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FROM THE EDITOR

For The American Chestnut Foundation fall is like a new beginning each year. Volunteers from Alabama to Maine, some as far north as Canada and others as far west as Indiana, go into the woods or into neatly tended plantings of chestnut trees to collect the year's harvest. In this issue of The Journal, Bruce Graham's poem poignantly describes the anticipation many of our staff and volunteer members feel at this time of year—ready to collect the seeds that will be planted in the ground next spring. Each year our efforts to collect chestnuts seem new and fresh, yet it is a time-honored tradition. While we collect nuts that are or will be incorporated into our breeding program, others before us have collected chestnuts for far different reasons, reasons we hope will motivate our grandchildren or our grandchildren's children to do the same.

In her essay on chestnuts and Native Americans, Dr. Anne Frazer Rogers describes a traditional Cherokee Indian chestnut bread which has been handed down for generations and is still served today. She goes on to explore how long chestnuts might have been used by Native Americans and for what purposes. While the archeological information is thin, she surmises that the use of chestnuts is long-standing, perhaps being used with corn before the bean was introduced into North America.

While Native Americans used the chestnut because of its nutritional value, good taste and versatility, in our efforts to restore this majestic tree we must look at the past and present structure of our forests. Quentin Bass in "Talking Trees" looks at the historical data of the Southern Appalachian Region to reveal inherent characteristics about chestnut regeneration in the forest. Indeed, he argues that the reproductive characteristics of chestnut gave it a competitive edge over other trees in the forest prior to the blight and Euro-American land practices. In returning the American chestnut to the forest, we must be aware of its reproductive strategy.

Steve Oak looks at the present composition of Southern Appalachian forests in "From the Bronx to Birmingham" and finds that without the American chestnut, the Southern Appalachian forest ecosystem cannot be considered healthy. Because American chestnut was virtually eliminated, oak trees have been elevated to an unprecedented position in the forest ecosystem. Yet oak trees are currently quite vulnerable to oak decline, a disease that kills mature trees. What he sees is a forest that is changing—one with fewer oaks and an increase of species that provide mast of lower value for wildlife.

Jayne Van Laurel's life was dedicated to nourishing wildlife. In her honor, husband Forrest MacGregor is sponsoring a portion of the 'Clapper' seed orchard at TACF's new Meadowview Farm. The blight resistant American chestnuts produced by this orchard will nourish all types of wildlife, continuing Jayne's work and enabling the American chestnut to step back into its original role within the Appalachian forest. Others who may also wish to sponsor part of the seed orchard will want to look at the information on page 22.

This overview ends where this issue of The Journal and much of our work at The American Chestnut Foundation truly begins, at Meadowview. In his annual summary of research, Staff Pathologist Dr. Fred Hebard notes that this year has been especially noteworthy because we harvested our first large crop of B_3F_2 seeds—nuts that will produce seed suitable for reforestation. He also provides a review of backcrossing and an initial plan for seed orchard design. The Castanea Guide on page 56 provides a graphic model of the design.

While once again the chill in the wind signals the fall harvest and next year's seeds to plant, we know that many decades of effort have led us to where we are now, closer than once thought possible to developing our first blight resistant American chestnut trees.

MEADOWVIEW NOTES 2001–2002

by Frederick V. Hebard, Staff Pathologist

In the year 2001, Meadowview again was blessed with abundant rainfall from May until mid-September, when drought set in and persisted until March 2002; it also was quite dry from April through June 2002. These conditions are very similar to what we experienced in 1999-2000, and 2000-2001. The winter of 2001-2002 was warmer than in the previous years. Several yellow rockets (Barbarea vulgaris) were in full bloom at the Price Farm on December 15, 2001!

Our current holdings are in Table 1, and changes from 2001 to 2002 are indicated in Table 2. We now have more than 17,000 trees covering more than 60 acres.

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 28,000 trees.

The highlight of the 2001 harvest (Table 4) was our first large crop of B_3-F_2 nuts! We hope the B_3-F_2 nuts include some highly blight resistant individuals that will produce nuts suitable for reforestation in a few years. Over the next 4 to 5 years we expect to produce many more B_3-F_2 nuts.

The most exciting event this year has been the planting of over 1000 B_3-F_2 nuts at a new farm purchased exclusively for use as a seed orchard. We needed a small parcel isolated from our principal research farm so the B_3-F_2 progeny would only be pollinated by each other, rather than by other chestnut trees with potentially undesirable qualities. I very much appreciate the collective effort of the Foundation in acquiring this land.

Basic Backcrossing

It might be helpful to review the basics of the backcross method of plant breeding to explain what a B_3-F_2 is before discussing methods of producing and planting them!

At The American Chestnut Foundation, we are trying to transfer the blight resistance of the Chinese chestnut tree to its American cousin, but otherwise restore the traits of the American chestnut. So we first cross the two species to get trees that are one-half Chinese, one-half American; these are known as F_1s. We then backcross an F_1 to another American chestnut, reducing the fraction of Chinese genes by a factor of one-half, on aver-

A Quick Guide to Chestnut Breeding Terminology

American x Chinese	=	F_1—F-one
F_1 x F_1	=	F_2—F-two
F_2 x F_2	=	F_3—F-three
F_1 x American	=	B_1—1st backcross
B_1 x American	=	B_2—2nd backcross
B_2 x American	=	B_3—3rd backcross
B3 x American	=	B_4—4th backcross
B_1 x B_1	=	B_1-F_2—1st backcross F-two
B_1-F_2 x B_1-F_2	=	B_1-F_3—1st backcross F-three
B_2 x B_2	=	B_2-F_2—2nd backcross F-two
B_2-F_2 x B_2-F_2	=	B_2-F_3—2nd backcross F-three
B_3 x B_3	=	B_3-F_2—3rd backcross F-two
B_3-F_2 x B_3-F_2	=	B_3-F_3—3rd backcross F-three

age, giving us trees that are one-quarter Chinese, three-quarters American; these are known as B_1s. A second cycle of backcrossing reduces the fraction of Chinese genes by another factor of one-half, yielding trees that are one-eighth Chinese, seven-eighths American, on average; these are known as B_2s. A third cycle of backcrossing yields trees that are one-sixteenth Chinese, fifteen-sixteenths American, known as B_3s. Thus we are progressively diluting out all the traits of the Chinese chestnut, except for blight resistance, for which we select at each backcross generation by giving the trees the disease and picking the most resistant ones.

Many organisms, including people and chestnut trees, have two copies of each gene, one they inherit from their mother, and one from their father. Our American by Chinese chestnut F_1s and various backcrosses have an American chestnut parent, from whom they always inherit copies of the genes for susceptibility to blight. Those genes for susceptibility to blight render the F_1s (and subsequent backcrosses) intermediate in resistance between the two parent species. However, if we cross two F_1s or two backcross trees with each other, their offspring, known as F_2s, have a chance of inheriting the genes for blight resistance from both parents. We have done this cross with F_1s, B_1s and B_2s, (to get F_2s, B_1-F_2s and B_2-F_2s, respectively) and indeed have recovered highly blight resistant progeny, usually at frequencies of 1 to 5 percent of all progeny. (These trials have provided us important information on the heritability of blight resistance; however, they were not designed to produce a tree with American morphology).

Because these selected, highly blight resistant F_2s inherited only the genes for blight resistance from their parents, they cannot pass on any genes for blight susceptibility to their progeny. They are said to be true-breeding for blight resistance. Also, because they only have genes for blight resistance, and none for susceptibility, they are said to be homozygous for blight resistance, rather than heterozygous for blight resistance, unlike their F_1 parents.

In order to recover American characteristics in the breeding process we are making three backcrosses before intercrossing the third backcross trees to produce B_3-F_2 progeny. We then intend to select for high levels of blight resistance and intercross the B_3-F_2 trees to produce B_3-F_3 nuts, most of which we expect will also be highly blight resistant. We then plan to plant these B_3-F_3 nuts out in the forest to see whether they grow like the American chestnut trees of old, and whether their blight resistance holds for an extended time.

Seed Orchard Design

We hope before long to prepare a comprehensive plan detailing the later stages of the breeding program, those entailing intercrossing of backcross trees and planting of B_3-F_3 nuts in the forest. It might be helpful to review those portions of the plan currently available, since there has been much interest from the chapters and since I now have one year's experience implementing the intercrossing portion of the plan.

We expect that we need to obtain 9 highly blight-resistant B_3-F_2 progeny from each straight B_3 parent, in order to have a 95% chance of capturing most of the alleles in each parent. If we fail to capture most of the alleles in each parent, they will become much more inbred in each successive generation. Inbreeding has deleterious effects on chestnut, just like people, and we want to avoid it if possible. The derivation of the formula for making this calculation is given in the appendix (assuming there is one recombination per chromosome pair, resulting in about 20 linkage groups, effectively).

We have been planning this breeding program from the start assuming that blight resistance might be controlled by three genes. Currently, we still have not determined whether blight resistance is controlled by two or three genes. My guess is that two genes are involved, but it looks like three because other inherited factors modify the resistance response, such as those that influence tree vigor. Thus I think it best if we continue to plan for three genes.

See the Castenea Guide, p. 56 for a model seed orchard design.

To have a 99% chance of obtaining 9 highly blight resistant B_3-F_2 progeny homozygous for three genes, we would need to grow about 1080 trees, using the formula given by Hebard (Hebard, F.V. 1994. The American Chestnut Foundation Breeding Plan: Beginning and Intermediate Steps. The Journal of the American Chestnut Foundation, Vol. VIII, No. 1:21–28). When planting nuts, we generally get about 8 trees for every 10 nuts planted. Thus we would need to plant about 1350 nuts from each B3 parent to obtain our 9 highly blight-resistant B_3-F2 progeny, or 150 nuts for each single B_3-F_2.

Foresters have found that 20 to 40 trees per acre is the best density for seed orchards. We picked 30 trees per acre as our desired size. That means each selected tree has to be in a square about 35 to 40 feet on a side. As indicated above, to obtain that selected tree, we need to plant 150 nuts in each subplot. I chose to plant these 1 foot apart in five rows of 30 nuts each, with 7 feet between rows. With a border of 10 feet between rows at the edge of the subplot and 8 feet along the rows, each subplot is square, measuring 38 feet on a side. We plan to screen these B_3-F_2 seedlings for blight resistance when they are 2 years old and then begin roguing down to the one highly blight resistant tree selected to produce B_3-F_3 nuts for reforestation.

We have about 30 straight B_3 parents derived from the 'Clapper' tree, each of which needs to generate 9 progeny. It would be better to plant only one offspring from each B_3 in a block of trees, to minimize crossing between full brother and sister. One would then plant 9 blocks total.

At the above spacing, 9 progeny each of 30 straight B_3 parents would take up about 15 acres, given waste space. One would need about 10 acres for 20 straight B3 parents. Most of TACF's chapters expect to have about 20 straight B3 parents.

Seed Orchard Planting Technique

Several chapters thought that it would be beyond their resources to establish seed orchards such as described above, although many chapters have been successful in gathering limited resources to establish breeding orchards. On the contrary, my observation leads me to believe that it would be possible for chapters to plant and maintain seed orchards.

First, the 9 blocks need not be planted in one spot. If 9 members of a chapter were each to plant a block, they would have only 1 acre to tend, similar to the size of the breeding orchards now established. Once selections are made, one would only need to tend 20 to 30 trees.

Second, the amount of work involved in planting and tending 3000 nuts on one acre is not as huge as it seems and is similar to establishing a breeding orchard. This year, for 1000 nuts, we spent one day tilling ground, one day planting, and parts of four days weeding, mowing and fertilizing. We essentially planted this orchard and walked away. It would not have taken appreciably more time to plant and tend 3000 nuts rather than the 1000 we did plant.

One important factor was that we used landscape fabric to control weeds in the orchard, rather than our usual plastic mulch. Landscape fabric costs about 10 times more than plastic mulch, which is why we don't use it on our larger acreages. But it has the advantage of being permeable to water, so that we could fertilize by broadcasting granular fertilizer twice a year in mid May and late June (200 lb./acre N, 60 LB/acre P&K as ammonium nitrate, diammonium phosphate and potash) rather than pumping Mir Acid down past the plastic every other week. Chapters would need to weigh the cost of one technique against the time required for another.

I expect it will take us about half a day to inoculate these trees with the blight fungus to screen them for resistance, another half day to rate their resistance, and another day to rogue the orchard. After that, one needs to mow the orchard two to four times a year, fertilize, and pick up the nuts. It might take a little bit longer for those who don't have experience establishing a seed orchard or who have limited resources, but it can be done.

Mating Design

The question has been raised as to whether it would be best to follow Charles Burnham's original plan and use open pollination to produce the B_3-F_2 generation, or to follow the recommendation of the 1999 science review panel and use controlled pollination. I don't think it will be possible to generate the needed number of progeny (1500 with controlled pollination in a circular mating design) using our current method of bagging female flowers. For instance, over the last four years, we have made 23 different F_2, B_1-F_2, B_2-F_2 and B_3-F_2 controlled crosses, using 1193 bags, but these yielded only 789 nuts. Bob Leffel, Science Coodinator for the PA Chapter, who also has considerable experience making controlled pollination of chestnut trees, concurs in my opinion. The other option would be to plant

B_3s in isolated pairs of progeny and leave two to interpollinate. Unfortunately, this frequently would not be feasible due to land and labor constraints.

There would be several advantages to using controlled pollination, but some of the most compelling ones are more important in other breeding programs than in ours. For instance, if a particular straight B_3 tree is not a good parent, its progeny can easily be identified and rogued when controlled pollination is used. Using open pollination, one cannot identify the progeny of a bad father, without very expensive paternity tests. However, we want to capture as much of the genetic background of the American chestnut as possible, warts and all; we're not interested in improving the growth rate of the tree, only incorporating blight resistance. Thus, in our breeding program, a tree would only be a poor parent if it did not have all the blight resistance genes. I am confident that all the blight resistance genes will be present in the trees we use as parents.

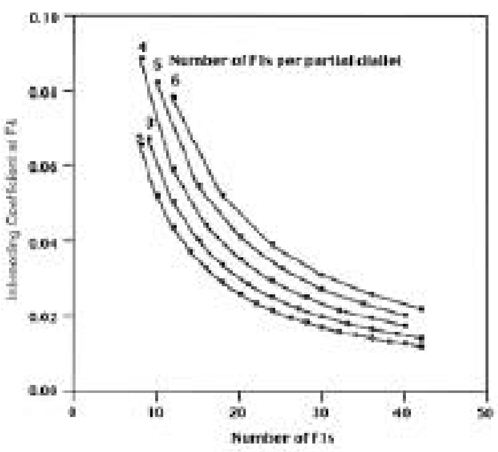

Figure 1. Inbreeding Coefficient at F_4 versus the number of F_1s in the founder population, for partial diallel mating designs with 2 to 6 individuals per diallel, when one male parent pollinates the other parents and itself is pollinated by one other parent, and there are ten F_2 offspring per F_1 mother.

Another theoretical advantage of controlled pollination is that one tree cannot come to dominate the pollinations and be the sole father of the nuts produced by the other trees. It has been suggested that such an occurrence would strongly increase inbreeding in subsequent generations. I assessed this effect by simulation and found the increase in the inbreeding coefficient was fairly small as long as the number of trees being intercrossed at one time was less than 5 or 6 (Figure 1). When one tree did not dominate the pollinations, which would occur much more frequently than one tree dominating the pollinations, the degree of inbreeding was independent of the number of trees being intercrossed.

The most important advantage for us of controlled pollination to produce B_3-F_2 trees is that we would only need to produce 10 progeny from each cross of two straight B_3 trees to capture 95% of the alleles in both of them. In contrast, under open pollination we need to produce 9 progeny from each straight B_3 to capture 95% of its alleles, since we don't know how many progeny it fathered. So, with controlled pollination, the seed orchards are halved in size (and we also cut their potential seed yield in half). However, I do not find this to be a compelling advantage of controlled pollination; it is helpful, but not compelling.

Efficiency of Controlled Pollination

We have been working to try to improve the efficiency of controlled pollination. We expect that dead pollen will not yield many nuts, so pollen viability is an important parameter to measure. Last year, Rachel Taylor, an intern from Emory and Henry College, succeeded in germinating chestnut pollen so we could assess its viability. The key was to incubate the pollen at 31 degrees C, rather than room temperature (25 C), which we had been unable to do before Rob Doudrick of the U.S. Forest Service and Farm Director Jim Wilson arranged for the loan of an incubator capable of reaching that temperature. This year, Benji Cornett, another intern from Emory and Henry, who is our new agricultural research technician, extended Rachel's work. We also installed an experiment comparing the efficiency of pollination using the glass slide technique versus fresh catkins; previous work suggested, but did not directly test, that pollination yields are higher using the glass slide technique. Another factor in pollination efficiency may be the amount of pollen released by a collection of anthers. We currently are exploring these factors as best we can.

I would like to thank Lou Silveri, Ron Myers, Jack Johnson, 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 would not get done without your help. If you would be interested in helping pollinate 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.

We would like to remind all TACF members that you are welcome to visit Meadowview Research 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).

NOTE

For "n" progeny of a single, diploid parent (the open-pollinated case, not the controlled pollination, circular mating case where you are concerned with both parents):

> There are 2^n ways of apportioning one heterozygous locus among the progeny. For instance, with three progeny, and a locus with alleles "A" and "a", these would be:
>
> AAA, AAa, AaA, Aaa, aAA, aAa, aaA, & aaa.
>
> And for any one locus, there are two sets of progeny where only one of the alleles in the parent has been transmitted. Hence there are $(2^n–2)$ sets of "n" progeny where both alleles of a single heterozygous locus have been transmitted from a diploid parent.

For "a" independent, heterozygous loci in a single diploid parent:

> There are $(2^n)^a$ ways of apportioning the loci among sets of "n" progeny, and $(2^n–2)^a$ ways of transmitting both alleles of each locus.

Therefore the fraction of sets containing "n" progeny possessing all alleles from a single diploid parent with "a" independent, heterozygous loci is:

$$(2^n–2)^a / (2^n)^a,$$

which reduces to $(1–2^{1-n})^a$

For the controlled-pollination case, one needs to square this fraction, which is equivalent to the open-pollinated case for twice as many loci.

TABLE 1

Type and number of chestnut trees and planted nuts at TACF Meadowview Research Farms in May 2002, with the number of sources of blight resistance and the number of American chestnut lines in the breeding stock.

	Number of		
	Nuts or Trees	Sources of Resistance	American Lines*
Type of Tree			
American	1931		167
Chinese	898	42	
Chinese x American: F_1	651	24	84
American x (Chinese x American): B_1	1021	12	41
American x [American x (Chinese x American)]: B_2	2073	9	105
American x {American x [American x (Chinese x American)]}: B_3		6318	5
72			
Am x (Am x {Am x [Am x (Chin x Am)]}):B_4	100	1	1
(Chinese x American) x (Chinese x American): F_2	780	5	19
[Ch x Am) x (Ch x Am)] x [Ch x Am) x (Ch x Am)]:F_3	6	1	1
[Amer x (Chin x Amer)] x [Amer x (Chin x Amer)]: B_1-F_2	509	3	6
{Am x [Am x (Ch x Am)]} x {Am x [Am x (Ch x Am)]}:B_2-F_2	393	4	9
[A x (A x {A x [A x (C x A)]})] x [A x (A x {A x [A x (C x A)]})]:B_3-F_2		1274	2
8			
Chinese x (Chinese x American): Chinese B_1	142		
Chinese x [American x (Chinese x American)]	41		
Japanese	3	2	
American x Japanese: F_1	16	2	3
(American x Japanese) x American: B_1	198	2	2
Castanea seguinii	48	1	
Chinese x Castanea pumila: F_1	9		
Large, Surviving American x American: F_1	304	12	36
(Large, Surviving American x American) x American: B_1	585	7	10
Large, Surviving American x Large, Surviving American: I_1	62	4	5
Large, Surviving American: F_2=F_1 x F_2, same as parent	345	5	10
Large, Surviving American Other	75	2	7
Irradiated American x American: F_1	41	1	1
Other	59		
Total	17,882		

* 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 rather than one line (this only occurs rarely).

TABLE 2

Changes between 2001 and 2002 in the number of chestnut trees and planted nuts of different types at TACF 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	-16		66
Chinese	120	1	
Chinese x American: F_1	-9	0	-4
American x (Chinese x American): B_1	-188	2	16
American x [American x (Chinese x American)]: B_2	-119	1	2
American x {American x [American x (Chinese x American)]}: B_3	793	3	8
Am x (Am x {Am x [Am x (Chin x Am)]}):B_4	0	0	0
(Chinese x American) x (Chinese x American): F_2	288	2	16
[Ch x Am) x (Ch x Am)] x [Ch x Am) x (Ch x Am)]:F_3	0	0	0
[Amer x (Chin x Amer)] x [Amer x (Chin x Amer)]: B_1-F_2	35	1	4
{Am x [Am x (Ch x Am)]} x {Am x [Am x (Ch x Am)]}:B_2-F_2	-20	0	-3
[A x (A x {A x [A x (C x A)]})] x [A x (A x {A x [A x (C x A)]})]:B_3-F_2		1072	1
6			
Chinese x (Chinese x American): Chinese B_1	0		
Chinese x [American x (Chinese x American)]	0		
Japanese	0	0	
American x Japanese: F_1	0	0	1
(American x Japanese) x American: B_1	0	0	0
Castanea seguinii	0	0	
Chinese x Castanea pumila: F_1	0		
Large, Surviving American x American: F_1	-18	1	1
(Large, Surviving American x American) x American: B_1	85	2	3
Large, Surviving American x Large, Surviving American: I_1	-1	0	1
Large, Surviving American: F_2 = F_1xF_1, same LS parent	125	2	7
Large, Surviving American: Other	75	2	7
Irradiated American x American: F_1	0	0	0
Other	-1		
Total	2221		

* The decreases in B_1, B_2, B_2-F_2 and Large, Surviving American F_1 & I_1 trees reflects roguing of trees with inadequate levels of blight resistance. The increases reflect further breeding and collecting.

TABLE 3

Number of third-backcross chestnut trees and harvested nuts at TACF Chapters in 2002, with the number of sources of blight resistance and the number of American chestnut lines in the breeding stock.

		Number of	
	Nuts or Trees	Sources of Resistance	American Lines*
Chapter			
Maine	1267	2	15
Massachusetts	670	2	8
Pennsylvania	7089	2	26
Indiana	1099	1	7
Kentucky	150	1	1
North Carolina	507	2	6
Tennessee	93	5	4
Total	10,875		

TABLE 4

The American Chestnut Foundation Meadowview Farms 2001 nut harvest from controlled pollinations and selected open pollinations.

			Pollinated			Unpollinated Checks			Number of American Chestnut Lines*
Nut Type	Female Parent	Pollen Parent	nuts	bags	burs	nuts	bags	burs	
B_1-F_2	Meiling B_1	Meiling B_1	35	116	409	0	13	44	2
B_2	American	Meiling B_1	51	48	103	1	4	7	2
B_2	American	Nanking B_1	10	137	245	0	13	26	2
B_2	American	R10T10 B_1	55	124	195	5	13	19	9
B_2	Meiling B_1	American	90	46	119	0	5	7	2
B_2	Nanking B_1	American	44	90	123	0	8	8	4
B_2	R11T14 B_1	American	1	62	113	0	8	10	1
B_2-F_2	Clapper B_2	op	1676	open pollinated					8
B_2-F_3	op Clapper B_2	op	1673	open pollinated					2

(Continued on next page)

TABLE 4 (continued)

Nut Type	Female Parent	Pollen Parent	Pollinated nuts	Pollinated bags	Pollinated burs	Unpollinated Checks nuts	Unpollinated Checks bags	Unpollinated Checks burs	Number of American Chestnut Lines*
B_3	American	Clapper B_2	219	86	275	2	7	17	3
B_3	American	Douglas B_2	38	34	88	0	4	13	1
B_3	American	Graves B_2	246	213	531	10	26	58	11
B_3	American	R4T23 B_2	7	70	292	0	8	29	2
B_3	Clapper B_2	American	132	58	189	0	6	18	2
B_3	Douglas B_2	American	30	1	0	0	4	10	2
B_3	Graves B_2	American	158	221	408	7	25	55	11
B_3	R1T7 B_2	American	57	36	8	0	2	1	3
B_3-F_2	Clapper B_3	op	1369	open pollinated					6
F_1	European	American	56	19	28	0	2	0	1
F_1	Kuling Chinese	American	11	91	154	4	5	11	1
F_1	Nanking Chinese	American	34	106	184	0	14	23	3
F_2	72-211 F_1	72-211 F_1	246	299	526	2	28	53	4
F_2	Nanking F_1	Nanking F_1	36	167	269	1	17	45	2
F_2	Orrin F_1	Orrin F_1	57	95	150	3	9	15	2
Isa B_1	American	Amherst F_1	39	108	292	0	10	27	4
Isa B_1	American	Ort F1	1	50	100	0	5	10	1
Isa B_1	Ort F_1	American	13	42	104	0	4	8	1
Isa F_2	Amherst F1	Amherst F_1	16	39	70	0	5	15	2
Isa F_2	Ort F_1	Ort F_1	108	87	149	0	9	33	5
Isa I_1 x am	American	op Dares Beach	77	75	208	0	9	20	1
Isa I_1 x am	American	op Weekly	62	77	132	0	8	16	6
Other			22	23	16	0	0	0	4
Total Controlled Pollinations 1951			2620	5480	35	271	598		

*The number of American lines for this table is restricted to the number of American chestnut trees that were direct parents, not grandparents, of progeny.

A Thought for Autumn

A stillness, the bark of dog far away
Geese winging over the forest cover
A chipmunk disappears behind a skeleton of an old chestnut stump
The chatter of a red squirrel dropping burrs to be opened later
A continuous spree from nature's forest haven
The graceful white pines, the mighty red oak blend in nicely with the majestic American Chestnuts
It's that time of year that's almost upon us, that silence, the chill in the air,
that gust of wind that seems to sneak up behind us
It's almost time for the nut gatherers to enter the forest

Bruce Graham
Burford Tree Nursery
Grand River Conservation Authority
Burford Ontario, Canada

THE JAYNE VAN LAUREL MEMORIAL SEED ORCHARD SECTION AT TACF'S NEW FARM

By Forrest MacGregor

Jayne Kelly Van Laurel took her name from the pristine Madison County, NC woods in which we spent four wonderful years in the early 1990s. Born Mary Janette Fishburne in 1952, she worked constantly to make the 63 rural acres we lived on even more of an Eden than it was. Wildflower hikes for friends

Jayne Kelly Van Laurel

in the spring, habitat improvement for the foxes, boomers, and birds, protection from the feral cats and dogs were just a few of the gifts she gave to the land.

We married in 1974, fresh out of college, and spent the next quarter century together, until an unfair death claimed her in 1998 at age 46. I once described her as a woman who never ate breakfast until the birds were fed, and it is fair to say she began her own daily nourishment by feeding care to the world around her. Rain, snow or drought often found her outside, planting edible plants for the wildlife, installing 'water features' so that the upland chorus frogs had someplace to mate in mid-February at the height of our North Carolina winter, or making sure the redstarts had a place to drink on their journey up north to breed.

After she died I tried, and for a while did a pretty good job, to care for her charges with the same heart and determination that she did. But it is a tough act to follow, and not all of us have her single-minded purpose. The world is a colder place without her, and we and her animal friends are all the poorer for her absence, even if most never knew her name.

It is with this thought in mind that Jayne's brother, Frank Fishburne and I decided to sponsor, in her memory, a portion of The American Chestnut Foundation's first seed orchard. The trees that will one day come from this orchard, some 2 million per acre per year when it hits its maximum production, will each do what Jayne Van Laurel did when she was with us. They will feed and nourish the wildlife on her behalf, and will never tire of the task. When the time comes for Frank and I to leave this life, we will do so secure in the knowledge that the process will continue, and that the memory of this wonderful woman will be partly responsible for the trees that do the job she would be doing, if fate were so kind as to have left her here with us. I know she would be touched by the sentiment and heartily approve of the symbol.

The Jayne Van Laurel Memorial Section is located at the new 'Clapper' seed orchard at TACF's new farm in Abingdon, VA, an isolated location close to the TACF breeding orchards on the Price and Wagner Research Farms. The orchard will eventually be home to 288 BC_3F_2 TACF chestnuts whose open pollinated progeny, the BC_3F_3 generation, will be the first field-deployable American chestnut hybrids with near 100% blight resistance. They will be 94% American, on average, and be able to pass on their high blight resistance to their progeny. Forest testing of these trees will begin in approximately 2007, and may require many years to determine if the initial hybrids will survive in forest settings.

If you would like to dedicate a portion of the new seed orchard
in honor or memory of someone,please see reverse or contact Marshal Case at 802-447-0110.

INFORMATION ON SPONSORSHIP OF THE SEED ORCHARD AT THE NEW FARM

Sponsorship of TACF's seed orchard will honor someone you love in a touching and unique way by giving back to our fragile ecosystem something it has lost for some time – the American chestnut. You may wish to sponsor one of the nine reforestation blocks that will each eventually contain 32 trees that will produce our first blight resistant nuts at TACF's new farm. Or you may want to sponsor a portion of one of these reforestation blocks, a single plot which will represent one future orchard tree (the plot begins as a planting of 150 B_2F_2 siblings but only the one with the highest blight resistance is kept) or provide a donation. All of these sponsorship levels can be made in memory or honor of someone. Sponsorships of reforestation blocks and plots will be honored with a small plaque and will go toward the payment of the property and maintenance of the orchard.

To find out more about the new seed orchardsee Meadowview Notes (p.7) or Castanea Guide (p. 56).

Sponsorship Levels

- ❑ 1 reforestation block (32 seed orchard trees) = $25,000
- ❑ H reforestation block (16 seed orchard trees) = $14,000
- ❑ G reforestation block (8 seed orchard trees) = $7,000
- ❑ 1 reforestation plot (1 seed orchard tree) = $1,000
- ❑ Other _______________

In honor / memory (circle one)
of:____
Name: ____
Address: ____
Tel:_____________________ Email: ________________________________

Sponsorship does not convey any particular preference to nuts produced by trees from sponsored area. TACF is a 501 (c)3 non-profit organization. Contributions are tax deductible to the full extent allowed by law.

Please send form and payment to:
The American Chestnut Foundation, P.O. Box 4044, Bennington, VT 05201-4044

memories

CHESTNUTS AND NATIVE AMERICANS

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Each year during the first week in October, the Eastern Band of Cherokee Indians sponsors the Cherokee Indian Fair, a long standing celebration of the fall harvest. At this event, a number of local people have booths serving traditional foods. One of the special foods served is chestnut bread, created by mixing chestnuts with corn meal, shaping the dough into flat cakes, wrapping the cakes in corn blades or leaves of hickory, oak or cucumber trees, and cooking in boiling water (Ulmer and Beck, 1951:44-45).

Chestnuts are identified as having a number of important uses for food, medicine, dye as well as other uses by the Cherokee. Hamel and Chiltoskey (1975:29) list the following uses provided by various sources:

" 'In July, half boil chestnuts and take off the rind. Slice rows of corn and pound in a large wooden mortar which is wider at the top than at the bottom. Knead both together, then wrap them up in a green cornblade, about an inch thick, and boil well...' (from James Adair); tea of year old leaves for heart trouble; leaves from young sprouts cure old sores; cold bark tea with buckeye to stop bleeding after birth; apply warmed galls to make infant's navel recede; boil leaves with mullein and brown sugar for cough syrup; dip leaves in hot water and put on sores; tea for typhoid; for stomach; bark makes brown dye; firewood (pops badly); lumber (wormy or good); rails for fences; acid wood; coffee substitute (parched)." Mary Ulmer Chiltoskey, although not Cherokee herself, spent most of her life living among the Eastern Band, and was an important chronicler of their traditional knowledge.

The former abundance of chestnut trees before the blight destroyed them is evident in an excerpt from an article by Rice et al., first published in Foxfire 6, in The Journal of the American Chestnut Foundation, Vol. XV, No. 1:26-31. In that article, several people interviewed in North Georgia mention the size and extent of chestnut trees when they were growing throughout the forests in the southern Appalachian region. They also mention the large crop of nuts that these trees pro-

Grinding Corn and Nuts.

TARA PRINDLE
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duced, indicating that "almost every year was a good year for chestnuts" (p. 29), with "thousands of bushels of 'em shipped out of these mountains to cities" (p. 30). It seems probable that the trees were just as productive in the years prior to that time.

No one knows how long Cherokees and other Native Americans used chestnuts in their diets and for other purposes. It is likely that Native Americans utilized these nuts from the time of their initial occupation of the southern Appalachians, a period that extends back more than 10,000 years. At that time, the people who occupied this area, called "Paleo-Indians" by archaeologists, lived in small groups that roamed across the landscape hunting animals and foraging for whatever vegetable foods they could find. There is no evidence for the types of tools used for processing nuts or other vegetable foods, but presumably nuts would have been used as they were encountered while people traveled from place to place.

The Paleo-Indian lifestyle persisted until around 8000 B.C., when a warming trend throughout the Northern Hemisphere caused a reduction in coniferous trees and the spread of deciduous trees across much of the area. These included oaks, hickories, walnuts, and chestnuts. During the succeeding archaeological period, the Archaic, there is increasing evidence for incorporation of various types of nuts in the diets of these people. Grinding stones become especially prevalent during the latter part of this period, the Late Archaic. These are associated with an increasingly sedentary lifestyle, and a concomitant increase in population. It is during this period, which lasted from around 8000 B.C. until around 1500 B.C., that Caldwell (1958) has proposed that expanding knowledge of the ways in which forest resources could be exploited established what he defined as the "necessary preconditions" for the development of agriculture.

Use of nuts continued as part of the diet during the two succeeding archaeological periods in the southern Appalachians, the Woodland and the Mississippian. From around 1500 B.C. until the time the Europeans arrived in North America, there is ample archaeological evidence for the use of nuts throughout the Southeast. The use of nuts in Native American diets is documented in several early historic sources as well. There are also references to the intentional burning of woodlands to encourage the growth of edge-related food resources (Arber 1910, Bland 1651, Hammett 1992, and Lefler 1967, all cited in Hammett 1997), which may have included nut-bearing trees.

Unfortunately, there is a notable scarcity of chestnut remains in the archaeological record. In an extensive analysis of plant remains performed by Blake and Cutler (2001) from many sites in the east, midwest and southwest United States, only three of the 444 sites whose botanical remains they examined produced evidence of chestnuts. One of these consisted of a chestnut burr recovered from a pit filled with uncarbonized materials found beneath Mound 51 at Cahokia, in Illinois, a major Mississippian site. The second came from the Sheeprock Shelter in Pennsylvania, probably from around 155 A.D., dating to the Early Woodland period. This material was also recovered in an uncarbonized state. The third example is from the Gnagey site in Pennsylvania and dates from the Late Woodland period, which in that area dates from around A.D. 800 until the time of European contact. The materials in this deposit were carbonized. All chestnut remains Blake and Cutler identified were associated with other nuts and seeds.

The absence of material remains of chestnuts is puzzling, considering the apparent importance these nuts had in historic times. Oak, hickory, and walnut shells are found in many sites, usually in fire pits where the remains were carbonized and thus preserved more effectively than is the case when remains are not carbonized and therefore subject to decay. One possible explanation for this absence is that chestnuts were processed at the places where they were gathered, with shells left behind. This could be explained by the fact that they did not need the heavy pounding that hickory and walnut require to shatter their shells.

As chestnut shells are thinner than those of walnuts or hickory, they would be less difficult to remove. Another possibility is that chestnuts were boiled before shelling, as is the case today. Present-day Cherokees first boil the chestnuts, remove the shells, and remove the outer covering of the nut before preparing chestnut bread. This was also the practice in the 1700s, as reported by James Adair (1940) in his History of the American Indians, first published in 1775. As the shells would have been wet when they were removed, they would probably not have been disposed of in the cooking fire. There is no way of knowing the antiquity of the practice of boiling the nuts before shelling, but it may be one of long-standing.

Chestnuts also produce a much smaller amount of shell than other nuts, and this may have influenced the amount found in the archaeological record. For example, charts shown in McCarthy and Matthews (1984) that provide percentage of shell in relation to nut meat for various types of nuts indicate this. One hundred grams of dried acorns contained 38% shell; butternuts, 73% shell; hickory nuts, 68% shell, and black walnuts, 76% shell. Although data are not given for Castanea dentata, the amount of shell in relation to nut meat given for dried Castanea sativa, European chestnut, was only 20% per 100 grams. This is substantially less that amounts of shell for the other types of nuts, almost half that for acorns, the next lowest amount of shell in relation to meat.

Another interesting aspect of nut utilization is that, at least at some sites, the amount of nutshell recovered increases through time. Yarnell and Black (1985) note an increase in the use of both acorns and hickory nuts from the Archaic through the Woodland periods in a survey of sites throughout the Southeast. Their only record of the use of chestnut is in the Early Archaic period, with a very small amount recovered from that time period. One possible factor for the increased use of nuts through time is the growing importance of corn (Zea mays) in Native American diets during the Woodland period. Corn, when eaten alone, provides mainly carbohydrate in the human diet. However, when combined with another source of vegetable protein, such as nuts, it can be a very satisfactory substitute for animal protein.

Once again, there is no reliable way to determine whether corn and nuts were actually combined as frequently during the pre-European period as they were later, but given the persistence of corn combined with other foods it seems likely that this practice has a long history in Native American diets. In fact, the rapid adoption of beans shortly after they were introduced in eastern North America from the southwest may indicate that beans were used in the same way nuts had been utilized prior to that time.

The multitude of uses for chestnuts for medicinal purposes also suggests that they have a long history of use by the Cherokees. As Hamel and Chiltoskey (1975) note, tea made for the leaves of the chestnut was useful in a number of ways, and the bark was also used for dye.

These uses would have likely developed over many years, not just in recent times.

It is clear that we have more questions than answers concerning the long-term use of chestnuts by Native Americans. The ideas presented here are, of necessity, speculative. However, given the persistence of the use of chestnuts in combination with corn every year in the fall, it certainly seems reasonable that this is a practice of long standing, at least among the Cherokee.

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science and natural history

FROM THE BRONX TO BIRMINGHAM:

Impact of Chestnut Blight and Management Practices on Forest Health Risks in the Southern Appalachian Mountains

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Southern Appalachian forest landscapes evoke images of the primeval forest in many people today. Indeed, most vegetation components in these forests have been present in varying mixtures and distributions for at least 58 million years (Delcourt and Delcourt 1981). However, the only thing constant about these landscapes has been change. Advancing and retreating ice sheets, drought, flood, wind, and fire all served to shape forest composition and structure. Irrepressible as these forces are, people have been perhaps the most important change agents since arriving in the region at least 9,000 years ago (DeVivo 1991, Hudson and Tesser 1993). In this context, the types and sequence of human-influenced disturbances since the middle of the 19th century have resulted in Southern Appalachian forests that bear little resemblance in terms of composition and structure to any that have existed in the past. These disturbances include the widespread use of fire, first by native people and then by European settlers; land clearing and agriculture followed by abandonment of marginally productive lands; widespread and sometimes abusive logging to supply fuel and building materials to a growing nation; industrialization and concurrent urbanization; and the implementation of aggressive fire suppression.

Perhaps the most profound ecological disturbance of all occurred with the introduction to North America and spread of Cryphonectria parasitica (Murrill) Barr, the fungus pathogen that causes chestnut blight. It caused unequaled impacts in eastern hardwood forests generally, and the Southern Appalachians specifically, that are still manifest today. American chestnut (Castanea dentata [Marsh.] Borkh.) was the most important hardwood tree in Southern Appalachian forests. Estimates of composition at large regional scales ranged from 25 to 50 percent (Ashe 1911, Buttrick 1925). Originating in Asia, the chestnut blight pathogen was first detected in the Bronx, New York in 1904.

The pathogen spread rapidly, since native chestnuts lacked co-evolved disease resistance. By 1940, chestnut blight had killed 50 to 99 percent of the American chestnuts throughout its botanical range. The tree persists today as sprout growth from residual root systems but usually attains diameters of only a few inches and rarely flowers before succumbing again.

The history of past disturbances, especially repeated light ground fire followed by nearly complete fire suppression, set the stage for the new forest that succeeded the blight-killed chestnut forest. Native people and European settlers alike had used this type of fire regime to reduce rank understory vegetation and promote browse for game. Aggressive sprouters like American chestnut and the oaks have a relative advantage over other tree species under this fire regime, and built up large reproduction reserves in the understory. As chestnuts died and aggressive fire suppression was implemented, newly available growing space was quickly occupied by these species already positioned in the mid- and understory. While chestnut replacement was variable, oak species (Quercus prinus L., Q. rubra L. and Q. velutina Lam., in particular) typically increased (Korstian and Stickel 1927).

These changes occurred over a very short time span on millions of acres in the Southern Appalachian Mountains. State-federal cooperative fire control programs, public land acquisition to form national forests and parks, and lower rates of harvest compared to previous levels resulted in oak forests which have aged relatively free of disturbance for 70 to 90 years. These forests are contrasted with those found around the time of European settlement in Table 1. Current characteristics make them vulnerable to a stress-mediated disease known as

Table 1. Comparison of Southern Appalachian forest composition: structure, disturbance characteristics, and values perspective; pre-1900 vs. current.

PRE-1900	CURRENT
Composition American Chestnut	Composition Oak
Relatively Young and More Complex Age Structure	Cohorts 80-100 Years Old
Sparse Understory	Dense Understory
Widely Spaced, Large Diameter Overstory	Dense, Small Diameter Overstory
High Disturbance (Fire, Farming, Logging)	Low Disturbance (Fire Suppression)
Small, Dispersed Human Population	Large, Urbanized Human Population
Forest Utilization Perspective	Ecosystem Protection Perspective

Chestnut blight stem infection: Previous land use practices and the death of millions of American chestnuts during the chestnut blight epidemic opened the forest canopy to oaks and other species positioned to exploit newly available growing space.

oak decline, which is affecting landscapes throughout the Southern Appalachians. The disease is both an indicator of and a contributor to compromised ecosystem health.

Oak Decline Biology, Incidence, and Effects

Oak decline is a disease of complex etiology affecting physiologically mature trees. It involves interactions between long-term predisposing factors, such as climate, soil characteristics, landform, advanced physiologic age, or tree species composition; short term inciting stress such as that caused by drought or spring insect defoliation; and contributing organisms of secondary action such as armillaria root disease (caused by Armillaria mellea [Vahl. Ex Fr.] and perhaps other Armillaria spp.), and the two-lined chestnut borer (Agrilus bilineatus Weber). The temporal sequence of these three groups of factors is important in the ultimate expression of oak decline.

Predisposing factors such as climate and site productivity determine the onset of physiologic maturity in oak (Hyink and Zedaker 1987). Inciting stress factors such as extended drought or spring defoliation by insects or late spring frost alter carbohydrate chemistry in the roots of physiologically mature trees. This change stimulates A. mellea, a ubiquitous saprophyte in oak forests, to become an aggressive pathogen. The tree's root system is reduced by root disease, which further compromises the water relations of the still-robust crown (Wargo 1974). Twigs and branches in the upper crown die back progressively over a period of years in an effort to accommodate the impaired root system. The two-lined chestnut borer is attracted to stressed oaks and, together with root disease, kills them (Wargo 1977). Most oaks killed by decline exhibit dieback evidence that can be dated back 2 to 5 years. Analysis of radial growth increment has revealed differences between neighboring healthy and decline-killed oaks of the same species and age class that date back decades earlier (Tainter and others 1990).

The pattern of oak decline on the landscape varies with initial stand species composition, stand age structure, decline severity, mortality incidence, and the duration of decline before inciting stress is eased. Patches of mortality can range from a few trees in stands with diverse species composition and age structure, to several hundred acres on landscapes with a more uniform composition of physiologically mature red oaks defoliated repeatedly by the non-native gypsy moth (Lymantria dispar (L.)).

Widespread oak decline incidence during the mid 1980's in the southeastern U.S. reflects the coincidence of physiologic maturity of oak cohorts on a regional scale that developed after chestnut blight, fire control, and extended regional drought. Inventories have estimated oak forest types cover about 17.4 million acres in the Southern Appalachian Mountains in parts of six states (SAMAB 1996). About 54 percent of this area was classified as vulnerable to oak decline damage with oak decline incidence estimated on 1.7 million acres. National forests had a disproportionately high oak decline incidence compared with other ownerships (Table 2).

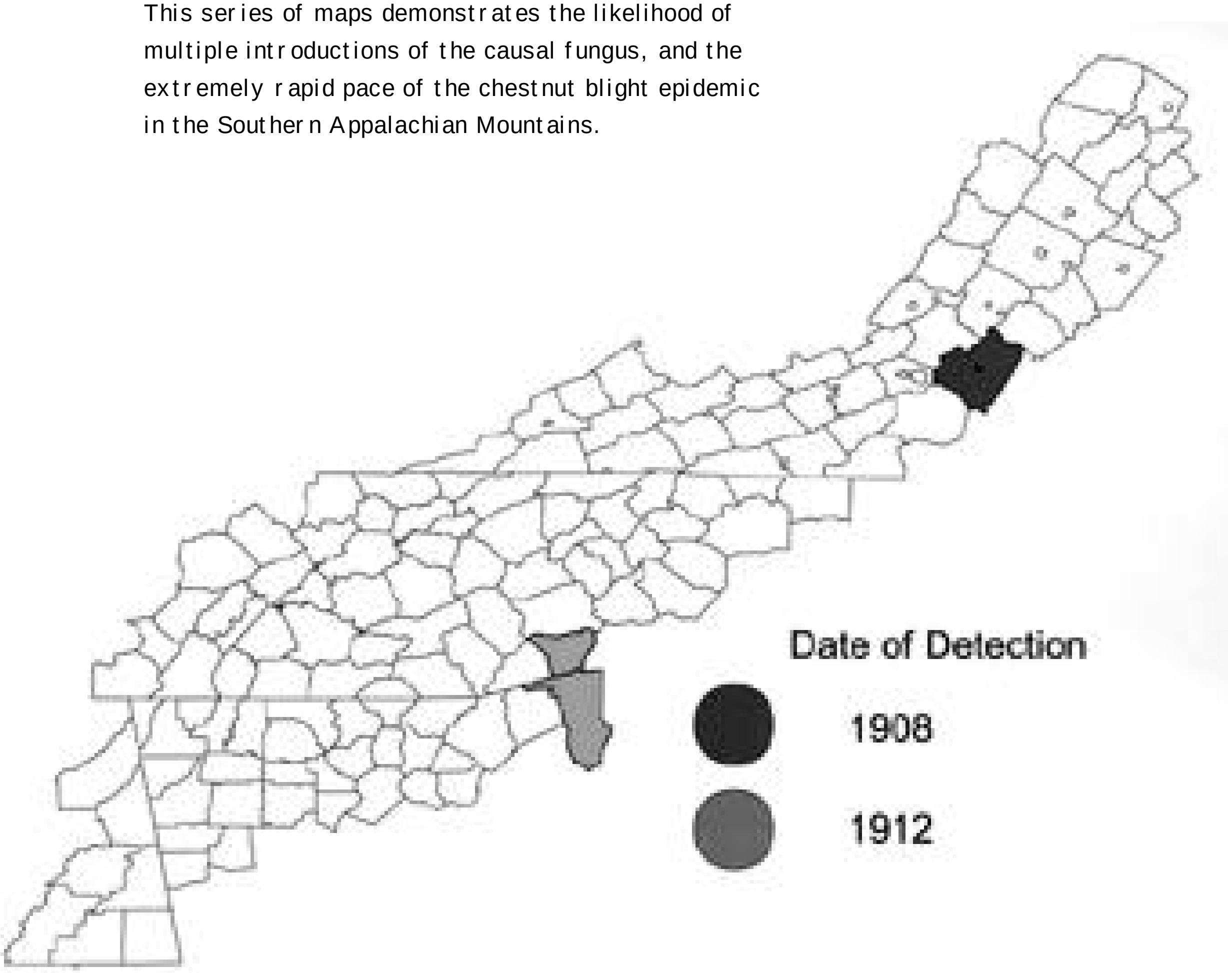
Table 2. Area and incidence of oak decline in the Southern Appalachian Assessment Area, by ownership class (SAMAB 1996).

	Host Type	Vulnerable		Affected		
Owner	Acres	Acres	% Host	Acres	% Vulnerable	% Host
National Forest	3,197,356	2,233,916	70	552,223	25	17
Other Public	419,387	249,986	60	58,453	23	14
Private	13,831,492	7,009,361	51	1,105,133	16	8
Total	17,448,235	9,493,263	54	1,715,809	18	10

Oak and others (1988) interpreted the habitat impacts of oak decline to include both detrimental and beneficial changes, depending on the wildlife species of interest. Structural changes included creation of small to large canopy openings, reduced canopy density, short-term stimulation of understory species, potential increases in cover type

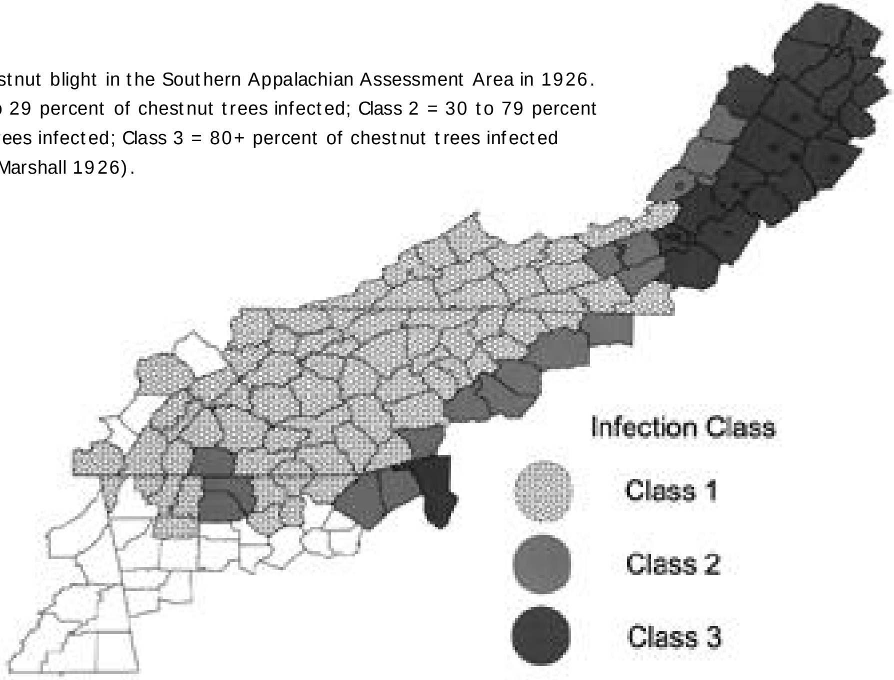
MAPS

This series of maps demonstrates the likelihood of multiple introductions of the causal fungus, and the extremely rapid pace of the chestnut blight epidemic in the Southern Appalachian Mountains.

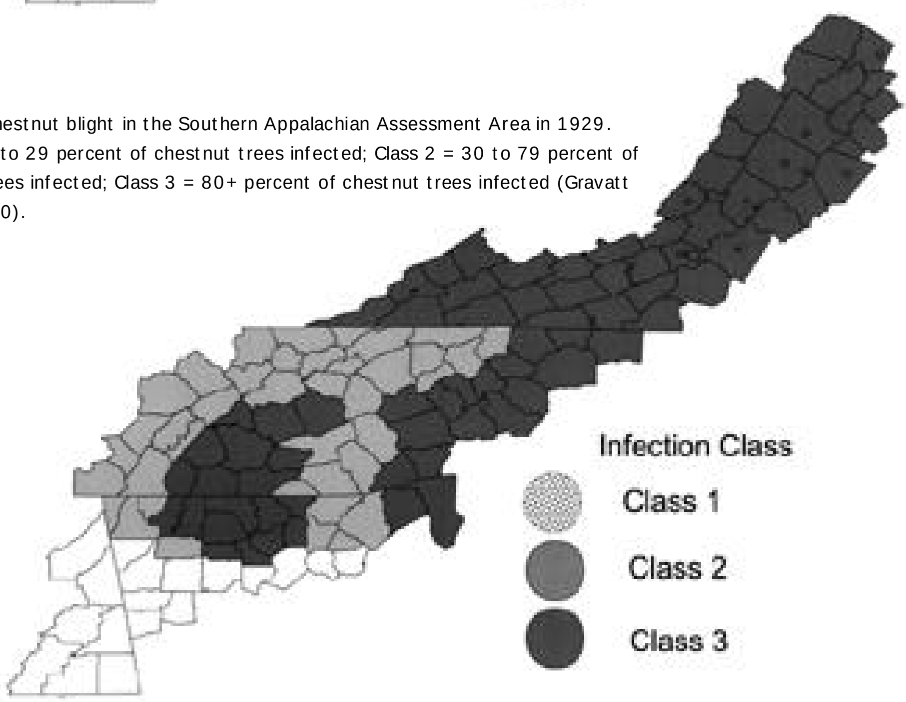


Date of first detection of chestnut blight in the Southern Appalachian Assessment Area. Bedford Co. VA, 1908; Henderson Co., NC and Greenville Co., SC, 1912 (Gravatt 1925).

Status of chestnut blight in the Southern Appalachian Assessment Area in 1926. Class 1 = 1 to 29 percent of chestnut trees infected; Class 2 = 30 to 79 percent of chestnut trees infected; Class 3 = 80+ percent of chestnut trees infected (Gravatt and Marshall 1926).



Status of chestnut blight in the Southern Appalachian Assessment Area in 1929. Class 1 = 1 to 29 percent of chestnut trees infected; Class 2 = 30 to 79 percent of chestnut trees infected; Class 3 = 80+ percent of chestnut trees infected (Gravatt and Gill 1930).




Oak decline is the progressive dieback of the crown of physiologically mature oaks occurring over many years. It often ends in the death of susceptible trees.

diversity, and increased denning and cavity nesting sites. Long-term shifts in tree species composition can occur where competitive oak reproduction is absent or in short supply. The new forest now taking shape has fewer oaks, lower oak diversity, and more shade-tolerant species that are less valued by wildlife. Mast production potential was estimated to be 41% lower than if decline were absent, and projected to be 58% lower within 5 years. These projected reductions would persist for a long time because residual oaks are themselves prone to future decline episodes, and competitive oak reproduction for replacement of dead overstory oaks is lacking due to the absence of stand disturbance of the type necessary to recruit oak seedlings into larger size classes. The lack of oak replacement has consequences for wildlife species that depend on acorns for food, especially in view of the fact that chestnuts, once a mainstay, are no longer available.

The elimination of American chestnut as a canopy species has elevated oaks to an unprecedented position as the most dominant tree species group in Southern Appalachian landscapes. To the extent that healthy forest ecosystems have the full array of native biotic resources, and diverse seral stages and stand structures that provide habitat for native species and essential ecosystem processes (Kolb and others 1994), Southern Appalachian forest ecosystems cannot be con-

Today's Southern Appalachian upland hardwood forests reflect past land use practices such as frequent fire, farming, and logging as well as the aftermath of the chestnut blight epidemic. The remnant forest in the background of this area logged for charcoal production gave rise to a forest far different than any that has ever existed in terms of composition and structure. (Photo used with permission of the West Virginia Agricultural and Forestry Experiment Station.)

sidered healthy until American chestnut can be re-introduced as a functioning component of that ecosystem. Multiple lines of American chestnut adapted to the broad former geographic range possessing durable resistance to chestnut blight will be needed to achieve that goal.

As daunting as the science of resistance breeding and the management of hypovirulence have been, I believe the social obstacles to reintroduction will be even more so. Early silvicultural research indicates a chestnut regeneration strategy similar to the oaks. The low disturbance regimes prevailing in hardwood forest management for nearly a century are inadequate to provide the conditions necessary for successful chestnut establishment and proliferation. Forest openings will have to be created across the landscape and maintained, which will entail increased harvesting, use of selective herbicides, and perhaps the judicious reintroduction of prescribed fire at some point in stand development. All of these practices are presently unpopular among the general public, whose support is essential to success.

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TALKING TREES: THE APPALACHIAN FOREST ECOSYSTEM AND THE AMERICAN CHESTNUT

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Cherokee National Forest

Soon, through the efforts of The American Chestnut Foundation, a hybrid of the American chestnut will be available that is⁄fi/¡§ths American and presumably resistant to blight. Inevitably, this will evoke a call for the reintroduction of this species into the forests, especially into the region where it was most numerous and where it attained its greatest dimensions, the Southern Appalachian Physiographic Province. This area includes: the Cumberland Plateau (extending from north Alabama, Tennessee and eastern Kentucky); the Ridge and Valley Province (from northeast Alabama through east Tennessee to southwest Virginia); and the Southern Appalachian Mountains (from northwest South Carolina, north Georgia, through western North Carolina and east Tennessee and past the New River basin in Virginia) — in all, an area encompassing approximately 50 million acres.

Insofar as the forest of the Southern Appalachian Physiographic Province that now remains should be treated first and foremost as a forest ecosystem, the reintroduction of this chestnut into the forest is only fitting and proper as it was a dominant species integral to the forest ecosystem. But, before reintroduction, there should be an understanding of the rules. How and where exactly did chestnut manifest in the forest ecosystem in the Southern Appalachian Physiographic Province? How did it regenerate? What is its reproduction and growth regime in the forest ecosystem? This brings in a larger question. What are the canopy species composition and the canopy reproduction and turnover regime of the forest ecosystem?

The Forest Ecosystem

The forest ecosystem of all national forests in the Southern Appalachian Physiographic Province is presently managed with the view that a cycle of succession is the process that governs the regeneration of the forest canopy. That is, the forest obtains dynamic equilibrium because the forest canopy composition continually regenerates itself through a cycle of early, middle, and late succession, each successive stage being manifested by distinctively different canopy species types that “climax” in “old growth” forest. The disturbance event that commonly catalyzes the succession process is lightning-generated fire.

However, an examination of the late 19th and early 20th century documentation of the canopy species composition, process and regime of the forest ecosystem of the Southern Appalachian Physiographic Province, provides a very different picture. These exhaustive studies illustrate, clearly, that in this region a cycle of succession is not the process that maintains the forest ecosystem in a state of dynamic equilibrium because fire is not a major natural disturbance event for the region. The Southern Appalachian Physiographic Province averages between 55 and 60 inches of rain a year, culminating in over 100 inches of annual rainfall in the area around Highlands, North Carolina (Southern Appalachian Assessment, Terrestrial Report, 1996), therefore, the fuel load (dead trees, limbs and brush) does not accumulate, but rather decays and the ground generally stays moist, except on dry mountain ridge crests, especially, ones with southern or western aspects.

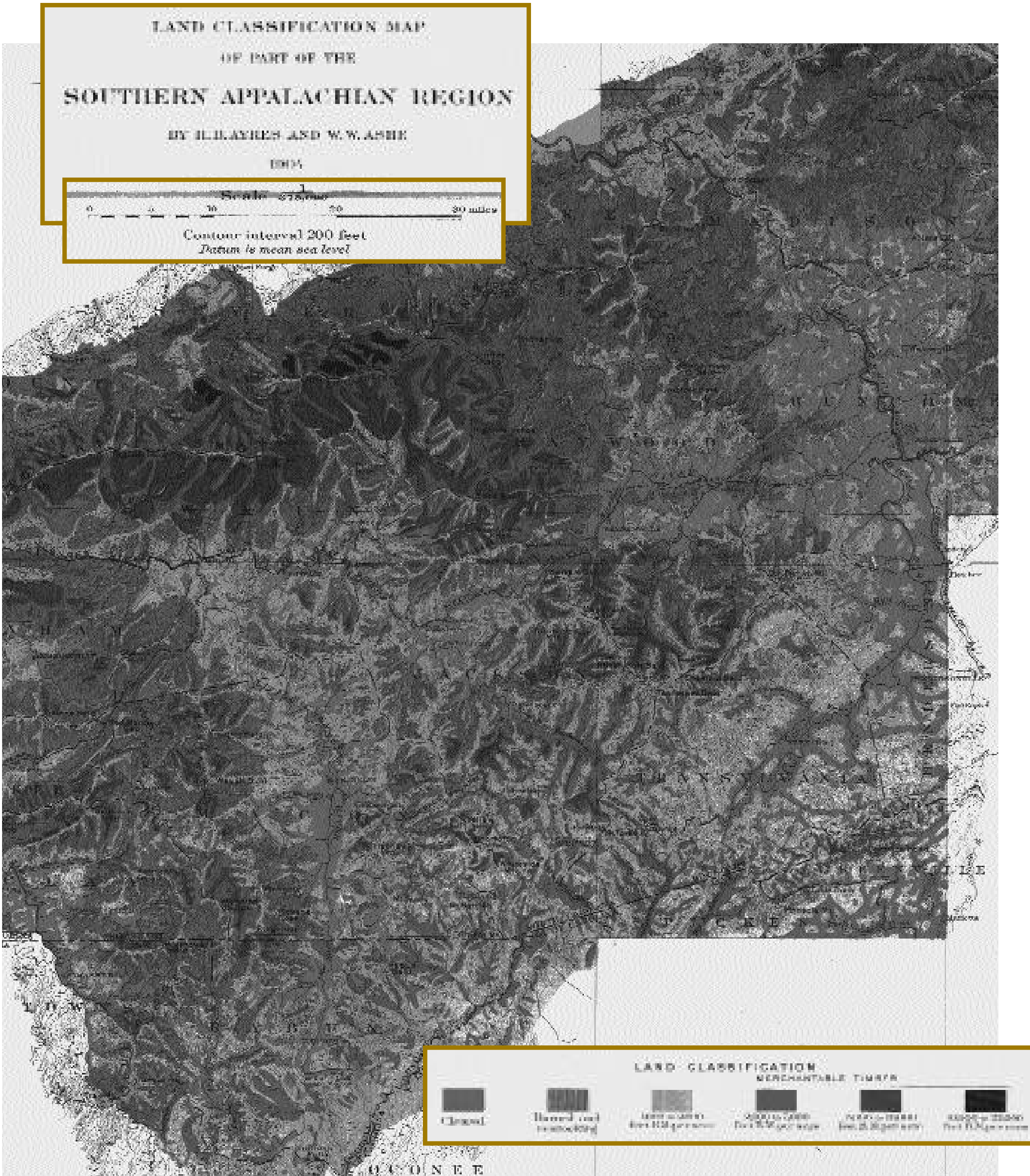
As a consequence, when lightning-generated fire does occur, it does not behave as it does in forests that regenerate through a process of succession. In succession forests, canopy-killing forest fires typically burn through the forest canopy regardless of topography. Instead, in the Southern Appalachian Physiographic Province lightning-generated fire initiates or “catches” principally on dry ridge crests and run down slope (Southern Appalachian Assessment, Terrestrial Report, 1996). Lacking a fuel load, these fires are low-intensity, ground-running fires. As such, they affect the forest not at the canopy level, but the reproduction level. Moreover, there are on average only two to six lightning-generated fires per million acres per year in the Appalachian Physiographic Province (Southern Appalachian Assessment, Terrestrial Report, 1996). As a consequence, lightning-generated fire has effected the evolution of the canopy types, but not their regeneration at any point in time.

The “fingerprint” of the evolutionary effects of this low-intensity, rare and, site-specific pattern of fire behavior is thoroughly documented in the early studies, inventories and land acquisition records throughout the Southern Appalachian Mountains. Fire-intolerant species such as white pine, poplar, maple, black cherry, basswood, white ash, etc. predominate in the closed forest canopy types located in the cove and the protected north aspects of slopes. Conversely, fire-tolerant species (oaks, short leaf pine, etc.) prevail in the forest canopy types located on drier slopes and ridges. So-called "fire-dependent" species (pitch pine and table mountain pine) prevail in the forest canopy types located in isolated ellipses on the crests of dry ridges, especially, on the drier southern and western-facing, elevations below 3,000 feet AMSL (above mean sea level) (Ayres and Ashe, 1905; Pinchot and Ashe, 1897; Ashe, 1895).

Some researchers (Delcourt and Delcourt, 1997 and 1998) have recently suggested that widespread prehistoric (prior to 1492 a.d.) occurrence of chestnut pollen in bog samples is evidence of proliferation of chestnut through a Native American program of burning of the forest ecosystem. These interpretations apparently emanate from the popularly held folklore that Native Americans significantly altered the forest ecosystem and that chestnut is not only resistant to fire but somehow proliferates under its influence. However, all the scientific literature and the historic record illustrate the effects of fire on chestnut was precisely the opposite. Fire destroyed the chestnut mast crop and interrupted chestnut reproduction by killing chestnut when it was most vulnerable to fire, in the seedling, sapling and pole stages of growth. Moreover, fire destroyed chestnut stump sprouts even more readily and also killed standing members of the forest canopy.

The destructive effects of fire to chestnut and the entire Appalachian forest ecosystem are documented, unequivocally, in the Forest Service initial survey of the Southern Appalachian Mountains and in all subsequent Forest Service acquisition tracts containing chestnut which had been subjected to a prolonged fire regime practiced by Euro-Americans, not Native Americans. In the 19th and early 20th century, Euro-Americans used fire to aid in fallow field farming (slash-and-burn agriculture) and open-range grazing over virtually the entire landscape of the Southern Appalachian Physiographic Province. The effects of these land uses can be seen throughout the Southern Appalachian Mountains in a mapped survey carried out in 1900-1901 (see Figure 1). Fully, 24 percent of the

Figure 1. Timber density, land use. Southern Appalachians 1900.

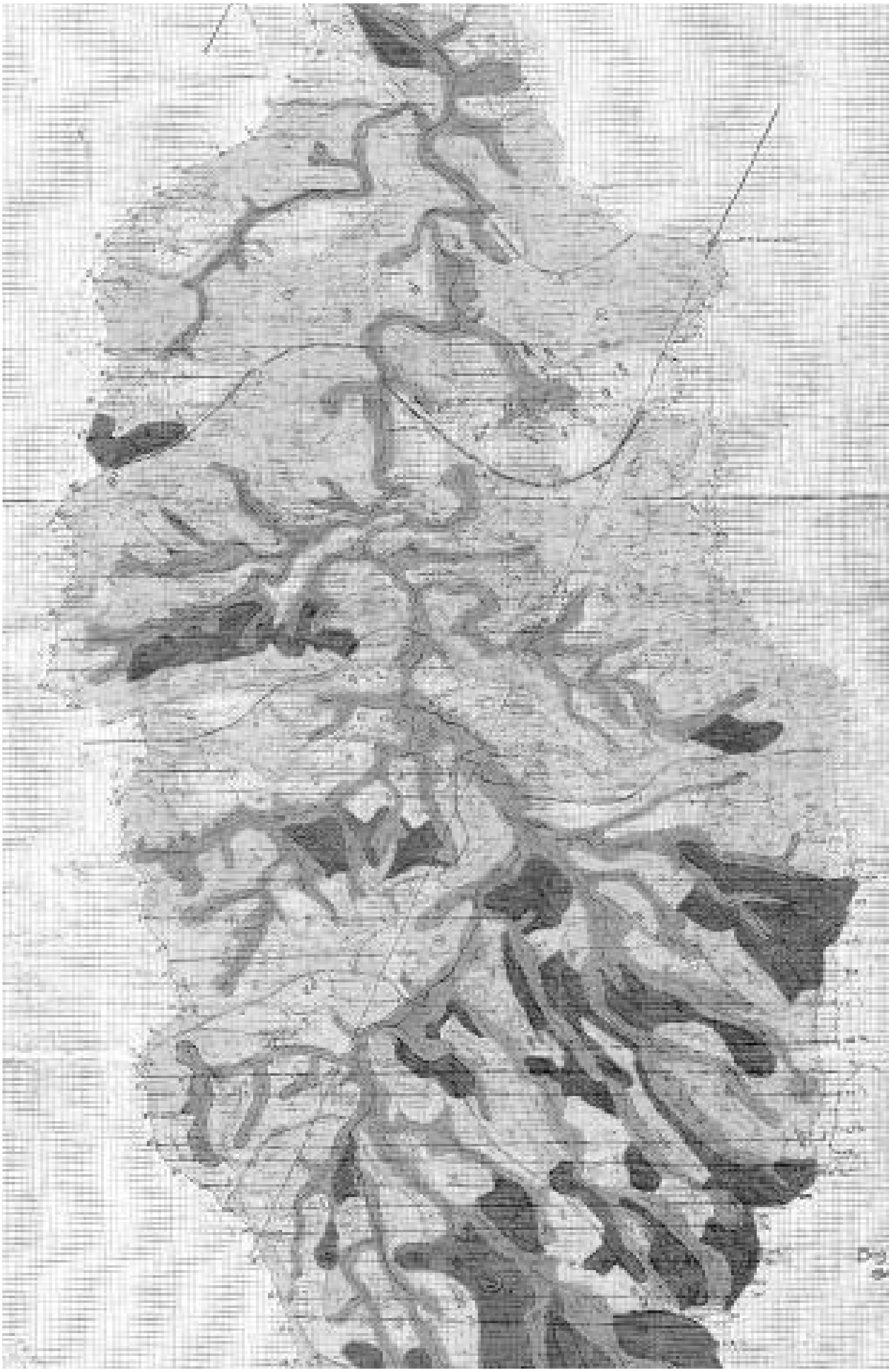


forest ecosystem had already been completely removed ('Cleared' in legend), all but 7.4 percent of the canopy had been culled, and virtually all of the forest ecosystem had been burned to one degree or another, after only two or three generations of Euro-American land use (Ayres and Ashe, 1905; Bass, 2002).

Ashe (1911) is unambiguous about the adverse effects of fire on chestnut: "Until past the pole stage, chestnut suffers severely from fire because of its thin bark. Sprout trees not only have thinner bark (than seedlings), but are likely to be injured through the burning of the old stumps (page 10)." Further, he notes: "To obtain the best yields from chestnut stands, protection from fire is absolutely necessary, because the trees, and particularly the young trees, are extremely sensitive to fire injury (page 35)." And, finally, with regard to mature chestnut in the forest canopy, Ashe states: "For many years the chestnut on the lower mountains in the southeastern portion of the State (Tennessee) has been dying out…it seems to be due more to excessive burning and to the consequent destruction of humus and impoverishment of the soil (page 11)."

A graphic illustration of the adverse effects of fire to the forest ecosystem, and chestnut, is presented in Figure 2, a canopy type mapping of the Big Creek drainage, a tributary of the Ocoee River (confluence at upper end of the map), in Polk County, Tennessee near the Tennessee/Georgia state line. At the time of inventory (1927), this drainage had yet not been subjected to commercial logging and, the upper half of the drainage (bottom of map) displays the distribution of permanent canopy types typical for the region prior to significant human alteration. However, the lower half of the drainage (top of map) had been subjected to a yearly program of burning for at least the previous 60 years to provide grazing lands for cattle. This burning is documented by the explosive expansion of pitch pine in this area and by the obliteration of fire-intolerant species, including chestnut, and chestnut "pure" canopy types. As opposed to the pitch pine on the ridges in the upper half of the drainage that are labeled "merchantable," the pitch pine in the lower portion of the drainage is labeled "unmerchantable," relatively young growth resulting from the Euro-American program of burning.

Given these facts, the documented widespread occurrence of chestnut throughout the forest before the arrival of Euro-Americans argues,



Big Creek Timber Survey

Original Field Map
Showing Control
Timber Types

October 1907

- Chestnut
- Cove
- Chestnut Oak
- Plateau Oak
- Pitch Pine (and short leaf)
- White Oak
- Burned

Figure 2. Forest Canopy types, Big Creek drainage, north aspect of Big Frog Mountain. Lower portion of drainage (upper half of map) displays pronounced expansion of pitch pine and diminishment of fire-intolerant canopy types (e.g.. chestnut "pure" canopy type) as a result of yearly firing of landscape for grazing. (USDA Land Acquisition Files, Cherokee National Forest, Big Creek Timber Sale, Wasilik, 1927).

strongly, not for the presence of fire, anthropogenic or otherwise, in the Southern Appalachian Physiographic Province, but its absence. Rather, the forest ecosystem of the Southern Appalachian Physiographic Province regenerated by another process than succession.

Ashe (1922) defined the canopy types for the Appalachian Physiographic Province. Importantly, he documented that, in the absence of large-scale disturbance events, the forest canopy types are permanent, exponents of the site type. In other words, the manifestation and distribution of the canopy types was determined by the variables of slope, elevation, aspect and the edaphic (soils and moisture availability). Ashe also documented that, because of the general absence of a disturbance regime, the canopy types regenerated primarily by direct self-replacement of canopy species or alternation of cohort canopy species when individual trees dropped out of the canopy as a result of age, disease, drought, etc. Due to this gap phase regeneration process, the canopy trees were uneven in age, or as Ashe termed them “all age.”

The turnover regime of these forest canopy types was dictated by the life cycles and the regenerative and reproductive characteristics that the respective canopy species evolved in adaptation to the variables at each site. Canopy types that generated in the richer, deeper, moister soils of the coves and protected slopes (north aspect) typically possessed a closed canopy with canopy shade, and therefore a slow reproduction and canopy turnover regime and an open under story. Canopy types that generated in the dry, thinned-soiled upper slopes and ridge sites displayed an open canopy that provided more sun light, and therefore a more rapid turnover and reproductive regime and a denser under story (Ashe, 1922; Frothingham, 1921).

For the more productive coves and the protected slopes of the Appalachian Physiographic Province the slow canopy turnover regime produced many canopy species that were long-lived and which attained very large sizes (e. g., poplar, hemlock, white oak, chestnut, white pine, buckeye, northern red oak, basswood, cucumber, cherry, etc). The growth curve studies performed in the early 20th century illustrate that on average a minimum of 100 years, were required for canopy species of the canopy types of dry ridge sites to reach “maturity” (cessation of rapid growth in height, that is, becoming a member of the superior canopy, Frothingham, 1921), while canopy species of the canopy types of the cove and lower slope sites required at least 200 to 250 years to reach "maturity." For the dry, thin-soiled ridge sites the superior canopy of the canopy types averaged 70 feet in height, while the superior canopy of the canopy types of the cove and protected (north aspect) slope sites ranged from 110 to 200 feet (Frothingham, 1921). This cessation of growth in height, by no means, indicates the age or the girth the trees attained. Rather, it merely documents the minimum time it took for the canopy species that grew in these sites to become standing members of the superior canopy. It is in this process and regime that the American chestnut evolved, grew, and thrived.

Chestnut in the Southern Appalachian Physiographic Province

American chestnut was, without doubt, the most adaptable canopy species in the entire Appalachian Physiographic Province. It is documented as occurring from 500 feet to 5,500 feet AMSL in the region and in the 1900-1901 survey of the Southern Appalachian Mountains it is inventoried as composing ten to 20 percent, of the canopy in every drainage (Ashe, 1911; Ayres and Ashe, 1905). Chestnut required well-drained surface soils and moderately moist subsoils that were fairly deep in order to accommodate the massive root system it developed in later life. Other than this, it occupied a wide variety of soils ranging from peaty sub acid soils in coves to highly acidic soils on ridge crests that were deficient in lime and potash. It would, however, rarely occupy limestone or clay soils (Ashe, 1911). This tolerance for a wide range of soil types and a demand for only moderate subsoil moisture allowed chestnut to grow in virtually every canopy type in the mountains, either as a cohort or dominant species or on the protected northern aspects of the mountains as a chestnut "pure" type (chestnut composing at least 66 per cent of the canopy of this type). (Figure 2, see upper portion of drainage for classic expressions of the chestnut "pure" canopy type).

Because chestnut occupied a wide range of site types, ranging from good to poor growing sites, it grew to different heights. Accordingly, Ashe defined three "quality" types (developed heights) for chestnut. Quality 1 chestnut grew in the rich, deep, moist soils of lower cove sites.

Figure 3. Quality 1 chestnut in the Southern Appalachian Mountains. Adult at base of tree for scale (Pinchot and Ashe, 1897).

Here chestnut reached its best development, attaining a clear trunk length of up to 72 feet, an overall height of 120 feet and a diameter averaging between four and five feet, breast height (see Figure 3). Given good growing conditions, it could even achieve enormous diameters in these sites, developing a massive root system, the trunk assuming a pyramidal shape, measuring up to 13 feet in diameter and sometimes even 20 feet in diameter at the butt. Quality 2 chestnut developed along the lower slopes, the chestnut pure type manifested on upper slopes with a north aspect, and in upper coves. In these sites chestnut developed a clear log length of 65 feet and an overall height of 90 feet. Quality 3 chestnut occurred in canopy types that occupied the dry, thin, acid soils of ridges and south facing slopes. Here, it achieved its poorest development, with a maximum clear trunk length of 45 feet and, along with other cohort species of the canopy types in which it occurred, a maximum height of 70 feet (Table 1).

In the example of the Big Creek drainage (Figure 2), quality 1 chestnut, four to five feet in diameter, is documented in the cove site type, quality 2 chestnut is inventoried in the canopy types found in the

Table 1. Distribution of chestnut in the Appalachian Physiographic Province by quality, site type and canopy type (after Ashe, 1911, 1922a).

Quality	Site Type	Canopy Type/Canopy species association
1	lower cove	yellow poplar, oaks, basswood, white ash, locust
1	lower slope, north aspect	chestnut pure type
2	upper slope, north aspect	chestnut pure type
2	upper cove	hemlock, birch, sugar maple, beech, white ash, basswood
2	lower slope	chestnut oak, chestnut type (chestnut dominant), with scrub pine (Virginia pine and pitch pine)
3	ridge, south slope	chestnut oak, chestnut type (chestnut dominant), with scrub pine (Virginia pine and pitch pine)
3	ridge, south slope	mixed oaks (red, black and scarlet oak), chestnut type (chestnut dominant), yellow pine (short leaf and pitch pine), sourwood

slopes, including the chestnut “pure” type canopy types displayed here, and quality 3 chestnut is documented in the so-called “fire-dependent” pitch pine canopy types situated on the dry ridge crests.

This wide range of site types to which chestnut was adapted also can be attributed to its unusual reproduction and growth characteristics. As opposed to the oaks and hickories, chestnut seeded every year, and every other year prolifically in amounts that are, still today, legendary. Chestnut bloom, since it occurred in mid-summer, was unaffected by frost. Indeed, it is still remembered by the elderly that on the north aspects of the mountains with chestnut “pure” canopy types it looked as though it had snowed in June or July. Additionally, chestnut required very little sunlight or moisture for seed germination. This, and the heavy mast crop it produced, alone would explain the prevalence of the species in the Appalachians. However, chestnut is also documented as being very tolerant of shade. It quite literally would sit beneath the canopy for decades with no adverse effect, except for suppression of its growth. Conversely, given sunlight, chestnut was also documented to be, in its earliest stages of growth, the fastest growing canopy species in the Appalachian forest ecosystem. Regardless of site type, chestnut would, in full sunlight, leap into the forest canopy, attaining half of the height of the superior canopy in but 20 twenty years and become a standing member of that canopy in 80 years. Additionally, as is well known, chestnut sprouted from the stump more readily, and certainly more persistently, than any other canopy species in the Southern Appalachian Physiographic Province. Finally, the massive ramifying root system and tapering trunk chestnut obtained when it became a member of the superior forest canopy made it virtually immune to wind throw (Ashe, 1911).

Before the blight struck, the chestnut’s growth and reproduction characteristics gave chestnut a competitive edge for reproduction over virtually every other canopy species in the Southern Appalachian Physiographic Province when the normal turnover regime of the superior forest canopy was interrupted by Euro-American land uses, particularly commercial logging. Ashe (1911) records that in logged forest stands in which chestnut was present, the regrowth of chestnut would be such that it would dominate the canopy, often to the exclusion of other canopy species.

So, these are the facts. Chestnut evolved and grew in a forest ecosystem of permanent canopy types that regenerated principally by gap phase reproduction. Chestnut developed all of its reproduction and growth characteristics within and subordinate to this process and regime. When this process is altered, things happen. If fire is not excluded from the forest, chestnut will fare poorly. If, on the other hand, the forest ecosystem is managed as a even-age forest rather than permanent canopy types that principally regenerate by gap phase reproduction, then chestnut will come to dominate the forest at the expense of other species. These effects can be surmised, not only from the known context and reproductive and growth characteristics of chestnut, as discussed, they have already happened.

It may seem ironic, but if chestnut is to be reintroduced into the forest ecosystem in the near future, it appears our descendents will face, in approximately one hundred years, the same issues and problems our ancestors faced one hundred years ago, prior to the demise of chestnut. But perhaps there is another answer. If the American chestnut is to resume its proper place in the forest ecosystem, then perhaps the forest ecosystem, and the American chestnut, should be treated with respect as to what they are, as opposed to what we want. Perhaps all of this can be better understood in a poem:

The Harp of the Forest

All the trees of the forest sing to each other in community.
Their community forms a harp, that plays a song, that is the forest.
The trees sing to us, and the harp of the forest plays for all to hear.
We play our songs.
We change the forest, we change its song.
We remove the harp.
There is no song, there is no forest.
But the forest knows only one instrument, one song.
It plays this, or there is silence.

—Quentin Bass, 2002

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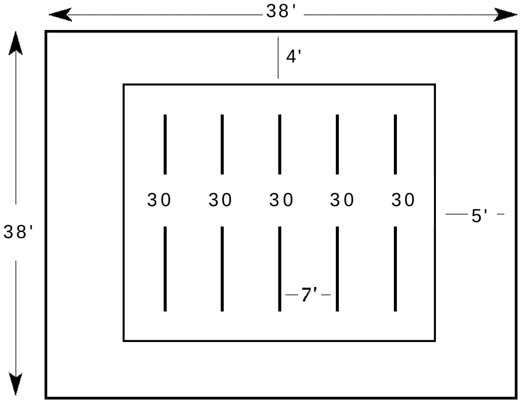
Castenea Guide

An Insider's Guide to the American Chestnut and TACF Science

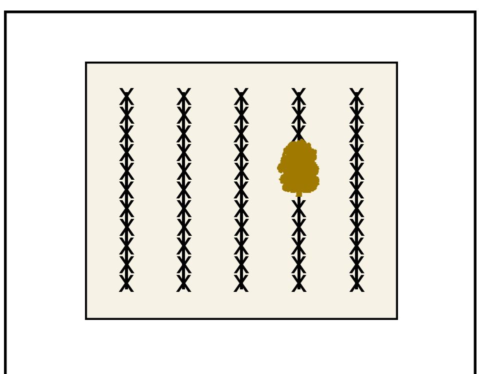
THE MAKING OF A MODEL SEED ORCHARD

That produces B_3F_3 Seed Suitable for Reforestation



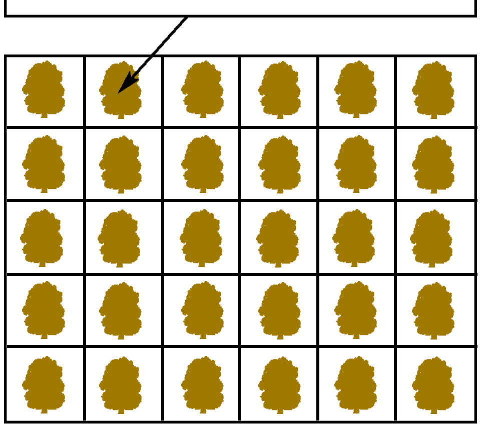
The Plot: the smallest unit

One hundred and fifty B_3-F_2 nuts, all progeny of the same B_3 tree, are planted in one plot in five rows of thirty nuts each. The rows are seven feet apart and the nuts are one foot apart within each row. A four to five foot border is maintained around the seedlings.



Selection occurs in each plot

At two years of age the seedlings are inoculated with the blight fungus. The trees are rogued over period of years, with the most blight-susceptible rogued first. Only one seedling, the most blight resistant, is ultimately chosen to remain as part of the seed orchard.



The Block: the intermediate unit

Thirty plots form a block. Eventually, when the plots are rogued, the block contains a single progeny from 30 different B_3 trees. Nine replications of a block form the orchard. (One block shown).

Note: For TACF's seed orchard at the new Meadowview Farms property, there are 32 plots arranged in an 8x4 pattern.