in Connecticut in the 1970s. Most research beginning in the early 1970s and continuing to the present in Connecticut and several other states has been on hypovirulence as a possible method of blight control

None of the other survivors in those forest-type plantings were ideal for beginning the breeding program. They were complex hybrids or from backcrosses to the resistant parent, not to the American chestnut.

Dr. Jaynes and others were skeptical about the prospects of success of a backcross program, but provided information on some of the missing pedigrees and answered questions. Records of the breeding program and reports of Mr. Liu and others who had sent material from China had been transferred from the USDA in Washington, D.C. to the Forest Products Laboratory in Madison, Wisconsin. I visited there and borrowed the record books and later also the Plant Introduction cards for chestnuts.

The Clapper tree had died. No sprouts developed from the tree. Only two clonal sources have been located. Grafts on the Chinese chestnut were in the Lesesne State Forest in Virginia, but Tom Dierauf, Virginia Division of Forestry, checked and found the Clapper scions had been winter killed. Then, late in 1982, Richard Jaynes remembered that 3 Clapper grafts on a Chinese chestnut were growing in a Connecticut Experiment Station planting near Hamden, Connecticut. In 1983 he crossed them on a Scientists Cliff American chestnut and also with pollen from an American chestnut identified as being somewhat resistant to the blight -this is the Floyd American tree (Griffin, et al. 1982). The nuts produced from these crosses are second backcrosses. Clapper pollen was used also on the American trees in the University of Minnesota Arboretum and also by Rutter on American chestnut trees in Iowa. The nuts were stratified here in Minnesota and the sprouted nuts were sent as follows: nuts from the Clapper x Floyd American to Blacksburg, Virginia, the others divided between Morgantown, West Virginia; Great Smoky Mountain National Park, and here at the University of Minnesota. Grafts of some of Shafer's F3s on chestnuts at West Virginia University, Morgantown, failed (William MacDonald in a recent communication). Clapper pollen was used again in 1985 on American chestnuts in the Arboretum and in Iowa. These are growing at the University of Minnesota. The Clapper clones in Connecticut are still flowering and were used again in 1989 for crosses in Connecticut.

The seedlings from the 1983 crosses were to be cloned at each location so that they could be sent to the other locations. Each location would have a complete set. American chestnut leaves have only a few simple hairs on the underside. Chinese chestnut leaves have a woolly mat of simple and stellate hairs. There are some exceptions. The leaves of CxA F1 hybrids are intermediate in numbers of hairs, but these usually appear in seedlings only at the end of the second year of growth. Under conditions favorable for rapid growth this has occurred at the end of the first year. The leaves on the Clapper clones have only a few simple hairs, an occasional stellate hair. Stronghold, Inc., at Sugarloaf Mountain near Washington, D.C., has seven flowering and fruiting trees from open pollinated nuts from the Clapper tree. These are near their headquarters building. The leaves on branches I obtained in 1987 when I visited there show that for all but one the hairiness is intermediate, and must have come from crosses with other hybrids or with the Chinese chestnuts in the Carterville planting. Nuts were mature at the time of my visit in October. The burs were just beginning to open. All had three large nuts per bur.

FOUNDING THE FOUNDATION

Some funds for the work had been received for the project, but it became obvious that these would not be sufficient. Rutter proposed that a Chestnut Foundation be established. With the help of Mr. Donald Willeke, a Minneapolis lawyer with an active interest in trees and the Chestnut work, The American Chestnut Foundation was established in 1984 in Washington, D.C., but the first officers of the Foundation were all in Minnesota: Philip Rutter, President, David French, Treasurer. The University of Minnesota Agricultural Extension Service sent a news release about the Foundation, on March 8, 1984, in a list of local papers and other publications in the states within the natural range of the American chestnut plus the Experiment Station's Horticulture list.

Beginning December 1988, Dr. William MacDonald, West Virginia University, became Treasurer.

MICRO-PROPAGATION

Yang Qui-guang, a Chinese scholar who had worked with chestnuts in China, spent a little over a year (1985-86) in Dr. Paul Read's Horticulture Department lab working on tissue culture propagation of the American and European chestnuts. He was successful in getting proliferation of microshoots. Rooting percentages varied from 2 to 8 in 10-microshoot tests. He also was able to establish them in soil in pots (Yang et al., 1986, *Hart. Science 21:)*. Attempts to repeat tl1e final procedures, transfer to soil, since then have failed.

CHESTNUT WORKERS

The immediate goal is to complete the transfer of blight resistance to American chestnuts as rapidly as possible with the backcrosses made in 1982 to 1986. These blight-resistant American chestnuts can then be used in the later backcrosses in the long-term program described above, these will not encounter the difficulties that probably are occurring in the progeny from crosses between the American and Chinese chestnut species in the first steps in the backcross program.

The ultimate goal is to establish breeding populations of blight-resistant American chestnuts, each of which will be adapted to a different growth zone in the natural range, as described by Inman in 1987 and 1989 in the *Journal of The American Chestnut Foundation.*

The Foundation also hopes to manage and document existing sprout populations and the occasional larger American chestnuts so that they can be used in crosses to introduce blight resistance.

Beginning in 1987, pollen from the hybrids being used in the 15 backcross programs was sent to several people who have fruiting American chestnut survivors in the natural range. Those now involved in this program include Tom Dierauf, Virginia Division of Forestry, Charlottesville; Tom Hall, Tennessee Tech University, Cookeville; Scott Schlarbaum, University of Tennessee, Knoxville; John Kuser, Rutgers University, New Brunswick, New Jersey; Philip Gordon, Yale University, New Haven, Connecticut; Sandra Anagnostakis, Connecticut Agricultural Experiment Station, New Haven; Charles Maynard, State University of New York, Syracuse; John Kelley and Alan Newhall, Cornell University, Ithaca, New York; and Paul Galloway, Walpole, New Hampshire.

American chestnuts homozygous for the genes for blight resistance can be established in each of the different growth zones, the progeny from crosses between them and American chestnuts in the same zone that are heterozygous for those genes will range in resistance from moderate, like that of F1s, to full resistance.

ADDENDUM:

This story would not be complete without acknowledging the many chestnut workers who have provided information through correspondence and telephone conversations. They have shared not only their own experience, but also their information from unpublished work of others, e.g., that of the late Bruce Givens, through John Elkins. I have learned much from those involved in the earlier breeding program, i.e., Fred. Berry, Richard Jaynes, Hans Nienstaedt, and Jack Elliston, and from many people who are currently active in chestnut research such as William MacDonald, Gary Griffin, Tom Dierauf and John Elkins. Sandra Anagnostakis has used the plans for the original chestnut planting plans to locate and identify the various species and hybrids, and Philip Gordon is locating, identif)Ting and cataloging the chestnut sprout populations and older trees now growing in Connecticut and in several other states.

Thanks to the Wagner family in Washington, D.C., the Foundation now has the use of part of their farm near Meadowview, in southwestern Virginia, for chestnut research. Research there is being conducted by Dr. Fred Hebard. In 1989 Hebard utilized the White Memorial Foundation plantings ofCxA and AxC F1 hybrids and Chinese chestnuts at Litchfield, Connecticut for crosses. These Litchfield plantings were made *by* Graves and Nienstaedt in 1944 and 1953. Hebard also used the Clapper clones for crosses with Chinese and American chestnuts in 1989.

Every *Castanea* species is now represented in those plantings. Included are winter hardy versions of the blight-resistant Chinese and Japanese chestnuts. These are being used for crosses with American chestnuts to produce F1 hybrids for which both parent trees are known. There are two excellent Japanese chestnut trees in Connecticut that were planted about 1876. Chinese chestnut cultivars were crossed also with American chestnuts in 1987 to provide F1 s with known parentage.

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VOICES OF THE PAST

- Elizabeth Daniels Membership Director

D.

The American Chestnut Foundation has been collecting stories from those who remember the American chestnut tree. This includes memories of harvesting American chestnuts, their use as a food item, as well as the tree's timber for building purposes. An archive of memories can be a vital tool for creating a more vivid picture of our past and to deepen our understanding of a bygone era.

The oral history project is designed to record the memories and feelings of a variety of people whose lives have been affected by the American chestnut tree. Gathering and preserving historical information through interviews and statements from various people creates an awareness of past events and ways of life that were shaped by this extraordinary tree. An anthology of historical recollections will enable people to document their personal experiences and those of their families and communities. It preserves the past for future generations so they can gain a sense of what life was like with the American chestnut tree.

I have received stories from those who have personally experienced life with the American chestnut, and from others who have only heard stories passed down from friends and relatives. Members and non-members alike have submitted memories ranging from the humorous to the disheartening. Evelyn Glazier of Storrs, Connecticut writes, "I have never forgotten the day the teacher at our one-room schoolhouse told us that we'd no longer be able to gather chestnuts because a blight was killing the trees. I grieved deeply over what seemed to me a great loss, and still, when I recall feel its sorrow." Many of these

Once Americans could read beneath Giant American Chestnut Trees.

stories and anecdotes suggest a livelihood dependent upon the seasonal chestnut mast, while others indicate that people merely enjoyed the nuts as an occasional treat. In addition, many accounts detailed the multiple uses of the American chestnut tree. Recollections include the nut as a food source for humans and wildlife, the timber for building, and the bark for tanning. Forrest Stafford from Liberty, Kentucky states simply, "It served man and animal as no other tree that I know of today."

When the blight hit, many people observed that the trees just began to disappear. Some individuals gave specific timelines for the decline of the American chestnut population in their region, while others slowly came to realize that all that was left standing were ghosts of the former giants. No one really understood the impact this would subsequently have on the land and people. These anecdotes all lead to the conclusion that the loss of the American chestnut tree was felt deeply and by many. Building an archive of memories of the American chestnut will aid future generations in comprehending the significance not only of the loss, but also the return of this native giant.

Members or non-members who know of a parent, grandparent, relative, friend, neighbor, or anyone else who grew up in or who has remembrances of chestnut times, are urged to send in their stories. The Foundation continues to gather memories of the chestnut for both archival and publishing purposes. We are accepting handwritten or typed memories sent by postal service, fax, or email. Photographs are also welcomed and will be returned. Please send your stories to:

Oral History Project
The American Chestnut Foundation
P.O Box 4044
Bennington, VT 05201
Phone: 802-447-0110
Fax: 802-442-6855
Beth@acf.org

CHESTNUT SKELETONS AND GHOSTS

Clarence Wherry Brown

Note: Mr. Brown, born on March 15, 1917, *still liJ1es on the family farm in Cecil County, Maryland, one half mile south of the Mason-Dixon line.*

In 1925 my parents bought a 147 -acre farm adjacent to a smaller farm owned by relatives in the northeast corner of Maryland. I was about eight years old at the time.

A steam-powered sawmill had just harvested about 20 of the 40 acres of wooded land on the farm. The remaining twenty acres of woodland had been harvested earlier and now grew young mixed hardwoods aver-

Dead chesnut trees after the blight struck aging 25 feet in height. This new vigorous growth was evidently resulting from the opening to sunlight that had occurred when the big chestnuts had died several years earlier. The chestnut's skeletons. were lying helter-skelter and at all sorts of angles throughout the woods. They had fallen against one another or against some unwanted oak or beech or other undesirable tree when the sawmill had harvested the wood eight or ten years earlier. The bark from the chestnuts was mostly gone by 1925. The exposed wood was very light in color, about the color of bleached cattle bones.

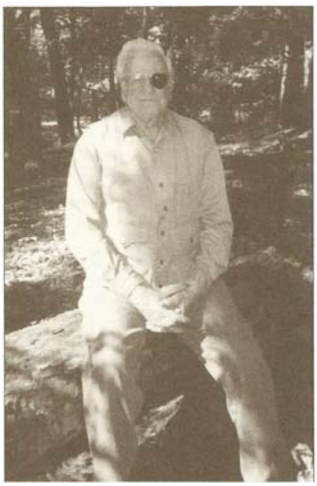
During the next several years, my friends would join me on adventures into this "haunted" environment. We'd see how high we could climb a leaner or how snug we would feel in the great holes left where a root system had been partly pulled out when the eighty foot tree had toppled during a windy storm. **In** retrospect, it appeared they tumbled one or a few at a time, not as a big group might in a violent thunder storm where they'd probably all fall in one direction. A favorite game was trying to run through the forest without ever touching the ground, like a raccoon, opossum, or squirrel might travel, transferring from tree to tree, the path dictated by the erratic patterns made by the fallen chestnuts.

The remains of the mighty chestnuts that had lodged in living, supporting trees could be seen for many years. Other chestnuts that had fallen directly to the earth disappeared within the next ten to fifteen years. All that remains today are the impressions in the earth where the mighty chestnuts became uprooted and fell, creating big holes in the earth during the first decade of the 20th century and the early 1920's .

Chestnut Hunting In 1930

Robert W. McGowan
Professor Emeritus of Biology, University of Memphis

Perry County is a Tennessee River County lying on the Western section of the Highland Rim of Tennessee. On Sunday, 20 August 1995, a native Perry Countian, knowing of my familiarity with the region's native flora led me to a single American chestnut tree, *Castanea dentata.* The lone tree (no other chestnut trees in the area) was mature enough to bear one bur near the top of its branches. As I looked at the bur through my binoculars, memories flowed.



The year was 1929 or 1930. The place was Henry County, another Tennessee River County in Northwest Tennessee. I was 7 or 8 years old. I remember distinctly that there were three or four large chestnut trees on that particular wooded slope where we went to gather chestnuts during those bright October days. And I remember quite vividly too that one of the trees had a portion of its bole that was bare of bark, showing grayish white wood. Of course we knew nothing of the chestnut blight. We would have guessed that the lifeless portion of the tree could have been an injury by lightning or other usual causes. Since, however, this was the early 1930s, my guess now is that we were seeing the demise of the tree from blight, a stranger to us. I am certain, however, of the memory of those days.

The large chestnut trees were loaded with burs. Inside those spiny, velvet lined burs were two or three nuts. My father screwed a large metal nut on the end of a two or three-foot long broom handle. We called this a flailing stick. We threw the stick into the tree, dislodging the nuts or bringing down the entire bur. The burs that were not open.

We opened with our feet, usually clad in canvas tennis shoes. I remember well the distinct discomfort from the spines sticking through the canvas.

I remember best however the pocketfuls of sweet chestnuts. We carried the pocketfuls to school and for some reason the teacher permitted nibbling on chestnuts, but definitely not on a Milky Way candy bar.

A few remaining chestnut fence rails still remain on the ridges and in the hollows of lands on Tennessee farms. The chestnut trees were abundant and the split rail fences were built on the spot. But the days of the split-rail fence, of pocketfuls of sweet chestnuts, of October nut-gathering are now only precious memories.

science and natural history

THE IMPACT OF FIRE ON CHESTNUT IN THE CENTRAL HARDWOOD REGION

John Perry, Berea College Forester

Cecil Ison, Forest Archeologist, Daniel Boone National Forest

INTRODUCTION

Prior to the devastating blight *(Cryphonectria parasitica)*, the American chestnut *(Castanea dentata)* was considered the redwood of the East because it was common to see trees three to four feet in diameter. It was also one of the most numerous tree species in me Central hardwood region (Braun 1950, Delcourt & Delcourt 1987, Hicks 1998). The looming prospect of successfully returning American chestnut to the forests of the region is exciting. However, chestnuts disappeared from me region before extensive silvicultural research had been conducted. When blight-resistant seedlings become available, mangers will lack a body of research and experience to guide their restoration efforts.

Even with the shortage of silviculture research on chestnut regeneration methods, the past may hold some clues. The dominance of chestnut, from late prehistoric times until the blight, coincided with a period of frequent fire on the landscape (Pyne 1982, Delcourt & Delcourt 1998, Hicks 1998, Bonnicksen 2000). While fire certainly played a role in shaping the forests of the region, the extent of that role played by anthropogenic fires has been poorly understood. Examining me relationship that chestnut may have with conditions created by fires could hold clues to help in its reestablishment.

NATIVE AMERICAN INFLUENCE

The use of broadcast fire for clearing the forest for purposes such as hunting, agriculture or other desires by the Indians of the Eastern U.S. was almost universal (cf. Day 1953). The problem arises when we try to pro~ vide time-depth to the use of fire before the written record. Botanical remains from archaeological sites along with pollen and charcoal studies from pond and lake deposits provide this time-depth and have advanced our understanding of presettlement ecosystems.

The earliest clues for the prehistoric use of anthropogenic or human-caused wildland fire began in the 1930's when Volney Jones, an ethno-botanist at the University of Michigan, examined a small sample of vegetal remains recovered from the Newt Kash rockshelter site in eastern Kentucky. Jones' analysis indicated that the grass, which made up the bulk of the sleeping beds was big bluestem *(Andropogon furcatus,* now *A.gerardiii)i,* a robust, fire tolerant grass commonly associated with prairie or open woodland environments. Of the identified woods, hickory was the most common followed by chestnut and oak (Jones 1936), again species that are uniquely fire adapted.

A crown dominant chestnut from sprouts released by fire 14 years ago on the Berea College Forest. The stand was initiated by a stand replacement fire (most overstory killed). 2 low/moderate intensity fires in the 20 year before the 1988 fire. 16 crown dominant chestnuts found in the acre surrounding this tree.

The study of the botanical materials from the Newt Kash Hollow rockshelter led Jones to speculate the occupation of the shelter was during a period of transition of the flora from prairie to forest or reverse (Jones 1936). With the advent of radiocarbon dating in the 1950's, the intensive occupation of Newt Kash shelter has been determined to have been occupied around 3,000 years ago (Gremillion 1997), a time when the forests were undergoing a rapid transformation as a result of Eastern Woodland Indians experimenting with horticulture (Ison 1991) .

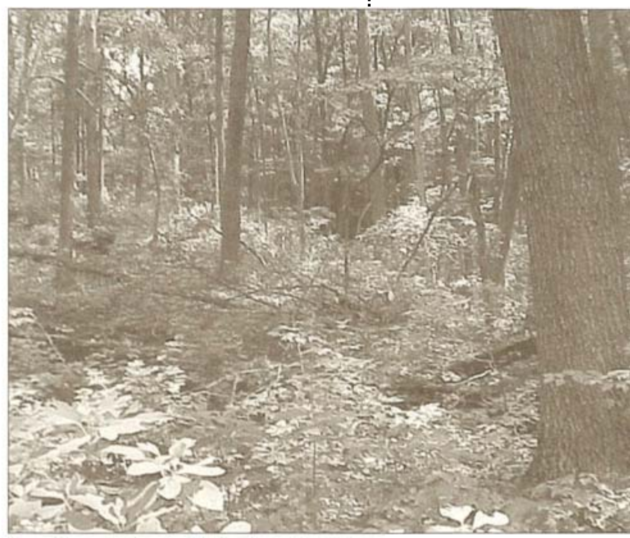
Conditions that most greatly affected the development of early horticultural practices (and later, large agricultural fields) were local topography and fire. Throughout the world the most effective method for forest farming is swidden or slash and burn agriculture. Since Jones' pioneering work of the 1930's, evidence for the transformation of the woodlands through the use of slash and burn fire has been repeated in numerous other agricultural sites within the region e.g. (Cowan 1985; Rossen and Ison 1986; Gremillion, 1995, 1998, 1999).

Pollen and charcoal spectra recovered from pond and lake sediments tell a similar story. For example, when the charcoal deposition in annually laminated lake sediments was compared to the appearance of Iroquois settlements between AD 1360 - 1650 an increase in wide scale burning was detected (Clark et al. 1996). Within the Southern Appalachians peat and pond deposits have yielded evidence for a direct relationship between prehistoric Indians use of fire and increases in oak and chestnut in the forest composition. At Cliff Palace Pond in southeastern Kentucky, substantial increase in chestnut pollen and large charcoal particles were detected in the core sample at about the same time that prehistoric inhabitants of nearby archaeological sites began clearing the forest for their garden plots (Delcourt et al. 1998). At Horse Bog Cove in western North Carolina, the pollen record shows a dramatic increase in chestnut from a low of about 10% of all tree pollen 2,000 years ago to nearly 40% after about 1,600 years ago. This corresponds with the cultivation of native plants and maize within the cove (Delcourt and Delcourt 1998). Increases in chestnut pollen and large charcoal particles were again discovered at Tuskegee Pond in eastern Tennessee during a period of intensive forest farming by the indigenous Indians (Delcourt and Delcourt 1998).

FIRE AND CHESTNUT SILVICS

The pollen data show a rapid expansion of chestnut dominance that corresponds to increased fire occurrence and the period when Native American cultivation became widespread in the region (Delcourt and Delcourt 1998, Bonnicksen 2000). The human use of fire in the early post settlement period in the region is also well documented. (Pyne 1982, Otto 1983, Hicks 1998, Williams 1989). Other human disturbance activities that influenced forest composition began with settlement, but chestnut continued to maintain a dominant role up until the blight. It is important to explore the link between fire and chestnut silvics in order to begin to make useful inferences from this.

The particular combination of factors that make a tree species (or any, species) one that responds favorably to fire is complex. Such species are referred to as "fire tolerant" or "fire increasers," that is, their numbers on the landscape relative to competing species increase in response to fire. Fire tolerance involves the interaction of two factors: fire regime and silvics. The fire regime involves such factors as the fire frequency, seasonality, intensity (e.g rate of spread and flame lengths), and severity (e.g. the effect on competing species). The nature of the pre and early settlement fire regime favored chestnut and oak (Quercus sp.) domination of much of the landscape of the region (Delcourt and Delcourt 1989, Bonnicksen 2000). Region wide, presettlement forests that included a significant component of oaks and chestnut indicate a low to moderate fire disturbance regime that created open understory conditions and larger canopy openings that cannot be explained by "gap-phase" dynamics (Bratton and Meier 1998, Bonnicksen 2000).



Berea College Forest: The open understory conditions that favor oak and chestnut regeneration: too much shade for fast growing pioneer species and shade tolerant mid and understory competition eliminated. Advanced oaks dominate the seedling layer.

Though other human influences were introduced at settlement, fire was present and remained a significant influence on forests up until the blight (Pyne 1982, Hicks 1998). Chestnut maintained its dominance through this and other moderate to heavy disturbance that began at settlement: logging, charcoal production, increased land clearing with subsequent abandonment, free range livestock, intense slash burning, etc. (Hicks 1998). Pre- and postsettlement, chestnut thrived through a moderately intense regime of fires or other forest disturbances.

It is important to examine the silvics of American chestnut, that is, its biological and ecological characteristics, to draw inference from its tolerance of fire and the other factors. Fire tolerance in a species is not an isolated set of characteristics, but the relationship of its characteristics to those of its competitors within a particular fire regime and ecosystem. **It** is not necessarily that fire increasers are not harmed by fire. It is that, over time, they are harmed less than their competitors. Though chestnut was a dominant species of the region's forest from settlement until the blight, oak was by far the dominant genus (Braun 1950, Delcourt and Delcourt

1989, Hicks 1998, Bonnicksen 2000). Whatever forces favored oaks over their competitors, also favored chestnut. Modern study of oaks indicates that the oak dominance is related to a low to moderate intensity tire regime: One that creates open, high sunlight understory environments, the need for repeated root collar sprouting, and occasional large canopy openings (Thor and Nichols 1973, Watt, et a11993, Abrams 1992, Lorimer 1992, Van Lear and Watt 1992). Chestnuts gained advantage under the same tire regime (Bratton and Meier 1998, Delcourt and Delcourt 1998, Bonnicksen 2000).

Chestnut silvics are those ofa tire tolerant tree throughout its life cycle: decay resistant wood (if fire scarred), prolitlc and sustained sprouting ability once top killed, relatively rapid seedling/ sprout growth, the ability to tolerate sites toward the middle and dry end of the moisture spectrum in the region (tolerance of leaf litter removal and presence on sites that are more likely to burn), and thick, insulating bark that develops early in life (Harlow, et. al. 1978). In these tire tolerance characteristics, chestnut appears to meet, and usually exceed, most of the oak species of the region. Like oaks, chestnuts were dependent on seed dispersal by animals that cache acorns/nuts in the soil and forget them. Jays (Cyanocitta sp.) and squirrels (Sciurus sp.) have been shown to prefer areas of thin leaf litter, a result of tire, for caching acorns (Bossema 1979, Darley- Hill & Johnson 1981, Healey 1988). In shade tolerance and successional position, chestnut, like the oaks, is in the middle relative to competitors in the region (Harlow, et. al. 1978, Hodges and Gardiner 1992, Bonnicksen 2000), and like oaks, chestnut places importance on larger, established seedlings ("advance regeneration") and root collar sprouts for regeneration. This combination requires open understories and sizable crown gaps for release (Abrams 1992, Bratton and Meier 1998, Bonnicksen 2000). Chestnut possesses similar traits to those that make oaks tire tolerant.

SUMMARY

Since the tlrst peopling of the Americas, tire has played an important role in shaping the forests. Ever-increasing data is revealing that prehistoric human-set tires were instrumental in creating the "natural beauty" ofthe forests of the eastern United States. The interaction of human activities, both historic and prehistoric, and forest dynamics on the landscape took place by way of the inter-relationships among the cultural use of fire, cultivation of plants, and forest succession. That fire undoubtedly shaped the ecosystems of the Central hardwood region is evidenced by numerous examples.

Both the presettlement dynamics of the Central hardwood region and silvics suggest chestnut to be a fire tolerant species. It held that dominance share through mid to heavy levels of fire and other similar disturbance factors of the post-settlement period. Silvicultural techniques to reestablish it should take this into account. Where prescribed fire is not a management option, mechanical silviculture will have to imitate some of the characteristics of forest landscapes influenced by a moderate intensity fire regime. Establishment by seed or seedling will require adequate sunlight and competition control for development and release. In established chestnut stands, understories will need to be open, moderately high light environments for seedling and sprout development for natural regeneration. Once such regeneration is developed, crown openings should be sufficiently large to release the regeneration to dominance. Small canopy gaps are not the principal way these trees achieve crown dominance in fire-influenced landscapes (Bratton and Meier 1998, Bonnicksen 2000). With blight resistance and proper management, chestnut can continue to benefit from its past success in a fire shaped landscape. The future use of fire as a management tool may be critical if we are to successfully restore the American chestnut to its former glory in tomorrow's forests.

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RETURN TO RUSSIAN CHESTNUT FORESTS—WITH AN AGENDA

Dr. Fredrick Paillet

Editor's Note: Dr. Frederick Paillet has been a frequent contributor to The Journal *since* 1989. *In his articles he has discussed various aspects of chestll1tt science from the tree's ability to sprout from the root crown collar, to advance reproduction through ten-year old "seedlings" and hypovirulence. Most recently he has written about his research on European chest1tuts located in the Caucasus region of Russia which provides us with a better understand the ecology of the American chestnut. These articles were based on a* 1995 *visit. In the present article, Dr. Paillet discusses his return to the Caucasus' Mountains in the summer of 2002 and outlines his findings in his obsC11Jations and illust,-ati01/)·. Formerly Project Chief of the Borehole Geophysics Research Project with the U.S Geological SU'1Jey, Dr. Paillet is now at the University of Maine .*

Let's start with a recapitulation of the background for my return trip to the old-growth chestnut forests of the Caucasian region of Russia. In 1995 I used funding from my general paleoclimate/hydrology research work to arrange a visit to a research watershed in the Caucasus through my contacts with Russian scientists at Hubbard Brook Experimental Forest. Because of a glitch in arrangements, I arrived at the Biosphere Preserve headquarters in the Black Sea City of Sochi with no one to greet me. The reasonable response of the institute was to arrange to deliver me to one of the forest research watersheds where I would shift for myself. This resulted in my having no way to move around the area except by foot, but left me alone in the midst of a mature, essentially untouched chestnut-dominated forest. Thus, I had time to examine in detail the structure of the forest around the Laura Station (figures 1 & 2), but was left wondering about how representative this one location was of the forest at large. Nevertheless, with that one prominent reservation, I identified several important issues that might be relevant to American chestnut propagation and ecology:

Where is the blight? I could find no sign of blight at Laura. How could these trees escape infection if they are: a) susceptible, and b) blight has been introduced into the area?

Where is the advanced regeneration? At Laura, I saw many new seedlings established but very little advanced reproduction. Since previous visitors from America had noted extensive disturbance to forest soils by wild pigs, I suspected that pigs had prevented seedling establishment until the recent relaxation of wildlife protection.

How is chestnut related to microsite? The Russians had indicated that chestnut was a "cove" species growing in ravines and along lower slopes. In contrast, I seemed to see chestnut growing everywhere at Laura.

Does wild European chestnut sprout in a way similar to American chestnut? American chestnut sprouts primarily from pre-formed buds on the root collar, and mature, uninjured chestnut trees are usually characterized by basal sprouts.

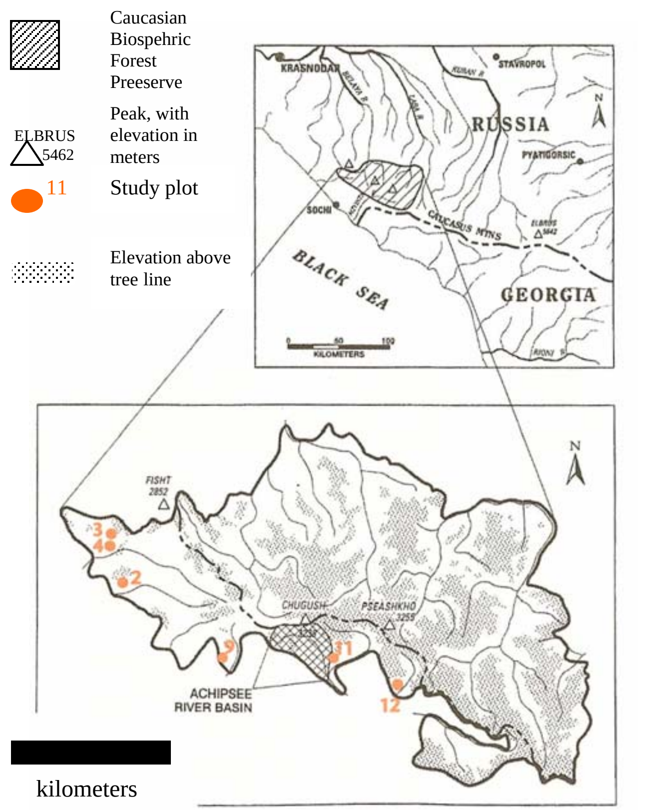
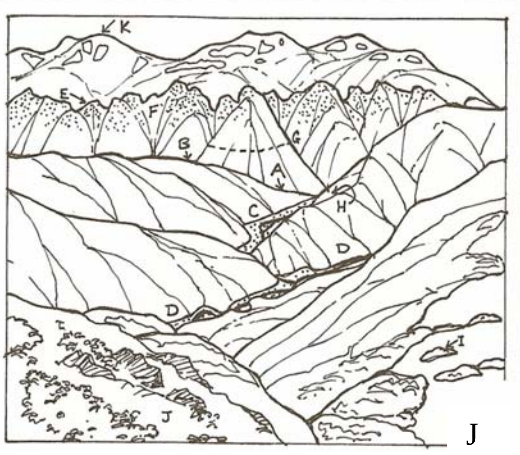


Figure 1 – Map of the Caucasian Biosphere Preserve; the laura station is located across the Aichipsee River from site 11

What happens to old-growth forest when a major disturbance occurs? It was hard to tell because there was so little disturbance at the Laura station. In 1995, I observed a few tree-fall gaps that were not doing anything. Chestnut seemed to be filling gaps by sprouting into openings generated by landslides at higher elevations, but the rare catastrophic regeneration of the low-elevation old growtl1 will probably require some detective work to understand.

PREPARING FOR THE RETURN TRIP

In planning a return, I wanted to make two kinds of observations: a) check the forest I saw at the Laura Station to document changes; and b) observe other locations where different soils, disturbance regime, climate, or altitude might influence chestnut. I was especially interested in visiting sites where chestnut was in the process of regenerating, and asked Russian Forester Dr. Mikhail Pridnya to schedule such visits. A major consideration in my visit would be the cost of transportation. Individual scientists and scientific programs just don't have their own vehicles. Reasonable expectations were to see chestnut over an altitude range in the high mountains, and to make a few "spot" visits to other locations. These objectives were achieved by taking first a ski lift tour of the slopes near the Laura Station, a jeep ride up a primitive road on Mt. Chugush at Laura, and then a visit to another chestnut site in much lower mountains and in a region of less rainfall on the northern edge of the chestnut range. I was also fortunate in just missing (by a fraction of a day) the onset of torrential rains that resulted in much property damage and loss of life in the Black Sea region. The other chestnut location was in a foothill area to the north of the main mountain range, providing another climatic sampling point, and in an area subject to frequent and variable (but all human related) disturbances.



A. Laura Forestry Station (elevation 500 meters)
B. Aichipsee River valley
C. Laura River
D. Mzyimta River
E. Tree line (2200 meters)
F. Subapline fir-maple-mountain ash forest
G. Upper limit of chestnut (1400 meters)
H. Location of 1970 tree harvest in Laura Valley
I. Scrub birch thickets in tundra
J. Rhododendron and rock outcrops
K. Summit of Mt. Chugush (3200 meters)

Figure 2 - Schematic view of the Aichipsee River watershed showing topography, distribution of chestnut-dominated forests, and various locations or features mentioned in the discussion.

SUMMARY OF RESULTS:

Blight. We all now agree that there really isn't chestnut blight in the Caucasian forests. It is either not there, or the trees are immune. The Russians, having placed great value on their chestnut forest resources, have been almost paranoid about blight. Mikhail now states unequivocally that he and his colleagues agree that blight just is not there, and all reported instances were almost certainly false alarms.

Advanced regeneration. The many new seedlings I saw in 1995 (figure 3A) have turned into older seedlings (figure 3B) at the locations I revisited this year. They are not necessarily impressive, being at most 2 feet "tall", and most often leaning heavily downhill under the weight of forest litter. These little trees do not seem well prepared for rapid upward growth, but new basal sprouts from them should still be able to out-compete other species. I did verify that there were already pre-formed buds on the little root collars of these seedlings (figure 3C), just as identified on the collars of American chestnut seedlings by Peter Del Tridici in his tissue studies at the Arnold Arboretum.

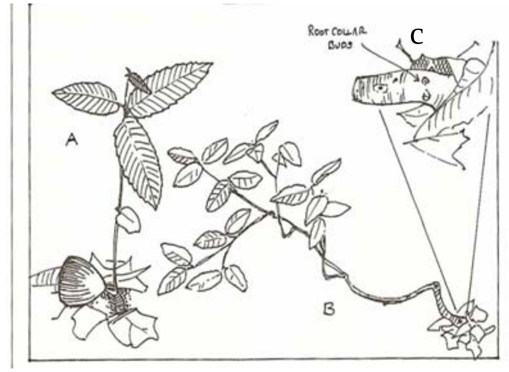


Figure 3- Examples of chestnut reproduction: A) new chestnut seeding, B)established seedling after at least five years of growth, and C) close-up of base of older seedlinng showing root collar buds.

Chestnut and microsite. My viewing of chestnut over wider areas generally confirms that chestnut is concentrated on lower slopes, in coves, and on topographic concavities. This was evident thanks to the minor damage to oak crowns produced by some sort of leaf miner. The reddened and frayed edges to otherwise healthy oak leaves made oak foliage visible at a distance, and showed that oaks were concentrated on upper slopes and ridge crests. But chestnut was still at least an occasional companion of oaks, and showed a definite increase in abundance near the upper elevation limit, at least at Laura. This was attributed to the more frequent disturbance (more exposure to wind, steeper slopes, more shallow soils) and the way that disturbance regime favors trees that sprout.

The 2002 nut crop. The trees again seemed to be full of new burs. From the ski lift I did see maybe one or two trees without burs, but this may have been a result of knowing what to look for. The bumper crop of1995 was not a coincidence, and a steady crop of nuts is indicated by the number of new seedlings on the forest floor (figure 3A).

Sprouting physiology. All characteristics of sprouting seem to be identical in American and European chestnut. I suspect that mature trees of both species have vigorous basal sprouts even when trees are not injured nor their bases exposed to elevated light levels - as indicated by both Russian and West Salem trees. The anatomical features of the "burls" where sprouts arise appear similar on old dead wood in America and Russia (figure 4A). However, in Russia you can see that sprouting from the stem above the root collar can be important, and there are hints that this is important for American chestnut, too - in both the old literature and at West Salem. In cases where suppressed sprouts were associated with old chestnut stumps it was clear that Russian chestnut trees produced new root systems separate from those of the "parent" stump, just as observed in the case of American chestnut (figure 4B).

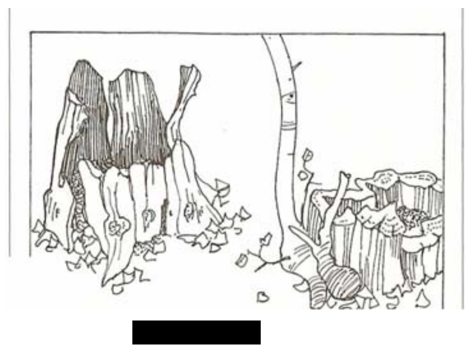


Figure 4 - Examples of old dead chestnut stumps: A) completely dead chestnut stump in the Aichipsee valley with broken top and burls marking the location of root collar sprouts that would have been undermined by slope erosion; and B) cut stump in the Experimental Forest where accumulation of debris allowed root collar sprouts to develop their own roots.

Response to disturbance. Disturbance is a critical f.1ctor in establishing European and American chestnut in natural forests. Disturbance history is evidently an important factor in Russian chestnut forests, because all chestnut trees I saw on my visit appeared to have become established as the result of a disturbance to the forest. In those extensive parts of the watershed that have been free of disturbance for some time, increment borings show that mature chestnut trees originated in distinct age classes in the mid nineteenth century. This clustering of ages in the old-growth trees implies that these trees originated after some earlier disturbance to the forest. We just do not know what kind of disturbance that might have been.

DIRECT OBSERVATION OF CHESTNUT TREE REGENERATION

Chestnut reproduction in canopy gaps. Of the five canopy gaps in old growth forest 1 encountered in the Aichipsee valley - all apparently produced by wind throw, only one had a chestnut sapling growing up into the opening. The other four were dominated by luxurious growth of the understory scrubs, herbs, and ferns, with one or two slowly-growing beech saplings beginning to fill out in the enhanced sunlight. All of these gaps were at least several years old, and it is unlikely that any recent chestnut seedlings would have been able to compete with the dense tangle of blackberry and ferns covering the forest floor. The one instance where a chestnut sapling was rapidly growing into a recent opening involved the generation of vigorous adventitious shoots from a point about 1.5 meters (5 feet) above the base of a 5-cm (2-inch) diameter sapling that had been broken by the tree-fall event. This seemed a limited sample afforest disturbance biased by the previous lack of advanced chestnut reproduction in the valley. Even so, it seemed clear that advanced chestnut reproduction would have been able to out-grow any competition in these treefall gaps if such chestnut saplings had been present at the time the gaps were generated.

Chestnut reproduction after harvest. Visits to former harvest sites where trees were logged about 20 to 30 years ago in the Laura Valley and the Experimental Forest clearly demonstrated that most reproduction originates as sprouts from stun1ps, augmented by growth from advanced reproduction. The stump sprouts were easy to recognize as they were clustered around old stumps, and usually had three to five trunks in the cluster (figure 5C). Large, dead lower branches indicated that these stump sprouts were initially growing as if in the open, with the big lower branches eventually dying as the canopy generated from the stump sprouts closed overhead. On the Laura site where forests may have had some protection from livestock foraging, many more chestnut stems were not associated with stumps and tended to be single or double stemmed (figures A and B). These trees had basal crooks or bends indicating that they originated from poorly-formed subcanopy saplings - what we would call advanced reproduction. These trees also had larger dead branches, although usually not as large as the stump sprouts. This is also taken as evidence that these trees effectively outgrew the competition in their early years, although perhaps not to the extent that the stump sprouts did. The shape of these trees is quite consistent with the observed tendency of older seedlings to lean sharply downhill under the influence of the slope and the

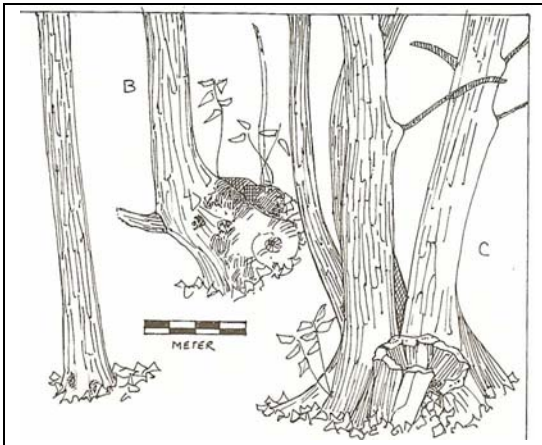


Figure 5 - Examples of chestnut regeneration on a slope clear-cut about 1970: A) Rare instance of a chestnut tree that originated as a straight seedling; B) Chestnut tree that probably arose from a heavily suppressed sapling; and C) Clump of large chestnut stems that clearly originated from the stump of a tree cut in the 1970 logging episode.

Chestnut reproduction in old fields. Abandoned tea plantations in the Experimental Forest provided a close analog to chestnut invasion of abandoned pastures in New England. In both cases, chestnut would be seeding into open, grass and shrub dominated areas in competition with other trees. It was evident that chestnut was one of the principle invaders of the abandoned tea fields (figure 6). A rough visual survey of the old tea fields suggested that maybe 20% of the young trees over shoulder height were chestnut. The most numerous invading saplings were hornbeam, and the largest were aspen - both more numerous than chestnut. A few specimens of several different maple species rounded out the mix. These trees had become established within a matrix of blackberry and tall grass filling the rows between the ragged but still living remains of the tea plants. One simple way to assess the success of the main tree species here was to estimate the average length of the current year's growth on the terminal shots: My estimates are:

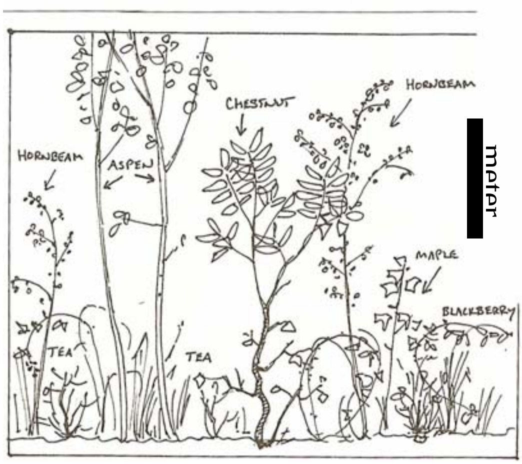


Figure 6 - Young trees seeding into an abandoned tea plantation provide a close analogy with tree invasion of abandoned fields in New England; note that the effects of browsing have clearly impacted the establishment of chestnut whereas other trees like hornbeam, aspen, and maple appear to have escaped browsing altogether.

Aspen:	1.5-2.0 meters
Hornbeam:	1.0-1.5 meters
Chestnut:	1.0-1.5 meters
Maple:	<0.5-1.0 meters

According to these figures, chestnut is certainly holding its own. But one observation seemed especially important: all of the lower branches on every chestnut sapling had been repeatedly browsed. This caused chestnut saplings to have a larger and more crooked basal stem than any of its competitors. One wonders that if chestnut seedlings had not been attacked by livestock they would not have been more numerous. The appearance of the chestnut saplings certainly indicated that they had to struggle to finally achieve a height where upward growth would not be repeatedly trimmed back. Indications of livestock activity in the area were surprisingly light. Daily cows were seen wandering around the forest roads during my visit, but there were no extensive livestock trails or other signs of intense livestock use anywhere in the forests. Apparently even light exposure to livestock can have a significant effect on chestnut reproduction.

CONCLUSIONS

The single most important objective of my return visit to the Caucasus was to follow up on the hypothesis that the lack of advanced chestnut reproduction at the Laura Station was caused by the previous intensity of wildlife foraging in the forest. The region had been managed for more than a century as a hunting preserve where the numbers of wild pigs were kept as high as possible. The wild boar is one of Europe's premier game species. Previous visits by western forest scientists had generated reports of extensive rooting on the forest floor such that essentially all of the leaf litter was turned over in a quest for chestnut, acorns, and beechnuts. Foraging by domestic livestock was also a problem in the vicinity of settlements around the forest edge. When I visited the area in 1995 there was almost no sign of wild pig foraging, and domestic livestock were not venturing far into the forest. Although it was hard to get the local rangers to be specific, my impression was that the hard economic times and the degradation of infrastructure during the end of the soviet system caused a drastic reduction in wildlife.

My second visit showed that wild pig foraging was still limited, and that all livestock except for the horses used to patrol the preserve were being kept out of the Aichipsee valley. New chestnut seedlings were still common on the forest floor, and older seedlings were as abundant as one would expect. Very few larger chestnut saplings that would be equivalent to the larger chestnut sprouts we see in America were encountered. But those larger saplings are typically a decade or more in age, and have been able to draw on the resources of root systems established even longer. After maybe a decade of protection from intensive seed predation, the Aichipsee Valley has developed a population of established seedlings that are well on the way towards becoming advanced reproduction for chestnut. On top of that, observations of a former tree harvest in the adjacent Laura Valley indicate that generation of trees from advanced reproduction was important in the past.

Having seen chestnut at more than one location, and having seen how chestnut is distributed along the altitude gradient, I have a much better idea of what the chestnut population of the Caucasus region is like. The chestnut forests can be broken into three basic types:

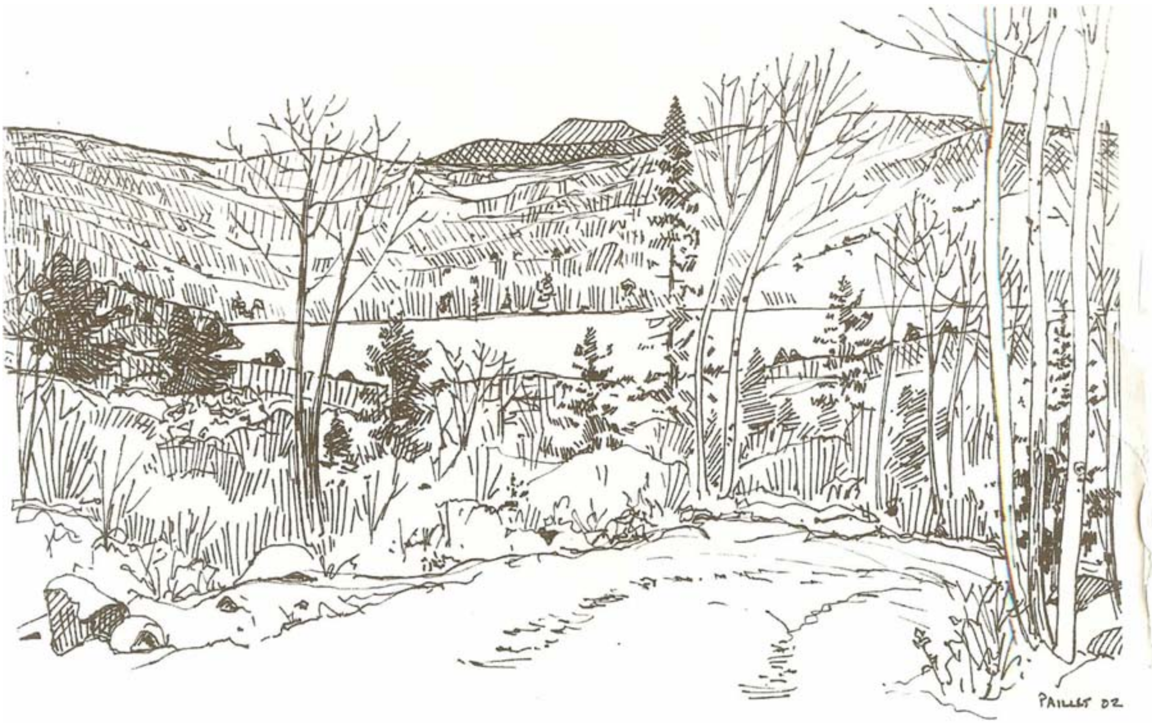
Type A: Chestnut forests of the foothills. These trees grow under relatively lower amounts of rainfall and in an environment where human activities are both frequent and the primary cause of disturbance to the forest. Chestnut is considered a valuable resource, but regeneration of chestnut stands is geared entirely to stump sprouting. Russian foresters expect such regeneration to occur, and do not consider that there is a chestnut reproduction "problem". Although I did not gain much insight into specific forestry practices, one supposes that Russian foresters have a set of guidelines about how and when chestnut should be cut, and how to protect the new sprouts such that regeneration is effective. It is possible that cultural activities have enhanced the role of chestnut in these forests in a manner similar to the inferred increase in chestnut after European settlement in Connecticut.

Type B: Chestnut forests of the mountain valleys (200-800m in elevation). These old-growth forests are not subject to any kind of recent disturbance. They are old growth timber that is destined to get older. Chestnut is most abundant on lower slopes and in coves (concave slopes), whereas oak becomes dominant on convex slopes within this altitude range. A major question remains as to how these trees will eventually turn over in the absence of any human activity such as timber harvest. This remains one of the real mysteries of chestnut, and presents a relevant issue for national parks and other pristine areas where American chestnut might be reintroduced. All one can say is that with the removal of intensive wild pig foraging many chestnut seedlings are surviving on the forest floor, and that in roadside areas and under the ski lift where the forest has been opened manually, chestnut *is* outgrowing all competition. All of which is consistent with the theory of chestnut adaptation for release and colonization of canopy gaps in mature forests.

Type C: High-altitude chestnut forests (800-1400 m). These forests are subject to frequent disturbance in the form of windthrow and landslide because of the shallow soils, steep slopes, and exposed positions where they grow. Natural stump sprouting and the ability of sprouts to survive in a suppressed form until a subsequent disturbance releases them amplify the abundance of chestnut in these forests. The form of disturbance often results in breakage of stems at points well above the root collar. It is evident that chestnut stems can be re-generated by sprouting from points located above the root collar, and that sprouts originate from adventitious buds stimulated by injury to the cambium or by "rejuvenation" of suppressed side-branches in addition to sprouting from pre-formed buds on the root collar. This may well apply to American chestnut where we have no means of recognizing this kind of sprouting because 1) we don't see such damage to mature trees just because we don't have them to study; and 2) much of the chestnut sprouting we do see is in response to deliberate cutting just above the root collar as in land clearing at rural construction sites, or stem girdling near the base by blight. A strong hint that sprouting from points above the root collar is an issue for American chestnut is the old forest practice of cutting suppressed chestnut stems during logging to insure generation of a new stem. This practice is definitely indicated in a number of old forestry references that deal with chestnut propagation.

It is hard to know what to make of the absence of blight in the Caucasus. If European chestnut is susceptible to blight, the widely distributed chestnut stands of the western Caucasus must represent a large biological target for fungal colonization. The fragmented distribution of chestnut in France, Italy, Switzerland, and Spain has been credited for the relatively slow advance of blight in Western Europe. This explanation does not work in Russia, Georgia, and Azerbaijan, where chestnut seems much more continuously distributed. If nothing else, Russian biologists should continue to take steps to prevent the introduction of blight spores because blight may be difficult to control once it gains a foothold.

Last but by no means least; I want to acknowledge the hospitality of Dr. Mikhail Pridnya during my visit, and the support from the Russian Institute of Mountain Forestry. The Institute made Mikhail available to escort me during my visit, and provided transportation to the various chestnut sites. Because of the remote location of the forests and the difficult travel in mountain terrain, my observations on chestnut ecology would have been impossible without this level of support.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