An illustration from a taxonomic study completed, in part, at Harvard Forest (LaFrankie, 1985); here, illustrating the differences between the eastern and western varieties of the common woodland herb "false Solomon's seal" (Smilacina racemosa): A = subterranean stem, B = fruiting stem, C = foliage leaf of the eastern variety, D = foliage leaf, E = aerial shoot of the western variety.
ANNUAL REPORT OF ACTIVITIES AT THE HARVARD FOREST
1984 - 1985

STAFF

Paul O. Bofinger, Bullard Fellow (from September 1984)
Emery Boose, Computer Assistant
John Brady, Assistant to the Manager of the Black Rock Forest
Marcia Brightman, Librarian (part-time)
Catherine M. Danahar, Business Secretary (until October 1984)
John Edwards, Physical Plant Manager (from October 1984)
Wayne E. Elliott, Custodian
Frank W. Ewers, Cabot Research Fellow (until September 1984)
Barbara J. Flye, Clerk Typist (from October 1984)
Mark S. Fontaine, Research Assistant (until September 1984; from June 1985)
David R. Foster, Assistant Professor of Biology
Arturo Gomez-Pompa, Bullard Fellow (from September 1984)
Ernest M. Gould, Jr., Forest Economist, Senior Lecturer on Biology,
Assistant Director of the Harvard Forest (from July 1984)
Anne K. Hachey, Greenhouse Assistant
Jeffrey A. Hart, Post-doctoral Fellow (from February 1985)
Edward M. Hyde, Woods Crew
Adrian M. Juncosa, Post-doctoral Fellow
Jack J. Karnig, Forest Manager, Black Rock Forest
Hayes Lamont, Post-doctoral Fellow (from September 1984)
Susan Lancelle, Research Assistant (until September 1984)
Ralph L. Lundquist, Head of Greenhouse
Monica R. Mattmuller, Research Assistant
Gordon B. Mitchell, Woods Crew Superintendent
Marcia A. Murry, Post-doctoral Fellow (NIH) (until September 1984)
Frances E. O'Brien, Secretary
Ellen Ostromecki, Greenhouse Assistant (part-time)
William A. Patterson, Bullard Fellow (from September 1984)
Frances N. Phillips, Secretary
Suzanne Racette, Research Assistant (from October 1984)
Hugh M. Raup, Charles Bullard Professor of Forestry, Emeritus
Dorothy R. Smith, Secretary
Charles C. Spooner, Woods Crew
C. Dana Tomlin, Associate of the Harvard Forest
P. Barry Tomlinson, Professor of Botany
John G. Torrey, Charles Bullard Professor of Forestry and
Director of the Harvard Forest (from July 1984)
George J. Wilder, Cabot Research Associate (NSF) (until July 1984)
Patricia H. Young, Laboratory Technician
Jenq-Chuan Yang, Visiting Scholar (from October 1984 to April 1985)
Beata Zagorska-Marek, Visiting Scholar (from January 1985)
Jacek Zakrzewski, Bullard Fellow (from October 1984)
Zhang Zhongze, Visiting Scholar (until October 1984)
John G. Torrey was appointed Director of the Harvard Forest for a three year term, beginning in July 1984. He and his wife Noreen took up residence in the Director's House on Prospect Hill Road in November 1984. Effective July 1, 1984, Dr. Torrey was appointed the Charles Bullard Professor of Forestry. Earlier occupants of the Bullard chair were Hugh M. Raup, former Director of the Harvard Forest and currently Charles Bullard Professor of Forestry, Emeritus and Martin H. Zimmermann who, until his death in 1984, had been Director of the Harvard Forest and Charles Bullard Professor of Forestry.

P. Barry Tomlinson has been appointed the Edward C. Jeffrey Professor of Biology, effective July 1, 1985. Barry is the second Jeffrey Professor, following the retirement of R. E. Schultes who was the first faculty member appointed to this position.

Ernest M. Gould, Jr. was made Assistant Director of the Harvard Forest beginning in July 1984.

John Edwards, who came to the Harvard Forest from the Department of Forestry and Wildlife Management of the University of Massachusetts at Amherst, was appointed Physical Plant Manager beginning in October 1984. John's training and qualifications in forestry and his experience in physical plant operations have combined to give considerable momentum to the current upsurging of activities at the Harvard Forest.

Barry Tomlinson, newly appointed Jeffrey Professor of Biology, and Dottie Smith confer on details for another book.
Students of David Foster's course, Biology 160, on a field trip to the Pisgah Forest in Winchester, New Hampshire. Under the hat is Samer Mansour, student from Wageningen, The Netherlands, who spent six months at the Harvard Forest assisting in forest research.

The following courses were taught in Cambridge by Harvard Forest staff members. During the fall term David Foster taught Forest Ecology (Biol. 160). The group made field trips to the Harvard Forest in Petersham and to the Harvard Pisgah Tract in southern New Hampshire. Barry Tomlinson taught the course on Diversity in the Plant Kingdom (Biol. 18) and participated as well in a new course on the Biology of the Flower (Biol. 144). For the first time students in Biology 18 made a weekend visit to Harvard Forest, with an overnight stop, as a substitute for a field trip previously held at Estabrook Woods, Concord. In the spring term David Foster was involved with two seminar courses, Forest Practice and Research (Biol. 299r) and Topics in Vegetation History and Quaternary Paleoecology (Biol. 204). The Harvard Forest Freshman Seminar which involved all the staff was given in the spring term. Freshmen have the opportunity to spend 4 - 5 weekends in Petersham, becoming involved in the field and laboratory activities at the Forest.

John Torrey joined with C. Smith and J. Einset of the Arnold Arboretum in giving the Freshman Seminar in Plant Propagation in the spring term, primarily in Cambridge. Two field trips to the Harvard Forest in Petersham and to the Arnold Arboretum in Jamaica Plain exposed the students to a variety of methods and techniques.

Dana Tomlin and Carl Steinitz gave Landscape Planning and Design Studio in the spring using a Harvard Forest and Petersham data base. Having this geographic, economic and biological information prepared for computer processing will be of considerable value to the Department and the Forest in the years ahead.
Jim Morris, Harvard undergraduate placing water-cultured Myrica plants in the growth chamber.

Although in no way a formal course, an informal summer program was initiated in the summer of 1985 which was designed to bring Harvard undergraduate students to Harvard Forest for research and field experience. With partial support from work-study or faculty-aid resources, five students spent eight or more weeks in residence in Shaler Hall, each working with members of the faculty. Students were Carolyn Hertzberg R85, Jeff Chapman H86, Bill Stevens H86, Yin Man Lam H88 and Jim Morris H88. In addition to research projects, the students attended weekly discussion meetings over lunch, learning about research in progress at the Harvard Forest.

Carolyn Hertzberg took a reading course (Biol. 91r) with Barry Tomlinson on the research of Wilhelm Hofmeister.

Two candidates for the Masters of Forest Science (MFS) degree have been in Petersham during the past year. Kevin Fetherston who started in early summer 1984 is evaluating the site and vegetation factors that controlled wind damage from the 1938 hurricane. He has used Dana Tomlin's Map Analysis Package in these studies. He plans to complete his study under the direction of David Foster in September.

Charles Caron arrived in early June 1985 and has begun his MFS degree project under the supervision of David Foster.

The year 1985 has been a banner year for student accomplishment at the Harvard Forest. Three degrees were awarded this spring to students at the Harvard Forest. Dr. Mary Lopez was awarded the PhD degree from the Department of Botany, University of Massachusetts at Amherst under the direction of John Torrey. Her thesis was on carbon metabolism in Frankia, the actinomycetous bacterium which produces N2-fixing root nodules on many woody plants. Dr. James LaFrankie and Dr. John Sperry both took their PhD degrees in the Department of Organismic and Evolutionary Biology of Harvard University under the supervision of Barry Tomlinson.Jim's thesis research was on the morphology and taxonomy of false Solomon's seal (Smilacina) and its relatives. John Sperry's research was initiated under Martin Zimmermann and pursued common interest in the hydraulic architecture of the Rhapis palm.
Dr. Lopez will begin a post-doctoral fellowship in September in the laboratory of Dr. E. Signer at Massachusetts Institute of Technology in Cambridge. Dr. LaFrankie will spend six months in Costa Rica beginning in August. Dr. Sperry plans to work as a post-doctoral fellow with Professor Melvin Tyree.

Two students continue their research for the PhD under John Torrey. Deborah Marvel, who has worked during most of her graduate research in the laboratory of Dr. Fred Ausubel of the Department of Molecular Biology, Massachusetts General Hospital in Boston, expects to complete her thesis research on the molecular genetics of Rhizobium strains which nodulate the tropical tree Parasponia in the fall term of 1985.

Having passed her qualifying exam for the PhD degree program in November 1984, Ann Lewis is able to devote full time in Petersham to her thesis research on determining mechanisms involved in embolism of xylem conduits under water stress. Ann's status is notable in two respects: first, her research is supported under a cooperative education working agreement between Harvard University and the USDA Forest Service (a first for Harvard) and second, her advisory committee is unique, comprised as it is of colleagues of the late Martin Zimmermann.

John Sperry (left) and Jim LaFrankie in the greenhouse checking on their plants for research (foreground the palm Rhapis excelsa; Jim holding a potted plant of Smilacina).
Melvin Tyree, currently at the University of Toronto and Thomas McMahon of the Department of Applied Physics of Harvard University will serve as expert advisors on Ann's research. Barry Tomlinson provides anatomical advice on the local scene.

Sandra Tomlin continued her work with Ernie Gould on a doctoral dissertation to be taken at the University of Connecticut at Storrs involving spatial optimization techniques in timber harvest planning for the White Mountain National Forest.

Tim Sipe, a graduate student working with Fahkri Bazzaz, is studying the physiological ecology of regeneration of maples and birches following gap formation. Tim led discussions on this topic at the annual meeting of the Friends of the Harvard Forest last September. Tim's work in the field will be at the Harvard Forest. Glasshouse and growth chamber experiments will be conducted in Cambridge.

Paul Rich, graduate student in the Department of Organismic and Evolutionary Biology (OEB) with Barry Tomlinson, is conducting ecological and morphological studies of arborescent palms in the lowland rainforest of Costa Rica.

After a summer in Petersham in 1984, Peter Schoonmaker has begun his work for the PhD degree in the OEB with David Foster. Although based in Cambridge for his course work and teaching, Peter spends such weekends as he can in Petersham on his research concerning the disturbance history and vegetation dynamics of the Harvard Pisgah Tract.

MEETINGS AND VISITORS

The annual gathering of the students of the Graduate School of Design under the direction of Richard Forman and Dana Tomlin of that School was held in Petersham in September 1984 for an Introduction to the New England Landscape.

In October we had a coordinated presentation of research in progress at the Harvard Forest by staff members from the Ecosystems Center, Marine Biological Laboratory, Woods Hole, Massachusetts and Virginia Polytechnic Institute under the general supervision of Dr. Jerry Melillo. Speakers included Drs. Charles McClaugherty, Peter Linkins and Knute Nadelhoffer. These groups are continuing to use the Harvard Forest as one of their selected research sites.

In early November 1984 the Harvard Forest hosted the Seventh Annual Northeast Paleobotanical Conference organized by Bruce H. Tiffney of Yale University.

Also in November, the New England Forestry Foundation held their annual meeting at the Harvard Forest.
In mid-November a distinguished group of scientists came to Harvard Forest at the invitation of Dr. Torrey and Dean John Gordon of the Yale School of Forestry and Environmental Studies for a weekend of discussion and planning for the creation of a joint program between Yale and Harvard in the field of forest microbiology. The meeting was supported by funds from the A. W. Mellon Foundation of New York. The announcement of the establishment of this program was made in May 1985.

Early in December a group of foresters and conservationists from the area of Harbin in the People's Republic of China visited the Harvard Forest. They were particularly interested in forest and wildlife management. Mr. Bruce Spencer, Forester of the Metropolitan District Commission, joined us in serving as their hosts. Despite snow on the ground and conveyance by an open truck, the group had an enthusiastic visit to the Dana site of the Quabbin Reservoir.

Late in March the Harvard Forest hosted the New Hampshire Service Foresters for a two-day conference.

In May the 16th annual New England Fern Conference was held under the leadership of Diana B. Stein of Mount Holyoke College and David S. Conant of Lyndonville State College. Of the sixteen annual meetings of this group, only one was held elsewhere due to renovations taking place in Shaler Hall.

With the sponsorship of UNESCO, Dr. Arturo Gomez-Pompa organized a Conference on Regeneration Management of Tropical Forests. Fifteen scientists from seven foreign countries and from around the United States came together for discussions and to plan for a World Conference on the subject to be held in the future.

Our usual seminar program was reactivated in the spring after a quiet fall. In addition to a number of seminars from local staff and post-doctoral fellows, we had talks from several outside visitors including A. M. Gill of the Division of Plant Industry, CSIRO, Canberra, A.C.T., Australia; P. Graul, College of Forestry and Environmental Studies, State University of New York, Syracuse; and F. Paillet, U. S. Geological Survey, Denver.

Informal visits to faculty at the Harvard Forest included Dr. Daphne J. Osborn of the Weed Research Organization, Oxford, England; Dr. M. Phillips, Department of Forestry, University of Aberdeen; Dr. Svante Björk, Department of Quaternary Geology, Lund University, Sweden; Drs. Rod Riedel and Jacques Mugnier of the Genetics Institute, Boston; together with Dr. David Tepfer of Gif-Sur-Yvette, France; Dr. Beata Barnabas of the Agricultural Research Institute of the Hungarian Academy of Sciences, Martonvasar; and Dr. Orlando Balboa, Catholic University of Chile, Santiago, Chile.

Other visitors to the Harvard Forest were Dr. M. S. Hopkins of the CSIRO, Australia; Dr. Salvador Flores of the University of El Salvador; Mr. Rodolfo Ogarris, President of Monarca A. C., a private organization of nature conservation in Mexico; Dr. Shirley Tucker, Louisiana State University; Dr. Sophie Ducker and Dr. Cameron McConchie, both of the University of Melbourne, Australia.
Events not otherwise noted but quite memorable were a retirement party at the end of October for Mrs. Catherine Danahar after many years of faithful service and in May a brief ceremony in the courtyard of the Biological Laboratories in Cambridge to mark the placement of the Martin H. Zimmermann Memorial at the site of a tree planted in his memory. Former students of Martin spoke, remembering especially his achievements as a teacher.

BULLARD FELLOWS

Jacek Zakrewski of the Department of Forest Botany, Agricultural University of Warsaw, worked at the Harvard Forest on a Bullard Fellowship beginning in October 1984. His interests in the hormonal control of wood formation and vessel differentiation were promoted by the application of a variety of analytical methods which have been developed at Harvard Forest. These techniques included, in addition to general methods of plant histology, cinematographic methods of studying vascular systems, analyses of vessel length distribution and measurement of transport capabilities. He worked on a diversity of plant types, including tree ferns, palms and monocotyledons with secondary thickening. Jacek also tested the idea that auxin waves in the vascular cambium account, in part, for aspects of wood structure. Xylem distribution was stimulated by appropriate hormonal treatment and the distribution of induced vessels was examined cinematographically.

Arturo Gomez-Pompa assumed his Bullard Fellowship in September 1984 after a period with UNESCO in Paris, France. His home base is the National Institute of Biotic Resources of Mexico (INIREB), Xalapa, Veracruz, Mexico. In his research Dr. Gomez-Pompa has sought to determine the role of human beings, past and present, on tropical forest regeneration with the hope of describing improved silvicultural systems for lowland humid and semi-humid tropics. He chose for his case study the Maya area of Mexico and Central America since there exists strong evidence that the old Maya had advanced silvicultural techniques.

His studies have included research on the vegetation dynamics of the region and on ethnobotanical evidence available from present day Maya on their resources, and their management and conservation.
Using new advances in anthropology, archaeology, tropical forestry and ecology, Dr. Gomez-Pompa hopes to develop a theoretical model for an artificial tropical forest which may help to design successful man-made forests for the future. The study is part of a collaboration with the project "Ethnoflora Yucatanensis" at INIREB.

William Patterson is a Bullard Fellow from the Department of Forestry and Wildlife Management of the University of Massachusetts in Amherst who took up the Bullard Fellowship beginning in September 1984. His research interests focus on the role of disturbance (especially fire) in forest succession, and documenting the history of fire and its effects on vegetation in New England and in northwest Alaska. Other recent projects have involved: analysis of barrier island dynamics on Fire Island, Long Island; the effects of beech bark disease on succession in northern hardwood forests of New England; vegetation succession following the demise of chestnut in Massachusetts; and the characteristics of old growth northern hardwood forests. This summer he plans to evaluate the composition and structure of plantations on the Harvard Forest.

On May 31, 1985 Bill Patterson arranged a prescribed burn in Compartment III of the Prospect Hill Tract. Here Bill (left) and Kevin Fetherston set the limits of the fire. From this experience the personnel of the Harvard Forest have become more aware of the nature of the hazards of forest fires and of control procedures.
At the completion of his Bullard Fellowship in August 1985, Paul Bofinger will return to his position as President/Forester of the Society for the Protection of New Hampshire Forests after a year's study and activity in a variety of forest policy and forestland protection issues. He travelled to Great Britain where he researched land protection techniques and to Germany's Black Forest to see first hand the dramatic impacts of air pollution. Knowledge of the German experience was very useful in his role as co-chairman of the Air Pollution/Forest Productivity Working Group established by the New England Governors and the Eastern Canadian Premiers. The policy recommendations of this group were recently adopted by the Governors and Premiers. A forestland protection program setting goals and priorities for the next decade, has been prepared for the New Hampshire Forest Society.

RESEARCH

Ernie Gould's research has continued to center on the problems of public resource and land use planning. The major problems of starting to implement the Massachusetts Forest Cutting Practices Act have been overcome and the State Forestry Committee is planning research to appraise the Act's impact on logging practices.

Ernie is also one of the Governor's appointees on the Massachusetts Water Resources Authority Advisory Committee with the special charge of watching for donor area problems. The current drought lends added weight to the need for proper watershed land management practices, as well as waste water treatment.

Study is continuing of attempts to get a new plan for the White Mountain National Forest that can mobilize a working consensus of users, bureaucrats, and legislators. Tentatively, it appears that planning all uses, on the whole forest, for a fifty-year period - in conformity to the Resource Planning Act (RPA) - may be counterproductive. This master plan of a global solution may well mobilize opposition rather than promote agreement on a course of action. It might be more effective to use "incremental planning" to identify and promptly correct current forest operating problems as they arise and are still of manageable size and complexity. Continuing experience with RPA planning processes reinforces the need for further social invention to make multiple use forestry a viable operating concept.

David Foster returned to Scandinavia for a month in July 1984, and again during July 1985, to continue research on vegetation history and bog development in central Sweden and coastal Norway. This work involved collaboration with H. E. Wright, Jr., University of Minnesota, Nils Malmer University of Lund and H. J. Birks, University of Bergen, and is funded by the Swedish government and the International Program of the National Science Foundation. In mid-August 1984 he returned to Labrador, Canada to continue studies of paleoecology, bog development, and fire ecology with H. E. Wright, Jr., and G. A. King from the University of Minnesota.
Work was continued on the assessment and modeling of catastrophic wind damage to forest vegetation. Using Dana Tomlin's Map Analysis Package, Kevin Fetherston, MFS student working with David Foster, has been evaluating the site and vegetation factors that controlled damage from the 1938 hurricane. Dana Tomlin has adapted the MAP program to the IBM-PC microcomputer for use at the Harvard Forest, and Emery Boose has written programs to facilitate the display and statistical analysis of output maps. With David Foster these three have started to develop a model simulating hurricane damage that will be tested on maps of the Town of Petersham.

In 1984 George J. Wilder, post-doctoral fellow with Barry Tomlinson, supported jointly by Cabot and National Science Foundation funds, completed work on the systematic anatomy of the monocotyledonous family Cyclanthaceae and wrote up most of the information for publication. Three papers have appeared while four more have been accepted for publication. As part of the same project Barry Tomlinson completed a survey of floral anatomy of representative species of the Cyclanthaceae. These show the relative uniformity of reproductive structures in the group. The results will be invaluable in field studies of pollination mechanisms which will be undertaken in the future.

Another research project well underway with full support of the National Science Foundation, is a study of reproductive processes in mangrove Rhizophoraceae at the hands of Adrian Juncosa and Barry Tomlinson. In this instance we have a good idea of floral mechanisms, which are diverse. Major emphasis is now on floral anatomy and development with an extension of previous work done by Adrian on embryology. Previous hypotheses concerning the evolutionary relationships of the genera involved, based on floral biology, have been somewhat confounded. For example, Kandelia candel, with seemingly unspecialized floral biology, has a surprisingly complex floral development. Embryological information for a total of seven genera of Rhizophoraceae, both mangrove and terrestrial, emphasize the close phyletic relationships between the otherwise contrasted ecological groups.

Beginning in January 1985, Beata Zagorska-Marek from the University of Wroclaw, Poland continued research at the Harvard Forest on variation in sapling stems of Abies balsamea. The research had begun with a fellowship from the National Research Council of Canada at the University of New Brunswick and was continued with Cabot research funds in Petersham. Her initial observations had demonstrated frequent changes in the phyllotaxis of shoots within large populations of seedlings, especially those with fasciated or bifurcate axes. By careful correlation of the vascular system with the leaf arrangement,
which can be analyzed cinematographically, Dr. Zagorska-Marek is able to test general theories about vascular organization in seed plants. If leaf arrangement precisely controls vascular organization, a change in vascular interconnection should follow a change in phyllotaxis. Preliminary information of phyllotaxis and a change in leaf pattern always occurs in a way which disrupts the vascular system minimally.

Jeffrey Hart, Atkins post-doctoral fellow, began an investigation of microscopic features of the reproductive cycle of conifers. The emphasis is on rarer coniferous species, especially those from the southern hemisphere and the tropics. The geographic distribution of rare conifers is clearly relictual and has importance for biogeographic and evolutionary theory, while complete knowledge of life cycles is essential where conservation measures need to be applied to species of potential economic importance. Dr. Hart is well qualified to initiate such a project, having completed a cladistic analysis of the Coniferales. A precise reconstruction of the phylogeny of the conifers should be possible because this group has an extensive fossil history. The initial survey was useful in revealing areas of ignorance about reproductive structures in these plants; not unexpectedly, most gaps relate to species which occupy less accessible areas. Outside funding is being sought to continue this work.

Dr. Torrey and his research group continue to devote their efforts toward a better understanding of the filamentous soil actinomycete Frankia which infects the roots of a number of woody dicotyledonous plants, forming root nodules capable of fixing atmospheric nitrogen. The dinitrogen is converted to reduced form, initially into amino acids and amides which are incorporated into bacterial growth but also to host plant growth and ultimately the combined nitrogen is returned to the soil via leaf litter to add to the enrichment of the environment.

Three areas within this broad field have received particular attention from this group, viz., the infection process, vesicle formation and sporulation by Frankia and these aspects have been studied both in the plant and in the cultured microorganism.
Vesicle formation was first reported in free-living cultured Frankia by Tjepkema, Ormerod and Torrey. Since then, extensive studies of vesicle formation and nitrogenase expression have been made at the Harvard Forest. In Frankia strains HFPArI3 and HFPCcI3 isolated from Alnus rubra and Casuarina cunninghamiana, respectively, it has been shown that vesicle formation is induced by removal of combined nitrogen from the medium. Vesicle development involves terminal swelling of the Frankia filaments and the formation of a multilaminate envelope which provides protection within the vesicle for O₂ labile nitrogenase. Nitrogenase activity, measured as acetylene reduction, proceeds even at oxygen levels above 30%. In Alnus and several other host genera, vesicles of the spherical, septate type occur and function as in vitro. In Casuarina species no vesicles are observed in N₂-fixing root nodules. O₂ protection seems to be afforded the nitrogenase formed within Frankia filaments by specialized cell wall suberization of the infected host cells. Marcia Murry demonstrated that Frankia grown in defined medium lacking combined nitrogen compounds was able to develop nitrogenase without vesicle formation if grown at very low (pO₂ = ~0.3%) oxygen levels. Studies of factors controlling vesicle form and function are continuing.

Sporulation in Frankia, grown in culture, occurs abundantly in many nutrient media. Dr. Hayes Lamont, a post-doctoral fellow supported on Dr. Torrey's USDA research grant, has studied the suppression of sporulation by complex media containing combined nitrogen compounds. While NH₄Cl does not influence sporulation, glutamine at low levels completely suppresses sporulation. These in vitro studies are being pursued in the effort to understand sporulation in root nodules in field situations.

At the Harvard Pond, Myrica gale at two sites behaves differently with respect to sporulation by Frankia within root nodules. Our efforts are directed toward understanding whether this difference is due to two genetically distinct Frankia strains, as claimed in the literature, or can be attributed to different physiological states of the host plants.

Transmission electron micrograph of a section through a vesicle cluster of the actinomycete Frankia isolated by maceration from a root nodule of the red alder (Alnus rubra). Preparation by M. Lopez, photograph by S. Lancelle.
Infection of root systems of actinorhizal plants by *Frankia* involves either root hair deformation and invasion as in *Alnus* or direct penetration of the root epidermis via intercellular sites as in *Eleagnus*. A comparative study has begun of cross-inoculations using eight host genera and all possible cross-inoculations with *Frankia* strains from these hosts. Root hair deformation, nodule initiation and development and acetylene reduction activity are being measured. The purpose is to gain better insight into the specificity of the infective process.

Dr. Jenq-Chuan Yang, Senior Research Scientist at the Taiwan Forestry Research Institute, Lu-Kuei, Taiwan, spent six months in Dr. Torrey's laboratory working on isolation and greenhouse trials of *Frankia*. Dr. Yang came to work on actinorhizal plants on funds provided by his own country. After a series of successful experiments with *Alnus formosana* and related species, he returned to Taiwan.

Dr. Enrico Gregori of the Research Institute for the Study and Conservation of the Soil, Firenze, Italy, spent a month in our laboratory supported by his government to become familiar with *Frankia* and its isolation and culture.

**FOREST OPERATIONS**

The addition of our Forester and Physical Plant Manager, John Edwards, made possible the addition of two part-time employees to the woods crew. These changes have made it feasible to improve many of the existing demonstration plots on the trails, initiate two forest operations and, with the cooperation of the Petersham Highway Department, repair the section of Tom Swamp Road known as the causeway.

Persons using our nature trails will find new photography on our signs, improvements to our cordwood demonstration plot on the Natural History Trail and, if you stroll down to the sawmill, you will find it operational.

Timber operations included a Plantation Improvement Cutting on Tom Swamp I which yielded 70 cords of wood. Considerable improvement was made in the method of timber removal. Cordwood is now skidded in 12' lengths using a tracked crawler to the landing as opposed to stump cutting 4' lengths.

Pete Spooner with a grease gun for use on the 1958 vintage John Deere tracked crawler-loader.
or whole tree removal. Twelve foot logs are loaded at the landing for delivery to the processing yard located at the mill where they are then bucked, split and stacked for drying. These changes have resulted in two less wood handlings, better equipment utilization and reduced man hours per cord without any increases in residual stand damage.

Our second forest operation this year is an additional demonstration plot on the Natural History Trail through John Sanderson's Farm. The thinning of a pure red pine plantation marked by Peter Hannah is underway. Sawlogs and fence posts and rails are being harvested, the latter will be treated with copper sulfate. We have started a sequence of photographs to demonstrate slash decomposition and forest regeneration.

HARVARD BLACK ROCK FOREST

On June 3-4, staff from the Harvard Forest in Petersham travelled to Cornwall for a two-day visit to the Black Rock Forest. David Foster, Ernie Gould and John Torrey had the opportunity to study the current operations and be brought up to date by Jack Karnig, Forest Manager. Their visit coincided with the start of a vegetation survey of the entire property. James B. and Kathleen S. Friday, students from Yale University, have been employed to install over 300 permanent plots and prepare the data on vegetation for computer processing. The permanent sample plots can be used as the basis for future assessments and changes in the vegetation. Their survey will serve as an up-to-date inventory of the vegetation resources of the Black Rock Forest.
Cutting for fuelwood in marked thinning operations has continued, primarily in Compartment XI and XII under an outside contractor. John Brady, assistant to the manager, has cut red and white oak trees for logs from Compartment VIII. High grade logs were sold to a local log buyer. Low grade logs were made into sawed lumber at a local sawmill in Cornwall and brought to the forest shed for our own use.

Monitoring of survival rates of oak seedlings from a large natural seeding in the spring of 1984 has continued into a second year. Data suggest that deer browsing has resulted in a 25 percent attrition in oak regeneration in two years. Compared with oak seedlings raised in the nursery, wild seedlings are obviously in distress. Nursery-grown seedlings of oak and black walnut have been planted in Compartment IV after the clearcut made in 1982. Seedlings have been fenced to prevent browsing by deer.

The Institute of Ecosystems Studies of the New York Botanical Garden is again actively monitoring gypsy moth populations during the spring and summer of 1985. Research specialists from the Cary Arboretum have made frequent visits to the Frog Hill area along the west side of Hulse Road. Some heavy defoliation has been observed in Compartment VIII west of Sphagnum Pond due to gypsy moth and the oak leaf skeletonizer.
ACKNOWLEDGEMENTS

The successful operation of the Harvard Forest depends upon the continuous effective interaction among people, the land and financial resources. The Harvard Forest exists through the foresight and generosity of past benefactors. Endowments undergird the institution, contributing to salaries for staff, renewal and renovation of the physical plant and operations on the land. In addition, an increasing proportion of the cost of research activities and of on-going expenses comes from financial resources outside of Harvard University. Acknowledgement of these important contributions is made in reference to each published research article. Contributors during the year reported here include the following donors to whom we are indebted:

Atkins Garden Fund
Maria Moors Cabot Foundation for Botanical Research
Fred Harris Daniels Foundation, Inc.
United States Department of Energy
Friends of the Harvard Forest
Andrew W. Mellon Foundation
Milton Fund
National Science Foundation
United States Department of Agriculture, Competitive Grants Program
United States Department of Agriculture, Forest Service
Swedish National Science Research Council
Charles H. Tozier Fund
William P. Wharton Trust

On the occasion of the annual luncheon meeting of the Friends of the Harvard Forest in September, Ernie Gould (second from left) is explaining about gap formation in the forest. The Friends include (left to right) Roger Corey, Richard Riley and Robert Chandler. (Photograph courtesy of Emily Arnold)
The following articles have appeared in print during the fiscal year 1984-85:


Wilder, G. J. 1984. Anatomy of the noncostal portions of lamina in the Cyclanthaceae (Monocotyledoneae). V. Tables of data. Bot. Mus. Leaflets, Harvard Univ. 30(2): 103. (George J. Wilder, Department of Biology, Science Building, Room 219, Cleveland State University, 2399 Euclid Avenue, Cleveland Ohio 44115)


This is a list of publications which have appeared in print between July 1, 1984 and June 30, 1985. 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, MA 01366, or where the address is given, directly to the authors.

Petersham, Massachusetts
August 1985

John G. Torrey
Director
Looking south along Connors Pond as it refills following major renovations of the dam shown in detail on the left. This scenic fishing area is administered by the Swift River Valley Trust which is made up of the Trustees of Reservations, Massachusetts Audubon Society and the Harvard Forest. Each institution helped anonymous friends finance the improvements.