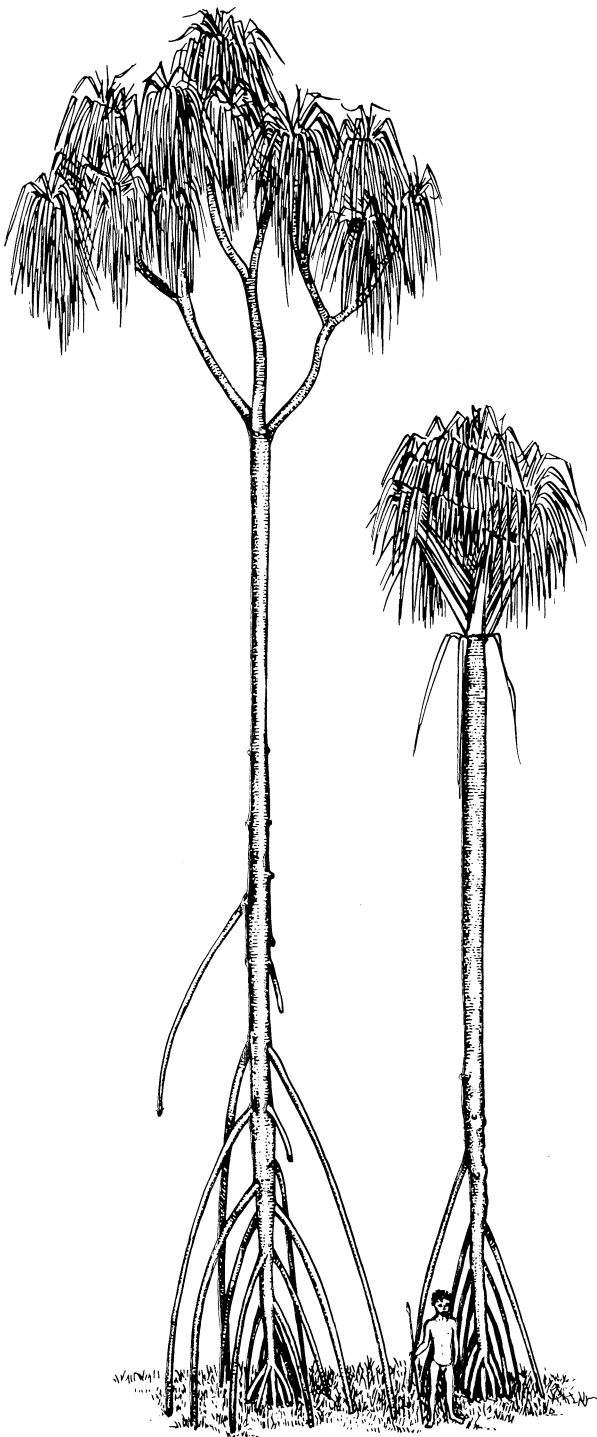




THE HARVARD FOREST, 1972-73

Harvard University



Frontispiece: These trees do not grow at the Harvard Forest, but they have been subject of an intensive study in the Harvard Forest's tropical research program (see page 13). They are monocotyledonous trees like the palms. On the left is Pandanus (cf.) julianettii, native to New Guinea, on the right a cultivar growing in the Fairchild Tropical Garden, P. (cf.) baptisii, probably originating in Madagascar. The drawings have been made by Priscilla Fawcett, Botanical Illustrator of the Fairchild Tropical Garden.

ANNUAL REPORT OF HARVARD UNIVERSITY ACTIVITIES

AT THE HARVARD FOREST 1972-73

STAFF

The staff during the year of 1972-73 consisted of the following persons:

Adrian D. Bell, Research Fellow
Ernest M. Gould, Jr., Forest Economist
Jack J. Karnig, Forest Manager
Jon A. Kusler, Bullard Fellow (from March 1, 1973)
Walter H. Lyford, Soil Scientist
Susan G. Murray, Research Fellow (until August 31, 1972)
James H. Patric, Bullard Fellow
William L. Pritchett, Bullard Fellow (from September 15, 1972)
Hugh M. Raup, Charles Bullard Professor of Forestry, Emeritus
Terry L. Shininger, Research Fellow (until December 31, 1972)
J. Mark A. Swan, Forest Ecologist
P. Barry Tomlinson, Professor of Botany
John G. Torrey, Professor of Botany and Director of the Cabot Foundation
Arthur L. VanSlyke, Bullard Fellow
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

Supporting personnel included:

Catherine M. Danahar, Secretary
Peter J. Del Tredici, Research Assistant
Wayne E. Elliott, Custodian
Vibeke Holm, Assistant to the Librarian
Edward H. Hyde, Woods Crew
Barbara M. Kelley, Business Secretary and Librarian
George T. Kenney, Woods Crew
Monica R. Mattmüller, Laboratory Technician
Donald C. Mitchell, Assistant to the Manager of the Black Rock Forest
Gordon B. Mitchell, Woods Crew (Woods Superintendent from January 1, 1973)
Frances E. O'Brien, Secretary
Linda Reznikiewicz, Laboratory Technician
Jennifer Richards, Laboratory Technician
Charles F. Upham, Woods Superintendent (retired April 14, 1973)



Above: Mr. Charles F. Upham, foreman of our woods crew, who retired after thirty years of service at the Harvard Forest. Still in excellent health, he expects to continue working on a part-time basis.

The past year brought the usual turn-over in post-doctoral fellows. Dr. Murray took up a teaching position at Plymouth State College in Plymouth, New Hampshire, and Dr. Shininger accepted an offer as Assistant Professor at the Department of Biology, University of Utah, Salt Lake City, Utah. New arrivals are Dr. Bell from the school of Plant Biology, University College of North Wales, Bangor, United Kingdom, and Dr. Zobel who came from the Department of Vegetable Crops of the University of California in Davis.

STUDENTS

Numerous courses were given by staff members of the Harvard Forest. At the Forest itself, the summer course "Plants in Relation to their Environment" (Biol. S-146) was given the second time during the summer of 1972 and the third time in the summer of 1973. Dr. Gould and Mr. Lyford gave their course "Soil, Land, and Human Environment" (Biol. 298) again during the fall term. As long as the demand continues to exist, this course will be offered annually. For organizational reasons the enrollment has to be limited to 10 students.

Courses offered in Cambridge during the past year included Mr. White's "Structure and Functioning of Plant Communities" (Biol. 149), Dr. Tomlinson's "Plant Form and Structure" (Biol. 168; offered for the first time during the Spring Term of 1973), and my course "Structure and Physiology of Trees" (Biol. 111). These courses are all relatively small in enrollment, but they do fill very specific needs. They normally include at least one field trip to the Harvard Forest. But field trips to Petersham are not limited to courses given by staff members who live and work here. A number of other biology courses schedule such field trips as well so that a fair number of biology students get an opportunity to see the Harvard Forest.

As in previous years, the Landscape Architects had a week-long pre-registration session (in two parts) at the Harvard Forest.

Mr. Robert Willhite measured public reactions to selected forest scenes and attitudes toward some aspects of forest management. Underlying causes of differences were studied in the hope that a better understanding of the reactions could be used to help solve controversy over some traditional forestry practices. Using color slides, he found which types of logging methods retain attractive scenic qualities. In addition he used questionnaires to show that preconceived "mental pictures" of what a forest "should be" also affected how people reacted to forest scenes. The study also indicated specific areas of public concern which required education. Mr. Willhite wrote a thesis about this and received his Masters degree of Forest Sciences in June 1973. In September he will assume the Department of Forestry Chairmanship at Sierra College in Rocklin, California, and will be an instructor in their Community College Forestry Technician Program.

The following students carried out undergraduate research (Biol. 96r) - John Falk (logging problems in forestry), Andrew Narva (soil deterioration on hiking trails in the White Mountains), Richard Salvato (bogs). Two students took units of Biology 299 - Jim Strassenburg (management of orchards) and Sam Greeley (clear cutting controversy). A

graduate student, Richard Leo worked on soil genesis and classification for two semesters (Biol. 311).

During the summer of 1973 Elizabeth Gross (Radcliffe '76) assisted our research in soil-root relationships and transport in roots. Edward Taintor, a forestry undergraduate (University of Massachusetts '76), helped Robert Willhite with surveying work. Several local students were again hired to help in various phases of research during the past year. Mary Ann Bryant (Emmanuel College, Boston, Massachusetts), Deborah Germond (University of Rhode Island, Kingston, Rhode Island, on a summer work study program), Luanne Pierson, Jerry Savage and Brenda Warrington (Mahar Regional High School).



Mr. Steven Jenkins, a graduate student of the Biology Department continued his investigation of the feeding habits of beavers.

BULLARD FELLOWS

Mr. Jon A. Kusler finished research and writing for an N.S.F. - funded project through the University of Wisconsin concerning the handling of land-use regulations to protect state and national parks from incompatible adjacent development and to enhance public recreation opportunities. The study approaches the subject from the viewpoint of a lawyer-planner. It compares English national parks' planning controls, focusing upon the Lake District National Park, with U.S. experiences focusing upon Cape Cod National Seashore (Massachusetts), Adirondack State Park (New York), and Gettysburg National Military Park (Pennsylvania). When published in August or September, the study will be distributed to park managers, lawyers and legislators. -- In a second project, funded by the University of Wisconsin Sea Grant program, Mr. Kusler is conducting the research dealing with data requirements for regulating lands of statewide concern such as wetlands, flood plains, prime agricultural lands, shorelands, etc. The study will document a variety of programs in New England and elsewhere concerning data needs and methods of data acquisition.

Dr. William L. Pritchett, Professor of Forest Soils at the University of Florida, spent most of his year on two major writing projects. First, he developed a syllabus to be used in teaching a graduate course in forest soils. Second, he summarized results from 15 years of research in forest fertilization in the coastal plains. He wrote a bulletin, to be published by the Florida Experiment Station, based on these results. He also wrote two technical papers from parts of these data, advised with the Canadian Interprovincial Forest Fertilization Technical Committee, presented seminars at the University of New Brunswick and the Norwegian Forest Institute, and visited forest soils research institutions in seven countries in Central and Northern Europe during April and May, 1973.

Mr. James H. Patric of the United States Forest Service Timber and Watershed Laboratory in Parsons, West Virginia, completed an analysis of 23 years of hydrologic data obtained with the San Dimas (California) lysimeters. The manuscript reporting these results has been revised after extensive outside review and will soon be published as a Research Bulletin by the Department of Agriculture. Some smaller undertakings included a review assigned by the United States Forest Service in January, of the extensive literature concerning nutrient cycling in the eastern deciduous forests of North America. Analysis of hydrologic data from the Harvard Forest Library gave evidence of major flow increases in the Connecticut and Merrimack Rivers persisting for three years after widespread forest blowdowns caused by the 1938 hurricane.

These findings are significant to forest hydrology research because flow increases following forest destruction had not previously been detected on rivers of this size. Analysis of other hydrologic records showed a small but consistent decrease in flow of several rivers accompanying the 19th century afforestation of central New England.

Professor Arthur L. VanSlyke, of the Faculty of Forestry, University of New Brunswick, divided his year as a Bullard Fellow between the planning of forest biometry course work and the analysis of tree, crown, and growth data of red and white spruce. The former included revisions of existing mensuration and statistical methods, syllabi, and the preparation of some visual aids and other instructional materials. The latter involved computer processing for many multiple regression analyses. A host of simpler calculations were performed with the programmable calculator of the Cabot Foundation. Results to date seem to verify that short term, individual-tree growth rates are sufficiently related to certain tree and crown measures to provide suitable guidance for the construction of growth models.

VISITORS

The Forest was again visited by numerous scientists from many parts of the world, and the Fisher Museum, now modernized, continues to attract student groups as well as individual visitors.

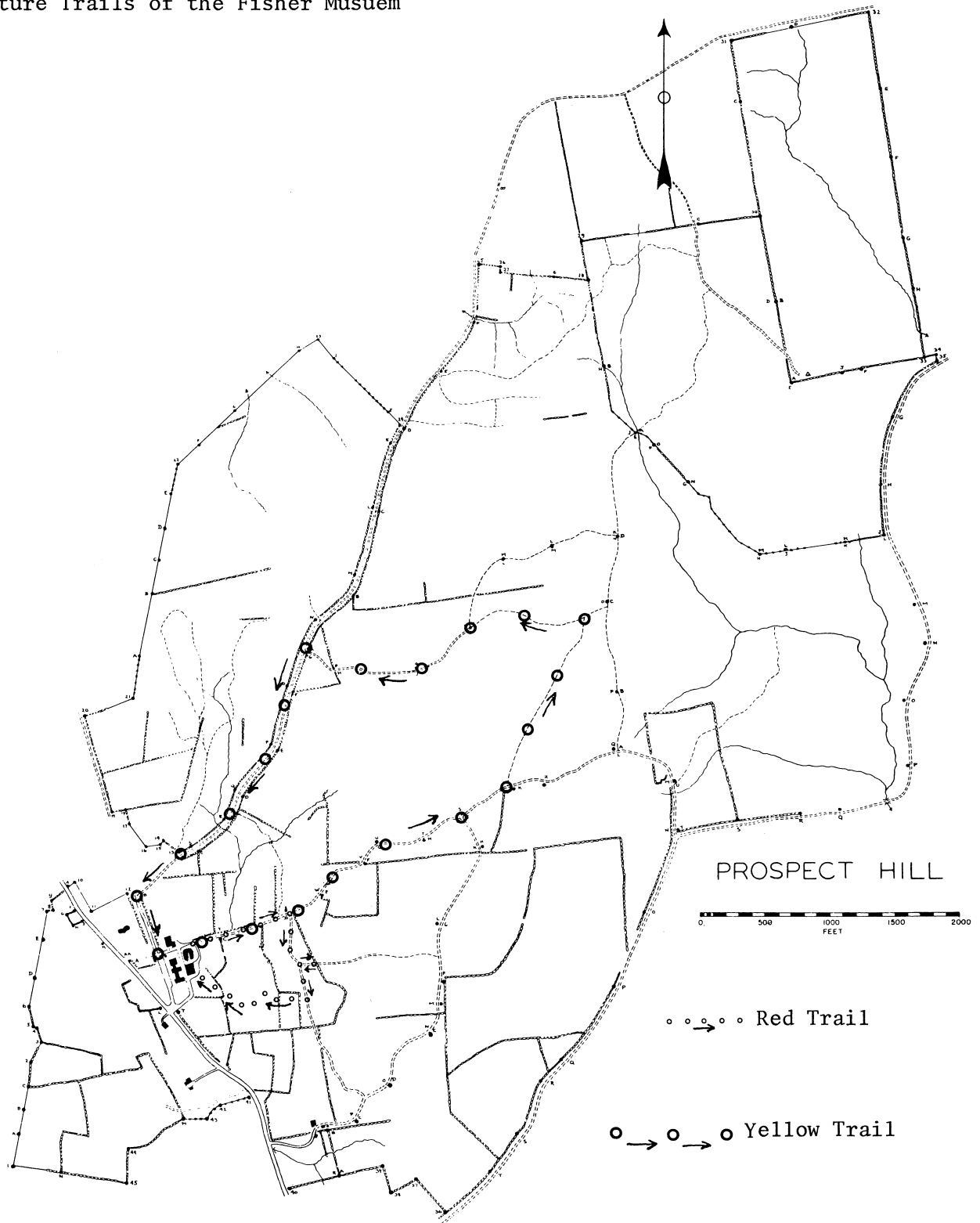
Our new lecture room in the museum is very useful for larger classes, and a number of conservation groups only loosely associated with the Harvard Forest have also met here.

During the fall of 1972 the Northeastern Forest Economists again met here. The informal atmosphere in Petersham helps in the exchange of ideas that enables participants to keep abreast of the research being done by some two dozen people.

On March 4th, 1973, the Massachusetts Forest and Park Association held a meeting in the Fisher Museum. This organization, in the 75th year of its existence, promotes good conservation legislation and opposes that which would eventually lead to the destruction of our natural resources. In other words, it is Massachusetts' watchdog of conservation legislation.

The fourth New England Fern Conference, organized by Drs. Winslow Briggs, Rolla and Alice Tryon of the Department of Biology in Cambridge, was held at the Harvard Forest May 11-13, 1973. Gametophytes, spores, Devonian fossils from Maine and genetic systems were among the

Nature Trails of the Fisher Museum



topics discussed. Half a day was devoted to short contributed papers. The conference was concluded with a field trip in the Forest.

In June Dr. Howard E. Bigelow, Professor of Botany at the University of Massachusetts, brought ninety-six persons from all over the United States and Canada to the Harvard Forest for the 1973 Mycological Society Foray. Although it was a bit early for the fleshy species, many interesting finds were made.

RESEARCH

In September 1972, Dr. Ernest M. Gould, Jr. returned from Germany where he had been guest professor at the University of Freiburg in Breisgau, lecturing to graduate students and staff. Although most of them spoke English very well, Dr. Gould found that colloquial American did not communicate too well at times. His five months on the continent was a very exciting experience. He managed to see something of the forests and land-use practices in ten countries, including three in eastern Europe. Most of the time was spent in Germany, especially in the Black Forest area of Baden-Württemberg. Thanks to the kindness and cooperation of his hosts he was able to learn a good deal about how foresters are managing their lands, especially for the benefit of urban people. With so many forests located close to German cities and towns a great deal of emphasis is placed on the recognized "social functions" of forests. Altogether there are some sixty kinds of areas which occur in a forest that require special management so that people can realize the unique benefit of each area. These social functions are in addition to the regular yield of forest products. German foresters have gone far toward making plans which combine timber management with the production of social values. Perhaps the fact that urbanites find it easy to have a pleasant, intimate contact with a forested environment explains in some small measure how Europeans manage to live comfortably in crowded city environments.

Dr. Gould served on one of the several committees set up by the United States Forest Service to develop a Guide for managing the National Forests of New England. This was a first attempt to get public participation in developing forest policy.

Work on the Petersham Mapping Project continued during the summer with Robert Leupold working under the direction of Mr. Walter Lyford. During the winter Joan Beskenis, a student of the University of Massachusetts, George Kenney and Edward Hyde of our woods crew also helped on the project so that we are rapidly drawing it to a close. The final information collected should provide a rich source of research

material for future land-use research. One immediate benefit will be to speed up progress toward a natural resource plan for the Town, prepared by the Petersham Conservation Commission, on which Dr. Gould continues to serve.

Besides his work on the Petersham Mapping Project, Mr. Walter Lyford continued with root-soil and watershed studies. He is also much involved in showing visiting student groups the soil-root relations in the forest. Major emphasis was placed during the year on writing up a backlog of research, including his studies in Sweden in 1966, soils mapped along cross-country trenches in 1964 and 1968, red oak root growth, Collembola migration (see last year's report) and watershed studies.

Dr. J. Mark Swan spent most of the year working with the Fisher Museum. The recent renovation was an opportunity to review its aims and values. A major aim was to make the 60 years of research at the Harvard Forest available to students and the general public by explaining common features of the forest landscape so that the local environment can be better understood and enjoyed. Dr. Swan has updated the existing diorama museum and worked on a plan for the new upstairs museum area covering such topics as the importance of natural disturbance - specifically hurricanes - in our forests, land-use history from settlement to the present, tree-species identification and habitat information, structural and functional characteristics of trees, their stems and roots, etc. We know of no similar museum in Massachusetts and think that this will be of unique value for students and the community as a whole in these days of increasing environmental interest.

In addition, Dr. Swan is now publishing a paper on the reconstruction of forest history in the Harvard Pisgah Tract in southwestern New Hampshire. The paper discusses the extent to which hurricanes determine the character of forest composition and landscape.

Mr. James White was quite involved with students last year, teaching and supervising special student work. He continued his research on the population ecology of plants and prepared the results for publication.

Dr. Tomlinson's work on the monocotyledons of the tropics (mainly woody ones) continues with the aid of a grant from the National Science Foundation and facilities provided at the Fairchild Tropical Garden in Miami. Several visits were made to the Garden and permitted the continued study of the biology of trees native to South Florida. This project, to be published as a book, is nearing completion. On a more cosmopolitan scale, Dr. Tomlinson collaborates with Dr. Frances Hallé of the Université du Languedoc, Montpellier, France, and Dr. Roelof Oldeman, ORSTOM (the



Above: Students holding a single leaf of the palm Raphia taedigiera, in Costa Rica. They represent a cross section of people at various stages in their professional career attending one of Dr. Tomlinson's courses in tropical botany.

French overseas research organization) Cayenne, French Guiana. This joint work aims at the publication of a book about the growth forms found in tropical trees. Miscellaneous topics in tropical botany are also being investigated.

Dr. Bell, post-doctoral fellow from the University College of North Wales (United Kingdom), is investigating the vascular anatomy of shell-ginger (Alpinia speciosa) using the motion-picture technique of analysis. Alpinia is a member of the Zingiberales, an order of plants including edible ginger, banana and many cultivated ornamentals. The vascular pattern in this plant appears to be basically palm-like but shows a number of distinct differences. The rhizome of Alpinia branches in a very precise manner, growing at one end whilst rotting at the rear. The plant is thus perpetually creeping around in the soil like many other, unrelated plants. A large clump was excavated in Miami in order to study the rhizome system in detail. A number of plants were replanted in Miami and in the greenhouse at Petersham to further study their mode of growth.

My own work on the differentiation of vascular patterns in arborescent monocotyledons continued in collaboration with Dr. Tomlinson. A paper on the family Pandanaceae has been completed and submitted for publication (see the cover picture). It is based upon several years' work and the examination of some 30,000 stem transverse views. We continued investigation of additional palm species and began work on a new family, the Araceae. The study of monocotyledons continues to reveal patterns of vascular development which are quite different, more flexible and variable than that of the dicotyledons. -- A technological improvement is the development of an electronic flash, by Harvard's Electronics Design Center. This instrument gives us sufficiently strong light for convenient surface motion-picture analysis. It differs from commercially available flash units in its fast recycling time ($\frac{1}{2}$ sec.) and in its capacity to fire tens of thousands of flashes without suffering excessive wear. With it, we are now in a position to make use of the maximum depth of field of the camera lens. Theoretical resolution decreases with increasing depth of field. The powerful light requires great care so that the depth of field is not increased beyond the point at which theoretical resolution becomes less than the resolving power of the film.

The major part of Professor Torrey's research activities during the past year, supported in part by a National Science Foundation grant, concerned studies of legume and non-legume symbiotic nitrogen fixing systems. In their study of legumes Dr. Torrey's group continued the analysis of nodule initiation in the garden pea, using a number of strains of Rhizobium of different effectiveness. Cytological analysis showed polyploid mitoses occurring in all strains inducing nodule proliferation. A study of nodulation in Vicia faba similarly indicated that the early mitoses were polyploid. In collaboration with Dr. Richard Zobel, a post-doctoral fellow of the Cabot Foundation a program was initiated using mutagen treatment of pea seed to induce mutations affecting the root nodulation system.

During the period January 1 - June 30, 1973 Professor Torrey took his sabbatical leave in the laboratory of Professor G. Bond of the University of Glasgow in Scotland. There he worked on the initiation and development of root nodules on several different genera of non-leguminous plants capable of symbiotic nitrogen fixation, including Alnus, Casuarina, Hippophae and Myrica. His intention to work also with one of our local species Comptonia peregrina was frustrated by the difficulty of getting good seed germination and producing seedlings, a problem on which he is still working. The most interesting feature of nodule formation in Casuarina which was studied in some detail is that the nodule is in fact a highly condensed lateral root branching system, initiated by an unidentified microorganism, probably an actinomycete. The anatomical and physiological bases for this structure offer a number of interesting problems they hope to pursue.

Dr. R.W. Zobel is primarily concerned with the genetic control of plant root development. Special emphasis is currently being placed on tomato and pea because of their relatively small size and distinct root patterns. Tomato root development appears to approximate that of other perennials including many of the deciduous trees in the surrounding forest. Pea root development on the other hand is typical of root development in many annual plants. Root mutants are induced in both species so that some genetic markers will be available for investigation of the control of root development. Several tomato mutants have been investigated in detail and have provided insight into the biochemical control over lateral root initiation.

Mr. C.R. Landgren, a Ph.D. candidate in the Department of Biology residing in Petersham, continued his thesis research on the properties and potentialities of protoplasts isolated from pea root cortical cells and grown in sterile culture. He has studied the conditions which allow these naked cells, which have had their walls removed by osmotic and enzyme treatment, to reform new walls, undergo mitosis and cell division, resulting in small cell colonies. His studies are preliminary steps toward the use of these protoplasts for experiments with cell fusion and in vitro infection by Rhizobium.

FOREST OPERATIONS

With Mr. Upham's retirement (see p. 4) our woods crew has decreased to three men. The future will show whether a fourth man will be necessary. For the present at least Mr. Upham will still be able to help out on a part-time basis whenever necessary. The percentage of time spent by the woods crew in actual forest operation has been further decreased to slightly over 20%. There are two reasons for this. First, the men's time has been taken up increasingly by maintenance work such as repair of residences, repainting of buildings, etc. Secondly, the decision has been made not to sell any more firewood unless there is a surplus over our own needs available from experimental cuttings.

The present situation is not necessarily a permanent one. We are still "catching up" with building improvement. Once this has been accomplished the routine maintenance work will require somewhat less time. We have done little silvicultural research work during recent years. This situation may change. In August 1973 our staff will be joined by a post-doctoral fellow, Dr. Chadwick D. Oliver, a silviculturist who received his graduate training at Yale. Thus, silvicultural research will be re-activated.

HARVARD BLACK ROCK FOREST

The sugar maple plantation which had been established in 1929 along the east side of Continental Road in Compartment XV, and measured in 1966, was re-measured during May and June of 1973. These trees are all numbered and mapped and their growth will be studied over the years.

A small black walnut plantation has been started in the field alongside and in front of the Forest Headquarters. Seedlings, grown from nuts collected from the three large walnut trees on the property are making favorable growth. These trees have been numbered, measured, pruned and fertilized during the spring of 1973. We expect to measure these trees annually in order to learn what specific cultural treatments tend to produce optimum growth in this high-value timber species.



Left: The Harvard Black Rock Forest. Steven VanSlyke overlooking Sutherland Pond from Split Rock. Right: Michelle Karnig standing beside one of the black walnut trees planted in October 1969. Both photographs were taken in June 1973.

The wildlife habitat improvement program, financed by the Black Rock Fish and Game Club was resumed during July and August of 1972. Hired for the summer were Louis Berchielli of Schenectady and Bruce Vizino of Cornwall. They experimentally clearcut a 0.52 acre patch of oak timber in Compartment XXV and performed timber stand improvement work on 7.12 acres. From this operation and from fuelwood cuttings along Continental Road in Compartment XIII a total of 43 cords was harvested and sold. A new cutting operation was started along the west side of the Hall Road in Compartment XI by Mr. Mitchell.

Once again the Forest suffered by heavy rains during the past year. It took several weeks of concentrated work during the spring of 1973 to rehabilitate the main roads. Trail maintenance work has been carried out by Mr. Mitchell in order to accommodate hikers and to define compartment boundaries. The S-Sk trail in the Mine Hill area was relocated to bypass private property. A new trail was located and constructed along the east side of Arthur's Pond. It connects Bog Meadow Road with the White Oak Trail where the latter crosses Arthur's Pond dam. It is 0.6 miles long and has been named Tower Vue Trail.

The Black Rock Forest was again visited by many groups and individuals.

ACQUISITION OF LAND

Mrs. DeWitt and Mr. Lucking, Trustees under agreement with the late Kenneth Peck, have generously donated a parcel of approximately 49 acres to the Harvard Black Rock Forest. This parcel is located between Route 9W and our northern boundary and represents an important access zone to the main body of the forest. It also contains a small stand of sugar maples, a tree species rather rare in the rest of the Forest.

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This is a list of publications which have appeared in print between July 1, 1972 and June 30, 1973. Naturally, publication always lags one or more years behind the description of the 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
July, 1973

Martin H. Zimmermann
Director