MISSOURI BOTANICAL GARDEN BULLETIN

VOLUME IV

WITH 30 PLATES

1916

ST. LOUIS, MISSOURI

PUBLISHED MONTHLY BY THE BOARD OF TRUSTEES

SUBSCRIPTION PRICE:

ONE DOLLAR PER YEAR SINGLE NUMBERS TEN CENTS

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CONTENTS

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OF THE MISSOURI BOTANICAL GARDEN

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Missouri Botanical Garden Bulletin

Vol. IV St. Louis, Mo., January, 1916 No. 1

REPORT OF THE OFFICERS OF THE BOARD

SUBMITTED TO THE TRUSTEES JANUARY 12, 1916

To the Board of Trustees of the Missouri Botanical Garden:

We submit for your consideration a statement of the financial transactions for the year ending December 31, 1915.

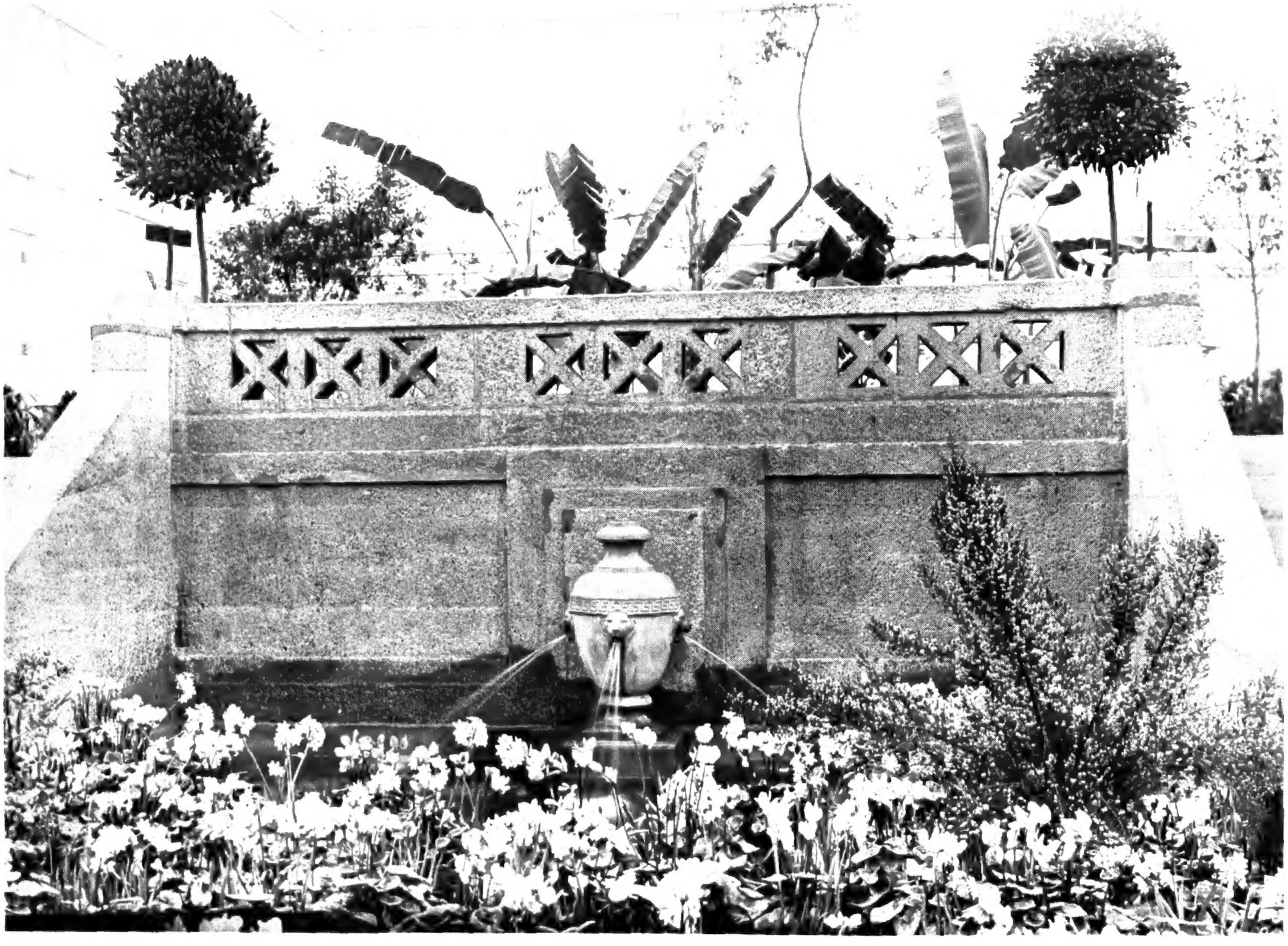
The results during the past year have been satisfactory, considering business conditions, as we have had fewer vacancies in our properties than for several years past, and our income from rentals and investments was $2,652.71 in excess of the previous year.

At present we have only one vacant building—producing when rented $1,800.00 per annum—and a small tenement, and our vacancies for the year amounted to only $1,436.00.

During the year we disposed of a piece of property containing ten dwellings which were erected by Mr. Shaw some thirty-five years ago, and on account of their age necessitated a large and constant outlay for repairs; these were traded in part for three pieces of business property on Locust Street valued at $125,000.00 — all of which are occupied.

During the year we graded and partially improved a piece of land at the southeast corner of Arsenal Street and Kingshighway, containing twelve acres, improvements made costing $20,049.88, and we have sold about one-fifth for residences and apartments.

We have been successful in disposing of the subdivision improved in the summer of 1914, known as Lafayette Avenue Addition No. 3, having disposed of about two-thirds of it at prices ranging from $22.50 to $35.00 per front foot.



SOUTH END OF FLORAL DISPLAY HOUSE.

Our sales of residence property were as follows:

Lafayette Avenue Additions. .	5,907 front feet .	$225,954 25
Arsenal Street Addition . .	614 front feet .	20,550 00
Flora Boulevard Subdivision .	110 front feet .	7,400 00
		$253,804 25

Early in the year it was discovered that many of the display and growing houses at the Garden were in a very bad condition, some of them dangerous, and it was decided to replace them with new houses at an estimated cost of $75,000.00.

Under Mr. Shaw's will the net income only can be used for Garden purposes, necessitating application to the courts for permission to use part of the permanent fund for erecting the new buildings. A decree authorizing the trustees to borrow from the principal the sum of $50,000.00, to be repaid out of the annual income in five annual installments of not less than $10,000.00 each, was granted.

This amount, in addition to the surplus standing on the books of $25,182.04, enabled us to build a series of houses for display and growing purposes at a cost of about $72,-000.00. These are now about completed, some of them being already occupied.

There was also erected a range of experimental houses for the study and treatment of diseases of plants, at a cost of $12,000.00.

Other changes were made in the Garden grounds in the way of general improvements at a cost of about $5,000.00.

Additions to the library and herbarium collections by purchase and gift during the year are valued at the following sums:

Library	$2,493 07
Herbarium	5,134 65

Only two of the annual bequests provided for in Mr. Shaw's will were carried out, the Annual Flower Sermon and the Gardeners' Banquet.

After charging against the income the expenses for the year, excepting streets and other improvements and expenses attending sales of real estate, we find expenses exceeded the income $59,824.15, after deducting surplus of $25,182.04, leaving $34,642.11, which was used from funds permitted by court decree.

The new plant houses are not entirely paid for, and outstanding bills will not amount to over $12,000.00, which brings the cost within the estimates.

For an itemized account of the receipts and disbursements your attention is called to the following statement:

RECEIPTS

Rentals	$151,701 35	
Interest and dividends	20,193 47	
Total income receipts		$171,894 82
Sales of real estate under decree of court	$154,919 25	
Notes receivable, account of sales	49,226 40	
Notes payable, assumed account of purchases	70,000 00	
Certificates of deposit, cashed	10,000 00	
Shaw School of Botany, rentals	3,900 00	288,045 65
Total		$459,940 47
Cash balance December 31st, 1914		23,625 10
		$483,565 57

DISBURSEMENTS

Garden Account —		
Labor pay-roll	$31,540 72	
Fuel	4,664 91	
Water	826 85	
Repairs and supplies	4,970 07	
Plants and seeds	4,482 18	
Stable and implements	347 48	
Total care of Garden	$46,832 21	
Herbarium Account —		
Salaries	$3,570 00	
Current expenses and additions	3,465 34	7,035 34
Library Account —		
Salaries	$2,390 00	
Current expenses and additions	2,162 35	4,552 35
Garden Office Account —		
Salaries	$7,935 00	
Current expenses	1,404 32	9,339 32
Research and Instruction —		
Salaries, fellowships and scholarships	$14,013 52	
Current expenses and supplies	2,267 08	16,280 60
Publications —		
Annals, Bulletin, and Anniversary Volume	$5,701 72	5,701 72
		$89,741 54

Garden Improvements —		
General improvements	$ 4,973 35	
Experimental house	11,998 63	
New plant house (partial)	62,379 42	79,351 40
Total amount expended on Garden		$169,092 94
Property Account —		
State, school and city taxes	$37,400 92	
Sprinkling taxes	1,181 67	
Streets, sidewalks and sewers	29,555 81	
Gas and water pipe	1,054 00	
Insurance	6,161 43	
Repairs	3,510 97	
Improvements	182 00	79,046 80
Bequests —		
Annual Flower Sermon	$200 00	
Annual Gardeners' Banquet	350 00	550 00
Sundries —		
Office expenses	$ 6,588 73	
Legal expenses	2,077 25	
Commissions	12,156 21	
Shaw School of Botany, account rentals	3,900 00	24,722 19
Investments —		
Bonds	$15,000 00	
Assumed deeds of trust on property purchased	40,000 00	
Real estate, 2217-19 Locust Street	70,000 00	
Real estate, 2827-33 Locust Street	30,000 00	
Real estate, 3040-42 Locust Street	25,000 00	
Real estate, 432 S. Thirteenth Street	6,000 00	186,000 00
Total disbursements		$459,411 93
Cash balance December 31st, 1915		24,153 64
		$483,565 57

Respectfully submitted,

EDWARDS WHITAKER, President.

Attest:

A. D. CUNNINGHAM, Secretary.

TWENTY-SEVENTH ANNUAL REPORT OF THE DIRECTOR

SUBMITTED TO THE BOARD OF TRUSTEES OF THE MISSOURI BOTANICAL GARDEN, JANUARY 12, 1916

Gentlemen:

I have the honor to submit herewith the Twenty-seventh Annual Report of the Director.

The year 1915, in addition to developing the various established activities of the Garden, has seen a return to the policy of 1913, namely, that of construction work. The practical completion since the first of July of a new range of houses, which, for the purpose designed, is probably the best in the country, at last provides adequate growing space for some of the most interesting collections of plants maintained at the Garden. There has also been completed an experimental greenhouse erected near the laboratory, which, while not intended for the general public, has long been needed in connection with the work of the students and, in its way, is quite as notable an addition as the larger greenhouses. Considerable improvement has been made in the outdoor plantations, as well as some notable changes in the conservatories. The permanent collections of both dried and living plants have been increased and are in much better order than a year ago. The library has grown along conservative lines, and some progress has been made in the arrangement and classification of the books, together with a start toward the subject index. The laboratory, as evidenced by the number of students and published articles of scientific value, has had the most successful year of its existence.

A most gratifying evidence of the increasing usefulness of the Garden to the citizens of St. Louis, as well as to the country at large, has been the great number of inquiries upon every conceivable aspect of botany and horticulture. Almost daily, questions are answered not only concerning the care of plants and trees, the kinds to grow, where they may be obtained, etc., but the business man is turning to the Garden as never before for information concerning technical points which such an institution, with its trained staff and exceptional facilities, alone can give.

In recognition of what may now be seen and learned at the Garden and the appreciation of the public of the Sunday opening the Board of Trustees voted to extend this privilege to every Sunday in the year, and the Garden is now open, with the exception of New Year's Day, Fourth of July, Labor Day, and Christmas, from eight o'clock to one-half hour after sunset on week days, and on every Sunday afternoon.

NEW PLANT RANGE

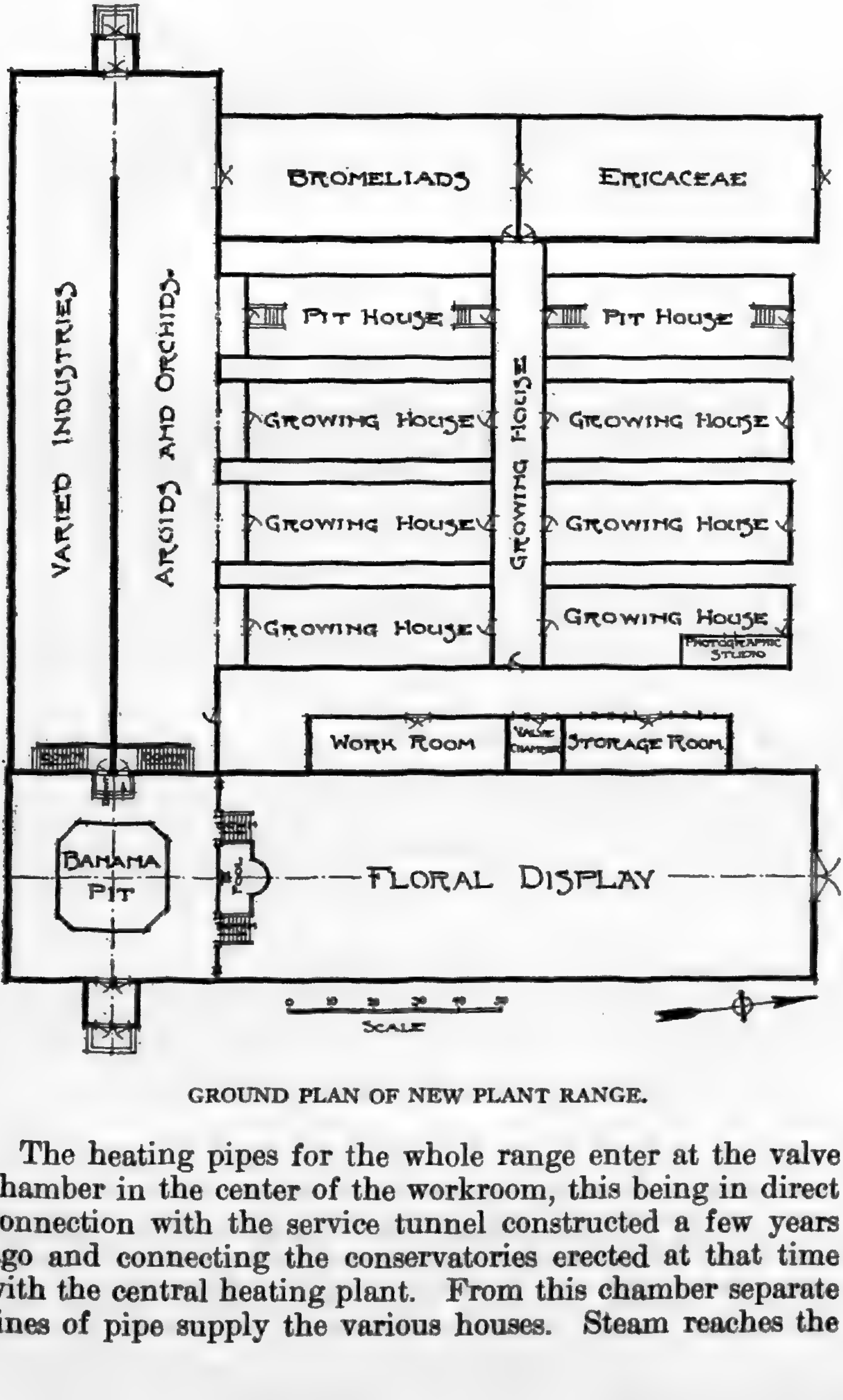
The new plant range, now practically completed, represents fourteen distinct units designed for as many or more different uses, and is unique in many respects. The plans were prepared by the Pierson U-Bar Co. of New York after sketches submitted by the Garden; the superstructure was built by the Lord & Burnham Co. of Chicago; and the foundations, walls, and all other work of every kind was done by the Garden. Great care has been taken to provide the best possible conditions, such as heat, ventilation, moisture, sunlight, etc., for the particular kinds of plants which are to be grown in the several houses. Indeed, the plan of the range is primarily based on the character of the plants to be grown therein; that is, utility has been the first consideration rather than an attempt to produce a pleasing architectural effect. Nevertheless, the range is one which immediately excites admiration because of its beautiful lines and simplicity of structure.

The approximate sizes of the houses and the uses to which they are to be put are as follows:

Floral display house, 50 x 190 x 40 feet high; varied industries house, 25 x 166 x 25 feet high; aroid house, of the same size as the varied industries house, with the addition of four display alcoves 20 x 7 feet; bromeliad house, 70 x 30 x 18 feet high; ericaceous house, 70 x 30 x 18 feet high; two pit houses, each 58 x 20 x 12½ feet high; six growing houses of the same size as the pit houses; one passage house, 12 x 104 x 10½ feet high. In addition there has been constructed a concrete workroom, 100 x 13 x 10 feet high, which provides for a valve chamber as well as a store-room. The combined area of the various houses is slightly more than three-quarters of an acre and represents about 60,000 square feet of glass. All of the greenhouses are built on the well-known curved-eave plan, with iron frames throughout, and having, even in the larger houses, the plain flat rafter. By this means, the heavy girders that are such a detriment to the appearance of show houses have been eliminated. More than the usual amount of ventilation has been provided,

VIEW OF NEW PLANT RANGE WITH CYCAD AND PALM HOUSE IN THE BACKGROUND.

and in the six growing houses, as well as the bromeliad and ericaceous houses, wall ventilators supplement the side and top ventilation.

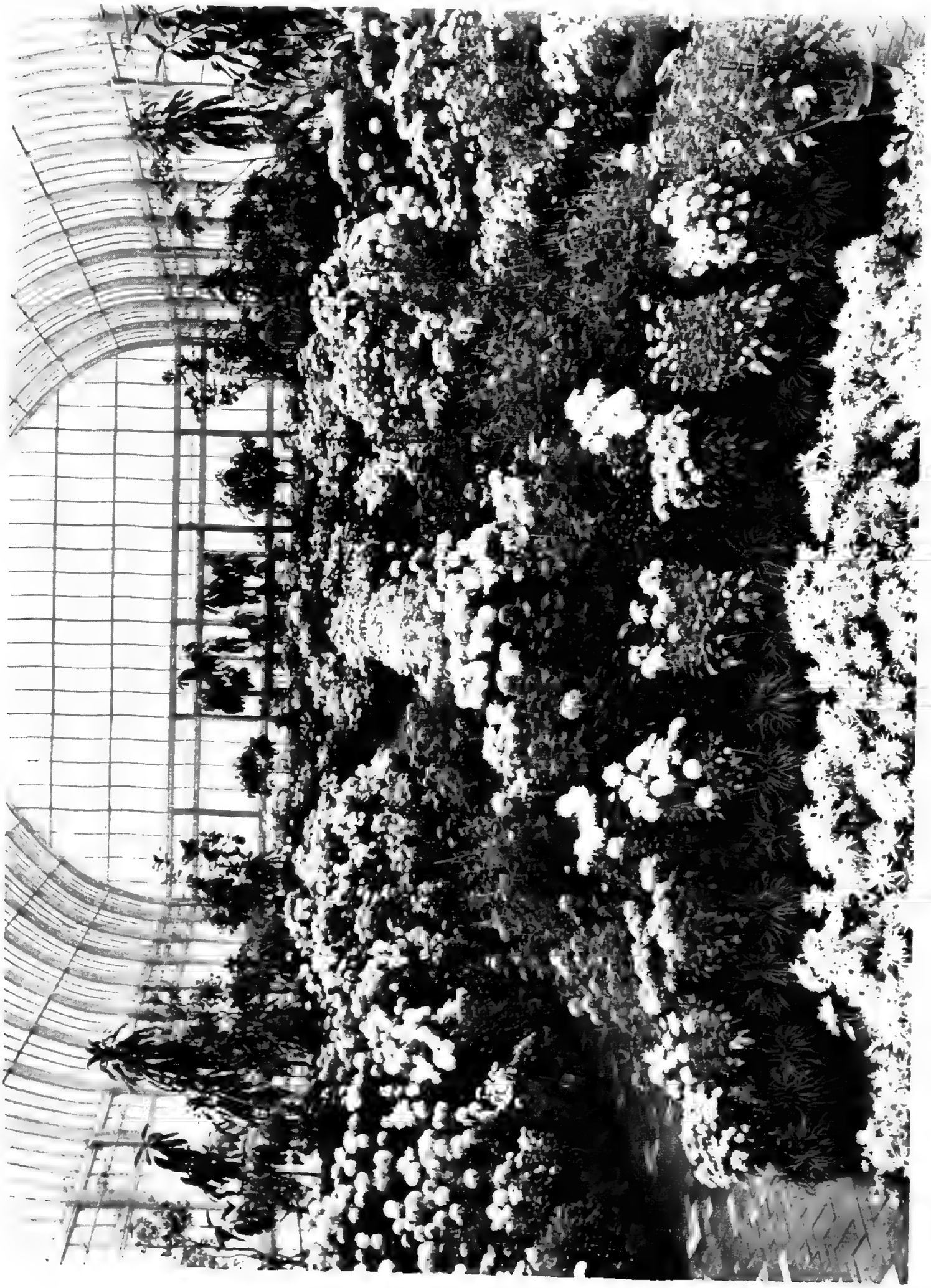


GROUND PLAN OF NEW PLANT RANGE.

The heating pipes for the whole range enter at the valve chamber in the center of the workroom, this being in direct connection with the service tunnel constructed a few years ago and connecting the conservatories erected at that time with the central heating plant. From this chamber separate lines of pipe supply the various houses. Steam reaches the

valve chamber at a pressure of about 60 pounds and is there reduced to 4 or 5 pounds. The vacuum system is used, and all pipes and fittings throughout the whole range are galvanized. The plan of screening the heating and water pipes by means of concrete walls has been followed in the new range, since the success of the system has been thoroughly demonstrated in the main conservatory. Cypress is the only wood used, and the glass is considerably heavier than that ordinarily employed in such greenhouses.

Floral Display House.—The south wing of the main conservatory, formerly used for floral displays, demonstrated that a house running east and west was not well adapted for this purpose. Not only did the afternoon sun shorten the life of the blooming plants, but an unequal light on the two sides of the house caused the plants to develop much more rapidly on one side than on the other. Consequently, the new floral display house has its main axis running north and south. The fine effect of entering the former flower house at an elevation above the main floor has been retained, but is extended so that in the present house a large balcony has been provided for viewing the flowers as a complete display. In order to obviate the difficulties experienced in the old house, of furnishing a temporary background of green plants, there is a permanent collection of foliage plants for this purpose. These are set in earth, banked up in front of the heating-pipe wall, and retained in position by a slightly lower front wall. The floor of the flower house proper, which is some 5 feet lower than the balcony, is about 150 feet long and 43 feet wide, between the permanent planting above referred to. This floor has been paved throughout with brick, and consequently there is great flexibility in the arrangement of the various potted plants used for floral display. The advantage of being able to vary the size and arrangement of the beds without involving any additional work because of walks can readily be appreciated. At the south end of the house is a large basin and fountain and stairways leading from the balcony to the main floor. In the center of the entrance floor is a pit, octagonal in shape, designed for the growing of bananas, the depressed area making it possible to show the flowers and fruit of these interesting plants in a manner not usually attained.



CHRYSANTHEMUMS IN FLORAL DISPLAY HOUSE.

This house was opened to the public on the last Sunday in October with the chrysanthemum show. This exhibit was followed by a display of poinsettias, paper white lilies, begonias, etc., which surpassed anything of the kind previously attempted. It is the intention to keep a continuous floral display here throughout the year, and it is believed that nowhere else in the country is there a house so well adapted for the purpose, and in which during the twelve months there will be shown such a magnificent lot of blooming and foliage plants.

Varied Industries House.—This and the adjoining house devoted to aroids have many things in common, yet the treatment of each has been so distinct that they need to be described as individual units. The two houses are about the same size and are divided in the center by a concrete wall 25 feet high and 145 feet long. On the south side of this wall will be grown many of the tropical climbers, and it will be possible to establish here such a collection of these plants as is seldom found in greenhouses. The entry to the varied industries house is from the west side of the floral display house, immediately opposite the main entrance. The floor of the house is ten feet lower than the platform of the floral display house, and from the top of the stairs the view is only surpassed by that of the floral display house itself. When the vines have attained their full growth, the impression will be that of looking down a long arbor of tropical vegetation. This house is designed to hold tropical plants from the Philippines and elsewhere, which have for the most part some economic use, but will also include a large collection of acacias, various species of Ficus, and numerous other unusual plants and trees which are of more than average interest.

Aroid House.—This house receives no direct sunlight and is admirably adapted for aroids, nepenthes, and other shade-loving plants. The wall which divides it from the varied industries house will serve for the growth of tall climbers which do not require direct sunlight. A waterfall starts near the top of the stairs leading into this house and supplies two pools near the center, over which will be hung the moisture-loving nepenthes, while the space from the wall to the walk at the north side will accommodate a large

variety of aroids and other similar plants. To the north of the walk are four alcoves, provided primarily for the display of orchids. Indeed, the whole house serves as a setting for the floral displays which are to be maintained in these alcoves throughout the year. The construction of this house necessitated placing heating pipes in a trench under the walk, but the center of the walk is a continuous slab of concrete, so that no discomfort will be occasioned by the heat which arises from below.

Bromeliad House.—This house opens from the west end of the aroid house and leads into the ericaceous house. A single straight walk leads directly to the exit at the north end, which during the summer will provide an easy and natural way to the arboretum. Owing to the fact that many of the bromeliads are epiphytic in habit, they will, for the most part, be established on old tree trunks or planted in baskets. The ground will be covered by dracaenas, pandanus, crotons, and similar plants. Near the partition at the north end a small pergola is to be constructed, upon which will be grown the large vanilla plant that for so many years has been an object of interest in the old range. While the vanilla is an orchid, it requires the same conditions as the bromeliads, and hence finds its natural place here.

Ericaceous House.—Since most plants of the ericaceous family will not thrive in any but an acid soil, peat, leaf mold, and similar constituents have been especially provided in which to establish the plants to be grown in this house. Rhododendrons, azaleas, heather, and other Ericaceae will be found here, and it is also probable that the fine collection of camellias, now being accumulated by the Garden, will finally be placed in this house.

Growing Houses.—The houses mentioned above constitute those which will be open to the general public. The remaining houses will be devoted primarily to the growing of orchids, a group of plants which requires very special and varied treatment. Large additions have been made to the Garden collection of orchids, both by purchase and gift, and for the first time conditions are provided which will insure their being cared for in a way to bring about satisfactory results. A few of the houses will be devoted to the growing of water-lilies for outdoor displays, as well as to the propagation and care of tropical material. Many plants require a resting period under conditions which cannot possibly be given in a display house, and there has long been felt the

VIEW FROM BALCONY IN FLORAL DISPLAY HOUSE.

need of an infirmary to which such plants could be relegated while they were recovering or resting, preparatory to another blooming period.

EXPERIMENTAL GREENHOUSES

The increase in the number of graduate students, as well as the reorganization of the school for gardening, necessitated providing better facilities for experimental work carried on by students at the Garden. Consequently, during the year there has been built on the site of the old greenhouses, between the rose garden and Mr. Shaw's residence, two greenhouses, 50 x 27 feet, with an adequate head house. The Garden prepared the plans and furnished all the labor for these houses, the material for the superstructure being purchased from the Lord & Burnham Co. One of these houses is divided into numerous compartments in which different temperatures and degrees of moisture may be obtained, and it is believed that the arrangement will provide facilities for a kind of work not possible in houses of the ordinary type. The compartments lend themselves well to pathological work, since plants affected with specific diseases may be isolated and studied under the most favorable conditions. Beneath these greenhouses are two cellars—one to be devoted to the experimental side of mushroom-growing, and the other to the investigation of fungi producing timber rot and methods for combating the same.

While this range of houses, because of its nature, cannot be open to the general public, it affords for the first time, to those especially interested in the experimental side of plant physiology and plant pathology, adequate space for demonstrating this aspect of the work.

MAIN CONSERVATORY

The chief change in this house during the year has been the replanting of the wing formerly used for floral displays with the succulents from the old range. This necessitated the removal of the benches and the entire rearrangement of the heating system. After the cacti, euphorbias, and other plants become established, and particularly when the climbing succulents have covered the trellises provided for the purpose, the collection will present an unusually fine appearance. The house is admirably adapted for the purpose, and the possibility of growing these plants directly in the ground, and maintaining the dry atmosphere required, will undoubtedly result in a display which will be far better than it was

ever possible to maintain under the old very unsatisfactory conditions.

All of the houses in this range have improved in appearance, the change in the cycad house being particularly noticeable. Additions of rare palms and ferns, as well as economic fruits, have been made to the collections.

MAIN GARDEN

Two outdoor gardens have been added during the year, namely, the formal garden, located back of the main conservatory, and the Linnean garden, surrounding the Linnean house at the north end of the Garden. Detailed descriptions of these two gardens appeared in the April number of the BULLETIN and need not be repeated here.

Numerous additions have been made to the permanent planting of new beds with hardy perennials and shrubs, and a considerable rearrangement of the walks has been accomplished. Owing to the erection of the experimental greenhouses, a replanting of part of the rose garden was necessitated, and some forty beds were added south of the pergola.

GIFTS OF PLANTS

The year 1915 has been marked by an unusual number of valuable additions made by gift to the various collections of plants at the Garden.

Mr. D. S. Brown, of "Brownhurst," Kirkwood, Missouri, whose collection of orchids is known throughout the world, has recently presented to the Garden some of his choicest plants, and these, added to the orchids already at the Garden, constitute one of the largest and most representative collections of this interesting group in the country. Among the orchids obtained from Mr. Brown was a collection of cypripediums, including over 130 plants of *C. insigne, C. Leeanum,* and various hybrids; a collection of dendrobiums, including thirty plants of *D. nobile* and its hybrids; a miscellaneous collection of laelias and cattleyas, including such species as *Laelia purpurata, L. crispa, L. tenebrosa, L. Boothiana, Cattleya intermedia, C. labiata, C. Mossiae, C. Percivaliana, C. Skinneri, C. maxima, C. Schroederae, C. guttata* var. *Leopoldii, C. Bowringiana, C. Trianaei,* and a recent importation of about fifty specimen plants of *Laelia Perrinii* and *Cattleya Lueddemanniana.* The gift likewise included nearly two hundred rare hybrids between cattleyas, laelias, and brassavolas, among which are the following: *C. Trianaei* × *L. tenebrosa, C. Forbesii* × *B. Digbyana, C. gigas Sanderiana*

VIEW IN FLORAL DISPLAY HOUSE.

× *L. tenebrosa, C. Warneri* × *B. Digbyana, C. labiata* × *L. C. Exoniensis, C. gigas* × *L. C. Endymion, L. tenebrosa* × *L. C. Canhamiana, L. tenebrosa* × *C. Mendelii, L. purpurata* × *L. C. Canhamiana Rex, L. C. Martineti* × *C. gigas, L. C. Gottoiana* × *C. labiata, L. C. Bleitchleyensis* × *C. Mossiae.* The East Indian orchids included such plants as *Vanda sacolabium, Rhynchostylis aerides,* and species of Angraecum, the collection being particularly noteworthy since plants from this region were poorly represented at the Garden. In addition to the orchids, Mr. Brown also gave a large number of bromeliads, aroids, and several species of Ficus not represented at the Garden, all of which were particularly acceptable at this time, since the new range of greenhouses affords ideal space for growing all of these plants.

Through Professor C. S. Sargent, of the Arnold Arboretum, there has been received a representative collection of plants obtained by Wilson and Purdom from China and similar regions. These are too numerous to list, but it is certain that a large part of the gift will provide new and most valuable material for use in both the greenhouse and outdoor planting. Perhaps the finest individual plant was a remarkably well-grown specimen of *Araucaria imbricata* which is now established in the cycad house.

From the Department of Agriculture various shipments have been received throughout the year, comprising economic plants, with tropical edible fruits predominating.

By exchange there has been obtained from Garfield Park, Chicago, and the New York Botanical Garden a miscellaneous collection of aroids which make a valuable addition to those already on hand and constitute a notable display in the new aroid house. Noteworthy additions to the palms, tillandsias, and miscellaneous economic plants have been made by Father Jerome, Saint Leo, Florida, and many interesting seeds and bulbs have been presented by Mr. Orville Matthews, of Parral, Mexico, L. D. Yager, of Alton, Illinois, and others.

ATTENDANCE

The attendance for the year 1915 is listed below. The opening of the Garden on Sunday afternoons in December made it possible for about 5,000 more people to attend than could visit the Garden in 1914. Including this number, the gain over 1914 is about 15,000, approximately three times the gain of 1914 over 1913, so that it would appear that the interest in the Garden is gradually increasing. The chief gain this year has been in the Sunday attendance, over 20,000 more people coming to the Garden on Sunday afternoon in 1915 than in 1914.

ATTENDANCE FOR THE YEAR 1915

	Week-days	Sundays
January	1,498	.....
February	2,865	.....
March	4,534	.....
April	18,304	22,406
May	9,565	13,423
June	11,746	9,343
July	10,908	7,821
August	13,468	10,948
September	10,899	7,071
October	13,461	14,195
November	24,824	21,202
December	6,844	5,178
	128,916	111,587
		128,916
TOTAL		240,503

RESEARCH AND INSTRUCTION

The facilities for research and graduate instruction have been materially strengthened by the addition to the laboratory equipment of important pieces of apparatus needed especially in physiological investigation. The installation of a commodious hood and canopy makes possible several types of work, the execution of which was formerly attended with much inconvenience.

The completion of the small range of greenhouses, constructed primarily for experimental purposes, to which reference has already been made, affords a much needed adjunct to the laboratory work.

Instruction, Lectures, Etc.—The graduate and undergraduate courses offered during 1914-15 in the Henry Shaw School of Botany by members of the staff who are at the same time members of the faculty of Washington University, were thirteen in number. No new courses were introduced during this academic year, and it may be said that those now offered are so related and stabilized as to suggest that few changes will need to be made in the immediate future. The courses regularly announced included work in general botany, biology (in coöperation with the department of zoölogy), histology, bacteriology, morphology and taxonomy of the fungi, morphology and taxonomy of the spermatophytes, morphology and taxonomy of the bryophytes and pteridophytes, plant geography, advanced physiology, special chapters in fermentation and in metabolism, seminar, and research in morphology, taxonomy, physiology, and applied mycology. For the first semester of 1915-16 twelve courses

EXPERIMENTAL GREENHOUSES.

are being offered, with a total registration in courses (including biology) of 128, of which 51 are graduate registrations.

Lectures and addresses by members of the scientific and Garden staffs during 1915 include the following:

Hermann von Schrenk, January 12, before the Engineers' Club of St. Louis, "Uses of Wood."

G. H. Pring, January 14, before the Garden Club of Webster Groves, "Aquatic Gardening."

Hermann von Schrenk, January 21, before the American Wood Preservers' Association, Chicago, "On the Wood Preserving Industry."

Hermann von Schrenk, February 2, before the Michigan Retail Lumber Manufacturers' Association, Mt. Clemens, Michigan, "On Uses of Wood."

Hermann von Schrenk, February 3, before the Ohio Retail Lumber Manufacturers' Association, Toledo, Ohio, "Wood Values."

John Noyes, February 18, before the Garden Club of Webster Groves, "How the Improvement of Home Grounds Promotes City Planning."

Hermann von Schrenk, February 24, before the Forest Products Federation, Chicago, "Wood Utilization."

George T. Moore, February 26, before the St. Louis Y. M. C. A., Central Branch, "Agriculture as a Life Work."

W. W. Ohlweiler, March 11, before the St. Louis Florists' Club, "A Few Things About Soils."

F. G. Grossart, March 16, before the St. Louis Academy of Science, Entomological Section, "The Evolution of the Chrysanthemum."

George T. Moore, March 18, before the Washington University Chapter of the Society of the Sigma Xi, "Botany as an Applied Science."

C. W. Garrett, March 18, before the Garden Club of Webster Groves, "Roses."

George T. Moore, March 22, before the St. Louis Y. M. C. A., Railroad Branch, "The Missouri Botanical Garden and Its Service to the City."

Hermann von Schrenk, March 24, before the Commercial Club of Kansas City, "Wood Blocks Paving."

Hermann von Schrenk, March 30, before the Kansas City City Club, "Wood Blocks Streets."

C. H. Thompson, April 1, before the Mothers' Circle of the Horace Mann School, "Popular Educational Features of the Missouri Botanical Garden."

C. H. Thompson, April 22, before the Garden Club of Webster Groves, "Flowers and Insects."

George T. Moore, May 21, before the Nebraska Academy of Sciences, "The Missouri Botanical Garden as a Scientific Institution."

Hermann von Schrenk, October 14, Burroughs Nature Study Club, "Trees."

R. A. Studhalter, October 18, before the St. Louis Academy of Science, "The Present Status of the Chestnut Bark Disease."

John Noyes, November 19, before the Missouri Botanical Garden Alumni Association, "The Pursuit of Beauty."

B. M. Duggar, November 23, before the Washington University Association, "Chance and Adjustment Versus Purpose in the Responses and Evolution of Living Things."

George T. Moore, December 4, before the St. Louis Medical Association, "Plant Diseases."

S. M. Zeller, December 20, before the St. Louis Academy of Science, "Infectious and Non-infectious Chlorosis of Plants."

A meeting of the Society of the Sigma Xi, with invitations extended to the Biological Society of St. Louis, was held in the graduate laboratory on March 18, with an address by Dr. Moore and with demonstrations of some of the lines of investigation being pursued by graduate students. A meeting of the Graduate Club was also held in the laboratories, November 14.

Graduates and Fellows.—Dr. A. R. Davis, formerly Rufus J. Lackland fellow, was appointed research assistant in June, since which time he has continued the prosecution of important investigations.

The following are the 1915 appointments to the Rufus J. Lackland fellowships:

G. W. Freiberg, B.S. South Dakota Agricultural College (formerly assistant in botany and graduate student, University of Missouri), reappointed second year; R. A. Studhalter, A. B. University of Texas (formerly assistant in forest pathology, Bureau of Plant Industry, Department of Agriculture), reappointed second year; W. W. Bonns, S.B. Massachusetts Institute of Technology, B.S.A. Cornell University (formerly assistant professor of pomology, University of California, Citrus Experiment Station, Riverside, California); C. W. Dodge, A.B. Middlebury College (formerly teacher of elementary botany, Middlebury High School); H. C. Young, B.S. Ohio University, M.S. North Carolina Agricultural College (formerly instructor in botany, North Carolina Agricultural College).

Other appointments were as follows:

S. M. Zeller, special research assistant Yellow Pine Association, B.S. Greenville College, A.B. and A.M. University of Washington (formerly instructor in botany, University of Washington), reappointed second year; W. S. Reeves, B.S. Pomona College, scientific assistant to the Director.

Graduate students holding positions in Washington University are the following:

H. M. Jennison, B.Sc. Massachusetts Agricultural College, M.A. Wabash College (assistant professor of botany and bacteriology, Montana State College, on leave of absence), assistant in botany; J. W. Severy, A.B. Oberlin College, teaching fellow in the Henry Shaw School of Botany.

In addition to the graduates mentioned in the preceding paragraphs, others registered for graduate work during the calendar year as candidates for advanced degrees in Washington University or elsewhere are as follows: M. C. Merrill (formerly research assistant); A. R. Davis, L. O. Overholts, and J. C. Gilman (formerly Rufus J. Lackland fellows); F. B. Wann (formerly teaching fellow, Washington University); M. R. Ensign, B.S. Utah Agricultural College; Mary M. Bryan, A.B. Washington University; Clara B. Hill, A.B. Vassar College; Ruth Beattie, A.B. University of Missouri; Lucy D. Foote, A.B. Clark College; D. C. Neal, B.S. Mississippi A. and M. College; Alice Pickel, A.B. Washington University; J. Mathilde Rollman, A.B. and B.S. University of Missouri; and Laetitia M. Snow (associate professor of botany, Wellesley College).

Those who terminated their connection with the laboratory during the year are as follows: M. C. Merrill (formerly research assistant), appointed Head of Agricultural Department of the Idaho Technical Institute; J. C. Gilman (formerly Rufus J. Lackland fellow), appointed professor of biology in Ripon College; L. O. Overholts (formerly Rufus J. Lackland fellow), appointed instructor in botany at the Pennsylvania State College; F. B. Wann (formerly teaching fellow), appointed instructor in botany in Cornell University; Mary M. Bryan, appointed teacher in New York City schools; and M. R. Ensign.

Degrees.—At the Commencement, June 10, advanced degrees were awarded graduate students in the Henry Shaw School of Botany as follows: Doctor of Philosophy—A. R. Davis (thesis, "Enzyme action in the marine algae"), W. H. Emig (thesis, "The occurrence in nature of certain yeast-

like fungi with relation to their possible pathogenicity in the higher animals"), J. C. Gilman (thesis, "Cabbage yellows and the relation of temperature to its occurrence"), M. C. Merrill (thesis, "Electrolytic determination of exosmosis from the roots of plants subjected to the action of various agents"), and L. O. Overholts (thesis, "Comparative studies in the Polyporaceae"); Master of Arts—Mary M. Bryan (thesis, "A spurless variety of *Habenaria psychodes*").

Publications and Papers.—The following is a list of papers published as a result of work and observations in the laboratories, herbarium, library, and garden:

Burt, E. A. "The Thelephoraceae of North America. IV." Ann. Mo. Bot. Gard., No. 3, 1915.

Burt, E. A. *Ibid.* V. Ann. Mo. Bot. Gard., No. 4, 1915.

Davis, A. R. "Enzyme Action in the Marine Algae." Ann. Mo. Bot. Gard., No. 4, 1915.

Duggar, B. M. "Physiology and Ecology." American Year Book, 1915.

Duggar, B. M. "Mushroom Growing." Orange Judd Co., pp. I–VIII and 1–250. 31 pls. 1915.

Duggar, B. M. "Rhizoctonia Crocorum (Pers.) DC. and R. Solani Kühn (Corticium vagum B. & C.) with Notes on Other Species." Ann. Mo. Bot. Gard., No. 3, 1915.

Duggar, B. M. (The following subjects in Bailey's Standard Cyclopedia of Horticulture, 1915): "Fertilization," "Mushroom, Mushroom Culture, and Mushroom Families," "Nectar."

Greenman, J. M. "Morphology as a Factor in Determining Relationships." Am. Jour. Bot., 1915.

Greenman, J. M. "Monograph of the North and Central American Species of the Genus Senecio—Part II." Ann. Mo. Bot. Gard., No. 3, 1915.

Knudson, L. "Toxicity of Galactose for Certain of the Higher Plants." Ann. Mo. Bot. Gard., No. 4, 1915.

Merrill, M. C. "Some Relations of Plants to Distilled Water and Certain Dilute Toxic Solutions." Ann. Mo. Bot. Gard., No. 3, 1915.

Merrill, M. C. "Electrolytic Determination of Exosmosis from the Roots of Plants Subjected to the Action of Various Agents." Ann. Mo. Bot. Gard., No. 3, 1915.

Noyes, John. "The 'Places' of St. Louis." The American City, 1915.

Ohlweiler, W. W. "Producing Natural Effects in Conservatory Planting." The Gardeners' Chronicle of America, 1915.

Overholts, L. O. "Comparative Studies in the Polyporaceae." Ann. Mo. Bot. Gard., No. 4, 1915.

Overholts, L. O. "The Polyporaceae of the Middle-Western United States." Washington University Studies, 1915.

von Schrenk, Hermann. "A Specification for a Coal Tar Creosote Solution." Proc. Am. Wood Pres. Assn., 1915.

von Schrenk, Hermann. "Modern Uses of Wood." Jour. West. Soc. of Engineers, 1915.

Studhalter, R. A., and Heald, F. D. "The Persistence of Viable Pycnospores of the Chestnut-blight Fungus on Normal Bark below Lesions." Am. Jour. Bot., 1915.

Studhalter, R. A., and Ruggles, A. G. "Insects as Carriers of the Chestnut-blight Fungus." Pa. Dept. Forestry Bull., 1915.

Studhalter, R. A. (with Heald, F. D.) "The Effect of Continued Desiccation on the Expulsion of Ascospores of Endothia parasitica." Mycologia, 1915.

Studhalter, R. A. (with Heald, F. D.) "Longevity of Pycnospores and Ascospores of Endothia parasitica under Artificial Conditions." Phytopathology, 1915.

Studhalter, R. A. (with Heald, F. D., and Gardner, M. W.) "Air and Wind Dissemination of Ascospores of the Chestnut-blight Fungus." Jour. Agr. Res., 1915.

Studhalter, R. A. (with Heald, F. D.) "Seasonal Duration of Ascospore expulsion of Endothia parasitica." Am. Jour. Bot., 1915.

Zeller, S. M. "Notes on Cryptoporus volvatus." Mycologia, 1915.

Zeller, S. M. (with Frye, T. C.) "Hormiscia tetraciliata sp. nov." Puget Sound Marine Station Publ., 1915.

Zeller, S. M., and Abigail Neikirk. "Gas Exchange in the Pneumatocyst of Nereocystis Luetkeana (Mertens) P. & R." Puget Sound Marine Station Publ., 1915.

In the paragraphs below there are given, for the year 1915, some indications of the results from the published investigations by members of the scientific staff and graduate laboratory.

Burt, E. A. Ann. Mo. Bot. Gard. 2:627–656, 731–770. Continuing the monograph of the Thelephoraceae of North America, the first paper discusses the parasitic genus Exobasidium. This fungus produces gall-like deformities and discoloration of leaves, fruits, and flowers of various heaths and of Symplocos. A critical study of the American collections leads to the conclusion that there are but three species distinguishable on morphological grounds. In the second

paper three unusually interesting genera are discussed, namely, Tremellodendron, Eichleriella, and Sebacina. Of the first named, seven species are described; of the second, five; and of the third, fourteen species. Among these, eleven species are new and several new combinations are given.

Davis, A. R. Ann. Mo. Bot. Gard. **2**:771–836. Studying the distribution and intensity of action of the digestive and other ferments in marine algae, some results of special significance have been obtained. Ferments digesting starch and related carbohydrates were isolated, but no ferment digesting either cane or malt sugar could be identified. Likewise, no enzyme was found which would digest the cellulose walls of plants, and none affecting simple esters. In all cases the ferments isolated were found to act with unusual slowness, but it is suggested that certain inhibiting agents are responsible for the low rate. It seems possible that tannoid compounds may be important in this connection.

Duggar. B. M. Ann. Mo. Bot. Gard. **2**:403–458. Among the more important parasitic root fungi of economic plants are *Rhizoctonia Crocorum,* the violet root felt fungus so long well known in Europe, and *R. Solani,* the common American species. In this study an account is given of the distribution of these two fungi throughout the world, a description of the types of diseases induced by them, and an exposition of the morphological and pathological differences between the species, together with notes upon other species less well known.

Greenman, J. M. Ann. Mo. Bot. Gard. **2**:573–626. This article marks the beginning of a series which will constitute a monograph of the genus Senecio or groundsel. This large genus of composites is particularly well represented in the western United States and southward, and the material for the study has been collected for a period of years. The first article includes descriptions of thirty-two species representing a few sections of the subgenus Eusenecio.

Knudson, L. Ann. Mo. Bot. Gard. **2**: 659–664. In this study it is shown that one of the hexose sugars, galactose, is injurious to green plants when employed at concentrations which, in the case of cane sugar, fruit sugar, milk sugar, and malt sugar, would promote growth.

Merrill, M. C. Ann. Mo. Bot. Gard. **2**:459–506. In experimental work on the relations of plants to nutrients and to deleterious agents it is necessary to grow control plants with the roots immersed in distilled water; but such control

plants suffer certain disorders, the causes of which it is important to know. It is believed that in distilled water the food relations play an important rôle in the incipiency of the disorders, and this has the effect of predisposing the plant to the action of bacteria and mold fungi ordinarily present in the culture solution.

Merrill, M. C. Ann. Mo. Bot. Gard. 2: 507–572. In this paper a report is made upon an elaborate series of experiments and determinations regarding the effects of various injurious agents upon plants. By studying changes in the electrical conductivity of water in which the roots of treated plants were immersed, it was found that the electrical method gives a delicate and reliable measure of the effects of gases or other deleterious agents or conditions. Numerous data are given regarding the action of the various substances employed.

Overholts, L. O. Ann. Mo. Bot. Gard. 2:667-730. This paper is a critical study of some of the more different groups of species of the polypores. A special attempt has been made to use microscopical characters in the separation of the species; in short, an attempt to employ more exact characters in the determination of closely related forms.

Overholts, L. O. Washington Univ. Studies 3 (Part I, No. 1): 1–84. This is in reality a manual of the polypores of the middle-western United States. It should prove serviceable to all who would have to identify these fungi, many of which cause disastrous diseases of trees, likewise important timber decays. The manual includes 132 species, with analytical and synoptical keys.

The School for Gardening.—The resignation of Mr. Charles H. Thompson, Mr. K. Svetlikoff, Mr. C. W. Garrett, and Mr. H. M. Biekart has necessitated considerable change in the conduct of some of the courses. Temporarily, other members of the Garden staff have been carrying this additional work, and Mr. G. H. Pring has been added to the permanent corps of instructors. Plans are now under way for additions to this staff, and it is expected that early in the year 1916 the teaching force will be restored to its normal size.

Mr. Fred G. Grossart completed the course on September 30 and was awarded a Garden certificate. He is now head gardener at Valhalla Cemetery.

As the result of competitive examination, Mr. James Monteith was appointed to the only vacant scholarship on October 1, and besides those holding scholarships there are five students paying tuition.

On November 19, about twenty-five of the former pupils gathered for an informal meeting of the Missouri Botanical Garden Alumni Association. The program was given in the November BULLETIN.

HERBARIUM

Marked progress has been made during the year, particularly in the critical study of certain groups of plants and the further organization of material in the general herbarium. Additional cases have been fitted up in the gallery of the museum building for the growing collection of parasitic and fleshy fungi, and a new steel case has been installed for the reception of special sets of *exsiccata*.

New Accessions.—A relatively large number of accessions has been received, some of the more important of which are the following: E. Bartholomew, "North American Uredinales," Cent. XII, XIII, XIV, Nos. 1101–1400, and "Fungi Columbiani," Cent. XLVI, Nos. 4501–4600; Botanic Garden of Pisa, lichens and fungi of Italy; T. S. Brandegee, plants of Mexico, collected by C. A. Purpus in 1914; Bureau of Science, Manila, plants of the Philippine Islands; B. F. Bush, plants of Missouri; Ira W. Clokey, plants of Illinois; F. S. Collins, "Phycotheca Boreali-Americana," Nos. 2001–2050; Dr. F. V. Coville, plants of Mexico, collected by Dr. Edward Palmer in 1910; Dr. A. R. Davis, plants of California and the Philippine Islands; Rev. John Davis, plants of Missouri; Prof. John Dearness, thelephoraceous fungi from British Columbia and Ontario; J. A. Drushel, plants of Alabama, Ohio, Illinois, Missouri, Texas, Colorado, and California; Miss Charlotte Ellis, plants of New Mexico; Prof. A. W. Evans, Hepaticae of Jamaica; Prof. W. G. Farlow, fungi from various localities, and mosses from Trinidad and Granada, W. I.; O. A. Farwell, plants of Michigan; Prof. J. H. Faull, fungi from Canada; G. W. Freiberg, plants of Minnesota; R. Friedländer & Sohn, Sydow's "Mycotheca germanica," Fasc. XXV, XXVI, Nos. 1201–1300; P. W. Graff, fungi from Connecticut; J. M. Greenman, Krieger's "Schädliche Pilze," and miscellaneous plants from various localities; A. A. Heller, plants of California; Th. Holm, plants of Porto Rico, Maryland, Virginia, and Colorado; J. M. Holzinger, plants of New Mexico; Dr. Alfred L. Kammerer, plants of New Mexico and Washington; J. H. Kellogg, plants of Missouri; Dr. W. H. Long, fungi from Arizona and New Mexico; John Macoun, fungi of British Columbia; E. O. Matthews, fungi, lichens, mosses, and hepatics; Dr. W. A. Murrill, thelephoraceous fungi from western United

States and Mexico; Prof. A. Nelson, plants of Colorado; New York Botanical Garden, flowering plants from Bermuda, and fungi from Florida; L. O. Overholts, flowering plants from Ohio, Indiana, Missouri, and Colorado, and fungi from various localities; Prof. W. A. Setchell, fungi from California and Washington; H. Sydow, "Fungi exotici exsiccati," Fasc. VII, VIII, IX, Nos. 301–450; Stuart L. Thompson, plants of Manitoba; U. S. Dept. of Agriculture, plants of China, and "American Grasses," Nos. 201–400; U. S. Nat. Museum, plants from South America, fragments of types of American senecios, and fungi from New Mexico; Dr. H. von Schrenk, flowering plants and fungi from various localities; University of California, plants of California; T. O. Weigel, plants of the Philippine Islands, and Zenker's "Plantae Kamerunenses," Cent. VI, Nos. 500–599; J. R. Weir, fungi from western United States and British Columbia. A complete list of the accessions received during each month of the year has been recorded in the successive issues of the BULLETIN.

Mounting and Distribution.—The mounting of herbarium specimens has continued throughout the year; and nearly all material received on current accessions has been mounted, poisoned, and incorporated in the general herbarium. In addition to this, the excellent suite of specimens acquired by the purchase of the private herbarium of Mr. Ernest J. Palmer has been mounted; and the Letterman herbarium, which was purchased in 1913, has been partly organized. From the latter collection more than 7500 specimens have been mounted and distributed in the general herbarium, and several thousand specimens have been laid out in sets as exchange material, ready for distribution to correspondents. Very few exchanges have been made, because of the unusual delays and risk involved in sending material to European institutions. The mounting has been very greatly facilitated by the introduction of a specially constructed movable metal case for use in poisoning herbarium specimens.

Field Work.—The coöperative field work which has been carried on so successfully during the past two years with the Arnold Arboretum has been continued, and Mr. E. J. Palmer has been in the field the entire season from the middle of March to November, except for a brief period in August. A general botanical survey has been conducted in western Louisiana, eastern Texas, southeastern Oklahoma, and southwestern Arkansas. Collections have been made at Natchitoches, Chopin, Grand Ecore, Creston, Shreveport, Alexan-

dria, Jennings, Welsh, Sulphur, Monroe, Windsor, Cameron, and Lake Charles, Louisiana; at San Augustine, Carthage, Long View, Jacksonville, Larissa, Liberty, Dayton, Houston, Bryan, College Station, Corsicana, Groesbeck, and Marshall, Texas; at Poteau, Fort Towson, Antlers, Idabel, Hugo, and Page, Oklahoma; and at Fulton, McNab, Arkadelphia, Gum Springs, Benton, Malvern, Little Rock, Ozark, London, Fayetteville, Winslow, Westgate, Ashdown, Cotter, Horatio, and Pine Bluff, Arkansas. Several of these stations were visited twice or more during the season in order to secure plants of the spring and autumnal floras, as well as to obtain flowering and fruiting specimens of the same species. Upwards of 10,000 herbarium specimens were collected during the season, which will be of the utmost value in elaborating the proposed "Flora of the Southwest."

Use of Herbarium by Outside Botanists.—Several specialists from different parts of the country have visited the herbarium for the purpose of studying large series of specimens in technical genera and especially to consult type material. Numerous loans have been made to specialists engaged in the monographic study of particular groups of plants.

Statistical Summary: (For the year ending December 31, 1915).

Number of specimens acquired on new accessions:		
By purchase	**6,677**	
By gift	**5,025**	
By exchange	**1,311**	
By field work	**8,387**	
Total	**21,400 valued at**	**$1,712.00**
Number of specimens mounted and incorporated:		
From Chapman Herbarium	**271**	
From Letterman Herbarium	**7,635**	
From Palmer Herbarium	**4,671**	
From all other sources	**21,654**	
Total	**34,231 valued at**	**$5,134.65**
Number of specimens discarded from the herbarium	**53**	
Number of specimens in unorganized herbarium	**(estimated at 60,000) valued at**	**$4,800.00**
Number of specimens in organized herbarium	**691,639 valued at**	**$103,745.85**
Wood specimens, etc., supplementing the herbarium, valued at		**280.00**
Microscope slides, etc., valued at		**410.00**
Total valuation		**$109,235.85**

LIBRARY

During the year a considerable part of the time of the library staff has been devoted to checking up and entering the publications which have been received, sending them at once on the round of the laboratories, collating them for the binder, and finally indexing and distributing them on the shelves.

There have been but few opportunities to purchase books which will fill gaps in incomplete sets, for the catalogues coming from foreign dealers appear to be almost wholly re-offerings of works in former catalogues. Private libraries are apparently not now being taken by foreign dealers.

Reclassification of Books.—To make the books and pamphlets bearing on plant physiology and plant pathology more available for quick reference, there have been reclassified under the present subdivisions of physiology all the publications in this section, as well as the books and pamphlets of importance in plant pathology from the section mycology. These changes have necessitated alterations in the corresponding cards in the card catalogue and also in the original accession slips stored in the vault. This part of the work is not yet finished.

Publications.—The current volume of the Annals of the Missouri Botanical Garden, which is the principal exchange for publications of scientific institutions and societies, contains 841 pages, 27 plates, and 79 text figures. It contains the papers prepared for the Twenty-fifth Anniversary of the Garden and also the results of botanical researches completed by individuals connected with the Garden. It is computed that the value per year of the exchanges received for the ANNALS is $1,335.00. Some exchanges are also received for the BULLETIN.

List of Serial Publications.—The list of the serial publications to date in the library of the Missouri Botanical Garden was published in the Washington University Serial List, Washington University Record, Vol. 10, No. 6, April, 1915. This list gives not only all serials in our library, but states also how complete the file is for each. In addition to being useful for our own use, this list will enable those who desire to consult volumes of such serials to inform themselves as to whether they are available in the Garden library. We have had in the past many inquiries of this nature from educational institutions of the middle west.

Loans of Books.—The library is not a circulating library; nevertheless, its usefulness is not confined to those who can examine its books in the library building. Loans are made of some books for a short period to other libraries for the use of investigators. Thirty-seven such loans, totaling 105 books, were made.

Subject Index.—Work on the subject index of titles of botanical articles published by scientific societies of the world has been continued. Indexing such serial publications of Great Britain and Ireland has been completed, and a beginning has been made on German publications. In all, 6,800 articles are indexed in 51 publications. The cards afford immediate reference to many important papers and to large numbers of observations and notes on plants and plant phenomena. The members of the scientific staff coöperate in the classification of the cards to make the index of the greatest scientific value.

Statistical.—There have been 514 volumes, valued at $901.24, and 1,083 pamphlets, valued at $162.25, donated to the library; and 287 volumes, valued at $1,116.75, and 5 pamphlets, valued at $2.30, purchased. The library now contains 33,757 books and 44,100 pamphlets, a total of 77,857, valued at $116,982.55. There are also 325 manuscripts, valued at $1,601.25, 154 maps and charts, valued at $254.10, and 867,125 index cards, valued at $8,671.25, making the total estimated value of the library and card catalogue $127,509.15. A total of 31,053 index cards have been added, 13,781 of which were typewritten by Garden employees, and 17,272 purchased at a cost of $219.05. The number of books bound was 461, and one map was mounted.

ANNUAL BEQUESTS

The flower sermon, provided for in Mr. Shaw's will, was preached in Christ Church Cathedral by the Rev. A. A. V. Binnington, of Lebanon, Pennsylvania, on May 16, 1915.

The Twenty-sixth Gardeners' Banquet was held on the evening of November 19, 1915, at the Liederkranz Club. Mr. John K. M. L. Farquhar, president of the Massachusetts Horticultural Society, spoke on "Bulb Growing in Holland."

Respectfully submitted,

GEORGE T. MOORE,
Director.

STATISTICAL INFORMATION FOR DECEMBER, 1915

GARDEN ATTENDANCE:

Total number of visitors	12,022

PLANT ACCESSIONS:

Total number of plants received in exchange	70
Total number of packets of seeds received in exchange	4

PLANT DISTRIBUTION:

Total number of plants distributed free	20
Total number of plants distributed in exchange	3

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought	22
Total number of books and pamphlets donated	225

HERBARIUM ACCESSIONS:

By Purchase —

Geo. W. Stevens—Plants of Oklahoma	1,400
H. Sudre — "Batotheca Europaea," Fasc. XIII, Nos. 601–650	50
H. Sudre — "Herbarium Hieraciorum," Fasc. V, Nos. 201–250	50

By Gift —

Walter H. Aiken—*Verbesina virginica* L. from Louisiana	1
B. F. Bush—*Polysaccum crassipes* from Montevallo, Missouri	1
J. Dearness—Fungi of Ontario and British Columbia	7
J. A. Drushel—Plants from Ohio, Missouri, Texas, Colorado, Utah, and California	23
J. More and Milton T. Greenman—Plants of Missouri	3
C. J. Humphrey—*Thelephoraceae* of Cuba	54
E. L. Johnston—Plants of Colorado	95
O. S. Ledman—Plants of Missouri	17
W. H. Long—Fungi on lumbering "slash" in Arkansas	53
Mrs. J. T. Monell — Private herbarium of the late Joseph Tarrigan Monell (estimated at)	1,000
L. O. Overholts—Type specimens of *Agaricaceae* from Missouri	5
L. O. Overholts—Specimens of *Thelephoraceae* from Pennsylvania	7
G. L. Peltier—*Corticium vagum* on stems of carrot, horseradish, radish, rhubarb, *Sedum*, wintervetch, and on tomato fruit	7
C. V. Piper—Specimens of *Senecio* from Oregon	4
F. Pitzman—*Magnolia sp.* from Cairo, Illinois	1
Royal Botanic Gardens, Kew, England — Specimens of *Corticium salmonicolor*, the "pink disease" of tropical plants	3
H. von Schrenk—*Gordonia Lasianthus* Ell., the "tan-bay" or "loblolly-bay," from Georgia	7
J. R. Wier — Timber-destroying fungi of Montana, Idaho, Washington, and British Columbia	57

By Field Work —

E. J. Palmer — Plants of Louisiana, Texas, Arkansas, and Oklahoma (estimated at)	8,292
TOTAL	11,137

The Garden is open to the public every day in the year, except New Year's, Fourth of July, Labor Day, and Christmas—week days from 8:00 A. M. until one-half hour after sunset; Sundays, from December to April, 1:00 P. M. until sunset, from April to December, 2:00 P. M. until sunset.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Boulevard, on the Vandeventer Avenue car line. Transfer south from all intersecting lines.

STAFF
OF THE MISSOURI BOTANICAL GARDEN

Director.

GEORGE T. MOORE.

BENJAMIN MINGE DUGGAR,
Physiologist, in charge of Graduate Laboratory.

EDWARD A. BURT,
Mycologist and Librarian.

HERMANN VON SCHRENK,
Pathologist.

ALVA R. DAVIS,
Research Assistant.

JESSE M. GREENMAN,
Curator of the Herbarium.

C. E. HUTCHINGS,
Photographer.

KATHERINE H. LEIGH,
Secretary to the Director.

JAMES GURNEY,
Head Gardener, *Emeritus.*

WILLIAM W. OHLWEILER,
General Manager.

JOHN NOYES,
Landscape Designer.

E. D. EMME,
Recording and Labeling.

W. F. LANGAN,
Engineer.

J. ERDMAN,
Plant Propagation.

G. H. PRING,
Orchids and other Exotics.

C. R. FOLLEM,
Construction.

M. SCHILLER,
New Conservatories.

P. FOERSTER,
Farm and Stables.

MISSOURI BOTANICAL GARDEN BULLETIN

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CONTENTS

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Bishop of the Diocese of Missouri.

A. D. CUNNINGHAM, *Secretary.*

TOWER GROVE PARK STATUE OF SHAKESPEARE, THE WORK OF BARON VON MUELLER OF MUNICH, PRESENTED TO THE CITIZENS OF ST. LOUIS BY HENRY SHAW ON APRIL 23, 1878

Missouri Botanical Garden Bulletin

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A SHAKESPEAREAN GARDEN

No celebration of the three-hundredth anniversary of Shakespeare's death would be complete without a Shakespearean garden. The works of the great dramatist abound in plant lore and garden craft, and prove beyond question that he knew and loved the plants and gardens of his time.

The era in which Shakespeare lived and worked was one particularly favorable for gardening, as well as for literature and the other arts. It was only just previous to this period that the nobility began to erect their great country mansions, and the garden was considered a very important adjunct. Probably at no other time has landscape gardening taken a higher rank, the garden giving, as it did, a special and finished character to the building, and being an essential part of the general scheme. The architect-builder of the house was usually the designer of the garden, John Thorpe being one of the most famous architects of the period, who designed many estates combining house and grounds. That the landscaping was considered no mean task is evidenced by Bacon's statement that "Men come to build stately sooner than to garden finely; as if gardening were the greater perfection."

It is natural, therefore, that the history of the architecture and gardening of the Elizabethan era should be closely related. Religious persecution in parts of Europe, combined with other causes, brought many gardeners, as well as build-

ing artisans and artists, to England. On the other hand, traveling on the Continent was popular among the wealthier classes, and comparatively safe. Consequently, many foreign ideas were introduced, especially those of the Renaissance, and the style of architecture began to change from the Gothic to the more classical English Renaissance, resulting in what is now known as the Elizabethan style. The influence of these changes was soon felt in the garden which combined ideas of the Tudor period with those obtained from abroad. This fusion of ideas happily resulted in a style purely national, much better adapted to England than a strict adherence to the gardens of any other country. Some of the principal Tudor features that remained were the railed flower bed, the mount, topiary work, hedges, simple knots and arbors, pleached alleys, arched galleries, walls, and trellised fences. Europe contributed the terrace, the fountain, the labyrinth or maze, and the more elaborate arbor and parterre, while architecture and sculpture became more common in gardens through foreign influence.

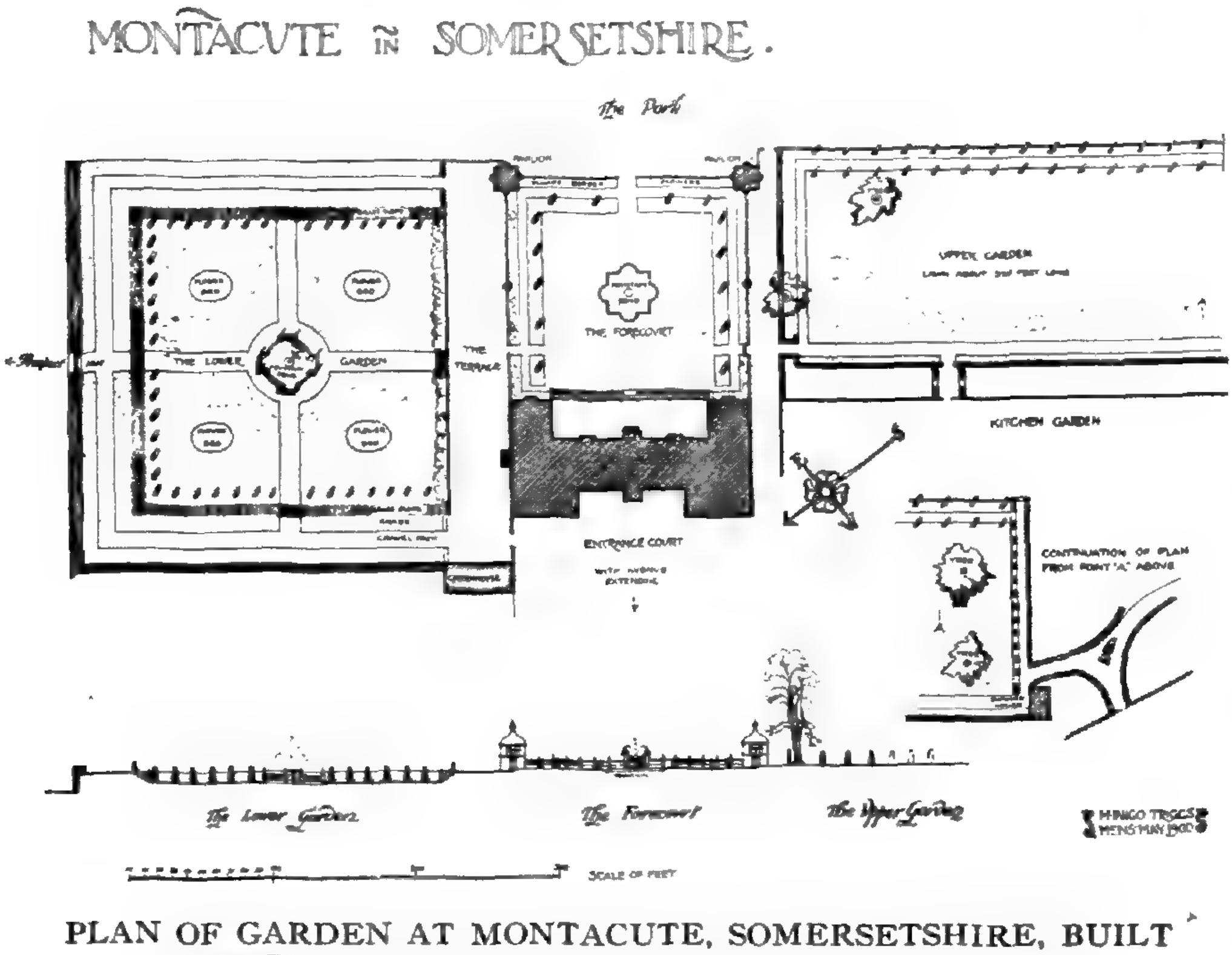
It should perhaps be mentioned first that the ideal Elizabethan garden was square, or, if oblong, divided into square parts. The building, with its wings and forecourt, dominated the design, the balustraded terraces which formed the connecting link between house and garden, dropping to the garden grade by means of a grassy slope, or a brick or stone retaining wall. The walks, called "forthrights," made of sand, gravel, or turf, were straight and very broad. "Covert" alleys at the sides were very popular, sometimes formed by vines on arched trellises, and sometimes by pleached alleys, the

VIEW ACROSS THE POND AT MONTACUTE.

GARDEN HOUSE AND PAVILION AT MONTACUTE.

latter made by interweaving overhead the branches of the trees on either side the walk. Willows, lindens, elms, hornbeam, cornel, privet, and hawthorn were popular for this purpose.

Flowers were used in abundance in the knots or parterres, also in other beds, usually bordered with a low hedge of box or similar plants, or with lead, brick, pebbles, tiles, or even the shank bones of sheep. Larger beds were "railed," either by a low trellis, or a single railing on posts at the corners,



PLAN OF GARDEN AT MONTACUTE, SOMERSETSHIRE, BUILT BETWEEN 1580 AND 1601 AND PRACTICALLY UNALTERED AT PRESENT TIME.

such rails and trellises being usually painted green and white, the Tudor colors. Beds were often raised above the level of the walk by a low brick or stone wall. The mount, a relic of monastic gardens, was a high artificial hill, sometimes in the center of the garden, sometimes at the end, overlooking the garden and the countryside. These flower garden railings and mounts are seldom used in modern garden craft.

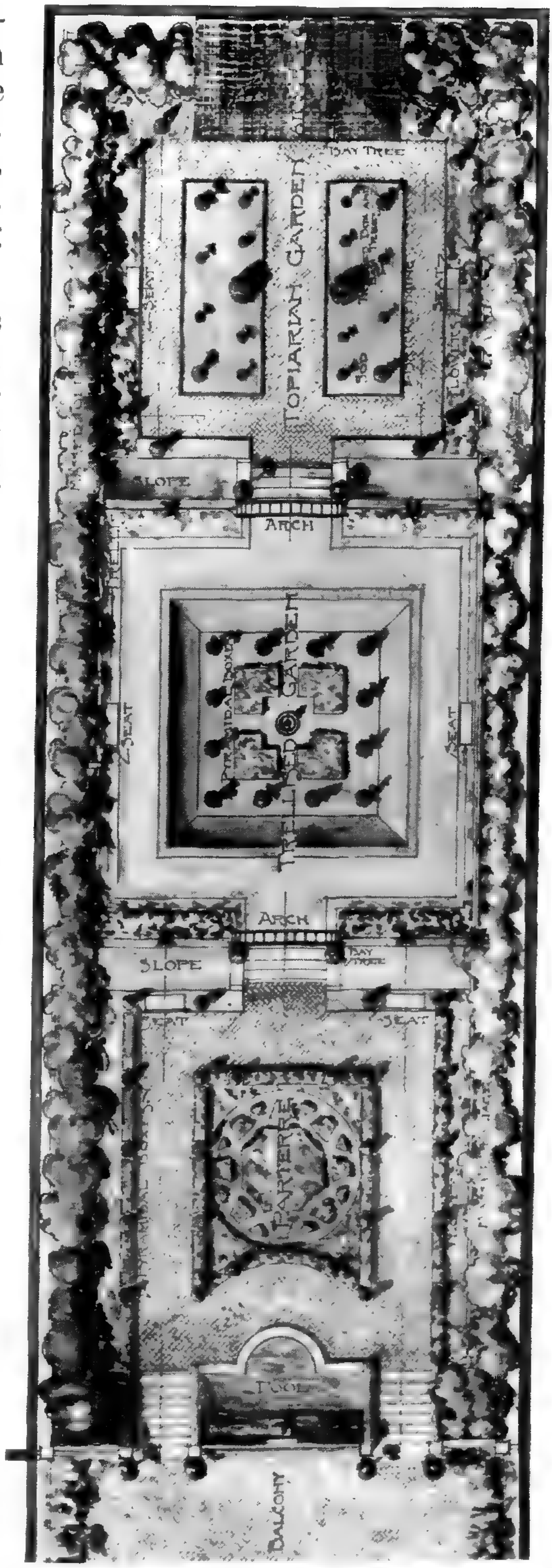
The garden of Shakespeare's time was always enclosed, sometimes by a wall of brick or stone, sometimes by a trellis fence or high hedge. "He hath a garden circummured with brick," writes Shakespeare. Flowering and fruiting vines covered the walls and trellises. Hedges were used inside the garden also, in various shapes and sizes, box, cypress, yew, privet, hawthorn, roses, fruit trees, juniper, hornbeam, and cornel being the plants most commonly employed. Wood-

trellised arbors were frequently used, though those of brick or stone were sometimes seen. Topiary work was of yew, box, privet, or juniper, the peacock forms being most popular.

Of all these famous old gardens, one only, Montacute, in Somersetshire, remains practically unchanged, although the gardens of Hatfield House, Hertfordshire, have been restored and may be considered typical of the period. Remnants of many gardens are left, however — examples of garden furniture, a few pleached alleys or mounts — and several good illustrations and written descriptions are extant.

Although Shakespeare wrote of many countries and peoples, his scenes and characters are essentially English, as are his plants and gardens. A Shakespearean garden, therefore, could not be other than an English garden of the period— an Elizabethan garden.

During the last week in April and the month of May such a garden will be shown in the floral display house of the new plant range. This will not be an attempt to copy any par-



PLAN OF SHAKESPEAREAN GARDEN TO BE ARRANGED IN FLORAL DISPLAY HOUSE.

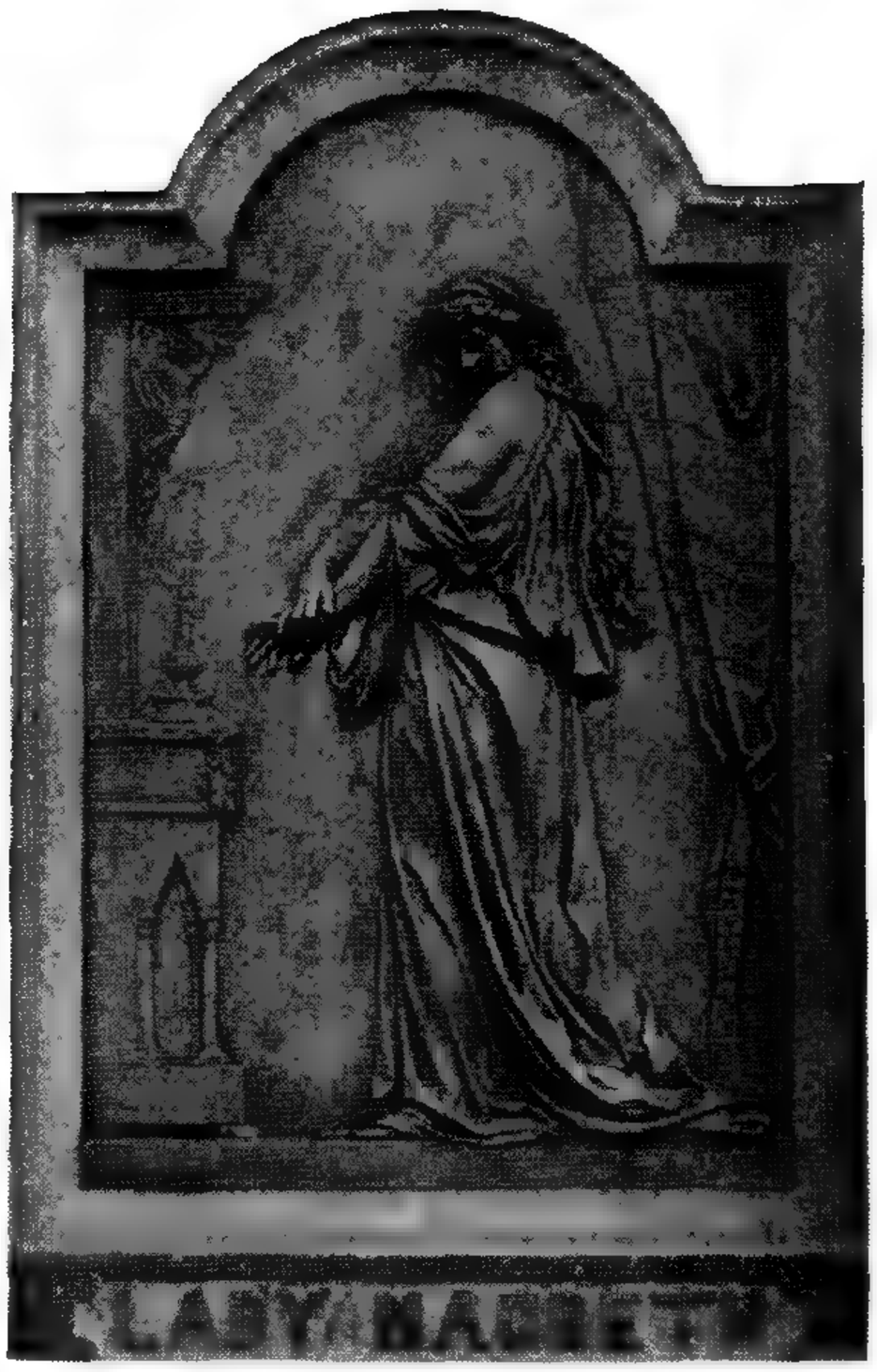
ticular garden of Shakespeare's time, and the limited area makes impossible anything but a garden in miniature. It will, however, embody most of the features that characterized the gardens of the Elizabethan period, the accompanying plan giving a good idea of the arrangement. The house will be divided into three square gardens, each 50 x 50 feet, the parterre, the trellised garden, and the topiarian garden, each dominated by several Elizabethan motifs.

The balcony of the floral display house, with the pool and

THE GARDEN AND MAZE AT HATFIELD HOUSE, HERTFORDSHIRE, BUILT 1605 AND RESTORED.

fountain below, lends itself admirably to the scheme, and affords a good view of the parterre or knot and the gardens beyond. The pattern to be used in this parterre was one very popular in Shakespearean times. The flower beds along the sides, as well as the parterre itself, will be bordered with a hedge of privet and juniper.

The trellised garden, as its name implies, will be enclosed by a high trellis with arched entrances, over which are to be trained climbing roses and other vines. This garden will be terraced, with turfed slopes, and flower beds and graveled walks above. The plan of the interior was taken from the lower garden at Montacute, the central portion being de-



pressed, a fountain, junipers, and small flower beds forming a part of the design. All woodwork in the parterre and trellised garden will be painted green and white.

The topiarian garden will be devoted principally to box trees trimmed into various shapes, an arbor of trellis work, covered with vines, terminating the main axis of the three gardens. The motif for the arbor was taken from the plans of the old Wilton House gardens, designed by Isaac de Caux. Within this garden will be shown the greater number of the collection of plants mentioned by Shakespeare in his works. It should be borne in mind that, while it is possible to identify most of these, some are doubtfully referred to existing species, and in a few cases the name used by Shakespeare may have been misleading. However, the list as given is the result of a careful compilation of all the information obtainable from various authorities, and is believed to be as accurate as anything of the kind that could be prepared.

A list of the trees, shrubs, vines, and flowers used in the three gardens, is as follows:

SHAKESPEAREAN NAME	SCIENTIFIC NAME	REFERENCE
Almond	*Amygdalus communis*	Troilus and Cressida, v. 2.
Apple	*Pyrus malus*	Twelfth Night, i. 5.
Ash	*Fraxinus americana*	Coriolanus, iv. 5.
Aspen	*Populus deltoides*	Second Henry IV, ii. 4.
Bachelor's buttons	*Gomphrena globosa*	Merry Wives of Windsor, iii. 2.
Balsam	*Pistacia Lentiscus*	Timon of Athens, iii. 5.
Barley	*Hordeum vulgare*	The Tempest, iv. 1.
Bay-tree	*Laurus nobilis*	Richard II, ii. 4.
Bean	*Faba vulgaris*	First Henry IV, ii. 1.
Birch	*Betula nigra*	Measure for Measure, i. 4.
Blackberry or Bramble	*Rubus fruticosus*	As You Like It, iii. 2.
Box	*Buxus sempervirens*	Twelfth Night, ii. 5.
Briar	*Rosa rubiginosa*	The Tempest, iv. 1.
Broom	*Cytisus scoparius*	Midsummer Night's Dream, v. 2.
Cabbage	*Brassica oleracea*	Merry Wives of Windsor, i. 1.
Camomile	*Anthemis nobilis*	First Henry IV, ii. 4.
Carnation	*Caryophyllus sp.*	Winter's Tale, iv. 3.
Carraway	*Carum Carvi*	Second Henry IV, v. 3.

SHAKESPEAREAN NAME	SCIENTIFIC NAME	REFERENCE
Caret	*Daucus Carota*	Merry Wives of Windsor, iv. 1.
Cherry	*Prunus Cerasus*	King John, ii. 1.
Clover	*Trifolium repens*	Henry V, v. 2.
Cockle	*Lychnis Githago*	Coriolanus, iii. 1.
Columbine	*Aquilegia vulgaris*	Hamlet, iv. 5.
Cork	*Phellodendron amurense*	Winter's Tale, iii. 3.
Corn	*Zea Mays* *Triticum vulgare* *Avena sativa*	The Tempest, ii. 1.
Corn-flower	*Lychnis Flos-cuculi*	Hamlet, iv. 7.
Currant	*Vitis corinthiaca*	Winter's Tale, iv. 2.
Cypress	*Cupressus sempervirens*	Taming of the Shrew, ii. 1.
Daffodil	*Narcissus Pseudo-Narcissus*	Winter's Tale, iv. 3.
Daisy	*Bellis perennis*	Cymbeline, iv. 2.
Darnel	*Lolium temulentum*	Henry V, v. 2.
Date	*Phoenix dactylifera*	Romeo and Juliet, iv. 4.
Dewberry	*Rubus caesius*	Midsummer Night's Dream, iii. 1.
Eglantine	*Rosa sp.*	Cymbeline, iv. 2.
Elder	*Sambucus canadensis*	Merry Wives of Windsor, ii. 3.
Elm	*Ulmus sp.*	Comedy of Errors, ii. 2.
Fennel	*Foeniculum vulgare*	Hamlet, iv. 5.
Fern	*Pteris aquilina*	First Henry IV, ii. 1.
Fig	*Ficus Carica*	Antony and Cleopatra, v. 2.
Flag	*Iris sp.*	Antony and Cleopatra, i. 4.
Flax	*Linum usitatissimum*	Merry Wives of Windsor, v. 5.
Flower-de-luce	*Iris Pseudacorus*	Winter's Tale, iv. 3.
Fumitory	*Fumaria officinalis*	Henry V, v. 2.
Garlick	*Allium odorum*	Coriolanus, iv. 6.
Ginger	*Zingiber officinale*	Merchant of Venice, iii. 1.
Gooseberry	*Ribes Grossularia*	Second Henry IV, i. 2.
Gorse	*Genista canariensis*	The Tempest, iv. 1.
Hawthorn	*Crataegus Oxycantha*	King Lear, ii. 4.
Hazel	*Hamamelis virginiana*	Romeo and Juliet, i. 4.
Heath	*Calluna vulgaris*, or any Erica	The Tempest, i. 1.
Holly	*Ilex opaca*	As You Like It, ii. 7.
Honeysuckle	*Lonicera Periclymenum*	Midsummer Night's Dream, iv. 1.
Hyssop	*Hyssopus officinalis*	Othello, i. 3.
Ivy	*Hedera Helix*	Comedy of Errors, ii. 2.
Knot-grass	*Polygonum aviculare*	Midsummer Night's Dream, iii. 2.
Laurel	*Laurea apolinus* (*Laurus nobilis*)	Troilus and Cressida, i. 3.
Lavender	*Lavendula officinalis*	Winter's Tale, iv. 3.
Leek	*Allium Porrum*	Henry V, iv. 1.
Lemon	*Citrus Lemonum*	Love's Labours Lost, v. 2.
Lettuce	*Lactuca sp.*	Othello, i. 3.
Lily	*Lilium candidum*	Two Gentlemen of Verona, ii. 3.
Lime	*Tilia sp.*	The Tempest, v. 1.
Locust	*Ceratonia Siliqua*	Othello, i. 3.
Mallow	*Malva sylvestris*	The Tempest, ii. 1.
Marigold	*Calendula officinalis*	Pericles, iv. 1.
Marjoram	*Origanum vulgare*	All's Well That Ends Well, iv. 5.
Mint	*Mentha piperita*	Winter's Tale, iv. 2.
Mulberry	*Morus rubra*	Coriolanus, iii. 2.
Mushroom	Hydnum, Boletus, and Agaricus	The Tempest, v. 1.

SHAKESPEAREAN NAME	SCIENTIFIC NAME	REFERENCE
Mustard	*Brassica nigra*	Taming of the Shrew, iv. 3.
Myrtle	*Myrtus communis*	Measure for Measure, ii. 2.
Oak	*Quercus sp.*	The Tempest, i. 2.
Oats	*Avena sativa*	King Lear, v. 3.
Olive	*Olea europaea*	Timon of Athens, v. 5.
Onion	*Allium Cepa*	Midsummer Night's Dream, iv. 2.
Orange	*Citrus Aurantium*	Much Ado About Nothing, ii. 1.
Oxlip	*Primula elatior*	Winter's Tale, iv. 3.
Palm tree	*Phoenix dactylifera* / *Salix Caprea*	As You Like It, iii. 2.
Pansy	*Viola tricolor*	Hamlet, iv. 5.
Parsley	*Carum Petroselinum*	Taming of the Shrew, iv. 4.
Peach	*Prunus Persica*	Second Henry IV, ii. 2.
Pear	*Pyrus communis*	Merry Wives of Windsor, iv. 5.
Pea	*Pisum sativum*	The Tempest, iv. 1.
Pepper	*Piper nigrum*	First Henry IV, iii. 1.
Pine	*Pinus sylvestris*	Troilus and Cressida, i. 3.
Pink	*Dianthus sp.*	Romeo and Juliet, ii. 4.
Piony	*Paeonia corallina*	The Tempest, iv. 1.
Plum, damson, prune	*Prunus communis* (?)	King John, ii. 1.
Pomegranate	*Punica Granatum*	All's Well That Ends Well, ii. 3.
Poppy	*Papaver somniferum*	Othello, iii. 3.
Potato	*Solanum tuberosum*	Troilus and Cressida, v. 2.
Primrose	*Primula veris*	Cymbeline, i. 6.
Pumpion	*Cucurbita Pepo*	Merry Wives of Windsor, iii. 3.
Quince	*Pyrus Cydonia*	Romeo and Juliet, iv. 4.
Radish	*Raphanus sativus*	Second Henry IV, iii. 2.
Raisin	*Vitis (Muscatel) sp.*	Winter's Tale, iv. 2.
Reed	*Arundo Phragmites*	Antony and Cleopatra, ii. 7.
Rhubarb	*Rheum sp.*	Macbeth, v. 3.
Rice	*Oryza sativa*	Winter's Tale, iv. 2.
Rose	*Rosa sp.*	Merry Wives of Windsor, iii. 1.
Rosemary	*Rosmarinus sp.*	Pericles, iv. 6.
Rue	*Ruta graveolens*	Richard II, iii. 4.
Rush	*Acorus Calamus*	As You Like it, iii. 2.
Rye	*Secale cereale*	The Tempest, iv. 1.
Saffron	*Crocus sativus*	Comedy of Errors, iv. 4.
Savory	*Satureia sp.* (?)	Winter's Tale, iv. 3.
Strawberry	*Fragaria vesca*	Othello, iii. 3.
Sugar	*Sorghum vulgare*	Merry Wives of Windsor, ii. 2.
Sycamore	*Platanus orientalis*	Romeo and Juliet, i. 1.
Thistle	*Carduus sp.*	Henry V, v. 2.
Thorn	*Crataegus Oxycantha*	The Tempest, iv. 1.
Thyme	*Thymus vulgaris*	Othello, i. 3.
Turnip	*Brassica Rapa*	Merry Wives of Windsor, iii. 4.
Vetch	*Vicia sativa*	The Tempest, iv. 1.
Vine	*Vitis sp.*	Antony and Cleopatra, ii. 7.
Violet	*Viola sp.*	Cymbeline, i. 6.
Walnut	*Juglans regia*	Taming of the Shrew, iv. 3.
Wheat	*Hordeum vulgare*	Merchant of Venice, i. 1.
Willow	*Salix Caprea*	Twelfth Night, i. 5.
Wormwood	*Artemisia sp.*	Love's Labours Lost, v. 2.
Yew	*Buxus sempervirens*	Romeo and Juliet, v. 3.

Below are given the titles of a few of the more important books pertaining to flowers and plants mentioned by Shakespeare:

Ellacombe, Henry N. The plant-lore and garden-craft of Shakespeare. Exeter, 1878.

Foxton, W. Shakespeare garden and wayside flowers. With appropriate quotations for every flower. London, 1914.

Giraud, I. E. The flowers of Shakespeare. Faversham, 1846. A collection of lithographed and hand-colored plates, most of which are signed I. E. G., bearing quotations from Shakespeare. To be shown in the arbor of the Shakespearean garden.

Grindon, Leo H. The Shakspere flora. Manchester and London, 1883. A guide to all the principal passages in which mention is made of trees, plants, flowers, and vegetable productions; with comments and botanical particulars.

MacBride, Thomas H. The botany of Shakespeare. Davenport, Iowa, 1899.

NATURAL GRAFTS

Grafting, in the horticultural sense, is an art which has been handed down from antiquity. The operation consists essentially in closely joining two cut surfaces of one or different plants, so that, under proper conditions, the parts will unite and continue to grow. That part which, by means of its roots, supplies the nutrients for growth, is known as the stock, and that which is inserted into, or brought in contact with the stock, is called the scion.

Just when the art of grafting was discovered is not certain. That it was well known and practiced by the Romans is shown by references in the classical literature. As was commonly the case, however, the art was closely bound with tradition and superstition, and statements appear that are not founded upon fact. It is now well established that, in general, grafting is possible only between members of the same or closely related species or genera of plants. Nevertheless, in the writings of Columella one finds the statement that the olive may be grafted upon the fig tree. Pliny speaks of a tree in the garden of Lucullus which was grafted to bear pears, apples, figs, plums, olives, almonds, and grapes; and Virgil says:

> "But thou shalt lend
> Grafts of rude arbute unto the walnut tree,
> Shalt bid the unfruitful plane sound apples bear,
> Chestnuts the beech, the ash blow white with the pear,
> And under the elm the sow on acorns fare."

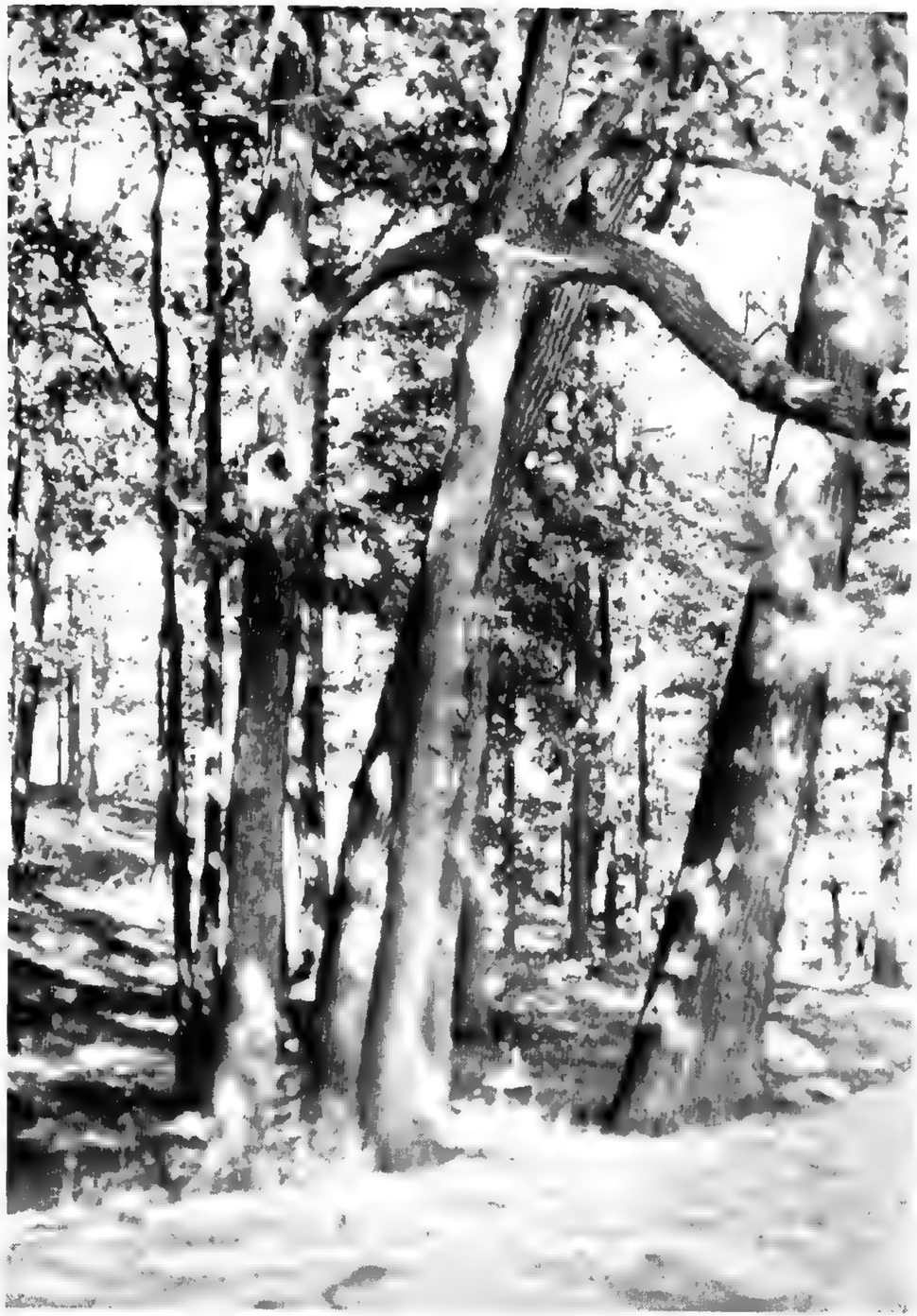


FIG. 1. NATURAL GRAFT OF RED OAKS AT WORCESTER, MASSACHUSETTS.

FIG. 2. SELF-GRAFTS ON HAWTHORN IN GARDEN.

MO. BOT. GARD. BULL., VOL. 4, 1916.

FIG. 1. SELF-GRAFTS ON OSAGE ORANGE IN GARDEN.

FIG. 2. SELF-GRAFTS ON GINKGO IN GARDEN.

Curious traditions were associated by the ancients with grafting operations. Thus Pliny emphasizes the fact that the graft must not be sharpened while the wind blows; and again, "It is a point most religiously observed to insert the graft during the moon's increase."

There are numerous modes of grafting, but the one of present interest is that known as grafting by approach or inarching. If we believe, with Pliny, that this art was taught to man by nature, it is highly probable that examples of natural inarching were the inspiration of present grafting practices. Inarching differs from other modes of grafting in that it involves the union of two individuals growing on their own roots. When this method is used in horticulture, the plant intended for the scion is severed from its lower portion as soon as the union of the two individuals is complete. Natural grafts are, of course, purely the result of chance. The essential condition for their development is the same as in artificial grafting, namely, that the region of actively growing cells—the cambium layer—of both plants shall be in close contact. In nature this is effected when two trees of the same or related species grow sufficiently close together for a branch of one to interlock with, or to grow across and in contact with, a branch of the other. The continued growth of both branches causes great pressure and friction, which is increased by winds, so that ultimately the bark is worn away, the cambium regions come in contact, and union of the limbs occurs. Plate 9, fig. 1, shows such a union of two red oaks (*Quercus rubra*) growing in Worcester, Massachusetts.

Of more common occurrence than natural grafts between two individuals are those between two portions of the same plant. Trees furnish many examples of this type of union, which may be regarded as natural bridge grafting or self-grafting. Thus a tree, branching from its trunk, may develop limbs which unite in the manner just described.

There are several examples of self-grafted trees in the Garden, which visitors may be interested in seeing. Plate 9, fig. 2, shows a self-grafted hawthorn (Crataegus) on the left side of the path which parallels the east wall of the Garden, about two hundred feet north of the main entrance. If, upon entering the main gate, one turns directly to the left and takes the path to the south along the same wall, he will come to a striking self-grafted specimen of Osage orange, *Maclura pomifera* (Plate 10, fig. 1), one of a group of five trees about one hundred feet north of the Cleveland Avenue gate and about fifteen or twenty feet west of the path. In both hawthorn and Osage orange the union has been effected in several places, indicated by the arrows.

TWO VIEWS OF A SELF-GRAFT AT THE FORK OF TWO BRANCHES.

Another interesting example is the Chinese maidenhair tree (*Ginkgo biloba*), standing a few feet east of the path that leads from the main conservatories to the floral display house. In this case a bridge graft has been formed by a small branch which has developed from the trunk, and, turning up and inward in its growth, has united with the juncture of two larger limbs with the main stem (Plate 10, fig. 2). This graft is seen to greatest advantage from the southeast. All the examples cited can be best observed during the season of defoliation. An unusual type of self-grafting is shown in Plate 11. In this case a branch has grown between two smaller ones and has united with them at the fork.

FLORAL DISPLAY FOR MARCH

At the end of February the present collection of flowering plants in the floral display house, consisting of poinsettias, rhododendrons, azaleas, etc., will be removed, and an entirely new show installed for the month of March. The new display will be composed mainly of the many varieties of cinerarias. The great difference in habit and color of the flowers has made these plants immensely popular for display purposes, and the Garden is showing some 2000 specimens this season in the hopes of presenting an exhibit which will rival that of the chrysanthemums in November. Cinerarias, in many ways, resemble the single-flowered chrysanthemums, but far surpass them in the brilliancy of the floral coloring, white and all shades of red, blue, and purple being included. In the new floral display house these plants will be seen to better advantage than ever before.

In addition to the main exhibit, as indicated above, there will be shown a number of plants of astilbe, a white or pinkish plume-like flower, and some genistas, yellow-flowering plants, which have been clipped to take the form of the common round bay-trees. Later in the month a large variety of snapdragons or antirrhinums will be on display, and these, with the calceolarias, are to be transferred to the flower alcoves of the aroid house during the latter part of April. In the same alcoves many orchids, such as *Cattleya labiata, C. Mossiae,* and a variety of cypripediums or lady slipper orchids, are now in flower.

This exhibit in the floral display house will be replaced during the last week of April by the Shakespearean garden, referred to elsewhere in the BULLETIN.

NOTES

On February 11, the class from the University of Illinois Library School visited the Garden library.

Mr. W. H. Chambers of the Department of Dairy Bacteriology, University of Illinois, was a visitor at the Garden on February 9.

The Engineering News, February 3, contains an article on "Creosote for Wood Block Paving" by Dr. Hermann von Schrenk, Pathologist to the Garden.

Mr. R. A. Studhalter, Rufus J. Lackland Research Fellow, gave an illustrated talk on the Garden and its activities at the San Antonio High School, December 22.

Dr. George T. Moore, Director of the Garden, delivered an address, January 29, before the Massachusetts Horticultural Society at Boston, on "The Missouri Botanical Garden."

On February 17, Mr. W. W. Ohlweiler, General Manager to the Garden, spoke before the American Wheel Association at the American Annex on "The Missouri Botanical Garden."

Mr. I. C. Hoffman, Industrial Fellow and Graduate Student, Department of Horticulture, Purdue University, has registered in the graduate laboratory for special work during the second term.

Dr. Simoens da Silva, representative of the Brazilian government at the 19th International Congress of Americanists, and of several scientific societies of Brazil to the 2nd Pan-American Scientific Congress, visited the Garden, February 10.

A meeting of the Timber Committee of the American Society for Testing Materials was held at the Garden on February 8, and on February 9 the Committee on Lumber of the American Railway Engineering Association met at the Garden.

The paper of Dr. M. C. Merrill on "Some Relations of Plants to Distilled Water, Etc.," which appeared in the September number of the Annals of the Missouri Botanical Garden, has been reprinted in full in the American Journal of Pharmacy.

Dr. B. M. Duggar, Physiologist to the Garden, lectured before the St. Louis Academy of Science, January 3, on "An Economic Fungus of Wide Distribution," and before the Missouri State Horticultural Society, January 13, on "The Development of Color in Flowers and Fruits."

The following addresses have been recently made by Dr. Hermann von Schrenk, Pathologist to the Garden: On January 5, "Timber Specifications," before the Society of Federal Contractors, U. S. Treasury Department; January 18, "Fungi Which Grow on Timber," before Convention of American Wood Preservers' Association, Chicago; January 20, "Timber Conservation and Use," before Meeting of Architects at Minneapolis; January 25, "Timber Conservation and Use," before Illinois Society of Architects, Chicago; January 27, "Timber Conservation and Use," before the Architects of Detroit.

STATISTICAL INFORMATION FOR JANUARY, 1916

GARDEN ATTENDANCE:

Total number of visitors	5,138

PLANT ACCESSIONS:

Total number of plants received in exchange	130
Total number of packets of seeds received in exchange	6

PLANT DISTRIBUTION:

Total number of plants distributed in exchange	25

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought	24
Total number of books and pamphlets donated	28

HERBARIUM ACCESSIONS:

By Purchase—

E. Bartholomew—"Fungi Columbiani," Cents. XLVII and XLVIII, Nos. 4601-4800	200
Rev. John Davis—Plants of Missouri	300
F. C. Seymour—Plants of Hampden Co., Massachusetts, Nos. 134-313	179
Th. O. Weigel—"Cyperaceae, Juncaceae, Typhaceae et Sparganiaceae Hungaricae exsiccatae," Fasc. I-IV, Nos. 1-200	200

By Gift—

B. F. Bush—Mosses of New York	3
B. F. Bush—Mosses of Missouri	900
S. H. Burnham—Fungi of Lake George region, New York	39
J. A. Drushel—Plants of Ohio, Missouri, Texas, Colorado, and California	35
O. S. Ledman—*Covillea glutinosa* (Engelm.) Rydb. from Laredo, Texas	1
G. E. Morris—Specimens of fungi from New Hampshire	7
W. W. Ohlweiler—Private herbarium, consisting of plants of Connecticut and Missouri, also numerous horticultural varieties (estimated at)	600
A. H. W. Povah—Fungi from Michigan, chiefly	19
W. S. Reeves—*Phoradendron flavescens* Nutt. from California	1
Edward Teas—*Tsuga Sieboldii* Carr. cultivated at Houston, Texas	1

Exchange—

E. E. Sherff—Photographs of type specimens of *Bidens*	13
TOTAL	2,498

The Garden is open to the public every day in the year, except New Year's, Fourth of July, Labor Day, and Christmas—week days from 8:00 A. M. until one-half hour after sunset; Sundays, from December to April, 1:00 P. M. until sunset, from April to December, 2:00 P. M. until sunset.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Boulevard, on the Vandeventer Avenue car line. Transfer south from all intersecting lines.

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MISSOURI BOTANICAL GARDEN BULLETIN

ALUMNI NUMBER

Vol. IV MARCH, 1916 No. 3

CONTENTS

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1916
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VIEW FROM CATHEDRAL GROUNDS AT SALISBURY, ENGLAND.

THE BISHOP'S PALACE, SALISBURY.

Missouri Botanical Garden Bulletin

ALUMNI NUMBER

Vol. IV St. Louis, Mo., March, 1916 No. 3

A MESSAGE FROM THE PRESIDENT OF THE ALUMNI ASSOCIATION

It is with much joy and extreme gratification that I contribute these lines to the first official publication of the Missouri Botanical Garden Alumni Association. This number opens a new era for the Alumni Association, and demonstrates clearly that the organization has various distinct functions to perform. It is still in its infancy, and if it is to be a success must have the continued coöperation of all who have so generously responded to the first call. Every graduate should be a member of the Association, for he will in some way benefit by it. A friend of mine and a well-known horticultural writer recently made the following statement with reference to affiliation with a certain national society:

> "If advancement is to be made the man of to-morrow must be better than the man of yesterday or the man of to-day; if not, his efficiency and his chance for success will measure low in comparison with the standards set by his more intelligent and progressive fellows. To a young man imbued with the right purpose and spirit to go ahead, affiliation with an organization which can count in its ranks the leading men in their class, as our great national society unquestionably does, cannot but serve as a healthy stimulant and practical helper."

I like to feel this way about our organization, which, although young, has already shown that the men who were responsible for bringing it into life had a broad vision. If the Association has done nothing else, it has at least brought the graduates of the Garden course into closer contact, and it has familiarized them with the work and the wonderful progress that has been made at the institution where they spent four of the best years of their lives.

The alphabetical list of the graduates contained in this issue should be of value to all members of the Association, for it not only shows where and in what lines of work the men are engaged, but also proves that the men who have graduated from this course are among the leaders in all lines of hor-

ticultural work. To the present students this should serve as an inspiration, and prove to them that the time they are spending at the Garden is time well spent.

As president of the Association I am happy to have the opportunity to send greetings to all members. I beg of them a continuance of their loyalty and willingness to coöperate with the officers, so that a permanent institution may be built up, which will in the future receive national recognition.

In conclusion I wish to thank my fellow officers, especially Secretary Gross, for his splendid work and coöperation. I also wish to express my gratitude to Dr. Moore and the Board of Trustees for placing this number of the BULLETIN at our disposal.

ARNO H. NEHRLING,
Head of Department of Floriculture,
Massachusetts Agricultural College,
Amherst, Massachusetts.

GARDEN STUDENTS, MEMBERS OF MISSOURI BOTANICAL GARDEN ALUMNI ASSOCIATION

Bogula, Otto.—Born, Detroit, Mich., November 20, 1875; son of C. H. and Minnie Bogula. Completed grammar school course and attended high school one year; awarded Garden scholarship, 1893; graduated, 1897. Horticulturist, Mt. Holyoke College, South Hadley, Mass., one year; gardener, Kew Gardens, London, England, 1898-99, while there making herbarium of British native plants listed in London catalogue. Between April, 1899, and February, 1906, held the following positions: propagator and sub-foreman, Mt. Desert Nurseries, Bar Harbor, Me.; gardener for Mr. W. J. Van Patten, Burlington, Vt.; in charge of greenhouses for Capitol Avenue Greenhouses, Lansing, Mich.; head gardener, Water Works Park, Jackson, Tenn.; in charge of improvement work, Stevens estate, Martinsville, Va. In charge of herbaceous and seed departments, Missouri Botanical Garden, 1906-11; at present engaged in commercial floriculture, Detroit, Mich. Address, 394 Military Avenue, Detroit, Mich.

Cella, Andrew Jameson.—Born, St. Louis, Mo., July 19, 1896; son of James A. and Minnie (Mueninghaus) Cella. Graduated from St. Louis grammar school and attended high school six months, leaving to enter law department, M. K. & T. Railroad; entered Garden, July, 1912; awarded scholarship, September, 1913, which is still holding.

Craig, Clark W.—Born, Winnebago Co., Wis., June 23, 1891; son of Lucius N. and Bertha (Walker) Craig. At-

tended grammar school, Ripon Academy one year, and Winnebago County Agricultural College two years; entered Garden, 1909; left, 1911. Instructor, Bee County Agricultural School, Tex.; employed in drug mills, Fond du Lac, Wis.; later in charge of drug plant farm, Kansas; now on own farm, following dairying and fruit growing. Married, August 4, 1915, to Lola M. Waite. Address, Rush Lake, Wis.

Deusner, Charles W.—Born, Terre Haute, Ind., December 1, 1876; son of William and Philapena (Newhart) Deusner. Graduated from grammar school, Terre Haute, Ind. Engaged in vegetable and fruit gardening; then in publishing house until awarded Garden scholarship in 1896; graduated, 1900. Entered office of O. C. Simonds, landscape gardener, Chicago, later becoming member of O. C. Simonds & Co.; in 1912 withdrew, and for two years engaged in practice of landscape architecture at Pasadena, Cal.; now engaged in horticulture near Batavia, Ill. Married, November 6, 1912, to Helen A. Dupuy.

Erwin, Arthur T.—Born, Fulton, Mo., November 8, 1874; son of J. L. and Elizabeth (Birney) Erwin. Attended grammar and high school; awarded Garden scholarship, 1892; graduated, 1896. Superintendent of planting in St. Louis for Olmsted Bros. for two years; special student in horticulture, University of Missouri, 1898; assistant in horticulture, University of Arkansas, 1899, taking undergraduate work and receiving B. S. degree; graduate work, 1900-02, Iowa State College, and granted M. S. degree. From then until present time located at Ames, Ia.; major portion of work in class room until 1914, since which time attention devoted wholly to experimental work, mainly truck crops; at present chief in truck crops, Iowa Agricultural Experiment Station. Married, 1906, to Mary E. Turner; three children.

Federer, William A.—Born, St. Louis, Mo., February 4, 1887; son of William and Agnes (Faust) Federer. Attended SS. Peter and Paul Parochial School and St. Louis public high school; entered Garden, 1904; left to enter advertising business in St. Louis and various other cities. Later connected with Tower Grove and Southwestern Building Association, St. Louis, and became interested in land development work in Alabama; in May, 1914, entered general real estate and insurance business, in which is still engaged. Address, 2615 S. Jefferson Avenue, St. Louis, Mo.

Fuhr, Clara.—Born, Augusta, St. Charles Co., Mo., April 9, 1883; daughter of Otto J. and Theresa (Hundhausen) Fuhr. Attended Augusta public school; graduated, Missouri

State Normal School, Warrensburg, Mo. Teacher, St. Charles County schools, State Normal School at Warrensburg, and high school at Liberty, Mo.; at present Garden student. Address, 1921 Oregon Avenue, St. Louis, Mo.

Fullgraf, Charles W.—Born, St. Louis, Mo., October 8, 1884; son of William and Anna (Matthews) Fullgraf. Attended public schools, St. Louis; awarded Garden scholarship, 1900; graduated, 1904. In charge of Garden North American tract and arboretum until November, 1908; inspector for St. Louis city forester until February, 1910; from 1910 until present engaged in practice of landscape gardening and forestry, St. Louis. Address, 1104 Chemical Building, St. Louis, Mo.

Giebel, Carl Frederick.—Born, St. Louis, Mo., 1895; son of Phillip and Marie Giebel. Completed grammar school and attended high school at St. Louis three years; awarded Garden scholarship, 1912, which is still holding.

Gillies, Walter.—Born, Osage, Mo., June 11, 1884; son of E. M. and T. Gillies. Attended grammar school; entered Garden, 1903; left to take charge of conservatories, Louisiana Purchase Exposition. Later in employ of Michel Plant & Bulb Co. and Eggling Floral Co., St. Louis; now foreman, Forest Park greenhouses, St. Louis. Married, December, 1904, to Estella Lindsey; five children. Address, 5700 West Park Avenue, St. Louis, Mo.

Gross, Arthur R.—Born, Jefferson City, Mo., July 12, 1879; son of Robert and Elise (Spitz) Gross. Completed grammar school course; graduated high school, Belleville, Ill., 1896; entered Garden as special student, 1896; awarded scholarship, 1897; graduated, 1901. In charge of Garden North American tract until October, 1901, when took charge of extension work, Mt. Greenwood Cemetery, Morgan Park, Chicago, under Mr. W. N. Rudd. With exception of six months spent in office of O. C. Simonds, Chicago, and one year as superintendent, Lafayette Park, St. Louis, continued in this work until appointed superintendent of Mt. Greenwood Cemetery, 1909; at present acting in this capacity. Married, July 11, 1908, to Julia E. Martin; one son. Address, Mt. Greenwood Cemetery, Morgan Park, Chicago, Ill.

Grossart, Frederick Gustave.—Born, Belleville, Ill., May 23, 1894; son of Gustave William and Emelia (Fuchs) Grossart. Attended grammar school, and one and one-half years high school, Belleville, Ill.; awarded Garden scholarship, 1911; graduated, 1915. Appointed head gardener in charge of landscape and greenhouse work, Valhalla Cemetery, St. Louis, which position now holds.

Haltenhoff, Karl A.—Born, Wilhelmsberg, Germany, October 2, 1891; son of Fritz Ernst and Elise (Gerberding) Haltenhoff. Attended Oakland and Winter Garden high schools, Oakland, Fla.; awarded Garden scholarship, 1909; graduated, 1913. From graduation to August, 1914, employed by Muskopf-Irish Co., St. Louis, as city foreman and draftsman, and by Mr. H. Nehrling, of Palm Cottage Gardens, Fla.; since then in charge of landscape work for the Kemble, Smith, Flindt Co., Boone, Ia.

Hummel, Walter H.—Born, Milwaukee, Wis., January 22, 1884; son of Henry D. and Elise (Markert) Hummel. Attended grammar school, high school, and business college, Milwaukee; for some time assistant-foreman on ranch in Dakota; entered Garden, 1903; left to enter employ of Currie Bros. Co., florists, Milwaukee. Associated with father in real estate business four years; for past eight years, manager for Hummel & Co., florists. Address, 641 Third Street, Milwaukee, Wis.

Jones, Shelby C.—Born on farm, Wayne Co., Ill., August 13, 1883; son of Thomas H. and Laura (Johnson) Jones. Attended grammar school in Kansas, Jenning's Seminary, Aurora, Ill., and Lake View High School, Chicago; awarded Garden scholarship, 1903; graduated, 1907. From graduation until August, 1909, employed at the Garden in herbaceous, nursery, and seed-collecting departments, and at Vaughan's Seed Store, Chicago, as catalogue compiler; then assistant to advertising manager of Jas. S. Kirk & Co., manufacturers perfumes, and chemists, Chicago. From November, 1910, to May, 1911, chief, publicity department, J. Horace McFarland Co., publishers, Harrisburg, Pa.; since then, manager publicity department, Jas. S. Kirk & Co., Chicago. Married, September 5, 1910, to Agnes Mae Barney; one child. Address, 1770 Morse Avenue, Chicago, Ill.

Kohl, Paul A.—Born, Indianapolis, Ind., March 28, 1895; son of Julius F. and Ida (Reis) Kohl. Attended grammar school, Belleville, Ill.; graduated from high school, St. Louis. From graduation until entered Garden in fall, 1914, where is still studying, employed as stenographer, Terminal Railway Association, St. Louis.

Mische, Emil T.—Born, Syracuse, N. Y., January 29, 1874; son of John Henry and Sophia (Nubbers) Mische. Attended high school at Syracuse; awarded Garden scholarship, 1892; graduated, 1896. From graduation until January, 1898, post-graduate work at Arnold Arboretum, Boston, Mass., and Royal Botanic Gardens, Kew, England; for eight years assistant to Olmsted, Olmsted & Eliot, later to Olmsted

Bros., landscape architects, Brookline, Mass., during which developed the plan of the Missouri Botanical Garden, including a remodeling of the Garden area and the extension of the 20-acre farm and the 80-acre pasture. January, 1906, to March, 1908, park superintendent, Madison, Wis.; for six and one-half years park superintendent, later landscape advisor, Portland, Ore. Married, July 8, 1898, to Nellie M. Carpenter; four children. Address, 394 Jackson Street, Portland, Ore.

Mohr, Rudolph J.—Born, Omaha, Neb., May 3, 1880; son of Bernhard M. and Louisa (Meyers) Mohr. Attended grammar school, and high school one and one-half years; in greenhouse work two and one-half years before receiving Garden scholarship in 1898; graduated, 1902. Travelled for Plant Seed Co., St. Louis; later with Chicago Carnation Co., Joliet, Ill.; assistant superintendent, British exhibit, Louisiana Purchase Exposition, and with W. J. Smythe, florist, Chicago. Purchased floral business in Racine, Wis.; later in charge of nursery and fruit plantation in Idaho; at present, manager for A. Lange, florist, Chicago. Married, August 17, 1907, to Kathryn Park; one child. Address, 4122 Kenneth Avenue, Chicago, Ill.

Nehrling, Arno H.—Born, Freistadt, Mo., July 25, 1886; son of Henry and Sophia (Schoff) Nehrling. Attended public schools, and Concordia College, Milwaukee; awarded Garden scholarship, 1905; graduated, 1909. Instructor, nature study and school gardening to July, 1909; assistant in floricultural department, University of Illinois, until 1910, when appointed instructor; appointed associate in floriculture, 1912; in 1914 appointed head of department of floriculture, with rank of associate professor, Massachusetts Agricultural College, Amherst, Mass.

Nehrling, Bruno.—Born, Houston, Tex., June 27, 1879; son of Henry and Sophia (Schoff) Nehrling. Finished preparatory work, Concordia College, Milwaukee; awarded Garden scholarship, 1899; graduated, 1903. For a time employed at Louisiana Purchase Exposition; superintendent of grounds, 1904-14, and later instructor, normal department, Illinois State Normal School, Normal, Ill.; for short time had own office for practice of landscape gardening; since March, 1914, superintendent and stockholder, South Bend Highland Cemetery, South Bend, Ind. Married, April 18, 1904, to Eleanor L. Michel; four children.

Nehrling, Walter H.—Born, Chicago, Ill., February 28, 1877; son of Henry and Sophia (Schoff) Nehrling. Attended Lutheran schools and Concordia College, Milwaukee; awarded

Garden scholarship, 1895; graduated, 1899. In charge of herbaceous section at Garden until 1903; since then superintendent of grounds and landscape gardener, Eastern Illinois State Normal School, Charleston, Ill. Married, January 1, 1900, to Elizabeth Dunford; two children.

Nyden, Edwin.—Born, Marshalltown, Ia., April 26, 1890; son of George and Ida Nyden. Attended grammar and high schools, Marshalltown, Ia.; awarded Garden scholarship, 1907; graduated, 1911. In construction and greenhouse work, St. Louis park department, two years, and general contracting business, Portland, Ore., one year; since then landscape architect, School District No. 1, comprising Portland and suburbs. Address, 303 Courthouse, Portland, Ore.

Ochs, Henry L.—Born, St. Louis, Mo., August 31, 1888; son of Henry and Anna Ochs. Attended St. Louis grammar schools, and high school three years; awarded Garden scholarship, 1905; graduated, 1909. One and one-half years in charge of Garden North American tract, one year with Michel, florist, St. Louis, and later with Grimm & Gorly, St. Louis. After engaging in window trimming, entered employ Anheuser-Busch Brewing Co., St. Louis, where is in charge receiving department. Married, October 21, 1910, to Erna Mueller; one son.

Pedlow, Clarence.—Born, Indianapolis, Ind., 1895; son of Richard J. Pedlow. Graduated Shortridge High School, Indianapolis; before entering Garden employed by Indianapolis Flower & Plant Co. and Rodenbeck Bros., floral establishment, Indianapolis; entered Garden, October, 1914, where is now studying. Address, 2721A Kingshighway, St. Louis, Mo.

Philippi, Nestor Simmons.—Born, St. Louis, Mo., 1893; son of Matilde (Simmons) Philippi. Attended grammar school, and high school, St. Louis, one year; entered Garden as a special student, 1912; awarded scholarship, 1913, which is still holding.

Pillsbury, Joshua Plummer, Jr.—Born, Buena Vista, Ohio, December 7, 1873; son of Joshua Plummer and Harriet (Ross) Pillsbury. Attended grammar school and high school, Newark, Ohio; awarded Garden scholarship, 1891; graduated, 1894. After graduation, until 1911, at Pennsylvania State College, State College, Pa., at first as head gardener, then assistant in horticulture, in charge of floriculture and landscape gardening; later assistant professor of horticulture, securing in meantime B.S. degree; from then until present time, professor of horticulture, North Carolina College of

Agriculture and Mechanic Arts, West Raleigh, N. C. Married, October 17, 1895, to Charlotte Dunford; two children.

Retzer, Walter.—Born, Frankfort-on-Main, Germany, August 27, 1879; son of Carl and Emma (Urich) Retzer. Attended public schools and Miss Byrne's private school, St. Louis; awarded Garden scholarship, 1895; graduated, 1899. With O. C. Simonds, Chicago, about one year, then purchased floral establishment of Albert Fuchs, Chicago, retaining same three years; practiced landscape gardening; later opened floral establishment, Seattle, Wash. Associated with Grimm & Gorly and St. Louis Seed Co., St. Louis, 1906-10; general manager of plantation, Honduras National Railway Co., Spanish Honduras; farmed three years in Texas; established the "Gulf Florist" with A. E. Dosbaugh, 1913; assumed entire ownership, 1915. Married, November 14, 1902, to Irene Urich; three children. Address, Corner Main and Rusk Streets, Houston, Tex.

Schulte, George D.—Born, Oregon, Mo., June 4, 1882; son of Daniel and Louisa Schulte. Graduated from Oregon High School; awarded Garden scholarship, 1903; graduated, 1907. During 1907 greenhouse assistant, Mt. Greenwood Cemetery, Chicago, and superintendent ranch near Saratoga, Wyo.; at present engaged in farming and stock raising, Oregon, Mo.

Smith, Arthur H.—Born, Marshalltown, Ia., August 29, 1889; son of Charles J. and Bessie (Thimanson) Smith. Attended public schools, Marshalltown, Ia.; awarded Garden scholarship, 1907; graduated, 1911. Associated with I. O. Kemble in florist business, Boone, Ia.; July, 1912, incorporated Kemble, Smith, Flindt Co., enlarging business and adding ornamental nursery; now secretary and treasurer, acting as manager of the firm. Married, July 14, 1915, to Alice S. Hartman.

Sutermeister, Eda A.—Entered Garden, 1897; received certificate, 1900. For two years with George E. Kessler, landscape gardener, Kansas City, Mo.; 1903-06, associated with George E. Kessler, advisory landscape architect, Louisiana Purchase Exposition; 1906-08, general planting work, Kansas City, Mo.; since 1908 with George E. Kessler, Kansas City and St. Louis. Address, 423 Security Building, St. Louis, Mo.

Toeppen, Herta A.—Born, Hamburg, Germany, May 14, 1881; daughter of Hugo and Anna (Weissermel) Toeppen. Graduated, Mary Institute, St. Louis; entered Garden, 1901; received certificate, 1909. From 1903 to 1906 gardener, Selma, Mo., with St. Louis Carnation Co., and Michel Plant &

Bulb Co.; later, instructor, College of Industrial Arts, Denton, Tex., and grower, Pekin, Ill., and Akron, N. Y. One and one-half years assistant at Gratwick Laboratory; at present instructor of swimming, 20th Century Club, Buffalo, N. Y. Address, 595 Delaware Avenue, Buffalo, N. Y.

Tuggle, Jesse B.—Born, Lawson, Mo., June 6, 1888; son of George B. and Ida (Marsh) Tuggle. Attended high school; entered Garden, 1907; left, 1909, to enter landscape contracting, Kansas City. After two years took position of assistant manager of agricultural and horticultural department and general manager of campus, Park College, Parkville, Mo.

Tull, J. Hollister.—Born, Morganton, N. C., May 29, 1882; son of Dr. John and Lizzie (McKeehan) Tull. Educated, private schools, Morganton, N. C.; two years previous to entering Garden, with American Rose Co., Washington, D. C., and Dreer's Nurseries, Philadelphia; awarded Garden scholarship, 1900; graduated, 1904. Entered horticultural department, Louisiana Purchase Exposition, 1904; fall, 1904, assistant in horticultural department, Cornell University; spring, 1905, office of foreign seed and plant introduction, United States Department of Agriculture. Explorer in this and foreign countries for three years, after which appointed assistant superintendent of Arlington experiment farm, Washington, D. C.; the following year appointed agricultural commissioner for the Kansas City Southern Railroad, holding this position at present. Married, June 2, 1908, to Grace L. Cavanagh.

Washburn, George A.—Born, Danvers, Ill., September 22, 1873; son of Andrew and Cordelia (Loomis) Washburn. Attended grammar school; entered Garden, 1890; left, 1891, to enter floral business with two brothers in Bloomington, Ill. Married, March 26, 1903, to Anna B. Percy; three children.

Winther, Cornelius.—Born, St. Louis, Mo., October 28, 1880; son of Hans Nielsen and Anne (Petersen) Winther. Completed grammar school, St. Louis; awarded Garden scholarship, 1896; graduated, 1900. Gardener, Tower Grove Park, St. Louis, summer of 1900; about one year in horticultural department, Agricultural College, Texas; since 1902, in charge of gardening work, Bellefontaine Cemetery, St. Louis.

IN MEMORIAM

Since the establishment of the Garden course in 1890, the graduates have suffered the loss of two of their number, Clyde M. Blankenship and Homer Riggle.

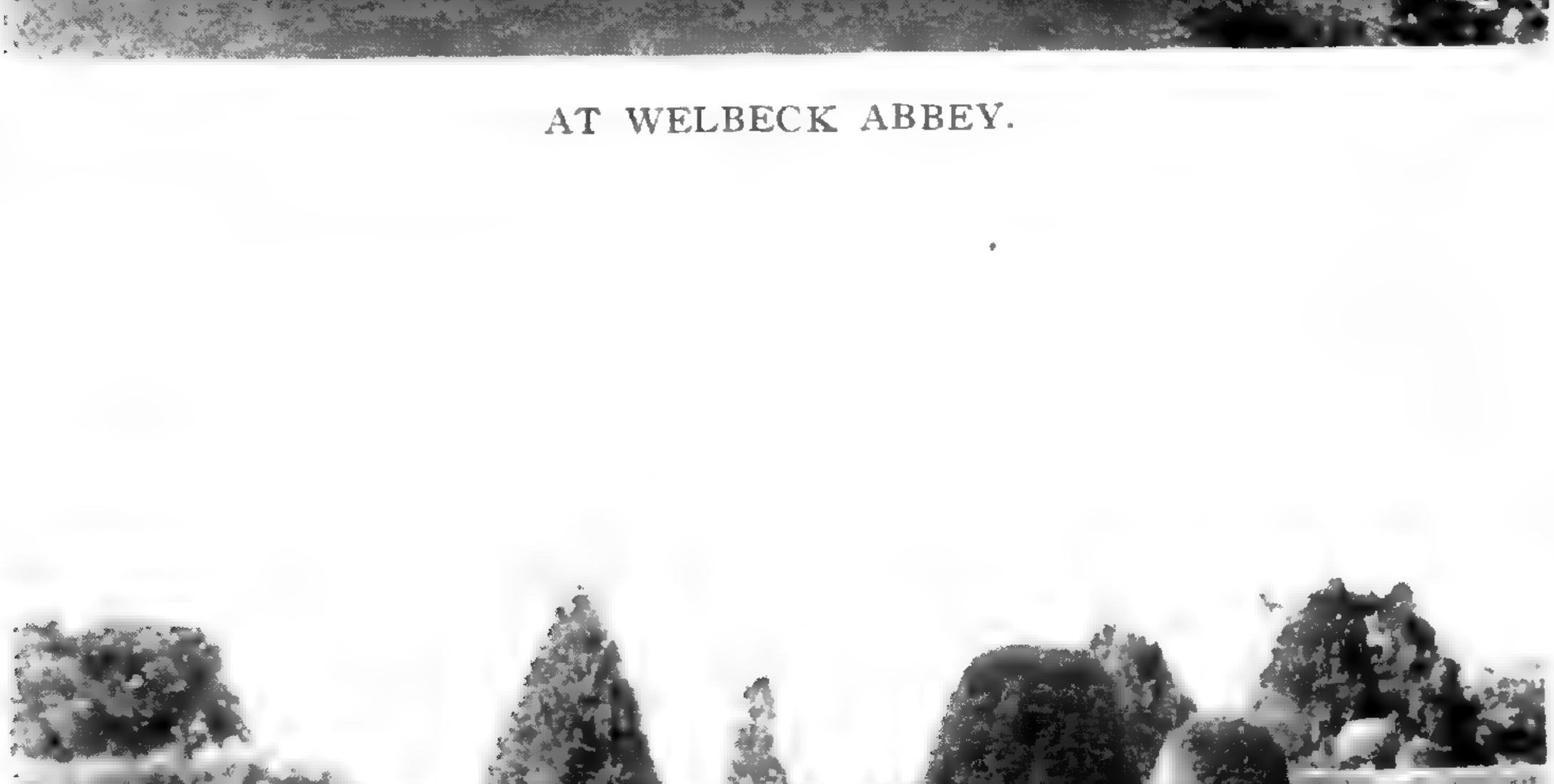
Clyde M. Blankenship was born near Springfield, Missouri, May 5, 1874, his early youth being spent in Missouri and California. He came to the Garden from Berkeley, California, in 1892, graduating in 1896. He was very active in the Missouri state militia, and during the Spanish-American war enlisted in his country's service. After graduating he practiced landscape gardening about one year, and then left St. Louis and became interested in civil engineering. After serving the Frisco Railroad as a civil engineer for eight years he was obliged to give up his work on account of illness, and for about a year travelled in Colorado seeking to regain his health. He was married, August 14, 1903, to Alice Dunford. After a lingering illness he died in St. Louis, May 9, 1906.

Homer Riggle was born May 20, 1872, in Washington, Pennsylvania. He was the son of Clark and Martha (Dagg) Riggle. His early education was received in the public schools of Washington, Pennsylvania. In 1890 he was awarded the Garden scholarship, and graduated in 1894. After leaving the Garden he was employed as a florist in different parts of Missouri, and was for a time at the Ohio State University, Columbus. For about two years he served as motor-cycle policeman in Kansas City, and was killed February 28, 1913, while in the performance of his duties.

OBSERVATIONS OF A LANDSCAPE GARDENER ABROAD

The landscape gardener abroad will see much of interest in every country, but for a study of examples of design which might directly affect his practice in America he will find England the most valuable. Not only will he be inspired by the larger estates but also by the charm of the small villages to which every householder contributes—houses covered with vines, flowery hedges separating the fields, and fine old trees everywhere regarded and preserved. An example of English cottage landscaping, as seen at Salisbury, is shown in Plate 12, fig. 1. As always, hedge or fence marks the boundary, the space between the house and hedge being filled with a variety of flowers, and beeches, elms or other trees forming the background. Another illustration of good landscape work which may be seen at Salisbury is the bishop's palace, a beautiful vine-covered old house surrounded by trees and fronting on a lake. Every place with a modest acreage has been well planned for attractive and economical use of the ground, the influence of English traditions on our own landscape methods being easily recognized.

AT WELBECK ABBEY.



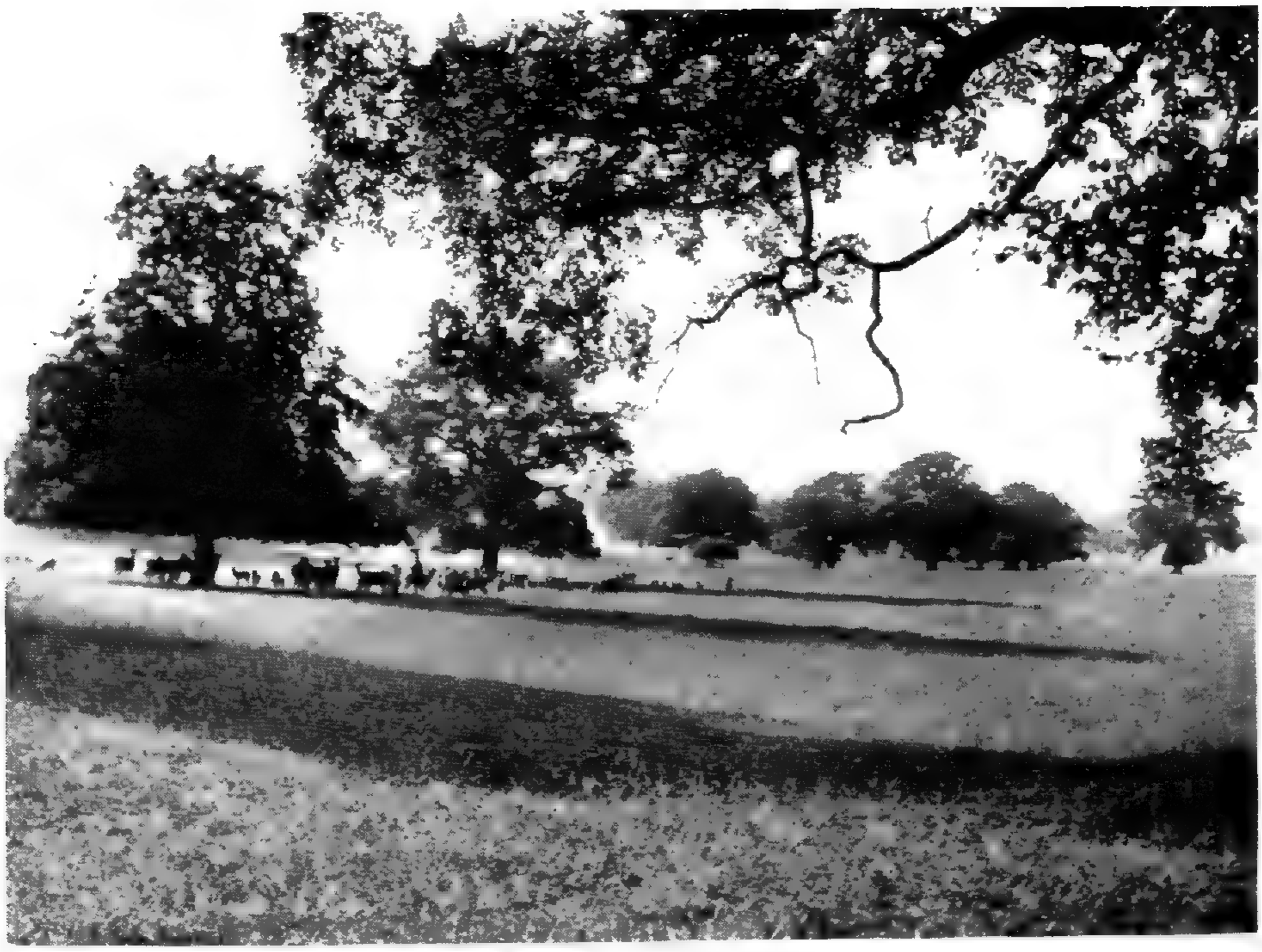
GARDEN AT BROCKENHURST PARK.

While some of the estates in England are open to the public on certain days, the privacy of most of them is rigidly guarded. We found, however, that, as visiting gardeners, we were always cordially received by the head gardeners and shown through the greenhouses and gardens. Chatsworth, Salisbury, Welbeck Abbey, and Windsor were among the places visited. Plate 13, fig. 1, shows a wonderful border plantation, seen at Welbeck Abbey, perennials being used for the main planting with many kinds of annuals and summer flowering plants to enrich the color and provide succession of bloom. A much more formal arrangement was seen at Brockenhurst Park with its clipped hedges, and statuary (Plate 13, fig. 2), while the accompanying illustration shows a typical (Plate 14, fig. 1) of Windsor Great Park English park scene with luxuriant turf.

OPERA HOUSE AT FRANKFORT-ON-MAIN.

The gardens of France and Italy, such as Versailles, Chantilly, and the Boboli Gardens, serve much better as historical examples than as practical inspirations for modern landscape work. They were built at a time when the nobility controlled an immense amount of labor, and when extravagant display was the order of the day. In modern times there can hardly be a repetition of undertakings of such great cost, and the old places will be retained merely as examples of historical interest and for public enjoyment.

The Petit Trianon at Versailles is a good example of classic architecture in a setting of natural park scenery. In contrast



WINDSOR GREAT PARK.

CHATSWORTH, A GREAT ENGLISH COUNTRY SEAT.

PALACE OF THE PETIT TRIANON, VERSAILLES.

THE HAMEAU IN THE GARDENS OF THE PETIT TRIANON.

THE CHATEAU OF BAGATELLE, PARIS.

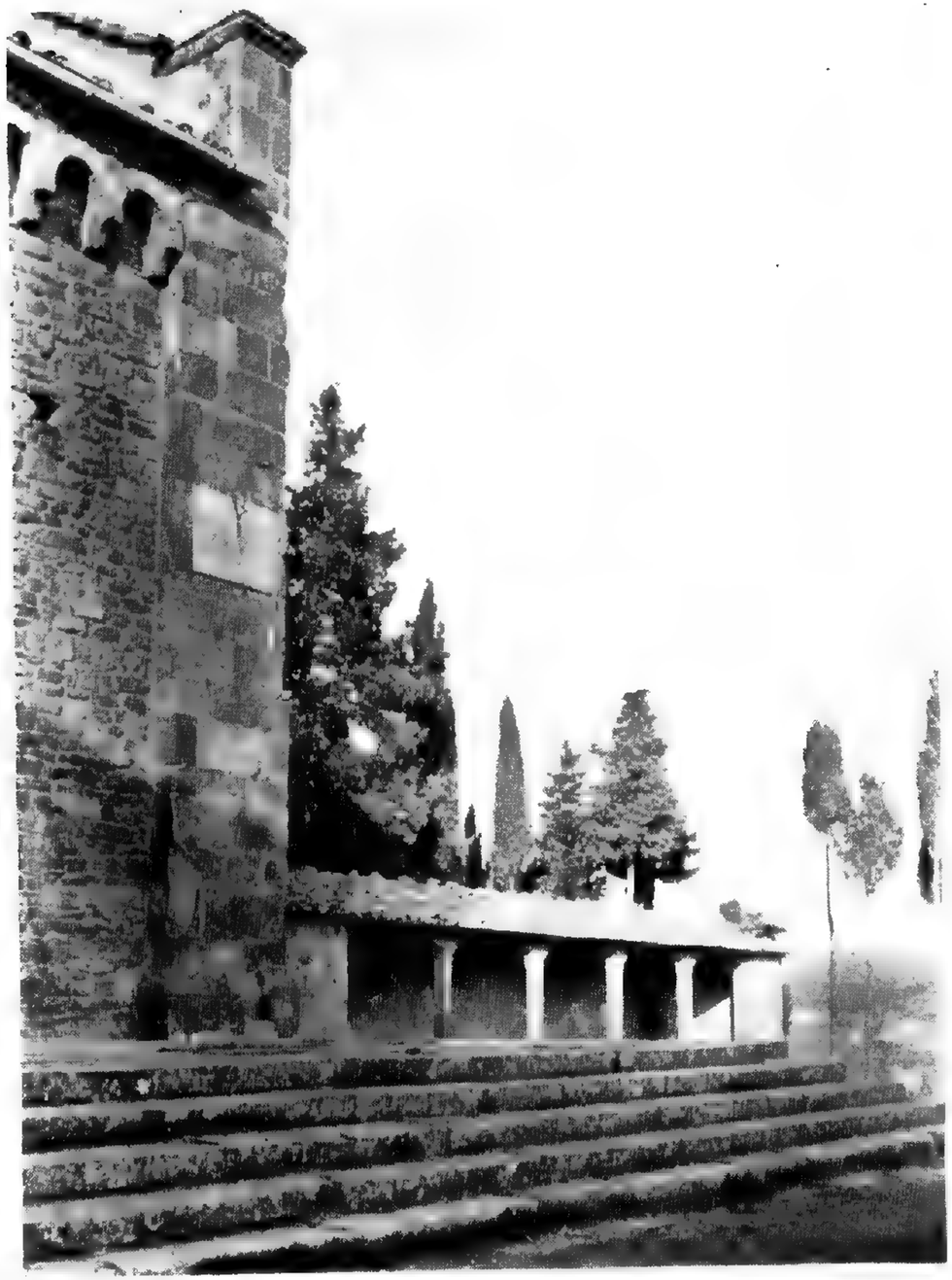
MODERN RESIDENCE SECTION OF FLORENCE.

to the rest of the landscaping, the hameau where Marie Antoinette and her court ladies played at idyllic country life, is laid out in the informal English style. Many of the fine old trees growing in these gardens are American species and were planted by Jussieu. The picturesque one in the foreground of Plate 15, fig. 1, is *Koelreuteria paniculata*. Another illustration of French landscape treatment is shown in the little chateau of Bagatelle in Paris, the foliage masses forming the background and clipped forms on the terraces being in keeping with the architecture of the building.

THE CHATEAU OF BABELSBERG, NEAR POTSDAM.

Chantilly, near Paris, formerly the seat of a great nobleman and now a public park, was designed by Le Nôtre and is of especial interest because of the treatment of its forest. Through this fine old forest are cut avenues, converging here and there to centers treated architecturally with fountains and statues. The turf extends to the edges of the paths, from which may be caught glimpses of charming vistas into glades and deep woods, and this park is a favorite resort of the French people, with their guests, on Sunday afternoons.

The great interest in Germany centers in the solution of municipal problems: the scientific planning for the future growth of cities and the treatment of streets, public squares, and watersides. This goes hand in hand with a very active modern development in architecture. At Frankfort-on-Main, particularly, one is constantly impressed with the modern



AT FIESOLE, NEAR FLORENCE.

A SIDE STREET IN FLORENCE.

MO. BOT. GARD. BULL., VOL. 4, 1916.

landscape work which has been done, this being the center of a group of able landscape gardeners who edit that interesting monthly, "Gartenkunst." An idea of German gardening is given by the accompanying illustrations. The space beside the opera house at Frankfort-on-Main has been converted into a beautiful little park with very unusual planting, the unsightly blank wall of the building having been almost completely covered with vines trained on lattices. The tree in this view is our American black locust.

In Italy, Florence and Fiesole were among the places visited, and here we were impressed with the magnificent coloring of sky and country. Hedges are used in abundance in the modern residence section of Florence, laurustinus, box, euonymus, honeysuckle, camellias, roses, jasmine, and plumbago being among the plants most commonly seen (Plate 16, fig. 2). The American black locust which shows prominently in this photograph, is a very popular tree in all countries of Europe, and attains great size and beauty. Apparently the wood borer which attacks our trees is not present there. The most characteristic Italian tree, however, and the one which seems to be in the most intimate harmony with the surrounding architecture is the pyramidal cypress (Plate 17, fig. 1). Olive trees are seen, of course, and in Plate 17, fig. 2, is shown a side street with these trees overhanging the garden walls.

Everywhere abroad, especially on the Continent, one is impressed with the close connection between landscaping and architecture. The Europeans genuinely appreciate the fact that a fine building requires a beautiful setting, and that fountains and statues count for little without background and dignified approaches.

CHARLES W. DEUSNER,
Horticulturist, Batavia, Illinois.

THE HORTICULTURAL EXPERIMENTALIST AND HIS WORK

Millet's picture of the toilers in the field is a true portrayal of the farmer of other days. His story was one of toil without recompense. Frequently the products of the farm sold for less than the chemical elements composing them could be purchased on the market, not allowing anything either for living or for interest on his investment. As a result of these conditions, the farmer was compelled to mine out the plant food of the soil, and the countless run-down farms of the east are the consequence. The condition was, in the main, due to

NEW GREENHOUSES AT IOWA STATE COLLEGE.

The range consists of twelve houses of iron construction and comprises approximately 22,000 square feet under glass. It is used for experimental and instructional work in vegetable crops and floriculture. The building immediately adjoining on the north is the new horticultural laboratory.

two factors, the first being unfavorable economic conditions, and the second, unsolved cultural problems.

The last decade and a half has marked a great change in agricultural conditions, however, and the farmer to-day is rapidly coming into his own. The state experiment station has had no small part in bringing this about. It represents organized research in agriculture, and through its channels and those of the federal department are concentrated the technical training and energy of a large corps of workers whose interests are centered upon the problems of the farmer. These problems are largely local in character, and in the brief space allotted me, I cannot hope to do more than outline a few of the horticultural projects in the solution of which the Iowa grower is primarily interested. In the main, they group themselves under three heads, the first being control methods for insects and diseases, the second, cultural methods, and the third, varietal adaptation.

In the northern half of the state there is a superabundance of summer and fall apples and a corresponding scarcity of winter fruit. On the Iowa Experiment Station grounds are several thousand apple seedlings representing crosses, in which are combined the most desirable qualities of a number of existing varieties. Out of the many, it is hoped that at least one or more may be found which will prove valuable as a winter apple for that section, and this material also affords an unusual opportunity for the study of Mendelian characters in the apple, and in time, should give definite information as to what varieties should be bred from for certain definite characteristics.

About 150,000 acres or more are devoted to potatoes in Iowa. At the present values of $150.00–$300.00 an acre, this represents a considerable investment. The varieties so far grown were all originated in other sections than the corn belt, and in our dry atmosphere and high temperature soon deteriorate. As a result, most growers send north every second or third year for a new supply of seed, and in this way are continually beginning over. There is an excellent opportunity to develop, by plant breeding and selection, a variety of potato that is adapted to corn belt conditions, and one that is also resistant to some of the diseases that are common to this region. Preliminary plans are now on the way for work leading to this end.

About 25 per cent of the world's supply of sweet corn is packed in Iowa. Despite the fact that the state is in the heart of the corn belt, the claim is made by many canners that on account of the weather conditions the kernel quickly loses its

sugar, hence deteriorates in quality, so that every second or third year they send to Maine or some of the adjoining states for their seed supply. There is no encouragement for the grower to build up his seed stock on this basis, and herein lies another interesting and important problem in plant breeding, and also one of considerable economic importance.

In southeastern Iowa the Heinz Company and others grow a considerable acreage of cabbage and other truck crops. The production of cabbage has gradually declined, due to the fact that the soil has become infected with cabbage yellows. This disease has become so serious that hundreds of acres have had to be abandoned for cabbage purposes. Steps are now under way toward the breeding and selection of a disease-resistant strain adapted to this region, and the results so far obtained are very encouraging. Indications are that through this means a large acreage can be reclaimed for cabbage growing.

Particularly in the case of the orchard fruits, there are a number of insect and other diseases of economic importance. The loss to the grower from these is considerable, and with the rapid increase in the price of land, the problem of heading off these leaks becomes all the more urgent. Within the last few years, for example, the Illinois canker disease has spread rapidly over the southern and western parts of the state. A field study has brought out the fact that the Ben Davis is a particularly susceptible variety. The apple scab is also very destructive some years, and in 1915, in some instances where this fruit had not been sprayed, it was not worth gathering. In a spraying experiment, conducted by the department for the control of this disease, three applications, one of Bordeaux and two of lime sulphur, gave 12 per cent of scabby fruit, while the unsprayed plot showed 80 per cent infected. For the one lot, the grower received seventy-five cents a bushel and for the other twenty-five cents.

There are also a number of interesting problems dealing with cultural methods as they affect the yield, returns, and quality of the product. In the case of the potato, for example, there has been under way, for a number of years, an experiment to determine the best time for planting late potatoes. Plots have been planted each year at ten-day intervals, and the time of planting correlated with soil temperature and atmospheric conditions. In the year 1915, for example, the early planted plots yielded upwards of 300 bushels an acre, and the late plantings 70, the difference being due largely perhaps to an outbreak of the late blight which struck the later plantings at a critical period of their development.

During the heated period the soil temperature runs very high and is thought to be one of the limiting factors in potato

production in the corn belt. On account of this excessive temperature, often 100° F. or more at the surface of the ground, the plant becomes devitalized. One series of experiments has to do with cultural methods dealing with the control of soil temperature.

In this work the investigator may meet with a few successes, and is likely to meet with many failures. However, this fact merely challenges him to a greater effort, and the rewards are all the more worth while when they do come.

A. T. ERWIN,
Chief in Truck Crops, Iowa Experiment Station.

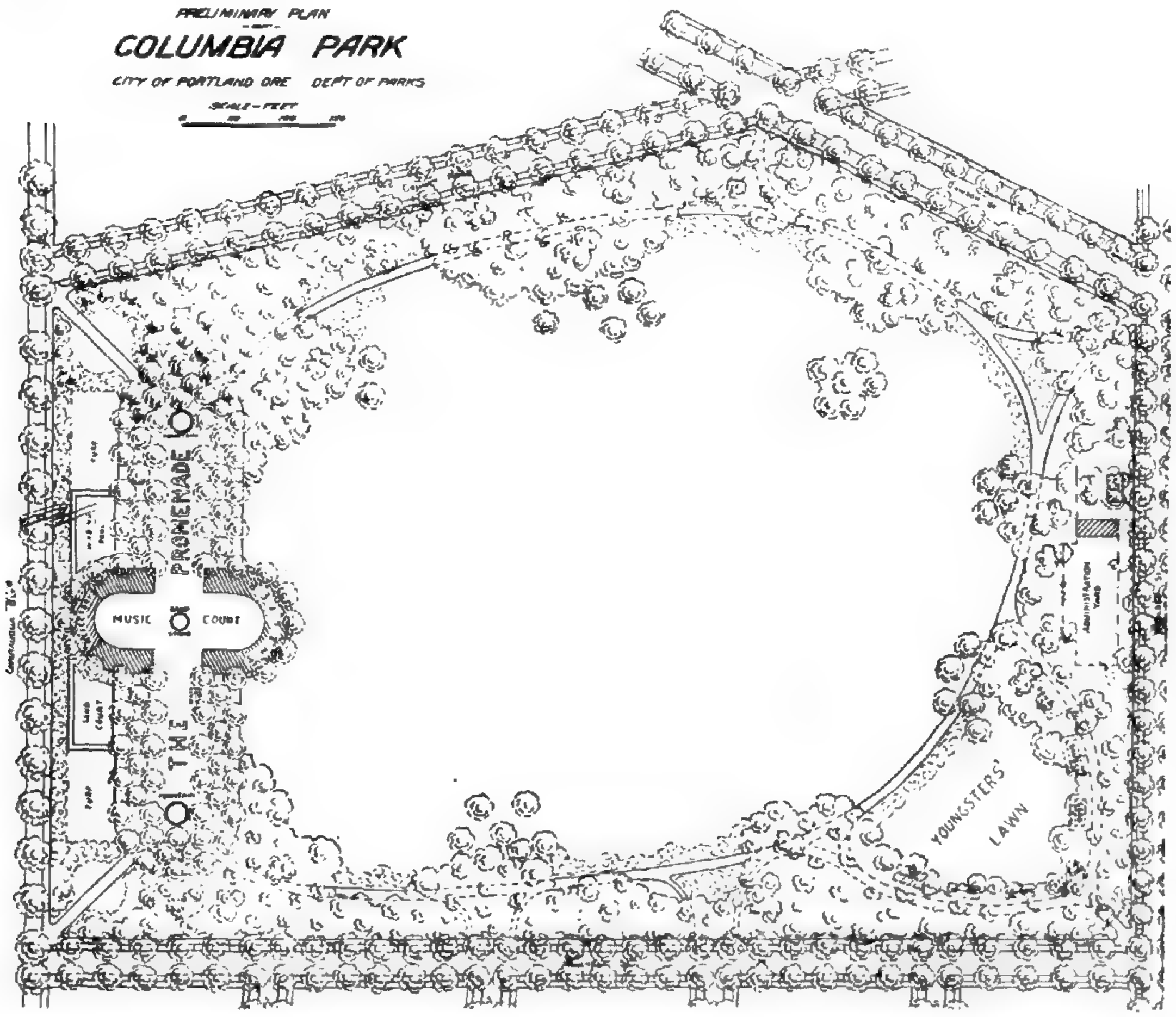
PHASES OF LANDSCAPE WORK IN PORTLAND, OREGON

Presumably what would be of interest in my career to Garden pupils are the phases of professional and executive work in landscape development in the West.

In 1908 I arrived in Portland immediately after the electorate authorized a million dollar bond issue for park extension. The prosperity wave which commenced to extend over the entire nation in 1904 and 1905, influenced Portland and caused her to share in the accelerated vigor of progress, peculiar especially to the Pacific coast which was experiencing an enormous increase in population. The American people show a constant trend of immigration westward, and the ambitious, virile spirit of youth anxious to better itself, is felt in the main body of inflow to these coast cities. The hardihood of the early pioneer who braved the hostile Indians and the hardships of the frontier is still a distinguishing mark of the new arrival to-day, although he comes to a more settled and cosmopolitan community. The boundless optimism, the courage and enterprise which typify the social body must be seen to be fully appreciated. They are demonstrated by the rearing in a few short years of a new and better San Francisco on the ashes and ruins of a devastated city; they transform an arid waste into a national playground of beauty, culture, and happy living at Los Angeles; and they build factories, ship the products of a vast surrounding region, and distribute roses broadcast at Portland.

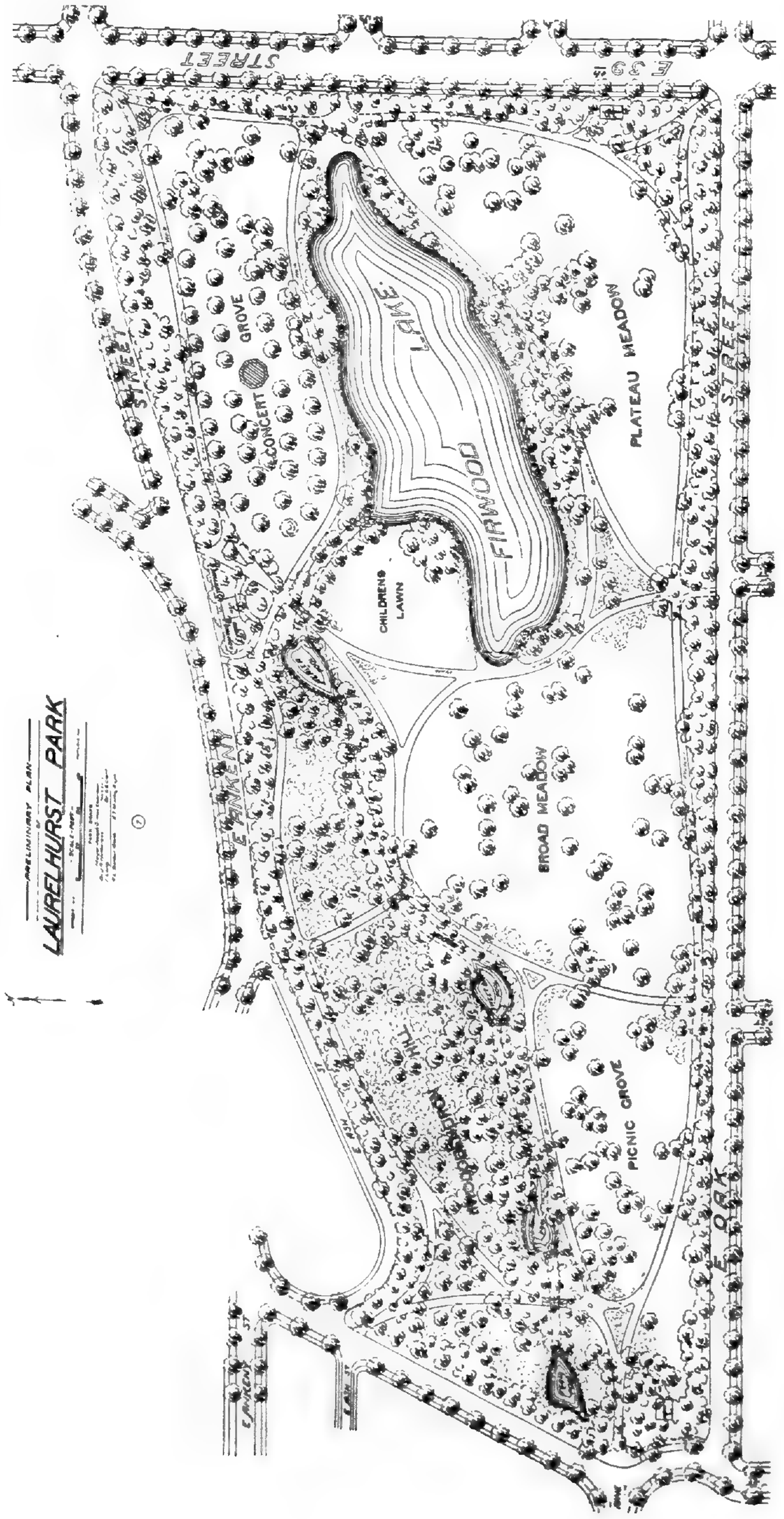
Into this feverishly active, buoyant, and aggressive community I came in 1908 to assume responsibility for its public parks and the future of their development. Generously and loyally supported by successive park boards (and often bitterly assailed by private individuals and a part of the press), it has been a pleasure to plan and execute in a virgin field in a

position of guide and leader. It is true that mistakes and deficiencies have developed in abundance, but taken as a whole, the onward strides and successes give ample cause for a measure of satisfaction and a feeling of having used well one's inherent talents. With the passing of years I appreciate more deeply the solidity, breadth, thoroughness, and practical application of the Garden course given so distinctively at the Missouri Botanical Garden as compared with that of agricul-



tural colleges, and I take this opportunity of acknowledging that to the solid and thorough foundation secured at the Garden is due what measure of success I have attained. I am impelled to add the hope that casual culture will never dictate the curricula at the expense of the highly specialized, purely scientific teaching so admirably intermixed with a good proportion of well selected practice.

In 1900 Portland had a population of 90,000; to-day it has nearly 300,000. The rapid transition from swaddling clothes to habiliments of maturity caused awkwardness, growing pains, and paradoxes, and the parks shared the effects of the encircling atmosphere. My position, officially, at the outset was purely executive, but it gradually partook of the professional, advisory duties. As an executive it was my duty to


PRELIMINARY PLAN
LAURELHURST PARK
STREET
E 39 th
GROVE
CONCERT
LAKE
FIRWOOD
PLATEAU MEADOW
STREET
CHILDREN'S LAWN
EMBANKMENT
BROAD MEADOW
PICNIC GROVE
OAK

handle men, organize, direct, control, construct, and execute work and movements. As an advisor it became my task to prepare plans, to advise the board upon matters of policy, to interpret facts occurring in the daily life of the city and to point out their significance, their dangers, and opportunities in the interests of a park program adopted as a municipal project.

What is apparent as an established accomplishment in the discharge of the duties of this dual office can perhaps best be noted by personal observation on the ground, but an idea of it may be conveyed by the illustrations accompanying this article. A technical discussion of "shop" would be out of place here, but if there are any interested in the detail and technique I shall be glad to supply printed reports, photographs, plans, and other information relating to the landscape work at Portland.

The expenditure of two million dollars, the establishment of twenty-six playgrounds, the promotion of a mountain reservation, the construction of parkways, and the development of a series of public parks has been a task consuming vitality, but the result is worth far more than it costs; the worry lies in there being no more worlds to conquer.

Perhaps the most interesting feature of our parks to Garden folk is the vast range of flora that can be employed by reason of mild winters and equable temperatures, the immense size of the vegetation, and the luxuriance and thrift of its growth. In equal opportunity we compare with Georgia and South Carolina, or with London or Paris; indeed, the abundance of European holly, of aucubas, and laurustinus suggest the similitude. As an illustration it may be mentioned that we cultivate in the open *Pittosporum Tobira, Camellia japonica, C. theifera, Azalea indica, Prunus lusitanica,* gardenias, fuchsias, neriums, daphnes, laurocerasus, and similar sorts. Our difficulty is not the intensity of cold, but the uninterrupted growth without resting in the fall and the consequent injury should frost subsequently appear, and the cool nights.

EMIL T. MISCHE,
Landscape Advisor, Portland, Oregon.

RAILROAD AGRICULTURE

What can or what does a railroad do for agriculture or horticulture? Or, what does a railroad man know about farming? These questions are often asked by people unfamiliar with the new line of development which is so rapidly gaining favor in the agricultural sections of our country. Of

course, the answer in a few words is: "Coöperate with the farmers living along the line." But to this they reply that the farmers, from boyhood up, have been taught to fight the railroads in every way possible. This is true to a large degree, and we sometimes see practical demonstrations of it to-day. For instance, when a finger is pinched in the car door, because one was standing up when he was warned by a sign on the door to "Sit down until train stops" and "Passengers are not allowed on the platform when trains are moving," he sues the railroad for $50,000, and gets, after several years, a few hundred, and the lawyer gets about nine-tenths of that; and when a razorback is killed, the road is asked to pay for a registered Duroc if it is red, or a Poland China or a Berkshire if it is black.

These conditions are largely passing, however, and to-day the car door of an official bears the sign, "Office Car" or "Business Car," instead of the warning, "Private." Railroad officials are merely business men, and to-day they mix with the people living along their line more than ever before. The railroad is dependent upon the farmer for a great part of its business, and the farmer, on the other hand, must have transportation facilities; and this mutual dependence makes a common meeting ground.

There are numerous ways by which this development or educational work can be, and is being, carried on by the railroads. To begin with, agricultural, industrial, and immigration development all come under one general head, and frequently they are operated under one department with an expert in charge of each division. At other times they are divided into different departments, all separately reporting to the traffic officials.

A careful survey has recently been made of the railroads of the country, and it has been found that over three-fourths of their mileage is controlled by companies having an organized agricultural, industrial, and immigration department. In this survey a step farther was made, and it was found that this work could be distributed under about thirty-nine different heads. To emphasize what these heads are, a few will be outlined covering duties of the agricultural department as it particularly affects the work of the writer, viz.:

Encouraging and assisting farmers in planting diversified crops; employing agricultural experts to instruct farmers with respect to the selection of seed, planting, cultivation and preparation of crops for markets; organizing and conducting demonstration farms; sending out special trains in the interest of good roads, seed, silo, soil, packing, and better farming;

CROWDS ENTERING TRAINS TO HEAR K. C. S. AGRICULTURAL LECTURES.

VISITORS, INCLUDING SCHOOL CLASSES, LISTENING TO LECTURES AND VIEWING EXHIBITS ON K. C. S. AGRICULTURAL TRAIN AT WESTVILLE, OKLAHOMA.

equipping exhibit cars with agricultural products and sending them over the line. (These cars usually spend a day and evening in each town, giving chart talks in the day time and lantern-slide or moving-picture shows at night.) The work also includes: defraying expenses of lecturers to farmers' institutes and other meetings; preparing and printing agricultural bulletins of information and distributing them among farmers, either through the mails or from agricultural trains; providing special rates and free transportation to farmers' institute workers, especially federal and state employes; furnishing pure-bred stock to farmers for breeding purposes; collecting data and furnishing reports on the condition of crops along the line, this information being also given to the traffic department, so that they can make arrangements for hasty handling, and proper refrigeration of perishables, also for extra telegraph service during a rush season, etc.; getting in touch with produce commission men in the cities with a view to assisting the growers and shippers in proper and profitable marketing; furnishing daily, through the local agents, telegraphic reports to shippers respecting market conditions; informing farmers as to the customs and requirements of the various markets; organizing poultry, dairy, horticultural, and truck-growing associations; aiding in securing a supply of agricultural labor and transporting it at a reduced rate; furnishing free, good seed, fertilizers, etc., and providing inoculation material for use in growing legumes.

This, in brief, gives an idea of the possibilities of railroad agriculture, and of some of the problems being worked out by the railroads for the benefit of people living along the line.

J. HOLLISTER TULL,
Agriculturist, Kansas City Southern Railway.

NOTICE

There are a number who have registered as Garden pupils since 1890 who are not members of the Alumni Association, and whom we would like very much to have join. In some instances we have been unable to locate them, and would be glad if anyone knowing their whereabouts would advise the secretary, or if the members who are best acquainted would lend a helping hand to awaken their interest.

Name	Year	Last Address
Chilton, John A	1911	36 Paris Road, Louisiana, Mo.
Culling, Louis	1912	Webster Groves, Mo.
Dunford, J. W	1890	Sioux City, Ia.
Field, Ernest P	1898	Kansas City, Mo.
Kawase, Harutaro	1893	Sapporo, Japan.

Name	Year	Last Address
Lipscomb, John	1894	No address.
Marker, Oliver P	1900	Evansville, Ind.
Meyer, Robert	1899	St. Louis, Mo.
Nelson, A. J	1890	No address.
Overland, Ralph G	1901	No address.
Polst, William	1902	No address.
Reed, Homer Earl	1909	503 Georgia St., Louisiana, Mo.
Roper, Paul	1904	Fresno, Cal.
Shepherd, Hugh	1890	No address.
Smyth, Eugene	1905	Department of Agriculture, Washington, D. C.
Wakely, Cecil	1911	Care of Stark Bros. Orchard & Nursery Co., Louisiana, Mo.
Weymann, Otto H	1901	No address.

In accordance with the constitution and by-laws adopted by our association, the next regular meeting takes place in 1917. It is our desire to have every member bear this in mind and make his plans so that he may be able to attend. No definite date has as yet been set, but undoubtedly it will be so arranged that the meeting can be held at the time of the Gardeners' Banquet which usually takes place in November.

We wish to make this meeting an especially interesting one and have as many present as possible, so that we may celebrate an enjoyable "home coming." There are no doubt a number of you who are planning a trip in the direction of St. Louis, and if made at that time we feel that you would be amply repaid. Now, remember; if you cannot, make a note, write your chums and say to every member you see, "Meet me at the Garden in November, 1917."

A. R. GROSS,
Sec'y-Treas., Missouri Botanical Garden Alumni Association.

SCHOOL FOR GARDENING

OFFICERS OF ADMINISTRATION AND INSTRUCTION

George Thomas Moore, A.M., Ph.D., *Director of the Garden, and Engelmann Professor in the Henry Shaw School of Botany of Washington University.*

Jesse More Greenman, A.M., Ph.D.; *Curator of the Herbarium, and Associate Professor in the Henry Shaw School of Botany of Washington University.*

Edward Angus Burt, A.M., Ph.D., *Mycologist and Librarian to the Garden, and Associate Professor in the Henry Shaw School of Botany of Washington University.*

Harry Milliken Jennison, A.B., A.M., *Assistant in Botany in the Henry Shaw School of Botany of Washington University.*

William Woodward Ohlweiler, B.S., A.M., *General Manager to the Garden.*
B.S., Connecticut Agricultural College; A.M., Washington University; Missouri Botanical Garden, 1907-; Teaching Fellow, Washington University, 1912-13.

John Noyes, S.B., *Landscape Designer to the Garden.*
S.B., Massachusetts Agricultural College; Instructor in Landscape Gardening, Massachusetts Agricultural College, 1909-11; with Warren H. Manning, Boston, 1911-14; Missouri Botanical Garden, 1914-

Alexander Lurie, B.S., *Horticulturist to the Garden.*
B.S., Cornell University. Charge of ornamentals and greenhouses, Greening Bros. Nurseries, Monroe, Mich., 1913-14; Instructor in Floriculture, in charge of greenhouses and grounds, University of Maine, 1914-16; Missouri Botanical Garden, 1916-

George Harry Pring, *Orchids and other Exotics.*
Royal Botanic Gardens, Kew, 1899-1906; Missouri Botanical Garden, 1906-

Max Schiller, *Palms, Ferns, and Floral Displays.*
Palmgarten, Frankfurt am Main, 1893-1903; Missouri Botanical Garden, 1903-

Julius Erdman, *Rose, Medicinal, and Economic Gardens.*
Hoehere Gartenbau Lehranstalt, Koestritz, Germany, 1897; Department of Horticulture, Iowa State College, 1903-08; Florist, Colorado State College, 1909-14; Missouri Botanical Garden, 1914-

COURSES OF INSTRUCTION

First Year

1. GENERAL BOTANY. (At Washington University.) Laboratory course with lectures and quizzes dealing with the form and structure of plants, with special reference to their life processes. A brief study will be made of living plants in relation to their environment. October to July.
(Jennison)

2. GENERAL FLORICULTURE. The general principles of greenhouse management. Methods of propagation by seeds, cuttings, division, layering, grafting, etc., under glass and outdoors. Cultural methods for successful growing of outdoor roses, bulbs, tubers, decorative and bedding plants, etc. October to April.
(Lurie)

3. COMMERCIAL FLORICULTURE. Culture of roses, carnations, chrysanthemums, violets, orchids, sweet peas, bulbs,

ferns, palms, and other decorative and flowering plants. Marketing, packing, shipping, designing. April to October. (Lurie)

4. VEGETABLE GARDENING. Methods of growing, harvesting, and marketing vegetables for commercial purposes. Home gardens. July and September. (Lurie)

5. DISEASE CONTROL. Methods of control of fungous and insect diseases affecting greenhouse and other cultivated plants and trees. Sprays and spray machinery. April to October. (Lurie)

6. SURVEYING. Topographical surveying and plotting, principally with the Wye level and transit, using the stadia. Practice in the use of the hand level, compass, etc. Staking out, setting grades, etc., from plans, and practice in grading design, estimating cut and fill, etc. October to April. (Noyes)

7. CONSTRUCTION. Concrete construction, retaining walls, drains, sewers, culvert and road making, ditches, greenhouse construction, paints, etc. April to July. (Ohlweiler)

8. ADMINISTRATION. Management of public parks, estates, cemeteries, public grounds, etc. A practical discussion from the administrative standpoint. July and September. (Ohlweiler)

9. MECHANICAL DRAWING. Lettering, geometrical drawing, projections, shades and shadows, perspective, architectural drawing. October to April. (Noyes)

10. FREE-HAND DRAWING. Pencil, charcoal and water color work, sketching of simple models, casts, flowers, trees, shrubs, etc. April to October. (Noyes)

Second Year

11. DENDROLOGY. Nursery work. Planting, growing, pruning, and care of trees and shrubs. Tree surgery. Fundamentals of forestry, including forest management, mensuration, protection, utilization, by-products, and wood preservation. October to April. (Lurie)

12. FORCING FRUITS AND VEGETABLES. Forcing of grapes, peaches, nectarines, figs, strawberries, pineapples, etc., under glass. Forcing of lettuce, tomatoes, cucumbers, melons, radishes, etc., under glass. January to April. (Lurie)

13. Plant Breeding. The principles and practice of plant breeding. Hybridization and selection. The origin of horticultural varieties. April to October. (Lurie)

14. Plant Materials. Flowering trees, shrubs, perennials, and annuals used in landscape designs and private gardens in this country. Intended to familiarize the student with the variety of flowering material at his disposal, together with the facilities of various nurseries and growers in America. April to October. (Ohlweiler)

15. Soils. A consideration of the soil as a medium for root development and as a reservoir for the storage and conservation of water. Water movement, capillarity, aëration, temperature, natural minerals, soil organisms, etc. October to April. (Ohlweiler)

16. Fertilizers. Function of manure and commercial fertilizers, including a special study of nitrates, nitrites, phosphates, superphosphates, etc. A résumé of the present status of the subject with special reference to horticultural uses. October to April. (Ohlweiler)

17. Aquatic Gardening. Culture and use of aquatic plants. April to October. (Pring)

18. Pure Design. Theory and practice; its application to all arts, especially landscape gardening. October to January. (Noyes)

19. Principles of Landscape Gardening. Lectures on history and theory. Practice in drafting, rendering in ink and water colors; office methods. Analysis of landscape designs. January to July. (Noyes)

20. Landscape Design. Practice in design of home grounds, private estates, parks, playgrounds, cemeteries, subdivisions, etc. July and September. (Noyes)

Third Year

21. Pathology. Laboratory work with lectures on the common diseases of greenhouse and other cultivated plants and trees. October to April. (Burt)

22. Systematic Botany. Gross anatomy of plants, the study of the relationships between the various groups and individuals to be found cultivated and wild; designed primarily to train the student in the ready identification of plants. The period from January to March is devoted to the

study of trees and shrubs in their winter condition. Making an herbarium. October to October. (Greenman)

23. Economic Botany. The uses of plants and their products; fibers, fruits, condiments, perfumes, medicinal plants, etc. April to October. (Pring)

24. Fruit Growing. A consideration of the various fruit areas of the United States, and of the climatic and topographical conditions influencing them; the location of orchards and fruit lands; windbreaks, tillage and moisture; planting schemes, harvesting, and marketing. April to October. (Ohlweiler)

20. Landscape Design (*Continued*). October to January. (Noyes)

25. Planting Design. Study of harmony of color, form, foliage, etc., in plants for outdoor use; analysis of designs. Practice in planting design for various locations and purposes, for private estates, parks, city streets, flower gardens, etc. January to July. (Noyes)

26. Garden Architecture. Lectures on architectural styles and design. Practice in design of garden furniture, pergolas, arbors, summer houses, gates, entrances, etc. July and September. (Noyes)

27. Thesis. During the second year the student will choose or be assigned some definite problem leading out of the courses given, and in the third year he will be expected to pursue this topic with the intention of presenting a thesis covering the work done.

First Year

Time	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Oct. to Jan.	General Botany 1	General Floriculture 2	Surveying 6	General Botany 1	Mechanical Drawing 9	Special Work
Jan. to Apr.	General Botany 1	General Floriculture 2	Surveying 6	General Botany 1	Mechanical Drawing 9	Special Work
Apr. to July	General Botany 1	Commercial Floricult. 3 Construction 7	Construction 7	General Botany 1	Free-Hand Drawing 10	Disease Control 5
July and Sept. *	Vegetable Gardening 4	Commercial Floricult. 3 Administration 8	Construction 7 Administion 8	Special Work	Free-Hand Drawing 10	Disease Control 5

Second Year

Oct. to Jan.	Dendrology 11	Soils 15	Fertilizers 16	Pure Design 18	Pure Design 18	Special Work
Jan. to Apr.	Dendrology 11	Soils 15 Fertilizers 16	Forcing Fruits and Vegetables 12	Principles of Landscape Gardening 19	Principles of Landscape Gardening 19	Special Work
Apr. to July	Plant Breeding 13	Plant Materials 14	Aquatic Gardening 17	Principles of Landscape Gardening 19	Principles of Landscape Gardening 19	Special Work
July and Sept. *	Plant Breeding 13	Plant Materials 14	Aquatic Gardening 17	Landscape Design 20	Landscape Design 20	Special Work

Third Year

Oct. to Jan.	Thesis 27	Pathology 21	Systematic Botany 22	Landscape Design 20	Landscape Design 20	Thesis 27
Jan. to Apr.	Thesis 27	Pathology 21	Systematic Botany 22	Planting Design 25	Planting Design 25	Thesis 27
Apr. to July	Economic Botany 23	Fruit Growing 24	Systematic Botany 22	Planting Design 25	Planting Design 25	Thesis 27
July and Sept. *	Economic Botany 23	Fruit Growing 24	Systematic Botany 22	Garden Architecture 26	Garden Architecture 26	Thesis 27

* Vacation during August.

SUMMARY OF AFTERNOON COURSES

One or more exercises, afternoons of each week. Lectures, laboratory work, and demonstrations supplemented by practical work each morning, in the various departments of the Garden.

BOTANY

First year:
- General Botany ..... 9 months

Third year:
- Systematic Botany ... 11 months
- Economic Botany .... 5 months
- Pathology ..... 6 months

ENGINEERING

First year:
- Surveying ..... 6 months
- Construction ..... 3 months
- Administration ..... 2 months

HORTICULTURE

First year:
- General Floriculture .. 6 months
- Commercial Floriculture ..... 5 months
- Vegetable Gardening .. 2 months
- Disease Control ..... 5 months

Second year:
- Dendrology ..... 6 months
- Forcing Fruits and Vegetables ..... 3 months
- Plant Breeding ..... 5 months
- Soils ..... 6 months
- Fertilizers ..... 6 months
- Aquatic Gardening .. 5 months

Third year:
- Fruit Growing ..... 5 months

LANDSCAPE ARCHITECTURE

First year:
- Mechanical Drawing .. 6 months
- Free-Hand Drawing .. 5 months

Second year:
- Plant Materials ..... 5 months
- Pure Design ..... 3 months
- Landscape Gardening .. 6 months
- Landscape Design .... 2 months

Third year:
- Landscape Design .... 3 months
- Planting Design ..... 6 months
- Garden Architecture ..... 2 months

Morning Work.—During the three years, the regular garden pupils are assigned to the various departments, both indoors and outdoors, the work being arranged to afford as much experience and practice as possible in propagating, growing, and caring for the very large variety of plants maintained at the Garden. The time devoted to each department will depend upon circumstances.

Scholarships.—Six scholarships, of the annual value of $350 each, are offered to students between the ages of sixteen and twenty years, possessing at least the education afforded by a regular high school course of recognized standing, or its equivalent. Since a scholarship may be reconferred upon the original recipient for two additional years, there are ordinarily but two scholarships to be awarded each year. All scholarships are awarded by a competitive examination held on the first Saturday in September, in the administration building of the Garden, Tower Grove and Botanical Avenues. Application blanks may be obtained at the Director's office and must be returned not later than August 15. Examinations are held in United States History, English Literature, Arithmetic, Algebra, Elements of Botany and one other

science (either Zoölogy, Chemistry, Physics, or Physiology) to be selected by the candidate, and one foreign language (either German, French, Spanish, Latin, or Greek) according to the training of the candidate.

Candidates who live at places remote from St. Louis may send, with their application, the name and address of the principal or a teacher in the nearest high school who will be willing to take charge of the examination. All applications of this character must be received by the Director not later than August 15. The charges for and place of holding such an examination must be a matter of mutual arrangement between the examiner and the student. The Garden in no way can assume the slightest responsibility for such matters.

Tuition.—In addition to those holding garden scholarships, a few suitably prepared pupils will be admitted to the regular course at the rate of $50.00 per year. The charge for a single course of nine months, or more, is $15.00; for one of five or six months, $10.00; and for one of three months or less, $5.00.

Certificate.—Upon the satisfactory completion of the regular three-years' course and the passing of such examinations as may be required, a student shall receive a certificate from the Garden, indicating the work accomplished.

STATISTICAL INFORMATION FOR FEBRUARY, 1916

GARDEN ATTENDANCE:

Total number of visitors	5,819

PLANT ACCESSIONS:

Total number of plants received in exchange	10
Total number of packets of seeds received in exchange	4

PLANT DISTRIBUTION:

Total number of plants distributed	121

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought	32
Total number of books and pamphlets donated	47

HERBARIUM ACCESSIONS:

By Purchase —	
B. F. Bush—Mosses of Missouri	1,748
J. M. Holzinger — "Musci Acrocarpi Boreali-Americana," Nos. 326–350	25
Pedro Jurgensen—Plants of Argentina	100
By Gift —	
B. F. Bush—Plants of Missouri	160
J. A. Drushel—Plants of Alabama, Ohio, Missouri, Texas, Colorado, and California	48
Mrs. A. Jones—*Cassia sp.*, cultivated at Houston, Texas	1
O. S. Ledman—*Oenanthe bracteata*	1
Mrs. B. Mackensen—Plants of Texas	35
E. J. Palmer—Seeds of *Baptisia sp.*	1
G. S. Stone—*Ipomoea fistulosa* from Punta Gorda, Florida	1
By Exchange —	
New York Botanical Garden—Plants of Jamaica	350
U. S. National Museum—Fragments of the type of *Senecio hypotrichus* Greenm.	1
TOTAL	2,471

The Garden is open to the public every day in the year, except New Year's, Fourth of July, Labor Day, and Christmas—week days from 8:00 A. M. until one-half hour after sunset; Sundays, from December to April, 1:00 P. M. until sunset, from April to December, 2:00 P. M. until sunset.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Boulevard, on the Vandeventer Avenue car line. Transfer south from all intersecting lines.

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Mycologist and Librarian.

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Pathologist.

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Research Assistant.

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Curator of the Herbarium.

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W. F. LANGAN,
Engineer.

J. ERDMAN,
Plant Propagation.

G. H. PRING,
Orchids and other Exotics.

C. R. FOLLEN,
Construction.

M. SCHILLER,
New Conservatories.

P. FOERSTER,
Farm and Stables.

MISSOURI BOTANICAL GARDEN BULLETIN

Vol. IV APRIL, 1916 No. 4

CONTENTS

ST. LOUIS, MO.
1916
PUBLISHED MONTHLY BY THE BOARD OF TRUSTEES

SUBSCRIPTION PRICE:
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Dr George Engelmann
1860

Missouri Botanical Garden Bulletin

Vol. IV St. Louis, Mo., April, 1916 No. 4

DR. GEORGE ENGELMANN'S GRAPE INVESTIGATIONS

As is well known, the late Dr. George Engelmann, of St. Louis, in the midst of a busy life as a physician found time to pursue investigations of great value to the botanist. In addition to his published works, the results of these studies are to be found in sixty large volumes of notes in the library of the Missouri Botanical Garden. One of these volumes, that upon the grape, is interesting both to the casual reader for its revelations as to the methods of work of this unusual man, and to the viticulturist for its detailed studies as well as the breadth of view shown.

Dr. Engelmann's notes on the grape are of a character to interest the anatomist, the horticulturist, and the systematist, and contain careful pencil drawings of many structural details of stem, berry, leaf, and flower. Included with the personal observations are notes from catalogues, extracts from articles, quotations from correspondence, comment upon blooming time and visitations of insects, copies from herbarium specimens, outlines of leaves of species, drawings of internodes and seeds, lists of varieties, mention of species' characteristics, types of flowers, and pollen, photographs of viticulturists, and much else. The list might be extended to a greater length, but the points covered are enough to show the activity of the man's mind, the thoroughness of his observations, and the keenness with which he followed important details of structure from the taxonomic standpoint.

In addition to being well informed as to the culture of the grape, Dr. Engelmann contributed materially to a knowledge of the classification of this group of plants. He was a careful observer of the species of other botanists and was also a thorough student of new forms. His studies upon new species of this genus were published rather extensively, and his writings are widely read and quoted to-day.

Dr. Engelmann was quick to see the taxonomic value of a number of structures of the seed, fruit, cane, and leaf.

Among the important taxonomic characters on which he placed especial emphasis is the diaphragm, or the partition in the node at each leaf. This is present in all species, excepting *Vitis rotundifolia,* being thick in some and thin in others. He pointed out clearly, and has illustrated carefully, the taxonomic value of the cord-like raphe in the seed of *V. cordifolia,* the central position of the chalaza in *V. rotundifolia,* the notched or rounded condition of the distal end of the seed, as in *V. Labrusca* and *V. rupestris,* and the long beak of the seed of *V. vinifera.* He made careful records and observations of the difference in the blooming time of different species and its bearing upon interspecific crosses in the wild forms. He had gone so far into the taxonomy of the grape as to make accurate and detailed tracings of the type specimens in herbaria, including those of Michaux, and five of his species are generally accepted by taxonomists to-day.

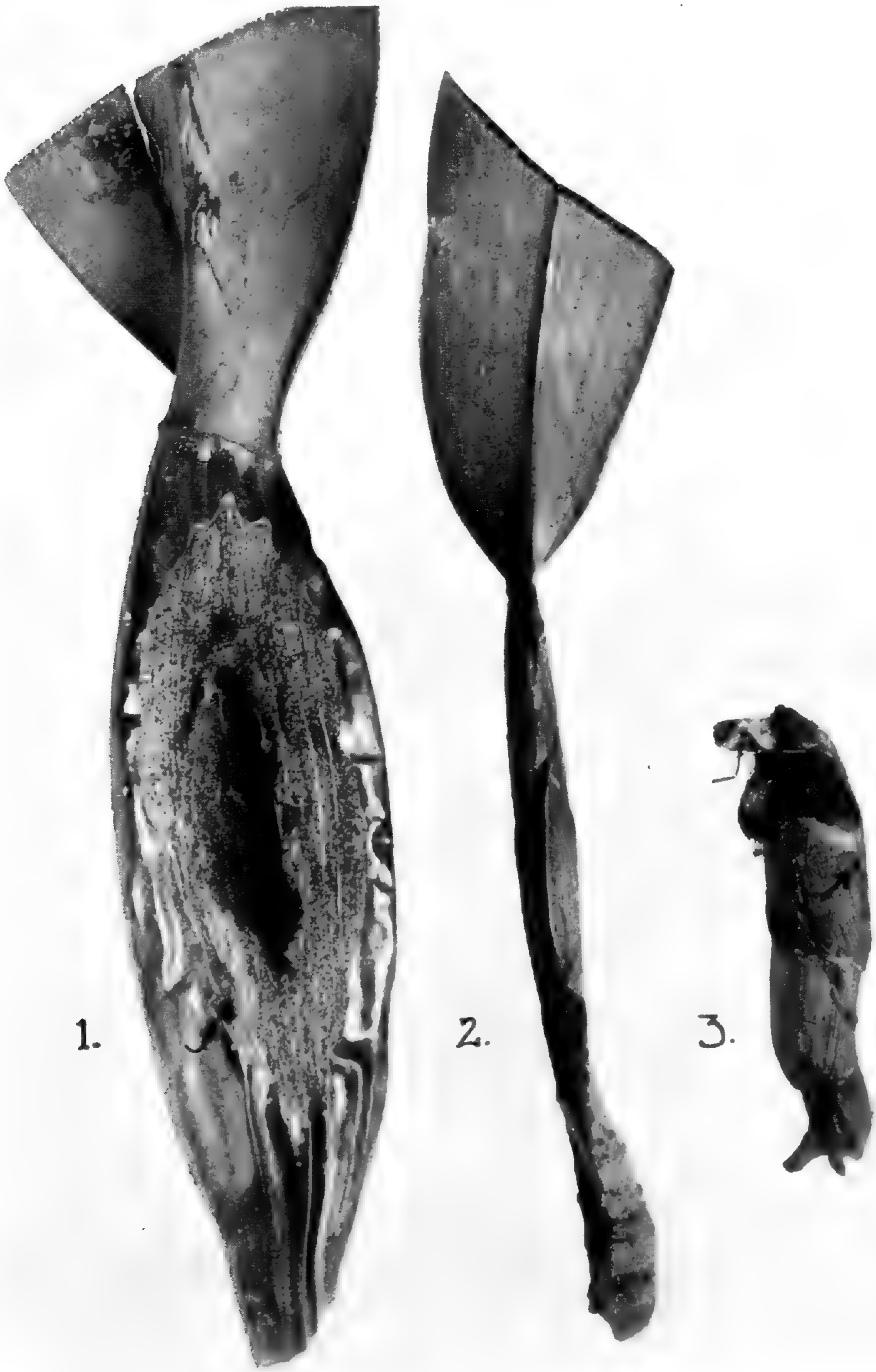
The writings of Dr. Engelmann upon the grape include several articles published in the scientific journals as well as in horticultural papers. These have to do with taxonomy, culture, diseases, varieties, and general observations, and they contain many priority statements with reference to species and points of taxonomy. His notes show also that he was in correspondence with a large number of viticulturists of Europe and America, and include quotations and letters.

This brief account of the notes of Dr. Engelmann on the grape is offered partly as an appreciation of his services in the study of this group, and partly as an estimate of the man and his methods of investigation. The same might be repeated with equal or greater emphasis with reference to many other genera. Dr. Engelmann was typical of a number of men of his day, whose services to science were most important. With their passing, however, was ushered in a new type of worker who, because of the development of science and the broadening and deepening of the field of knowledge, have necessarily been forced to adopt new methods.

THE CATTLEYA ORCHID FLY

Requests from various parts of the country have come to the Garden at different times for full information regarding the cattleya fly or borer (*Isosoma orchidearum*) which is occasionally imported from the Cordilleras in South America, this being the cattleya region.

When fresh importations arrive, the plants are usually in resting condition. In case the fly is present, an examina-



1. NORMAL PSEUDO-BULB CUT TO SHOW THE EFFECT OF THE LARVAE, WITH HOLE WHERE THE INSECTS ESCAPED. 2. ABNORMAL PSEUDO-BULB INCAPABLE OF PRODUCING FLOWERS. 3. PERMANENTLY INJURED GROWTH SHOWING WHERE THE INSECTS ESCAPED.

(About Natural Size)

tion of the pseudo-bulbs will reveal the damage done, in the form of small holes bored for its exit. On cutting the bulbs in half large cavities are disclosed, showing the full extent of this injury. In Plate 21 may be seen the effect of the insect, the plants in figs. 2 and 3 being grown at the Garden for experimental purposes. In their natural state the orchids are stronger and are able to withstand these attacks without any material damage. Under cultivated conditions, however, their growth is more or less restrained, and unless careful precautions are taken, an attack by these insects results in the final destruction of the plants.

The Adult Fly.—In the "American Gardening," Vol. XXI, the following description is given:

"The perfect insect or fly is black, and has clear, shining iridescent wings. The female is about one-seventh of an inch long, while the male is considerably smaller, being only about one-tenth of an inch in length. The head and thorax are rough and unpolished, the microscope showing them to be covered with tiny pits, from each of which little bristles or hairs project. The abdomen is black, smooth, polished and shining, and is without hairs except on the smaller last segments. The abdomen of the female is pointed and somewhat wedge-shaped beneath, while that of the male is small, being not more than half the length of the female abdomen and terminating bluntly or abruptly. Under the microscope the sexes may be readily separated by the antennae. In the female most of the joints are about the same size and shape, being symmetrical and connected together by inconspicuous pedicels; while the male antennae are somewhat longer, the chief joints being longer and abruptly tapering to a slender neck or pedicel at the anterior ends, and lacking symmetry by being much more swollen on one side than on the other. The whorls of hair or bristles are very much longer than on the female antennae.

"The legs at the joints are red, the thighs being black, the middle portion yellowish or reddish, except on the hind pair—where they are blackish, and the feet (tarsi) are pale or dull white and tipped with minute dark claws.

"The female is provided with a long and extremely slender ovipositor, which it inserts into the tissue of the plant when depositing its eggs. When not in use this ovipositor lies quite concealed by a groove and protecting sheaths."

Larva.—The little footless larva is white, a little less than a sixth of an inch in length when full grown. This is the feeding period, when the growths of the pseudo-bulbs are tunneled. From this it develops into a pupa and is black

in color, measuring one-seventh of an inch in length. From the pupa develops the winged insect, completing the life cycle.

Detection and Eradication.—When importations arrive from South America it is almost impossible to find any traces of the pests except in the developed pseudo-bulbs, from which they have made their escape. However, it is advisable to take the precaution of fumigating with hydrocyanic gas, as there is always the possibility of the winged insect having developed in transit. After the plants have become established and the dormant eyes begin to show activity, daily examination is essential, since this is the critical period when the larvae are feeding and may be detected. The first fumigation should not be relied upon as final, because if the young growths do contain eggs, it is not possible to reach and destroy them with gas.

The presence of the insect in the young growths may be detected by their abnormal shape. Under normal conditions they are strap-shaped and slightly rounded at the base. If the growths are infested with the larvae or pupae, they will appear unnaturally large, rounded and gradually tapering to a point, especially when they are about two to three inches in height. If these characteristics are noticed, there should not be the slightest hesitancy in cutting the growths off close to the parent pseudo-bulb and burning them, because each contains eight to ten small black pupae which will eventually develop into adult or winged insects. Commercial growers would no doubt hesitate to cut these young shoots because of losing the blooms. However, if they are left, the growths are finally too crippled to develop flowers and an opportunity is given the insect to reproduce. The parent pseudo-bulb is always supplied with dormant eyes or growths which will soon develop after the infested growth has been removed, and will produce flowers almost as fine as the lead, although the flowering period will naturally be a few weeks later.

Cyanide Fumigation.—Even if the orchid fly has been located during its early stages, there is still a possibility that some have been overlooked and have developed into winged insects. In any case it is advisable to fumigate with hydrocyanic gas weekly until the pseudo-bulbs are well developed. This will certainly eradicate the pest in the final stage, preventing the possibility of reproduction.

Careful preparations should be made for fumigating, evening being the best time for the work. The greenhouse and plants should be kept dry the entire preceding day, the

1.

2.

3.

1. THREE ABNORMAL GROWTHS CONTAINING PUPAE, THE MIDDLE ONE CUT TO SHOW CAVITY AND PUPAE. 2. PUPAE JUST BEFORE EMERGING INTO THE WINGED INSECTS. 3. NORMAL GROWTH NOT ATTACKED BY THE INSECTS.

(Twice Natural Size)

plants not to be watered under any circumstances, because of the succulent nature of the leaves. The cubic feet of space in the house should be exactly determined, the ratio to be one ounce of cyanide of potassium (98 to 100 per cent pure) and one ounce of commercial sulphuric acid in three ounces of water, to 2,000 cubic feet. Earthenware jars should be used, as glass jars will break when filled with the sulphuric acid. The water should be poured into the jars first, then the sulphuric acid added, and the jars placed at equal distances throughout the house. Before adding the cyanide, the steam valves should be regulated to carry the necessary temperature throughout the night. When these preparations are complete, the cyanide (previously wrapped in tissue paper to prevent contact with the hands) should be dropped into the solution by two men—one on each side of the house — and the house immediately vacated and locked, and signs attached warning against entrance.

Next morning the doors should be left open for a few minutes, and then the top ventilators opened to allow the remaining fumes to escape. It should be borne in mind that cyanide is a dangerous poison, and the utmost care is necessary in using it in fumigation.

LIST OF BIRDS OBSERVED IN THE MISSOURI BOTANICAL GARDEN DURING THE MONTH OF APRIL

The birds on the following list were observed by members of the St. Louis Bird Club in the Missouri Botanical Garden, with the exception of those listed on April 19, which were observed by Mr. Otto Widmann:

April 1	April 8
	American Tree Sparrow
Bob-white	Bob-white
	Brown Thrasher
Bronzed Grackle	Bronzed Grackle
Cardinal	Cardinal
	Cedar Waxwing
	Chipping Sparrow
Crow	Crow
Downy Woodpecker	
English Sparrow	English Sparrow
	European Sparrow
	Flicker
Fox Sparrow	Fox Sparrow
Junco	Junco
Meadow-lark	Meadow-lark
Robin	Robin
Rusty Blackbird	
Song Sparrow	Song Sparrow
	Tufted Titmouse

April 15

Bluebird

Bob-white
Brown Thrasher
Bronzed Grackle
Cardinal
Cedar Waxwing

Chipping Sparrow

Cowbird
Crow
Downy Woodpecker
English House Sparrow
European Tree Sparrow
Field Sparrow
Flicker

Junco
Meadow-lark

Red-winged Blackbird
Robin
Ruby-crowned Kinglet
Song Sparrow
Towhee

Yellow-bellied Sapsucker

April 19

Bluebird
Blue-gray Gnatcatcher
Blue Jay

Brown Thrasher
Bronzed Grackle
Cardinal
Cedar Waxwing
Chimney-swift

Cooper's Hawk

Crow

European Tree Sparrow

Flicker
Hermit Thrush
House Sparrow
House Wren
Junco
Meadow-lark
Mourning Dove
Palm-warbler
Red-breasted Nuthatch
Red-shouldered Hawk
Red-winged Blackbird
Robin
Ruby-crowned Kinglet
Song Sparrow
Towhee
White-throated Sparrow
Winter Wren
Yellow-bellied Sapsucker

THE SHAKESPEAREAN GARDEN

The Shakespearean garden, which was described in detail in the February number of the BULLETIN, was opened to the public in the floral display house on Sunday, April 23, and will continue as the main attraction throughout the month of May. This show will be interesting not only because of its architectural and landscape features, but also for the abundance and variety of flowering material used. The list of plants published in the previous BULLETIN does not suggest the color possibilities, but roses, daisies, lilies, pansies, tulips, zinnias, and marigolds will be grouped in the most effective way possible. On the platform at the south end of the house will be massed a large quantity of flowering plants, such as calceolarias, spiraeas, lilies, hydrangeas, etc. The entrance passage will likewise be filled with bloom, and the floral display will extend even to the flower alcoves in the aroid house.

NOTES

The Rufus J. Lackland fellowships for the year 1916–17 have been awarded to the following:

Mr. W. W. Bonns, B.S., Massachusetts Institute of Technology, 1899; B.S.A., Cornell University, 1909, reappointed.

Mr. Carroll W. Dodge, A.B., Middlebury College, 1915, reappointed.

Mr. R. A. Studhalter, A.B., University of Texas, 1912, reappointed.

Mr. H. C. Young, B.S., Ohio State University, 1913; M.S., Agricultural and Mechanics College of North Carolina, 1915, reappointed.

Mr. D. C. Neal, B.S., Mississippi Agricultural and Mechanical College, 1909; graduate work, University of Chicago, 1915, and Henry Shaw School of Botany, 1915–16.

Mr. George W. Freiberg, Rufus J. Lackland Fellow, has been appointed Research Assistant to succeed Dr. A. R. Davis.

Dr. Samuro Kakiuchi, of the Imperial University, Tokio, was a Garden visitor February 9.

Mr. G. H. Pring delivered an address on "The Mimicry of Orchids" before the Mothers' Circle of the Clifton Heights School on April 6.

Dr. B. M. Duggar, Physiologist to the Garden, discussed before the St. Louis Garden Club "Some Fundamental Facts of Plant Life," on April 11.

Dr. A. R. Davis, Research Assistant to the Garden, addressed the Academy of Science, March 20, on "Enzyme Action in the Marine Algae."

On March 27, Dr. George T. Moore, Director of the Garden, lectured before the Kirkwood Monday Evening Club on the "Missouri Botanical Garden."

Dr. Edwin C. Miller of Kansas Agricultural College, Manhattan, Kansas, visited the Garden, April 4–6, and Mr. C. H. Winkler of the Department of Botany, University of Texas, April 14.

Dr. George T. Moore, Director of the Garden, served on the Board of Jurors of the National Flower Show at Philadelphia, March 25–April 2, and in the same capacity at the New York Show, April 5–12.

The 1915 volume of the Proceedings of the American Society for Municipal Improvements contains an article by Dr. Hermann von Schrenk, Pathologist to the Garden, on "Creosote for Wood Block Paving."

Dr. Joseph Erlanger, Head of the Department of Physiology, Washington University Medical School, gave an address before the graduate seminar, April 12, on "Faradic Stimuli: A Physical-Physiological Study."

Dr. Hermann von Schrenk, Pathologist to the Garden, presided at the meeting of the Douglas Fir Manufacturers' Association, and at the American Society for Testing Materials, at Seattle, Washington, April 6–8.

Among the visitors to the Garden during March were Mr. J. B. Swayne, florist and mushroom grower, Kennett Square, Pennsylvania, and Mr. B. H. Slavis, Assistant Superintendent Park Department, Rochester, New York.

The position of Horticulturist to the Garden has been filled by the appointment of Mr. Alexander Lurie. Mr. Lurie is a graduate of Cornell University, and has been in charge of greenhouses and ornamentals, Greening Bros.' Nurseries, Monroe, Michigan, and Instructor in Floriculture, in charge of greenhouses and grounds, University of Maine.

STATISTICAL INFORMATION FOR MARCH, 1916

GARDEN ATTENDANCE:

Total number of visitors	8,872

PLANT ACCESSIONS:

Total number of plants received in exchange	26
Total number of packets of seeds received in exchange	14

PLANT DISTRIBUTION:

Total number of plants distributed in exchange	108

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought	55
Total number of books and pamphlets donated	157

HERBARIUM ACCESSIONS:

By Purchase —	
E. Bartholomew — "North American Uredinales," Cents. XV and XVI, Nos. 1401–1600	200
By Gift —	
E. Bartholomew—Fungi from the Pacific States	9
W. C. Coker—Fungi from Chapel Hill, North Carolina	6
J. A. Drushel—Flowering plants from Alabama, Missouri, Texas, Colorado, Arizona, and California	54
W. G. Farlow—Fungi from New England and Venezuela	39
C. H. Kauffman — Fungi from New York, Michigan, and Washington	52
Meyer Brothers, Druggists—*Chrysanthemum cinerariaefolium* (Trev.) Bocc.	1

Geo. L. Moxley—Ferns and flowering plants of California.. 15
Miss Minnie E. Nash—*Asplenium platyneuron* (L.) Oakes from Louisiana 1
C. E. Owens—Wood-destroying fungi from Oregon..... 2
S. B. Parish—Flowering plants from California..... 51
W. H. Rankin — *Stereum rameale* as a trunk parasite on *Syringa vulgaris* 1
J. B. Rorer — "Pink disease" on *Amherstia nobilis* from Trinidad 1
H. von Schrenk—Specimens of *Pinguicula* and *Mayaca* from Alabama and Mississippi..... 3
A. B. Seymour—The fungus *Poria aurea* Pk. from Massachusetts 1
P. Spaulding — Fungus on living *Pinus Strobus* from Maine 1
Geo. W. Stevens—Specimen of *Senecio glabellus* Poir. from Oklahoma 1
John A. Stevenson—Fungi from Porto Rico..... 37
R. Thaxter—The smallest kind of hymenomycetous fungus so far known, constituting a new genus and species, from Connecticut 1
L. A. Zimm—Fungi from New York..... 8

By Exchange —

Arnold Arboretum, Harvard University—Woody plants of Alaska, China, etc. 233
Carnegie Museum, Pittsburgh—Mosses from Pennsylvania and Ontario 84
J. M. Grant—Flowering plants and ferns of Washington... 200
University of Texas, by Dr. Mary S. Young — Plants of Texas 352

TOTAL..... 1,353

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MISSOURI BOTANICAL GARDEN BULLETIN

Vol. IV MAY, 1916 No. 5

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Bishop of the Diocese of Missouri.

A. D. CUNNINGHAM, Secretary.

FLORIDA MOSS (X) AND SPECIES OF THE TANK EPIPHYTE, KARATAS (Y).

Missouri Botanical Garden Bulletin

Vol. IV St. Louis, Mo., May, 1916 No. 5

EPIPHYTIC PLANTS

The establishment of a bromeliad house as part of the new plant range, recently completed at the Garden, warrants calling attention to the peculiar habit of growth of a number of these plants which normally are not dependent on the earth for their existence but live as epiphytes.

Epiphytic plants are those which spend all or the greater part of their existence upon other plants. In its broader sense the term would include such non-flowering plants as the fungi and the lichens, but usually it is limited to the higher, or the flowering plants, and it is so understood here. Epiphytes may be truly parasitic, i. e., completely dependent upon the plant upon which they grow for all nutrition, or the host plant may simply function as a support. Most epiphytes are of this latter type and obtain their mineral food, either from the dust particles of the air, or from the decaying vegetable matter which collects in their leaves and about their roots, while their water comes from chance rains.

Such plants are very plentiful in moist tropical countries, and especially in forests where the heavy foliage overhead prevents sunlight from reaching the ground. In the struggle for existence under these conditions, only those small plants can survive which are able to utilize the diffuse light on the forest floor, or which have become adapted to an aërial habit, thus being placed within reach of the sunshine overhead. In such localities many orchids, members of the pineapple family (bromeliads), as well as diverse species of ferns, are found growing on the branches and in the axes of limbs far above the ground.

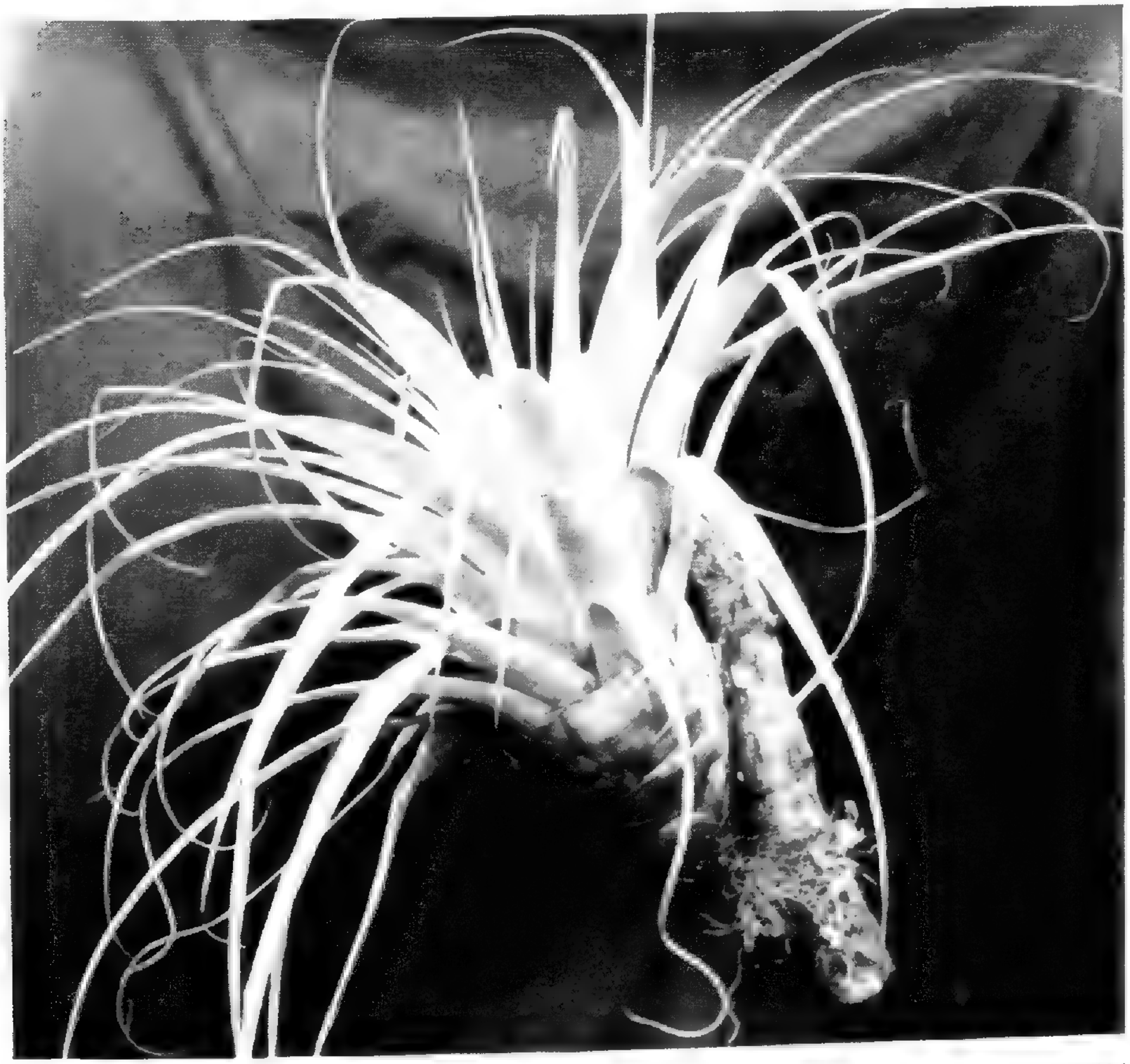
Although less frequently met with in northern latitudes, there are some plants found here which show this dependent habit very well. In the immediate vicinity of St. Louis the dodder or the lover's twine is a familiar type. In the summer and fall one frequently sees the yellowish brown vine forming an interlacing network over shrubs and herbs. A close observation at the proper season will reveal the presence of small inconspicuous white flowers. These form seeds

which germinate in the earth and send out long thread-like shoots which soon come in contact with near-by plants. These shoots twine about the stems of such plants and here and there form small suckers which tap the food and water supply of the host. All connection with the earth is then lost and the dodder settles down to its parasitic existence. The plant rarely becomes a pest, although when once established in a bed of flowers or in shrubbery it becomes very difficult to eradicate.

Another epiphytic plant, perhaps better known for its various Christmas uses than for the peculiarity of its epiphytic habit, is the mistletoe. In the west and southwest it grows so abundantly on the sycamore, fir, pine, and oak, as to cause the early death of many trees. Unlike the dodder, this plant never has any direct connection with the ground, but spends all its life as a parasite. When the waxy berries ripen they are eaten by birds, or being extremely sticky, may cling to the feet of birds and are thus dispersed from tree to tree. Coming to lodge in a crack or a knot-hole these seeds germinate and send root-like processes into the host tissue. So firmly connected do these become that the union appears similar to a natural graft.

The Garden is very fortunate in the possession of many representatives of the tropical and sub-tropical epiphytes. One of the latter, very familiar to many readers, is the Spanish moss (*Tillandsia usneoides* L.), sometimes called Florida or Louisiana moss from its prevalence in those two regions. The plant is especially interesting in that it illustrates the extreme modification in structure and function of various organs which may result from an abnormal habit of growth. Only weak and insignificant root development ever takes place, and this only in the very earliest stages of seed germination. Such roots are quickly lost, and the mature moss, as one finds it draped gracefully over the branches of trees, consists wholly of stems and leaves. The plant is not a parasite and does not have any connection with the tree upon which it grows. Naturally one might expect to find here the question of food and water supply a serious one. Organic foods, as sugars, are formed by the green pigment of the leaves, as is true in normal plants. The entire outer surface of the stems and leaves are covered with extremely small scales which during a rain greedily absorb the falling drops much as a sponge absorbs water. This water is held by capillary attraction and is given up to the plant as needed. Every drop of such water is precious and must be made to go as far as possible. It is not surprising then that one finds that during a dry spell the scales be-

PLATYCERIUM ALCICORNE OR STAG-HORN FERN—A NEST EPIPHYTE. NOTE THE CLASPING BASAL LEAVES WHICH RETAIN DECAYING VEGETABLE MATTER.



TILLANDSIA ALOIFOLIA, A TANK EPIPHYTE. THE ROOTS SEEN SERVE ONLY TO FASTEN THE PLANTS TO THE BRANCH.

come closely appressed to the surface, thus diminishing to a great extent the loss by evaporation. The necessary mineral food of the moss is gathered from the air by these very same scales. Dust particles blown about by the wind and containing substances which may be utilizable as mineral food come to lodge in them, and becoming dissolved in the water held by the scale eventually pass into the plant. The "host" plant in this instance simply acts as a support, and one might expect that the moss could grow and thrive on almost anything that offered such a support whether it be tree or not. This explains the phenomenon reported from time to time in popular magazines, of plants growing on telephone wires and the like. Propagation is chiefly by means of wisps which are blown about by the wind or are carried by birds as nest material.

Besides the Florida moss there are some other exceptionally good specimens of epiphytic bromeliads in the bromeliad house. Several species of Tillandsia looking very much like aërial pineapple plants are perched on the old stump just inside the entrance. These are all of the so-called "tank epiphyte" type, that is, the leaves are firmly appressed to each other at the base (Plates 23 and 24), thus forming pockets or reservoirs in which water collects during rains. In the larger plants as much as two or three quarts of water may be held in the pockets so formed. Not only water is collected, but leaves and decaying vegetable matter as well which are made use of as a food supply for the plant. The roots are very poorly developed; indeed, in most cases they simply act as anchors to fasten the plant to its host. The leaves, on the other hand, assume most of the root functions, and one finds in their basal portion special modifications which permit the taking in of water and substances in solution. Many of the plants of this group, which in their native habitat ordinarily have an aërial habit, may also grow on the earth, several such being shown on the ground on either side of the walk, particularly species of Karatas, Aechmea, and Billbergia.

The ferns also have many representatives which, under their native conditions at least, are epiphytic. One of the best examples possessed by the Garden is the "stag-horn" fern, of which a number are found attached to the rustic railing just inside the fern house door. When examined the plant reveals two types of leaves—those which simulate the stag-horn, and the broad basal ones. Decaying vegetable matter, humus and the like, collects in these latter and is held by means of the peculiar clasping manner of growth. Thus a natural reservoir is formed which affords an

efficient source of mineral food supply. A fibrous mass of absorbing roots penetrates this decaying matter in all directions, while anchorage is maintained by means of other roots which seem to function in no other way. Plants collecting humus in this way have been termed "nest" epiphytes.

There are several other noteworthy epiphytic ferns in the collection—some, as *Psilotum triquetrum,* growing on the trunks of tree ferns, others in the hanging baskets overhead.

A discussion of epiphytic plants would be incomplete without mention of the tropical orchids. As a group they are essentially epiphytic, growing luxuriantly in most inaccesable tree-tops, in the crevices of limbs, and indeed far out on the ends of branches. Besides being interesting from the standpoint of floral modification, the group attracts attention by reason of the modifications which an aërial environment has brought about in the functions of other organs. Notably is this true where the absorption of water is concerned. Many orchids send down long aërial roots, the central cylinder alone of which is made up of living tissue. The thick coat surrounding this is composed of empty dead cells which absorb water very readily. As was true with the Spanish moss, water is taken in during rainfall and held in these empty cells which act as a reservoir. Orchids are not parasitic—they extract no nourishment from the tree upon which they live. When they anchor themselves, dead material accumulates in the mass of leaves and roots, which through its decay affords a mineral food supply to the plant.

TWO RARE EPIPHYTIC GESNERIACEAE

The family Gesneriaceae is familiar through the well-known genus Gloxinia (see April, 1915, number of the BULLETIN), species of which are extensively grown and a good collection of which may be seen in the floral display house during the month of June. In the aroid house at the Garden, however, are two genera of Gesneriaceae which are so little known and so unusual that it seems especial attention should be called to them, i. e., Aeschynanthus and Columnea.

There are upwards of forty species of Aeschynanthus, most of which are natives of the East Indies. They are found associated with orchids and other epiphytes, attaching themselves to the trunks and branches of trees by their roots which are freely produced from the trailing branches or stems.

AESCHYNANTHUS LAMPONGA.

Aeschynanthus Lamponga which is displayed in the floral orchid alcoves, is a native of Sumatra. The flowers are produced in clusters at the end of pendant branches and are covered with very fine silky hairs. The calyx is tubular or vase-shaped and purplish brown in color from the interior. The bright scarlet corolla gradually emerges until it is twice the length of the calyx when fully open, and the yellow throat with its dark-colored markings emphasizes the gaping effect of the corolla. It is this latter characteristic which gives the name to the genus, Aeschynanthus being derived from the Greek words, aischyne, shame, and anthos, flower.

Being of epiphytic habit, the plant is best grown in hanging baskets, as exhibited at the Garden. The growing medium consists of equal parts of orchid or fibrous peat and sphagnum moss. The temperature should be 65–70° F., and since heat and moisture are essential requirements, the conditions will be ideal if grown with the pitcher plants (Nepenthes).

Propagation may be accomplished either by seeds or cuttings, the latter being preferable. These should be made in the spring by dividing the long trailing stems in sections about three inches long, and laying or inserting these in a mixture of finely chopped sphagnum moss and sand. They should then be placed in the propagating case, or the pan should be covered with a Bell jar and kept fairly moist. If conditions are favorable they will readily root, after which they may be transferred into the permanent baskets. When the young growths begin to hang over the edge of the basket they should be carefully pegged to the side until the peat is entirely covered. The new growths should then be allowed to hang down and in time will produce the remarkable scarlet flowers. Two years, however, will elapse between the cutting stage and the flowering period.

The genus Columnea is named in honor of Fabius Columnea, or more correctly Fabio Colonna, an Italian of noble family and author of several botanical books published in the sixteenth century. The genus embraces upwards of one hundred species, but representatives are very rarely grown except in botanical gardens. Like the Aeschynanthus it is epiphytic in habit and is usually grown in association with orchids. The various species are native to Mexico, Colombia, Guiana, Brazil, and the West Indies.

Columnea Schiedeana, which is frequently in flower at the Garden, is a herbaceous climbing plant and a native of Mexico and Panama. Both the stem and the oblong-lanceolate leaves are clothed with silky hairs. The flowers,

which are very showy, are produced along the stem from short solitary racemes. The corolla is about six inches long, variegated with yellow and brown, and clothed with glandular hairs. The calycine segments are also spotted and hairy.

In propagating, the terminal shoots should be used for cuttings, and the stem divided into lengths about two inches long, laid flat, and treated in the same manner as advised for the Aeschynanthus, except that it is not advisable to peg the shrubby stems to the basket, as they are very brittle.

BIRDS IN THE MISSOURI BOTANICAL GARDEN

The birds on the lists of April 22 and 29 were observed by the members of the St. Louis Bird Club; those of April 30 were seen by Mr. George F. Tatum; and those of May 2 and 8 by Mr. and Mrs. Otto Widmann.

April 22	April 29	April 30
	Green Heron	
Bob-white	Bob-white	Bob-white
		Mourning Dove
Downy Woodpecker		Downy Woodpecker
Yellow-bellied Sapsucker		
	Red-headed Woodpecker	Red-headed Woodpecker
Flicker	Flicker	Flicker
		Night-hawk
		Swift
Chimney-swift	Chimney-swift	
		Ruby-throated Humming-bird
	Kingbird	Kingbird
Crow	Crow	Crow
Blue Jay	Blue Jay	Blue Jay
	Cowbird	Cowbird
Red-winged Blackbird	Red-winged Blackbird	Red-winged Blackbird
Meadow-lark	Meadow-lark	Meadow-lark
	Baltimore Oriole	Baltimore Oriole
Bronzed Grackle	Bronzed Grackle	Bronzed Grackle
	Goldfinch	Goldfinch
European Tree Sparrow	European Tree Sparrow	European Tree Sparrow
White-throated Sparrow	White-throated Sparrow	White-throated Sparrow
Chipping Sparrow	Chipping Sparrow	Chipping Sparrow
	Field Sparrow	Field Sparrow
Song Sparrow	Song Sparrow	Song Sparrow
		Lincoln Sparrow
		Swamp Sparrow
Towhee	Towhee	Towhee
Cardinal	Cardinal	Cardinal
	Rose-breasted Grosbeak	Rose-breasted Grosbeak
		Purple Martin
Waxwing	Waxwing	
		Cedar Waxwing
Warbling Vireo	Warbling Vireo	Warbling Vireo
	Bell's Vireo	
		Black-and-white Warbler
Yellow Warbler	Yellow Warbler	Yellow Warbler

Myrtle Warbler	Myrtle Warbler	Myrtle Warbler
	Maryland Yellow-throat	Maryland Yellow-throat
		Mocking-bird
		Catbird
Brown Thrasher	Brown Thrasher	Brown Thrasher
House Wren	House Wren	House Wren
		Tufted Titmouse
Ruby-crowned Kinglet	Ruby-crowned Kinglet	Ruby-crowned Kinglet
		Wood Thrush
		Olive-backed Thrush
Robin	Robin	Robin
Bluebird	Bluebird	Bluebird

May 2	May 8
Green Heron	Green Heron
	Woodcock
Spotted Sandpiper	
Bob-white	Bob-white
Downy Woodpecker	Downy Woodpecker
Red-headed Woodpecker	Red-headed Woodpecker
Flicker	Flicker
Chimney-swift	Chimney-swift
	Ruby-throated Hummingbird
	Crested Flycatcher
	Wood Pewee
Blue Jay	Blue Jay
Crow	Crow
Cowbird	Cowbird
Red-winged Blackbird	Red-winged Blackbird
Meadow-lark	Meadow-lark
	Orchard Oriole
Baltimore Oriole	Baltimore Oriole
Bronzed Grackle	Bronzed Grackle
European Tree Sparrow	European Tree Sparrow
White-crowned Sparrow	
White-throated Sparrow	
Chipping Sparrow	Chipping Sparrow
Song Sparrow	Song Sparrow
Swamp Sparrow	
Towhee	Towhee
Cardinal	Cardinal
Indigo Bunting	Indigo Bunting
Warbling Vireo	Warbling Vireo
Yellow Warbler	Yellow Warbler
Grinnell's Water Thrush	
Maryland Yellow-throat	Maryland Yellow-throat
Catbird	Catbird
Brown Thrasher	Brown Thrasher
House Wren	House Wren
Prairie Marsh Wren	
Ruby-crowned Kinglet	
Wood Thrush	Wood Thrush
Gray-cheeked Thrush	Gray-cheeked Thrush
Olive-backed Thrush	Olive-backed Thrush
Robin	Robin

The following notes were supplied by Mr. George F. Tatum:

"After many years' observation of the birds in various places in and around St. Louis, I feel warranted in asserting that the most favored locality is the Missouri Botanical Garden where, during a morning or afternoon walk of not exceeding an hour, in the spring or early summer, one may see or hear from twenty-five to forty species, and usually under such conditions that identification is not difficult.

"That many of our summer birds, particularly those that are highly migratory, i. e., wintering in or near the tropics, vary but little in the date of their arrival in the Garden is evident from the following first appearance tables:

	1913	1914	1915	1916
Yellow-billed Cuckoo	May 24	May 3	May 15	May 8
Night-hawk	April 30	April 26	April 26	April 30
Great crested Flycatcher	May 11	May 3	April 30	May 5
Wood Pewee	May 20	May 10	May 13	May 8
Traill's Flycatcher	June 4	May 16	May 2	May 13
Orchard Oriole	May 8	May 2	May 8	May 7
Baltimore Oriole	April 23	April 26	April 25	April 19
Rose-breasted Grosbeak	April 27	April 22	April 27	April 29
Warbling Vireo	May 3	April 23	April 28	April 23
Yellow Warbler	May 4	April 25	April 26	April 23
Maryland Yellow-throat	April 27	April 25	April 25	April 23
Catbird	April 27	May 2	May 2	April 29
Wood Thrush	April 23	April 25	April 24	April 23

"Much has been written on the early singing of the birds, and the following from my 'Bird Record' for Sunday, June 7, 1914, on which day I was out by 3 A. M., gives the time at which the various species were first heard:

Purple Martin	3:25 A. M.
Robin	3:35 A. M.
Chipping Sparrow	3:45 A. M.
English Sparrow	4:10 A. M.
Cuckoo	4:15 A. M.
Rose-breasted Grosbeak	4:15 A. M.
Meadow-lark	4:15 A. M.
Brown Thrasher	4:20 A. M.
Blue Jay	4:20 A. M.
Grackle	4:25 A. M.
Flicker	4:30 A. M.
Orchard Oriole	4:40 A. M.
Warbling Vireo	4:50 A. M.
Wood Thrush	4:50 A. M.
Cardinal	5:00 A. M.

FLORAL DISPLAY FOR THE SUMMER MONTHS

The collection of Shakespearean plants which formed such an interesting feature of the Shakespearean garden during

April and May will be replaced by a new floral display for the summer months. The effect of the three gardens, with the trellis and arbor work, will be retained, but in the borders will be shown such flowering plants as require greenhouse protection even during warm weather. Hydrangeas in pink, blue, and white, purple achimenes, many varieties of fuchsia, and velvety gloxinias in shades of pink, blue, and purple will form the greater part of this exhibit. Fancy-leaved caladiums will also be on display, while tuberous begonias will vie with the gloxinias in variety of form and color.

In the floral alcoves will be found many of the late-flowering orchids which, while not presenting the color effect of the winter-blooming varieties, may prove of greater interest because of their rarity. Many other tropical plants, seldom seen even in greenhouses, will be placed in these alcoves as they come into bloom.

Of the various out-door displays, especial attention should be called to the rose garden in which many plants are now coming into bloom.

NOTES

Dr. W. Van Fleet, of the Office of Drug Plant Investigations, U. S. Department of Agriculture, was a Garden visitor on April 24.

The delegates and members who attended the sixty-fourth annual meeting of the Western Unitarian Conference visited the Garden on May 16.

Mr. Alexander Lurie, Horticulturist to the Garden, spoke before the open meeting of the graduate seminar, April 26, and the St. Louis Florist club, May 11, on "The Development of the Carnation."

The Annual Flower Sermon, provided for in Mr. Shaw's will, was preached on Sunday, May 21, at Christ Church Cathedral by Rev. George C. Dunlop, Rector of Christ Church, Springfield, Illinois.

On May 19, Mr. Angelo Corrubia, of Cann & Corrubia, Architects, gave an informal talk to the landscape students on "Architectural Design." Several of Mr Corrubia's sketches, made abroad and in this country, were exhibited.

A party from the University of Missouri, consisting of Prof. George M. Reed, Professor of Botany, Prof. H. W. Lawrence, Professor of Horticulture, and Prof. Herman Schlundt, Professor of Chemistry, visited the Garden on April 22.

Mr. Wychoff, Secretary of the Pacific Coast Cedar Manufacturers' Association, visited the Garden on May 9.

Dr. Hermann von Schrenk spoke before the science section of the Wednesday Club, April 25, on "Diseases of Trees."

Mr. Henry L. Ochs, a graduate of the Garden course, has become associated with Mr. Edward Sedivic in the floral and landscape business.

On May 26, Dr. B. M. Duggar, Physiologist to the Garden, delivered an address at the Harris Teachers' College before the St. Louis Association of Science and Mathematics Teachers on "Chance and Adjustment vs. Purpose in Responses and Evolution of Living Things."

Mr. W. W. Ohlweiler, General Manager to the Garden, addressed the Lindell Boulevard Improvement Association, May 2, on "Flowering Plants for St. Louis," and Mr. John Noyes, Landscape Designer to the Garden, spoke before the same organization, May 9, on "Boulevard Design."

STATISTICAL INFORMATION FOR APRIL, 1916

GARDEN ATTENDANCE:

Total number of visitors	35,194

PLANT ACCESSIONS:

Total number of plants received in exchange	17
Total number of packets of seeds received in exchange	66
Plants donated	104

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought	39
Total number of books and pamphlets donated	140

HERBARIUM ACCESSIONS:

By Purchase —	
B. F. Bush—Plants of Missouri	785
F. S, Collins — "Phycotheca Boreali-Americana," Fasc. XLII, Nos. 2051–2100	50
By Gift —	
J. A. Drushel—Plants of Ohio, Missouri, Texas, Colorado, and California	32
B. M. Duggar—Specimens of fungi	3
W. H. Emig—Liverworts, lichens, etc., from Oklahoma	113
E. O. Matthews—Specimens of *Stereum fasciculatum* from Mexico	1
H. von Schrenk — Flowering plants from Tennessee, Montana, and Washington	5
J. A. Stevenson—Fungi injurious to orange and grape-fruit trees of Porto Rico	2
By Exchange —	
Bernice Pauahi Bishop Museum, by Charles N. Forbes— Plants of the Hawaiian Islands	812
By Field Work —	
E. J. Palmer — Fruit and seeds of Arkansas and Texas plants	3
TOTAL	1,806

The Garden is open to the public every day in the year, except New Year's, Fourth of July, Labor Day, and Christmas—week days from 8:00 A. M. until one-half hour after sunset; Sundays, from December to April, 1:00 P. M. until sunset, from April to December, 2:00 P. M. until sunset.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Boulevard, on the Vandeventer Avenue car line. Transfer south from all intersecting lines.

The Garden will be open all day on Decoration Day, May 30.

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M. SCHILLER,
New Conservatories.

MISSOURI BOTANICAL GARDEN BULLETIN

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CONTENTS

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Missouri Botanical Garden Bulletin

Vol. IV St. Louis, Mo., June, 1916 No. 6

TUBEROUS BEGONIAS

During the summer the tuberous begonia, with its large waxy flowers of various colors, has no equal for an indoor floral display, and the Garden will have a large collection on exhibit during the months of July and August.

The begonia was named after a French patron of botany, M. Begon, and the term "tuberous" is applied because the group possesses perennial rootstocks. Thirty-five years ago the plant was just beginning to attract popular attention. At that time a number of hybrid forms were introduced, and the evolution since then has resulted in the production of varieties with large-sized blossoms as double as a rose. At the present time nearly every imaginable tint is being shown, as well as many shapes which often present an extraordinary similarity to other flowers, such as camellia, rose, hollyhock, carnation, and peony. In a great many varieties the petals are round, in some short and narrow, while in others they are fine and frilled; sometimes they are loose and open and often the reverse is true. Many of the flowers are flat when open, a few are anemone-centered, and others are globular, pyramidal, or elliptical. The plant blooms continuously from June to October, the duration of the individual flowers varying from three to six weeks from time of opening.

The first species concerned in the parentage of the present-day forms was *Begonia boliviensis,* which was introduced into England from Bolivia in 1864. It is characterized by long narrow leaves and scarlet fuchsia-like flowers. This species has recently been crossed with some of the double and single forms and has given rise to a type with long pendulous stems and drooping flowers which is very suitable for hanging baskets.

The next species to be introduced was *Begonia Pearci,* also from Bolivia, in 1866. The plant has large yellow flowers in axillary panicles and has been the chief factor in the production of hundreds of yellow, buff, and orange forms. In 1867 *B. rosaeflora* was brought from Peru. It bears large

rose-red flowers and has proved to be important in the creation of some of the white forms, the best known of these being the "Queen of the Whites." The same year *B. Veitchii* followed, with its round vermillion-tinted flowers, to which many of our present-day varieties owe their coloring. In 1876 *B. Clarkei* and *B. Davisii* were introduced. The former has rose-colored blossoms, and the latter, a dwarf plant with smooth glossy foliage, has been of great value to the hybridists who, by crossing it with other strains derived from *B. boliviensis* and *B. Veitchii,* have produced a number of varieties with a dwarf compact habit but moderate sized and highly colored flowers.

The above-named species are the chief parents of the present-day forms and in their native habitats grow at an altitude of 11,000 to 13,000 feet, which, however, does not signify that they are hardy in our climate. It will be noticed that, with the exception of the yellow-flowered *B. Pearci,* all the original species have red, scarlet, or crimson flowers; yet the result of hybridizing and crossing has been the production of progeny showing many varieties of color, such as white, pink, yellow, orange, crimson, and many intermediate shades. Veitch & Sons of England, and Crousse of France were the pioneers in the work, and when the small drooping flowers of the parents are compared with the large brilliant flowers of to-day, it seems hardly credible that such magnificent results could have been produced in a little over thirty years.

Cultivation.—The cultivation of the tuberous begonia is not difficult. The easiest way is to purchase the young tubers from a specialist and start them in February or March in shallow boxes filled with sandy loam. They should be placed far enough apart to prevent matting and tangling of the roots when taken up to be potted, and kept at a temperature of 60–65°F. The plants are ready for potting when the new shoots are about two inches long. The soil should consist of sandy loam and well-rotted manure in proportion of four to one. The size of the pots should vary according to the tuber, but generally a three-inch size is large enough for the first potting. After potting watering should be moderate, as excessive moisture causes decay at the base. A light, airy house and a temperature of 55–60° F. are necessary for the best development. However, when the flower buds begin to form it is advisable to apply shade to the glass. This not only improves the coloring of the flowers but also their keeping qualities.

By the first of June all the plants should be in their flowering pots. The amount of water given at this time

should vary according to the weather and the growth. It is important, however, to water in the morning, for if the foliage is wet when the sun is powerful, brown blotches occur where the drops of moisture have rested. To produce fine bushy plants early flower buds should be pinched off so that the strength will go to the plant itself, and the leading shoots should be removed to encourage side growths from lower down the stem. In order to bring forth showy specimens growth should be stimulated by feeding with liquid manure two or three times a week. The liquid manure may be made by suspending a half-bushel sack of cow manure in a 50-gallon barrel of water.

In October, when signs of ripening begin to show, the water should be gradually withheld until the growths decay, and the pots then placed on their sides under the benches in a greenhouse at a temperature of 40° F.; or the tubers may be taken out of the pots and placed in dry sand in a cool cellar. In either case, care must be taken to prevent any moisture from reaching the tubers during the resting period. In the spring, as soon as the tubers show signs of growth, they should be potted, the best plants being produced during the second year, although they are good for several years.

Propagation.—Tuberous begonias are propagated by seeds, division of tubers, or by cuttings of side shoots, the most common and satisfactory method being from seed. The seed should be sowed in shallow boxes or seed pans about February 1, the compost consisting of equal parts of leaf mold and peat and one-quarter charcoal. The seed are very minute, resembling tobacco dust, and for this reason are best sown directly on the surface of the soil. The pan should be covered with a glass pane and shaded to prevent drying out, but as soon as the seed germinate the glass and the shading should be removed. When the plants show the third leaf they should be pricked into flats containing a compost similar to the one mentioned above, and spaced two inches each way. It is advisable to keep the flats in a moist atmosphere, and near the glass of the greenhouses to prevent spindling. Later the plants should be transferred to four-inch pots using soil similar to that used for the tubers. The subsequent treatment corresponds to that of the tubers.

If it is desired to retain and increase the stock of any variety this may be done by taking cuttings of side shoots, two to three inches long, during the summer and inserting them into leaf mold, sphagnum moss, or cocoanut fibre. The cuttings should be kept close and shaded for several days, a

moist atmosphere maintained by sprinkling overhead, and the temperature kept at 60–65° F. As soon as the cuttings root they should be potted.

Another method of increasing the stock of any desired variety is to cut large tubers into parts, each of which contains a bud. This should be done in the spring, and the treatment thereafter is similar to that for the tubers. A necessary precaution in this method is to dip the tubers into slaked lime or charcoal to hasten the healing of the cut.

Hybridization.—The raising of new varieties from seed is a most interesting occupation. The grower's enthusiasm is somewhat dampened at the start by the uncertainty of results, but the variety and brilliance of the flowers are hardly to be equalled by any other plant. The operation itself is simple. The female parent is chosen and the stamens are cut off before the pollen is ripe, and the flower enclosed in a small waxed paper bag to prevent any foreign pollen from settling on the stigma. The male flower may also be enclosed in a similar bag to avoid the intermixing of pollen from other plants by insects. As soon as the stigma of the female plant is ripe—which can be told by the protruding of little hairs upon it—the pollen of the male plant may be brought to it by means of a camel's-hair brush or forceps, this being best accomplished in the middle of a bright day. In a day or two the stigma will turn brown and gradually die away, thus indicating that fertilization has taken place. A pod, which is soon formed, bursts at the top when ripe, and the seeds fall to the bottom of it. Some difficulty is experienced with the double flowers. Very often these fail to produce pollen, as the pollen-bearing stamens may have changed into petals. This condition may be avoided, however, by starving the plant, that is, reducing the water supply, thus forcing the flowers to be smaller and sometimes changing them into single flowers with some pollen-bearing stamens. This procedure is not always successful, however.

PAPAWS[1]

Of all the important native fruits of the United States, the least known is probably the papaw, which flourishes in the forests of the southern part of the Mississippi valley, and extends west to Oklahoma and north to Michigan and

[1] The numerous papaw trees in the region reached by the BULLETIN warrants the reprinting of the following article from the July number of the "Journal of Heredity" (organ of the American Genetic Association), Washington, D. C.

New York. As an ornamental tree or shrub, it is occasionally grown over a much wider range.

Belonging to the family of Anonaceae or custard-apples, the papaw has a good deal in common with those delicious fruits. Its creamy pulp is of exquisite texture in the mouth, while its distinctive flavor and its aroma, often too pungent, give it a decided individuality. The shiny black seeds occupy more space than is desirable, in most specimens.

The poor shipping quality of the fruit doubtless accounts largely for the fact that it is so little known outside of the immediate localities where it grows wild. It is not considered eatable until it is dead ripe and has begun to turn blackish in color; it sometimes hangs on the tree until Christmas, although it will have reached maturity in the latter half of September, when the flesh is usually yellow, occasionally white. Good individual fruits, according to Little, usually weigh about half a pound apiece, but sometimes they attain a pound in weight.

Not only is it too soft to ship, under most circumstances, but it does not keep well after it is picked. Sometimes it can be held for a number of days, if picked a little firm, but ordinarily it must be eaten from the tree.

The drawbacks of the fruit, then, are largely of a commercial character. They are drawbacks which can probably be removed by intelligent breeding. With this idea a number of individuals have undertaken during the last few years to improve the papaw; but there is still plenty of room for work, and the American Genetic Association therefore feels the desirability of calling attention to the papaw, and pointing out the attractiveness of the problem it offers.

BEST SEEDLINGS WANTED

Among the wild trees along the creeks and in the underbrush of the river bottoms, there must be many a seedling which combines superior quality with a tougher skin and greater firmness than usual. Probably farmers have picked out some of these trees and transplanted them to the orchard. The American Genetic Association wants to locate these superior trees, in order that they may be made available for rapid propagation; and a member has given $100 as a stimulus to the search for the superior specimens.

Two rewards are offered from this fund. Fifty dollars will be paid for the largest individual tree, and $50 for the tree, regardless of size, which bears the best fruit. The offer will terminate on January 1, 1917, thus including the com-

ing crop-season in which members (or others interested) can keep an eye open for superior specimens.

The award for the largest tree will be made on the basis of photographs. The conditions to be observed are as follows:

Photographs must be on glossy paper, not smaller than 4 x 5 or 3¼ x 5½ inches, and must be of sufficient excellence to allow reproduction in the "Journal of Heredity" or elsewhere. Photographs in which the tree is so small that its details cannot be made out, cannot be considered. The measurement of the tree must be given in detail. In making it, the only method which may be followed is to take the circumference of the trunk at two feet from the ground. It is desirable that the full height of the tree and spread of branches, as well as the girth, should be stated; if they cannot be measured exactly, they should be estimated. Photographs should, when possible, contain some object, such as a human figure, which will aid in giving a realization of the size of the tree; but such figure should be beside, not in front of the tree. It is necessary that the photograph should include the whole tree. If there are other trees growing beside it and cutting off part of it, these other trees should be included in the picture. Contestants may send photographs of as many different trees as they like.

With each photograph, a statement should be submitted telling all that is known about the tree, with reference to its age, the size of crop it bears, the quality of the fruit; the character of the soil and surrounding vegetation. It is particularly necessary that photographers should state whether there are many other papaw trees in the neighborhood—within a radius, say, of five miles. If the tree is on private land, and likely to be destroyed, the fact should be mentioned. It will be helpful if photographers can tell to what extent the tree is subject to attacks by disease or insects. In short, the council desires to gain as much information as possible about the papaw trees of the United States; but it imposes as few hard-and-fast restrictions as possible, because of the varying conditions under which photographs may have to be taken, or under which they have been taken at some time in the past.

The tree should be shown with full summer foliage.

All photographs submitted will become the property of the American Genetic Association, to be kept as a scientific record or used in any way that the council may think desirable.

In the award for excellence of fruit, it will not be necessary to submit a photograph of the tree, since many of the best papaws grow in dense thickets where it would be impossible to make a picture. It will be necessary, however, to give a description of the tree from which the fruit is taken, telling approximately how large it is, exactly where located, and whether or not it can be transplanted, or twigs obtained for grafting. The amount of fruit it bears should also be stated. The contestant must send by parcel post to the office of the American Genetic Association, 511 Eleventh Street N. W., Washington, D. C., at least six fruits, all from the same tree, and all ripe enough to be eaten. The award will be made on the basis of the excellence of flavor, small

number and size of seeds, but more particularly on the condition in which the fruits reach this office, taking into consideration the number of days they have been in transit; for the great need of the market is for a fruit that will keep and ship well, and if these qualities are once obtained, selection of the best for propagation can be depended on gradually to improve the quality.

The same tree may, of course, be entered for both awards —for size of tree and for quality of fruit.

CULTIVATED TREES ELIGIBLE

If anyone is cultivating the papaw and has produced a variety that he considers of superior excellence, it will be entirely permissible for him to enter this in competition. The award is not limited to wild trees; although the number of trees in cultivation is believed to be so small that it is probable some of the many wild trees will be found superior to anything known in orchards.

It is the hope of this association that the superior trees found will be propagated by grafting, and a large quantity of them secured within a few years. The papaw can be grown from seed, but only with difficulty from suckers, while transplanting is recognized to offer much trouble. One correspondent describes the general experience when he says, "I have been growing papaws for seventy-five years, not willingly but because I could not help it. It is claimed there is no way to kill a papaw except to transplant it and try to make it grow."

Grafting in the spring has been found to offer no great obstacles, however, and is the best means of propagation, from the plant-breeder's point of view. Budding has not given good results, but this may be due to wrong technique. So far as is recorded, the papaw has not been grafted on any stock except its own, and there appears to be no necessity for any other stock.

One of the promising fields for plant-breeding, in connection with the papaw, appears to be in hybridizing it with its close relatives, the tropical anonas, the genus which includes the bullock's-heart, sweet-sop, sour-sop, and the imcomparable custard-apple or cherimoya. These fruits are larger and finer than the papaw, but too tender to grow in the United States except in southern California and southern Florida. There would appear to be a good chance that they could be crossed with the papaw, and a fruit produced which would be hardy in a large part of the United States, while

superior in quality to the papaw itself. So far as is recorded, this cross has never been made.

PROPAGATION FROM SEED

It may be helpful to give the advice of the late James A. Little on the propagation of the papaw. To grow seedlings, he writes, "My plan, which has been entirely successful, is to make a hill like a watermelon hill and plant about five seeds two or three inches deep in the fall. In part for protection but mainly for shading the plants when they come up I place a barrel with both heads out over the hill and let it remain for a year or two. After that the barrel may be removed and then the plants will bear the sun. It must not be expected that the plants will come up until the harvest or later. The plants will not get more than 2 or 3 inches high the first year, but the root will be proportionately much larger than the top. The second year the plants will grow 6 or 8 inches high and after that they will greatly increase in growth from year to year. It will take them six or eight years to come into bearing."

More recent experiments than those of Mr. Little indicate that if planted as soon as taken from the fruits the seeds lie dormant in the soil for one year and germinate the second spring. There appears to be little difficulty in transplanting the young seedlings from the seed bed to the nursery row and getting plants 12 to 18 inches tall in two years, providing they are grown in rich garden earth. Transplanting has to be done in the spring before any growth starts.

A NEW LILY

In keeping with the practice of the Missouri Botanical Garden to obtain and grow, whenever possible, horticultural novelties which may be of value to flower lovers in St. Louis, there is now being shown in the formal garden the new regal lily (*Lilium regale*). This lily, which was discovered growing wild in Thibet about six years ago by the well-known botanical explorer, Mr. E. H. Wilson, although not yet in general cultivation, promises within the near future to be one of the most widely grown plants. Aside from the rare beauty of the flower, which is pink on the outside and white within—with the exception of a yellow throat—the plant has a number of advantages which will enable it to be cultivated extensively. So far as known, *Lilium regale* is not subject to any disease and will flourish in any fair soil. It is perfectly hardy in this climate and when once planted need not be disturbed for years. The stem, which

may bear as many as twenty-five funnel-shaped flowers, is strong enough to withstand wind and rain without support, and the pollen is so waxy that it does not readily fall off, discoloring the interior of the blossom.

Because of these many superiorities over other lilies which can be grown under similar conditions, it would not be surprising to find within the next generation that *Lilium regale* has become the most widely distributed and best known of this popular group of plants. Some authorities believe it to be the finest addition to gardens which has been made in years, and those interested should not fail to visit the formal garden in the enclosure bounded by the main conservatory, where about a hundred plants will be found blooming at the base of the Juno statue.

BIRDS IN THE MISSOURI BOTANICAL GARDEN

The lists of May 15 and 22 contain eight species of transient visitants which stopped over for a short time on the way to their breeding grounds. All these were gone by May 30, as were also seven species which breed in our region but apparently did not find conditions to their liking.

As subsequent lists made on June 9 and 14 are identical with that of May 30, it shows that the thirty species noted on these three days are either nesting in parts of the Garden itself or so near to it that they use the Garden as regular feeding grounds, some of them attracted to it by the abundance of ripening mulberries. The birds on the following lists were observed by Mr. and Mrs. Otto Widmann:

May 15	May 22	May 30, June 9 and 14
Green Heron		
Mourning Dove	Mourning Dove	Mourning Dove
Bob-white	Bob-white	Bob-white
Yellow-billed Cuckoo	Yellow-billed Cuckoo	Yellow-billed Cuckoo
Red-headed Woodpecker	Red-headed Woodpecker	Red-headed Woodpecker
Flicker	Flicker	Flicker
Chimney-swift	Chimney-swift	Chimney-swift
Ruby-throated Hummingbird	Ruby-throated Hummingbird	
		Kingbird
Crested Flycatcher	Crested Flycatcher	Crested Flycatcher
Wood Pewee	Wood Pewee	
Traill's Flycatcher	Traill's Flycatcher	Traill's Flycatcher
	Least Flycatcher	
Blue Jay		
Crow	Crow	Crow
Cowbird	Cowbird	Cowbird
Red-winged Blackbird	Red-winged Blackbird	Red-winged Blackbird
Meadow-lark	Meadow-lark	Meadow-lark
Orchard Oriole	Orchard Oriole	Orchard Oriole

Baltimore Oriole	Baltimore Oriole	
Bronzed Grackle	Bronzed Grackle	Bronzed Grackle
		Goldfinch
European Tree Sparrow	European Tree Sparrow	European Tree Sparrow
Chipping Sparrow	Chipping Sparrow	Chipping Sparrow
Song Sparrow	Song Sparrow	Song Sparrow
Cardinal	Cardinal	Cardinal
		Rose-breasted Grosbeak
Red-eyed Vireo		
Warbling Vireo	Warbling Vireo	Warbling Vireo
Yellow Warbler	Yellow Warbler	Yellow Warbler
	Magnolia Warbler	
Grinnell's Water Thrush		
Maryland Yellow-throat	Maryland Yellow-throat	Maryland Yellow-throat
Yellow-breasted Chat		
Wilson's Warbler	Wilson's Warbler	
	Canada Warbler	
Redstart	Redstart	
Catbird	Catbird	Catbird
Brown Thrasher	Brown Thrasher	Brown Thrasher
House Wren	House Wren	House Wren
Ruby-crowned Kinglet		
Wood Thrush	Wood Thrush	Wood Thrush
Veery		
Olive-backed Thrush		
Robin	Robin	Robin
Bluebird	Bluebird	Bluebird

NOTES

A party of fifty ladies attending the Democratic National Convention were Garden visitors on June 15.

Mr. Tomi Inouye, a graduate of the Horticultural College of Japan in 1914, has registered for the Garden course.

On June 14 the delegates to the Democratic National Convention visited the Garden and were conducted through the greenhouses and grounds by especially appointed guides.

The noteworthy specimen of *Cereus giganteus*, which was described in detail in the July, 1914, number of the BULLETIN, is now in flower and may be seen in the succulent house.

Mr. Alexander Lurie, Horticulturist to the Garden, attended the meeting of the Missouri State Florists' Association at Columbia, May 24–25, and made response to the speech of welcome by Dean Mumford.

Dr. A. R. Davis, for the past year Research Assistant to the Garden, has gone to Pomona College, Claremont, California, to conduct a course in Botany during the summer months. Mr. George W. Freiberg will succeed Dr. Davis at the Garden.

The Garden has sent a set of its scientific publications to help constitute the North American library which the Carnegie Endowment for International Peace is to present to the Museo Social Argentino on July 4. The total publications, about 11,000, will serve as a symbol of good will and a permanent interpretation of the feelings of the people of the United States in the largest of the South American cities.

STATISTICAL INFORMATION FOR MAY, 1916

GARDEN ATTENDANCE:

Total number of visitors	30,012

PLANT ACCESSIONS:

Total number of plants received in exchange	11
Total number of packets of seeds received in exchange	94
Plants donated	6

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought	39
Total number of books and pamphlets donated	92

HERBARIUM ACCESSIONS:

By Purchase —

John Weldon & Co.—"Fungi Britannici," Parts I and II, Nos. 1–200, and "Micro-fungi Britannici," Fasc. I, Nos. 1–100, collected, named and prepared by J. E. Vize	300
"British Fungi": consisting of dried specimens of the species described in vol. v, part ii of the English Flora, Fasc. I and II, Nos. 1–120, by M. J. Berkeley	120

By Gift —

Mrs. J. R. Bettis—*Brassica arvensis* (L.) Ktze. from Missouri	1
Miss N. E. Boddie—*Collinsonia violacea* Nutt. from Missouri	1
R. P. Burke—Fungi of Alabama	48
J. A. Drushel—Plants of Illinois, Missouri, Colorado, and California	25
B. M. Duggar—*Ruppia maritima*, var. *subcapitata* Fernald & Wiegand from Massachusetts	4
J. Herter—*Hypolyssus Montagnei* from Cuba	1
O. S. Ledman—Plants of Missouri	9
R. S. Mills—Plants of Illinois	39
L. O. Overholts—Fungi from Pennsylvania and other localities	17
F. W. Patterson — An undescribed *Aleurodiscus* from the state of Washington	1
Mrs. A. M. Pier—Specimens of fungi from Maine	12
H. von Schrenk—Flowering plants from the state of Washington	2

A. H. Schroeder—*Rhamnus Padus* from plant cultivated in St. Louis 1
C. O. Smith — Basidiomycetous fungi on living leaves of black walnut 2
S. W. Stanford—Plants of Texas 7
G. W. Stevens—*Senecio obovatus* Muhl., var. *rotundus* Britt. from Oklahoma 2

By Exchange —

University of Wisconsin—"Fungi Wisconsinenses Exsiccati," Nos. 11–20 10

TOTAL 602

The Garden is open to the public every day in the year, except New Year's, Fourth of July, Labor Day, and Christmas—week days from 8:00 A. M. until one-half hour after sunset; Sundays, from December to April, 1:00 P. M. until sunset, from April to December, 2:00 P. M. until sunset.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Boulevard, on the Vandeventer Avenue car line. Transfer south from all intersecting lines.

The Garden will be closed all day July 4.

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Plant Propagation.

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G. H. PRING,
Orchids and other Exotics.

M. SCHILLER,
New Conservatories.

MISSOURI BOTANICAL GARDEN BULLETIN

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CONTENTS

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Missouri Botanical Garden Bulletin

Vol. IV St. Louis, Mo., July, 1916 No. 7

HARDY PHLOX

Among the great variety of perennial flowering plants which are in use in our gardens for border effects and color grouping, the phlox may well lay claim to a high position. Their vigor, upright, compact habit of growth, immense panicles of flowers, and long period of bloom make them a great asset. The colors of the flowers are rich and varied, comprising white, pink, rose, salmon, orange, scarlet, crimson, lilac, lavender, mauve, purple, and violet. Phlox are among the earliest plants to appear in the spring and the last to die down in the fall. A period of continuous bloom from July to October may be secured by planting a succession of varieties and by cutting away the first trusses, others being produced later.

The present-day phlox are chiefly of hybrid origin. They belong to the family Polemoniaceae and are close relatives to Gilia and Polemonium. *Phlox paniculata* (*decussata*) and *P. maculata* were the parents of most of the highly developed varieties of to-day. *Phlox paniculata* is an erect plant growing to a height of two to four feet, with pink-purple flowers varying to white. *Phlox maculata* is a somewhat more slender and a more dwarf plant with spotted stems and pink-purple flowers. Both of these species are indigenous to the United States, but up to 1850 they were seldom cultivated. At that time improvement was begun, and by 1885 varieties of such high merit had been produced that it seemed that a stage had been reached which would be difficult to surpass. However, this opinion was soon dispelled as the phlox shortly demonstrated that its powers of variation and improvement were not yet exhausted. The chief advancement up to thirty years ago was the development in the size and shape of the flowers, while improvement of color was overlooked. At that time there was a superabundance of varieties with pink, purplish, and slate-colored flowers, with or without deeper coloring at the center. Later, bright reds made their appearance, followed by orange-scarlets of dazzling brilliancy, and in due course the rich

purples and deep violet-blues were obtained. At present the late-flowering kinds are being ignored, which is to be deplored, for although they have smaller flowers, the panicles are denser and more pyramidal. The quality of lateness is worthy of crossing with the finest strains so as to extend the season and thus make the plant play its part to the fullest extent. Recently a remarkable strain was obtained in England as a result of a cross between *P. paniculata* and a hybrid form secured from a cross between *P. canadensis* and *P. Laphamii.* These two are early-flowering plants, ten to eighteen inches in height, with small panicles of bluish fragrant flowers. The new strain, *P. Arendsii,* is a vigorous grower of branching habit, with flowers varying in color from white to rose and pale violet. It attains a height of two feet and produces a succession of bloom from May to July.

Of the various species of hardy phlox, one that deserves especial mention is *Phlox subulata* (moss or mountain pink). This dwarf species is suitable for low borders and rockeries, forming a mat of pretty moss-like foliage over the surface of the ground. The plant is a very profuse bloomer, producing a great mass of pink or blue flowers, which hide the foliage completely. It blooms early in May and is exceedingly hardy. Hard frosts rarely cause any injury, although it is not unusual for patches to die away in winter when the weather is mild and damp.

Propagation.—Phlox may be propagated by seeds, cuttings, or division. The hybrid phlox will not breed true from seed but it is found that about forty per cent of the seedlings will be as good as the parents. In order to secure the best results with seed, cross pollination is necessary. The seed should be sown in February in moderate temperature, and as soon as the seedlings are large enough to handle, they should be placed singly in 2½-inch pots and grown in cold-frames or a greenhouse. The new plants should be set out early in the spring, allowing two to two and one-half feet between plants. In this manner it is possible to secure bloom the first season from seed.

To perpetuate varieties of especial merit propagation by cuttings is resorted to. Cuttings may be taken in the fall from flowering stems which had been previously cut back immediately after flowering. Cuttings two to three inches long should be selected, preferably with a heel, and rooted in sand in a shady cold-frame. They should then be potted in light sandy loam and kept in the cold-frame over winter with a protection of sash and straw. Early in the spring these young plants should be set out similarly to seedlings, or placed in a nursery row until they have attained sufficient

size for permanent planting. Another method employed where greenhouse facilities are available is to take up old plants from the garden in December, pot them, and force growth. Good strong cuttings may then be obtained in March, which are rooted and potted in the usual manner.

The most common and easiest method of propagation to be employed by amateurs consists of taking up the plants in the fall or spring and dividing the clumps with a spade or knife. Phlox increase by underground stolons growing outward, and it is these young vigorous shoots on the outside which produce best plants. The newly divided plants should be set out at once. With the dwarf and creeping species (*P. subulata*), large plants may be converted into numerous small ones by shaking some light soil among them in the summer and then dividing in the fall, when the trailing branches will be found to have rooted.

The garden culture of phlox is very simple. As they are gross feeders, the soil should be worked up to a depth of eighteen inches to two feet and well enriched with well-rotted manure. The manure is especially necessary in light sandy soil to conserve moisture. It should be used sparingly in stiff heavy soil, however, in view of a prevalent spot disease caused by a fungus, *Cercospora phlogina*. The disease is characterized by circular brown spots on the foliage, which on the upper surface show a dark brown border. The distance of planting should vary from two to three feet, depending upon the effects desired. For color grouping clumps may be set two feet apart without being overcrowded. Phlox suffer in hot weather because of their tendency to form roots at the surface. To avoid this, mulching with well-decayed cow manure should be resorted to in June. Moderate shade is also beneficial during the hot part of the day, so that an eastern or western border is preferable to one facing south. For the best results phlox should be divided every three or four years.

The Garden has a good collection of phlox in the economic garden, consisting of the following varieties arranged according to their coloring:

WHITE

Diadem.—Dwarf.
Jeanne d'Arc.—Large flowers. Late-flowering.
Louise Abbema.—Dwarf.
Mrs. Jenkins.—Very large flower trusses. Early-flowering. The best of the whites.

WHITE WITH CRIMSON CENTER

Albion.—White with faint red eye.
Bridesmaid.—Pure white with large carmine center.

H. O. Wijers.—Pure white with crimson-carmine eye.
Henry Murger.—White with large red eye. The best of the type.

LIGHT PINK

Henry Royer.—Dwarf. Light rose-colored.
Manzelbrunnen.—Pink with white eye.
Mme. Paul Dutrie.—Delicate lilac-rose, with large flower heads.
W. C. Egan.—One of the best. Very large flowers.

BRIGHT PINK

Bacchante.—Rose with crimson eye.
Pantheon.—Uniform rose-colored.
R. P. Struthers.—Crimson-salmon with red eye.
Rynstrom.—Clear bright pink. Very large trusses. The best of the type.

SCARLET

Baron von Dedem.—Brilliant red.
Danton.—Scarlet with purple eye.
Henry Marcel.—Pure red with salmon shading.
Siebold.—Bright scarlet. One of the best.
Sunshine.—Aniline-red with crimson eye.

MAGENTA

Rosenberg.—Bright reddish violet with red eye.

LAVENDER

Anton Mercie.—Light lavender.
B. Comte.—Brilliant purple.
La Vague.—Pure mauve with red eye.

On the knolls will be found the following additional varieties:

MAGENTA

Champs Elysee.—Bright rosy magenta.
Obergartner Wittig.—Bright magenta with red eye. The best of the type.

ORANGE-SCARLET

L'Evenement.—Orange-scarlet overlaid with pink.
Pierre Bayle.—Red overlaid with orange-scarlet.
Professor Virchow.—Bright red overlaid with orange-scarlet.

LIGHT PINK

Professor Schlieman.—Lilac-rose. Late-flowering.

BRIGHT PINK

Beacon.—Cherry-colored. Very effective.

WEED ERADICATION

A question that annually confronts the owner of a lawn, large or small, is how to get rid of the unwelcome plants called weeds. The name "weed" is applied to any herbaceous

plant that is useless or troublesome and which persists upon places where it is not wanted. Some plants, however, which are called weeds, may be ornamental and useful in suitable situations; and perhaps the best definition of a weed is a "plant out of place."

The beauty of a lawn is due chiefly to its smoothness and the uniformity of color and texture of the grass. Therefore, any plant which tends to detract from this appearance must be eradicated. The farmer is able to get rid of the noxious weeds by means of thorough cultivation and crop rotation, but of course such a treatment is not feasible upon a lawn and other means must be sought. However, the weed problem loses some of its importance if the lawn is well made and, above all, well kept and fertilized. Fertilization helps by keeping up a constant and vigorous growth of the lawn grass, thus preventing weeds from getting a foothold. Another factor which may keep weeds in check is heavy seeding with Kentucky bluegrass two or three times during the season. The seed form a fine mat over the entire area, preventing bare spots wherein weed seed may lodge and germinate. The young weed seedlings cannot withstand a dense growth of young grass and are killed out even should they find a favorable spot for germination.

The most common weeds that infest lawns are crab grass (*Digitaria humifusa*), quack grass (*Agropyrum repens*), dandelion (*Taraxacum officinale*), plantain (*Plantago Rugelii*), chickweed (*Stellaria media*), moneywort (*Lysimachia Nummularia*), shepherd's purse (*Capsella Bursa-pastoris*), and pigweed (*Amaranthus retroflexus*).

The crab grass and quack grass are very difficult to eradicate once they become established. The former is an annual and may be gotten rid of by raking off the dead grass early in the spring, seeding down with good grass seed, and by constant mowing, especially in the fall, in order to prevent the maturing of the seed. In this way after several years the lawn may be freed of the pest. The only treatment available for the quack grass is radical in its nature and consists of plowing up the lawn, growing a cultivated crop upon the land for one year, and then reseeding. Of the other weeds mentioned, dandelion and plantain may be eradicated, if not too abundant, by cutting the tops with a knife. If all the leaves are kept cut so that there will be no food stored in the roots, these will eventually starve and the plant will die.

One of the most efficient methods of weed eradication is by means of a chemical spray which kills the weeds with-

out injury to the grass, it having been found that all plants with broad leaves will be destroyed while the narrow-leaved plants will not. The grasses are especially protected because they have not the extended absorbing surfaces of the broad-leaved weeds. Besides, they are intermediate growers while young, growing from the inside outward at the stem ends, the young or growing point being protected at the base. The parts which come into contact with the spray are the tips and these have already done their chief physiological work. Even if the tips are killed the basal portion continues to grow, furnishing new surface to the sunlight. The grasses also have a waxy covered cuticle which causes the chemical spray to remain in round spheres which rattle off at the first wind. In the case of the wide-leaved weeds the drop of moisture extends at once over the entire surface and comes in direct contact with the juices of the plant. This readily explains why crab grass and quack grass do not succumb to the treatment by chemical sprays, as both are narrow-leaved and grass-like.

The use of chemicals for weed eradication has been successfully employed at the Garden, and it has been found that the one which is most efficient and which causes no injury to the grass is iron sulphate. It should be applied to the lawns by means of a compressed-air type of hand sprayer or a traction or cart sprayer, depending upon the size of the lawn. Sufficient pressure to make a fine spray is necessary, for too much solution at one place may cause injury to the young grass shoots just beneath the surface, which have only a slight power of resistance. If a hand sprayer is used it should be fitted with three feet of compression hose and a three-foot extension rod for swinging the nozzle over the lawn. The solution is made by dissolving two pounds of iron sulphate in one gallon of water, and, to be effective, lawns should be sprayed five to six times during the season in order that each set of new leaves may be destroyed as they appear. The solution should be applied on bright days, for if the rain comes too soon after spraying it may wash off the iron sulphate before it has had a chance to act. It is not advisable to spray until two to three days after mowing, and the grass should not be mowed until two to three days after spraying. Care must be taken not to get the solution upon clothing or stone walks, on account of discoloration.

Copper sulphate is sometimes used in a similar way to that described for iron sulphate, except that, as it is about ten times as destructive as iron sulphate, the solution should be weaker—about eight to ten pounds of copper sulphate to fifty gallons of water.

Ammonium sulphate, though sometimes used in small quantities as a fertilizer, in larger amounts mixed with such inert material as sand, has been applied successfully upon lawns for the destruction of broad-leaved weeds. This chemical generally forms the basis of the commercial "lawn sand" and when spread upon the lawn checks the growth of all vegetation. The grass soon recovers, however, and through the stimulus received, produces luxuriant growth, choking out the weeds.

For walks, roads, tennis courts, and all places where complete and lasting extermination of all plant life is desired other chemicals are used. The most important of these is arsenate of soda. This is a very active poison and care must be exercised in its use. Two pounds to ten gallons is the formula employed. The solution may be applied with a watering can, using care not to get too close to valuable trees.

Carbolic acid is a very powerful and quick acting weed killer, but its effects are not as enduring as those of the arsenical solution. The formula is one pint to four gallons of water. Salt may also be used in the form of hot brine, the solution being strong enough to show crystals forming on the surface. Better than carbolic acid or salt, however, for the destruction of woody plants, like poison ivy, is caustic soda (either sodium hydrate or sodium hydroxide). It should be applied hot in practically a saturated solution, during dry weather. After the destruction of the weed the soil should be thoroughly watered in order to wash out the soda and permit other vegetation to grow.

In general, complete and permanent eradication of weeds is an economic impossibility, because they have gained a world-wide distribution and are found in waste places from which they are readily disseminated.

NOTES

Volume III, Number 1, of the Annals of the Missouri Botanical Garden has been issued with the following contents:

"Rhizoctonia Solani in Relation to the 'Mopopilz' and the 'Vermehrungspilz.'" B. M. Duggar.

"The Texas Root Rot Fungus and Its Conidial Stage." B. M. Duggar.

"Cabbage Yellows and the Relation of Temperature to Its Occurrence." J. C. Gilman.

"Monograph of the North and Central American Species of the Genus Senecio—Part II." J. M. Greenman.

"New or Interesting Species of Gill Fungi from Missouri." L. O. Overholts.

Dr. J. R. Schramm, Assistant Professor of Botany, Cornell University, recently spent a few weeks at the Garden consulting the library.

Dr. Hermann von Schrenk, Pathologist to the Garden, attended the Motor Car Builders' Convention at Atlantic City, June 14–16.

Dr. B. M. Duggar, Physiologist to the Garden, gave a course of five lectures on "Cell Entity or Growth Organization," July 17–23, at the Graduate School of the Massachusetts Agricultural College, Amherst, Massachusetts.

Dr. Hermann von Schrenk, Pathologist to the Garden, spoke before the National Lumber Manufacturers' Association, Chicago, May 31, on "Fire Resistive Wood" and before the architects and engineers of Indianapolis, June 7, on "Timber Uses."

Mr. H. L. Merkel and Mr. R. S. Hoyt, proprietor and landscape designer, respectively, of Watrous Nursery Co., Des Moines, Iowa, spent July 15 and 17 at the Garden studying plant material. Other recent visitors include Dr. B. Leonard Grondal, Instructor in Forestry, University of Washington, on July 10, Prof. Hugo Winkenwerder, Dean of the College of Forestry, University of Washington, on June 24, and Prof. V. R. Gardner, of the Department of Horticulture, Oregon Agricultural College, on July 20.

STATISTICAL INFORMATION FOR JUNE, 1916

GARDEN ATTENDANCE:

Total number of visitors	26,083

PLANT ACCESSIONS:

Total number of plants received in exchange	18
Total number of packets of seeds received in exchange	20
Plants donated	37

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought	12
Total number of books and pamphlets donated	61

HERBARIUM ACCESSIONS:

By Purchase —	
F. C. Clements—"Herbaria Ecadium Californiae"	350
Rev. John Davis—Plants of Missouri	160
By Gift —	
R. P. Burke—Fungi of Alabama	120

J. A. Drushel—Plants of Alabama, Ohio, Missouri, Colorado, Texas, and California 31
W. H. Emig—Plants of Missouri and Oklahoma..... 500
O. A. Farwell—*Quamassia hyacinthina* (Raf.) Britton.... 1
H. S. Fawcett—*Septobasidium pedicellatum* from Florida and Cuba 3
Mrs. Ida M. Jackson—*Liparis liliifolia* (L.) Richards from Indiana 1
E. L. Johnston—Plants of Colorado..... 31
O. S. Ledman—Plants of Missouri and Colorado..... 4
Bayard Long—Duplicate type of *Scirpus Longii* Fernald from New Jersey 1
E. O. Matthews—Fungi from Mexico..... 27
Mrs. K. L. Monteith—*Sarcodes sanguinea* Torr. from California 1
L. O. Overholts—Fungi from various localities..... 6
H. von Schrenk—*Peniophora gigantea* on shortleaf pine ties from Adelaide, Pennsylvania..... 1
Mary E. Sharer—*Hydrangea arborescens* L. from Missouri.. 1
J. A. Stevenson—Fungi from Porto Rico..... 2
L. B. Strube—Plants of Porto Rico..... 3
Edward Teas—Cultivated specimens of *Duranta repens* L. from Texas 1
Mrs. E. H. Vance—Cultivated specimen of linden from Malvern, Arkansas 1
Mrs. Kathryn Walsh—*Saponaria Vaccaria* L. from Missouri 1
Mrs. Mayo Scott Wood—*Lilium Grayi* Watson from Tennessee 1

By Exchange—
University of California—Plants of California..... 451

TOTAL..... 1,698

The Garden is open to the public every day in the year, except New Year's, Fourth of July, Labor Day, and Christmas—week days from 8:00 A. M. until one-half hour after sunset; Sundays, from December to April, 1:00 P. M. until sunset, from April to December, 2:00 P. M. until sunset.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Boulevard, on the Vandeventer Avenue car line. Transfer south from all intersecting lines.

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Orchids and other Exotics.

M. SCHILLER,
New Conservatories.

MISSOURI BOTANICAL GARDEN BULLETIN

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CONTENTS

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NEST OF YELLOW WARBLER, WITH TWO EGGS AND ONE COWBIRD EGG, IN HAWTHORN TREE.

(PHOTOGRAPHED BY MR. E. S. DANIELS.)

Missouri Botanical Garden Bulletin

Vol. IV St. Louis, Mo., August, 1916 No. 8

NEW HYBRID WATER-LILIES

Climatic conditions in St. Louis during the summer are admirably adapted to the growth of tropical lilies. Within the last four years the aquatic collection at the Garden has been greatly augmented, and the area of water devoted to this fascinating branch of floriculture considerably extended.

Water-liles may be divided into two groups: (1) diurnal flowering, representatives of the two sub-groups, Anecphya and Brachyceras, and (2) nocturnal flowering, more commonly called the "night bloomers," which are representatives of the Lotos group. During a bright August day flowers of the diurnal lilies will be open between 7:00 A. M. and 7:00 P. M., but if the weather is dull and rainy they remain closed. In the night bloomers the flowers open at sunset and stay open until about 10:00 o'clock the following morning. However, if the weather is inclined to be cloudy, they will remain open during the entire day, acting the reverse of the diurnal type.

The blossoms of the nocturnal lilies are considered by many far superior to those of the diurnal, or "day bloomers," and thus many visitors coming to the Garden during the water-lily season, are disappointed. With this in mind, a number of experiments are being carried on in an effort to improve and fix the few types of day bloomers, the present-day plants having resulted largely from insect pollination, especially the Brachyceras representatives.

The *Nymphaea capensis* and its varieties, commonly found in gardens, are far from the typical species. They are the crosses resulting from insect pollination, between the blue and rose, and possibly the Egyptian *N. caerulea,* until we find gradations of color from the darkest blue to deep pink. These, being self-pollinated, result in a breaking up into blues, pinks, and dark pinks.

One method of selecting the color of lilies to be planted out is to examine the under side of the young leaves, the color which appears here usually giving some indication of the ultimate color of the flowers. This somewhat haphazard

method undoubtedly eliminates the tedious work of preparing the flowers for pollination, but is not to be advocated, as the true identification of the parents is always lacking in hybrids of this nature.

Pollination.—Probably the best month for experiments in pollination is August, when the plants have usually attained their maximum growth and are producing their best flowers. Intercrossing must be done at a time when the concave stigmas of the flowers are well filled with nectar, as without this fertilization cannot be accomplished. Experience has shown that the hours between 9:00 and 11:00 A. M. are best suited for this process.

Plants are selected which will produce the desired qualification in the progeny. The pistillate parent, or flower which is to bear the seed, is carefully emasculated in the bud stage. This should be done the day before opening, when the stamens are easily broken off and no sign of pollen has appeared. The bud is then allowed to close. The next essential factor is the total exclusion of all insects by enclosing the bud in fine cheese-cloth and tying below the ovary. The staminate parent, or flower which is to supply the pollen, is then selected, also in the bud stage, and is protected in the same manner as the emasculated flower. Pollen should never be removed from anthers which have been exposed to the insect's trail, because of the possibility of foreign pollen being left behind. The second day the act of pollination is accomplished by the aid of a camel's-hair brush, the pollen readily adhering to the brush, especially if it is passed over the anthers with an upward movement. The pollen thus obtained is then deposited on the stigma which is filled with nectar, the nectar immediately changing to a light yellow color. The flower is then rewrapped, securely fastened to a stake, and a label attached indicating the cross. Within three weeks the seed will be ready for collection.

Nymphaea castaliaflora Pring.—This pink-flowered hybrid is the result of the intercrossing during 1912 of two varieties of *N. capensis*, selected from the miscellaneous hybrids of insect agency. This is a large, cup-shaped, well-petaled flower, far superior to anything else of its type. Since 1912 the plant has been pollinated each year with its own pollen and by careful selecting and crossing has become fixed; in other words, by self pollination the progeny will be an exact replica of the parent with a total exclusion of the blue color. The plant is readily recognized by its numerous petals and stamens, and large flowers which measure eight inches across. It bears as many as six flowers at one

time. The leaves in the seedling stage are prominently blotched with dark pink on the upper surface. The under side is also of a dark pink or almost red color. The adult leaves during the summer are entirely green on the upper surface, but the same reddish color is retained on the under side and even intensified.

The hybrid is named after the hardy or native water-lily, which it resembles in several respects, such as the concave or cup-shaped flower, and the fact that when first opening the four whorls of petals are separated and after the third day the flower rests on the surface of the water. In the bud it is also suggestive of the castalia. It has proved itself a good subject for breeding, especially for the purpose of increasing the number of petals, the amount of perfume, and the length of the blooming period.

Nymphaea "Mrs. Edwards Whitaker," Pring.—This hybrid, between *N. castaliaflora* and *N. ovalifolia,* is so far superior to the other day bloomers in size, shape, length of blooming period, and growth that it could be easily mistaken for *Nymphaea Lotus.* The flowers, during the month of August, measure ten inches in diameter, the measurement being taken just below the sepals. The maximum number of open flowers found on a single plant is six.

The parents used were the recently introduced *N. ovalifolia* and the fixed hybrid, *N. castaliaflora.* The flowers of the former are white, occasionally tipped with blue, stellate in shape, the few petals narrow, and the flowers supported by a more or less weak peduncle. The leaves are oval, as the specific name indicates, some varieties being faintly blotched with dark red on the upper side, while others are spotted with purple. *N. castaliaflora* was used as the staminate, or pollen-bearing parent, because of its large, concave, semi-double flowers, which possess strong supporting peduncles.

This combination has produced in the offspring large, well-petaled, light blue flowers. The growth of the hybrid, in general, is much stronger than that of either parent. The length of the blooming period is extended through the influence of the staminate parent, the flowers opening as early as 6:30 A. M. and closing as late as 7:30 P. M. The individual flowers last from four to six days, bleaching to almost pure white the third day, the contrast which then appears between the old white flowers and the fresh blue ones on the same plant being an interesting phenomenon. The shape of the leaves is intermediate, being almost round, and measuring eighteen inches across.

There are two prominent factors in the leaf character: first, where the base of the leaf is green and both sides bear a few bluish purple spots, the under side also showing indication of the red color of the staminate parent; second, where the upper surface of the leaf is beautifully streaked with dark red, radiating from the central axis, some of these bars, which terminate at the edge of the leaf, being an inch wide. The under side is regularly blotched with red and bluish purple, upon a light green base. These prominent markings of the leaves are characteristic of the staminate parent in the seedling stage and the pistillate parent in the adult stage and are sufficiently striking to warrant the adoption of a varietal name. This variety will be known as *Nymphaea* "Mrs. Edwards Whitaker" var. "marmorata."

A detailed description of these lilies, with colored plates, will occur in a subsequent number of the Annals.

HYBRIDIZATION IN PLANTS

During the past few years numerous experiments have been carried on at the Garden in crossing antirrhinums, calceolarias, begonias, cinerarias, primroses, water-lilies and other flowering plants, as well as tomatoes, melons and a few other vegetables. While in some cases it will require a number of years to attain the results desired, sufficient indication of the effect of some of the crosses made has been obtained to warrant the statement that some new and valuable hybrids are to be added to the Garden collections as a result of this work, the new water-lilies, referred to elsewhere in this BULLETIN, being an example.

Although the knowledge of hybridization in plants has been greatly augmented within recent years, there still remains a great deal to discover. Just what will happen when two species or varieties of plants are crossed is a question to which there is an almost unlimited number of possible and conceivable answers, and the problem has been discussed and diligently experimented upon ever since the latter part of the seventeenth century.

Koelreuter, who made extensive experiments near the end of the eighteenth century and published his results chiefly at the Academy of Science in Petrograd, laid the foundation for an empirical knowledge of the subject. He, together with Sprengel and others, studied the part insects play in effecting cross-pollination, and Knight, a little earlier in England, devoted a large amount of time to the improvement of many fruits and vegetables by cross-pollination.

Gaertner, in the period preceding the publication of the "Origin of Species," experimented extensively in crossing different plants, but his work for the most part was not sufficiently methodical, nor was it carried far enough to discover any underlying principle.

Wichura, in 1865, combined six species of willows into one complex hybrid. In France, Naudin, Gordon, and Jordan made notable additions to the subject of hybridization, the first-named coming very near to discovering the law which is now associated with the name of Mendel. At the same time Naegeli was concerned with the hybridization of plants in Germany, while Darwin, as is well known, made many important contributions, particularly on such subjects as the inheritance of the various forms of the primrose and other flowers. By the early eighties an immense literature on the subject had been accumulated, and the number of plants experimented upon constituted a formidable list. In spite of this fact, the advance made in so complex a subject was comparatively slow, and the greatest differences of opinion prevailed concerning all questions of hybridization. This condition resulted partly from lack of knowledge of the essential nature of fertilization and the structure of the germ cells which unite to form new individuals, and partly from the small number of hybrids usually produced from a cross, as well as the insufficient study of the later generations of the hybrids.

Investigators at this time were chiefly concerned with such questions as the degree and cause of sterility in hybrids, the relative influence of the male and female parent, whether the hybrid was an actual blend of the elements involved, or a mere mosaic, and similar problems. By this time, however, two laws seem to have been pretty well established, namely, that in a cross between two pure races or species, the hybrids of the first generation were all alike, and secondly, that the male and female characteristics produce ultimately an equal effect on the offspring. Notwithstanding the rather general applicability of these conclusions, they did not go far enough to make possible the formulation of any general laws of hybrid inheritance, and the whole subject was more or less confused.

About 1865, at a time when experimentation with plant hybrids was very active, Mendel, Abbot of Brünn, Austria, discovered an illuminating and far-reaching principle which since 1900 has been associated with his name. It is a curious fact that the significance of Mendel's experiments with garden peas was entirely overlooked by his contemporaries, though they are mentioned by Focke as an important con-

tribution to the subject of hybridization. Mendel appealed to Naegeli, the leading botanist of his time in Germany, but Naegeli failed to see the importance of the work, so that Mendel's researches lay buried until the end of the century, when the principle was rediscovered by independent workers in Germany, Austria, and Holland, and published within a few weeks of each other.

It seems probable that the lack of knowledge of the actual factors involved in the reproduction of plants prevented the realization of the importance of Mendel's discovery. Moreover, Mendel was in advance of his time both in his conception of the organism and in the methodical way in which he attacked this particular problem. Briefly stated, the essence of Mendel's discovery is that in the hybrid offspring the different characters of the parents are independently inherited. Previously hybrids had been compared with their parents, organ for organ, the whole plant being treated as a unit. Mendel's method, which has proved so useful in modern experimental work, was to compare the races which he crossed, character for character, and in this way to study the inheritance of each parental difference independently of all the others. This result was achieved by confining his experiments to plants which differed not in many ways, but in a single feature. Thus Mendel crossed peas having yellow seeds with those having green ones, the plants in every other respect being alike. As a consequence the inheritance of this single character, yellow or green seeds, could then be studied in the offspring. By this means the fundamental fact was demonstrated that, whereas a first generation (F_1) of hybrids produced seed of a uniform color (all yellow), the parental difference of green seed reappeared in the second generation (F_2). This latter fact is now known as the principle of segregation, since the second generation plants, the result of self pollinating the hybrid plants of the first generation, produce seeds, some yellow and others green. Simple as this fact appears, it is the principle of segregation which constitutes Mendel's chief contribution to the subject. Not only does the diversity of parental characters appear in the second generation but the two types are in a fairly definite proportion. Mendel obtained from 253 first generation hybrid plants a total of 6,022 yellow seed and 2,001 green seed, which is very close to theoretical expectation, namely, a ratio of three to one.

When some of the yellow and green seed thus obtained were planted it was found that the green seed always produced plants bearing nothing but green seed; in other words, this character bred true. But when the yellow seed were

planted they produced some plants which bore yellow seed, and others which produced seed both yellow and green in the ratio of three to one. The latter plants were therefore hybrid in nature since they possessed the two types which were combined in the seeds of the first generation. The green character of the seed in this case is now spoken of as "recessive" and the yellow as "dominant," because in hybrid plants when both characters are present in the germ, only one of them, the yellow, appears. This led Mendel to attempt to explain the three-to-one ratio, and he believed that in the germ cells of the first generation hybrids, as well as in those of later generations which contained the two characters, the yellow and green factors were separated so that each plant contained the capacity of producing one or the other character but not both. The differences then which led to the production of one character or the other must therefore be segregated at some time in the production of the elements which fuse to ultimately produce seed.

Still another pair of factors experimented with by Mendel was that of size, by crossing a pea plant which was normally tall with one which was normally short. It is now known that in many plants and animals if a dwarf race is crossed with a tall one that the resulting progeny are all tall. This was true in the case of peas, but in the second generation, derived from self fertilizing the first generation, there was obtained approximately the ratio of three tall to one short.

If we represent the dominant character, tallness, by *T* and the recessive character, shortness—which may be thought of as the absence of tallness—by *t*, then the first generation hybrid would possess both characters and be represented by *Tt*. Since tallness is dominant, however, none of the plants would be short. In the next generation, these characters would unite in the following four possible combinations: seeds containing only the tall character represented by *TT*; seeds possessing tallness and shortness, *Tt*; seeds possessing shortness and tallness represented by *tT*; and finally those possessing only shortness represented by *tt*. Since tallness is completely dominant over shortness (represented by *T*) the first three combinations would produce nothing but tall plants, and although the germ cells were differently constituted, it would be impossible to tell one lot of plants from the other. The plants which possess only shortness, however, (*tt*), would of course be dwarfed, and consequently in the second generation the ratio of tall to short plants would be three to one. The same principles apply to all cases of Mendelian inheritance, although many complications have, as the result of actual experience, been

discovered since 1900. In general, however, the law applies widely to such characters as the color and size of flowers as well as the coats of animals. Many vegetables and blooming plants have been hybridized from this point of view and the predictions of particular crosses resulting have been proved to be correct.

It has likewise been noted in Mendelian inheritance, showing the ratio of three to one, that it is impossible to distinguish between true dominants and dominant hybrids, their behavior in subsequent generations being the only test. On the other hand, the recessives with respect to any one character appearing in the second generation will subsequently breed true for this character. Consequently, recessives give the practical breeder an opportunity of determining the value of a new form much sooner than would otherwise be the case.

Among the plants whose constitution has been investigated may be mentioned the primrose (Primula), sweet pea (*Lathyrus odoratus*), stock (Matthiola), four o'clock (Mirabilis), violet (Viola), shepherd's purse (*Capsella Bursa-pastoris*), tobacco (Nicotiana), foxglove (Digitalis), snapdragon (Antirrhinum), as well as peas, beans, and various other vegetables.

Mendel believed that in order to study heredity intelligently it was necessary to contrast individuals in such a way that they might be considered as constituting a pair, each factor to be paired with a different one; for example, characters for yellow and green-seeded peas formed a pair. A somewhat different conception is held at the present time, and it is now known that in some cases the coöperation or presence of more than two factors which are independently inherited is necessary for the production of a particular character. It should be explained here that by a "factor" is meant a difference in the germ which leads to the development of a particular character, and consequently the absence of any character means that the factor associated with it fails to develop. The fundamental nature of a factor is, however, only partly understood. In the case of the flowers referred to, at least one of the factors is always a chromogen, or color-producing substance, while others may be various enzymes or ferments which have an effect on the particular color produced.

BIRDS IN THE MISSOURI BOTANICAL GARDEN

The following observations were made by Mr. Edward S. Daniels and Mr. R. F. O'Neal:

"Bird life was at high-tide in Shaw's Garden in June, and a forenoon in the first half of the month was a good time for exploring in the North American tract. Incidentally, it afforded an opportunity for some observations a little out of the usual lines.

"It was a showery morning of summer and seemed just right for the quest that led us along the little stream and around the marshy brink that borders the straggling cattails. We were seeking an elusive bird—so elusive, indeed, that we found nothing that indicated that he might be found within these grounds. In May, 1914, a woodcock was flushed in the rushes near the arboretum. This, it seems, was the first record of this fine game bird in the Garden; but it was the opinion of those familiar with his habits that he might do well to bring his mate to the shelter of the bulrushes where they would be protected against all hunters, save those who hunt with cameras, or with empty hands. One of these birds was seen in the North American tract on May 8th; another, or the same one, on the 9th. We were seeking his lurking place, for a good picture of these furtive denizens of the marshes, with the female, perchance, sitting on her reed-sheltered nest would add much to the bird lore of the Garden.

"In the midst of our search we were caught in a shower that caused us to seek shelter under the dense foliage of a red-fruited thorn—a circumstance that turned ill luck into a lucky find; for in the wet grass, fresh and dainty as a precious pearl, was the unbroken egg of the yellow warbler, the well-known summer yellow bird. Parting the tall grass, we found an egg of the cowbird, a much larger bird, and one whose ways are past finding out. We went through the grass very carefully and soon we found another of the little warbler's eggs and remnants of two others. We turned our attention to the thorny branches above our heads, and at first saw only leaves, branches, and thorns; then we espied the nest from whose fibre cup the eggs had evidently fallen during a recent storm. It was eight or ten feet from the ground—high up for a nest of this kind; but in return for the privileges of the Garden, with its wealth of flora and fauna, surely we should undertake to put the eggs in the nest and get a picture of the little home that had been broken up—another one of the many tragedies in which the nests and their builders are the hapless victims.

"We got it—just how would be tedious to relate—a good picture of the nest and the three eggs (see Plate 26). The yellow warbler is the little artist that sometimes thwarts the wary cowbird by abandoning her first clutch of eggs and

building a new nest on the first one, a double-decker affair, in the effort to get rid of one that is alien and unwelcome. And sometimes the cowbird shows that she is not offended and lays two eggs in the yellow warbler's second-story nest.

"The yellow warbler builds a beautiful and compact little nest and, as may be seen in the accompanying plate, this one is so thin in places that it may be easily seen through."

NOTES

Mr. Ernest J. Palmer, collector for the Missouri Botanical Garden and the Arnold Arboretum, is spending a few weeks at the Garden organizing the plants collected during the early part of the season.

The competitive examinations for the Garden scholarships will be held the first Saturday in September. Those wishing to take the examinations may obtain application blanks from the office at the Garden.

Dr. George T. Moore, Director of the Garden, has returned from a trip to Devils Lake, North Dakota, where he spent a few days at the Biological Station of the University of North Dakota, collecting and studying the algae of that region.

Recent visitors to the Garden include Dr. George W. Stevens, formerly of Harvard University, on August 11, Mr. A. G. Hecht, Instructor in Floriculture, University of Illinois, on August 19, and Mr. John Dunbar, Assistant Superintendent of Parks, Rochester, New York, on August 21.

The position of Assistant Botanist to the Garden has been filled by the appointment of Mr. J. C. Th. Uphof. Mr. Uphof graduated from the College of Horticulture at Frederiksoord, Netherlands, in 1905, taking the degree of M.S. from the University of Amsterdam in 1907. From 1908 to 1911 he travelled and studied in Germany, Sweden, Norway, Denmark, France, Belgium, Switzerland, Italy, and England. Since coming to this country he has been Instructor in Botany and Curator of the Botanical Garden and Herbarium of the Michigan Agricultural College, East Lansing, for one year, and Assistant Professor of Botany at the University of Arizona, Tucson, for three years.

STATISTICAL INFORMATION FOR JULY, 1916

GARDEN ATTENDANCE:

Total number of visitors 16,893

PLANT ACCESSIONS:

Total number of packets of seeds received in exchange 1
Plants donated 112

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought 6
Total number of books and pamphlets donated 106

HERBARIUM ACCESSIONS:

By Purchase —

G. W. Freiberg—Plants of Washington 675
P. Jörgensen—Plants of Argentina 124
G. W. Stevens—Plants of Oklahoma 340
C. A. Wenzel—Plants of the Philippine Islands 1,375

By Gift —

Miss Mary Baier—*Cissus arborea* (L.) Des Moulins from Missouri 1
Mrs. L. M. Brown—*Acacia filicoides* (Cav.) Trelease, cultivated specimen 1
P. R. Burke—Fungi of Alabama 18
W. C. Coker—Fungus from North Carolina 1
J. Dearness—*Merulius lachrymans* from Canada 1
J. A. Drushel—Plants from Missouri, Texas, and Colorado 49
Mrs. Harry January — *Menispermum canadense* L. from Missouri 1
O. S. Ledman—Plants from Missouri 4
J. Macoun—Fungi from Vancouver Island, B. C 99
L. O. Overholts—Fungi from various localities 3
S. B. Parish—Flowering plants from California 36
N. E. Pfeiffer—Plants of North Dakota 2
H. von Schrenk—Anthracnose of Sycamore from Pawling, N. Y. 1
J. H. Schlachter—*Lychnis chalcedonica* L., cultivated specimen 1
J. A. Stevenson—Fungi injurious to sugar cane and species of *Citrus;* also wood-rotting fungi 25
U. S. National Museum—Fragments of *Citharexylum spinosum* HBK. from Peru, and *Senecio Faydenii* Griseb., var. *dolichanthus* Urb. from Jamaica 2
J. R. Wier—Fungi of Idaho 6

By Exchange —

New York Botanical Garden—Plants of the West Indies .. 674
U. S. Dept. of Agriculture, Bureau of Plant Industry—Plants of China 87

TOTAL 3,526

The Garden is open to the public every day in the year, except New Year's, Fourth of July, Labor Day, and Christmas—week days from 8:00 A. M. until one-half hour after sunset; Sundays from December to April, 1:00 P. M. until sunset, from April to December, 2:00 P. M. until sunset.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Boulevard, on the Vandeventer Avenue car line. Transfer south from all intersecting lines.

The Garden will be open all day Sunday, September 3, but closed on Labor Day, September 4.

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M. SCHILLER,
New Conservatories.

MISSOURI BOTANICAL GARDEN BULLETIN

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CONTENTS

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BULBS AND TUBEROUS PLANTS

The brilliancy of coloring, ease of culture, and comparative cheapness make bulbous plants the favorites with the amateur, as well as the professional gardener. Moreover, the amateur is not placed at a disadvantage because of his lack of skill, for the bulbs have their latent beauty stored up in them and at first are little dependent upon the knowledge of the grower. These plants are used in formal beds and borders, as well as the wild spots, the rockery and the aquatic garden, the shady nooks and the sunny places. At the present time the natural arrangement of bulbs is beginning to supplant the formal manner of grouping, and they are being planted profusely in masses in the open lawn, around the bases of evergreens, in front of shrubbery borders, and scattered upon terraces and slopes. The effects are not lasting but nothing could be more pleasing in the spring than tufts of crocuses, daffodils, or snowdrops contrasted against the light green of the rejuvenated lawn or peeping from beneath the trailing branches of the evergreens.

Popularly, any plant that stores up food during the growing season in a fleshy root, so that it lasts through the next season of bloom, is known as a "bulb." According to their structure "bulbs" may be classified as bulbs, corms, tubers, rhizomes, pips, etc. A bulb is a specialized bud which is made up of an axis closely encased in bulb-scales or thickened leaves, at the base of which roots are emitted. The more common bulbs are lily, hyacinth, daffodil, snowdrop, tulip, etc. A corm differs from a bulb in that it is solid throughout, the expansion being composed of the swollen base of the stem, the leaves having degenerated into sheaths which act as a protective envelope. Gladiolus, crocus, and montbretia are representatives of this class. A tuber is a thickened portion of the underground stem having buds at the surface, like the dahlia or potato. A rhizome or rootstock is a fleshy underground stem divided into nodes, as in canna, each branch developing a terminal bud at the end of the

season, which gives rise to a flowering stem next season. A crown or pip is a detachable part of the rhizome bearing a prominent bud and roots, the lily-of-the-valley being an illustration of this class.

In addition to the above classification, the "bulbs" may be grouped into hardy, chiefly spring-blooming, and tender, summer-blooming. In the first group are placed crocus (*Crocus vernus*), glory of the snow (*Chionodoxa Luciliae*), crown imperial (*Fritillaria Imperialis*), daffodils (*Narcissus sp.*), hyacinth (*Hyacinthus orientalis*), ixia (*Ixia maculata*), lilies (*Lilium sp.*), lily-of-the-valley (*Convallaria majalis*), montbretia (*Tritonia Pottsii*), snowdrop (*Galanthus nivalis*), squill (*Scilla sibirica*), tulip (*Tulipa suaveolens* and *T. Gesneriana*). Of these, the hyacinth and the lilies are not strictly hardy. In the second group are found canna (*Canna indica* hybrids), *Dahlia coccinea,* and gladiolus hybrids.

The growing of bulbs for market is done chiefly in Holland, on account of the favorable climatic and soil conditions and cheapness of labor. However, the United States Department of Agriculture is trying out bulb growing in this country, chiefly in the State of Washington, with very successful results. A light, sandy, fine-grained soil and periodical rains are the ideal conditions.

The methods of propagation of bulbs are diverse and dependent upon their structure and reproduction. Seed propagation is rarely resorted to except when new varieties are desired, as the mixed hybrid origin of many of the varieties and the constant mixing through the insect cross pollination of the flowers make the results uncertain. The bulbs and corms have a natural tendency to reproduce by means of offsets, and in commercial propagation this method is followed with lilies, tulips, daffodils, gladioli, etc. The hyacinths normally produce very few offsets or "slabs," so that artificial means are employed of "scoring" and "scooping." For "scooping," large, healthy hyacinth bulbs are selected in July and the base scooped out with a curved knife or a special machine manufactured for the purpose, so as to expose the scales just above where they unite with the base. This destroys the growing point, and the strength of the bulb is thrown into the production of small bulblets at the cut surface. After scooping the bulbs are placed upon trays and set in the sun for a day to allow the freshly cut surfaces to dry. They are then removed to a shed where a temperature of 75–90° is maintained, and in a few weeks the scales separate, callus, and produce new bulblets. In October the

mother bulbs with the bulblets are set out in rows four inches apart and eight inches between the rows, and covered with three inches of soil. Later these beds are mulched with straw to a depth of three to five inches for winter protection, the mulch being removed in the spring. At the time of harvest in July the old bulb will have rotted off and the new bulbs are then taken up and dried. These are grown in beds and taken up every year for five or six years until bulbs of marketable size are obtained. The method of "scoring" produces fewer but larger bulblets and reduces the time of maturity to three to five years. The process consists of making four cross cuts across the base of the bulb about one-third the way through. This kills the growing point and produces the same result as the scooping. The treatment thereafter is similar to the scooping except that some growers prefer to bury the scored bulbs in trenches for six weeks before taking them to the propagating sheds.

The bulbs and corms which produce an abundance of offsets are simply taken up each year and the offsets allowed to develop. The time required to reach maturity is much shorter than with the hyacinths, varying from one to three years. In this connection it is necessary to note the reproduction of corms. During the season a new corm grows above the old one and at the base the cormlets are produced. At the same time two kinds of roots are noticed coming from the base of the new corm, the feeding and the thicker, ringed roots. The latter push deeper into the soil than the feeding roots and then contract, thus bringing the new corm to the same level as the old one.

The tubers and rhizomes are propagated by means of division, the clumps of "roots" being cut into sections bearing at least one bud. These divisions are planted out in the spring and the roots are readily developed in a warm soil. If greenhouse facilities are available the cannas may be started in sand, and as soon as the roots are formed, potted, and grown until ready to be set outdoors. Under the same conditions dahlias are propagated by means of soft cuttings, two to three inches long, which are taken from the old shoots and rooted in propagating benches. The dahlia, unlike the potato, has no other buds than the one at the point of connection between the tuber and the old stem, and has not the function of producing adventitious buds, so that care should be taken to include the bud with the tuber in dividing old plants. The crowns or pips are propagated by separating the offsets from the main plant, each offset forming a new plant. This is generally done in the spring, although it may be done in the fall, as the lily-of-the-valley is hardy.

The ideal soil for growing bulbs is a well-drained loam, deep, moist, and underlaid by a heavier but fairly porous subsoil. The soil should contain plenty of humus but no fresh manure, as contact with the latter often results in the rotting of the bulbs. Light, dry soils should be made heavier and more retentive of moisture by plowing under a green crop, such as clover or cowpeas. Heavy, soggy soils should be made lighter by tile drainage, deep plowing, and the addition of lime.

When special beds are used for bulbs they should be prepared as follows: The soil should be removed to a depth of one foot, five to six inches of well-rotted manure placed at the bottom, and on top of that about one inch of sand to keep the bulbs from coming in contact with the manure. The bulbs are then set, base down, upon this layer of sand and covered with soil level with the surface. This planting is done in October or early in November with such hardy bulbs as daffodils, tulips, crocuses, snowdrops, jonquils, etc. The hyacinths may be planted at the same time, although they are not entirely hardy and ample protection during the cold weather is necessary. The distance and depth of planting vary with the different kinds and will be found in the accompanying table. The lilies need a deeper and warmer soil than the other bulbs, and as they are not strictly hardy, require greater protection during winter. All spring-blooming, fall-planted bulbs should be covered by a mulch of three to five inches of straw, grass, or even well-rotted manure. This should be applied after the ground is frozen in the case of the hardy bulbs, and is used chiefly to prevent alternate thawing and freezing during spring and consequent heaving and breaking of the roots. For naturalized hardy bulbs the soil itself is sufficient protection. In the partially hardy bulbs, like the lily and the hyacinth, the mulch should be put on before the first heavy frost. It should be removed from all the bulbs in the spring as soon as danger from frost is over. After flowering the bulb leaves should be left on until they begin to brown and wilt, the browning being an indication that the leaves have performed their function of storing food for another year, and the bulb is ready for its resting period.

If the bed which contained the bulbs is to be replanted with annuals or bedding plants, the bulbs may be taken up carefully before they have ripened, and trenched in a shady place where the ripening will proceed. If this operation is not performed carefully enough to prevent the wilting of the leaves, which is very likely to happen because it

takes some time for the roots to reëstablish themselves in the new soil, the ripening will not be completed and the resulting bulbs will be of inferior quality. After the bulbs have ripened they should be taken out of the soil, the leaves cut off, and the cleaned bulbs put away in cool, dry storage until planting time. It is not necessary to take up the naturalized bulbs every year, the hyacinths requiring attention every two years, the tulips every three or four years, while the others may be left undisturbed even longer.

The care of the tender bulbs differs somewhat from that of the hardy kinds. Gladiolus is one of the best summer-blooming bulbs, blooming late in the season and producing bright-colored spikes of flowers. The corms are planted five to six inches deep, this depth being necessary to furnish support for the tender leaves and the heavy spikes of flowers. As soon as the leaves attain a height of one foot the ground should be mulched with manure to stimulate growth and keep the moisture in the soil during hot, dry weather. After the first frost the corms should be taken up, left out for a few days to dry, and then stored over winter in a cool, dry cellar, the leaves having been previously cut off. Dahlias and cannas require a rich, deep, moist soil and do best in cool situations. Both are particularly attractive for their flowers, and the canna for its fine foliage as well. The plants should be set out after all danger of frost is over and should be given a thorough cultivation and plenty of water during the growing season. The first hard frost will kill their tops, which should then be cut off, and the roots taken up, cleaned, and stored in a cool, fairly moist cellar. Too dry and hot an atmosphere is injurious during the resting period. The roots should be placed stem end down to prevent the juices which are contained in the stems from running down into the tubers and rhizomes and causing them to rot. They are sometimes packed in sand or sawdust or hung up in bunches in the cellar.

LIST OF BULBS AND TUBEROUS PLANTS

Botanical name	Common name	Hardiness	Flower period	Time of planting	Depth of planting	Distance of planting	Standard variety	Color
Canna indica hybrids	Canna	Tend'r	July-Oct.	June	1 in.	12-18 in.	King Humbert	Orange fls., bronze foliage
							Italia	Red fls., green foliage
							Mme. Crozy	Red and yellow fls., green fol'ge
							Mt. Blanc	White fls., green foliage
							Mlle. Berat	Pink fls., green foliage
Chionodoxa Luciliae	Glory of the snow	Hardy	March	Oct.	3 in.	2 in.		White and blue-pink
Convallaria majalis	Lily-of-the-valley	Hardy	April	Oct. or March	At surface	8 in.		White
Crocus vernus	Crocus	Hardy	Spring	Oct.	3 in.	3 in.	Cloth of Gold	Yellow
							Mt. Blanc	White
							Hero	Purple
Dahlia coccinea	Dahlia	Tend'r	Aug.-Oct.	June	6 in.	36-48 in.	Show, Fancy, Pompon, Cactus, Decorative, Single, Collerette	White, pink, red, purple, yellow, and variegated
Fritillaria Imperialis	Crown Imperial	Hardy	May	Sept.	4 in.	8 in.		Yellow
Galanthus nivalis	Snowdrop	Hardy	Feb. and March	Sept.	2 in.	3 in.		White
Gladiolus (hybrids)	Gladiolus	Tend'r	July-Oct.	April	4-6 in.	8-10 in.	America	Pink
							Augusta	White
							Baron Hulot	Violet
							Golden King	Yellow
							Mrs. Frances King	Red
							Peace	White and lavender

LIST OF BULBS AND TUBEROUS PLANTS

Botanical name	Common name	Hardiness	Flower period	Time of planting	Depth of planting	Distance of planting	Standard variety	Color
Hyacinthus orientalis	Hyacinth (Dutch)	Half hardy	Spring	Oct.	5 in.	6 in.		White Pink Blue Yellow
Ixia maculata	Ixia	Hardy	May	Oct.	3 in.	3 in.		Brown White Yellow Purple
Lilium auratum	Gold-banded lily	Half hardy	Aug.	Oct.	3 in.	6 in.		Yellow and crimson
L. canadense	Canada lily	Half hardy	July	Oct.	3 in.	6 in.		Yellow and orange
L. candidum	Madonna lily	Half hardy	May and June	Aug.	3 in.	6 in.		White
L. elegans	Japan lily	Half hardy	July	Oct.	6 in.	6 in.		Yellow, orange, red
L. longiflorum	Easter lily	Half hardy	Aug.	Oct.	5 in.	6 in.		White
L. speciosum	Autumn pink lily	Hardy	Aug.	Oct.	4 in.	6 in.		Pink, red, white
L. superbum	Turk's cap lily	Half hardy	July	Oct.	4 in.	6 in.		Orange
L. tenuifolium	Coral lily	Half hardy	June	Oct.	4 in.	6 in.		Scarlet
L. tigrinum	Tiger lily	Half hardy	Aug.	Oct.	4 in.	6 in.		Orange, red-spotted
L. regale	Regal lily	Hardy	May and June	Oct.	6 in.	8 in.		White and pink
Narcissus Pseudo-Narcissus	Daffodil	Hardy	March	Oct.	4 in.	6 in.	Van Sion Emperor Golden Spur	Double yellow Single yellow Yellow
N. Jonquilla	Jonquil	Hardy	April	Oct.	4 in.	6 in.	Rugulosus	Yellow
N. poeticus	Poet's narcissus	Hardy	May	Oct.	4 in.	6 in.	Ornatus	White and red
N. incomparabilis		Hardy	April	Oct.	4 in.	6 in.	Sir Watkin Orange Phoenix	Yellow Yellow
Scilla sibirica	Squill	Hardy	Feb.	Oct.	3 in.	2 in.		White

LIST OF BULBS AND TUBEROUS PLANTS

Botanical name	Common name	Hardiness	Flower period	Time of planting	Depth of planting	Distance of planting	Standard variety	Color
Tritonia Pottsii	Montbretia	Hardy	July and Aug.	Oct. or March	3 in.	3 in.		Orange, scarlet
Tulipa Gesneriana	Late tulip	Hardy	May	Oct.	4 in.	6 in.	Bouton d'Or	Yellow
							Innocence	White
							May Queen	Lilac
	Darwin	Hardy	May	Oct.	4 in.	6 in.	Bronze Queen	Old gold
							Painted Lady	White
							Glow	Vermilion
	Parrot	Hardy	May	Oct.	4 in.	6 in.	Dracontia	Red, yellow
							Duc Van Thol	Crimson, yellow
							Chrysolora	Yellow
							Cottage Maid	Pink
T. suaveolens	Early tulip	Hardy	April	Oct.	4 in.	6 in.	Vermilion Brilliant	Scarlet
							Pink Beauty	Rose-pink
							Proserpine	Deep rose

PRODUCTION OF LIGHT AND HEAT BY PLANTS

Phosphorescence or the emission of light by insects, such as the firefly, has attracted the attention of everyone, but its occurrence among plants is of such a singular or comparatively rare occurrence as to be known only to those whose attention is directed more or less constantly toward the observation of plant habits.

The discovery of the luminous property of nasturtium leaves is ascribed to a daughter of Linnaeus, who published her observations in the "Transactions of the Stockholm Academy" for 1762, under the title "Remarks on a luminous appearance of Indian cresses."

Pulteny in his "General View of the Writings of Linnaeus," refers to the matter as follows: "This appearance, which had never been noticed before, is like the sparks that arise from a fulminating powder, and was first observed by

this lady while walking in her father's garden at Hammarly. She mentions its being visible only in the dusk of evening and ceasing when the darkness came on. Subjoined to her account are some observations by M. Wilckes, a celebrated electrician, who considered the phenomenon as being of an electrical nature."

The various collections of flowering plants in the Garden include a number of species of which the flowers—and in rare cases the leaves—have been reported to display the rather phenomenal capacity of self-illumination. This ability is not a constant characteristic of the plants in which it has been observed, but appears intermittently. It is apparently of an electrical nature, since the illumination is reported to be very pronounced when the atmosphere is dry and the temperature high, and most striking immediately preceding electrical storms when the atmosphere is warm and sultry.

The supposition that so-called phosphorescence in the flowering plants is of a physical nature, i. e., electrical, rather than the result of metabolic activity or an evidence of chemical changes taking place in the tissue, has been substantiated by evoking this phenomenon experimentally. Pots containing plants were insulated from conducting material by placing them on glass plates or on inverted glass tumblers, and the plants were then charged by means of a small electrostatic instrument. The gradual accumulation of the charge finally resulted in a difference of potential great enough to warrant a discharge from the flowers and buds identical with that observed in nature. In the light of these experiments and in view of the fact that in nature this phenomenon is observed when meteorological conditions are most favorable for electrical disturbances, we have reason to believe that self-illumination in the flowering plants can be accounted for on purely physical grounds. Some of the plants in which it has been observed are nasturtium (*Tropaeolum majus*), firelily (*Lilium bulbiferum*), sunflower (*Helianthus annuus*), velvet-flower (*Tagetes patula*), poppy (*Papaver orientale*), and others, notably some occurring in tropical forests. It seems probable that the luminous mosses which have made certain caves in central Europe famous, likewise produce their light electrically.

Some of the lower plants display phosphorescence which cannot be accounted for on physical grounds, about twenty-five species of bacteria, and about as many species of filamentous fungi and "toadstools" having exhibited this capacity. In these plants light is not emitted at irregular intervals but as a continuous glow. Cultures of filamentous

fungi have retained this power for one and one-half years, while cultures of bacteria emitted light for two years, the only limiting factor being that of nutrition. The phosphorescence of wood is almost invariably due to a filamentous fungus, or the vegetative stage of a toadstool, which is causing its decay, while the phenomenon in dead tissues of animals may be attributed to phosphorescent bacteria, such as *Bacterium phosphorescens, Microspira luminosa,* etc. A rough estimate regarding the amount of light emitted by bacteria shows that it would require a colony 2,000 meters square to produce one candle power of light. "Bacterial lamps," made by coating the interior of large flasks with nutrient media and inoculating them with phosphorescent bacteria, produce enough light to make reading of large type possible. Photographic plates are sensitive to the light emitted, a ten to fifteen-hour exposure, however, being necessary to satisfactorily photograph objects illuminated by "bacterial lamps." In but one instance was the light produced by a culture of these organisms strong enough to be resolved into spectral colors—green, blue, and violet. In all other cases no colors appeared, though a faint luminescence appeared in the yellow, blue, and green portion of the spectrum.

Self-illumination of this nature is associated with metabolic activity and must be accounted for on biological grounds. It is the result of oxidative processes which, however, are not of a respiratory nature, since an increase of the intensity of illumination does not necessarily result in an increase of carbon dioxide production. It should, therefore, be looked upon as an indication of complex chemical oxidative changes in the living matter of the cells, rather than of simpler oxidation, as in respiration, which results in energy release and the immediate liberation of carbon dioxide.

It is of interest to note that no other form of energy, as for example, heat, accompanies light radiation; at least the sensitive radiometers used were unable to measure any heat. That plants are capable of producing an appreciable amount of heat is, however, well known. The arums, of which there are a considerable number in the aroid house, present some of the most notable examples of this power. *Arum italicum,* at the time of the opening of the spathe, recorded a temperature of 44°C. immediately within the spathe, while the temperature of the surrounding air was 15°C. While this is probably the maximum amount of heat produced by a plant, it is believed that many, if not all, flowers show a rise of temperature at the time of opening.

The Garden contains a number of plants for which the internal temperature of leaves, resulting from the absorption of radiant energy, has been definitely determined. It has been found that during winter the leaves of the Austrian pine (*Pinus Laricio* var. *austriaca*) will, under brilliant illumination, attain a temperature from 2–10°C. higher than the surrounding air, the temperature of which may be as low as —15°C. Even diffuse light, according to its intensity, will raise the temperature from 0.5–2°C. Leaves from tropical plants, such as the cucumber-tree (*Magnolia sphenocarpa*) and the three-seeded mercury (*Acalypha tricolor*) will, under full illumination, attain a temperature from 10–16° above that of the surrounding air, or an actual temperature as high as 43°C. This is of interest since the lethal temperature for living material or protoplasm is approximately 50°C.

The internal temperature is greatly influenced by external factors such as humidity and air currents, but also, and this is of primary interest here, by the internal factor of pigmentation. The yellow leaves of *Codiaeum variegatum* attain a temperature 8°C. above that of the surrounding air, while the green leaves of the same plant reach a temperature 11° above that of the atmosphere. Similarly, the internal temperature of green and red leaves of variegated caladiums is about 4°C. higher than that attained by green and white leaves of similar plants. The difference, of course, is attributed to the higher absorptive power of the more pigmented leaves. Similarly, young leaves of the cacao tree (*Theobroma Cacao*), which are of a red color due to their high content of the red coloring matter, anthocyanin, may attain a temperature 3 or 4°C. higher than that of older green leaves relatively poor in anthocyanin. The internal temperature attained by thin leaves is practically the same as that attained by thick or fleshy leaves, but the latter reach their temperature more slowly and, being influenced less easily by breezes, retain their temperature longer and more constantly.

LANDSCAPE ARCHITECTURE EXHIBIT

In an effort to stimulate interest in landscape architecture there will be held in the Museum of the Garden, during the month of October, an exhibition of plans, drawings, models, and photographs of some of the best of the recent landscape developments in this country. This exhibition will be under the management of the American Society of Landscape Architects and of the Missouri Botanical Garden. Several

of the best-known landscape architects of this country will contribute, and the Departments of Landscape Architecture of Harvard University, Massachusetts Agricultural College, the School for Gardening of the Missouri Botanical Garden, and other institutions will be represented.

Similar exhibitions are held annually in Boston, New York, and other places, and have proved to be exceedingly instructive and interesting, not only to architects, landscape architects, engineers, and gardeners, but to the general public as well. The work shown will include developments of private estates and home grounds, parks, playgrounds, cemeteries, and subdivisions, and a few plans and sketches showing the beautification of civic and neighborhood centers will probably be on display.

STATISTICAL INFORMATION FOR AUGUST, 1916

GARDEN ATTENDANCE:

Total number of visitors	18,687

PLANT ACCESSIONS:

Total number of packets of seeds received in exchange	1
Total number of plants received in exchange	1
Plants donated	6

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought	13
Total number of books and pamphlets donated	82

HERBARIUM ACCESSIONS:

By Purchase —	
F. S. Collins — "Phycotheca Boreali-Americana," Fasc. XLIII, Nos. 2101–2150	50
Rev. John Davis—Plants of Missouri	260
Miss Marion E. Moodie—Plants of Alberta	146
By Gift —	
W. C. Coker—*Hydnum spongiosipes* from North Carolina	1
J. A. Drushel—Plants of Missouri	5
E. D. Hull—*Clitoria Ternatea* L., cultivated specimen	1
E. L. Jensen—Fungi of Minnesota	10
O. S. Ledman—Plants of Illinois	2
L. C. Monahan—*Stereum hirsutum* causing injury to living *Betula lenta*	1
C. L. Shear—Fungi from various localities and fragment of authentic *Thelephora illinita* Wallr	4
By Field Work —	
J. M. Greenman—Plants of Missouri	54
TOTAL	534

The Garden is open to the public every day in the year, except New Year's, Fourth of July, Labor Day, and Christmas—week days from 8:00 A. M. until one-half hour after sunset; Sundays from December to April, 1:00 P. M. until sunset, from April to December, 2:00 P. M. until sunset.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Boulevard, on the Vandeventer Avenue car line. Transfer south from all intersecting lines.

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MISSOURI BOTANICAL GARDEN BULLETIN

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CONTENTS

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VIEW IN ECONOMIC HOUSE, SHOWING COFFEE TREE IN LEFT FOREGROUND.

Missouri Botanical Garden Bulletin

Vol. IV St. Louis, Mo., October, 1916 No. 10

PLANTS IN ECONOMIC HOUSE

The permanent plantations in the various display houses having become well established, it is now possible to furnish a list of the plants to be found in these greenhouses. Beginning with this issue of the BULLETIN there will be printed from time to time as complete an inventory as possible of the various collections at the Garden, with such items of general interest concerning each plant as may be included. It is hoped that such lists may serve as a guide to each house until such time as a complete guide to the Garden can be prepared.

CONDIMENTS

Amomum Cardamon. Scitaminaceae. Cardamom. — A ginger-like herb of the East Indies, 4–5 feet in height. The leaves are thick and spicy, and the seeds are the cardamom seeds of commerce.

Camellia Thea. Ternstroemiaceae. Tea plant.—A native of Assam and probably also of China, though in the latter country it is known only under cultivation. Black and green teas are obtained from the same plant. Green tea is prepared by rapidly drying the leaves, considerable artificial heat being used, whereas black tea is manufactured by a slower process, the leaves being withered and fermented. Tea is produced largely in India, Ceylon, China, Japan, and Java. For some years the plant has been grown in South Carolina, at first only experimentally, but now on a commercial scale. Both black and green teas are prepared from the domestic product, and while the total production is small, the plants are of very superior quality and the industry promises to grow.

Cinnamomum Cassia. Lauraceae. Cassia.—A tree native of south China. The unripe fruits, cassia-buds, are used as a spice, chiefly in confections. Cassia-lignea is the bark of this tree and closely resembles the true, or Ceylon cinnamon and is used for the same purposes. The true cinnamon is obtained from the bark of *Cinnamomum zeylanicum.*

Cinnamomum Tamala, southern Europe. *C. grandiflorum,* southern Asia.

Coffea arabica. Rubiaceae. Coffee.—The name is derived from the Arabian word for drink. The berries may be dried as picked and the seeds afterwards extracted by a hulling machine, or the outer fleshy material may be removed before drying by a huller, leaving the coffee in its parchment. It is then fermented, washed to remove a slimy covering, and dried, after which its tough inner integument or parchment is removed by other machines, and the beans polished, graded, and marketed.

Coffea mauritiana, Mascarene Islands. *C. bengalensis* and *C. zanzibariensis,* South Africa.

Cola acuminata. Sterculiaceae. Cola-nut tree.—Cola-nuts are the seeds of a small tree native of west tropical Africa and naturalized in the West Indies. Powdered cola-nuts thrown into foul water are said to clarify it and render it agreeable to taste. The nuts are chiefly used, however, as an article of food and are said to enable those who eat them to endure prolonged labor without fatigue. The seeds contain about 2 per cent of caffeine, and are highly esteemed by natives of tropical Africa, a paste, similar to chocolate, being prepared by grinding them.

Cryptocarya sp. Lauraceae. Australian nutmeg.—A large tree, native of Australia, with aromatic fruit. The nuts are called nutmegs but are poor substitutes for the true nutmeg (*Myristica fragrans*).

Ilex paraguensis. Ilicineae. Paraguay tea.—A small tree native of Paraguay. An aromatic beverage, similar in its effects to coffee and tea, is prepared from the leaves. These are scorched and dried while still attached to the branches, after which they are beaten, separated, coarsely ground in rude mills, and packed in skins and leather bags.

Laurus nobilis. Lauraceae. Laurel.—A tree attaining 40–50 feet in height, native of southern Europe. The leaves are aromatic and are used for flavoring custard and puddings, and a few are often packed in fig boxes to give the figs a flavor. The tree is used ornamentally for esplanades, architectural appurtenances, etc., the head being trimmed to assume any desired shape.

Pimenta acris. Myrtaceae. Wild clove.—The dried unripe berries have similar properties to the pimento or allspice. From the leaves of this species is obtained the oil of myrica which furnishes the basis for bay-rum.

Pimenta officinalis. Myrtaceae. Allspice, pimento, or Jamaica pepper.—A tree native of the West Indies, but cultivated almost exclusively in Jamaica. The dried unripe fruits are imported to this country in large quantities and yield the allspice of commerce, so-called because it was supposed to combine the flavors of cinnamon, nutmeg, and cloves. Pimento is very largely employed as a spice, but is used also in medicine on account of its aromatic and stimulating qualities. Oil of pimento, obtained from the fruits by distillation, is used in perfumes, and is also often substituted for oil of cloves which it closely resembles. The wood of this tree is made into umbrella handles and canes.

Piper nigrum. Piperaceae. Pepper plant.—A creeping Indian vine, with minute flowers and jointed stems, cultivated in India, East India Islands, and elsewhere in the tropics. Black pepper is made from the dried unripe berries, while white pepper is a product of the ripe fruit deprived of the pulp by macerating.

Piper unguiculatum, Peru. *P. amplum,* Brazil. *P. geniculatum,* Peru.

Zingiber officinale. Scitaminaceae. Ginger.—The ginger plant is cultivated in the warmer parts of Asia, Africa, and the West Indies. The root-like stems yield the well-known condiment. In preparing it the shriveled rind may be retained, or it may be scraped off and bleaching further accomplished by means of chloride of lime or lime and water. Preserved ginger is merely the young shoots of the rhizome preserved in syrup.

DYES

Bixa Orellana. Bixaceae. Arnatto.—A small, bushy tree widely distributed in the tropics, with handsome white or pinkish flowers. An orange or yellow dye is prepared from the reddish yellow pulp surrounding the seeds, which is used for dyeing silks, woolens, and cottons, and as a color ingredient for butter, cheese, chocolate, varnishes, and lacquers. Both the prepared dye and the seeds are imported to this country chiefly from South America and the West Indies.

Coccoloba laurifolia. Polygonaceae. Seaside grape.—A small tree with cordate, oval leaves. It is a native of Barbados and other West Indian islands and belongs to the buckwheat family. The flowers are produced in spikes, and the calyx, becoming fleshy when ripe, has the appearance of a grape. The bark is astringent and has been used for tanning leather.

Semecarpus Anacardium. Anacardiaceae. Marking-nut tree.—A moderate-sized, deciduous tree, native of the East Indies. The juice of the nut, mixed with a little quick-lime and water, is employed throughout India for marking linen and cotton cloths, being far more durable than the marking inks of Europe. Undiluted, the juice acts as a vesicant, being used by the Hindus for rheumatism. A dye is prepared from the bark.

Wrightia tinctoria. Apocynaceae. Indigo tree.—A small tree native of India. The leaves when macerated in water yield a kind of indigo.

FRUITS

Aberia caffra. Flacourtiaceae. Kei apple.—A spring shrub, native of South Africa. The small, apple-like fruits, about 2 inches in diameter, are used when green for pickling, and when ripe are made into preserves.

Achras Sapota. Sapotaceae. Sapodilla plum. — A plant native of tropical America and the West Indies, and generally cultivated in the tropics. It yields an elastic gum known as chicle gum, which is imported into the United States in large quantities, being the principal ingredient of well-known brands of chewing gum. The fruit is much esteemed and tastes like a superior sort of persimmon.

Adansonia digitata. Bombaceae. Monkey bread or baobab.—A tree of immense size, native of tropical Africa and cultivated in India. It is known also as the African calabash tree. The large gourd-like fruits contain an acid pulp which is eaten by the natives, the gourds being further used as floats for fishing nets and bottles for holding water. Paper and cloth are made from the bark, the latter being prepared by beating out the inner bark. Trees are known to measure as much as 30 feet in diameter, but the wood is light, soft, and of little value.

Anona muricata. Anonaceae. Sour sop or custard-apple. —A tree 15–20 feet high, native of the West Indies and tropical America, and cultivated for its fruit, which varies in size from 6 to 9 inches in circumference. There are many forms of custard-apple, but the heart shape predominates, as indeed it does in fruits of most of the other anonas. Its pulp is wooly in appearance, but contains a fresh and agreeable sub-acid juice.

Anona laurifolia, West Indies. *A. glabra,* Florida.

Antidesma Bunius. Euphorbiaceae. Niggers cord. — A tree native of Australia. The fruit is about the size of a

VIEW IN ECONOMIC HOUSE, WITH FRUITING PAPAYA TREE IN BACKGROUND.

cherry, with sharp acid flavor, and is used for jelly. The juice is valuable in alleviating the parching of the throat in fever.

Artocarpus integrifolia. Urticaceae. Jak fruit. — This plant has been grown from time immemorial in southern Asia. The fruits attain an enormous size, and certain varieties are highly esteemed as articles of food by the natives of India. The name "Jak" is derived from the Sanskrit name of the fruit, "Tehakka." The wood is valuable for making furniture.

Atalantia trimera (*glauca*). Rutaceae. Desert lemon.—A tree native of Queensland and New South Wales. The fruit is globular, ½ inch in diameter. It may be used for preserves, or an agreeable beverage is made from its acid juice.

Blighia sapida. Sapindaceae. Akee tree.—A tree native of western tropical Africa, early introduced into the West Indies. It forms a handsome specimen 30 feet in height, having large broad-winged leaves. The fruit has a reddish color, is about 3 inches in length, and contains a yellowish pulpy aril in which are imbedded three black seeds. In its raw state it is considered poisonous, but cooking makes it wholesome. During the season large quantities are brought to Kingston (Jamaica) market.

Brosimum Alicastrum. Urticaceae. Bread-nut tree. — A large tree of the West Indies. It has lance-shaped leaves and fruit about the size of a plum, containing one nut-seed, which when roasted is edible. The wood has a fine grain like mahogany.

Calodendron capensis. Rutaceae. Cape chestnut. — The tree is a native of the Cape of Good Hope. It has broad, elliptical leaves, and snow-white flowers. The fruit is a five-celled, five-angled, prickly capsule, bearing some resemblance to the fruit of the chestnut. The seeds are shiny black.

Carica Papaya. Papayaceae. Papaw tree.—A fast-growing, soft-wooded tree of tropical America, averaging 20 feet in height. The thick stem is terminated by a crown of large-lobed leaves on long foot-stalks, the flowers being produced from the stem, below the leaves. The fruit when ripe is yellow, 8–10 inches long, and shaped like a melon. It is palatable when eaten with sugar and has the flavor of apricots. The tree and fruits are full of an acrid milky juice which is used to make animal flesh tender, old fowls or hogs being wrapped in the leaves.

Carissa grandiflora. Apocynaceae. Natal plum.—A low, prostrate shrub, native of South Africa, where it is used ex-

tensively as a hedge. The half-ripe fruit is used for pickles, and sauce made from the ripened berries has a flavor almost indistinguishable from that of cranberry sauce. The wood is well adapted for turning on the lathe.

Carissa Carandas, East Indies. *C. Arduina,* South Africa. *C. edulis,* Egypt.

Chiococca racemosa. Rubiaceae. Snowberry.—A climbing shrub of the Florida Keys and south Florida. It is cultivated in hothouses for its panicles of yellowish white flowers and the white fruits. The leaves are ovate to lanceolate, thick, shining, and entire, and the fruit is a globular drupe ¼ inch in diameter, turning glabrous.

Chrysophyllum sp. Sapotaceae. Star apple.—A native of the West Indies, attaining a height of 30–40 feet. The fruit is about the size of an apple and is wholesome, with an agreeable sweet flavor. It consists of ten cells, each containing a single seed, and when cut across has a star-like appearance.

Citrus Aurantium. Rutaceae. Orange. — A low, much-branched tree, native of western India. It was introduced into Italy in the ninth century, and is now grown all along the Mediterranean. The tree attains a great age, those in the groves of Spain being more than six hundred years old, and some trees producing six thousand fruits a year. The orange is naturalized in California and Florida, where immense quantities of the fruit are grown for consumption in the United States as well as for exporting. There are a great many cultivated varieties, among which are the Malta or blood orange, which has a red rind and flesh; the Mandarin with a small, flat fruit, from which the skin separates readily; the Bergamot from which an essence called bergamot oil is extracted; and the Seville or bitter orange which is largely used for making marmalade and candied peel.

Citrus grandis var. "Royal." Rutaceae. Grapefruit.—A tree native of the Malay Archipelago, growing to a height of 25–30 feet. It is extensively cultivated in Florida and to some extent in California. The fruit is globose, with pale yellow pulp, and is used largely for dessert. There are a number of varieties, many of which have been originated in Florida.

Citrus japonica. Rutaceae. Kumquat.—It is a small tree, native of Japan and China, growing upon the slopes of hills. The yellow fruit is preserved in jars and forms an important export. It is grown in California and Florida and is used in the United States either preserved or fresh. The pulp is sour, while the rind is sweet.

Citrus Medica var. *Limonum.* Rutaceae. Lemon.—A small, spreading tree or shrub, native of India, and cultivated in all tropical and subtropical regions of the world. The lemon is one of our most important commercial fruits, grown extensively in California and Florida and also imported in large quantities from Italy. The entire fruit, rind and pulp, is used widely for culinary and confectionery purposes, and for the manufacture of citric acid. The cultivated varieties must be propagated by budding, grafting, or cuttings, as they do not come true from seed.

Coccoloba uvifera. Polygonaceae. Sea or shore grape.—The sea grape is native of the West Indies and is found growing in sandy soil in the proximity of the sea. The red, grape-like fruits, occurring in large bunches, are edible but very astringent. The broadly heart-shaped leaves are worthy of note and make the plant attractive for horticultural purposes. The wood is used in cabinet work and when boiled turns red.

Coprosma Baueri. Rubiaceae. Tasmania currant.—A low, prostrate shrub or small tree native of Norfolk Island, where it varies in height from a few feet to 25 feet. The small currant-like fruit is used for preserves. The variegated-leaf variety is grown in California as an ornamental plant.

Cordia Myxa. Boraginaceae. Sebesten plum.—A small tree native of India. The fruit grows in clusters and consists of a drupe 1 inch in diameter, yellow, with soft and clammy pulp.

Cordia serratifolia and *C. Francisci,* Mexico. *C. angustifolia,* India.

Crataeva gynandra. Capparidaceae. Garlic tree.—A tree native of the West Indies. The fruit has an odor strongly resembling garlic.

Diospyros discolor. Ebenaceae. Mabolo.—A tree native to the Philippine Islands, medium-sized, with large, firm, light-colored leaves. The fruit is like a large quince, with an agreeable flavor.

Diospyros montana. Ebenaceae. Date plum.—A tree native of India and China, where it is cultivated for its fruit, which is about the size of a small apple. It is delicious and is often made into preserves.

Ehretia tinifolia. Boraginaceae.—Trees and shrubs found in the warmer regions of the world. The fruit is a yellow globose drupe, the size of a small pea, with edible thin pulp.

Ehretia laevis, Australia.

Eriobotrya japonica. Rosaceae. Loquat or Japanese plum.—The loquat is a native of China and Japan but is grown extensively in Florida and California. The large clusters of white flowers appear during the winter months, and the fruit ripens in the spring. The latter resembles a plum in shape but has a strong acid flavor. The loquat is also valued as a decorative plant, the variegated variety especially being frequently grown in the northern states.

Eugenia Jambos. Myrtaceae. Rose-apple. — A small tree native of India but cultivated in many tropical countries. The tree is planted for shade and ornament, as well as for the fruit, which is heavily rose-scented but very insipid in taste and almost without juice. It is usually about the size of a small apple, but varies in color from white to rose-pink, and is used for making jelly and confections. Candied rose-apples are much esteemed by the natives.

Eugenia uniflora. Myrtaceae. Pitanga or Surinam cherry.—A small tree or shrub, native of South America. It is used as a pot plant and ornamental shrub and is very attractive when the small, globular, white flowers are in bloom. The small, showy, ribbed berries resemble a miniature tomato. They have a spicy acid flavor and are much used for making jelly, sherbet, and a refreshing drink. The Surinam cherry is grown in southern Florida and southern California.

Eugenia Smithii (lilly-pilly), S. Wales. *E. Pitanga,* Brazil. *E. pungens* (myrtle), West Indies. *E. ternifolia,* Venezuela.

Feijoa Sellowiana. Myrtaceae. — This is considered a promising fruit plant in southern France. The fruits are about 2½ inches long, 2 inches thick, and 4-celled. The flesh is thick, white, pulpy, and watery, with a strong and agreeable odor and a sugary taste, resembling the pineapple and the guava.

Flacourtia Ramontchi. Flacourtiaceae. Indian plum.—A small tree, native of India, more or less spiny, with small alternate leaves. The fruit is about the size of a plum with a sharp but sweet taste.

Garcinia Mangostana. Guttiferae. Mangosteen.—A moderate-sized tree of Malacca and the Malay Archipelago, introduced into Ceylon and the West Indies. The fruit resembles a small apple in size and shape, is of a reddish brown color when ripe, and is considered by some the choicest of all tropical fruit. The rind of the fruit and the bark of the tree

are very astringent and have been used more or less in medicine.

Garcinia Livingstonei, tropical Africa. *G. Xanthochymus,* Malay Archipelago.

Harpephyllum caffrum. Anacardiaceae. Kaffir plum.—A tree native of the Cape of Good Hope, with edible, plum-like fruits.

Hovenia dulcis. Rhamnaceae. Japanese raisin tree.—A small tree, also known as the coral tree, distributed over China, Japan, and the Himalayas. The fruits, which are about the size of a pea and borne on enlarged fleshy peduncles, contain a sweet juice and are edible.

Hymenaea Courbaril. Leguminosae. Courbaril tree or West Indian locust.—A large tree with simple bilobed leaves, native of the West Indies and tropical America. The diameter of the true stem is 6–9 feet, surrounded by buttresses measuring around the base over 80 feet in circumference. Some trees are supposed to be more than a thousand years old. The pods are thick, flat, 3–4 inches long and 2 inches broad. They contain a few bean-like seeds, imbedded in pulp which becomes mealy as the pod ripens, and is eaten by the natives.

Inga dulcis. Leguminosae.—A tree of the Mimosa section of the bean family. It is a large showy specimen with simple winged leaves, cultivated for its pods which are 2 or more feet long, 3 inches broad, and pendulous. The seeds are imbedded in a sweet pulp which is eaten by the natives. Different species of Inga are common throughout the whole of tropical America and the West Indies, the pods of all containing a sweet, mucilaginous, edible pulp.

Lansium domesticum. Meliaceae. Lanseh.—A tree native of and cultivated throughout the Malay Archipelago. The fruit is yellow, the size of a pigeon's egg, and is produced in bunches. When ripe it consists of a transparent, pleasant, subacid pulp, enclosed in a very bitter skin, which must be removed before the fruit is eaten. The natives value the lanseh next to the mangosteen and durian in flavor, and Europeans rank it foremost among the Malayan fruits.

Lucuma mammosa. Sapotaceae. Marmalade plum.—The marmalade plum tree is native of the West Indies and South America. The fruit is filled with an agreeably flavored pulp, and the seeds, which contain hydrocyanic acid, are used in the West Indies as a substitute for bitter almonds in flavoring.

Lucuma Bonplandia, Cuba. *L. serpentaria,* Jamaica. *L. Rivicoa* var. *angustifolia,* Brazil.

Mangifera indica. Anacardiaceae. Mango.—This tree is common in India. The fruit may be called the apple of the tropics, and like the apple, has a great many varieties, differing in shape, size, color, and flavor. It varies in form from kidney-shaped to roundish, and the average weight is from one-fourth to three-fourths of a pound.

Manihot utillissima. Euphorbiaceae. Cassava.—A slender, erect shrub of Brazil, chiefly cultivated for the large fleshy roots which contain a great quantity of farina. This is obtained by grating the roots to a pulp, extracting the poisonous juice by washing, and pounding the mass into a coarse meal, which is then subjected to heat to drive off the remaining poison. The meal forms the basis of cassava bread, an important article of food in South America. In washing the pulp the starch is extracted and placed on hot plates, causing the grains to swell and burst, and forming the tapioca of commerce. An intoxicating drink is made from the cassava cakes. The women chew them and eject the masticated substance into a wooden bowl, where it is allowed to ferment, after which it is boiled.

Melicocca bijuga. Sapindaceae. Honey berry.—A tree, native to Guiana, where it attains a height of 40 feet and a circumference of 4–5 feet. It produces numerous egg-shaped fruits about one and one-half inches in length, the pulp having an agreeable vinous, aromatic flavor.

Nephelium Longana. Sapindaceae. Litchi, longan, and rambutan.—Small trees, seldom exceeding 20 feet in height. The litchi, which is the most celebrated native fruit of China, is nearly round, about ½–1 inch in diameter. The Chinese dry it when it becomes black like a prune, and thus preserve it for use throughout the year.

Oxyanthus natalensis. Rubiaceae.—A native shrub of Natal. It bears long white flowers in racemes, and the berries are edible.

Parkia Roxburghii. Leguminosae. Nutta.—Native of tropical Africa and Asia, attaining a height of 40 feet. The pods grow in bunches, each pod containing fifteen seeds imbedded in a yellowish sweet pulp which is made into a drink. In Africa the seeds are roasted, then bruised and placed in water which subsequently ferments and is allowed to stand until it becomes putrid. The seeds are then washed and pounded, and the powder made into little cakes which are used as a sauce for all kinds of food.

Persea gratissima. Lauraceae. Avocado or alligator pear. —The avocado pear is one of the most highly prized of the

tropical fruits and is widely grown throughout the tropics, having been cultivated in Mexico for centuries. It is grown commercially in Florida and is shipped to the northern states during winter months. Budded trees of improved types produce two to three hundred medium-sized fruits. The fruits are pear-shaped, light or dark green, and the interior is a mass of yellowish pulp of the consistency of firm butter and of a delicious nutty flavor. Varieties "El Oro," "El Fuerte," "San Sebastian."

Pithecolobium dulce. Leguminosae. Zamang. — A very large tree of Mexico. A circumference of 570 feet has been attained at the top branches, while the diameter of the stem reaches 9 feet. The pods are thick, flattish, curved, contain a sweetish pulp, and are commonly used for feeding cattle.

Pithecolobium filicifolium (wild tamarind), West Indies.

Psidium. Myrtaceae. Guavas, various species.—Small trees, native of tropical America. The collection embraces a number of species, among which are the lemon guava, red guava, and white guava. The trees are rather widely cultivated and have become naturalized in most tropical and subtropical countries, including Florida and California. The fruit is the important part of the plant, being used for desserts and jelly.

Psidium Cattleianum, P. Guajava, P. Araca, and *P. littorale,* Brazil. *P. cuneifolium, P. pyriferum,* and *P. acre,* tropical America. *P. chinense,* China.

Spondias dulcis. Anacardiaceae. Otaheite apple. — The tree abounds in Polynesian islands, and has been introduced in many parts of the tropics. It attains a height of 50–60 feet and has dark green, winged leaves, which contrast with the golden fruit. The average fruit is about the size of an apple. The rind tastes of turpentine, but the pulp has a fine apple-like smell and agreeable flavor. The wood is valued for making canoes.

Spondias lutea. Anacardiaceae. Hog-plum.—A tree attaining a height of 40–50 feet. It is commonly cultivated for its fruit, which is oval and yellow, and is used for feeding swine.

Tamarindus indica. Leguminosae. Tamarind. — The tree, found chiefly in Africa, grows to a height of 60–80 feet and has a wide-spreading head of dense foliage. Though cultivated for its fruit, it is frequently used as a shade tree in warm countries, and as such its value is enhanced by the fragrant flowers that it bears. The fruits have an agreeably acid taste and in hot countries are used for making cooling

drinks. The wood is heavy, so heavy in fact that it sinks in water.

Terminalia trifoliata. Combretaceae. Myrobalan.—Large trees common throughout India, the East Indies, Fiji, and other islands of the Pacific. The fruit is a winged drupe containing a hard stone about the size of a nutmeg. It is highly astringent, and large quantities are annually imported for tanning and for making black dye. The kernels of the nuts taste like filberts, but if eaten too freely produce intoxication.

Triphasia aurantiola. Rutaceae.—A native shrub of East Asia, which is often used for hedges. It has flowers of fine fragrance, and the fruits are small but of pleasant sweetness.

(To be continued)

LANDSCAPE ARCHITECTURE EXHIBIT

The exhibition of the American Society of Landscape Architects in the Museum of the Garden, during the month of October, proved of great interest, especially to those engaged in the allied professions of architecture, engineering, and gardening. A great variety of problems were presented, and although the geology and topography, the climate and the vegetation could not be indicated in every case the designs were very instructive and full of valuable ideas and suggestions. Many of the plans and perspectives, although incidental to the final development of the project, were in themselves works of art and presented a phase of the landscape architect's work but little appreciated. The photographs, besides suggesting the beauty of the subjects, showed excellent pictorial balance and composition.

At least one-half of the space was devoted to developments of home grounds and estates, these ranging in size from small lots to country homes of large area. Plans for water-front, hill, suburb, and country localities were included, the formal as well as the natural school being represented. The finish and elegance of many of these gardens would compare favorably with the best work abroad, and the natural features, being developed to the utmost, give a character truly American and typical of the locality. Plans and photographs of parks and playgrounds were also shown, the problems varying in size from city squares to large parks several hundred acres in extent. The necessity for a well-studied arrangement of buildings, roads, walks, etc., in institutional grounds was well brought out in the plans for hospital and school grounds.

In addition to the above, attractive subdivisions for all types of residence were presented in plan and photograph. The practice among large manufacturing concerns of providing improved conditions for their employes is growing, and practically all the subdivisions planned for such purposes not only furnish ample space for a lawn and garden on each lot but include within the areas parks and playgrounds for the recreation of the residents. The attention that all progressive cities and towns are giving the very necessary problem of city planning is of course well known, and the plans and perspectives of civic centers speak well for the possibilities of introducing beauty, convenience, and dignity in the arrangement of public buildings.

The work shown of the students promises well for the profession at large. Harvard University, University of Michigan, and University of Illinois had fine exhibits of their student work, consisting of studies in home grounds, parks, cemeteries, school grounds, subdivisions, etc. The central panel was devoted to the work of the School for Gardening of the Missouri Botanical Garden, typical work for all three years being shown. With the object of setting a higher standard for college students an organization known as the University Landscape Architects' Society was formed a few years ago, membership being awarded to students who have done work of a high grade. A three-year fellowship in landscape architecture at the American Academy at Rome was also recently established.

In addition to the schools mentioned above, the following landscape architects and organizations have contributed to the exhibition:

HOME GROUNDS AND COUNTRY ESTATES

Brett and Hall, Boston, Mass.
H. A. Caparn, New York, N. Y.
Hare and Hare, Kansas City, Mo.
H. J. Kellaway, Boston, Mass.
Morell and Nichols, Minneapolis, Minn.
Olmsted Bros., Brookline, Mass.
Phillips and Wilcox, Detroit, Mich.
Pray, Hubbard and White, Boston, Mass.
Charles H. Ramsdell, Minneapolis, Mimn.
F. A. C. Smith, Amherst, Mass.
Albert D. Taylor, Cleveland, Ohio
Ralph M. Weinrichter, Rochester, N. Y.
Phelps Wyman, Minneapolis, Minn.

PARKS, PLAYGROUNDS, CEMETERIES

Brooklyn Botanic Garden, Brooklyn, N. Y.
H. A. Caparn, New York, N. Y.

Hare and Hare, Kansas City, Mo.
Charles W. Leavitt, New York, N. Y.
Massachusetts Agricultural College, Extension Department
E. T. Mische, Portland, Ore.
Phillips and Wilcox, Detroit, Mich.

SCHOOLS AND HOSPITAL GROUNDS

H. J. Kellaway, Boston, Mass.
Charles H. Ramsdell, Minneapolis, Minn.
Albert D. Taylor, Cleveland, Ohio

CITY PLANNING AND SUBDIVISIONS

Brett and Hall, Boston, Mass.
H. A. Caparn, New York, N. Y.
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Warren H. Manning, Boston, Mass.
Olmsted Bros., Brookline, Mass.
Phillips and Wilcox, Detroit, Mich.
F. A. C. Smith, Amherst, Mass.
Albert D. Taylor, Cleveland, Ohio

THE CHRYSANTHEMUM SHOW

Following the custom of previous years, the chrysanthemum show, opening the first Sunday in November, will inaugurate the series of interior floral displays for the winter. The variety and quality of the blooms shown, together with the number of plants, will more than equal that of former displays. Over 2,000 plants, about equally divided between the single-stem and the bush forms, will be staged, and this means that there will be something over 10,000 flowers open at one time. All the known types from single, recurved, reflexed, incurved, and anemone, to the extreme pompon and hairy varieties are included, the colors varying from white to pink, red, crimson, and maroon, to yellow and bronze. An extra effort has been made to produce specimen plants of the various types, including the production of single large plants, as well as single large blossoms.

A specimen of the original wild type, *Chrysanthemum indicum,* from which practically all the modern chrysanthemums have been derived, will be shown in contrast with the white and yellow "William Turner," a variety which shows the extreme development of the chrysanthemum, so far as size is concerned.

The exhibition will be open to the public from 8:00 A. M. until 5:00 P. M. week days and from 2:00 P. M. until 5:00 P. M. Sundays.

NOTES

A spring flower show will be held in the Armory Building, March 15–18, 1917, under the direction of the St. Louis Flower Show Association.

Mr. G. H. Pring visited the E. T. Harvey collection of water-lilies, Bond Hill, Cincinnati, in the interest of the Garden, September 15–18.

Prof. Charles Sprague Sargent and Mr. Ames, of the Arnold Arboretum, recently spent a day at the Garden consulting oaks and other material in the herbarium.

A stereopticon lecture on "Insects and Flowers" was given by Mr. G. H. Pring before the members of the Clifton Heights Presbyterian Church, September 26.

A reception to the delegates to the General Convention of the Protestant Episcopal Churches was given in the floral display house of the Garden on October 21, about 2,000 attending.

The goose or pelican plant (*Aristolochia Gigas* var. *Sturtevantii*), described in detail in the June, 1914, number of the BULLETIN, is producing an abundance of flowers. The plant may be seen in the east side of the bromeliad house.

Mr. Henry Schmitz, B.S., University of Washington, 1915, M.S., University of Washington, 1916, and Mr. Louis J. Pessin, B.S., University of Georgia, 1915, curator of botany department, University of Georgia, have been awarded Rufus J. Lackland fellowships for the year 1916-17.

Recent visitors to the Garden include Mr. C. J. Humphrey of the United States Forests Products Laboratory, Madison, Wisconsin, September 6 and 7; Professor Arthur L. Peck, of the department of landscape architecture, Oregon State College, Corvallis, August 30; Mr. Emanuel T. Mische, a former Garden pupil and now landscape advisor, Portland, Oregon, October 7.

On October 8 about twenty-five members of the American Association of Park Superintendents visited the Garden, and were conducted through the greenhouses and grounds by special guides, particular interest being shown in the landscape architecture exhibit in the Museum. At the recent convention of the Association in New Orleans it was decided to hold the 1917 convention in St. Louis.

The second number of Volume III of the Annals of the Missouri Botanical Garden has been issued with the following contents:

"A New Senecio from Jamaica." J. M. Greenman.

"The Thelephoraceae of North America. VI." E. A. Burt.

"The Occurrence in Nature of Certain Yeast-Like Fungi with Reference to their Possible Pathogenicity in the Higher Animals." W. H. Emig.

STATISTICAL INFORMATION FOR SEPTEMBER, 1916

GARDEN ATTENDANCE:

Total number of visitors	28,940

PLANT ACCESSIONS:

Total number of packets of seeds received in exchange	54
Total number of plants received in exchange	1
Plants donated	126

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought	7
Total number of books and pamphlets donated	27

HERBARIUM ACCESSIONS:

By Exchange—

Oakes Ames—Orchids of the Philippine Islands	186
U. S. National Museum—Plants from various localities	183

By Gift—

S. Alexander—*Helianthus tuberosus* L. from Illinois	1
J. C. Arthur—Fragments of *Eupatorium phenicolepis* var. *guatemalensis* Rob. from Guatemala	1
Dr. Geo. Dock—*Eriogynia caespitosa* (Nutt.) Wats. from the Grand Canyon of Arizona	1
J. A. Drushel—Plants of Missouri, Alabama, Colorado, Utah, Oregon and California	21
Prof. B. M. Duggar—Parasitic fungi of Colorado	55
W. H. Emig—Plants of Oklahoma	114
Geo. R. Hill—Specimen of *Salicornia sp.* from Utah	1
A. Jaenike—Grasses of Colorado	5
La Mortola Botanical Gardens—Specimen and seeds of *Senecio Prainianus* Berger	1
O. S. Ledman—Plants of Illinois and Missouri	5
Mrs. K. H. Leigh—Specimen of the "tree tomato," *Cyphomandra betacea* Sendt., spontaneous in garden at Kirkwood, Mo.	1
Wm. Mittlebach—*Scrophularia marilandica* L. from Missouri	1
L. O. Overholts—Fungi from New York and Pennsylvania	7
G. H. Pring—Cultivated specimen of "jujube," *Zizyphus sativa* Gaertn.	1
TOTAL	584

The Garden is open to the public every day in the year, except New Year's, Fourth of July, Labor Day, and Christmas—week days from 8:00 A. M. until one-half hour after sunset; Sundays from December to April, 1:00 P. M. until sunset, from April to December, 2:00 P. M. until sunset.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Boulevard, on the Vandeventer Avenue car line. Transfer south from all intersecting lines.

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MISSOURI BOTANICAL GARDEN BULLETIN

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CONTENTS

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Missouri Botanical Garden Bulletin

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PLANTS IN ECONOMIC HOUSE

(Continued from October Bulletin)

GUMS

Acacia arabica. Leguminosae. Gum arabic tree.—A moderate-sized tree found in India, Arabia, Egypt, and tropical and southern Africa. This, together with several other species of the genus, yields the gum arabic of commerce, which is imported in the form of large, nearly black blocks or small rounded tears. It is used for imparting lustre to crape and silk, for thickening colors and mordants in calico printing, in the preparation of ink and blacking, as a mucilage, and in medicine. The wood of the tree is very durable if well seasoned, and is utilized in India for wheels, sugar and oil presses, rice pounders, agricultural implements, etc. The bark is used in dyeing and tanning industries.

Castilloa elastica. Urticaceae. Panama rubber tree.—A large tree native of Central America. It furnishes the india-rubber of this region, and is known by the natives as the ule-tree. A large tree, when first cut, yields eight gallons of milk, each gallon making two pounds of rubber. The plant has been introduced into India and Ceylon.

Clusia Hilariana. Guttiferae. Balsam tree.—A gum resin is obtained from the different species of Clusia, a genus native of the West Indies and tropical America. The trees are small, much-branched, and soft-wooded.

Clusia alba (balsam fig), India.

Cryptostegia grandiflora. Asclepiadaceae. India-rubber vine.—A climber, native of India and South Africa. Its milky juice contains caoutchouc. The plant is common but the quantity of juice is not sufficient to make it of great commercial importance.

Cryptostegia madagascariensis, Madagascar.

Hevea brasiliensis. Euphorbiaceae. Caoutchouc.—A tree attaining 50–100 feet in height, with smooth trifoliate leaves

and inconspicuous flowers. The fruit is a three-valved capsule containing three seeds. The stems contain a milky juice which is obtained by making deep vertical and slanting incisions in the bark. The juice is caught in receptacles, thickens by exposure to the air, and becomes a creamy paste. The paste is dried over a fire upon molds, and upon completion is the raw india-rubber of commerce. This substance did not come into general use until 1842, when the discovery was made that it possessed the power of absorbing sulphur, which rendered it unaffected by extremes of temperature and made it possible for any degree of texture to be obtained. At the present time innumerable articles are made from it.

Landlophia owariensis. Apocynaceae. African rubber plant.—A more or less climbing shrub or tree, widely distributed in tropical Africa, and one of the principal sources of African rubber. The fruits of some of the species, which are known as aboli, are eaten by the natives of the west African coast.

Mimusops sp. Sapotaceae. Monkey's face.—Trees native to northern Africa, possessing a milky juice which is extracted by making incisions in the bark. Upon exposure to the air the juice thickens and forms an adhesive glue similar to gutta-percha. The fruit is the size of an apple, juicy, and edible. The timber is hard and used for many purposes.

Mimusops Elengi, Africa.

Piptadenia rigida. Leguminosae. Angico gum.—A native tree of South America. It furnishes the angico gum similar to gum arabic. The wood is used in the building of ships.

Pistacia Lentiscus. Anacardiaceae. Mastich.—A tree 20 feet high, native of the Mediterranean region. It yields a balsamic sap, which is obtained by making incisions in the stems and branches. It hardens and is the mastic of commerce. Mastic has a sweet, resinous smell, and is chewed by the Turks to preserve the gums and teeth. It is also used in the preparation of a liquor called raki, as a varnish for pictures and maps on paper and canvas, and as a tooth cement.

Pistacia chinensis, China. *P. Khinjuk,* Egypt.

Schinus Molle. Anacardiaceae. California pepper tree.—A native of tropical America, where it is known also as the Peruvian mastic tree, owing to the gum which it exudes. In California it is extensively used as a shade tree, and in the southern portion attains a height of 50 feet. The tree is graceful, clothed with pendulous branches, and bears feathery panicles of greenish or yellowish white flowers, followed by pendant clusters of rose or red fruit. It is owing

to the strongly pungent character of the latter that the tree is called the pepper tree.

Shorea robusta. Dipterocarpaceae. Sal.—A large tree, native of India, attaining a height of 100 feet. Its wood is light brown, close-grained, strong and durable, being even stronger and heavier than teak. The tree yields a resin known as dammar, which is obtained by making incisions in the bark. An oil is obtained from its seeds.

MEDICINAL

Aloe vera. Liliaceae. Aloe.—A succulent plant native of south Africa. From the hardened juice of the plant is derived the purgative drug called "bitter aloes."

Anamirta Cocculus (Cocculus indica). Menispermaceae. Fish poison.—A climbing shrub of southern Asia. It is used in medicine as an ointment for chronic skin diseases. It is also said to be employed by brewers to increase the bitterness of malt liquors, but the practice is illegal because the berries of the plant contain an acrid irritant poison called picrotoxin. The berries are used by the Chinese as fly and fish poison.

Casearia glomerata. Samydaceae. Snake root.—A shrub or small tree native of Brazil. The leaves are somewhat astringent, and when boiled are applied to wounds and snake bites.

Casimiroa edulis. Rutaceae. Mexican apple.—A tree native of Mexico. The fruit is greenish yellow with thick rind, and resembles an orange in size and shape. It has a delicious flavor similar to the peach, but is used chiefly in inducing sleep, while the leaves are used as a remedy for diarrhea.

Cassia Fistula. Leguminosae. Senna.—An ornamental tree, native of tropical Asia, 20–50 feet high, bearing numerous racemes of bright yellow flowers. The seed pods are pendulous, often 2 feet long, cylindric, and when ripe of a dark purplish brown color. The small seeds are imbedded in a brownish pulp, which has a sweetish taste, and is used as a mild laxative. The bark is in considerable demand in India for tanning. The plant also yields a gum.

Cassia javanica and *C. nodosa,* Malay Archipelago.

Cerbera Tanghin. Apocynaceae. Poison ordeal-tree.—A soft-wooded, small tree of Madagascar, with stiff branches and elliptical leaves 4–5 inches long. It bears pretty white-pink flowers and a fleshy fibrous drupe about the size of a

plum, containing a hard seed, the kernel of which is highly poisonous. In Madagascar persons suspected of crime are made to swallow a small portion of the kernel, and if they die from its effects are supposed to be guilty. Condemned criminals are put to death by being pricked with a lance dipped in the juice of the kernels. It is said to produce death in 20 minutes.

Cerbera Odollam, East Indies.

Cinnamomum Camphora. Lauraceae. Camphor tree.—A tree native of Formosa, Japan, and China, also cultivated extensively in India and Ceylon. Camphor of commerce is obtained from the root, trunk, and branches, and in India is extracted successfully from the leaves and twigs also. The plant parts are broken up and heated with water in closed vessels, the volatilized camphor collecting as a sublimate upon rice straw. The product is further refined upon arrival in America. Camphor is used extensively in the manufacture of celluloid, smokeless gunpowder, and in the preparation of disinfectants and medicines.

Guaiacum officinale. Zygophyllaceae. Lignum-vitae.—A small tree (20–30 feet) native of Jamaica and other West Indian Islands, and parts of tropical America. It has a round head and conjugate winged leaves, and produces clusters of blue flowers resembling hepatica. The wood is extremely hard, and is extensively used in dockyards for pulleys and bearings of steam machinery. It contains a resin known as gum guaiacum, which has long been in use as a medicine, especially in rheumatic affections.

Hernandia sonora. Lauraceae. Jack-in-a-box.—A tree about 40 feet high, native of India. The leaves are glossy and light green with a red spot in the center. The fruit is large, whitish, and egg-shaped. The plant is much used in Europe for subtropical bedding, and produces a juice that removes hairs from the face without pain.

Ipomoea Horsfalliae var. *Briggsi.* Convolvulaceae. Bind weed.—A vine native of the East Indies. From the roots is obtained a resinous substance which is highly purgative.

Jatropha Curcas. Euphorbiaceae. Physic-nut plant.—A shrub native of tropical America but introduced into most tropical countries. The seeds yield an oil having strong purgative properties, and aside from its use in medicine, is employed in the manufacture of soap and candles.

Jatropha multifida, J. podagrica, and *J. urens,* tropical America.

Myroxylon toluiferum. Leguminosae. Balsam of tolu tree.—A tree native of Venezuela and Colombia. It grows to a height of 80 feet, and is often unbranched for a distance of 40–60 feet from the ground. Balsam is obtained by making V-shaped incisions through the bark of the growing tree and inserting calabash cups. Balsam of tolu is used in medicine as an expectorant and stimulant, and tolu lozenges are well known as a remedy for allaying coughs.

Myroxylon Pereirae (balsam of Peru).

Piper angustifolium. Piperaceae. Soldier's herb.—A plant native of South America. It is an erect-growing species, with lanceolate rough leaves, which are used for stanching the bleeding of wounds.

Pilocarpus pennatifolius. Rutaceae. Jaboranda plant.—A native of Brazil. The leaves and bark of this shrub contain essential oil and a peculiar alkaloid, pilocarpine, which are recommended as a sudorific and as a specific in diphtheria and hydrophobia. Pilocarpine contracts the pupil and also stimulates the salivary glands.

Pistacia Terebinthus. Anacardiaceae. Turpentine tree.—This tree has winged leaves, similar to those of ash, of a reddish tinge, and small and inconspicuous flowers. Solitary small trees are common in the Mediterranean region, Algeria, and Palestine, and are also found in Egypt and westward through northern Africa. A liquid flows from incisions made in the stem, which is the Chian turpentine of commerce, coming mainly from the island of Chios. The substance has a pleasant aromatic smell, and in the last two years has been brought into prominence as a remedy for cancer.

Smilax mauritanica. Smilaceae. Sarsaparilla.—A woody climber of Morocco. The leaves are alternate, smooth, and shiny. The flowers are inconspicuous, the fruit a berry. From the roots is obtained the drug sarsaparilla, which is considered to be a restorative in complaints arising from poorness of the blood.

Sophora secundiflora. Leguminosae. Sophora.—A round-headed tree, attaining a height of 40 feet and having light green winged leaves. It is a native of China and Japan where its white, papilionaceous flowers are used for dyeing both yellow and green. A purgative property pervades the whole of the tree, even affecting those who prune it or work with the wood.

OILS

Aleurites triloba. Euphorbiaceae. Candle nut or country walnut oil tree.—A handsome tree, widely distributed in

tropical countries. The seeds, strung upon a stick, are burned as candles in the Sandwich Islands. When pressed the seeds yield a large amount of pure oil similar to linseed oil, except that it dries more quickly and presents a harder and more waterproof surface, and is less light-proof and elastic. The oil derived from *Aleurites Fordii* is imported into the United States for use in varnishes, paints, soaps, linoleums, etc.

Calophyllum inophyllum. Guttiferae. Domba-oil tree.—A large tree, native of the East Indies and Polynesia, also known as Alexandrian laurel. From the fresh seeds a fragrant green oil is obtained, which in India is known as pinnay or domba oil. It is used for burning in lamps, and also as a medicine, being externally applied in the treatment of rheumatism.

Calophyllum Calaba (calaba oil), tropical America.

Olea europaea. Oleaceae. Olive tree.—An evergreen tree, native of Syria, Palestine, and Greece, naturalized abundantly on the shores of the Mediterranean, and cultivated extensively in California and southern Australia. The tree reaches 40 feet in height and attains great age. It is exceedingly productive, even thriving on poor, dry, sandy soils, and has been prized from antiquity on account of the oil obtained by pressure from the pulp of the fruit. Cotton-seed oil, which is sometimes used as an adulterant in olive oil, reduces silver nitrate, whereas olive oil does not, and this property makes possible the detection of adulteration as small as 1 per cent. Large quantities of olives are preserved or pickled, being prepared by soaking the unripe fruits in potash and lime to remove the bitter constituents, and then bottling in brine. Ripe olives are bluish black in color, and are also important as an article of commerce.

Olea cuspidata, southern Asia.

Salvadora persica. Salvadoraceae. Mustard tree.—A small, glaucous tree of India, Ceylon, and Arabia. Persians make tooth-brushes from the twigs, hence the tree is sometimes called the tooth-brush tree. The bark has an odor like that of cress, and is supposed to be the mustard of Luke XIII: 19. The root bark is very acrid and acts as a vesicant. The leaves are eaten as salad and also serve as fodder for cattle, and the seeds yield an oil, "kikuel-oil."

Terminalia Catappa. Combretaceae. Indian almond.—A large, deciduous tree, native of India, but naturalized in the West Indies and America. The wood is largely used for the construction of houses, carts, ships, etc. The kernels of the

nuts are large almond-like seeds, which are eaten raw or roasted and are said to compare with the filbert in taste. The nuts also yield an oil. Several species of this genus are used in tanning. Astringent galls which form on the young twigs are employed in India for making ink, as well as for dyeing.

ORNAMENTALS

Abrus precatorius. Leguminosae. Coral-bead plant.—A slender, twining, wing-leaved shrub, native of the East Indies. The seeds are scarlet with a black spot; and are used for rosaries, necklaces, goldsmiths' weights, etc.

Acacia spadicigera. Leguminosae. Bull horn.—A small tree of Mexico, with 1–3 erect stems, and a few lateral branches bearing numerous large, inflated spines, remarkable for their close resemblance to the horns of an ox or buffalo. The pods are eaten by pigs and other animals. The spines are utilized by certain stinging ants of the genus Pseudomyrma as nesting places for raising their young. The horns are hollowed out by the insects, which perforate one of the spines near the tip, usually on the under side so that no water can enter. The bipinnate leaves have nectar glands on the rachis and petiole, and are still further provided with peculiar processes on the tips of the leaflets, minute wax-like bodies rich in oil and protoplasm, which are used as food by the ants. Belt was the first to suggest that in return for the quarters and subsistence, the little ants protect their host as body-guard soldiers.

Antigonon leptopus. Polygonaceae. Mountain rose.—A tropical tendril climber, probably the only species cultivated in this country. The stem is slender, tall and glabrous, and the rose-pink flowers are in racemes. The plant requires an abundance of light but is one of the handsomest of summer-blooming greenhouse climbers. In the south it blooms freely in the open.

Artabotrys odorotissimus. Anonaceae. Climbing ylang-ylang.—A woody climber of China. It is widely cultivated in the tropics and conservatories for its flowers and fruits. The flowers are yellow, two inches long, fragrant, and showy.

Bignonia speciosa. Bignoniaceae. Trumpet flower.—An ornamental climber native of South America.

Bignonia violacea, B. buccinatoria, and *B. Tweediana.*

Brexia madagascariensis. Saxifragaceae.—A tree native of Madagascar, with alternate leaves furnished with minute stipules. The flowers are green, produced in axillary umbels. The plant is much used in conservatories.

Bunchosia sp. Malpighiaceae. West Indian cherry.—An ornamental evergreen shrub of Jamaica, with axillary flowers and fleshy smooth fruit containing three seeds.

Callicarpa americana. Verbenaceae. French mulberry.—This is a very effective shrub with handsome fruits, a native of southern United States.

Dianella caerulea. Liliaceae. Paroo lily.—A subshrubby plant, native of Australia, chiefly attractive for its blue berries which remain for several weeks. The stem is short, branching, with six leaves clustered at top. The leaves are 9–12 inches long, dark green, and rough on the back and margin.

Escallonia macrantha. Saxifragaceae. Chilean gum box.—A small tree of South America, used as an ornamental vine. The leaves are alternate, and the flowers are strongly odorous, red, and tubular in racemes.

Hura crepitans. Euphorbiaceae. Sandbox tree.—A large tree of western tropical America. The fruit is curious, being circular in form and consisting of 12–15 valved cells, which give it the appearance of a single flat seed. It is often kept as a curiosity, but with overheat or dryness, bursts with a report as loud as a gun, spreading its seeds and valves to a distance of several feet.

Nandina domestica. Berberidaceae. Sacred bamboo of China.—A small tree of China, bearing tufts of compound leaves on its apex, and terminal panicles of flowers, followed by red berries like those of holly. During the Chinese religious season, corresponding to our Christmas, the plant is used for decorating houses and altars in temples; hence the name of sacred bamboo.

Paradisea Liliastrum. Liliaceae. St. Bruno's lily.—A decorative plant of Europe. It has white, lily-like flowers borne on a scape 1 foot long. The leaves are linear, radical, 1 foot long.

Persea indica. Lauraceae. Canary wood.—This is a fine evergreen tree, native of the Canary Islands and Madeira. There are three species of this genus in the American trade, all being prized for their clean evergreen foliage.

Phyllanthus speciosus. Euphorbiaceae. Seaside laurel.—A small shrub, native of Jamaica, with floriferous lanceolate branches. More than 400 species of this genus exist, mostly in tropical regions, but only a few are cultivated, chiefly as foliage plants.

Saurauja lanceolata. Ternstroemiaceae.—A plant native of South America, and used chiefly as an ornamental in conservatories on account of its fine foliage and flowers.

Synadenium Grantii. Euphorbiaceae. Milk bush.—A succulent shrub of tropical Africa. The plant is smooth, thick-branched, with ovate leaves 3–4 inches long. The juice is milky.

Thevetia nereifolia. Apocynaceae. Lucky beans. — A small tree, native of South America, bearing yellow flowers. The hard, oblong seeds are mounted and used as pendants and charms.

Trachelospermum jasminoides. Apocynaceae. Star jasmine.—A climber, native of southern China, where it is especially valued for its flowers. When in bloom the plant seems to be covered with a white sheet, the flowers almost hiding the foliage and filling the air with a peculiar, pleasant fragrance.

Vitis capensis. Vitaceae. Grape. — An ornamental climber of the Cape of Good Hope.

PERFUMES

Acocanthera spectabilis. Apocynaceae. Winter-sweet.—A tender shrub of south Africa. It is cultivated in greenhouses and outdoors in Florida and California. The leaves are long, leathery, and shiny. The flowers are numerous in dense, axillary racemes, pure white, with odor of jasmine, and much used in the manufacture of perfume.

Jasminum Sambac. Oleaceae. Arabian jasmine. — An ornamental plant, native of tropical Asia, producing large double, white flowers with a strong, pleasant odor. From the flowers of this species, as well as of the other jasmines, the oil of jasmine is prepared. They are further used by the Hindus for making garlands.

Jasminum grandiflorum (royal jasmine), India. *J. cap-ense* (Cape jasmine), South Africa. *J. officinale,* tropical Africa and Asia. *J. simplicifolium,* Pacific islands. *J. paniculatum,* China. *J. fructicans,* southern Europe. *J. humile* (yellow jasmine), southern Asia.

Myrtus communis. Myrtaceae. Myrtle.—A shrub or small tree, native of western Asia and naturalized in southern Europe. The wood is hard and mottled, often knotty, and is much esteemed in Turkey. An oil is obtained from it which is used in perfumery, and the leaves are used to make sachet powder, potpourris, etc. The fruit is a pulpy black berry, and is used in some countries as an aromatic condiment.

Plumeria rubra, and *P. bicolor.* Apocynaceae. Frangipani.—These are shrubs, native of South America, with de-

liciously scented flowers from which perfumes are said to be made. The name frangipani is from the name of an ancient family of Rome, a descendant of which first invented a method of perfuming gloves, but what the perfume consisted of is not known.

Pogostemon Heyneanus. Labiatae. Patchouli.—A plant 2 or 3 feet high, native of India. The leaves are used by the Hindus for perfuming cashmere shawls. India-ink also owes its peculiar odor to this plant, and the essential oil from which this odor emanates is distilled for toilet use. The leaves are commonly used in sachets.

TEXTILES

Antiaris toxicaria. Moraceae. Upas-tree.—This is the celebrated poisonous tree of Java, which at one time was supposed to give off fumes fatal to animal life. The fresh juice is virulent poison and is used by aboriginal tribes in the Malay Archipelago to tip arrows. In western India sacks are made from the bark, which is removed whole by soaking and beating the trunk, a portion of the stem being left at the end to serve as a bottom for the bag.

Bauhinia candicans. Leguminosae.—A woody vine having stems 200–300 feet long, which climb over and interlace the highest trees. The plant often twists the trees so tightly that they become strangled and die. The bark is very tough and strong and is valuable for making ropes for suspension bridges. The leaves are about a foot in diameter and are used for making platters.

Boehmeria argentea. Urticaceae. Grass cloth.—An herbaceous perennial plant of Mexico, which sends up numerous rod-like stems 4–6 feet high. The leaves are heart-shaped and silvery white on the under surface. The stems contain fine fibre from which ropes and sail cloths are made.

Cyperus textilis. Cyperaceae.—A grass-like plant, growing in tufts, native of south Africa. From the flower stalks ropes and mats are made.

Lagetta lintearia. Thymelaeaceae. Lace bark.—A native of Jamaica, growing on limestone rocks and insinuating its roots in the fissures. The flower resembles the lily-of-the-valley, and the fruit is a pulpy white berry. The tree is remarkable for its bark which separates into twenty or more layers, assuming the appearance of lace. It was at one time used in Jamaica for net caps, bonnets, veils, ruffles, etc., and with care will stand washing.

Pachira campestris. Bombaceae. Silk cotton tree.—A tree, native of Brazil, attaining a height of 100 feet and having flowers 15 inches in length. The seeds are involved in silky, wool-like hairs, firmly packed in a capsular fruit. When this opens the hairs expand and form a wooly mass. The hairs are not adhesive and are brittle, and are used for stuffing cushions but cannot be spun.

Phormium tenax. Liliaceae. New Zealand flax.—Fibre is contained in abundance in the long sword-like leaves of this plant. Various attempts have been made to separate and clean the fibre on a large scale, but thus far the product so obtained does not equal that prepared by the native Maoris.

Phormium tenax var. *atropurpureum.*

Sansevieria zeylanica. Haemodoraceae. Bowstring hemp.—The plant is a native of Ceylon, India, and tropical Africa, and is found also in Mauritius and Jamaica. In Ceylon it is known as "niyanda" and in India as "moorva." The fibre, which is very tough and elastic, is obtained from the leaves and was used by the ancient Hindus for bowstrings, hence the common name. At the present time it is used chiefly in rope-making, etc.

WOODS

Afzelia rhomboidea. Leguminosae. Tindalo.—A native of Borneo and the Malay Archipelago. The wood is used for timber and cabinet-making.

Berria Ammonilla. Tiliaceae. Trincomalee wood.—A large, erect, handsome tree of southern Asia, used for timber.

Citharexylum quadrangulare. Verbenaceae. Fiddle wood.—A tree of the West Indies with branches permanently four-angled. Its leaves are elliptic-oblong, and the flowers white. The wood is used for making musical instruments.

Crescentia Cujete. Bignoniaceae. Calabash tree.—A medium-sized tree, native of the West Indies and South America. The hard shells of the gourd-like fruits are made into numerous domestic utensils, such as cups, basins, spoons, bottles, etc., and are often elaborately carved or painted. The peculiar knotted growth is noteworthy and characteristic of this plant which should not be confused with the calabash gourds of the West Indies.

Elaeodendron orientale. Celastraceae. Olive wood.—A native of Madagascar. It is a tree attaining a height of 30–40 feet. The timber is both hard and white, and is adapted for fancy and cabinet work.

Jacaranda ovalifolia. Bignoniaceae. Green ebony.—A native of Brazil, producing the fancy wood of commerce.

Macadamia ternifolia. Proteaceae. Queensland nut tree. —A tree, native of Australia, seldom attaining a great height. It is valued chiefly for its wood, which is marked by its peculiar silver grain and is used in cabinet-making. The tree bears an edible seed, which, however, is of little value.

Sterculia acerifolia. Sterculiaceae. Flame tree.—A native tree of New South Wales, attaining a height of 60–100 feet and a circumference of 6–8 feet. It has smooth, large-lobed leaves and racemes of showy red flowers.

Sterculia alata (Buddha cocoanut), India. *S. discolor,* Australia. *S. platanifolia* (Chinese parasol tree), China and Japan.

Swietenia Mahagoni. Meliaceae. Mahogany. — A large tree, native of Jamaica, with winged, dark-colored, ash-like leaves. The wood is used for interior fittings, furniture, and cabinet-work.

FLORAL DISPLAY FOR DECEMBER

During the month of December the display of flowering plants in the floral display house will typify the holiday season, the predominating colors being red and white. About 2,000 poinsettias, varying in size from the dwarf varieties about a foot or less in height to the tree plants as high as twelve feet, will constitute the greater part of this exhibit. Interesting variations of the poinsettia being shown in St. Louis for the first time are the white and pink-flowered varieties. As a matter of fact, however, the flowers of the poinsettias are neither white, pink, nor red but a sort of greenish yellow, the part of the plant usually called the flower being the conspicuous whorl of leaves immediately surrounding the cluster of flowers in the center.

As a setting for the poinsettias about 2,000 potted plants of the variegated stevia are being used. These plants have rather insignificant white flowers, but because of the looseness and natural gracefulness of the sprays they tend to set off to advantage the form and color of the poinsettia. In addition to the stevia about 2,000 bulbs of the paper-white narcissus will be on display, and besides adding to the white color of the exhibit will fill the house with fragrance. A few cyclamen in red, white, and lavender will be shown, and a few groups of the yellow-flowered reinwardtia will also be

used to vary the general red and white scheme. On the balcony overlooking the display house will be shown many begonias and a few hundred lilies of various varieties.

In point of beauty the December show bids fair to rival that of the chrysanthemums during the month of November.

ANNALS OF THE MISSOURI BOTANICAL GARDEN

It does not seem to be generally known in St. Louis that in addition to the BULLETIN, the Garden publishes a quarterly known as the Annals of the Missouri Botanical Garden. This journal is devoted exclusively to scientific papers contributed by members of the Garden staff, by graduate students in the Shaw School of Botany of Washington University, or by botanists using the extensive facilities offered by the Garden. Except when exchanged for an equivalent publication, the Annals is supplied only on subscription, $3.00 annually.

The scope and character of the Annals may be judged from the table of contents of the three volumes which have appeared thus far.

VOLUME I

VOLUME II

VOLUME III

NOTES

The third number of Volume III of the Annals of the Missouri Botanical Garden has been issued with the following contents:

"The Missouri Agrimonies." B. F. Bush.

"The Thelephoraceae of North America. VII." E. A. Burt.

"Catalogue of the Plants of Jasper County, Missouri." E. J. Palmer.

Mr. I. C. Hoffman, Industrial Fellow, Department of Horticulture, Purdue University, has registered for work in the graduate laboratory.

On November 22, Mr. Alexander Lurie, Horticulturist to the Garden, spoke before the Railroad Branch, Y. M. C. A., on "Flowers for the Home."

Dr. A. R. Davis, formerly Research Assistant to the Garden, has been appointed Assistant Professor of Botany at the University of Nebraska.

Mr. W. W. Ohlweiler, General Manager of the Garden, lectured before the Parkview Improvement Association, November 13, on "Garden Development About the Home."

As a result of the competitive examinations held in September, Miss Margaret Corley of St. Louis, and Mr. George Pedlow of Indianapolis, were awarded Garden scholarships.

Mr. W. W. Eggleston, of the Bureau of Plant Industry, U. S. Department of Agriculture, recently spent a day in the Garden herbarium studying certain plants which are poisonous to stock in the Northwest.

Recent visitors to the Garden include Dr. W. C. Sturgis, of Cambridge, Massachusetts, on October 21, and Mr. Martin Nelson and W. H. Wicks, respectively Director and Horticulturist of the Arkansas Agricultural Experiment Station, Fayetteville, on November 8.

The Association of Collegiate Alumnae of St. Louis held their November meeting in the graduate lecture room of the Garden, on November 11. Mr. Alexander Lurie, Horticulturist to the Garden, addressed the meeting on "Winter Protection of Plants."

Dr. Hermann von Schrenk, Pathologist to the Garden, attended the meetings of the American Society for Municipal Improvements as a member of the committee on Paving Standards, at Newark, New Jersey, October 10. He also attended the convention of South Cypress Manufacturers'

Association, Jacksonville, Florida, November 1, and gave a report on "Fire-resistive Methods in Wood Construction."

The following addresses have been delivered by Dr. Hermann von Schrenk, Pathologist to the Garden: "Timber Specifications," before the convention of Employes of Purchasing and Store Departments, Santa Fe System, at Temple, Texas, October 16; "On Defects of Timber and Preventive Methods" before the convention of American Railway Superintendents of Bridges and Buildings, at New Orleans, October 18; "On Structural Timbers, Their Use and Disuse" before the Purchasing Agents Association, Chicago, November 14.

STATISTICAL INFORMATION FOR OCTOBER, 1916

GARDEN ATTENDANCE:

Total number of visitors	28,785

PLANT ACCESSIONS:

Total number of plants received in exchange	397
Plants and seeds donated	18

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought	28
Total number of books and pamphlets donated	36

HERBARIUM ACCESSIONS:

By Purchase —	
Pedro Jörgensen—Plants of Argentina	104
Paul C. Standley—Plants of Florida	315
By Gift —	
J. A. Drushel—*Umbilicaria Dillenii* from Vermont	1
J. A. Drushel—*Quercus Cerris* L., "Austrian oak," a street tree in St. Louis	1
J. A. Drushel—Plants of Alabama, Colorado, Texas, and California	11
B. M. Duggar—Fungi from Creve Coeur, Mo	2
J. H. Kellogg—Specimens of *Quercus*, a hybrid oak from Allenton, Mo.	6
J. Matz—The "pink disease fungus," *Corticium salmonicolor* on *Ficus Carica* L., from Gainesville, Fla	1
Geo. L. Peltier—Fungi of Alabama	2
Geo. H. Pring—Type material of *Nymphaea*	2
Royal Botanic Gardens, Kew, England—Fragment of type and a recent collection of *Stereum vellereum* Berk., also *Stereum hirsutum* from Australia	3
L. B. Walker—Fungi of Nebraska	17
TOTAL	465

The Garden is open to the public every day in the year, except New Year's, Fourth of July, Labor Day, and Christmas—week days from 8:00 A. M. until one-half hour after sunset; Sundays from December to April, 1:00 P. M. until sunset, from April to December, 2:00 P. M. until sunset.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Boulevard, on the Vandeventer Avenue car line. Transfer south from all intersecting lines.

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M. SCHILLER,
New Conservatories.

MISSOURI BOTANICAL GARDEN BULLETIN

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CONTENTS

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BALD CYPRESS AT SANTA MARIA DEL TULE, MEXICO.

Missouri Botanical Garden Bulletin

Vol. IV St. Louis, Mo., December, 1916 No. 12

THE OLDEST LIVING TREE IN THE WORLD

Large trees have from time immemorial excited the interest and admiration of man. In Europe many trees of extraordinary size have been objects of curiosity to travelers, while in this country the great size and age of the giant redwoods of California have been the subject of frequent investigations and descriptions, notably by Muir, Dudley, and Huntington.

It is not so generally known, however, that trees belonging to a closely allied species, the bald cypress, attain an age equal to, and in one case certainly surpassing, that of any known redwood. The redwood and the bald cypress flourished during the same prehistoric periods, and were widely distributed not only in this country, but in Europe. At the present time, however, each is restricted to a limited area in the United States—the two species of redwood, to California, and the bald cypress, to narrow strips along the Atlantic Ocean and Gulf of Mexico, extending a short distance up the Mississippi Valley. A third related genus, Glyptostrobus, is now confined to a narrow region in southeast China. Although many of the cypress trees now growing in our southern swamps are very old, there are probably very few that even approach the age of the giant redwoods of California, and we must go to Mexico to find what is probably the oldest living tree in the world. There are a number of extraordinary specimens of the cypress tree in southern Mexico, some of which have attracted the attention of travelers and have been referred to in their writings. It is one of these which is the subject of this sketch.

In 1803, Alexander von Humboldt, during his travels through southern Mexico, came across an enormous cypress tree. He says of it: "In the village of Santa Maria del Tule, 22 km. east of the capital of Oaxaca, between Santa Lucia and Tlacochiguaya, there is an enormous trunk of a Cupressus disticha-(sabino), which has a circumference of 36 metres. This old tree is accordingly very much thicker

than the cypress of Atlixco, to which I have already made reference, and thicker than the dragon trees of the Canary Islands and all of the baobab (Adansoniae) in Africa. Mr. Anza, in making a detailed investigation of this trunk, found that it was not a single trunk, but is made up of three united trunks." At the time of his visit Humboldt inserted a square board into the side of the trunk, about 12 feet above the ground, cutting a shallow hole in the outer part of the tree for that purpose. This board bore a Spanish inscription, a copy of which does not seem to have been recorded.

Dr. Gray, in his charming essay on "The Longevity of Trees," refers to this tree as follows: "We possess three independent measurements of this enormous trunk. The first is that given by Humboldt, who states, probably on the authority of his informant, M. Anza, that the trunk is 36 metres (118 English feet) in circumference. In the year 1827, Mr. Poinsett, then our minister at the court of Mexico, transmitted to the American Philosophical Society at Philadelphia a cord which represented the exact circumference of this tree. Its extraordinary length naturally excited some doubts as to the correctness of the measurement; and immediate application was made to Mr. Poinsett for further particulars. He accordingly transmitted a communication from Mr. Exter, an English traveler who had just returned from Oaxaca, and who had carefully examined the tree in question. Mr. Exter's letter was afterwards published in Loudon's 'Magazine of Natural History'; and a French translation, accompanied by some interesting comments by the younger De Candolle, appeared in the 'Bibliotheque Universelle' for 1831. According to Mr. Exter's measurement, the trunk is 46 varas—one hundred and twenty-two English feet—in circumference; which is nearly in accordance with Humboldt's account. In neither case is the height at which the trunk was measured expressly mentioned. But this point has been duly attended to by a recent scientific observer, M. Galeotti, who visited this celebrated tree in 1839 and in 1840, and whose careful measurement gives to the trunk the circumference of 105 French (equal to 112 English) feet, at the height of four feet above the surface of the soil. The previous measurements, therefore, were taken somewhat nearer the base. The tree as yet shows no signs of decay, although it bears less foliage in proportion to its size than its younger fellows. But we find no authority for Mr. Exter's statement, that this tree was mentioned by Cortes, and that its shade once afforded shelter to his whole European army. Perhaps he had in some way confounded it in his memory with a cypress which the Conquistador passed on the march

PARTIALLY OVERGROWN PLATE INSERTED IN BALD CYPRESS
BY VON HUMBOLDT IN 1803.

to Mexico, and which is still traditionally associated with his name."

In 1903, Dr. Hermann von Schrenk, Pathologist to the Garden, visited this famous tree. At this time measurements were made of the trunk and photographs taken, two of which are herewith reproduced. Plate 29, taken from the roof of one of the buildings across the square of the small churchyard, where the cypress stands, gives a good idea of the general shape of the tree. The crown is almost round, and the tree has little resemblance to young cypress trees growing in dry localities or older ones growing in the swamps, but looks more like a large oak. It has an extremely massive, comparatively short trunk, deeply fluted.

A careful examination of the tree (incidentally it might be stated that this was made under the supervision of a guard of soldiers and a large percentage of the population of the village) showed no evidence of decay or disease of any sort, all of the branches appearing healthy and vigorous. The best indication of its good condition was evidenced by the manner in which the famous Humboldt plate had been more or less covered during the hundred years after its placing. Plate 30 shows a photograph of this plate, from which it will readily be seen that the tree had almost fully healed over the wound made by the insertion of the board. The photograph shows only indistinctly the Spanish words which are still evident on the board. Of Humboldt's name, the only parts legible are "der" of the first name, the small "v," and "Hum."

Dr. Gray, in his essay, makes the following remark: "We trust that the next intelligent traveler who visits this most ancient living monument, or any other cypress of remarkable size, will not fail to complete the evidence that is needed, as the full solution of this curious problem may throw light upon some interesting questions respecting the physical history of the world. One or more lateral incisions, not at all endangering the existence of the tree, would at once reveal its actual growth for the last few centuries. And if made at proper points, and carried to a sufficient depth, they might enable the judicious operator to disprove or confirm the surmise, that this huge bole may consist of the trunks of two or three original trees, long since united and blended into one. This conjecture is by no means very improbable, although there is nothing in the external appearance of the trunk to confirm it."

Unfortunately, it proved entirely impossible to carry out the suggestion made by Dr. Gray, because the slightest men-

tion of injury to this famous trunk was regarded with horror by the inhabitants. The external examination does not confirm the description which Humboldt attributes to his friend, Mr. Anza, but confirms the accounts of Mr. Exter and M. Galeotti, that the tree appears to be one solid trunk.

The measurements of the tree were made with difficulty, since it has a considerable swelling, which extends from six to eight feet up from the ground, and furthermore because of the tremendous buttresses, some of which are three to four feet deep. The measurement made by the writer showed a circumference of 126 feet, measured breast high.

The age of this great trunk has naturally been the subject of a great deal of speculation, but due chiefly to the fact that we have so few data as to the rate of growth of these large trees during the past century, no very accurate statement can be made. However, enough is definitely known to indicate that a conservative estimate of the age of this trunk would be considerably over 4,000 years, and probably nearer to 6,000 years. It is hard to realize that this particular tree started its growth at a period antedating any human records.

EVERGREENS

Evergreens have long been recognized as very effective both for decorative and for practical purposes. Their dark green, dense foliage persisting throughout the year, their symmetrical, conical forms with the lower branches remaining intact for a long time, as well as their value as windbreaks, hedges, and backgrounds for groups of deciduous trees and shrubs make them an acquisition to any garden, large or small. In spite of their many advantages, however, the evergreens are seldom used within city limits. This is due to the fact that they will not usually stand the dust and smoke and poisonous gases which are prevalent in the city, and it is away from this unnatural environment, in the deep, moist soil of the country, that the best effects may be realized.

Under the term "evergreens" are included the narrow-leaved, cone-bearing trees and the broad-leaved shrubs to which the azalea and rhododendron belong. Among the latter are to be found some of the most effective of ornamental shrubs. In the spring when they are completely covered with brilliantly colored flowers, they present a striking appearance, while during the rest of the year the dark green foliage is an addition to any landscape. In selecting a location for broad-leaved evergreens shelter from the hot

sun and the drying winds, both during the summer and winter, should be sought. This factor is even of greater importance than the soil, which should be a well-drained, peaty loam with an abundance of moisture and lack of limestone. During the summer water should be applied regularly to keep the roots in healthy condition. A top dressing of cow manure is also beneficial, but cultivation of the ground should not be resorted to, because the roots grow near the surface and injury will result. In the fall the ground should be covered with a mulch of leaves, hay, or other material which will keep the frost out. This mulch may be left on during the summer, especially if the plants are not large enough to shade the ground. After flowering the shriveled flowers should be removed to prevent the formation of seed, this treatment tending to force growth into the foliage and preparing the plants for extensive bloom the following spring.

The conifers are propagated chiefly by seed. The cones of most of them ripen in the fall and should be gathered at that time. They generally open up upon ripening, although in some cases heat must be applied to secure the seed. These are usually sown in May in finely pulverized, rich, sandy soil, and covered to a depth of ⅛–¼ inch in rows 6 inches apart. If a mulch of pine needles or straw is placed in between the rows, the necessity for watering and weeding will be reduced. The seeds do not need much moisture for germination, but as soon as the seedlings appear, they should be watered well and shaded to prevent burning by the sun and drying by the wind. Lath or canvas shades are the most desirable, these being removed upon cloudy days and towards the evening to prevent too close an atmosphere and consequent "damping off." A modification of this method of planting consists of sowing freshly ripe seeds thinly in pots or pans of peat or sphagnum moss, which are placed in a cold-frame over winter. The seedlings will germinate the following spring, when they should be transplanted to the lath houses.

The retinosporas, arbor-vitaes, and spruces are often propagated by mature cuttings in the fall. Cuttings of the entire season's growth, cut to a heel, should be obtained in October or November and placed in sand in a cool greenhouse, gentle bottom heat being given in the spring. As soon as the roots are formed, the plants should be potted singly and grown in a close atmosphere until established. They should then be placed in the cold-frames over winter with some protection, and planted out in the spring. The spruces

are very readily propagated by "veneer" grafting under glass in winter, using white spruce (*Picea canadensis*) for stock.

The broad-leaved evergreens, such as rhododendron, mountain laurel (*Kalmia latifolia*), azalea, holly (*Ilex opaca*), Andromeda, etc., are propagated by seeds, cuttings, grafting, and layering. The seeds should be sown in the spring in pans or boxes of sandy peat, and, if covered at all, finely cut sphagnum moss should be used lightly. As soon as the seedlings appear, they should be pricked off into flats, placed in a cool greenhouse or cold-frame, and gradually hardened off. Holly seeds, as a rule, take a long time to germinate, 2, and sometimes 3, years elapsing between the sowing of the seeds and the appearance of the seedlings. As soon as the seeds are ripe they should be collected and mixed with 2 or 3 times their bulk of sand in flats, and exposed to changes of weather for 12 months. At the end of that time they should be brought into a warm greenhouse to hasten germination. After the seedlings appear they should be left undisturbed for 2 years, when they should be taken up, their roots pruned back, and set out in the nursery. When propagation by cuttings is employed the half-ripe wood is cut to a heel, and the cuttings rooted in a greenhouse during the winter or in a specially prepared hot-bed during the summer. Veneer grafting is performed upon potted plants in late summer or early fall, the grafted plants being kept close, either in a greenhouse or covered with moist sphagnum moss, until callusing takes place. Layering is sometimes practised, but the layers cannot usually be separated until the second year.

Whatever the methods of propagation, it is necessary as soon as possible to plant the evergreens in the nursery row and to keep them cultivated for several years, at which time they are large enough to plant out permanently. Frequent transplanting should be practised in order to secure a compact, fibrous root system. This is best accomplished late in the spring during cloudy weather, in order that the roots may not become dry by exposure to the sun and wind. Fall planting is also practised with satisfactory results after the plants have become dormant in October or November. The trees are dug from the nursery row with a large ball of soil attached to the roots, these being less easily broken or made bare if wrapped in burlap until planting time. When planting, a hole is dug large enough to admit the entire ball of soil. If done in the spring "puddling" is resorted to by filling the hole with water several times, and after it settles putting the tree in place. Little benefit is derived from sur-

face watering after the tree is planted, because the diffusion of water through the soil is very slow and irregular and it frequently never reaches the root system. Ordinarily, with deciduous trees, pruning of the tops is necessary to produce a balance with the roots, which may be cut and bruised in the process of digging. With evergreens, however, very little pruning is practised, but a symmetrical form is produced by shortening the end branches, cutting out all but one leader, and removing any branches that are not needed.

While the cone-bearing trees are becoming established they require an abundance of water, and if this is not available a mulch of some material, like straw or grass, will help keep the moisture at the roots. The mulch must not be more than 2–3 inches deep, however, since, if too heavy, it will cause the roots to grow near the surface where they might be injured during winter or extremely dry weather. The treatment consists further of keeping up a healthy growth by judicious cultivation around the trees and the application of a fertilizer, either in the form of a mulch of manure, which is spaded in in the spring, or a commercial fertilizer, such as bone meal, acid phosphate, etc. After the conifers reach 25 years of age or more they begin to lose their symmetrical form, and the lower branches die out. It is then necessary to cut these limbs off close to the trunk so as to permit perfect callusing of the wounds, this work being best accomplished during the dormant period.

The treatment of coniferous evergreens, when used for hedges, requires special attention. A trench 2 feet deep and 3 feet wide should be dug the full length of the line where the hedge is to be, and the bottom filled with loose soil and puddled. The plants should be spaced 3–4 feet apart, and the soil made firm around the roots and overlaid with a mulch of sawdust or coal ashes. The trees or shrubs must be cut back about one-third, so as to make all the plants the same size and induce branching from the base, which is so essential in a good hedge. With proper pruning a compact hedge may be secured at the end of 4 years, and much of the subsequent success depends upon the shaping induced during the first few years. Pruning should be done once a year before the new growth appears. If done during the fall or winter, the cutting away of the growth which serves as a protection for the buds will probably result in injury and killing back of branches. When trimming, the cutting should be close to the wood of the previous year, leaving a small portion for the production of new growth. This portion need not be very long, for the longer it is the greater will be the resulting growth and the harder will it be to

keep the hedge within bounds. Evergreen hedges must not be handled roughly while frozen, since the branches are brittle and easily break off, leaving dead places in the hedge.

DESIRABLE EVERGREENS

Botanical name	Common name	Height in feet	Use
Abies balsamea	Balsam fir	50	Specimen
A. concolor	White fir	45	Specimen
A. Nordmanniana	Nordman's fir	40	Specimen
Andromeda floribunda	Andromeda	2	Group
Azalea nudiflora	Swamp pink	6–8	Group
A. mollis	Japanese azalea	6	Group
Chamaecyparis obtusa	Obtuse-leaved cypress	10–15	Specimen
C. pisifera	Thread-branched cypress	10–15	Specimen
Ilex opaca	Holly	15	Specimen
Juniperus communis	Juniper	3–4	Cover for banks
J. communis var. *hibernica*	Irish juniper	8–10	Specimen
J. Sabina	Savin juniper	3–4	Cover for banks
J. virginiana	Red cedar	20–30	Hedge, windbreak, specimen
Kalmia latifolia	Mountain laurel	5–10	Group or specimen
Picea canadensis	White spruce	50–75	Hedge, windbreak, specimen
P. excelsa	Norway spruce	50–75	Hedge, specimen
P. pungens	Colorado blue spruce	60–70	Specimen
Pinus Laricio var. *austriaca*	Austrian pine	40–50	Specimen
P. montana var. *Mughus*	Swiss mountain pine	8	Specimen
P. resinosa	Red pine	50–60	Specimen
P. Strobus	White pine	50–75	Specimen
P. sylvestris	Scotch pine	40–50	Specimen
Pseudotsuga mucronata	Douglas fir	40–50	Specimen
Rhododendron catawbiense		6–8	Group or specimen
R. maximum	Great laurel	8–10	Group or specimen
Taxus baccata	English yew	10–15	Specimen
T. canadensis	American yew	3–4	Group
T. cuspidata	Japanese yew	3–4	Group
Thuya orientalis	Oriental biota	4–5	Specimen
T. occidentalis (many varieties)	Arbor-vitae	15–20	Hedge, windbreak, specimen
Tsuga canadensis	Hemlock	60–70	Hedge, windbreak, specimen

NOTES

Mr. John Noyes, Landscape Designer to the Garden, spoke before the St. Louis Garden Club, December 12, on "Distinctiveness in the Garden."

Dr. Hermann von Schrenk, Pathologist to the Garden, gave an address before the Purchasing Agents' Association of St. Louis, December 19, on "Timber Specifications and How to Use Them."

Mr. Alexander Lurie, Horticulturist to the Garden, attended the meetings of the Missouri State Horticultural Society at Kansas City, December 5–7, and gave a talk on "Tree Surgery."

On December 15, Mr. W. W. Ohlweiler, General Manager to the Garden, lectured before the faculty and students of the St. Louis College of Pharmacy on "What the Missouri Botanical Garden Offers to the Student of Pharmacy."

The St. Louis chapter of the Association of Collegiate Alumnae met in the graduate lecture room on the evening of December 14. An interesting program consisting of moving pictures of horticultural and agricultural subjects was provided.

The annual Gardeners' Banquet, provided for in Mr. Shaw's will, was held December 1 at the University Club. Professor E. A. White, professor of floriculture, Cornell University, gave an address on "What Science Has Done for Floriculture."

Recent visitors to the Garden include Professor George Lefevre, professor of zoölogy, University of Missouri, and Professor A. S. Hitchcock, systematic agrostologist, Bureau of Plant Industry, U. S. Department of Agriculture, on November 24; Mr. L. C. Le Van, formerly teacher in the St. Louis public schools and now instructor at McKendree College, November 25; and Mr. Louis Agassiz Fuertes, bird painter and lecturer, December 5.

On December 15, the annual meeting of the State Audubon Society was held in the graduate lecture room. The principal speaker was Dr. R. J. Terry, who discussed "Birds in Relation to Human Life." An interesting exhibit of bird books was displayed, also bird houses and other means for the attraction and propagation of birds. The society decided to make an active educational campaign to promote interest in the protection of wild birds throughout the state.

STATISTICAL INFORMATION FOR NOVEMBER, 1916

GARDEN ATTENDANCE:

Total number of visitors 54,494

PLANT ACCESSIONS:

Total number of plants received in exchange 10
Plants and seeds donated 37

PLANT DISTRIBUTION:

Total number of plants distributed 249

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought 82
Total number of books and pamphlets donated 426

HERBARIUM ACCESSIONS:

By Purchase —

A. A. Heller—Plants of California 400
H. Sudre—Plants of Europe—"Batotheca Europea," Fasc. XIV., Nos. 651–700; "Herbarium Hieraciorum," Fasc. VI, Nos. 251–300 100

By Exchange —

C. W. Dodge—Ferns of Vermont 97
C. W. Dodge—*Polyporus Ellisianus* from Vermont 1
C. W. Dodge—*Merulius sulcatus* Pk. from Missouri 1
E. L. Johnston—Plants of Colorado 150
New York Botanical Garden—Plants of the West Indies and Florida 334

By Gift —

W. H. Aiken—*Polypremum procumbens* L. from Texas 1
W. H. Ballou—*Peniophora Allescheri* from New York 1
T. S. Brandegee—*Croton sp.* from Mexico 1
L. M. Dougan—Plants of Vermont, New York, and New Jersey 18
J. A. Drushel—Plants of Illinois, Kansas, Missouri, Colorado, and California 6
O. A. Farwell—*Camassia esculenta* (Ker) Rob. from Michigan 2
Miss Alice Flickinger—Cultivated specimen of *Callicarpa purpurea* Juss. from Webster Park, Missouri 1
Chas. Goessl—Specimen of *Othonna crassifolia* Harv., cultivated at Sheboygan, Wisconsin 1
Miss Caroline Haynes—American Hepaticae, chiefly from New York 53
H. D. House—Fungi of New York 67
O. S. Ledman—*Acalypha sp.* from India 1
W. A. Murrill—Fungi from New Mexico 5
W. A. Murrill—*Stereum elegantissimum* Speg. from Chile .. 1
W. A. Murrill—*Corticium polyporoideum* B. & C. from Virginia 1
C. V. Piper—*Exobasidium Vaccinii* on fruits of *Vaccinium membranaceum* from Idaho 1
J. B. Rorer — *Septobasidium pseudopedicellatum* Burt on orange trees in Tobago 1
Forest Shreve—Compositae from Arizona 29
J. R. Wier—Fungi of Oregon 27
E. Mead Wilcox—*Rhamnus lanceolata* Pursh from Kansas .. 1

TOTAL 1,301

The Garden is open to the public every day in the year, except New Year's, Fourth of July, Labor Day, and Christmas—week days from 8:00 A. M. until one-half hour after sunset; Sundays from December to April, 1:00 P. M. until sunset, from April to December, 2:00 P. M. until sunset.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Boulevard, on the Vandeventer Avenue car line. Transfer south from all intersecting lines.

Index to Illustrations

General Index

Figures in italics refer to page numbers of plates and cuts

C.

D.

E.

F.

G.

H.

I.

J.

K.

L.

M.

N.

S.

T.

U.

V.

STAFF
OF THE MISSOURI BOTANICAL GARDEN

Director.

GEORGE T. MOORE.

BENJAMIN MINGE DUGGAR,
Physiologist, in charge of Graduate Laboratory.

EDWARD A. BURT,
Mycologist and Librarian.

HERMANN VON SCHRENK,
Pathologist,

J. C. TH. UPHOF,
Assistant Botanist.

JESSE M. GREENMAN,
Curator of the Herbarium.

GEORGE W. FREIBERG,
Research Assistant.

KATHERINE H. LEIGH,
Secretary to the Director.

JAMES GURNEY,
Head Gardener, *Emeritus.*

WILLIAM W. OHLWEILER,
General Manager.

JOHN NOYES,
Landscape Designer.

ALEXANDER LURIE,
Horticulturist.

J. ERDMAN,
Outdoor Gardens.

W. F. LANGAN,
Engineer.

C. R. FOLLEN,
Construction.

G. H. PRING,
Conservatories.

P. FOERSTER,
Farm and Stables.

M. SCHILLER,
Floral Displays.