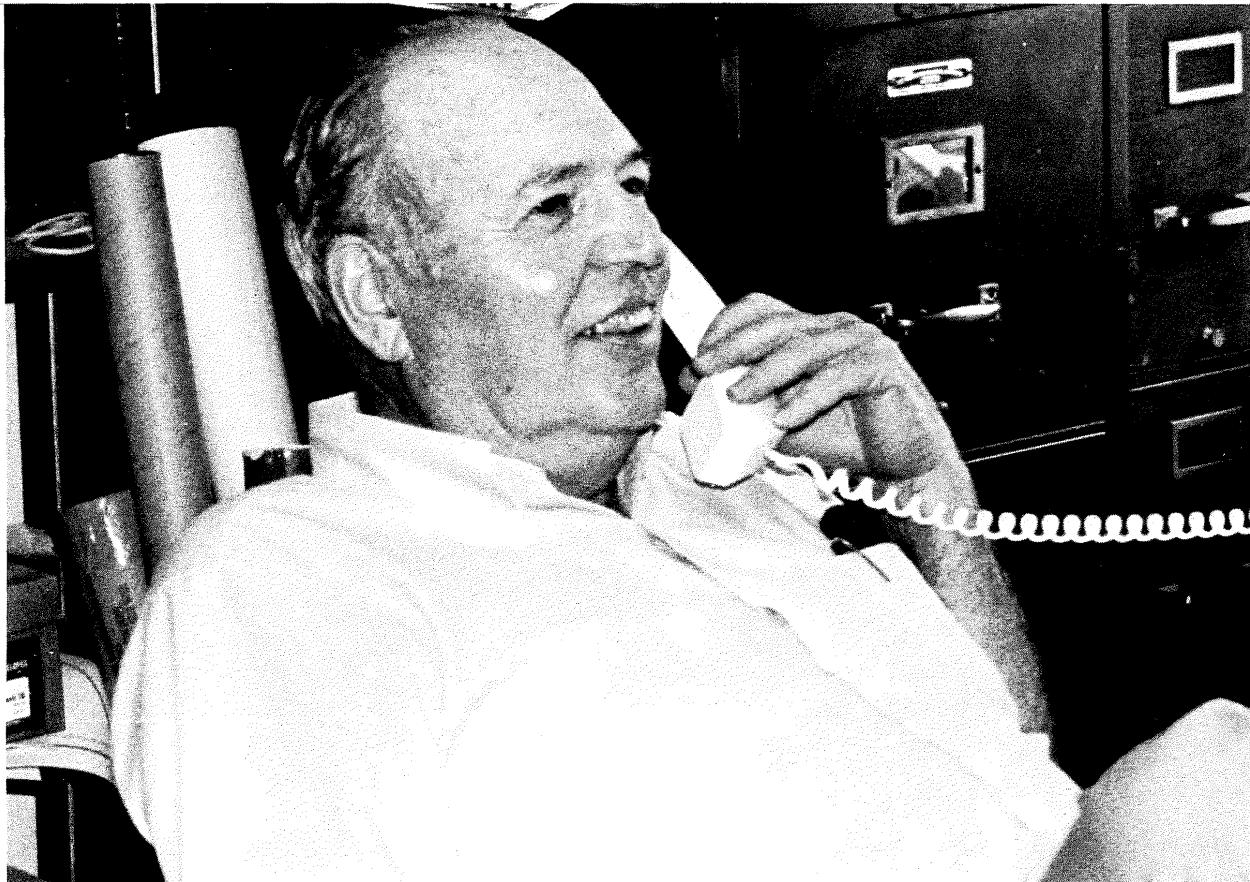




THE HARVARD FOREST, 1987-88

Harvard University





Ernest Morton Gould, Jr.

December 26, 1918

-

January 8, 1988

"Of all who plant and tend a crop, only the man of God and the man of the forest dedicate their lives to a certain faith in an everlasting harvest to be enjoyed in some future time by others."

Written by George Cheek, formerly of the American Forestry Association, these words truly depict our departed friend, Ernie. For he dedicated himself for over forty years to forestry, the profession he loved so dearly.

We, in the service of the Commonwealth, owe him a debt of gratitude for all of his help and efforts in ameliorating several controversial forestry issues. In 1977, Ernie chaired the Massachusetts Forestry Program Review Board, and in 1980, the Department's Forest Resources Advisory Committee -- responsible for developing and publishing the Massachusetts Forest Resources Plan. When in 1980 individual town bylaws attempted to deter the harvesting of forest products, Ernie helped amend the statewide Forest Cutting Practices Act. He was elected to chair the Massachusetts State Forestry Committee and almost singlehandedly authored the far-reaching Forest Cutting Practices Regulations. Another challenge arose within the last two years. Again, Dr. Gould came forward to lead the development of the Massachusetts Generic Environmental Impact Report which will ultimately shape Massachusetts logging methods.

In retrospect, these were mammoth and complex tasks and Ernie did them superbly well. The Commonwealth and its entire forestry community have much to thank him for.

To few are granted so warm a personality and so fine an intelligence. Professor Gould was not only the Senior Statesman for Forestry in Massachusetts, he was our "Sylvan Sage", our ombudsman, who had the knack of bringing together sparring factions and then developing cooperative working alternatives.

No person is eternal. We all must face the last barrier and Ernie has accomplished some very big tasks -- honestly and well. He has left behind him a fine heritage in many loyal friends, important works and shining examples. We will miss our friend Ernie very, very much, but we will never be without him, for his spirit is incorporated in every one of us.

May these thoughts help us carry on Ernie's important sylvan tasks.



Presented by Thomas F. Quink, Chief Forester, Massachusetts Department of Environmental Management, Division of Forests and Parks at the Memorial Service for Professor Gould, First Congregational Parish, Unitarian on January 16, 1988 at Petersham, Massachusetts.

ANNUAL REPORT OF ACTIVITIES AT THE HARVARD FOREST

1987-1988

PERSONNEL

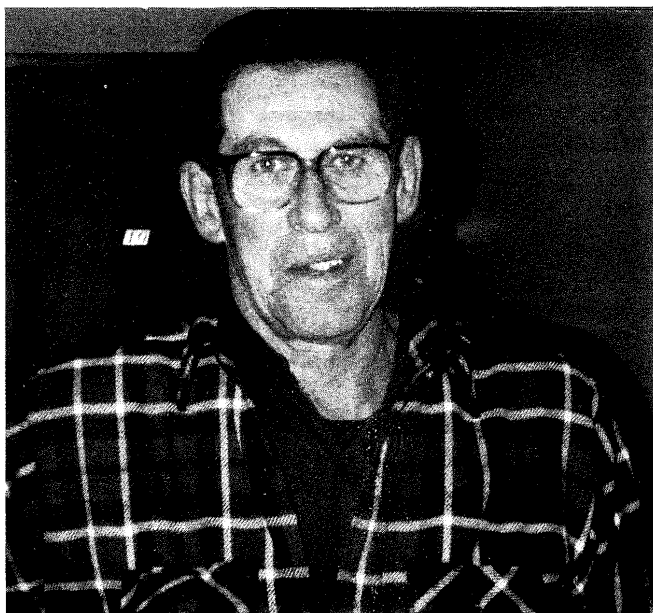
Dwight Baker, Research Scientist (from September 1987 until June 1988)
Donna Barker, Research Assistant (from October 1987)
Ruhama Berliner, Post-doctoral Fellow (until June 1988)
Emery Boose, Computer Assistant (until June 1988)
Gloria Boucher, Custodian (until September 1987)
Jeanne Boutelle, Custodian (from November 1987)
John Brady, Assistant to the Manager of the Black Rock Forest
Marcia Brightman, Librarian (part-time) (until August 1987)
Christopher Cronan, Bullard Fellow (from January 1988 until June 1988)
Elaine Doughty, Laboratory Assistant
John Edwards, Physical Plant Manager
Marion L. Ellsworth, Laboratory Aide (part time)
Barbara Flye, Secretary
David R. Foster, Associate Professor of Biology
Ernest M. Gould, Jr., Forest Economist, Senior Lecturer on Biology,
Assistant Director of the Harvard Forest (until
January 1988)
Anne K. Hachey, Greenhouse Assistant (part-time)
Gray S. Henderson, Bullard Fellow (from January 1988)
Donald Hesselton, Woods Crew (from September 1987)
Jack J. Karnig, Forest Manager, Black Rock Forest
Afzal M. Lodhi, Visiting Scholar (from September 1987 until March 1988)
Ralph L. Lundquist, Head of Greenhouse
Gordon B. Mitchell, Woods Crew Superintendent (until January 1988)
Ellen G. Moriarty, Graphic Artist (part-time)
Theresa Morris, Groundskeeper (until October 1987)
Frances E. O'Brien, Secretary
Frances N. Phillips, Secretary
Suzanne Racette, Research Assistant
Hugh M. Raup, Charles Bullard Professor of Forestry, *Emeritus*
Stephen Safo-Sampah, Post-doctoral Fellow (until June 1988)
Warwick B. Silvester, Visiting Scientist (until August 1987)
Dorothy R. Smith, Secretary
Charles C. Spooner, Woods Crew
Keith Spooner, Woods Crew (part-time) (from April 1988)
Tokushiro Takaso, Post-doctoral Fellow
C. Dana Tomlin, Associate of the Harvard Forest
P. Barry Tomlinson, E. C. Jeffrey Professor of Biology
John G. Torrey, Charles Bullard Professor of Forestry and Director of
the Harvard Forest
Shean-Shong Tzean, Post-doctoral Fellow (until September 1987)
Gordon Whitney, Archivist (from June 1988)
John Wisnewski, Woods Crew

STAFF

With the death of Professor Gould in January 1988, an era ended at the Harvard Forest. His passing marks the end of the Harvard Forest as a research center in forestry in the sense that was originally conceived by Professor Fisher, the first director and as it was modified and extended by Professor Raup and Professor Zimmermann. During the course of his forty years of service to Harvard Forest and to Harvard University, Professor Gould created a rich and indelible heritage that will continue to make itself felt as the Forest moves in new directions and into new roles and activities.

All of us will miss Ernie's direct friendliness, his cheerful willingness to consult on all manner of issues, from personal to professional, to regional or national. His wisdom and good sense undergirded many facets of the Harvard Forest community in ways that have made Petersham and the Forest an important and memorable place for many people.

The death of Gordon ("Buzz") Mitchell on January 8, 1988, after a losing battle with lung cancer, came as a double shock to our small community. Buzz served on the woods crew for thirty-seven years, the last fourteen as superintendent. His quiet and effective participation in the day-to-day operations of the forest and physical plant will be missed by all.



Beginning in May 1988, Dana Tomlin accepted a position as Associate Professor of Natural Resources at Ohio State University in Columbus. The Tomlins plan to maintain their residence in Petersham. Dr. Tomlin's appointment as Associate of the Harvard Forest will continue and Dana expects to contribute to the GIS operations at the Harvard Forest under the planned LTER program.

Emery Boose completed his stay as computer technician at the Harvard Forest in June 1988. During the past year he has been working closely with Professors Foster and Tomlin to develop graphics software for the Geographic Information System, to install new computer and digitizing equipment, and to complete software development for the Harvard Forest inventory, budget and archives. Having received his PhD degree in Sanskrit in June, Dr. Boose has accepted a position as Instructor in Sanskrit in the Department of Sanskrit and Indian Studies at Harvard University.



Beginning July 1, 1988, Dr. John O'Keefe joined the Harvard Forest staff as Coordinator of the Fisher Museum. John occupies a newly created staff position. He comes to us with qualifications particularly suited to the task of developing an educational program, especially for the lay public of all ages, centered in the Fisher Museum and the trails and lands of Harvard Forest. John completed his PhD in Forestry/Ecology at the University of Massachusetts, Amherst in 1987 under the supervision of Prof. B. F. Wilson. His undergraduate degree was in the social sciences at Harvard and his experiences included service as a Peace Corps volunteer in Lesotho, South Africa, fighter pilot in the Massachusetts National Guard, cook, steward and mate on a cruise schooner, and cartographic information research at the University of Massachusetts. His diverse interests and skills bring considerable strength to a job long waiting to be done. We welcome him to the Harvard Forest family in his new capacity.

Donald Hesselton was appointed to the woods crew of the Harvard Forest beginning full-time in September 1987. Jeanne Boutelle replaced Gloria Boucher as custodian starting in September 1987. Fran Phillips received a letter of commendation from the University administration in recognition of ten years of service at the Harvard Forest.

COURSES AND STUDENTS

In the fall term Dr. Tomlinson taught Biology 18, Diversity in the Plant Kingdom. In June-July 1988 Dr. Tomlinson travelled to Miami, Florida to teach Biology S-105, Plants of the Tropics at Fairchild Tropical Garden. This year marked the fourteenth time the course has been taught. Ten students from a diversity of institutions in North America attended. Dr. Foster participated in the teaching of Biology 204, Topics in Vegetation History and Quarternary Paleoeecology and Biology 299, Forest Practice and Research.

All of the Harvard Forest faculty participated in the Freshman Seminar on the Harvard Forest given in the spring term 1988. The Seminar, which is a long-standing tradition at the Harvard Forest, offers a dozen or so students an introduction to forest and tree biology through four weekend meetings starting in mid-winter and ending in mid-spring.

In addition to teaching classes either in Cambridge or Petersham, Harvard Forest faculty are involved in many other less formal forms of teaching. Dr. Tomlinson served as external examiner for a PhD student from the University of Western Australia on the topic of seagrass anatomy and physiology and in April 1988 visited the University of the South Pacific, Suva, Fiji as External Adviser to the Department of Biology.

Under Dr. Foster's supervision, Peter Schoonmaker undertook a detailed reconstruction of prior forest composition at the Pisgah Forest that included the anatomical identification of over 300 samples of woody litter along a 300-m transect. This historical reconstruction technique will be compared to forest surveys from 1908 and to the results of Peter's ongoing pollen studies at Pisgah. Glen Motzkin, forestry graduate student from the University of Massachusetts, worked with David on a study of the historical development and

current vegetation and environmental conditions of a kettle-hole bog in Belchertown. Another graduate student at UMASS, Tad Zebryk, has initiated a study of the history of spruce (black, red and white) in New England under the direction of David and Dr. Fred Paillet of the U. S. Geological Survey in Denver. The research involves palynology, phytogeography and forest ecological studies and is being funded by the U. S. Geological Survey. Jon Cherin from Sterling College in Craftsbury Common, Vermont worked with David on developing criteria for land management and ecological assessment using Geographic Information Systems.

Dr. Torrey supervised two graduate students, John Klingensmith and Carlos Klink, during the fall term in research reading under Biology 308. In March Dr. Torrey served as external member on the PhD thesis exam of J. Arnone, School of Forestry and Environmental Studies of Yale University.

Ann Lewis passed her PhD thesis exam in July 1987 and was awarded the PhD degree in the Department of Organismic and Evolutionary Biology of Harvard University. Her thesis, begun under the supervision of Prof. M. H. Zimmermann and continued under Prof. M. Tyree of the Department of Botany, University of Vermont, was concerned with restoration of water conducting channels in plants after embolism. Ann has continued her research this year with support of the U. S. Forest Service.

Suzanne Racette completed her thesis for the MSc degree in the Department of Botany, University of Massachusetts in Amherst in May 1988. Ms. Racette isolated a strain of Frankia from root nodules of the tropical tree Gymnostoma papuanum, native to Papua New Guinea and other South Pacific Islands. The Frankia strain effectively nodulated seedlings of Gymnostoma of the Casuarinaceae and also species of the families Elaeagnaceae and Myricaceae. Unlike all the other studied members of the Casuarinaceae, Gymnostoma shows the interesting capacity to form Frankia vesicles within the root nodules of young plants. Their significance in symbiotic nitrogen fixation remains to be demonstrated.

*Suzanne Racette taking
photographs through the
Zeiss microscope.*

(Photo by R. Silvester)



Stephen Burleigh is a Hampshire College undergraduate student on leave from Hampshire and working full-time in Dr. Torrey's laboratory on his Division III senior thesis. Mr. Burleigh's primary task was to develop a protocol for the production of a mass inoculum from cultured cells of Frankia that will prove useful for forestation in developing countries using actinorhizal plants, especially Casuarina ssp.

Samira Mansour arrived in May to pursue research on Frankia strains that nodulate Casuarina species of importance in Egypt. Ms. Mansour is a lecturer in microbiology in the Faculty of Science of the Suez Canal University in Ismailia, Egypt. With support of her government under the channel system, she will have two PhD thesis advisors, Prof. Torrey and Prof. A. Dewedar of the Suez Canal University and will conduct research at the Harvard Forest on the infective process of Casuarina by Frankia strains.

Each summer for the past three summers, faculty of the Harvard Forest have employed students from this or other universities and colleges to assist with field work based at the Forest. Students participating in the vegetation survey during the summer of 1988 included Kate Thoden, University of Massachusetts, Jon Cherin, Sterling College and Scott Navitsky and Philip Tomlinson, Harvard University. These students established over 300 permanent plots and accomplished the tedious task of blazing and reestablishing property bounds along the Swift River. For the students, the summer experience involved intense field work, drafting, mapping and computer storage of inventory data. The project was supervised and directed by David Foster and John Edwards. At least another full summer's work remains to complete the field portion of the survey.

Will Anderson, from the University of Massachusetts, assisted in data collection on growth, physiology and micrometeorology in experimental forest gap research. This research on comparative maple performance is being conducted at the Harvard Forest by graduate student Timothy Sipe under supervision of Prof. Fakhri Bazzaz.

Prof. R. Forman and Prof. D. Tomlin of the Department of Landscape Architecture, Graduate School of Design, once again brought their students to Petersham in September for their course, Introduction to the New England Landscape.

MEETINGS AND VISITORS

On October 18-21, 1987 about twenty-five scientists from around the world convened at the Harvard Forest for two days of intense discussion on available methods, including new electronic sensing instruments and complex computer recording devices, for measuring on a continuing basis the uptake of mineral elements in soil essential for growth. Sophisticated methods of studying gas exchange of developed root systems of agricultural crop plants and forest trees were also described. Of particular interest were studies of plant symbioses in which microorganisms of the soil form intimate beneficial associations with root systems in the form of root nodules or mycorrhizae - that is, modified roots produced by soil fungal infection of the fine root system. The origins of the associations and the benefit to host plants in the form of better growth and productivity were described.

Scientists in attendance came from as far as California and Florida in the United States and foreign participants included scientists from Canada, England, Wales, New Zealand and Israel. The discussions at the meeting will result in the publication in the coming year of a volume entitled Applications of Continuous and Steady-State Methods to Root Biology edited by J. G. Torrey and L. Winship and published by Kluwer Academic Publishers, Dordrecht, The Netherlands.

On January 22-23, 1988 a mini-symposium was held at the Harvard Forest which brought together interested staff of the Yale School of Forestry and Environmental Studies, the Harvard Forest and scientists from the Ecosystems Center, Marine Biological Laboratories at Woods Hole, the University of Maine at Orono and Clarkson University in Potsdam, New York. Discussions centered on topics of forest microbiology and ecosystems studies. This meeting was one of the regular annual get-togethers under the aegis of the Program in Forest Microbiology (PFM).

BULLARD FELLOWS

Christopher S. Cronan, Associate Professor of Botany and Ecology, came to the Harvard Forest from the Department of Botany and Plant Pathology and Forest Biology at the University of Maine at Orono. His primary research interests are in the areas of biogeochemistry and ecosystem ecology. The focus of his study was to develop new research concerning root system structure and function in forest ecosystems. During the first part of his fellowship, he reviewed the pertinent literature on tree root systems, assembled a computerized data base on belowground studies, and began to develop a review paper on patterns of fine root production. He then designed a series of experiments to examine (1) the influence of pH on cation selectivity by root surfaces of different tree species; and (2) in situ rates of ion uptake by natural forest stands as a function of soil depth, season and species. These experiments were subsequently initiated at Dr. Cronan's laboratory and in the university forest at the University of Maine. He also collaborated with colleagues at Smith College and the Institute of Ecosystem Studies in the development of a research paper of the effects of changes in acidic deposition on soil aluminum chemistry and aluminum toxicity to tree roots and aquatic organisms based on a computer simulation. In addition, he prepared three other papers for publication concerning the biogeochemistry and toxicity of aluminum in forested watersheds.

Gray S. Henderson, Professor of Forest Soils in the School of Forestry, Fisheries and Wildlife, University of Missouri - Columbia, began his fellowship period in January 1988. His research centered around investigations of the effects of soil acidity, aluminum and calcium on root growth of spruce, pine and sugar maple at the Harvard Forest. He prepared "ingrowth" cores and installed them with a soil auger in stands of trees at selected sites. These cores are composed of reconstituted soil modified as to pH and calcium content, encased in mesh bags, frozen and then placed in the soil. Subsequent excavations of the cores allow for chemical analyses of the soil and roots that grow into the cores. In addition to these studies, Dr. Henderson is attempting to develop a modified soil productivity index for assessing forest productivity potential. The modified index will be field tested in experimentation in the future.

RESEARCH

In August 1987 David Foster travelled to Sweden to continue his studies on landscape development and mire formation with Prof. H. E. Wright, University of Minnesota and Drs. Nils Malmer and Björn Berglund at the University of Lund, Sweden. Sites chosen for this research included mires that are very well known from the classic works of the Swedish ecologists Granlund, Osvald, Sjörs and Malmström. With the aid of detailed stratigraphic studies and radiocarbon dating, the current studies involve investigating the timing of formation and rate of expansion of mires and evaluating these results against hydrodynamic models of wetland formation. David has recently received funding from the Swedish National Research Council and Swedish Royal Society to continue this work.

In October Dr. Foster participated in a workshop at the Luguillo National Forest, Puerto Rico to draft a proposal to the National Science Foundation for a Long-term Ecological Research (LTER) Program on disturbance processes and ecosystem function in the tropical forests of El Verde, Puerto Rico. The study will examine ecosystem function in the tropical forest and recovery of ecosystems following natural disturbance including treefall, landslide and hurricane. David is working on a Geographic Information System analysis of hurricane damage to the forest that will be linked to models of forest and landscape dynamics. Similarities between studies in Petersham and Puerto Rico will lead to a comparison of temperate and tropical forest response to disturbance.

In a closely related effort, David Foster, Peter Schoonmaker, Gordon Whitney of Harvard Forest and Steward Pickett of the Institute of Ecosystem Studies at the Cary Arboretum met at the Allegheny National Forest in Pennsylvania to devise a research plan on tornado damage to old-growth forests in the Tionesta Scenic area. The tornadoes left blow-down areas up to a mile wide and twenty miles long. The proposed study will examine forest history, catastrophic wind damage to forests and vegetation recovery following wind damage.

In June 1988 Dr. Foster travelled to Egypt under an Egyptian Cultural Ministry program for graduate education. Under the program David will serve as an advisor to Abdelraouf A. Moustafa, graduate student at the Suez Canal University studying gradient analysis of montane vegetation in the southern Sinai. During his trip Dr. Foster visited the field sites for the research and discussed the program with the Egyptian supervisors. Mr. Moustafa will travel to the Harvard Forest in October to begin a year of study.

In late July 1987 Dr. Tomlinson attended the XIVth International Botanical Congress in West Berlin. Two scientific papers were presented and Dr. Tomlinson participated in a symposium organized on the topic "Multidisciplinary approaches to the systematics of the Araceae". As a continuance of his collaboration with Dr. Paul A. Cox, Brigham Young University, Dr. Tomlinson paid a visit to St. Croix, Virgin Islands in May 1988 that allowed him to pursue research on pollination biology and demography of seagrasses.

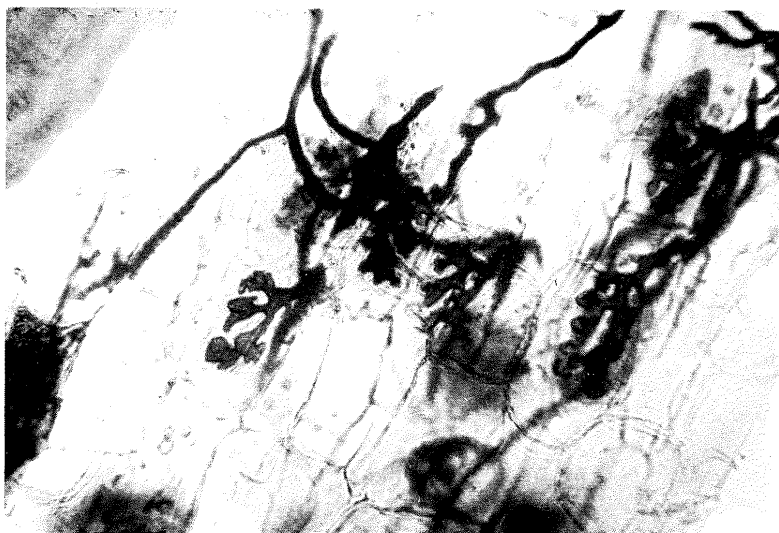
Dr. Tomlinson has been awarded a research grant from the National Science Foundation to study cone and ovule development in conifers. The research objective is to compare cone development, largely using scanning electron microscopy, in the Cupressaceae and Taxodiaceae. Dr. Tokushiro Takaso, post-

doctoral fellow from Japan, has returned to Petersham to continue in this research. Studies of Cryptomeria and Callitris have already shown that viewing the ovule-supporting complex in each bract-scale axil as a simple branch structure presents serious problems.

Final processing of a 500-page manuscript is being completed by Dr. Tomlinson and his assistants. The book on Structural Biology of Palms is planned for publication by Oxford University Press. The book surveys the entire family and will draw heavily on research carried out by Dr. Tomlinson in collaboration with the late Professor Zimmermann.

Dr. Torrey's research program, as in the past, has been notably supported by an active group of post-doctoral fellows. This year continues the tradition.

Mycorrhizal Research. With funding from the Mellon Foundation, Dr. Ruhama Berliner stayed on at the Harvard Forest after her year as a Bullard Fellow studying mycorrhizal relationships in forest trees. In a comprehensive study of the root systems of trees, shrubs and herbs, she showed that of the forty-four species commonly found in the conifer or hardwood plant communities in the forests of Petersham, 91% of the species were mycorrhizal and all five of the major types of mycorrhizae were represented. Seventy percent of the species were of the vesicular-arbuscular mycorrhizal (VAM) type. VAM fungi occurred more frequently in communities of high diversity; ectomycorrhizae were more common in communities of low diversity. At the end of June 1988, Dr. Berliner returned to Israel in anticipation that she will continue her root-rhizosphere research in her own country.



Light microscopic view of a cleared root of Smilacina racemosa showing stained hyphal structures of the symbiotic vesicular-arbuscular mycorrhizal fungus in the root cortical cells. x 580.

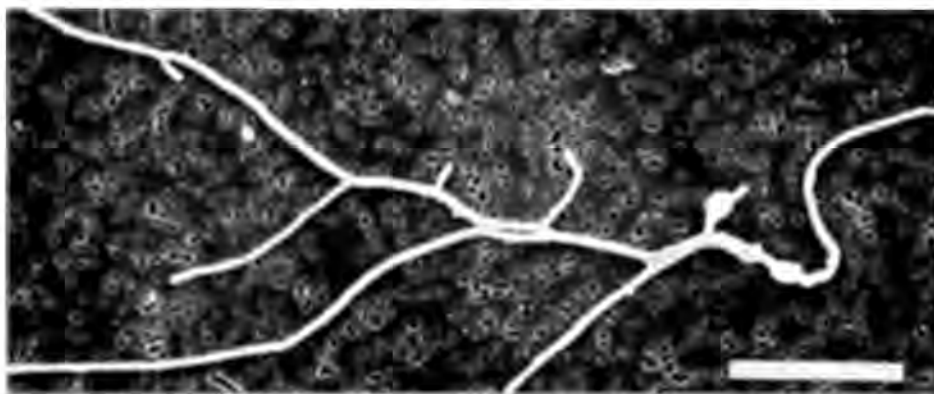
(Photo by R. Berliner)

Dr. M. Afzal K. Lodhi spent seven months in Dr. Torrey's laboratory while on leave of absence from the Department of Biology of the St. Louis Community College at Forest Park, Missouri. Dr. Lodhi's research interests concerned changes in soils and soil microorganisms and, in particular, mycorrhizal fungi as effected by controlled burns in a red pine stand in Harvard Forest. Dr. Lodhi returned at the end of his leave to his position as Professor of Biology and Ecology at his home institution.

Actinorhizal Research. Dr. Dwight D. Baker, Research Scientist in forest soil microbiology at Yale School of Forestry and Environmental Studies, had a half-time appointment at the Harvard Forest for this academic year. His primary role was to facilitate the functioning of the Program in Forest Microbiology established cooperatively between Harvard and Yale Universities. Dr. Baker was also active in research with Frankia, using experimental facilities both at New Haven and Petersham to study factors affecting the effectiveness of Frankia-actinorhizal plants for symbiotic nitrogen fixation. One of the cooperative products of this collaboration was the production this year of a Frankia Bibliography which lists publications of the past decade since the first confirmed isolation and culture of a Frankia strain from Comptonia.

Dr. Stephen Safo-Sampah completed his second year as a post-doctoral fellow in Dr. Torrey's laboratory. He demonstrated that cell-wall hydrolyzing enzymes are commonly produced by Frankia cells grown in pure culture. Such activity may help Frankia to live saprophytically in the soil as well as to dissolve cell walls during the infection process.

Dr. S. S. Tzean, post-doctoral fellow from the Department of Plant Pathology and Entomology of the National Taiwan University, Taipei, focused his attention during his five-month stay in Petersham on spore germination in Frankia. Two strains of Frankia isolated from Casuarina and sent to us by Howard Berg of the Department of Biology, Memphis State University were of particular value. In a defined nutrient medium the strains grow well, sporulate freely and then release mature spores into the medium. With the appropriate medium nearly 100% of the spores germinate on agar plates, form new colonies, that within two weeks sporulate and release, completing this bacterial life cycle. Understanding how to control spore germination in Frankia will open a new approach to the study of the biology of this important N_2 -fixing bacterium.



Two-day-old germinating spore(s) of Frankia photographed with a scanning electron microscope on a membrane filter with a $0.4\ \mu m$ pore size. Bar equals $10\ \mu m$. (Photo for S. S. Tzean by T. Rice)

Dr. Torrey's own research interests have centered over the past several years on a number of related problems concerning Frankia biology. Study of the control of Frankia sporulation both in free-living culture and in symbiosis continues. Dr. Lamont's past research on sporulation in culture is being continued by Donna Barker. Sporulation by Frankia in root nodules of

actinorhizal plants continues to be studied by Suzanne Racette. Suzanne is also involved in long-term studies of host specificity among actinorhizal plants for Frankia strains and the physiological basis for cross-inoculation.

Elaine Doughty, who maintains our Frankia culture collection, and Ralph Lundquist, greenhouse manager, and his assistant Anne Hachey play an indispensable part in these studies. Marion Ellsworth keeps the operation going in her role as laboratory aide.

Dr. Torrey travelled to Egypt in early January 1988 as consultant and thesis advisor to Samira Mansour at the Suez Canal University, Ismailia. During his stay in Egypt, Dr. Torrey was taken on field trips to several sites and field stations in the Sinai to observe plantations and occurrence of Casuarina, an actinorhizal tree of increasing importance in the arid areas of Egypt. During the visit arrangements were completed for Ms. Mansour to travel to Petersham to continue her PhD thesis studies of the Casuarinaceae and their actinomycete endosymbionts.

In March 1988 Dr. Torrey travelled to Köln, Germany to attend the 7th International Congress on Nitrogen Fixation where he presented a poster co-authored with S. Racette and W. Newcomb entitled "Vesicle formation and di-nitrogen fixation by Frankia in Gymnostoma, a genus of the Casuarinaceae".

Physiological Ecology. Prof. F. Bazzaz and graduate student Timothy Sipe have continued their research with experiments on the comparative physiology and growth of three maple species in response to forest understory and gap microenvironments. In Prospect Hill VII, trees were felled by the woods crew in October to create twelve experimental gaps of two sizes. The orientation (E-W) and shape (elliptical) of the gaps were controlled so that the effect of gap size on spatial and seasonal microenvironmental patterns and the response of planted maple seedlings to these environments could be determined. Twelve matching understory sites provide controls against which the effects of gap formation can be compared. Measurements of light, windspeed, relative humidity and soil and air temperature were begun in the summer of 1987 using portable electronic instrumentation to sample forest floor conditions continuously. These measurements have been continued in 1988. In addition, photosynthetic gas-exchange in the field is being measured and the growth and the architectural display of the three maple species is being followed on all sites.

The second experiment explores the effects of natural gaps on maple seedling performance in Tom Swamp I. In 1986 Tim planted maple seedlings in large clay pots buried to ground level in the understory. In the spring of 1988, half the pots were moved into five positions in each of three natural canopy gaps. Those remaining in the understory provide controls against which the response of the seedlings moved to gap environments can be compared. Microenvironmental conditions and physiological responses will be measured in the same manner as in Prospect Hill VII.

The third experiment will determine the extent to which soil moisture limits photosynthetic gas-exchange by the three maple species in the intact understory. Seedlings were planted in six pairs of plots in Prospect Hill IX in October 1987. Soil moisture and other microenvironmental variables have been monitored in these plots and experimental additions of water to one member of each plot pair will begin in the late summer of 1988.

FOREST OPERATIONS - PETERSHAM

Timber Harvesting. Silvicultural research continues on Prospect Hill VII and VIII. To date 6500 board feet of red and white pine saw logs and 65 cords of wood have been removed in conjunction with the combination patch cut and improvement cut on Prospect Hill VIII and plantation clearcut on Prospect Hill VII. Plantation cuttings have been milled in our sawmill to make red pine structural material and white pine siding for our pole barn.

Buildings and Grounds. Construction of the pole barn at the rear of Shaler garages as well as the conversion of one bay of the Shaler garage to lab space continues. Funding for these projects came in a Facilities Grant awarded to us by the National Science Foundation Biological Research Resource Program. The garage conversion, now completed, adds 650 square feet of modern laboratory space to our facility. The pole barn is a 39' x 60' structure which will add much needed space for equipment storage.

In other areas, the Community House has received a complete exterior paint job. More roofing work on Shaler Hall has been completed along with numerous areas painted inside. David Foster's lab in the basement has been newly remodeled with the help of NSF funds and serves as a modern computer facility.

Sawmill demonstration. Friends meeting, September 1987. (Photo by C. Harris)



Pole barn construction, July 1988, with timbers from Harvard Forest trees. (Photo by D. Foster)

HARVARD BLACK ROCK FOREST - CORNWALL, NEW YORK

Forest Operations. A harvest of mature overstory oak trees was contracted to Mark Siska, a sawmill operator from Catskill, New York. This operation took place during September 1987 in Compartment VIII along the west side of Sutherland Pond Road. Three hundred trees amounting to 46 Mbf were harvested from twenty acres.

John Brady continues to cut primarily dead trees resulting from severe defoliation by gypsy moths. Most of this activity has been centered around the Sutherland Pond to Jims Pond Road where thirty cords have been cut and sold. Another eight cords came from storm damage and natural mortality along Continental Road. John Brady began a new cutting operation at the northern end of Compartment IX. This entire Compartment was marked for thinning about two years ago but we failed to interest a contractor in buying stumpage at this location at a reasonable price.

A new main gate has been installed near the upper chlorinator on Reservoir (formerly Old West Point) Road. This change was permitted by the Town by virtue of their abandoning 1,300 feet of road which terminated at the Upper Reservoir. Black Rock Forest will now be responsible for the maintenance of this roadway. The primary purpose for this change was to protect the reservoir by excluding motor vehicles from the proximity to the water supply.

Coupled with gate relocation was the elimination of the rifle range near the reservoir. The lease for the use of this range by the Highland Rifle and Pistol Club has been terminated. The range was deemed a nuisance and a hazard and its closing will restore peace and quiet to this portion of the Forest.

On October 4, 1987 a freak snowstorm struck the lower Hudson Valley. In the Forest the greatest damage occurred at elevations above 1,100 feet where massive snow loads on trees caused large scale breakage and some uprooting. Downed trees and limbs closed most of our roads until we could clean up debris. Volunteers from the Black Rock Fish and Game Club assisted in the cleanup.

Research. Several ongoing research projects requiring continued measurements include: the Juglans nigra grove at Forest Headquarters, the oak seedling survival study, spruce thinning behind the Chatfield House in Compartment XIV and the Acer saccharum plantation in Compartment XV. In addition, an oak mortality survey was made in the vicinity of Sutherland Pond. Gypsy moth defoliation during the summer of 1987 caused noticeable mortality of white, red and chestnut oaks. Additional dying has been observed in late spring of 1988. Where practical, salvage operations are underway to remove and utilize these trees while they are still sound.

The Institute of Environmental Studies located at the Cary Arboretum completed its fourth year of study on gypsy moths in the fall of 1987. This research is ongoing in 1988 under the direction of Dr. Clive Jones.

For the past several years the Black Rock Forest has maintained a small tree nursery with tree species started either from seed or from seedlings. At present tree species include: white spruce, scotch pine, black walnut, butternut and several species of oak. Once these young trees are three to four years old, we outplant most of them into openings in the Forest.

Maintenance. During the past year a number of improvements to our physical plant were made. These included the exterior painting of trim and woodwork of the office building, refinishing of the dressers in dormitory rooms and panelling of the master bedroom at the Forest House. Much of the building maintenance and repair is undertaken with our own lumber.

Visitors. As in past years, many individuals and groups visit the Black Rock Forest to use its resources for research and education. Representative groups during the past year include the Dalton School, New York University, the American Museum of Natural History and City College of New York.

ACKNOWLEDGEMENTS

The Harvard Forest at Petersham operates with its primary support from endowment funds left in bequests to Harvard University for research and teaching in forest-related activities. To those earlier benefactors we continue to express our appreciation for their understanding and insights into the long-term needs and goals of the University and society.

In addition we acknowledge each year the substantial support for research and educational activities at the Harvard Forest from federal government agencies and from private foundations.

Contributions during the year just past include awards, gifts and donations from the following donors to whom we are indebted:

Friends of the Harvard Forest
Atkins Garden Fund
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Swedish Royal Society
United States Department of Agriculture, Competitive Research Grants,
Nitrogen Fixation
United States Department of Agriculture, Competitive Research Grants,
Forestry
United States Department of Agriculture, Forest Service
United States Department of Energy

IN ANTICIPATION...

During the past year several faculty members at the Harvard Forest, together with scientists from a number of sister institutions, have been working toward the establishment of a new research structure to be added to the existing organization and activities of the Harvard Forest. The opportunity arose for the Harvard Forest to enter an open competition announced by the National Science Foundation which planned to award funds for the creation of several new Long-term Ecological Research (LTER) sites to be added to an already established program involving fifteen existing sites.

A research proposal was submitted to the Division of Biotic Systems and Resources of the National Science Foundation on February 1, 1988. The principal investigators were J. G. Torrey and D. R. Foster of Harvard University, J. Aber of the University of New Hampshire and P. Steudler and K. Nadelhoffer of the Ecosystems Center Marine Biological Laboratories, Woods Hole, Massachusetts. All of these individuals already have been involved in long-term research at the Harvard Forest. Eleven additional co-investigators were listed including scientists from the Departments of Organismic and Evolutionary Biology, Earth and Planetary Sciences and the Graduate School of Design of Harvard University, Faculty in the Department of Biology at Clarkson University, Potsdam, New York and the University of Massachusetts at Amherst.

The unifying theme of the proposed research program for the Harvard Forest LTER is a comparison of the effects of historically important physical disturbances and recent and projected chemical disturbances on forest ecosystem structure and function. Research areas will include physiological ecology, plant development, forest microbiology, paleoecology, ecosystems studies and atmospheric chemistry.

A favorable response from the NSF to the Harvard Forest LTER proposal has led us to submit an addendum outlining a program of experimentation, measurement and modelling for the six-year period starting October 15, 1988 with a yearly budget of \$400,000. Final documentation of the award is awaited, but we have been encouraged to proceed with the planning necessary to begin the program expeditiously. An early phase is the creation in the Harvard Forest, removed from major sources of man-made pollution, of an Environmental Monitoring Station (EMS). A permanent data-collecting facility will be constructed for micrometeorological and atmospheric gases monitoring. The station is to be located 1.3 miles from Shaler Hall in the easterly direction off Locust Opening Road of Prospect Hill Tract. The facility will serve as a basis of significant research for many years to come.

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The foregoing is a list of publications which have appeared in print between July 1, 1987 and June 30, 1988. Publication lags one or more years behind the description of research in this report. Many of these publications are available as reprints. If you are interested in receiving any of these, please write to the Harvard Forest, Petersham, Massachusetts 01366, or where the address is given, directly to the authors.

Petersham, Massachusetts
August 1988

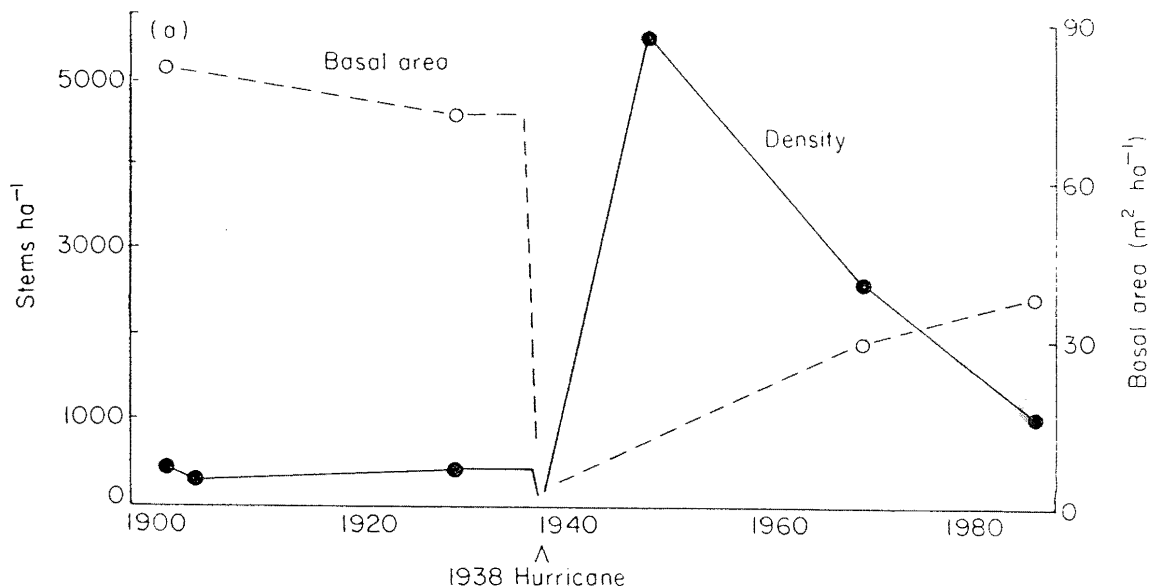
John G. Torrey
Director

Front cover: Prospect Hill Road (Photo by R. Berliner)
Inside front cover: (Photo by J. Silvester)

Fifty years ago - the 1938 hurricane



Salvage crew at Harvard Forest after the hurricane



Studies at the Pisgah Tract in S. W. New Hampshire provide a dramatic record of effects of catastrophic disturbance on forests. In early studies by Professor Fisher, the forest comprised a stand of great basal area and low density, mostly white pine, hemlock and hardwoods. The forest canopy was destroyed in the 1938 hurricane. Subsequent records for the Pisgah Tract show a progressive trend of natural thinning and increasing basal area of a forest comprised of beech, hemlock, maple and birch. (Foster, D. R. 1988. *J. Ecol.* 76: 105-134)