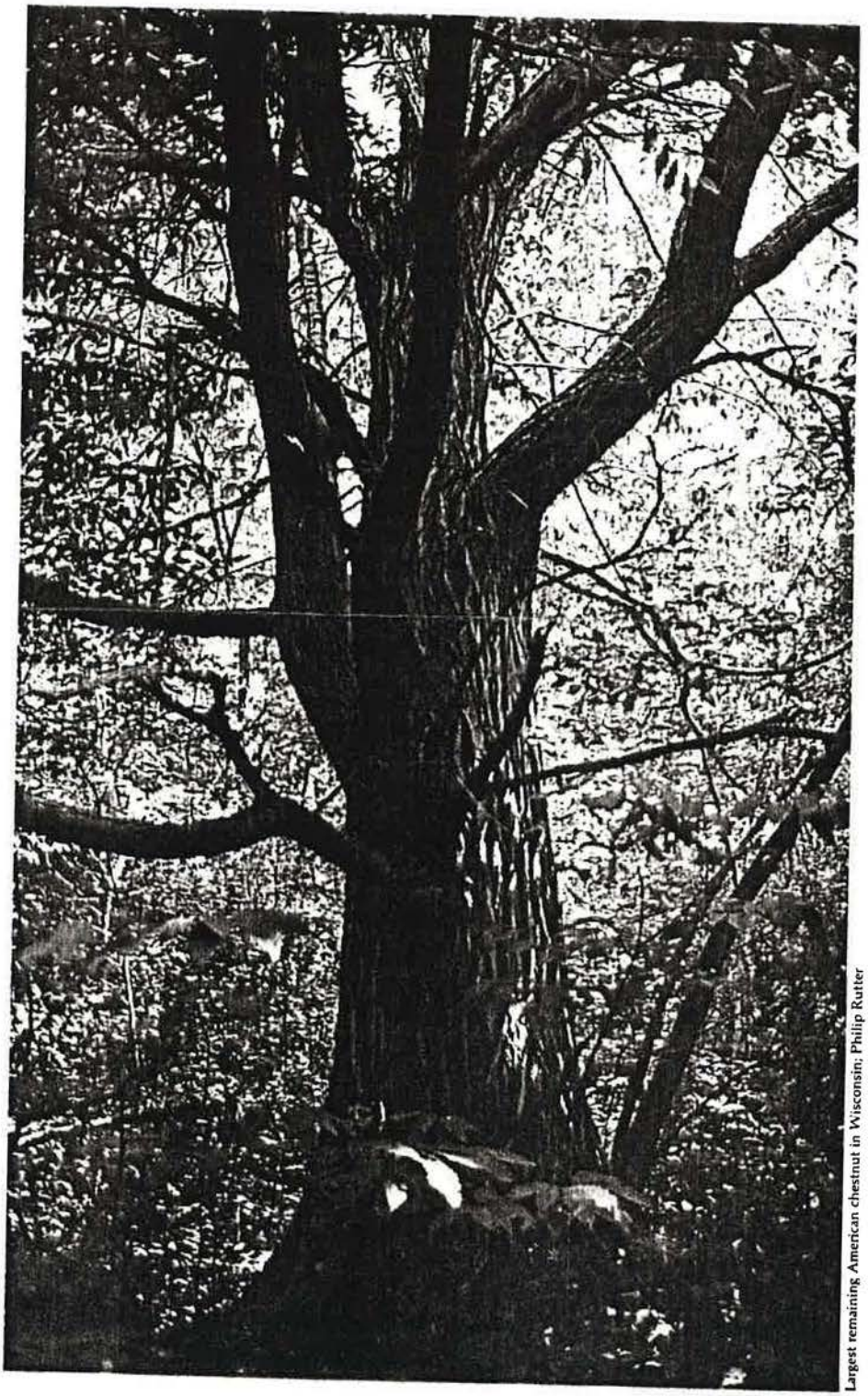
The Blighted Chestnut



Largest remaining American chestnut in Wisconsin; Philip Rutter

New research races with time to recover a great American tree

by Stephen Nash

At the turn of the century it would have been easy to take the massive straight trunks and abundant crowns of American chestnut trees for granted. The equivalent of nine million solid acres of chestnuts dominated the forests of the Appalachian region alone. Petrified groves on Specimen Ridge at Yellowstone National Park date back to the Eocene epoch, 50 million years ago.

Then, in 1904, at the New York Zoological Society's park in the Bronx, forester W.H. Merkel noticed that the tops of some of the park's chestnut trees were dying—an unfamiliar fungus had ruptured their bark.

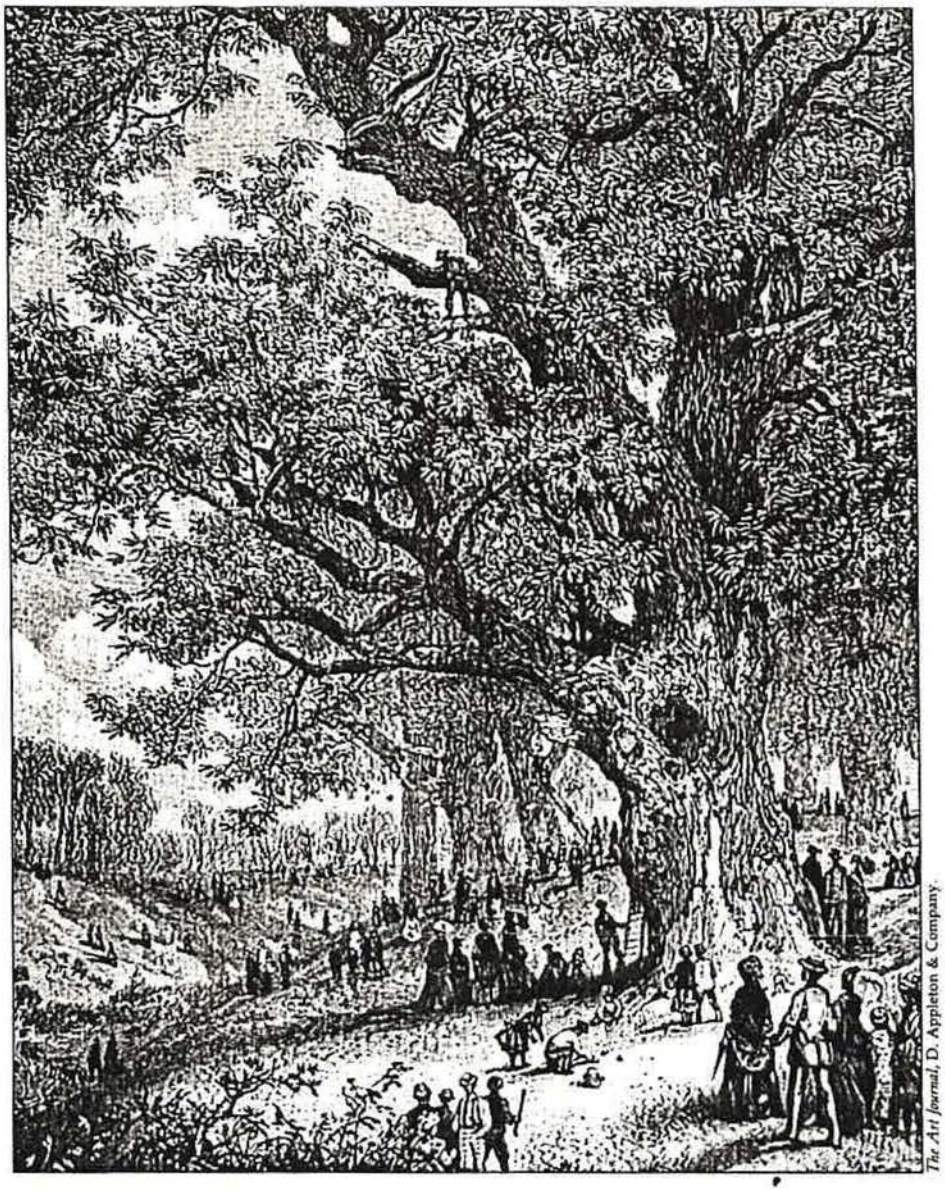
That was the first recorded sighting of *Endothia parasitica* in North America. Scientists later speculated that the fungus, common on Chinese and Japanese chestnuts, had entered through the Port of New York on nursery stock.

During the next 50 years the orange-colored blight spread like silent, lethal fire through the entire natural range of the American chestnut, from Maine to Alabama. The fungus can be spread by wind, rain, and perhaps by birds and insects; and it infects the chestnut through any small bark injury.

Of an estimated 3.5 billion mature trees almost none were spared. Only a few hundred seed-producing trees are left in the chestnut's natural range. Though the mature trees were killed by the blight, saplings still spring from the root systems of long-dead chestnuts. Those regenerative powers are vigorous: 15,000 to 20,000 sprouts per acre in some places.

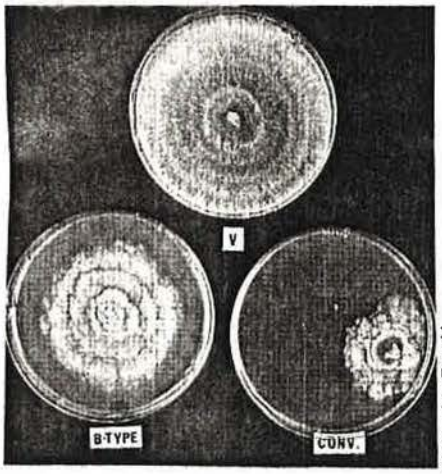
The saplings, however, exist in a biological limbo. After they have lived a decade or so, the fungus finds the young trees and kills them. Strands of fungus grow in mats, called mycelial fans, under the bark, cracking it open. When the widening wounds, or cankers, girdle the trunk, nutrient flow is choked off and the tree succumbs.

Efforts to stop the blight have been futile. Now, however, some remnant sprouts at Great Smoky



The Art Journal, D. Appleton & Company.

The "Nutting Party" appeared in the January 1878 *Art Journal*. The slate etching depicts Fairmount Park in Philadelphia at a time when chestnuts were abundant.



William MacDonald

V is virus; B-type is hypovirulent (hv); Conv. shows v being converted by hv.

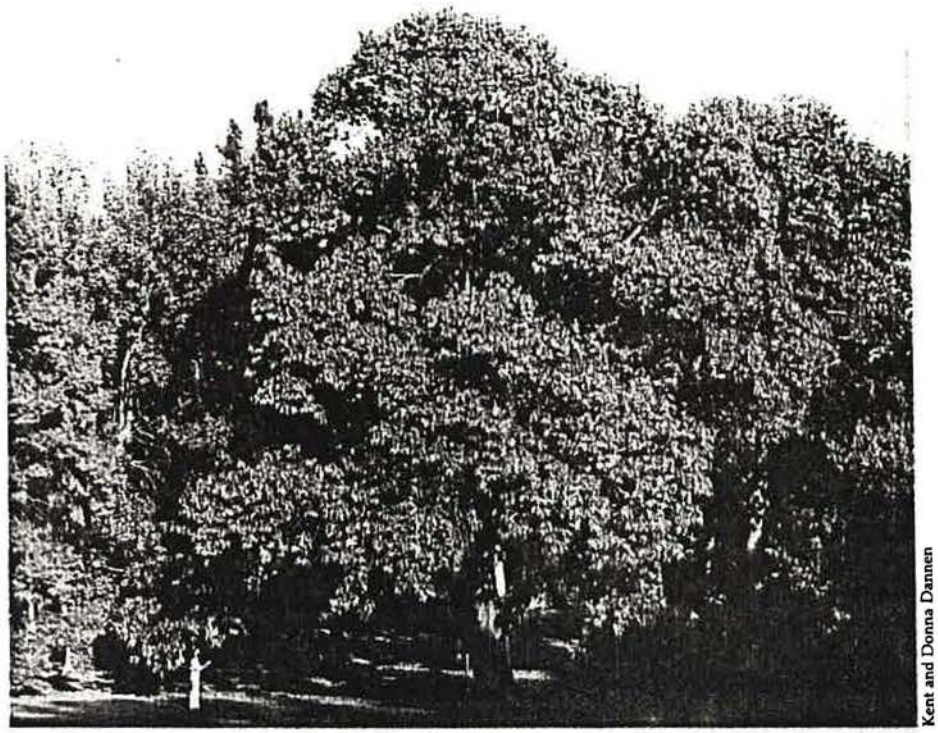
Mountains National Park and an experimental planting at the National Colonial Farm at Accokeek, Maryland, are providing raw material for two of several research efforts dedicated to returning chestnuts to the forests. The work is part of a renaissance of scientific interest in the all-but-extinct tree.

In the past, research has been stalled by unanticipated roadblocks. But new hypotheses, new laboratory methods, and new discoveries are providing fresh momentum.

Scientific interest divides broadly into two approaches. The goal of one strategy is to cripple *Endothia* with a competing strain of fungus—called "hypovirulent"—that is far less harmful to the tree. The other approach seeks to incorporate the blight resistance of oriental chestnuts into the American species through crossbreeding.

Research is eminently practical as well as ecologically desirable. For the ecology and economy of the eastern United States, the loss of the chestnut was colossal.

The fast-growing, straight-grained wood was used for telephone poles, bridge timbers, packing



Kent and Donna Dannen

A still-healthy chestnut dominates Arbor Lodge State Park, Nebraska. Arbor Lodge was once the estate of J. Sterling Morton, founder of Arbor Day.

crates, railroad ties, and general construction.

The tree was essential to mountain families as a building material and a cash crop. Wild razorback hogs foraged on chestnuts; and people, of course, dined on both.

"It didn't cost a cent to raise chestnuts or hogs in those days," mountain-dweller Johnnie Shifflett recalled in an oral history recorded in the Shenandoah National Park area. "It was a very inexpensive way to farm. The people had money and had meat on the table, too."

Carloads of chestnuts were harvested and shipped to the lowlands, especially during the Christmas season. (Most of those offered in stores today are imported from Italy, and a fraction come from the Orient.)

Chestnut bark and heartwood were used in tanning, and spring shoots were gathered for winter cattle feed. Mountain homes were built with chestnut logs and topped with chestnut shingles. Rot- and insect-resistant split-rail chestnut fences still line roads in the Appalachian highlands.

Animals—from bears to white-footed mice, deer, wild turkeys, woodpeckers, raccoons and jays, squirrels and foxes—were sustained by protein-rich chestnuts. Wildlife population counts were rare then, so we have no firm basis for comparison. We do know that the oaks and hickories that often replaced the chestnut produce only a fraction of its annual crop of nuts. That animal life has diminished proportionately is almost beyond question.

John McCaully, born in the Cades Cove section of the Smokies before the turn of the century, said, "There was worlds of chestnuts, I'm telling you. The whole earth was just black with them."

The 800-square-mile forest that is now the national park was 40 percent chestnut trees then. A ranger's survey found that 85 percent of those trees were dead or dying by 1938.

Deep in the Smokies 50 years later, a half-dozen seasonal National Park Service employees scrambled along brushy ridges, cutting foot-long scion twigs [botanical stock usually used in the upper portion of a graft] from a few of the rare remaining chestnut trees. They were inaugurating a grafting and breeding project designed by University of Tennessee forest genetics professor Scott Schlarbaum.

The older trees were stunted snags covered with fungus cankers, barely alive. But they had met the project's first criterion by surviving long enough—perhaps 10 or 12 years—to bear flowers.

"The scion still thinks it's that old, even after it has been grafted," Schlarbaum told the collecting crew.

Grafted onto understock from both Chinese chestnuts and healthy American chestnuts, the scions should flower quickly and cut several years off his experiment's breeding timetable.

"Time," Schlarbaum notes, "is the big stumbling block in breeding experiments."

The park represents a genetic "pocket of diversity" in the region, he explained. Each scion's parent tree had been chosen for its location at a different altitude and subclimate. That diversity will ensure a more heterogeneous, broadly adapted breeding population.

Once they flower, the scions will be fertilized with pollen from blight-resistant Chinese chestnut trees. The resulting crop of Sino-American nuts can be cultivated for another round of cross-pollination, the second cycle of a five-generation breeding plan.

Oriental chestnuts have been raised as orchard trees for perhaps 2,000 years. They are much smaller and less hardy than *Castanea dentata*, the American species, but they are resistant to chestnut blight.

Crossbreeding the two varieties was one of the earliest tactics of American scientists in the 1920s and '30s as they cast about for ways to salvage the devastated chestnut forests. But the progeny of one Chinese and one American parent was a tree with a half-measure of desirable American traits and not enough resistance to withstand blight.

The next logical step to improve resistance, it seemed, was to cross the new hybrid with a Chinese parent once again. It worked: the prog-

Great Smoky Mountains National Park

Encased in burrs, the nuts of the chestnut tree were a staple in the diets of bears and other mammals in Great Smoky Mountains National Park. Park staff say the less dependable crops of acorns and other nuts may have reduced park wildlife.

eny resisted blight. But the desirable characteristics of the American type—the 80-foot-high, five-foot-thick, straight-grained trunk that yielded great quantities of lumber, the wide crown of the tree with its prodigious harvest of nuts—had been almost completely bred out. After all, this "grandchild" chestnut tree was 75 percent Chinese.

In the words of American Chestnut Foundation President Philip Rutter, by the early 1960s nearly all such research had been abandoned "amid entrenched pessimism." New attempts awaited Rutter's exchange of ideas with renowned agricultural geneticist Charles Burnham, a professor emeritus of plant genetics from the University of Minnesota.

"We needed to understand where the wrong turn was made, and that insight came from Dr. Burnham," Rutter says.

Burnham's hypothesis, which Schlarbaum and Rutter are both pursuing in cooperative breeding programs, says that the original attempts to blend Chinese and American chestnut trees together like genetic marble cake were mistaken. Resistance to blight is genetically simple, according to the hypothesis. It depends on a very few genes, maybe just two. The goal is to transfer only those genes that determine blight resistance from one chestnut species to the other.

A simplified version of the hypothesis says that the genes necessary for blight resistance, paired in the Chinese trees, become separated in the first-generation hybrids. Further, the hypothesis postulates that these genes can be recombined in American trees after several generations of selective breeding.

Instead of crossing a Chinese-American hybrid with another Chinese tree to enhance resistance, the hypothesis points breeders in the other direction—crossing the hybrid with another pure American tree.

Most of this third generation of trees, genetically 75 percent American, will have no resistance to blight. In accordance with genetic principles, however, a few individuals will have picked up one gene for resistance.

Again, these trees are backcrossed to a pure American chestnut—in successive generations—until scientists are sure the hybrids have inherited all of the American characteristics. The final progeny are crossed among themselves.

If the hypothesis is right, the odds will have granted to a few of this last generation a full complement of resistance genes, passed down by patient selection from the original Chinese forebear.

Rutter's foundation is now working with a small but growing contingent of third-generation, three-quarters-American chestnuts. "My guess," he says, "is that we'll know in a couple of years whether they are carrying partial resistance."

Breeders usually have to wait several years for their greenhouse chestnut trees to flower. Another three to five years must pass before seedlings are old enough to be screened for blight resistance, using one of several techniques, such as introducing blight cells to a "broth" of chestnut tissue in the laboratory.

One of Rutter's more optimistic projections has the blight-resistant American chestnut seed arriving in

about the year 2000. An array of current research projects at several universities offers the hope that even that schedule can be speeded up considerably.

For example, scientists have developed a new technique for screening year-old seedlings for resistance. There has also been steady progress in the ability to clone chestnut tissue. Cloning, however, is only useful for producing backup "carbon copies" of individual trees.

These clones can be used for screening and for insurance against accidental loss of years of work invested in a single hybrid. A forest of clones, genetically identical, would not have the biological diversity necessary for the health of the species.

The long history of frustrated scientific efforts to outflank *Endothia* makes even the strongest chestnut partisan cautious, however. Early attempts to cut out the cankers and patch the holes with cement proved futile. Dirt poultices helped to heal blight cankers, but then more cankers reappeared to overwhelm the trees.

In 1966, NPCA published an appeal to its members to send nuts from still-standing chestnuts, thinking that surviving trees might be somewhat resistant. The resultant planting, on Sugar Loaf Mountain in Maryland, succumbed to the blight, and second-generation sprouts have shown no discernible resistance.

In 1979, French agronomist Jean Grente told a *Smithsonian* writer of the results of his efforts: "The American chestnut blight is vanquished. Yes, that's so."

It wasn't so, but his enthusiasm was well founded, if premature. He was working with an enfeebled strain of the blight fungus that had been found on chestnut trees in Italy. This variety still caused cankers, but the cankers were superficial, allowing the tree's natural defenses to prevail.

Best of all, whatever was weakening *Endothia* on the Italian chestnuts behaved like a virus, spreading from tree to tree. This hypovirulence ("lesser virulence") allowed the tree's natural defenses to take hold and heal the edges of the cankers as a sort of pox on the blight. A similar kind of hypovirulence was discovered on chestnut trees in Michigan.

These discoveries were startlingly like a Robert Frost poem, "Evil Tendencies Cancel," penned in 1930. In it, the chestnut ". . . keeps smoldering at the roots/ And sending up new shoots/ Till another parasite/ Shall come to end the blight."

What worked in Italy and in Michigan, however, did not help in the Appalachians, the American chestnut's natural range. So far, inoculations of hypovirulent strains will heal the canker, but they do not immunize the tree, and they do not spread reliably to other trees.

"I think the problem was that we were out looking for short-term results," says West Virginia University plant pathologist Dr. William MacDonald. "When we first started working with this—it's been almost ten years now—everyone thought, 'Boy, here we've got the ultimate control for chestnut blight.' "

Since the discovery of hypovirulent fungi, numerous strains have been found on chestnut sprouts in Virginia, West Virginia, and Maryland. Only a few, however, make *Endothia* properly sick. MacDonald and others are now trying to isolate these strains and encourage them to disseminate.

"Most biologists appreciate that there's nothing simple in nature," MacDonald says. "We know it works—it's working in some places now, naturally—but it's a matter of figuring out how it works and why, and then seeing if we can't get it to work here."

One theory is that it will take several years and a sufficiently large group of trees for the hypovirulence to begin to spread. That could be exactly what has occurred at the National Colonial Farm in Maryland.

"We do know that some of our

***Endothia parasitica*—chestnut blight—grows in mats under the bark, erupting in the cankers seen at right, which cut off a tree's nutrient flow.**

Stephen Nash

trees are doing very well," Dr. David Percy says. "They are healing over. They are not dying." Percy supervises research at the preserve, which is run by a private foundation with financial help from the National Park Service.

Percy recalls that chestnut seeds collected along the Blue Ridge Parkway in the mid-1960s were exposed to 2,000 roentgens of gamma rays at Argonne National Laboratory in Illinois. Researchers hoped that a mutation resulting in blight resistance would occur. Similar experiments with corn had proved useful.

These seeds were planted at the farm. But, as the years passed, there was no evidence that irradiation had helped.

"Then, serendipity struck," Percy says. During an annual inspection of the 660 first- and second-generation chestnuts in 1982, "we noticed that a number of infected trees were not dying. The blight tended to heal over."

Naturally occurring hypovirulent *Endothia* has been found on those trees; and MacDonald, among others, is examining the fungus to see if its vitality and ability to spread can be explained, and duplicated.

Dr. Jack Elliston, a plant pathologist at the Connecticut Agricultural Experiment Station in New Haven, has been seeing a similar turn of events. He mixed ten different hypovirulent fungus strains in a blender ten years ago and then applied the applesauce-like result to the cankers on some young chestnut trees.

The cankers did subside. So many new cankers continued to erupt, however, that the treatment had to be abandoned as futile.

Recently, however, the existing cankers have been healing on Elliston's trees. New cankers on the surviving trees are more and more often superficial, giving the tree something like a mild cold instead of polio, he says.

Although the trees are heavily blighted, their trunks are up to ten inches in diameter, and they are producing nuts. As in Maryland, no one can yet explain why the hypovirulence spread.

With new avenues open to them, chestnut researchers count a major "missing link" as common to all their efforts: money.

Scott Schlarbaum's four-year pilot project is unfunded past its first year. Most of Elliston's time is claimed by raspberry improvement work, which has support from growers. In contrast, chestnut research has failed to attract much help from the forest products industry, though one estimate puts the 1909 chestnut timber harvest at $20 million—about $240 million today.

"Basically, some people say we're trying to resurrect a dinosaur," MacDonald says. So funding from that quarter has been severely limited.

His interest is undiminished. "We've had several very successful field tests," MacDonald says.

Rutter, a catalyst for chestnut research, says, "I have two personalities. One is the scientist, and one is the man. The scientist requires constant skepticism, but it's hard for a human to live with that." He is confident that he will live to see a blight-resistant American chestnut. His human side puts the odds at 100 percent; the scientist says 80 percent.

"What keeps me going," Elliston says, "is the tree itself. As long as it keeps going, I'll keep going. And it just keeps on sprouting."

Stephen Nash, coordinator of the journalism program at the University of Richmond in Virginia, has worked as a reporter for the Oakland Tribune *and other newspapers.*

For more information, write the American Chestnut Foundation, c/o Dept. of Plant Pathology, University of Minnesota, St. Paul, MN 55108.

New York State proposes to establish a national chestnut research center, affiliated with the state university system and the American Chestnut Foundation. To support this proposal, write Assemblyman Francis J. Pordum, 146th Assembly District, Rm. 652, Legislative Office Bldg., Albany, NY 12248.