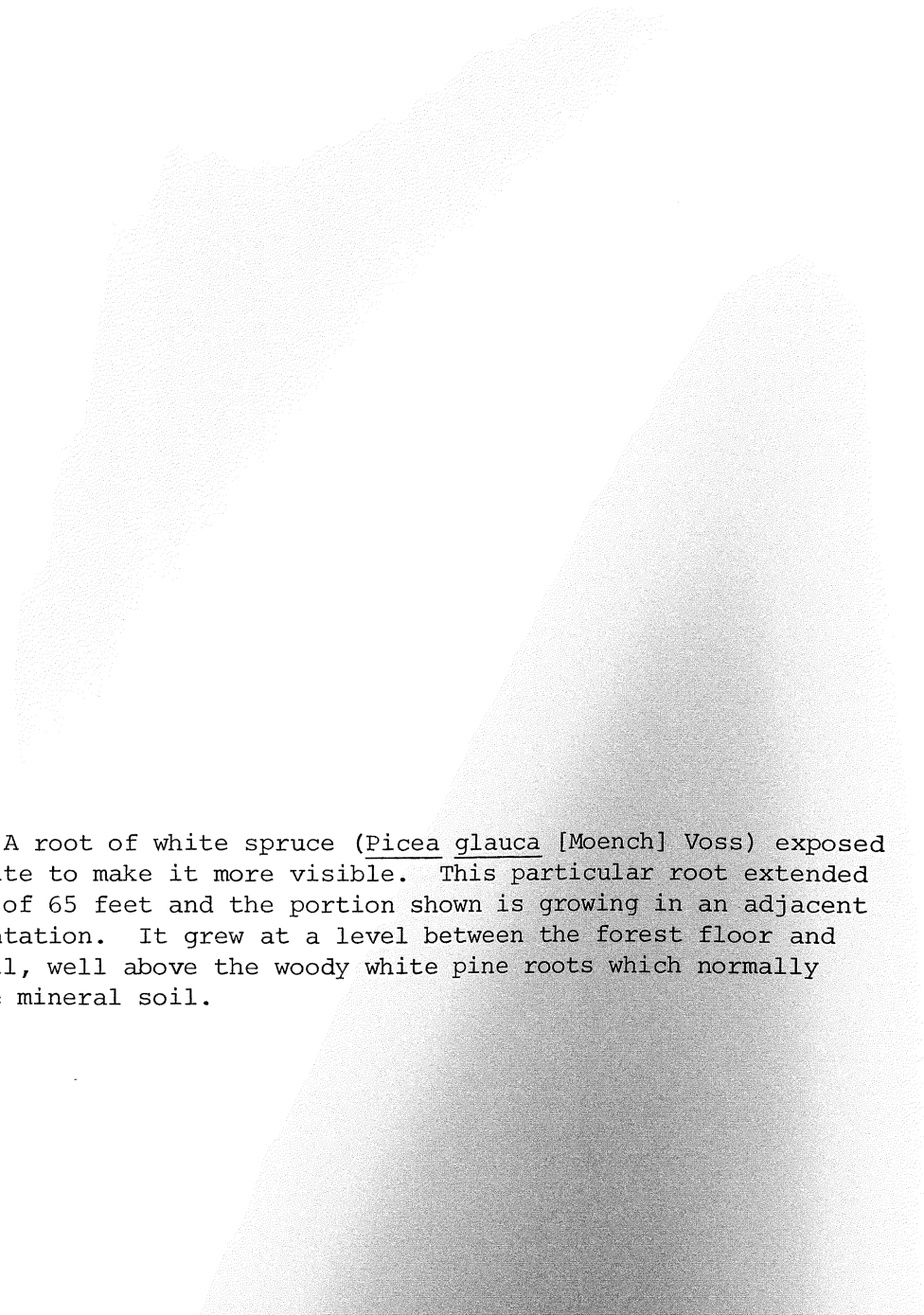
THE HARVARD FOREST, 1971-72

Harvard University



Frontispiece: A root of white spruce (Picea glauca [Moench] Voss) exposed and painted white to make it more visible. This particular root extended for a distance of 65 feet and the portion shown is growing in an adjacent white pine plantation. It grew at a level between the forest floor and the mineral soil, well above the woody white pine roots which normally grow within the mineral soil.

ANNUAL REPORT OF HARVARD UNIVERSITY ACTIVITIES

AT THE HARVARD FOREST 1971-72

STAFF

The staff during the year of 1971-72 consisted of the following persons:

Ernest M. Gould, Jr., Forest Economist
Werner A. Iten, Research Fellow (until October 31, 1971)
Jack J. Karnig, Forest Manager
Walter H. Lyford, Soil Scientist
Susan G. Murray, Research Fellow (from September 1, 1971)
Hugh M. Raup, Charles Bullard Professor of Forestry, Emeritus
Jörg J. Sauter, Research Fellow (until December 31, 1971)
Terry L. Shininger, Research Fellow (from September 1, 1971)
J. Mark A. Swan, Forest Ecologist (on leave of absence September 1, 1971-June 30, 1972)
P. Barry Tomlinson, Professor of Botany
John G. Torrey, Professor of Botany and Director of the Cabot Foundation
Brian H. Walker, Bullard Fellow (until December 31, 1971)
James F. White, Instructor in Biology (from October 18, 1971)
Martin H. Zimmermann, Charles Bullard Professor of Forestry and Director of the Harvard Forest

Supporting personnel included:

Catherine M. Danahar, Secretary
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. Mattmuller, Laboratory Technician
Barbara M. McCurda, Secretary (Deceased March 15, 1972)
Donald C. Mitchell, Assistant to the Manager of the Black Rock Forest
Gordon B. Mitchell, Woods Crew
James B. Nevins, Custodian (January 28, 1972-May 5, 1972)
Frances E. O'Brien, Secretary
Linda Reznikiewicz, Laboratory Technician
Charles F. Upham, Woods Superintendent

Staff changes this year included the appointment of Dr. Tomlinson as Professor of Botany. He took up permanent residence in Petersham, but still maintains an adjunct staff appointment at the Fairchild Tropical Garden. -- The field of ecology has been strengthened by the appointment of Mr. James White who arrived from University College, Dublin, Ireland, in October 1971. -- Dr. Iten returned to Switzerland to a teaching position and Dr. Sauter returned to Germany, taking over a professorial position at the University of Kiel.

Mrs. Barbara M. McCurda passed away suddenly on March 15, 1972 after a short illness. She had worked as my personal secretary for four years and done administrative work for the Cabot Foundation. Her devotion to her work and her loyal and intelligent service won for her the regard and admiration of all her associates.

STUDENTS

The need for a summer course in botany had been discussed for a number of years. Although staff members did and still do offer various courses in the Department of Biology in Cambridge, the timing of the fall and spring semester is such that field work and experimental studies outdoors are almost impossible, because plants are dormant during most of this time. During the summer of 1971, a course of field botany (S-146) was given for the first time at the Harvard Forest. This course, now to be continued annually, gives us the opportunity to put the main emphasis on combined outdoor and laboratory work rather than on formal lectures. Although it is offered within the administrative framework of the Harvard Summer School, the course is listed in the regular catalog and credit is given to Harvard and Radcliffe students. In the summer of 1971, four Harvard undergraduates and one graduate student attended. Two of the students took independent research courses at the same time. Many staff members were involved in the course as well as a number of guest instructors. The course was very successful although it was still experimental. The 1972 enrollment consists of seven undergraduate students (five Radcliffe, one Harvard, one Pomona College).

Another new course, "Plants of the Tropics" (Biology S-105), was also offered as a credit course outside the regular semester. Given by Professor Tomlinson for the first time during the summer of 1972, the students spent the first two weeks (June 16 - July 1) at the Fairchild Tropical Garden in Miami, and an additional two weeks (July 3 - 15) in Cambridge. The enrollment was six. This course did have a predecessor in one entitled "Tropical Botany", given for many years during summers first in Cuba, later in Costa Rica.

Above: During the early summer of 1972, two foxes visited the front lawn of the Community House almost every night. This photograph was taken by Monica Mattmuller from her living room window. Illumination was provided by two electronic flash heads mounted outside the house.

"Land, Soils, and Human Environment" (Biology 298), described in more detail in previous reports, continues to hold interest. The limit of enrollment (because of limited transportation capacity) is ten. In the fall of 1971 there were twenty five applicants.

In addition to these somewhat unusual courses, staff members are involved in regular course offerings in the Department of Biology in Cambridge during the semester. Professor Torrey gave a lecture course entitled "Plant growth and development" (Biology 165), and Mr. White taught "Structure and functioning of plant communities" (Biology 149).

The following students, both seniors, carried out independent undergraduate research at the Harvard Forest during a number of weekends. Henry B. Warren worked on the recognition of important landscape features in unfamiliar territory. This was a study to correct some personal educational deficiencies Mr. Warren noticed while doing field work in Angola. Jerry LeClaire wrote an honors thesis, entitled "Vascular construction and development in the aerial stem of Pandanus".

Mr. Stevo Orlić from the Yugoslav Research Institute for Conifers spent a year partly in Cambridge, partly at the Harvard Forest as a special student to the Faculty of Arts and Sciences. Mr. Orlić had been elected by the Yugoslav Academy of Sciences as recipient of the Zlatko and Joyce Balokovic Scholarship for study at Harvard University during the academic year of 1971-72.

Mr. Steven Jenkins, a graduate student in the Department of Biology, working towards a PhD. under Professor Bossert, is spending the summer of 1972 at the Harvard Forest to study the feeding habits of beavers.

Four students were hired to help in various phases of research during part of the spring semester and during the summer of 1972. They are Misses Deborah Germond and Luanne Pierson, both of the Mahar Regional High School, Miss Carol Nimick of Pomona College, and Mr. G.W. Bailey of the University of Miami.

Miss Laura Anderson, a senior student of Smith College, spent the month of January 1972 in Dr. Torrey's laboratory working on a winter term research project. She contributed to on-going research on cytodifferentiation in pea roots.

BULLARD FELLOWS

Dr. Brian H. Walker's activities centered around techniques of

vegetation sampling and data analysis. He developed an approach to rapid field sampling of floristic and physiognomic data and tested it on 44 stands of vegetation in the Harvard Forest. Several computer programs were either written or modified for analysis of these ecological data and the results are being prepared for publication. A basic program for simulation of a wildlife ecosystem was produced. The manipulation of ecological data prior to analysis has also been studied; a paper on this topic is also being prepared. Dr. Walker returned to his native Rhodesia at the beginning of the year.

VISITORS

Dr. Melvin Cannell of the Institute of Tree Biology, University of Edinburgh, Scotland, visited the Harvard Forest for several days in November to collect poplar cuttings from the plantations established many years ago by Dr. Scott Pauley, and to consult the extensive records of these plantations. His visit was financed in part by the Cabot Foundation.

Numerous scientists from all over the world visited the Forest again, as well as individual students and student groups. The Fisher Museum continues to attract visitors, a large percentage of these are from schools in various parts of New England. The Museum was closed during winter and spring because of construction work, described later in this report.

RESEARCH

Dr. Gould in collaboration with Dr. William G. O'Regan continued his computer research on the planning of the use of forest land as part of man's comfortable and healthy environment. He presented the keynote paper about this subject during a seminar of land planners at the State University of New York. He also helped the New England Natural Resources Center in the planning of a Symposium on New England Land Policy in Woodstock, Vermont in May. The intention was to bring representatives of all forest users (wood-using industries, Audubon and Sierra Clubs, trail hikers, cyclists and snowmobilers) together for a discussion of needs and problems. Dr. Gould also continued work with the Petersham Conservation Commission as its Chairman.

Dr. Gould is spending the period from early April to early September (1972) at the University of Freiburg in Germany as a guest professor. This is an excellent opportunity to study forest and land-use

planning methods used in Europe, especially systems of controlling the development of natural environment. Hopefully, many of the ideas will be useful in America.

Work on the Town Map by Dr. Gould and Mr. Lyford continued with the help of Mr. Daniel Olesak (summer 1971) and Mr. Robert Leupold (summer 1972). In spite of the fact that most properties are defined in terms of "metes and bounds" almost all have been located and placed on an enlarged aerial photo base map. Further work entails transfer to a black-and-white base and determination of acreage. The finished map will provide an extremely useful tool for present and future land use studies.

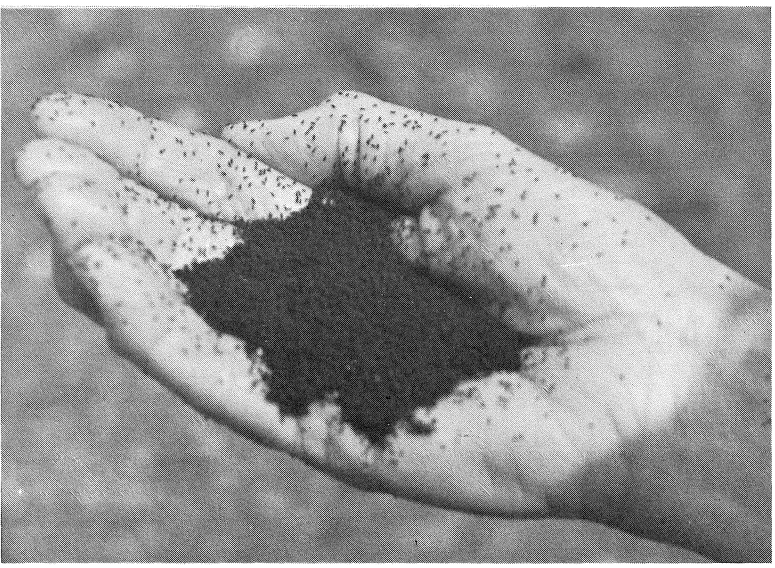
Mr. Lyford's work included determination of soil water content and movement in two small watersheds. Particular attention was given diurnal fluctuations of the water tables as recorded on continuous charts. Soil water content in trays where roots of mature trees were growing showed corresponding fluctuations. As expected, use of water by roots stopped when all leaves turned color in the fall. In late winter and early spring root weights increased during the day and decreased during the night, nicely confirming Dr. Sauter's theory of maple sap flow referred to in last year's annual report. Interestingly enough these fluctuations are also measurable in trees other than sugar maple although pressures in most species never exceed +1 atm. to cause flow.

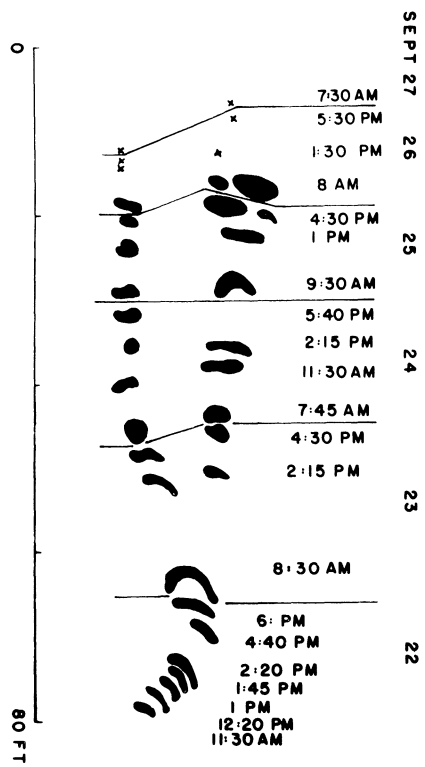
Dr. Sauter's work on the physiology of maple sap flow described in last year's report, was brought to a conclusion in the fall of 1971. Several papers are now being prepared for publication, partly in collaboration with Dr. Iten.

Mr. White spent some time during the winter months compiling material for a paper on thinning and survivorship in plant populations, using the extensive forestry literature in the library here.

Dr. Tomlinson is continuing his extensive research program in tropical botany which had been initiated at the Fairchild Tropical Garden in Miami. Part of his work includes the anatomy and development of woody monocotyledons. Special attention is presently given to studies of commercially important members such as the coconut. To this end a six week visit was made to Miami in April and May. A book on the trees of Florida is also in preparation.

Dr. Susan Murray's research deals with the vascular system of Chamaedorea, a large and diverse genus of palm, in an attempt to determine the variability of anatomical features within this taxonomic group. She also prepared a paper on her thesis work, done at Cornell, on aspects of endocarp formation in palm fruits.





Above and left:

Springtails (Hypogastrura nivicola Fitch) are insects of the Order Collembola. They form colonies 30 to 60 cm (1-2 ft.) in diameter containing half a million to several million individuals on the forest floor at the Harvard Forest. They disappear in the forest floor during the night and reappear at the surface in the morning. They repeatedly jump several centimeters into the air by means of a spring-like appendage of their body. Thus the whole colony moves gradually and its progress can be traced from day to day as shown on Walter Lyford's diagram on the left. Colonies can easily be collected in large numbers. The photograph above on the left, taken by Walter Lyford, indicates their size, there are probably about 200,000 individuals in the hand. The photograph on the right, taken by Monica Mattmuller, shows them highly magnified.

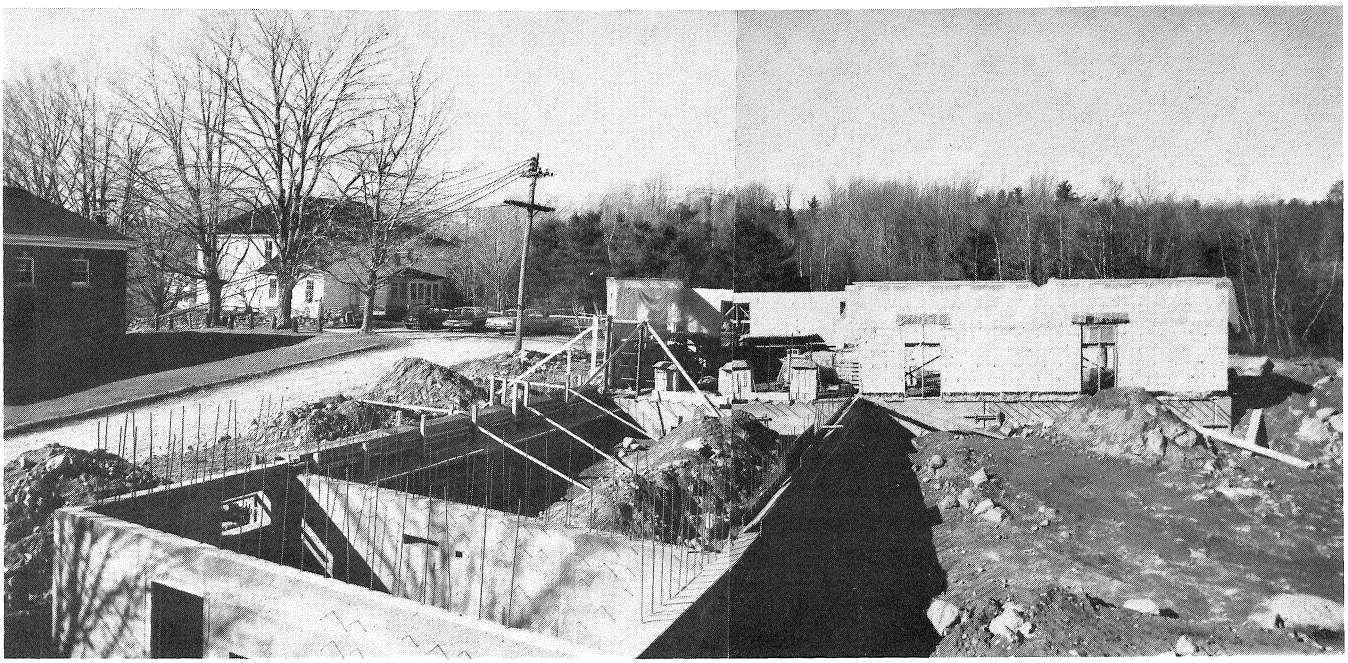
My own work concerned the vascular development of a number of palm species. A large amount of effort was also put into the elucidation of the development of the vascular system of the Pandanaceae (the screw pine family), much of it by a student, Mr. Jerry LeClaire.

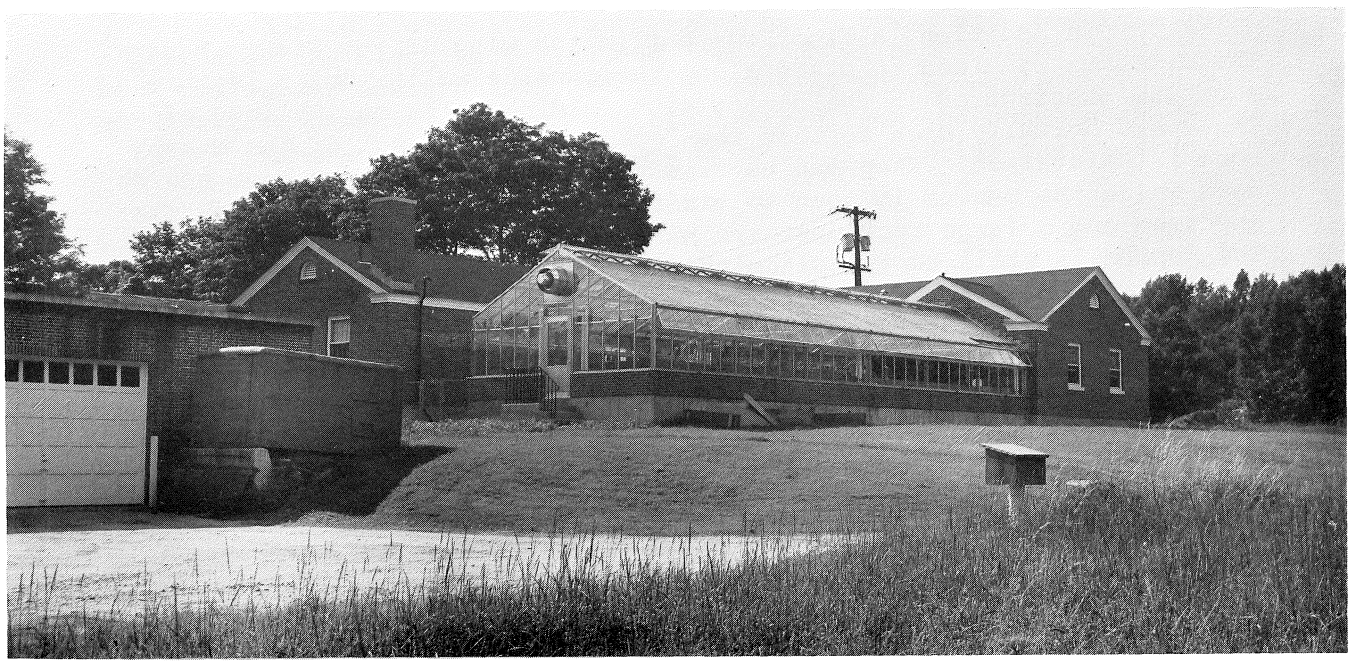
For the first time the technique of motion-picture analysis was used to follow a radioactive track through a stem. ^{14}C-glucose was fed to a small flap of a leaf of the palm Rhapis excelsa. The sugar entered the stem via a single vascular bundle. The radioactive label was followed throughout the complex vascular system of the stem in 10,000 microtome sections, all covered with photographic emulsion. The results confirmed expectations based on previous vascular analysis, namely that downward moving sugar in the stem reaches, via bridges, other leaf traces and thus other vascular bundles. Sugar from any one leaf can thus spread throughout the whole stem and is subsequently deposited in starch and in cell walls of fibers.

At his new laboratory in Shaler Hall, Dr. Torrey and his group pursued three closely related research problems. His own major research activity, supported in part by an NSF grant, concerned the initiation of root nodules in legume and non-legume symbiotic nitrogen fixation systems. Using pea seedlings grown in controlled environments and infected with a series of effective and ineffective bacterial symbionts (Rhizobium), he studied, with the assistance of Linda Reznikiewicz, the earliest cytological events leading to the formation of tumor-like root nodules. He hopes to understand the peculiar nature of the specificity of this kind of infection. In collaboration with a graduate student, Lewis Feldman (who is still located in Cambridge), he began a study of the anatomy and cytology of an important local non-legume brush species Comptonia peregrina whose roots are infected by an unknown microorganism, probably fungal, which causes root tissue proliferation resulting in nodule-like structures capable of fixing atmospheric nitrogen.

Dr. Terry Shininger has been working in collaboration with Dr. Torrey and with Dr. Richard Phillips, a Harkness Fellow from Birmingham, England on the control of tracheary element formation in cultured pea root cortical segments, focussing especially on the relationship between the cell cycle and cytodifferentiation. Dr. Shininger's work is an attempt to characterize the relationships which exist between cell division and the susceptibility of a cell to differentiation-inducing stimuli, in this case kinetin.

The third problem concerned vascular tissue pattern formation in cultured roots of the common bindweed Convolvulus arvensis. Collaborative work with a graduate student, William Wallace (still in Cambridge), demonstrated the possibility of manipulating the vascular pattern in roots from two to six stranded within the same root system. The composition of





Construction of new facilities at the Harvard Forest. Above: The Controlled Environment Facility on November 14, 1971, as seen from the roof of the garage (looking north). The greenhouse is still missing, it will be erected on the right. Below: View of the finished building, looking northwest.

the culture medium and the length and age of the root segment all influence pattern formation. Deborah Germond assisted in the anatomical aspects of this work in Petersham.

Some of Dr. Torrey's students and post-doctoral fellows still work in Cambridge. The Cambridge contingent came out to Petersham for a weekend in January to discuss root research and look at the new facilities in Petersham. It is expected that some of them will move to Petersham next year.

RESEARCH FACILITIES

The past year was one of considerable construction activity, made possible with Cabot Funds. A new building was erected east of the Fisher Museum, tentatively called the Controlled Environment Facility. It contains a greenhouse with a service room for potting plants etc., two laboratories and a large room for plant growth chambers. Three of these are installed and space is available for additional units as they are needed.

In addition, a floor was put in the wing of the Fisher Museum. The dioramas remained in place along the outside walls, but a lecture room was constructed in the center with folding walls on its long sides. These are normally open so that the "open-space feeling" of the museum room is maintained. They can be closed so that the lecture room can be used while the museum is open to visitors. The former gallery has disappeared and a large room upstairs has been designated museum space. This space is still empty; planning and constructing exhibitions there will be a fascinating and challenging task. We do not yet have any detailed plans, but a least part of the room will be devoted to the demonstration of wood structure.

Besides the museum room, the new upstairs area contains two offices and a room for herbarium, wood collections, etc., with ample working space for staff and students who are concerned with these collections. Five two-bed rooms replace the bedroom space lost by last year's laboratory construction in the south wing of Shaler Hall.

Finally, the Harvard Forest acquired not only an entirely new sewage system, but also an automatic emergency generator, driven by a Diesel engine, which operates the water pump, the heating system and the emergency (exit) lights of Shaler Hall and the Fisher Museum, in case of power failure.

ACQUISITION OF LAND

Miss Olive Simes, a long-time summer resident of Petersham willed to the Harvard Forest certain parcels of forest land. The generous bequest includes a total of about 740 acres and contains four parts. One of these (consisting of the Pierce and Goddard-Sawyer Lots) is contiguous with the Prospect Hill Tract, located south of the Pierce Road between the Pierce Farm cellar hole and the Phillipston Town line. The Walker Lot is next to the area of the Petersham Country Club and the Holman Lot west of Mann Hill. The largest area, ca. 308 acres, consists of the Ayers and Towne Lots and is located next to the Quabbin reservation north of Dugway Road. The total area is covered about equally with hardwood, mixedwood and softwood, in addition to a small amount of marshland. So far, surveys have been made only on aerial photographs, field surveys will be made in due time.

SILVICULTURAL WORK AT THE BLACK ROCK FOREST

A wildlife habitat improvement project was made possible by a gift from the Black Rock Fish and Game Club which provided funds to hire two summer assistants. Wood duck nesting boxes were constructed and erected, bass were netted and transferred from one pond to another, a timber stand improvement begun and a wildlife clearing was created.

Right:

Arbor Day, May 23, 1972. Seventh-grade students from Cornwall High School planting Norway Spruce in the municipal park near the Town Hall under the supervision of Mr. Martin Flayter, Town Horticulturist. The 16 trees were donated by the Harvard Black Rock Forest.

On August 28, 1971, the aftermath of hurricane Doria deluged the Forest with over 10 inches of rain during 24 hours. The exact amount could not be determined because the overnight rainfall exceeded the 7.5 inch capacity of the rain gauge. Many of the roads were washed out so severely that even Jeep travel became hazardous and the entire Forest had to be closed to vehicular traffic for about two months while emergency repairs were under way.

A relatively open winter allowed us to initiate some long-delayed cultural work in our red pine and white spruce plantations. Additional time was also spent with the updating of permanent sample plots. About 38 cords of fire wood was cut and sold from dead and dying trees along the roads.

An evaluation of the long-term effect of nitrogen fertilizer upon wood quality has been published by Dr. H.L. Mitchell, retired chief of the Wood Quality Division of the Forest Products Laboratory in Madison, Wisconsin (see the bibliography). The fertilizer experiments had been made nearly 40 years ago and are described in Black Rock Forest Bulletin No. 11. Another paper, by Mr. Karnig, concerning specifically the influence of nitrogen fertilizer on diameter growth of northern red oak, will appear in the Journal of Forestry.

BIBLIOGRAPHY

The following articles have appeared in print during the fiscal year of 1971-72:

Bala Bawa, S. and J.G. Torrey. 1971. "Budding" and nuclear division in cultured protoplasts of corn, Convolvulus and onion. Bot. Gaz. 132: 240-245.

Fisher, J.B. and P.B. Tomlinson. 1972. Morphological studies in Cordyline (Agavaceae). II. Vegetative morphology of Cordyline terminalis. J. Arnold Arbor. 53: 113-127.

Gill, A.M. and P.B. Tomlinson. 1971. Studies on the growth of red mangrove (Rhizophora mangle L.) 2. Growth and differentiation of aerial roots. Biotropica 3: 63-77.

Gill, A.M. and P.B. Tomlinson. 1971. Studies on the growth of red mangrove (Rhizophora mangle L.) 3. Phenology of the shoot. Biotropica 3: 109-124.

Harper, J.L. and J. White. 1972. The dynamics of plant populations. Pp. 41-63, in: Dynamics of Populations., P.J. den Boer and G.R. Gradwell, eds. Proc. Adv. Study Inst. Dynamics Numbers Popul. (Oosterbeek, 1970) Centre for Agric. Publishing and Documentation, Wageningen, Netherlands.

Jeglum, J.K., C.F. Wehrhann and J.M.A. Swan. 1971. Comparisons of environmental ordinations with principal component vegetational ordinations for sets of data having different degrees of complexity. Can. J. Forest Research 1: 99-112.

Kjøller, A. and S. Ødum. 1971. Evidence for longevity of seeds and micro-organisms in permafrost. ARCTIC (J. of the Arctic Inst. of North America) 24: 230-233.

Mitchell, H.L. 1971. Effect of nitrogen fertilizer on the growth rate and certain wood quality characteristics of sawlog size red oak, yellow poplar and white ash. Proceedings of Symposium on the Effect of Growth Acceleration on the Properties of Wood, Forest Products Lab., Madison, Wisconsin.

Morey, P.R. and E.D. Morey. 1971. Anatomy of lignitized wood from Senftenberg. Amer. J. Botany 58: 621-626.

Morey, P.R. and E.D. Morey. 1971. The cell wall residue of fossil wood from Senftenberg. Amer. J. Botany 58: 627-633.

Phillips, D.A. and J.G. Torrey. 1971. Studies on cytokinin production by Rhizobium. Plant Physiol. 49: 11-15.

Phillips, H.L., Jr. and J.G. Torrey. 1971. Deoxyribonucleic acid synthesis in root cap cells of cultured roots of Convolvulus. Plant Physiol. 48: 213-218.

Phillips, H.L., Jr. and J.G. Torrey. 1971. The quiescent center in cultured roots of Convolvulus arvensis L. Amer. J. Botany 58: 665-671.

Phillips, H.L., Jr. and J.G. Torrey. 1972. Duration of cell cycles in cultured roots of Convolvulus. Amer. J. Botany 59: 183-188.

Raup, H.M. 1971. Miscellaneous contributions on the vegetation of the Mesters Vig district, Northeast Greenland: Meddel. om Grønland, v. 194, No. 2, 105 p., 61 figs., 7 tab.

Raup, H.M. 1971. The vegetation of the Mesters Vig district, Northeast Greenland, general summary and discussion: Meddel. om Grønland, v. 194, No. 3, 48p., 12 figs., 3 tab.

Short, K.C. and J.G. Torrey. 1971. Cytokinins in seedling roots of pea. Plant Physiol. 49: 155-160.

Tomlinson, P.B. 1971. The shoot apex and its dichotomous branching in the Nypa palm. Ann. Bot. 35: 865-879.

Tomlinson, P.B. 1972. On the morphology and anatomy of turtle grass, Thalassia testudinum (Hydrocharitaceae). IV. Leaf anatomy and development. Bulletin of Marine Science 22: 75-93.

Tomlinson, P.B. and G.W. Bailey. 1972. Branching in Thalassia testudinum (Hydrocharitaceae) - a correction. Bot. Gaz. 133: 43-50.

Tomlinson, P.B. and F.C. Craighead, Sr. 1972. Growth ring studies on the native trees of sub-tropical Florida. Pp. 39-51 in: Research Trends in Plant Anatomy. A.K.M. Ghouse and Mohammed Yunus eds. (K.A. Chowdhury commemoration volume). Tata McGraw-Hill, New Delhi.

Tomlinson, P.B. and J.B. Fisher. 1971. Morphological studies in Cordyline (Agavaceae). I. Introduction and general morphology. J. Arnold Arboretum 52: 459-478.

Torrey, J.G. 1972. On the initiation of organization in the root apex. Pp. 1-13 in: The Dynamics of Meristem Cell Populations. M.W. Miller & C.C. Kuehnert, eds. Plenum Press, N. Y.

Torrey, J.G., D.E. Fosket and P.K. Hepler. 1971. Xylem formation: a paradigm of cytodifferentiation in higher plants. Am. Scientist 59: 338-352.

Zimmermann, M.H. 1971. Dicotyledonous wood structure - made apparent by sequential sections. 16 mm film published by the Institut für den wissenschaftlichen Film, Göttingen, Germany. Encyclopedia Cinematographica E-1735. With accompanying text (9 pages).

Zimmermann, M.H. 1971. Trees at work. Bull. of the Fairchild Tropical Garden 26 (3): 7-11. (David Fairchild Lecture in Botany, given Feb. 19, 1971).

Zimmermann, M.H. 1972. TREE. World Book Encyclopedia Vol. 19, 334-348g. Field Enterprises Educational Corp., Chicago, Ill.

Zimmermann, M.H. and C.L. Brown (with a chapter by M.T. Tyree). 1971. Trees: Structure and Function. 336 p., 135 ill. Springer-Verlag, New York-Heidelberg-Berlin.

This is a list of publications which have appeared in print between July 1, 1971 and June 30, 1972. 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
August, 1972

Martin H. Zimmermann
Director