The ARNOLD ARBORETUM of HARVARD UNIVERSITY

Annual Report 1939-1940

TO THE PRESIDENT OF THE UNIVERSITY:

SIR,

The extensive hurricane damage to the Arboretum plantings mentioned in my last annual report has been taken care of as far as this is physically possible. All fallen trees have been removed, the necessary pruning of broken branches accomplished, and much blockout planting of conifers in badly devastated areas has been done. Approximately 350 young trees three to four feet high were acquired and planted, while 200 additional ones are being carried in our nursery for placement in the next planting season. The net results are such that the casual visitor unfamiliar with our extensive plantings scarcely realizes that so much destruction was wrought by the disastrous hurricane of September 21, 1938.
A considerable amount of extra planting will be accomplished during the autumn of 1940 and the spring of 1941.

As in previous years the Arboretum has been the fortunate recipient of generous extra-budgetary support which enables the staff to accomplish much needed work that cannot be taken care of properly on the basis of the regular institutional income. Unrestricted gifts to the Cultural Purposes Fund amounted to $7,757 from 382 individuals, an increase of $657 over similar receipts in the preceding year. Belated returns from the Hurricane Rehabilitation appeal of October, 1938, increased that restricted fund by $60. The Massachusetts Society for Promoting Agriculture generously renewed its grant of $500 to finance botanical-horticultural explorations in China, and this special fund was increased by a gift of $450 from Mr. Harrison W. Smith of Tahiti. Special contributions amounting to $3,525 were made to support the George B. Emerson Fellowships 1, 11, and 111, $1,000 of this being from an anonymous donor. These Fellowships were so named in honor of the individual who originated the Arboretum idea. For special travelling expenses $790 was received, $590 of this amount being an anonymous gift, and $200 from Mrs. Edwin F. Atkins for special work at the Atkins Institution. A member of our Visiting Committee generously continued his annual gift of $500 for the care of conifers. A special grant of $1,500 has been received from the Milton Fund of Harvard University to be used under my direction for completing work on our extensive collections of plant material from southern China. At the Atkins Institution, $600 was received as grants-in-aid for visiting students. During the year the permanent endowment funds were increased by the receipt of $25,380.66 from the estate of the late Miss Grace L. Edwards of Boston, and

$1,205.18 was added from income to two special endowment funds in accordance with the original terms of gift.

At the end of December, 1939, Miss Ethelyn M. Tucker, Librarian, was retired after forty years of service at the Arboretum, first as an assistant, later in charge of the library. During this period the scope and value of the library was enormously increased. At the end of August, 1940, Professor Alfred Rehder will retire, having passed the age of 75 years, this being the ultimate age at which employment may be continued. At the same time Dr. J. H. Faull retires as Professor of Forest Pathology, having reached the age of 70 years. The services of these accomplished and productive individuals will be a distinct loss to the institution, although both Professor Rehder and Professor Faull plan to continue work in the special fields in which they are interested. Mrs. Janet Sellars has been promoted to the position of librarian, and Mr. V. Asmous was appointed assistant librarian. To succeed Professor Rehder as Curator of the Herbarium, Dr. A. C. Smith of the New York Botanical Garden has accepted appointment as of October 1, 1940. No appointment can yet be made in forest pathology because of the necessity of taking care of the genetics situation, which was lift in a very greatly reduced condition by the death of Dr. E. M. Eastin 1938.

The regular procedure has been followed as in past years with the objective of maintaining all buildings in good condition and in not only maintaining but also increasing the attractiveness of the grounds and plantings. A major operation, the widening of Bussey Street, is being accomplished by the City of Boston, involving the construction of a new masonry boundary wall along the south side adjoining the Peters Hill section. This, when completed, will be a great improvement. Various repairs to the road surfaces, benches, walls and entrance gates have been accomplished by the Park Department. During the year all survey work appertaining to the detailed mapping of the Arboretum plantings was completed. Final drawings were made of 30 panels, and these were checked for accuracy, making a total of 82 panels completed. The remaining 16 will be finished during the coming winter.

The *Forsythia* planting at the end of the lilac collection, cut to the ground two years ago is now in excellent condition, and henceforth should make a most attractive annual display. Another bank of *Forsythia intermedia spectabilis* has been planted on the slope back of the Administration Building facing the Arborway. As many unneeded duplicate *Weigelia* plants were removed from this rather neglected collection last fall, it became necessary to cut most of the remaining plants to the ground to stimulate new growth. During the winter all of the remaining old and decrepit willows were removed along the Arborway wall, red maples and sourgum being planted in their place. The rose collection was carefully checked, many duplicates discarded, and through the courtesy of Messrs. Bobbink and Atkins, forty species and varieties were added, the collection now containing about one hundred species and varieties, this being a botanical collection rather than a horticultural one. The largest single accession was a shipment of 115 plants acquired from Hillier's Nursery in England and delivered some months after the war commenced; a number of species in this lot are new to American collections.

From the Arboretum plantings 552 packets of seeds, and from the cooperative Fan Memorial Institution, Yunnan collections, 824 packets - a total of 1,376 packets - were distributed to institutions and individuals in the United States and nine foreign countries. At the same time 4,115 living plants and 946 lots of cuttings and scions went to various institutions and individuals in the United States and four foreign countries. Among the plants distributed were 3,000 hybrid ornamental crabapple seedlings to 337 institutions and individuals. In eliminating unwanted duplicate material from the general plantings, several truck loads of plants were presented to Boston University, Tufts College, the University of New Hampshire, and the Boston Park Department. Many other public institutions received living plants in the ordinary course of plant distribution.

Accessions by the Arboretum include 2,114 living plants, 140 packets of seeds (including only those actually planted in the propagating houses), 721 packets of Yunnan seeds from our cooperative field work with the Fan Memorial Institute of Biology, these mostly redistributed because the species represented are not adapted to New England climatic conditions, and 19 lots of cuttings and scions. In connection with the horticultural activities of the institution, many popular lectures have been given, the rapidly increasing correspondence regarding plants and plant problems has been taken care of, and the Bulletin distribution has been increased, the mailing list now exceeding 2,000 names. An interesting development has been the rapidly increasing use that is being made of our source list of desirable horticultural plants.

The work in experimental cytology under Dr. Sax has included an extensive analysis of differential sensitivity of cells to X-rays. X-ray sensitivity during the nuclear cycle in the Tradescantia microspore, as measured by chromosome aberrations, is at a minimum early in the resting stage and the period of greatest sensitivity is slightly before mid-prophase. Of the various cells the sporocyte is most sensitive with decreasing sensitivity found in microspores, root-tip cells and generative nuclei in Tradescantia. Tradescantia microspores are twice as sensitive to X-rays as are those of Allium. Differential sensitivity appears to be determined by factors involving the capacity for chromosome movement. The production of chromosome aberrations is only one of several effects of X-radiation which may cause the death of the cell.

The behavior of aberrant chromosomes in successive cell generations has been studied in onion root tips. Apparently, the cells with aberrant chromosomes cannot compete effectively with normal cells and in later cell generations few aberrations are found. This conclusion is also supported by the behavior of X-rayed seedlings of numerous ornamental trees and shrubs. Doses of X-ray (=- 40,000r), sufficient to inhibit growth for several weeks or longer, produced no apparent effect on the plants at a later period in their development. Abnormal plants resulting from gross chromosome aberrations can best be produced by X-raying pollen to produce zygotes with unbalanced genoms, which are not subject to competition with normal cells. This method has been used successfully with Petunia by Dr. Rick.

The radiation work has been extended considerably by Mr. Swanson and Dr. Giles. Mr. Swanson has found that ultra-violet radiation produces breaks in only one of the two sister

chromatids at prophase. X-rays may break one or both chromatids at a given locus, but a single "hit" resulting from neutron radiation can break one or both sister chromatids or chromatids of different chromosomes. This greater effectiveness of neutrons is attributed to greater ionization density in the proton path than in the electron path produced by X-rays.

The breeding work has been carried on extensively. Several thousand natural hybrid crabapple seedlings were grown in 1939. Several hundred were saved for testing and the others were distributed to persons interested in such work. In the spring of 1940 several thousand crabapple and an equal number of cherry seedlings were set out in the nursery to be selected or distributed next spring. Seeds from hybrids in the Arboretum have also been grown to get re-combinations of favorable characters. The controlled pollinations in species hybridization has been continued with apples, cherries, lilacs, azaleas, and magnolias. This work has been facilitated by the assistance of the graduate students, their wives, and of a volunteer worker, Mr. John Minns.

Extensive investigations of a wide range of representative dicotyledons have demonstrated that there are clearly defined trends of structural specialization in the cambium and xylem of the higher plants. Certain of these trends of evolutionary modification are irreversible and are significant not only in the identification of living and fossil woods but also in the investigation of the phylogeny and relationships of the various families and orders of the dicotyledons. Their significance in the study of lesser taxonomic units, viz., species, genera, tribes and sub-families, can be determined only by intensive investigations of specific families. During the last two years, we have initiated such an investigation of the pan-tropical family Icacinaceae, and have assembled material for detailed comparative studies of the stem, node, leaf, floral organs and pollen. It has been essential in this connection to devote considerable attention to the task of developing improved techniques for the microscopic analysis of herbarium material.

During the year, 3,374 microscopic slides have been added to the collection of wood sections, the total now being 23,593. An attempt has been made to secure a representation of various small families in this basic collection, eighteen families having been added. This material was received from various herbaria, and through the cooperation of Dean S. J. Record and Professor R. W. Hess of the Yale School of Forestry. Special attention has been given to sectioning representatives of the *Anacardiaceae, Meliaceae, Burseraceae, Rutaceae, Sapindaceae, Euphorbiaceae, Icacinaceae, Styraceae, Santalaceae, Polygalaceae* and *Alangiaceae*.

There has been an undiminished number of inquiries seeking advice on tree and shrub diseases. During the course of a year these naturally cover a wide range of subjects. But proper attention to them is important, for it fulfills one of the functions of the Arboretum and in addition sometimes helps to indicate needed research.

Dr. Seeler has completed an investigation of two hitherto unknown diseases of *Gleditsia*. Both prove to be caused by a fungus native to America, *Thyronectria austroamericana* (Speg.) Seeler. This subject was undertaken primarily to determine the cause of a wilt that suddenly destroyed some *Gleditsia japonica* trees in the Arboretum that had been doing well from the time the species had been introduced in 1904.

Mr. Prince, who had studied the species of *Gymnosporangium* occurring in Maine, elected to investigate *G. nidus-avis*, a broom forming rust on *Juniperus* and a parasite on certain of the Pomaceae. The wealth of experimental plants made available at the Arboretum has enabled him to complete important biological studies on that subject. As a result of the work we now have a much extended knowledge of the hosts subject to attack from species of *Gymnosporangium* and of their relative susceptibilities. Mr. Gilgut is continuing his investigation of a serious basal trunk canker of the flowering dogwood and has confirmed Creager's findings that it is caused by a species of *Phytophthora*. Our first attention to it was in connection with our work in a field laboratory on the estate of Mrs. Harold I. Pratt on Long Island. We now know that it occurs in other localities one of which is in western Massachusetts. In addition to etiological studies, efforts are being made to devise satisfactory control measures.

Dr. Faull's own work is still largely concerned with biological and taxonomic studies of certain rust genera. *Hyalopsora* rusts are the immediate subjects under investigation. Pertinent to this research, various parts of Mexico were visited last November and December ranging from the State of Chihuahua in the north to Chiapas in the south. Of special interest was the discovery in Chiapas of forests in which there is an intermixture of firs and tropical ferns. As ferns and firs are the alternate hosts of various rust fungi, and as these rusts may be perpetuated in mild climates on the fern hosts alone, an explanation is suggested for the unexpectedly rich development of these rusts on tropical ferns far beyond the range of *Abies*.

The number of mounted specimens actually inserted into the herbarium was rather small, only 9,525 sheets, but supplementing this number about 40,000 additional specimens were mounted. These are only in part identified and hence not yet ready for distribution into the herbarium. The total number of specimens now filed in the herbarium amounts to 494,467 sheets.

The number of specimens (including duplicates) received during the year amounts to 67,212 of which 42,497 are from America,13,701 from China, 4,825 from Eastern Asia exclusive of China,4,936 from Malaysia, Papuasia and Polynesia, and 1,253 from Europe, Central Asia and Africa. Among the more important Asiatic collections received is one of 7,911 specimens from Yunnan by T. T. Yui, two sendings of about 4,400 specimens (including duplicates) from Southeastern China by W. T. Tsang, one of 997 specimens from Indo-China by Dr. A. Petelot, and one of about 3,000 specimens (including duplicates) by W. T. Tsang also from Indo-China. Important American collections received were about 5,000 specimens from British Guiana made by A. C. Smith on the Terry-Holden Expedition, 2,875 specimens of Bolivian plants of the

Steinbach Herbarium, 3,452 specimens from Argentina and Chile, received by Dr. Johnston for identification and 1,540 specimens collected in Mexico by him, 3,331 specimens collected by Woodson, mostly from Panama, 1,312 specimens from Mexico and Central America received from the University of Michigan, 1,171 specimens collected by J. W. Thompson in British Columbia, and14,300 specimens collected by H. M. Raup in the Mackenzie Mountains in northwestern Canada.

In continuation of exchange 2,996 duplicate specimens were distributed, mostly to American institutions, and 1,298 duplicates were sent to various specialists for identification. To the Gray Herbarium were transferred 14,440 specimens and 1,743 illustrations and their accompanying descriptions, while 569 specimens and 240 illustrations and descriptions of orchids were sent to the Ames Orchid Herbarium at the Botanical Museum, and 162 specimens of cellular cryptogams to the Farlow Herbarium.

Twenty-six loans approximating 2,300 specimens were sent to 13 institutions, mostly American. For study by members of the staff, 36 loans involving over 2,100 specimens were received from institutions in the United States, Venezuela, England and China.

The collection of negatives representing types and critical specimens now amounts to 4,026 negatives, 75 of this number having been added during the fiscal year. The current card catalogue of references to new species and other important literature and illustrations of woody plants was increased by 4,642 items, the total now amounting to 125,819 cards.

Routine herbarium work has involved a further breaking down of the material in large genera into geographic sequences, at least a maintenance of the normal amount of mounting - although we are now far in arrears in this field and the incorporation of many thousands of additional typed or clipped descriptions and illustrations into the herbarium. The crowded condition of the available herbarium cases, mentioned in previous reports, becomes more and more critical.

In connection with the general herbarium work various staff members have devoted much time to their special activities, with gratifying results. Professor Alfred Rehder completed his time-consuming task of seeing the second and thoroughly revised edition of his *Manual of Cultivated Trees and Shrubs* through the press. Dr. Johnston continued work on the very extensive Goodspeed collections of Chile, Peru and Argentine plants, identified the White and Shreve collections of Mexican plants, his own collection made in Mexico in the summer of 1938, and at the same time has reported on extensive collections submitted for identification by his South American correspondents. He reported on nearly 600 specimens of Boraginaceae sent to him by numerous collectors for identification. Dr. H. M. Raup has made excellent progress on the study of his Mackenzie Mountains expedition plants collected in the past summer, and at the same time has identified and reported on important collections of Arctic and Saskatchewan plants submitted to him by various correspondents. He has also practically completed his report, in association with Mr. R. E. Carlson, on the land use history of the several tracts of land forming the Harvard Forest, the field work having been accomplished in the summer of 1938.

This investigation was financed in part by the Arnold Arboretum, but mostly by a grant from the Harvard committee on research in the social sciences. Dr. Kobuski has continued his work on the *Theaceae* and on the genus Jasminum, while Dr. Allen has devoted much time to her studies on various large collections of Old World *Lauraceae*. Dr. Perry has continued her work on the identification of the extensive Archbold Expedition collections of New Guinea plants. Dr. Croizat has devoted most of his time to a study of various genera of the *Euphorbiaceae*. Working under my general supervision, Miss Chen has completed a study of the eastern Asiatic species of Ormosia, and has initiated work on the peculiarly difficult genus Sabia. Such time as I have had available for herbarium work has been devoted to the study of various collections from China, the Philippines, Malaysia, Indo-China, and the 1938-39 collections of Captain F. Kingdon Ward on the Vernay-Cutting Expedition to Upper Burma. During the entire year Professor F. P. Metcalf of Lingnan University has occupied space in the herbarium, working on the manuscript of his *Flora of Fukien Province*. He is the recipient of a Guggenheim Fellowship that enables him to remain a second year with the objective of completing this task.

The Mackenzie Mountains expedition of Dr. H. M. Raup during the summer of 1939 was eminently successful. On June 8, headquarters were established on Brintnell Lake, in the headwaters of the South Nahanni River, about 200 miles west of Fort Simpson. To reach this base involved several hundred miles of travel by airplane. The party remained at this base until August 20, when they returned to Fort Simpson, field work being continued there for about three weeks. A total of 1,665 numbers, about 14,340 specimens, were collected from this hitherto botanically unexplored area. The expedition was financed by grants from the Milton Fund of Harvard University, the American Academy of Arts and Sciences, the National Academy of Sciences, the Arnold Arboretum, and generous donations from several individuals for this specific project.

Otherwise actual field work on behalf of the Arboretum has been done through the granting of modest subsidies to resident collectors and botanists, particularly in China. These include grants to the Fan Memorial Institute of Biology, Peiping; Sun Yatsen University, Hong Kong; Lu Shan Arboretum, Likang, Yunnan; Nanking University, Chengtu; Lingnan University, Canton; National Szechuan University; and to Dr. A. Petelot, Hanoi, Indo-China. This cooperative work has been outstandingly successful in spite of continued and increasingly adverse conditions in China.

At the end of the fiscal year the library comprised 44,506 bound volumes, several hundred unbound volumes, 12,726 pamphlets, 18,644 photographs, 3,200 slides, and several thousand nursery catalogues. During the year there were added 383 bound volumes, 257 pamphlets, and 200 photographs. A fine series of photographs of New Guinea vegetation was presented by Mr. Richard Archbold of New York, to supplement the extensive botanical collections received from him last year. The cards added to the periodical and author catalogue numbered 1,200, among which were 300 containing bibliographical information, and 1,406 slips were incorporated in the file which supplement the printed author and subject catalogues of

the library. Nineteen new periodicals were acquired, most of them to continue as exchanges with our official publications. About 200 volumes have been loaned to other libraries, and a few have been borrowed for use here. The periodical holdings of the library have been checked up to the letter L for inclusion in the new edition of the *Union List of Serials*. A collection of about 300bbooks, left to the Plymouth Public Library some years ago by Benjamin M. Watson, Jr., formerly of the Bussey Institution, was purchased from that library, and was found to contain some rare and desirable items.

The usual numbers of our *Journal* and of the *Bulletin of Popular Information* were issued. These official publications, however, reflect only in part the activities of the staff. The detailed bibliography of the published writings of the staff and students working under the supervision of staff members covering 65 items with approximately 1,732 pages is published in our *Journal*, vol. 21, pp.541-543.

ATKINS INSTITUTION

The plantings have been greatly extended, approximately thirty acres of the tract transferred last year to the garden, having been developed through the replanting of the living material in the genera *Acacia, Bauhinia, Erythrina, and Ficus*. During the rainy period, July and August, many palms were transferred to the palm section, while the vine section has been re-arranged. To increase efficiency in handling young plants a nursery area has been developed, to which material is transferred from the propagating house. Further interplantings of desirable native trees have been made in the naturally wooded section, the entire area now being under easy control through the elimination of undesirable undergrowth. The unusually cold winter season caused some damage to a few of the more tender species, but all of the damaged plants are recovering. The removal of the houses from Colonia Limones has proved to be a very excellent move from the standpoint of the garden, resulting in a cessation of damage by domestic animals and a great reduction in petty pilfering. As the cane fields surrounding the garden are turned into pasture, the fire hazards are correspondingly reduced. During the year, 516 packages of seeds, 369 living plants, and 54 lots of cuttings were received, and 404 packets of seeds and 95 lots of cuttings were distributed. About thirty individuals enjoyed the hospitality of Harvard House for shorter or longer periods of time. Graduate students of Harvard University working at the garden on various problems were Mr. C. T. Parson and G. E. Folk, Jr., while Dr. E. V. Watson, Commonwealth Fellow at Harvard included the institution in his travels in connection with his ecological observations. The number of students listed for the next year is largely in excess of those in previous years. This increased attendance at the Atkins Institution is a reflex associated with the additional housing facilities now available in Casa Catalina, and greater ease of access due to the improved roads leading to Cienfuegos.

E. D. MERRILL, Director