

# THE HARVARD FOREST, 1973-74

Harvard University



Frontispiece: A sugar maple under "intensive care". Dr. John Milburn and Miss Elizabeth Gross try to unlock the secrets of how sap moves in trees. This picture was taken in the summer when pressures in the xylem are negative (see p. 8).

# ANNUAL REPORT OF HARVARD UNIVERSITY ACTIVITIES AT THE HARVARD FOREST 1973-74

## STAFF

The staff during the year of 1973-74 consisted of the following persons:

J.E.M. Arnold, Bullard Fellow  
Adrian D. Bell, Research Fellow (until June 4, 1974)  
Susan Sovonick Dunford, Research Fellow (from September 1, 1973)  
Ernest M. Gould, Jr., Forest Economist  
Jack J. Karnig, Forest Manager  
Jon A. Kusler, Bullard Fellow (until August 31, 1973)  
Walter H. Lyford, Soil Scientist  
John A. Milburn, Bullard Fellow (from August 18, 1973)  
William Newcomb, Research Fellow (from August 1, 1973)  
Chadwick D. Oliver, Research Fellow (from October 1, 1973)  
William L. Pritchett, Bullard Fellow (until August 15, 1973)  
Hugh M. Raup, Charles Bullard Professor of Forestry, *Emeritus*  
Ian A. Staff, Bullard Fellow  
P. Barry Tomlinson, Professor of Botany  
John G. Torrey, Professor of Botany and Director of Cabot Foundation  
Wayne H. Weidlich, Research Fellow (from October 15, 1973)  
James F. White, Instructor in Biology  
Martin H. Zimmermann, Charles Bullard Professor of Forestry and  
Director of the Harvard Forest  
Richard W. Zobel, Research Fellow (until April 22, 1974)

Supporting personnel included:

Catherine M. Danahar, Business Secretary and Librarian  
Peter J. Del Tredici, Research Assistant  
Wayne E. Elliott, Custodian  
Patricia L. Goforth, Laboratory Technician (from January 14, 1974)  
Vibeke Holm, Assistant to the Librarian  
Edward H. Hyde, Woods Crew  
Barbara M. Kelley, Business Secretary and Librarian (until  
September 30, 1973)  
George T. Kenney, Woods Crew  
Shirley P. LaPointe, Laboratory Aide (from December 1, 1973)  
Monica R. Mattmüller, Laboratory Technician  
Donald C. Mitchell, Assistant to the Manager of the Black Rock Forest  
Gordon B. Mitchell, Woods Superintendent  
Frances E. O'Brien, Secretary  
Linda Reznikiewicz, Laboratory Technician (until October 31, 1973)  
Anita Schulman, Laboratory Technician  
Dorothy R. Smith, Clerk-Typist (from November 1, 1973)  
Charles F. Upham, Woods Crew  
Sandra K. Weidlich, Clerk-Typist (from November 19, 1973)

We had again the usual turnover of staff during the past year. Dr. Adrian Bell returned to the University College of North Wales in Bangor, United Kingdom, to work on a project on rhizome growth with Professor Harper. Dr. Richard Zobel, a post-doctoral fellow working with Professor Torrey, left in April to take up a research position with Monsanto Commercial Products Company in St. Louis, Missouri. Four new post-doctoral fellows joined our staff, Dr. Susan Sovonick Dunford who received her degree after studying with Professor Donald Geiger of the University of Dayton, Ohio, and arrived on September 1, 1973 to study translocation in trees. Dr. William Newcomb joined Dr. Torrey's laboratory in September. He had received his degree from the University of Saskatchewan in the laboratory of Dr. Taylor Steeves. Chadwick D. Oliver, a silviculturist completing his degree from the Yale Forestry School, arrived on October 1, 1973. Dr. Wayne H. Weidlich, who received his degree after studying with Professor R.A. White of Duke University, arrived on October 15, 1973, and is working on vascular anatomy of water lilies and ferns.

Miss Barbara Kelley who had faithfully served the Harvard Forest as Business Secretary and Librarian for twelve years, retired on September 30, 1973. A number of supporting personnel joined us during the year, some of them on a part-time basis.

Staff members have again been very actively participating in conferences, presenting papers and giving special invited lectures at universities both in this country and abroad.

## STUDENTS

The following courses were offered in Cambridge by our staff members. These courses, as well as other biology courses, included field trips to the Harvard Forest. Mr. White gave "Structure and Functioning of Plant Communities" (Biol. 149) and "Plant Population Ecology" (Biol. 249), both during the fall term. Also during the fall term, Dr. Torrey gave "Plant Growth and Development" (Biol. 165). During the spring term, Dr. Tomlinson taught "Plant Form and Structure" (Biol. 168), and Dr. Torrey offered a freshman seminar entitled "Plant Propagation" in collaboration with Mr. C.F. Smith, greenhouse supervisor in the Biological Laboratories. This seminar was an experiment to by-pass the stranglehold on the biology curriculum maintained by its overwhelming pre-medical orientation. From sixty freshman applicants interviewed, fifteen students were selected. Students really are interested in botany, but so far have had very little opportunity to satisfy their curiosity about plants in lower

level courses. At least half of each two-hour weekly session was devoted to greenhouse work with plants. Two field trips took the group one afternoon to the Northeastern University greenhouses at Woburn and the other weekend excursion to the Harvard Forest where plant propagation in the laboratory, greenhouse and field was illustrated and discussed. The experiment was successful enough to warrant a repeat next year.

In addition to this, some of us gave guest lectures in other Cambridge-based courses. For example, for a number of years I have given two lectures on forests and wood in Professor Schultes' course "Plants and Human Affairs" (Biol. 104).

Two courses are Petersham-based. "Soil, Land and Human Environment" (Biol. 298) has been given by Dr. Gould and Mr. Lyford annually for several years. It has been described in previous annual reports and continues to be in considerable demand as shown by the fact that there are always more applicants than we can take. The summer course "Plants in Relation to the Environment" (Biol. S-146) was again very successful. Many Harvard Forest staff members and guest lecturers are involved in this. We are still somewhat hampered by lack of financial aid, although we are able to give some students partial support. More fellowships are probably needed to expand enrollment because very few students can afford to spend money during the summer instead of earning a working summer's pay.

In addition to the two Petersham-based courses, "Plants of the Tropics" (Biol. S-105) was again offered by Drs. Tomlinson and Wood. The class spent the first two weeks at the Fairchild Tropical Garden in Miami, Florida and the following two weeks in Cambridge.

As in previous years, the Department of Landscape Architecture of the School of Design brought their graduate students to the Harvard Forest for a few days prior to registration in September 1973. In addition to this, they spent four days here during the summer with their Career Discovery Program.

Two graduate students left us this year. Mr. Steven Schulman received his M.F.S. degree in June 1974. He analyzed problems arising from public participation in the development of Forest Service land management plans and policy. He used case studies from the Bitterroot National Forest in Montana, the White Mountain National Forest in New Hampshire and Maine, and the Harvard Forest. Mr. Schulman will commence work on a Ph.D. program at the Yale Forestry School in September.

Mr. Craig R. Landgren completed his Ph.D. thesis on pea root protoplasts and was awarded the degree in June. His research on the culture and mitotic behavior of protoplasts derived from the cortical tissues of pea roots will serve as background for further studies on cytodifferentiation and the nature of the infection process in nodule formation of legumes. Dr. Landgren has taken a position as Assistant Professor in the Department of Biology at George Mason University in Fairfax, Virginia.

Mr. Steven Jenkins, spent another year studying the feeding habits of beavers and is now completing his Ph.D. thesis. He will leave us on August 12, 1974 to take up the position of Lecturer in Biology at the University of Nevada in Reno.

Miss Jane Smith, who is working toward a Ph.D. degree under the direction of Professor Bogorad, spent the time from December 22, 1973 through March 20, 1974 at the Harvard Forest, writing her thesis.

The following students took units of undergraduate and graduate research. Biol. 91r: Roberto DeBara (tree growth). Biol 96r: Daniel Cooley (theoretical agronomy), Christopher Field (plant ecology), David Weed (architecture of *Cornus alternifolius*). Freshman seminar, special project: Kevin Stone (trees of New England). Biol. 299: Douglas Foy (legal problem in rural land-use control), Samuel Greeley (silviculture), Marcie Mersky (branching patterns in beech), Robert Veal (forest history and management). Biol. 300: Sandra Simpson (xylem differentiation), Lewis Feldman (the quiescent center in roots), William Wallace (vascular patterns in roots), George Kidd (osmotic effects on plant cells).

During the summer of 1974 Elizabeth Gross (Radcliffe '76) assisted our research in tree water relations. Edward Taintor, a forestry undergraduate (U. of Massachusetts '76) helped Dr. Gould and Mr. Oliver in their work. Curtis Coolidge (U. of Michigan '77) is mapping and classifying abandoned roads and trails for the Village Improvement Society, supervised by Dr. Gould. John Makacinas and Robert Towne, both forestry graduates of the University of Massachusetts are working at Black Brook Plantations in Hamilton, Massachusetts, under the guidance of Mr. Oliver. Two local students are again hired to help in various phases of our work during the past year: Theresa St. Helaire (Greenfield Community College) and Brenda Warrington (Mahar Regional High School).

## BULLARD FELLOWS

Mr. John E.M. Arnold from the United Nations Food and Agricultural Organization (FAO) in Rome, Italy, spent a year at the Forest reviewing and evaluating selected recent experiences in planning forestry development in developing countries. These reports, which describe a number of pioneering applications of new analytical tools to forestry situations, tend to be fragmented and of limited access. Mr. Arnold's work was carried out in three forms. The first was the completion of a forestry-oriented review of current planning principles and methods. This had been started as part of an FAO program and is currently being published with funds provided by the Swedish International Development Authority under the title "An Introduction to Planning Forestry Development". The second was the preparation of a series of case studies from file and report material of projects assisted by the World Bank and by FAO and the U.N. Development Program. The third is a survey of the outcome of a wider range of forestry planning exercises which indicates where improvements might be made. This paper, entitled "Lessons of Experience in Planning Forestry Development", will be presented at the 10th Commonwealth Forestry Conference in the United Kingdom in September 1974. Mr. Arnold reported some of his findings and conclusions at seminars he gave at the University of Minnesota, Yale and the State University of N.Y. at Syracuse. Further useful contacts resulted from his participation in the seminar on decision making for economic development, given by members of Harvard's Development Advisory Service.

Dr. Ian A. Staff, a plant anatomist of La Trobe University, Australia, worked on a number of projects. One of his interests concerned the Australian grass trees (the family Xanthorrhoeaceae). He had collected most of the genera on a trip to Western Australia in May, 1973 where five of the eight genera are endemic. He made use of our specialized equipment to carry out motion-picture analyses of the vascular systems of these plants with the surface and shuttle-microscope method. He found that *Dasypogon hookeri* has bipolar vascular bundles similar to those of *Pandanus* (see the paper cited in the bibliography at the end of this report), but no secondary thickening of the stem. *Xanthorrhoea* and *Lomandra* were also investigated and a literature search was done on primary and secondary growth in monocotyledons. A possible new genus from New Guinea and New Britain was examined in association with Dr. Peter Stephens of Harvard. Its anatomy was found to be unlike that of *Lomandra*, its closest relative, with regard to secondary thickening. — To complete a manuscript on the symbiotic relationship between cycads and blue-green algae, Dr. Staff used Harvard's excellent library facilities to review older literature. He also gave a number

of seminars in various parts of the country, and travelled through Arizona and Mexico on his way home, in June 1974, in order to collect monocotyledons with secondary growth (*Beaucarnea*, *Dasyllirion*, *Fourcroya*, *Yucca*, etc.) for future study.

Dr. John A. Milburn of the University of Glasgow, Scotland, pursued several interlinked studies in vascular transport. He used knowledge of palm exudation, gained during a recent visit to India to study the translocation processes in the coconut palm. This problem is of pressing interest on account of the Lethal Yellowing disease which disrupts translocation and is decimating palms in several areas of the world including Florida. Considerable progress has been made in the virtually unknown fields of xylem and phloem transport in the palm. Pressure gradients in phloem sieve tubes if measured reliably could resolve the longstanding controversy over the mechanism of phloem transport. Attempts to make spot readings indicated pressure up to 11 bars in the bark of American ash, the main test species for translocation studies at the Forest. It is hoped to extend the technique to measure pressure gradients during the Summer 1974. During the winter, studies were made on sap flow in the sugar maple (FRONTIS-PIECE). Work previously performed at the Forest by Dr. J. Sauter has been confirmed and extended. The age-old problem of the mechanism producing sap flow from which maple syrup is made, is undoubtedly through gas expansion and contraction within the tree trunk in response to temperature changes to which the system is extraordinarily sensitive. The changing gas content of the wood fibers seems mainly responsible. Xylem sap pressures can be 1 - 2 bars positive through gas pressure in winter, hence sap exudation, but revert to negative pressures which often exceed 10 bars through transpiration in summer. Problems remain concerning root permeability and sugar secretion. Maples have not yet lost their fascination.

## MEETINGS AND VISITORS

The second Biennial Plant Development Workshop was held at the Harvard Forest on the weekend of January 11-13, 1974. About twenty-five students and faculty from Cambridge and Petersham met to discuss problems of plant development. Student papers were presented by S. Simpson, C.R. Landgren, W. Wallace, L. Feldman and P. Manos. Staff presentations were given by Drs. Newcomb and Zobel, Peter Del Tredici and by me. Included as scientific visitors were Dr. and Mrs. S. Maheshwari of the University of New Delhi.



Above: Members of the Plant Development Workshop on a Forest trail

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After two years of planning, the third Cabot Symposium was held here on April 8-12, 1974 under the title "The Structure and Function of Roots". About 35 scientists discussed roots, their anatomy, physiology, biochemistry and function in relation to the whole plant. Research workers from around the world were assembled under the auspices of the Maria Moors Cabot Foundation for Botanical Research. Those coming from the greatest distance were from Australia; others came from Great Britain, Holland, Canada, Czechoslovakia and, of course, many from this country. The symposium will be published in book form as were the two previous symposia.

The Fifth New England Fern Conference was held here on May 10-12, 1974. This meeting was organized by Drs. Rolla and Alice Tryon of Harvard University. In addition to the regular papers on taxonomy, distribution and physiology of ferns, the program included several reports on Devonian plants, the first plants to invade the land several hundred million years ago.

For the past several years we have held regular Harvard Forest seminars on Fridays, organized by Dr. Tomlinson. This series serves two purposes. Our activities are so diverse that it is very useful for staff members and students to report on their work so that we know what everybody is doing. Secondly, it gives us an opportunity to hear about the work of visitors from near and far.

On Monday, March 18, 1974, a television team of about ten from the Italian Radio TV System RAO Corporation spent the day, interviewing Dr. Torrey about his research on nitrogen fixing systems in herbaceous and woody species for their television series on the "Life and Death of the Vegetation World". A series of close-ups of the historical sequence of dioramas of the Fisher Museum were made in color. The telecast will be made in Italy and other European countries in the fall of 1974. Dr. Marconi of the University of Rome was the biological advisor to the team.

Many other groups had meetings at the Harvard Forest and many colleges again brought their classes to study land-use history and other topics. The Fisher Museum continues to be an attraction for groups and individual visitors.

Drs. Lorin Roberts and Collette Nitsch spent several months in Dr. Torrey's laboratories, their work is described under the heading of RESEARCH.

## RESEARCH

Dr. Gould's work on land-use planning included a continuation of service on public panels for the White Mountain Forest plans. This work is largely completed and provided the stimulus and information for the thesis study by Steve Schulman (see STUDENTS). Dr. Gould was invited to attend two very interesting meetings concerned with land-use planning. The first was "National Resources and the New England Economy", sponsored by the New England River Basin Commission and others, the second was the "Conference on Land Use" sponsored by the Conservation Foundation. He also served on the Conservation Committee of the New England Council. Practical application of land-use planning continues in his work with the Petersham Conservation Commission. A conservation plan for the town is well advanced thanks to completion of the Petersham property map. This map which was made at the Harvard Forest and is described in earlier annual reports, provides a wealth of information useful for planning (see p. 12-13).

On a more theoretical level, collaboration has continued with Dr. William O'Regan of the U.S. Forest Service in Berkeley, California, to develop a linear programming approach to long-term forest planning. It is hoped that a new computer program will be completed this fall that will facilitate the use of this algorithm by foresters.

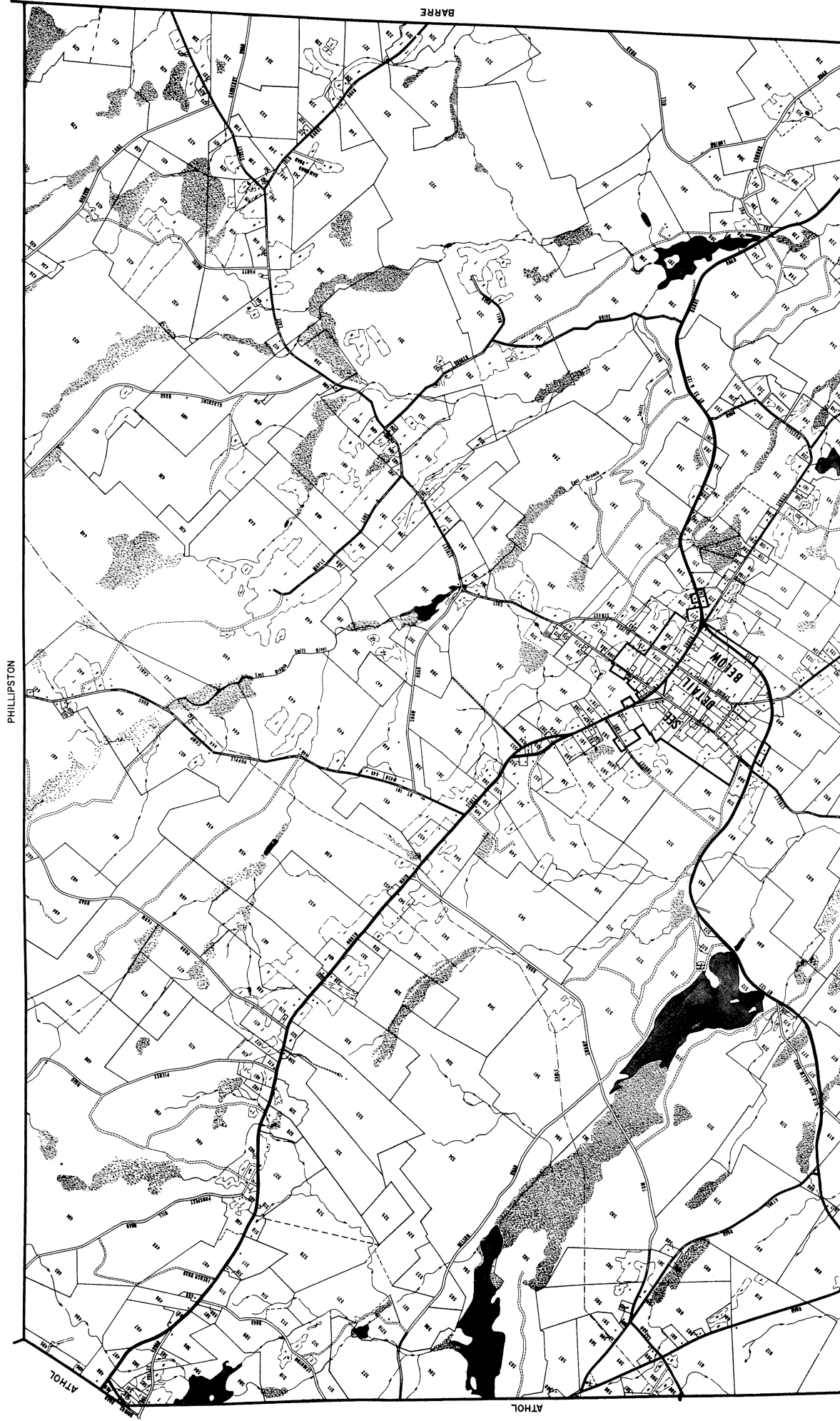
Mr. Lyford finished up the Petersham property map in collaboration with Dr. Gould. Most of his time, however, was devoted to the preparation of papers based on previous work on forest soils, soil-root relations, *Collembola* migration (see previous annual reports), watershed measurements of the previous four years.

Mr. White was active in teaching and gave lectures in Dublin, Ireland, Cornell, Yale, University of Western Ontario, Universidad Nacional Autónoma de México, etc. He received a Milton Fund Grant to study tropical tree architecture and visited Costa Rica for this purpose in May. He continued his research on plant population dynamics and prepared several papers for publication.

Mr. Oliver joined our staff as a postdoctoral fellow in silviculture from Yale in October 1973. He has taken an active part in our teaching activities and is also supervising summer research on species stratification that two undergraduate students are carrying out at the Concord Field Station, financed by an NSF grant. In cooperation with the Green Diamond Forestry Service Company he is obtaining data about the silviculture of red oak. In collaboration with the North Carolina State University's Hardwood Cooperative Research Program he is preparing growth data from southern hardwood stands for computer analysis. Here at the Harvard Forest, he is investigating areas which have been silviculturally manipulated.

Between 1951 and 1955 a student at the Harvard Forest, Earl P. Stephens, meticulously dissected a 0.89 acre stand of old growth forest within the Harvard Forest as part of his Ph.D. dissertation entitled *The historical-developmental method of determining forest trends*. His dissection included the mapping, aging, and measuring of all living and dead trees in the area; and the dissection of the soil to document past natural and man-made influences on the area. Because of the large amount of data collected, only part of it has ever been analyzed. The meticulousness of the study has provided useful data on the dynamics of plant communities — how trees grow and respond to various disturbances. With Dr. Stephen's permission, Mr. Oliver is presently systematizing the data on a computer and analyzing it for ecological and silvicultural implications.

The plant anatomy group was particularly active and numerous this year. It often took a good deal of planning so that everyone had access to equipment. For the first time we had a Bullard Fellow in this area, Dr. Staff, whose work is described above. Dr. Tomlinson spent much of his time working up information gathered earlier on the vascular anatomy of so-called sea grasses (not really true grasses) and related aquatic plants, mangroves and the root systems of tropical plants. He



BARRE

PHILLIPSTON

ATHOL

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BELVIDERE



is very interested in the growth and form of tropical trees. A milestone has been reached in the completion of the manuscript for a book "The Biology of Trees Native to South Florida" which will probably be published by the University of Florida Press. Another project concerns the architecture of tropical trees. For some years, Dr. Tomlinson has been collaborating with Dr. Francis Hallé (Université du Languedoc, Montpellier, France) and Dr. Roelof Oldeman (Office de la Recherche Scientifique et Technique d'Outre-Mer) on a book describing the developmental patterns categorized as "architectural models". Dr. Oldeman visited the Forest in October and at present Dr. Tomlinson is spending the summer in France working on the manuscript with his two collaborators.

One of Dr. Tomlinson's post-doctoral fellows, George J. Wilder, is working at the Fairchild Tropical Garden in Miami, Florida, on shoot morphology and leaf development of the tropical family Cyclanthaceae. This work seems to show that the family is not as closely related to the palms as it has often been considered. Dr. Wilder visited the Harvard Forest in April.

Dr. Bell completed his study of the vascular anatomy and morphology of shell ginger (*Alpinia speciosa*). The vasculature of this plant consists of an inner and an outer system separated by a well-defined tissue, the 'intermediate zone' which is meristematic in the aerial stem, but differentiates into a vascular network in the rhizome. The inner system conforms in general terms to the '*Rhapis* principle', the outer system corresponds to the cortical system of *Rhapis* but in a functionally more elaborate way. I might add at this point that *Rhapis* is a small palm which was the subject of our first investigation of the vascular anatomy of monocotyledons. Its structure is relatively simple and it is convenient to compare and relate to it structures that we find in other plants. — The rhizome of *Alpinia* branches in a highly organized manner. This may well be true of the majority of rhizomatous plants because the pattern is not apparent when only isolated parts are studied. Use was made of the computer and graphics display screen at the University of Massachusetts in Amherst in a pilot study to predict the fate of rhizomatous populations based on the relative success of their branching. At the same time, Dr. Bell studied the annual rhizome growth of one of our local forest herbs, *Medeola virginiana* (Indian cucumber). By putting his information on motion picture film in the form of a diagrammatic map, he could show in a few minutes how *Medeola* spreads throughout the forest floor over a period of several hundred years.

A part of my own research concerns vascular development in arborescent monocotyledons. The work on representatives of the family Araceae (to which Philodendrons belong, as well as some of our local herbs, such as Jack-in-the-pulpit) has been continued. In addition to this, further analyses of patterns of development in palms have been

made. We are just now in the process of solving the difficult problem of following strands in large apices where the apical meristem is 'sunk', i.e. at the bottom of a slight depression. It is rather important to understand the development of large palms, because most of the economically important species like coconut, date and oil palms are large plants.

It is perhaps appropriate at this point to mention that Drs. Tomlinson, Milburn and I were involved in an "emergency" conference in Miami about the Lethal Yellowing disease which has reached epidemic proportions in many parts of the world including south Florida, wiping out coconut and other palms by the thousands. This makes it clear, once more, how important fundamental research can be. Lethal Yellowing seems to be caused by a mycoplasma which destroys the phloem (the sugar transport channels). It is obvious that knowledge of the vascular anatomy, the development of the vascular system in the crown which has to be fed by the mature leaves via phloem, and the mechanism of sugar transport are essential for an understanding of the progress of the disease.

The waterlily family (Nymphaeaceae) is normally considered a dicotyledonous group, but it has many features in common with the monocotyledons. It will be interesting to see whether the vascular pattern of this family resembles the monocotyledons or the dicotyledons. This is the subject of Dr. Weidlich's main line of research. To date he has filmed and analyzed the subgenera *Castalia* and *Hydrocallis* of the genus *Nymphaea*, *Ondinea purpurea*, *Eurale ferox* and both species of *Victoria*, the giant waterlilies of the Amazon region. He also initiated a broad research project with Professor Richard A. White of Duke University on the construction of the vascular system in the stems of certain non-cyatheaceous tree ferns.

Long-distance transport in trees has been a subject of my personal interest for many years. During recent years it was a bit neglected in favor of monocotyledonous vascular development, but has been reactivated by the presence of Dr. Milburn, whose research is described under the heading BULLARD FELLOWS. We are also editing together a book on phloem transport which will probably be the first volume of the 'Encyclopedia of Plant Physiology, New Series', published by Springer. On June 16-20, 1974, the American Society of Plant Physiologists held its annual meeting at Cornell University. To mark the 50th anniversary of the Society's existence, a presidential symposium was organized under the title "Conceptual Developments in Plant Physiology 1924-74". Eight lectures were given during two half days and I was invited to speak on conceptual developments in long-distance transport in plants. This symposium will be published as a special issue in *Plant Physiology*, probably in September 1974.

Dr. Susan Sovonick Dunford, who arrived in September, 1973, is also actively engaged in a translocation program. She spent most of her initial time on a final analysis of her thesis data and the preparation of this work for publication. The subject was the movement of sugars in mature leaves of sugar beet, from the tissues in which the sugars are produced, to the vascular tissue in which they move throughout the plant. Here at the Forest, her subject of investigation is tall ash trees (*Fraxinus americana*) rather than small sugar beet seedlings. At the present time she is interested in two aspects, the dilution effect during exudation from sieve tubes and the movement of water from xylem to phloem. The other is metabolism in the sieve tubes (the sugar translocation channels), an investigation that ties in with some of my earlier work. The question is what kinds of enzymes remove the sugars from the sieve tubes to make them available for storage as starch in stem and roots and for the growth of trees. Her project for the winter months concerns the three-dimensional pattern of the vascular anatomy of the squash (*Cucurbita melopepo*) whose conducting bundles have two strands of phloem, the regular one outside the xylem and an additional one inside the xylem. The significance of this internal phloem and how it ties up with the leaf, as well as its function, are poorly understood.

Right:

Peter Del Tredici examining the root systems of young *Casuarina* plants growing in aeroponics in the greenhouse. Nodule roots growing vertically upward from root nodules caused by an unidentified microorganism show especially well under these growing conditions.



During the past year Dr. Torrey's research has centered on two problems: the differentiation of xylem in cultured explants of pea root cortex and the initiation of root nodules in legumes (pea) and non-legumes (*Casuarina* and *Comptonia*). The pea-root experiments aim to clarify the relationship between hormonally induced changes in nuclear DNA and the related subsequent events of mitosis and differentiation of tracheary elements. Nodulation work centers on developing reproducible nodulation in plants grown in water culture or aeroponics with a view to studying hormonal changes associated with nodule development.

Dr. Richard Zobel continued his research on the genetic control of root form and function, using mutants of tomato and pea produced by ethyl methane sulfonate treatment of seed. In pea as in tomato approximately 30% of all mutants found after mutagenesis had modified root systems. Mutations involved branching patterns, frequency of lateral root formation, frequency of nodulation in the presence of effective *Rhizobium* strains, size of nodules, effectiveness for nitrogen fixation and other characters.

For four months from March to July, 1974, Dr. Colette Nitsch of the Laboratoire de Physiologie Pluricellulaire of the Centre National de la Recherche Scientifique in Gif-Sur-Yvette, France, occupied the position of Visiting Professor of Biology in the Department of Biology and resided in Petersham. Her visit was timed to coincide with the major period of floral development in deciduous forest trees. Her efforts were devoted largely to the application of techniques she developed for the cultivation in sterile culture of microspore cells (pollen cell culture) with the purpose of producing large numbers of haploid embryos *in vitro*. She wished to extend to woody species methods which have successfully produced haploid embryos in *Nicotiana* (tobacco), *Datura* and *Lycopersicon* (tomato). Success in this research effort should open up new avenues to genetic research with forest trees.

While at Harvard Dr. Nitsch gave several research seminars on her research in Cambridge and in Petersham and informal instruction in her techniques to a number of visiting scientists from New England.

From June 10-14, 1974, Dr. Nitsch and Dr. Torrey participated in the International Symposium on Haploids in Higher Plants sponsored by the University of Guelph in Canada. Dr. Torrey served as chairman of the program on culture methods for producing haploids; Dr. Nitsch presented one of the invited papers in that program. Both Dr. Newcomb and Dr. Zobel also attended the Haploid Symposium which brought together nearly 200 scientists, representing geneticists, plant breeders and plant physiologists.

Dr. William Newcomb who joined Dr. Torrey's laboratory in September, is doing research on anther culture and microspore cell culture, especially with woody species. He and Dr. Nitsch worked together in this effort.

Dr. Lorin Roberts, Professor of Botany at the University of Idaho in Moscow, spent half a year's leave of absence in Dr. Torrey's Petersham laboratory writing a book entitled "Cytodifferentiation in Plants: Xylogenesis as a Model System." He presented seminars on his ideas and maintained a continuing discussion on the topic of his interest during his stay.

## FOREST OPERATIONS

About 5,000 board feet of lumber were sawn from storm-damaged trees requiring immediate salvage. An attempt is being made to maintain a small reserve of lumber for our own use for minor repairs to buildings and forest structures. Our regular three-man crew was ably augmented by the part-time assistance of Mr. Charles Upham, our former woods crew foreman. He has been invaluable when the men had to work the sawmill or handle woods work of various types.

Our crew was again substantially involved in maintenance work. Extensive remodeling and repairs to the Benson House, begun in the summer 1972, were continued and completed. Although local carpenters and plumbers did much of the work, our own men repaired floors, panelled walls and painted much of the interior.

Mr. Robert Willhite, a student who received his M.F.S. degree in June 1973 (see last year's report), stayed throughout the summer of 1973 to survey the boundaries of the newly acquired Simms Land. He was assisted in this by Edward Taintor, a forestry student employed during the summer.

A few of our forest tracts are supported by special endowments. One of these is the Black Brook or Mathews Plantations in South Hamilton, Massachusetts. We usually let the endowment income accumulate until we have enough to carry out a reasonable program. Work is now being done in the Mathews Plantations by two forestry students (see STUDENTS) under the supervision of Mr. Oliver. This work involves locating property boundaries with surveyor's transit and tape, taking stand inventories of the exotic coniferous species to determine their growth potential, and evaluating the feasibility of profitable commercial timber operations in the white and red pine stands.

## HARVARD BLACK ROCK FOREST

**Research.** Miss Constance A. Harrington served as a research aide during the summer of 1974. She provided valuable assistance in remeasuring several of our long-term silvicultural study plots, including a re-evaluation of our sugar maple plantation. She made a detailed study of a thinning experiment which originated in 1960 in Compartment IV. Miss Harrington is currently collecting soil depth data in Compartment XXV in an area which was clearcut in 1953. These data will be related to vegetation growth patterns she investigated in August 1973 while employed here. This work is being done to satisfy requirements for her master's degree thesis at the New York State College of Environmental Sciences and Forestry at Syracuse University.

Right:

Connie Harrington showing how well a plant has prospered within a fenced area in the 1971 wildlife clearcut experiment. Similar shrubs planted outside the fence were eliminated by deer browsing. (July 1973)



**Forest Operations.** During the summer of 1973, forestry aides Eric Ashcroft and Edward Riley assisted Donald C. Mitchell in forest maintenance and logging operations. Addition of these two young men to our work force was made possible through a grant provided by the Black Rock Fish and Game Club of Mountainville, New York. The major project undertaken by the summer helpers was logging the Compartment XI wildlife clearcutting.

A sale of mature oak timber was negotiated with the Mallery Lumber Company of Hancock, New York. The timber was located in Compartment VI, XVI, XVIII on the north slope of Hill of Pines. Soon after logging began, the Mallery loggers were thwarted by wet weather on the precipitous terrain so they left uncut an estimated one third of the 150 MBF of timber. The remaining trees were re-marked and sold to the Kelly Mill of Dover Plains, New York. Two additional parcels of mature timber have been marked in the same general area. Bid sheets on these two parcels, amounting to nearly 140 MBF have been mailed out to prospective buyers.

Demand for fireplace wood has taken a dramatic upsurge due to the "energy crisis". Since we did not anticipate such an increase in the popularity of wood, our supply of seasoned wood was exhausted by the end of December 1973. Sixty-three cords were cut and delivered to local customers by D.C. Mitchell. About one half of this supply came from the Compartment XI cutting. The remainder represents wood from dead and dying trees salvaged from alongside the Forest road network.

Don Mitchell and Jack Karnig continued to work on road maintenance. Winter damage to our road system was moderate this year, major rehabilitation was therefore not necessary. The Forest benefited greatly by the timely volunteer assistance provided by members of the Black Rock Fish and Game Club on road repairs. Many culverts have been repaired and several badly eroded sections of our roads have been re-surfaced through this cooperative project.

A new trail has been established between Mine Hill Road and the Sackett trail at the western side of the Forest. This trail, named the Mine Hill Trail, provides public access to hikers and has met with full approval of the NY-NJ Trail Conference. The standard Forest trail map was revised and updated. The new edition, dated August 1973, is now available. Requests for the map together with demand for Bulletins and Papers continues quite brisk. During 1973-74, 188 pieces were mailed. This compares with 153 sent out during the previous year.

Boundary signs have been posted on our most recent land acquisition — the Brook Tract — from the Peck and DeWitt Estate along Route 9W. This acreage contains some fine old-growth mixed hardwood timber. It presents us with an opportunity to practice stand manipulation for multiple use as well as for aesthetics.

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This is a list of publications which have appeared in print between July 1, 1973 and June 30, 1974. Naturally, publication always 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 authors or to the Harvard Forest, Petersham, Massachusetts 01366.

Petersham, Massachusetts  
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