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MISSOURI BOTANICAL GARDEN BULLETIN

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Cover: The Trail House at the Arboretum from the glades path.

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Please: Do not discard a copy of the Bulletin. If you have no further use for yours pass it along to a friend or return it to the Garden. Return postage will be guaranteed.

SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date until his death in 1889 it was maintained under his personal direction. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was chosen by Mr. Shaw and he definitely indicated that he wished it called by that name. The Garden passed at his death into the hands of a Board of Trustees, designated in Mr. Shaw's will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provision of the will the immediate direction of the Garden is vested in a Director, appointed by the Board. The Garden receives no support from city or state but is maintained almost exclusively from the estate left by Henry Shaw. Since 1939 many Garden Clubs and interested individuals have contributed to a "Friends of the Garden Fund" which is used in developing the new Arboretum, located at Gray Summit, Mo. The Arboretum (1) serves as a source of plants, trees and shrubs for the city Garden; (2) affords areas for gradually establishing a pinetum, a wild-flower reservation and various other features on a scale not possible in the city; (3) provides greenhouses for some 20,000 orchid plants.

The city Garden comprises 75 acres, where about 12,000 species of plants are grown, both out of doors and under glass. It is open every day in the year except New Year's Day and Christmas; week days, 8:00 a. m. until sunset; Sundays, 10:00 a. m. until sunset. The greenhouses are closed every day at 5:00 p. m.

The main entrance to the Garden is at Tower Grove and Flora Place, on the Sarah car line (No. 42). The Tower Grove bus (No. 21), direct from downtown, passes within three blocks of the main entrance.

THE POINSETTIA SHOW FOR DECEMBER, 1945

Missouri Botanical Garden Bulletin

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FIFTY-SEVENTH ANNUAL REPORT OF THE DIRECTOR

To the Board of Trustees:

The Director of the Garden has the honor to submit his report for the year ending December 31, 1945.

With the end of nearly four years of the most intense physical and intellectual activity that mankind has ever experienced we look forward to the future with two main objectives in view—a measure of relaxation from the strain of the immediate past, and an expansion to new peace-time needs, the result of the tremendous technical advances of the war years.

Educational and recreational institutions are certainly destined to play a leading role in any improvement in the general welfare, and we may rest assured that any real progress will be measured in very nearly direct proportion to the support that is accorded these institutions.

It is with special thought to the part that the Missouri Botanical Garden may play in the future development of horticultural and botanical science that the following pages are directed. It has been customary to devote the January issue of the Bulletin to a report of the work of the preceding year. The current report is intended, moreover, to present a general resumé of the Garden's undertakings of the past few decades and to point out the financial needs incident to the continual and successful execution of current programs as well as prospective future expansion.

No institution can long remain immobile. There must be either progress or retrogression. If the former, it is evident that continued financial support must be a prerequisite. But from the time Mr. Shaw established his Garden and opened it to the public no other individual has contributed other than the most modest sums. In spite of this the entire scope of the Garden's many activities has continually developed during the past half century. This has been possible to a very appreciable extent only through the sale of large unimproved tracts of the original Shaw estate, a source of income no longer existing.

This report is plainly an appeal for funds, but a few points may be clearly stated before presenting a detailed account of the Garden's functions and needs. Contrary to two commonly encountered conflicting public opinions, the Garden is neither in severe financial straits, nor is it overburdened with wealth. The value of Mr. Shaw's estate has increased many fold since the time of his decease. This is, of course, due in part to continued increase in the valuation of the St. Louis real estate from which a large part of the Garden income is derived. It is in no less degree due to most careful business management by the Board of Trustees through the decades that have elapsed since 1889. Every dollar of income has been effectively spent. This is a matter of record, and not merely institutional pride offered for the purposes of solicitation. A fuller account of the Garden's financial status will be found on pages 10–11.

This record of efficient management is noted for what measure of confidence it may carry to those who are willing to offer financial aid in the future.

It is evident that any strictly privately endowed and operated institution such as the Garden must sooner or later expect supplementary support over its original endowment if continued progress is to be expected. The Missouri Botanical Garden has reached this stage of its development. If we are to maintain a rate of growth comparable with that of other leading botanical and horticultural institutions of this country additional support must be forthcoming.

It is not the intention to launch one mighty campaign toward a financial goal to be made up largely from a very few wealthy individuals. Six years ago the "Friends of the Garden" group was initiated as a means of increasing the annual revenue through the contributions of many individuals. It is felt that the plan is a sound one in that it intends to maintain continued interest on the part of many contributors regardless of the amount of their annual donation. Four or five thousand dollars a year are at present donated in this way. "Shaw's Garden" probably enjoys one of the most unique positions of any organization of the sort in the country in that it is entirely private, receiving no support whatsoever from any governmental source. *In fact the taxes paid to St. Louis in normal years amount to about one quarter of the annual income.* Yet so free of access are its facilities to the public that it is, in the minds of most St. Louisans, one of their own institutions. We are, of course, pleased with such an attitude, and it would seem that many of these thousands of admirers, knowing more of the various activities of the Garden, might be willing to afford some modest annual support.

In spite of a considerable amount of facts that have been published from time to time, the functions of the Garden and its diverse undertakings are by no means precisely known, especially to the people of St. Louis. We have tried to present in the following pages a rather detailed account of some of the Garden activities and the purposes for which requested financial aid will be used

HISTORICAL SKETCH—THE EARLY DAYS

A number of historical sketches of Mr. Shaw and his Garden have appeared at various times in diverse publications. The information that is given below is intended primarily to answer questions that are most frequently asked concerning the origin of the Garden and to supplement the following chapters.

Henry Shaw first arrived in St. Louis in the spring of 1819, a young man in a young city. As a focal point and directing force of the tremendous westward expansion that soon followed, the city of St. Louis grew and prospered accordingly. It was an ideal time and place for a man of vigorous enterprise, and Henry Shaw was quick to avail himself of the opportunity. Starting with a small stock of cutlery that he had brought with him from his home in Sheffield, England, he rapidly expanded his business into a general merchandising concern. So successful was Mr. Shaw that at the age of forty-nine (1849) he retired from his business activities with an estate valued at approximately a quarter of a million dollars.

Following his retirement Mr. Shaw spent a considerable part of the next few years in European travel, and the high regard that he acquired for certain of the great English and continental gardens apparently crystallized in his mind an intention of devoting the remainder of his life and the bulk of his wealth to the creation of a comparable garden-estate in his adopted American city.

While retaining his city residence on Seventh and Locust Streets, Mr. Shaw had completed in 1849 a country home which he called Tower Grove. This was surrounded by 125 acres of prairie and woodland which, with the exception of 50 acres that was sold in 1925, composes the Botanical Garden as it exists today.

Through the friendly council and advice of Dr. George Engelmann of St. Louis, and Professor Asa Gray of Harvard University, two of America's leading botanists of the day, Tower Grove evolved into a botanical institution rather than simply a country estate. This was a decision of the utmost importance for if his plan had progressed as Mr. Shaw at first intended we should have had fine plantings and attractive gardens, but little else. As a botanical garden, attention was given to a much more varied, comprehensive and progressive program, many phases of which are not as strikingly apparent as a rose garden or a water-lily pool, but nevertheless of greater importance to botanical and horticultural advancement. The more important of these diverse activities or phases of the Garden's development are considered in detail in the following pages under separate headings.

About 1860, when a sufficient portion of the original Tower Grove tract had been landscaped and planted, "Shaw's Garden" was opened to the public. Mr. Shaw remained as the very active and guiding force of the Garden until his death in 1889. At that time the Garden passed into the hands of a self-perpetuating Board of Trustees, the original members of which were designated in Mr. Shaw's will. The Board in turn appoints a Director in whom is vested the immediate direction of Garden activities.

Specific Garden Needs of the Future.—

For the past few years the income derived from the Friends of the Garden Fund has been set aside for future development of the Arboretum tract at Gray Summit. The advances that have been made in landscaping this area, and in rendering accessible, by trail and road, the more interesting natural features are already such that present contributors should be thoroughly satisfied with the use to which the funds are being put.

Library.—

In establishing his garden as both a show place and an institution for botanical and horticultural research Mr. Shaw clearly understood the basic necessity of a fine library, and it was initiated early in the development of the Garden.

The library is not a public circulating library although it is consulted each year by many local, national, and foreign scholars and gardeners. The books and the services of the librarians are available to any one with a specific problem or need, and the library serves as a foundation upon which all of the botanical and horticultural research work of the staff members is based.

From a few hundred books in Mr. Shaw's time the library has grown to one of more than 56,000 volumes and 93,000 pamphlets on botanical and related scientific subjects. Botanical literature grows with accelerating speed with each year, and to acquire even a selected portion of the best and most necessary items a continually increasing expenditure is necessary. Although the Garden already owns an almost priceless collection of the older botanical works there remain many volumes, sets, and parts of sets to be acquired, and the present periodical subscriptions should also be expanded.

The Garden is now expending approximately $800.00 per year on books and about half that much for binding. This does not include periodicals that are obtained in exchange for our publications. In order to maintain our standing as a first-class library this figure should be at least doubled. The present over-all cost of maintaining the library amounts to approximately $12,000, including staff salaries and the publication of the quarterly ANNALS and the monthly BULLETIN. A few words of explanation may be added concerning these two publications. The ANNALS, a quarterly scientific journal now entering its thirty-third year, is devoted to the more technical botanical research work of the staff and advanced students. It has a wide circulation throughout the world and has probably contributed more to the Garden's international reputation than any other single activity. The BULLETIN is a popular magazine issued monthly, except July and August, and is devoted primarily to the horticulture of the St. Louis region.

St. Louis is a city that is not poor in library facilities by any means, with two universities, a large public library, the Mercantile Library, and others. Ours, however, is a library devoted almost exclusively to the plant sciences and related subjects. Moreover, it has the advantage over most botanical libraries, in that all the books are concentrated under one roof rather than in several departments or buildings. A glance at the list of out-of-town visitors on pages 34–35 shows how much this facility of the Garden is appreciated by research workers. The library is not to be duplicated in the Middle West, but additional support is necessary if it is to be maintained at its present high standards.

As scon as building materials are available a new wing will be erected to the present administration building to allow additional space for the already extremely crowded library and herbarium.

Botanical and Horticultural Expeditions.—

The Garden has always taken considerable pride in the fact that its staff members are not "arm-chair scientists." A number of modest expeditions have been sent to the American tropics during the past twenty years. These have contributed very materially toward our magnificent orchid collection and the comprehensive "Flora of Panama" which is now being published.

The importance of tropical research, especially in Central and South America, can hardly be over-emphasized, and any large American botanical institution that hopes to be progressive and productive cannot afford to neglect this field.

A certain amount of plant material from various parts of this country, as well as foreign regions, can of course be obtained most economically from professional collectors and dealers. However, in order to obtain the highest quality in specimens, and especially to prosecute original investigations, our own staff members must be sent out into the field.

When the Missouri Botanical Garden acquired the "Orchid Garden" of the late C. W. Powell of Balboa, Canal Zone, in 1926, the chief motives were to perpetuate that fine collection and eventually to add it to the already-famous collection at St. Louis. At that time, also, the Garden was engaged in collecting orchids of horticultural promise from the tropics of both hemispheres, and the Missouri Botanical Garden Tropical Station became the focal point of such collections en route to their new home in the United States. Almost at once, the Tropical Station attained a position in Panama similar to that of the Missouri Botanical Garden proper in St. Louis. Its interest and accessibility made it frequented by residents of the Canal Zone and Panama, as well as by tourists. The prestige and value of "Mr. Shaw's Garden" was maintained and increased by its southern reflection.

Beginning about the year 1935, the usefulness of the Tropical Station was expanded greatly by the application of its facilities for purely scientific, as well as for horticultural research. In that year the Garden sent to Panama an expedition consisting of Dr. C. W. Dodge, Dr. J. A. Steyermark, and Mr. Paul Allen to make botanical collections, using the Tropical Station as a base. The results of this expedition added so greatly to our knowledge of tropical American plants that the following year, and for several years thereafter, collecting parties from the St. Louis Garden continued to explore the interesting country within easy reach of the Canal Zone.

The Garden's great opportunity to contribute to tropical botanical science became fully realized in 1943, when it commenced publication of the monumental "Flora of Panama," now in its third volume. The "Flora" is designed not only as a comprehensive treatment of the plants of Panama, numbering perhaps 10,000 species, but also of their relationships to the vegetation of the American continent as a whole. One might dwell at length upon the theoretical and practical values of a work of this kind, but perhaps sufficient evidence is seen in the range of subscribers to the "Flora," from amateur naturalists to industrial concerns and the State Department at Washington.

In 1940 the Tropical Station was abandoned by the Missouri Botanical Garden in the face of financial strain and the prospect of war, and its grounds were returned to the government of the Canal Zone. Doing without the Tropical Station, however, has emphasized to us its great value, and the Garden is planning to resume its activities in Panama in 1946, although necessarily on a reduced scale. Until sufficient funds are available, Panama and the Canal Zone will not have their miniature "Shaw's Garden," but at least we shall have the services of Mr. Paul H. Allen, our manager of former years. With Mr. Allen as its tropical representative and collector, the Missouri Garden will continue to benefit from his talents and knowledge in accumulating plant specimens for the continuance of "Flora of Panama" and for exchanges with other botanical museums throughout the world. Mr. Allen also will serve the Garden by sending it living plants and seeds of tropical plants of horticultural promise. These activities represent two essential phases of any vigorous and competent botanical institution. Last, but by no means least, the Missouri Botanical Garden and the Henry Shaw School of Botany will again possess a base from which advanced students of botany can become introduced to the fascination and opportunities of tropical plant resources.

In addition to the tropical collecting trips, the Garden has from time to time sponsored numerous local ones. The plant groups in the Desert House have been very materially changed and increased as a result of recent collections of succulents made by Mr. Ladislaus Cutak in Florida and Mexico.

Since 1942 the branch of botany dealing with fossil plants has been a recognized phase of Garden research work. Dealing as it does with plants that lived thousands or millions of years ago, it enables us to look back to the floral vistas of by-gone ages and to understand more clearly how the plant kingdom came to be as we find it to-day.

Certain of the coal mines in Illinois and Iowa have yielded an abundance of well-preserved fossil remains, the study of which has contributed appreciably toward our knowledge of the Carboniferous forests that were responsible for the great coal deposits of the present time. Rather extensive collecting has also been carried out in the Cretaceous (Chalk Age) rock formations of Wyoming and Idaho, a phase of the work that has added an interesting chapter to our knowledge of the past history of the ferns.

Flower Shows.—

To the residents of St. Louis and the immediate vicinity probably the central attraction of the Garden is the Floral Display House. All the shows of course vary somewhat from year to year as to both quality and quantity. Plants are living things, and not always completely controllable by man. Although we may occasionally offer the weather as an excuse when displays, inside or out, do not fully meet expectations, in general the compliments we receive greatly outweigh adverse criticisms. During the war years the labor problems encountered by institutions such as this were probably more serious than with any other type of organization. Since it was quite out of the question to meet wage scales of war industries, all the garden units could not possibly be maintained at all times. Those gardens in season were given preference while at the height of their flowering period, and the others occasionally became weedy. While garden labor will soon undoubtedly become more readily available, it is certain that the wage rate will also increase.

An Azalea planting on the Knolls

As for the outdoor displays, the casual visitor to the Garden, when the iris or azaleas are at their height or when the Linnean Garden is a rainbow of spring flowers, might perhaps wonder at a plea for funds to improve them. Such displays could be kept, gradually dwindling through the years, for a long time. However, any garden, regardless of how large or small, remains a great garden only through constant care, by the continual replacement of old plants with new, and by the addition of new varieties. The expense in materials, as well as labor, is no small item, but materials and labor would be of little value without the creative genius of the best horticulturists available.

Last September a new member was added to the horticultural staff, Dr. Gustav Mehlquist, formerly of the University of California. Dr. Mehlquist is continuing his work with the breeding of delphiniums and carnations. This represents a new phase of experimental horticulture at the Garden and one that might be expanded almost without end provided sufficient funds are available.

Non-professional gardeners are often prone to take for granted the new plant creations that are offered in the seed and nursery catalogues each year.

Behind every new variety that appears on the market there is usually a long story of costly experimenting. Much of this work has been carried on by the great eastern and Pacific-coast institutions, and consequently the products of their labor are especially designed for their climates. It is not to the credit of the Midwest that experimental horticulture has lagged so in this region. There is much to be done, and the fine gardens that we do have are only suggestive of what might be.

Scores of lectures are given each year by the staff members, chiefly on horticultural subjects. This is recognized as a most important function of an institution such as ours, and these lectures are supplied gratis to a wide variety of local organizations. It does, however, absorb a considerable portion of the time of the horticultural staff whose hours for constructive gardening, writing, etc., are correspondingly limited. If it were possible to increase the present staff to the extent of two or three additional members the Garden's general horticultural productiveness would be greatly enhanced.

The Herbarium.—

Much of the botanical research work that has been carried on at the Garden during the past sixty years has dealt with the classification of plants. The basis of this line of study lies in the herbarium, the collection of pressed, mounted plants. This collection has now grown to about one and one half million specimens, and while it includes plants from all of the major regions of the world there are many gaps, both as to geographical regions and particular groups of plants, that remain to be filled.

The herbarium is consulted not only by resident botanists and students, but by numerous visitors to the Garden. Considerable numbers of specimens are also loaned to specialists in other institutions. Aside from its use as a research organ, the herbarium is a source of authentically named plants that is constantly referred to in identifying plants sent to the Garden. A large number of such specimens are received and named each year for which no charge is made.

A collection of this size necessarily entails a great deal of curatorial attention to keep it in good, accessible order and to provide for continual growth. For the past few years the bulk of this work has been accomplished by a single curator and an assistant—an impossible task for such a small personnel. It is hoped that this herbarium staff may be increased to at least four members who will be aided part time by advanced students. Funds are also very urgently needed for the purchase of specimens and for sending our own men into the field for the purpose of collecting.

Arboretum Developments.—

The Arboretum was made possible through the subdivision and sale of old pasture land west of the City Garden. The money thus obtained from the sale of building lots was devoted to the purchase of some 1600 acres of land near Gray Summit, Missouri, the erection of greenhouses and heating plant, grading, constructing a large lake which serves as a supplementary water supply, and to various fundamental landscaping operations. The expenses for the greenhouses, heating plant, and all outside work was met from this fund, since at no time has the acquisition of this new development been a charge against the amount available for the maintenance of the City Garden. As might be anticipated, the original fund was exhausted in the course of years, and other means for carrying on the work had to be found. Fortunately, the rapid expansion of the orchid department furnished the answer. Years ago, when local florists failed to receive shipments of orchid flowers, they would request the Garden to furnish them any surplus orchids to meet a specific need. This we were not in a position to do. Gradually, however, when the demand increased, the florists' organizations met and formally voted that the Garden be asked as an accommodation to sell orchids to the trade. Foreseeing that this might be the answer to the maintenance of the Arboretum, the Board of Trustees authorized the Director to sell such orchid flowers as might not be used for display. No plants at any time have been sold. The Director was also authorized to sell certain new varieties of water plants which had been developed at the Garden and could not be obtained elsewhere. While the water-lily business amounts to only a few hundred dollars a year, the demand for orchids has increased far beyond the ability of the Garden to supply the local demand. Selling such flowers as are available, particularly at holidays and other special days, has increased to such an extent that it is now possible to devote considerable amounts to research work that has been acknowledged by both amateur and commercial orchid growers as fundamental. With the increase of the orchid collection by vegetative propagation and by the thousands of new seedlings, the time may come when the fund derived from the sale of orchid flowers may maintain the Arboretum as it is now developed, as well as support the entire orchid department.

Finances.—

During the past ten years, the annual gross income of the Board of Trustees of the Missouri Botanical Garden has fluctuated from as little as \$212,925.00 to as much as \$229,410.00. Of the gross income, the expenses of the Estate annually absorbs a sum varying from \$51,000.00 to \$67,000.00 to pay real-estate taxes, insurance, legal services, repairs and maintenance of investment properties, bequests and office expense, which leaves at times as little as \$155,000.00 for appropriation by the Trustees for Garden expenses.

Unfortunately, the expenses of the Estate do not decline in proportion to gross income, and the Missouri Botanical Garden must absorb the full loss of income in periods of depression. There can only be appropriations for expenditures at the Garden from the net income remaining after Estate expenses are paid. This amount cannot be supplemented with appropriations from the Endowment Fund. A decline in the gross income results in the immediate curtailment of current activities at the Missouri Botanical Garden and interferes seriously with any long-range program of expansion. Another factor that frequently disrupts long-term financial planning is the heavy and often unexpected drain on Garden income caused by the age and obsolescence of the buildings and equipment in the Garden. As an illustration, it is estimated that the replacement of the heating plant alone will cost approximately $200,000.00, and since its average age is thirty years it requires an abnormal proportion of Garden income for safe and efficient maintenance.

Substantial improvements and renovation of existing buildings and greenhouses should more properly be financed from income of new endowments so that the principal purposes and scientific research of the Missouri Botanical Garden be not impaired through lack of income.

As mentioned heretofore in this report the gradual liquidation through the years of unimproved real estate has added substantially to the Endowment Fund and supplied additional income to permit a reasonable expansion of the Garden's physical plant and services to the public. The liquidation of unimproved real estate having ended several years ago, it appears certain that the gross income of the Board of Trustees of the Missouri Botanical Garden will remain fairly constant, subject, of course, to the fluctuating state of the national economy. We know from experience that even with careful management the income from trust estates is greatly reduced during periods of depression. To-day while Garden income is at a much more satisfactory level, its purchasing power is much less due to higher prices and the necessity of increasing wages.

It is hoped that by increasing the public's knowledge of the activities and the expansion program of the Missouri Botanical Garden and by explaining the need of additions to its Endowment Fund—as well as annual contributions—the result will be a generous response from friends of the Missouri Botanical Garden.

ARBORETUM

While the weather was quite dry during the early part of the year, when the rains did begin in early spring they continued and furnished just the right conditions for tree growth. A short hot spell in summer was broken by the finest fall that we have had in many years, and trees entered the winter with sufficient moisture. At the present time there is enough water in the soil to carry the conifers through without winter irrigation. This was the first year that pumping water into the greenhouse was done only twice, a total of 280,000 gallons having been taken from the Pinetum Lake in January and August for this purpose. In many years it is necessary to pump from four to eight times.

In 1941 a small area was set aside and prepared as a test and display garden for Boxwood. At that time many of the difficulties encountered in growing this plant were unsolved, and it was assumed that a small garden containing a limited number of species and varieties would be ample. But each year, as more and more kinds have been acquired and a larger number have appeared hardy, more room and a proper setting are needed to display the ones holding some promise of being suitable for this region. During the summer, work was begun on a serpentine brick wall, patterned after that built at the University of Virginia by Thomas Jefferson. Our wall is 649 feet long and almost encloses two sides of a three-acre garden; it is 5½ feet high and rests on a reenforced concrete footing. Within the enclosed garden 586 of the larger Boxwood have been planted; several hundred more of the smaller kinds, suitable for hedges, will be planted in the spring. Considerable effort was devoted to preparing the soil before planting. Thirteen tons of sand and 43 tons of manure were plowed under and thoroughly "rototilled," and 4000 gallons of sludge were applied to the surface. As manure becomes available, another 40 tons of it will be used as a mulch around the plants during the winter.

The highest flood in thirty years crested at the Arboretum on June 11, with the Meramec River virtually filling the entire valley from bluff to bluff. The ferry cable was torn from its anchorage by an immense sycamore carried by the flood. Fortunately the mooring lines fouled, and the ferry lodged in some trees where it was made fast. More damage to the banks and the standing timber along the banks followed this flood. At the ferry crossing the river was widened from 101 yards to 121 yards, making it necessary to rebuild the approach on three occasions. A logging operation has been started with a view toward salvaging those trees lodged along the banks and those in danger from the next high water. This is somewhat difficult and more costly than simply felling trees for a saw-mill, but we have need for the timber and the river banks should be protected. It appears that a thick stand of small trees is much more effective in preventing under-cutting than is a stand of mature timber.

Only 7,170 board feet of lumber were sawed at the mill this year, and 14 cords of firewood were sawed for local use. The firewood was sawed from mill slabs and small trees removed in the annual clearing of overgrown and abandoned fields. The clearing of the brush alone required 1,329 man hours. Much more of this work remains to be done, but we can see an increased amount of blue grass in the areas which had been cleared in previous years.

Actual farming operations required 601 hours of tractor operation. In addition, 32 hours were used to combine blue grass, and 42 hours for harvesting rye and soybeans. The flood in June destroyed 75 per cent of the young corn, but when these fields were dry enough to work they were replanted with soybeans. Balboa Rye, Lincoln and Boone Soybeans and hybrid corn were the principal crops, although an additional 40 acres were planted to field, pop, sweet, and flour corns; all of these were experimental varieties grown for study.

The pure-bred herd of Aberdeen-Angus produced a 67 per cent calf crop, some of which will be marketed during the next two months. Fortunately, ample food is available from the corn crop of 1944, which was held over for just such an emergency. The corn crop this year will be about 300 bushels as compared with over 5,000 bushels in 1944. However, this has been an excellent hay and pasture year—an important consideration in a year of flooded crop lands. The value of cattle on blue-grass sod was demonstrated when a small herd of young animals was moved to the Arboretum in May. They were placed in an area enclosed by an electric fence and received no feed other than that available in the enclosure until December. In those six months they eradicated virtually all the weeds which had gotten so far ahead of the blue grass that the field was considered worthless as a source of grass seed. At the present time the whole area is closely grazed, practically all weeds eliminated, and only white clover and grass remain. Since Narcissi have been naturalized in past years they should furnish a superior show this spring; at least they will not have to compete with grass during their flowering period.

Due to the cool wet spring the Crabapple collection did not flower well last year. The trees started to bud during the warmer days of March, but were cut short with the cool rainy spell in April. Later the Azaleas produced a beautiful show, and the Narcissi remained in flower longer than usual and furnished the best display in many years. The increased effectiveness of the white Narcissi was due in part to the shorter grass, which often is as tall as the flower spikes in normal years, and to the greater number of flowers which seems to result from carefully timed mowing. On the whole, the wild flower display was adversely affected by the spring, and even the Dogwoods were satisfactory only in certain locations. The Redbuds, however, gave a long and very colorful show in spite of the weather. The Box-woods grown in the nursery flowered very well, so well in fact that several quarts of seeds were collected. It seems that the late cold and wet spring delayed the flowering of the early types and hastened the later kinds, with the result that almost all were in bloom at one time. During the same period the bees had an opportunity to fly, and pollination was complete and seemingly successful. The seeds obtained should yield a vast array of hybrids and if grown on might produce hardier and unusual kinds. The nursery inventory shows about 20,000 plants, which means that the seed-frames and the nursery are both full.

During the year the trucks operated 935 hours and carried 861 loads, exclusive of the many trips transporting men, material, and tools, which are not classed as loads. The trucks operated 8,285 miles during the year and have reached a point where maintenance is a problem. They must be replaced before many months. Using cattle in some areas to help control weeds and grass held the amount of tractor mowing to 587 hours. About 400 hours were thereby gained, since some areas were not mowed at all and others clipped just once, and permitted a summer and fall mowing of the Pinetum.

The management of the Arboretum is under the direction of Mr. A. P. Beilmann.

Sunshine Record.—

COMPARATIVE HOURS OF CITY AND COUNTRY SUNSHINE

Month	*City Garden* *Hours*	*Arboretum* *Hours*
January	97.30	104
February	84	98.30
March	172.30	183
April	138.30	169
May	171	177.30
June	149.30	166.30
July	236	298
August	189	296.30
September	155	180.30
October	211	234
November	124	153
December	91.15	107
	1919.15	2167.30
		1919.15
Excess of sunshine hours at Arboretum		248.15

GARDENS

Thirty years ago many trees and shrubs were planted in the vicinity of the newly-built conservatories. Some of these have reached maturity and have had to be pruned or removed because of their crowded condition. The

The Iris Garden in May

vacant spaces were planted with *Magnolia Soulangeana*, Forsythia and hybrid Mollis Azaleas. This rehabilitation work was done in March and again in October and November.

For many years a demonstrational plot was maintained near the Palm House to emphasize the difference in appearance between a neat and a neglected garden. In 1942 these "Before" and "After" gardens were combined into a sample Victory Garden, in which were grown the best vegetables for a small plot of ground. As these projects had served their purpose, this garden was abandoned. The fence was removed in February and the area seeded with blue grass. A border of shrubs was also planted along the walk leading to the Rose Garden.

All the beds in the center and west end of the Linnean Garden were fertilized and replanted during the summer and fall. Out-moded varieties of iris were replaced with later varieties from the Iris Garden. Twenty-eight junipers of various kinds were planted around the pools of the Linnean Garden, the plants being brought from the evergreen nursery established in 1942. Darwin and cottage tulips were placed between these evergreens and in other parts of the garden, and 400 hyacinths were planted along the center walk in the west end of the garden.

The Main, Italian, Rose and Iris Gardens were maintained as in previous years. The beds in the Economic Garden were not planted with the usual farm and fiber crops, but were used for experimental plantings of corn.

Maintenance is the greatest time-consuming job in the gardens, spading, weeding, staking, labeling, watering and spraying being just a few of the many tasks which must be attended to each year. Weeds can easily be disposed of when they are small but this is not always possible. The weeding of an area which could be accomplished in a few hours when the plants were small, might require days to do after two weeks of rainy weather. The small weeds dry up in the sun, but large ones must be wheeled away lest they take root and revive after another rain. There are thousands of feet of grass edges and hedges in the formal gardens which must be repeatedly trimmed during the summer. Intensively cultivated gardens require much hand labor in contrast to large areas where the gasoline engine does the work. Moles are a nuisance, and rabbits, rats and squirrels are very destructive. These last three rodents are the most difficult problem in the garden to cope with, and all of them do about the same amount of damage but at different times of the year.

FLORAL DISPLAYS

In early January primroses and cyclamen were exhibited in the Floral Display House. The orchid show was held from January 28 until March 4. This was followed by a display of cinerarias to which azaleas were added later. The Easter show was held from March 25 until April 8. There then followed a series of spring displays of schizanthus, marguerites, calceolarias, salpiglossis, nasturtiums, foxgloves, canterbury bells and Martha Washington geraniums. Many plants were again sent to the Christ Church Cathedral for the annual flower sermon preached on April 15. The St. Louis Horticultural Society held its spring flower show on May 19 and 20, after which hydrangeas were placed in the Floral Display House. The summer display of fancy-leaved caladiums and fuchsias began on June 17. The Harvest Show was held on September 15 and 16. The St. Louis Horticultural Society held its annual dahlia show on September 29 and 30. The display was good but continuous rain on the two days reduced the attendance. The chrysanthemum show opened on November 4 and continued until December 2. A full color-page of pictures of the show appeared in the *St. Louis Post-Dispatch* on Sunday, November 25, and this publicity increased the attendance for the last Sunday in November. The Christmas display of poinsettias opened on December 9 and will continue into the second week in January. Pictures of the poinsettia show in the Sunday, December 9, issue of the *St. Louis Globe-Democrat* and the *St. Louis Post-Dispatch* brought many visitors to the display.

The growing of the plants, as well as the arrangement of the floral displays, is in charge of Mr. Paul A. Kohl, Floriculturist to the Garden. Mr. Kohl also has the responsibility of many of the outdoor gardens.

MAIN CONSERVATORIES AND EXOTIC RANGES

Some of the changes which were made in the greenhouses during the past year were necessitated by conditions beyond our control. For instance, some plants grow too exuberantly and in a few years take up much valuable space, thereby retarding growth of slower species and hindering development of the under-growth. This was the case in the Cactus House, where many of the Euphorbiaceous plants attained an enormous spread and either had to be severely pruned and removed to the South African House, or relegated to the brush heap. Of course, no plants were ever destroyed unless large cuttings were available for propagation of the species. A rather striking *Synadenium Grantii*, 35 feet high, was a victim of the axe, as was also a 35-ft. *Euphorbia Tirucalli* and several shrubby specimens of *Synadenium cupulare*.

All cacti and succulents at the Garden, prior to 1935, were maintained in one house, but as the collection increased another room was needed. Thus, most of the Old World xerophytes were segregated from the New World types, but for obvious reasons the African Euphorbias were still grown in the Cactus House up to the spring of 1945. At that time the work of transferring the cactoid Spurges was begun and continued throughout the year as time permitted. Successfully moved were specimen plants of *Euphorbia abyssinica, E. canariensis, E. conspicua, E. coerulescens, E. neutra, E. pseudocactus, E. ramipressa, E. similis, E. tenuirama, E. tetragona, E. Winkleri*, and a wonderful crested *E. lactea* which had to be split on account of its cumbersome weight.

The soil in the west bed in the Cactus House, where most of the Spurges were grown, was manured and made ready for desert-type Bromels, some of which have already become established. The Garden has always maintained a rather neat collection of epiphytic Bromeliads in pots on benches, but only in the past two years has there been a concerted effort to increase the xerophytic group. Now that a place has been made for them in the Cactus House it is believed that the Garden will be instrumental in developing a keener interest in these plants. Already growing in the bed are such outstanding species as *Bromelia antiacantha, B. Balansae, B. serra, Cryptanthus bahianus, Deuterocohnia Meziana, Dyckia altissima, D. floribunda, D. leptostachya, D. maritima, D. microcalyx, D. rariflora, D. remotiflora* var. *montevidensis, D. sulphurea, Encholirium Hoehneanum, Hechtia texensis, Hohenbergia catingae, Pseudananas macrodontes, Puya alpestris, P. assurgens* and *P. spathacea.* Scattered between the Bromels are plantings of Torch

Cacti belonging to the Cereanae group and South African Haworthias, which add height to the scene and cover the bare ground with their succulent rosettes. Haworthias will be the only outside succulents allowed to grow in the American desert house, as there is no place available for them in the crowded South African room.

Flowering desert shrubs became a feature in the Cactus House for the first time since plantings were made a few years ago. The outstanding profuse bloomer was the Desert Trumpet, *Tecoma stans* var. *angustatum*, an ornamental southwestern shrub producing handsome fragrant golden-yellow flowers and bright green fern-like foliage. The plant held the spotlight for six months and drew comments from the visitors. *Cassia Wislizenii*, a small, much-branched, spiny shrub of Arizona, which unfurled its first flowers in late summer, promises to become an ornamental species. Seeds of it were collected in 1935, as were those of other desert shrubs now thriving in the greenhouse. *Lycium brevipes*, the desert Matrimony Bush, not only produces small white to lavender sprays of flowers but also delightful little bright red berries about the size of peas. A pair of brown thrushes built their nest under the leafy canopy made by the interlacing branches and reared their young with security, utilizing the juicy berries for food. Several kinds of birds, including cardinals, doves, grackles, robins, thrushes and wrens use the conservatories for nesting sites each year, and at one time or another wild canaries, hummingbirds, owls and even pigeons have nested there.

In the Banana-Coffee Finca about twenty-five feet of the meandering cinder walk was dug up, filled with earth, and made available for more coffee and banana plants. These two economic plants always evoke delight, especially when loaded with their colorful fruits. During the past year a considerable amount of manure was worked into the soil, and as a result a good crop of bananas appeared on the plants. The narrow shallow bed in the northeast end of the finca never did support a thriving assemblage of coffee plants, being over the heat tunnel which dries out the soil excessively. This last year it was turned over to succulent plants, including Aloes, Spurges, Sansevierias and Crassulaceous odds-and-ends, and these have done remarkably well there.

In the Economic House the only worthy addition to the array of plants was a large bushy specimen of the variegated rubber tree, *Ficus elastica variegata*, donated by Mr. C. J. Briner. Frequently plants are offered to the Garden but they are accepted only when the plant is lacking in our collection or if it is considered a rarity.

Considerable attention was also given to the evergreen Aroids now making such a fine display in the Palm House. During the year additions have come in from various sources, especially from the New York Botanical Garden and from the private collection of Mr. David Barry, Jr., of California. The plants have found a cozy spot in the Palm House jungle. The common *Philodendron cordatum* clothes the trunk of the 30-ft. *Washingtonia filifera* in the southeast bed, from which the "skirt" of dead leaves has been removed. Two fine *Philodendron erubescens* ornament trunks of a 30-ft. wax palm, *Ceroxylon andicolum*, and a 30-ft. *Sabal Palmetto,* while another husky grower, *Philodendron radiatum*, has its roots wrapped around the trunks of a 25-ft. *Sabal mauritiaeformis* and a 35-ft. *Phoenix canariensis. Philodendron hastatum* has made good progress on *Pritchardia pacifica*, the Fan Palm of the Fiji Islands, and on a second Washingtonia palm in the southwest bed. Several other kinds of Philodendrons have been set out at the bases of the remaining tall palms.

In the Exotic Ranges the almost continuous blooming of *Strelitzia Reginae* has created somewhat of a record. There are about ten of these slender herbs scattered throughout the house, and when their orange and blue "birds of paradise" appear it is a sight that dazzles the eye. In the same room a number of the very old Stilt Plants was removed and new Pandanus planted in their place. A miscellaneous lot of semi-tropic ornamentals, mostly from the Teas Nursery of Texas, were set out in the beds.

Since the original orchid seedling house, which was erected when Miss Elinor Alberts began hybridizing and growing seedlings on a large scale at the Garden, has not been in practical use for many years, it was decided to utilize the space for growing aquatics such as water lettuce, water hyacinths and Cyperus grasses. The old concrete seedling bench was renovated, and a new concrete pot washing tank was constructed, approximately 68 inches long by 35 inches wide and 30 inches deep.

Mr. Ladislaus Cutak is in charge of the Main Conservatories, including Cacti and other succulents.

ORCHID DEPARTMENT

During the summer of 1945 all the orchid seedlings and experimental orchid plants were transferred from the Garden in St. Louis to the main range of greenhouses at the Arboretum. This move consolidated all orchid projects into one department and made it possible to continue research on a more comprehensive scale. Progress of certain phases of the experimental work is handicapped at present by lack of adequate laboratory facilities, but plans have been made to overcome this difficulty at an early date.

Installation of automatic chemical-feeder equipment has opened up a new approach in the field of nutrition, and may prove to have important bearing on future developments in "hydroponics."

Experiments with gravel cultures and nutrient solutions are progressing favorably. Three more benches have been converted for gravel-culture studies with Cattleyas, Dendrobiums and Phalaenopsis. Another new concrete bench (100 ft. x 5 ft.), specially constructed for gravel cultures, will soon be completed. These benches, together with the plants in individual pots, represent a total of more than 12,000 orchids now growing in gravel. This project has been particularly valuable since the gravel replaced orchid peat, the usual potting medium, which has practically disappeared from the market.

The use of Sani-fibre (made from the bark of Redwood trees) as a substitute for orchid peat has been entirely unsatisfactory. Extensive tests of this material with various kinds of orchids have given similar results in all cases; leaves turn yellow or deep red, growth is definitely retarded or completely stopped, and flower production is very poor.

The culture of hybrid orchid seedlings is an important part of the research program. Many thousands of choice seedlings from the flask stage on up to mature flowering plants are being raised. A large proportion of the hybrids that have bloomed so far produced flowers of superior quality and are a worth-while addition to the Garden's orchid collection. The temptation to continue hybridizing outstanding varieties is irresistible.

Repair and construction work in the greenhouses demand considerable time. Due to constant moisture, the wooden stagings are subject to rot and have to be replaced periodically. A new type of staging made with insulation board and Transite (an asbestos-cement material) is to be tested this year. If satisfactory, it may entirely replace wooden stagings on the benches and greatly reduce the cost of maintenance.

Apart from the annual orchid show in January-February, continuous displays were staged in the alcolves in the Aroid House. The following genera were represented during the year: Cattleya, Dendrobium, Laelia, Vanda, Angraecum, Oncidium, Calanthe, Paphiopedilum (Cypripedium), Phragmopedilum (Selenipedium), and Cymbidium, as well as various botanical representatives.

When admiring the displays, visitors will sometimes remark: "Isn't it too bad orchids die so soon after being brought up from the tropics." As a matter of fact, the plants being admired may have been in the Garden collection for twenty-five or thirty years and have flowered annually. The Brownhurst collection, which came to the Garden in 1916 and 1918, annually gives an excellent display of flowering Vandas, particularly *Vanda suavis* and *V. tricolor*. *Laelia anceps* and its white varieties are always conspicuous in the orchid show in January. These, with the green and yellow lady-slippers, are all from the original gift of Mr. D. S. Brown. Plants of

Cattleya Trianae, always a bright spot in the annual show, were collected in Colombia in 1923. They flower from November to February, according to the variety. After being in the collection for 22 years, it is recorded that 1,200 flowers bloomed this past year.

Dr. D. C. Fairburn, formerly Horticulturist to the Garden, is now Orchidologist in charge of the Orchid Houses, including the seedling work, at the Arboretum.

AMATEUR GARDEN COURSE

The winter course in gardening for amateurs was given by Dr. David C. Fairburn from February 6 to May 1. As in past years, the number of applicants exceeded the quota, and the participating students severely strained the available space in the experimental greenhouses.

SUPERVISED INSTRUCTION FOR SCHOOL-CHILDREN

The nature-study instruction for school-children, which was inaugurated at the Garden in 1936, was discontinued in June. For this work the Board of Education had appointed a special teacher, Miss Clara M. Heising, who held the position throughout the nine years.

RESEARCH AND INSTRUCTION

Dr. J. M. Greenman, Curator of the Herbarium and Professor in the Henry Shaw School of Botany of Washington University, has continued to devote most of his time to regular duties of the herbarium. During the college-term of 1944-45 he also supervised the work of graduate students majoring in taxonomy of the higher plants. Furthermore, Dr. Greenman has continued to pursue research on various monographic and floristic studies long under way. After thirty-two years of teaching in the Shaw School of Botany, at the end of the college-term of 1944-45 Dr. Greenman was appointed Professor Emeritus in Washington University; and this frees his entire time for work in the Herbarium of the Missouri Botanical Garden.

Dr. C. W. Dodge, Mycologist to the Garden and Professor in the Henry Shaw School of Botany of Washington University, has spent much of the time available for research in completing the study of lichens from the Australian Quadrant of Antarctica, the subantarctic islands of the Indian Ocean and Macquarie Island, and in preparing the manuscript for publication. The usual courses of instruction have been given. Mrs. Charles Heiser gave the course in general bacteriology during the summer session. Routine determinations of human pathogenic fungi from the armed forces and others have been made as the various cultures were received. An interesting imperfect yeast was studied for Anheuser Busch, Inc. Large series of lichens from tropical America, Montana, and Alaska, and small series from

Quebec, New Mexico, Arizona, and the Orient, have been determined for correspondents. During the autumn, Miss Dorothy Harper has assisted in making microscopic preparations and in routine insertion in the fungus and lichen herbaria.

Dr. Edgar Anderson, Geneticist to the Garden and Engelmann Professor of Botany in the Henry Shaw School of Botany, has continued to devote the major portion of his time to a general survey of the varieties of maize, past and present. In one direction this has led to a study of the prehistoric varieties assembled by archaeologists and anthropologists. All the collections in the Chicago Museum of Natural History, the Gila Pueblo at Globe, Arizona, the American Museum of Natural History, and in the National Museum have been examined and measured. In one or two years it should be possible to study the major prehistoric collections in this country and to bring all the data together in a comprehensive monograph. The project has already advanced to the point where it illuminates not only the history of maize, but of the peoples who grew it.

This general survey of the maize plant also furnishes a background for some of the pressing problems of modern maize breeding. During the year the Pioneer Hi-Bred Corn Company, of Des Moines, has continued to cooperate in various maize problems which require large experimental fields. Dr. William L. Brown, a former graduate student in the Henry Shaw School of Botany, has been added to the staff of the company and spends a portion of his time in gathering data for Dr. Anderson's studies. A special graduate fellowship established by the company is enabling Mr. John Jay Finan, under Dr. Anderson's direction, to begin a critical survey of the 16th and 17th century literature dealing with the introduction of maize into Europe. The Garden's excellent and readily available collection of pre-Linnean works makes possible a really exhaustive survey.

For various theoretical reasons it seems probable that popcorns may have been among the first kinds of maize to have been cultivated by primitive peoples. Unfortunately there is almost no literature on the subject, since the popping of corn has seemed to most people a rather trivial subject. Students of farm crops have considered that popcorn, like sweet corn, belonged in the vegetable garden, though vegetable specialists have considered the subject outside their province. There is, therefore, not even a checklist of the varieties of popcorn grown in the United States. With the help of Mr. Finan, Dr. Anderson has been assembling such a list, largely from the Garden's splendid collection of old seed catalogues. The first draft is now ready to put in mimeographed form, and will shortly be mailed out to popcorn experts and members of the seed trade in the hope of getting additions and corrections.

Though interesting in their own right, these general surveys of the maize plant are undertaken as a prelude to genetic investigations on the so-called quantitative characters of maize. While these characters are universally of supreme importance to plant breeders, they have proven difficult to analyze experimentally, and comparatively little is known about them from a theoretical point of view. Their experimental analysis in maize has been begun in cooperation with the Pioneer Hi-Bred Corn Company and is already yielding encouraging results. Principles derived from a study of maize will be of very general application. During the year Dr. Anderson travelled to California to consult with breeders of commercial lettuce, and to Oregon to investigate some of the problems of Narcissus breeding with the Oregon Bulb Farms. As the result of this latter trip a paper on the genetics of daffodil breeding is in the press and will appear shortly.

Dr. Robert E. Woodson, Jr., Assistant Curator of the Herbarium and Professor in the Henry Shaw School of Botany of Washington University, has continued his teaching duties at the University. The first fascicle of Part III of "Flora of Panama," which he edits with Dr. Schery, was published in the February, 1945, number of the ANNALS OF THE MISSOURI BOTANICAL GARDEN. This fascicle contains the treatments of the Monocotyledonae from Juncaceae through Marantaceae. Dr. Woodson also has continued his studies of leaf variation in the Butterfly-weeds *(Asclepias tuberosa)*, his revision of Asclepias in the United States, and his determinations of tropical Apocynaceae and Asclepiadaceae. Lately he also has become interested in the culture and breeding of lilies.

Dr. Henry N. Andrews, Assistant to the Director and Assistant Professor in the Henry Shaw School of Botany of Washington University, has devoted his research during the past year largely to a study of the Iowa Carboniferous fossils donated by Mr. Frederick O. Thompson of Des Moines. One article, dealing with Seed-fern stems, has been published, and two others are nearing completion. These last deal with certain seeds found in the Iowa petrifactions as well as another Seed-fern stem that was contained in Mr. Thompson's most recent shipment of specimens.

During September a collecting trip was made into southeastern Idaho. A week was spent at the ranch of Mr. Henry Thomas, of Wayan, and in spite of the exceptional early-winter conditions that prevailed a fine collection of Cretaceous petrified ferns was obtained. Mr. Thomas' very extensive collections, gathered largely within the past three years, were studied, and in themselves revealed much valuable and previously unrecorded information concerning the Chalk Age plants of the west. Special thanks are due Mr. Henry Thomas, and again to Mr. Frederick O. Thompson, for their generosity and cooperation in aiding our paleobotanical investigations.

Dr. Robert W. Schery, Research Assistant to the Garden, returned in December after three years work with the Rubber Development Corporation in South America.

Mr. Stanley Bettoney (M.S., Washington University, 1941) returned in December from three years of Army service and is assisting Dr. Fairburn in the orchid ranges at Gray Summit.

Degrees.—At the June 1945 Commencement of Washington University the degree of Master of Science was conferrd upon Julia Guzmán-Naranjo Institute of International Education Fellow and University Scholar, A.B., Universidad Nacional de Bogotá, Colombia, S. A. (Mycology).

Instructor.—Lillian Nagel, B.S., University of Illinois, M.S., University of Colorado, was appointed Instructor for the year 1945-46, at the same time continuing her research work in cytogenetics.

Graduates and Fellows: The following appointments were made in the Henry Shaw School of Botany for the year 1945-46:

Special Fellowship sponsored by the Pioneer Hi-Bred Corn Company: John Jay Finan, B.A., Washington University.

Tuition Scholarship: Dorothy Harper, A.B., Oklahoma Agricultural and Mechanical College.

Gerald B. Ownbey, B.A. and M.A., University of Wyoming, returned in December from three years Army service and is continuing his graduate studies in taxonomy.

Published Articles.—

Anderson, Edgar: Can We Grow the Snow Trillium in Missouri? Mo. Bot. Gard. Bull. 33:227; An Early-blooming Dark Red Day-lily. Mo. Bot. Gard. Bull. 33:132-133; An Early-flowering Japanese Cherry. Mo. Bot. Gard. Bull. 33:113; The Hardy Orange. Mo. Bot. Gard. Bull. 33:117-118; The Maize Collection from Painted Cave. App. I (pp. 77-85) of Emil W. Haury's "Painted Cave, Northeastern Arizona." Amerind Foundation No. 3; Maize in the New World. Chap. II (pp. 27-42) of Charles Morrow Wilson's "New Crops for the New World"; Pinole. The Herbarist, No. 11:33-39; *Rosa alba* in St. Louis. Mo. Bot. Gard. Bull. 33:130-132; Two Balkan Ivies for St. Louis Gardens. Mo. Bot. Gard. Bull. 33:59-63; What is Zea Mays? —A Report of Progress. Chron. Bot. 9:88-92; and John Jay Finan: Maize in the Yanhuitlán Codex. Ann. Mo. Bot. Gard. 32:361-368; with George F. Carter: A Preliminary Survey of Maize in the Southwestern United States. Ann. Mo. Bot. Gard. 32:297-322.

Andrews, Henry N.: Contributions to Our Knowledge of American Carboniferous Floras. VII. Some Pteridosperm Stems from Iowa. Ann. Mo. Bot. Gard. 32:323-360; An Evergreen for Shady Gardens. Mo. Bot. Gard. Bull. 33:133-134 (Reprinted in August 10 Southern Florist); A Fine

Chinese Lilac. Mo. Bot. Gard. Bull. 33:114-117; The Missouri Botanical Garden—1860-1945. Chemurgic Digest 4^5:97-100; The Pine-fern—A Living Link with the Past. Mo. Bot. Gard. Bull. 33:84-90; Vegetable Gardening Notes for 1945. Mo. Bot. Gard. Bull. 33:68-70; Carl C. Lindegren and: Cytoplasmic Hybrids in *Penicillium notatum*. Bull. Torr. Bot. Club 72:361-366.

Beilmann, August P.: Fungus Diseases and Insects of Evergreens. Mo. Bot. Gard. Bull. 33:221-222; Phloem Necrosis—A Serious Threat to the Elm. Mo. Bot. Gard. Bull. 33:128-130 (Extract in June 30 Florists' Exchange under title "A New Threat to Elms"); A Quarter Century of Tree Surgery. Mo. Bot. Gard. Bull. 33:78-83 (Reprinted in Trees 6^2:10-11, under title "A Quarter Century of Cavity Work"); The Short-leaf Pine. Mo. Bot. Gard. Bull. 33:223-225; The Size of a Tree. Horticulture 23:61, and April 6 Southern Florist (Reprinted from November 1944 BULLETIN); Wild Animal Life at the Arboretum. Mo. Bot. Gard. Bull. 33:167-170.

Cutak, Ladislaus: A Brazilian Air Cactus. Mo. Bot. Gard. Bull. 33:228-230; *Echinocereus chisoensis*. Mo. Bot. Gard. Bull. 33:134-136 (Reprinted in Aug. 18 Southern Florist); Insects that Attack Cacti and Succulents. Jour. Cactus & Succulent Soc. Amer. 17^5:67-72, and Desert Plant Life 17^1:5-10 (Reprinted from Nov. 1944 BULLETIN); The Night-blooming Cereus and Its Allies. Mo. Bot. Gard. Bull. 33:93-113 (Reprinted in June 15 and June 22 Southern Florist, also as supplement to Sept. Jour. Cactus & Succulent Soc. Amer.); Succulents—House Plants *de Luxe*. Garden Life 18:19; Spine Chats. Monthly contributions in Jour. Cactus & Succulent Soc. Amer.; and George H. Pring: Bromeliads are Fascinating Plants. Mo. Bot. Gard. Bull. 33:139-160.

Fairburn, David C.: All About Early Seed Sowing. Home Garden 5^2:62-65; Gravel Culture for Orchids (Reprinted from November 1944 BULLETIN in Orchid Digest 9^2:294, 297; and as supplement to Feb. Amer. Orchid Soc. Bull.); Growing Plants. II. Vegetative Propagation. Mo. Bot. Gard. Bull. 33:192-217; Home-grown Gardenias. Mo. Bot. Gard. Bull. 33:123-128; Why Plants Bloom Out of Season. Mo. Bot. Gard. Bull. 33:170-171 (Reprinted in Flower Grower 32:587); and Pring, G. H.: Light Requirements for Orchids in the Midwest. Mo. Bot. Gard. Bull. 33:33-56 (Reprinted in March 23, March 30, and April 6 Southern Florist; as supplement to April Amer. Orchid Soc. Bull.; and abstract in Orchid Digest 9^2:305-308).

Finan, John Jay: with Anderson, Edgar: Maize in the Yanhuitlán Codex. Ann. Mo. Bot. Gard. 32:361-368.

Greenman, J. M.: William Trelease. Mo. Bot. Gard Bull. 33:71-72 (with portrait).

Heiser, Charles B., Jr.: A Revision of the Genus Schkuhria. Ann. Mo. Bot. Gard. 32:265-278; The Hopi Sunflower. Mo. Bot. Gard. Bull. 33:163-166.

Heiser, Dorothy Gaebler: A Nectria Disease of Coffee. Ann. Mo. Bot. Gard. 32:287-296.

Kohl, Paul A.: Azaleas. Mo. Bot. Gard. Bull. 33:114; Grow Your Own Strawberries. Mo. Bot. Gard. Bull. 33:64-67; Growing Plants. I. From Seed. Mo. Bot. Gard. Bull. 33:179-191; The Hardy Begonia. Flower Grower 32^{1}:31 (Reprinted from March 1944 BULLETIN); The Horse-chestnut. Garden Path 15^{3}:7 (Reprinted from November 1942 BULLETIN); Strawberries are Scarce—Grow Your Own. April 13 Southern Florist (Reprinted from March Garden BULLETIN).

Lindegren, Carl C.: An Analysis of the Mechanism of Budding in Yeasts and Some Observations on the Structure of the Yeast Cell. Mycol. 37:767-780; The Induction of Dormancy in Vegetative Yeast Cells by Fat and Carbohydrate Storage and the Conditions for Reactivation. Arch. of Biochem. 8:119-134; Mendelian and Cytoplasmic Inheritance in Yeasts. Ann. Mo. Bot. Gard. 32:107-123; and Gertrude Lindegren: Vitamin-synthesizing Deficiencies in Yeasts Supplied by Hybridization. Science N. S. 102:33-34; and Henry Andrews: Cytoplasmic Hybrids in *Penicillium notatum*. Bull. Torrey Bot. Club 72:361-366; with S. Spiegelman and G. Lindegren: Survey of Growth and Gas Production of Genetic Variants of *Saccharomyces cerevisiae* on Different Sugars. Arch. of Biochem. 6:185-198; with S. Spiegelman and G. Lindegren: Maintenance and Increase of a Genetic Character by a Substrate-Cytoplasmic Interaction in the Absence of the Specific Gene. Proc. Nat. Acad. Sci. 31:95-102.

Mehlquist, G. A. L.: Inheritance in the Carnation. V. Tetraploid Carnations from Interspecific Hybridization. Amer. Soc. Hort. Sci. Proc. 46:397-406.

Pring, George H.: Barbey's Epidendrum—*Epidendrum Barbeyanum*. Amer. Orchid Soc. Bull. 13^{8}:261-262; A Noteworthy Philippine Orchid—*Vandopsis Davisii*. Mo. Bot. Gard. Bull. 33:175.; Pygmy Water-lilies for Small Pools. Home Gardening for the South 5^{3}:46-47; with Ladislaus Cutak: Bromeliads are Fascinating Plants. Mo. Bot. Gard. Bull. 33:139-160; with D. H. Fairburn: Light Requirements for Orchids in the Midwest—see Fairburn and Pring above.

Schery, Robert W., with Robert E. Woodson, Jr., and Collaborators: Flora of Panama. Part III. Fasc. I (Juncaceae–Marantaceae). Ann. Mo. Bot. Gard. 32:1-105.

Woodson, Robert E., Jr.: Notes on Some North American Asclepiads. Ann. Mo. Bot. Gard. 32:369-371; Robert W. Schery, and Collaborators.

Flora of Panama. Part III. Fasc. I (Juncaceae–Marantaceae). Ann. Mo. Bot. Gard. 32:1-105.

Scientific and Popular Lectures.—

Dr. Edgar Anderson, Geneticist to the Garden: February 10, before the weekly seminar, Pioneer Hi-Bred Corn Co., Johnston, Iowa, "Advances in Genetics"; October 5, St. Louis Horticultural Society, "Herbs" and "Narcissi."

Dr. Henry N. Andrews, Paleobotanist to the Garden: November 16, before Group IV of the Webster Groves Garden Club, "Plants of the Past."

Mr. August P. Beilmann, Manager of the Arboretum: June 1, before the St. Louis Horticultural Society, "Some Phases in the Development of an Arboretum"; September 21, Group 2, Clayton Garden Club, and October 14, Academy of Science of St. Louis, "Care and Selection of Trees"; October 28, Academy of Science of St. Louis, "Diseases and Insects that Attack Woody Plants."

Mr. Ladislaus Cutak, in charge of Succulents at the Garden: January 30, before the Business and Professional Women of the Y.W.C.A., and February 2, St. Louis Horticultural Society, "The Wonders of the Cactus World"; May 13, Henry Shaw Cactus Society, "Mammillarias"; September 12, Brentwood Garden Club No. 1, and November 28, the Webster Groves Garden Club, Group IV, "Cacti, the Ideal House Plants"; September 15, patients of the Veterans' Hospital, Jefferson Barracks, "Four Seasons of Flowers in the Garden"; October 14, Henry Shaw Cactus Society, "Cactus Hunt in Old Mexico."

Dr. Carroll W. Dodge, Mycologist to the Garden: April 3, before the Collinsville Study Club, and April 4, North St. Louis Real Estate Salesmen's Association, "Current Political and Economic Problems of Central America"; April 15, Adult Class of First Congregational Church of St. Louis, "Anti-clerical Feeling in Central America"; November 13, before the Business and Professional Women of the Y.W.C.A., "Current Central American Problems."

Dr. David C. Fairburn, Orchidologist to the Garden: January 19, before Clayton Garden Club No. 1, "House Plants"; March 6, Grantwood Garden Club, "Seed Sowing."

Mr. Paul A. Kohl, Floriculturist to the Garden: April 12, before the Bel-Nor Mothers' Club, "Four Seasons at the Missouri Botanical Garden"; April 17, the Garden Club of St. Louis, "Good Garden Plants"; April 30, the Clayton Garden Club, No. 1, "Roses"; November 30, Missouri Historical Society, "Four Seasons at the Missouri Botanical Garden."

Dr. Carl C. Lindegren: October 15, at the Commercial Solvents Corporation, Terre Haute, Ind., October 17, at University of Wisconsin, November 1, at University of California, Berkeley, and November 7, at California Institute of Technology, "Genetics of Yeast: Life Cycles, Adaptive Enzymes, and Vitamin Synthesis."

Mr. George H. Pring, Superintendent of the Garden: January 18, before the Business and Professional Women of Tyler Place Presbyterian Church, "Orchids"; February 16, before the Dallas Arboretum Foundation, at Dallas, Texas, February 19, the Garden Club of Angleton, Texas, and February 21, the Houston Garden Center, "Four Seasons of Bloom at the Missouri Botanical Garden"; March 1, at the two-day course on Flower Arrangement and Judging, under auspices of the East-Central Region of Garden Clubs of Missouri, at the Monday Club, Webster Groves, "Practical Knowledge for Every Horticulturist"; March 19, the Better Homes Section of the Monday Club of Webster Groves, "Development of the Orchid from Seed to Flower"; April 4, Men's Club, First Presbyterian Church, Collinsville, Ill., and April 7, Chicago Horticultural Society and Garden Center, Chicago, Ill., "Four Seasons at the Missouri Botanical Garden"; April 8, Chicago Orchid Society, "Orchids"; April 24, Women's Association, Tyler Place Presbyterian Church, "A Fantasy of Orchids," illustrated with floral specimens from the Garden; May 14, North St. Louis Physicians' Social Club, "Collecting the Para Rubber"; May 27, Fireside Group of Westminster Presbyterian Church, and June 6, Scottish Rite Women's Club, "The Romance of the Orchid"; September 26, Directors' meeting, Houston Flower Show, Houston, Texas, "Staging Flower Shows in St. Louis"; October 15, meeting of St. Louis Retail Florists' Association, "Orchids"; November 13, evening discussion group of Pilgrim Congregational Church, "Cultivation of Orchids"; December 10, Men's Club of Champaign, Ill., "Four Seasons at the Missouri Botanical Garden."

THE HERBARIUM

Activity and progress can be reported for the herbarium during the year 1945. The work has been greatly handicapped by the congestion of the collections because of the constant addition and insertion of new and important material.

New Accessions.—Paul Allen, 1 plant of Panama; Edgar Anderson, 71 plants and photographs mostly from horticulture; Edgar Anderson and Robert E. Woodson, 4 photographs of *Apocynum;* Arnold Arboretum of Harvard University, 412 plants of North America and foreign countries; Avenue Camera Store, 2 photographs of type specimens; E. B. Babcock, 118 photographs of *Crepis;* Mrs. Nettie Mae Bauer, 1 plant of horticulture; Mrs. Pamela Beard, 200 plants of British West Indies; Alan A. Beeble, 100 plants of California; F. L. Bennett, 1 plant of South Dakota; Mrs. J. R. Bettis, 1 plant of *Picea* of horticulture; Brooklyn Botanic Garden, 25 plants of South America; Carl Busch, 20 plants of New Caledonia; California Academy of Sciences, 2 plants of California; R. R. Casteneda, 86 plants of Colombia; E. L. Caum, 2 photographs of *Heliconia;* A. Chandler, 4 plants of Wisconsin and Missouri; Chicago Natural History Museum, 104 plants of Guatemala and Hawaii; R. T. Clausen and Harold Trapedo, 4 plants of western United States; Mrs. Mary S. Clemens, 101 plants of Queensland, Australia; M. T. Cook, 9 plants of Louisiana; V. L. Cory, 1 plant of Texas; C. C. Deam, 10 plants of Florida, Indiana, and Kentucky; Delzie Demaree, 29 plants of Arkansas; D. C. Fairburn, 1 plant of horticulture; Farlow Herbarium of Harvard University, 27 fungi; N. C. Fassett, 1 plant of Virginia; A. O. Garrett, 1 plant of Utah; Geo. J. Goodman, 2 photographs of *Eriogonum;* Gray Herbarium of Harvard University, 291 plants of Balearic Islands, Tanganyka, South America, and Rhode Island; C. R. Haines, 5 plants of Michigan; Ross Hardy, 4 Asclepiadaceae from Utah; Dorothy Harper, 1 plant of Oklahoma; Ada Hayden, 27 specimens of *Juniperus* from Iowa; Charles B. Heiser, 80 plants of Arkansas and Arizona; Alfred Herre, 5 plants of Texas; Charles Holton, 1 plant of Brazil; W. H. Horr, 15 plants of Kansas; K. W. Hunt, 7 plants of South Carolina; Leslie James, 9 plants of Alabama; O. S. Ledman, 2 plants of pharmacal trade; Frank T. McFarland, 27 plants of Kentucky; H. N. Moldenke, 1 plant of Utah; Margaret Murley, 3 plants of Iowa; W. A. Murrill, 39 plants of Florida; D. C. Neal, 1 plant of Louisiana; New York Botanical Garden, 277 plants of Greenland, Utah, and South America; University of Oklahoma by Geo. J. Goodman, 366 plants of Oklahoma; Marion Ownbey, 1 type specimen of *Polygonatum biflorum* var. *necopinum* R. Ownbey; L. F. Pinkus, 3 plants of Missouri; M. P. Porsild, 210 plants of Greenland; G. H. Pring, 3 plants of horticulture; W. W. Ray, 100 fungi from Oklahoma; Mrs. Geo. G. Richter, 1 plant from Florida; Rocky Mountain Herbarium by E. L. Porter, 112 plants of Wyoming; Bernardo Rosengurtt, 20 plants of Uruguay; Frank C. Seymour, 126 plants of North America; E. E. Sherff, 5 plants of Virginia, Michigan, and Illinois; L. H. Shinners, 8 plants of Wisconsin, Illinois, Oklahoma, and Texas; Gail Shofstall, 1 plant of Oklahoma; Mary L. Singletary, 2 Asclepias of Florida; State College of Washington by Marion Ownbey, 500 plants of mostly Washington and Oregon; H. K. Svenson, 1 specimen of *Isoetes pacifica* Svenson from Ecuador; Edward Teas, 3 plants of horticulture; J. W. Thomson, 1 plant of Haiti; United States National Arboretum, 1 plant of Brazil; United States Department of Agriculture, Division of Plant Exploration and Introduction, 70 plants of Haiti; United States Department of Agriculture, Forest Service, 29 plants of Ecuador; United States National Museum, 490 plants mostly from Tropical America;

University of Arizona, 106 plants of Arizona; University of California by T. H. Goodspeed, 564 plants from South America; University of California, 251 plants of eastern slopes of the Sierra Nevada and the Great Basin; University of Texas, 205 plants of Texas; University of Washington by C. L. Hitchcock, 357 plants of Idaho; Hermann von Schrenk, 1 plant of Missouri; U. T. Waterfall, 217 plants of Oklahoma, Texas, and New Mexico; West Virginia University, 88 plants of West Virginia; L. O. Williams, 7 plants of Brazil; Robert E. Woodson, 1 plant of Panama.

The above detailed records of accessions indicate clearly those regions from which most plants have been received during the year; moreover, the records show that the natural sphere of activity of this herbarium continues to be the western United States, Mexico, Central America, West Indies, and South America.

Mounting and Insertion of Specimens.—The mounting of herbarium specimens has been continued during the year; and this work has been carried on effectively by Miss Violet Bauer. About 12,000 specimens have been mounted. This represents all plants received in 1945 in addition to material which has accumulated during recent years. There remains in storage considerable plant material which is to be sorted, determined, labeled, mounted, and placed eventually in the organized herbarium.

Most of the new mounted specimens have been inserted in the general herbarium. This work has been done by the curator assisted by Mrs. Nettie Mae Bauer. However, on account of the already crowded herbarium cases in many places certain groups of plants have been put temporarily in large cartons and sealed. Naphthalene has been used freely to guard against the attack of herbarium insects.

Exchanges.—The exchanges of duplicate specimens during 1945 have been confined almost entirely with American institutions and individuals. We have received on the basis of exchange 3,737 specimens; and we have sent 928 duplicate specimens to correspondents.

Use of the Herbarium.—The use of the herbarium by visiting botanists has been more frequent than it was in the last year. It is noteworthy that visiting botanists have continued a keen interest in economic plants; and many visitors have asked the opportunity to see herbarium specimens of economic plants. A very important phase of usefulness of the herbarium is concerned with loans of specimens for monographic study. The scientific value of herbarium specimens which have been critically studied is greatly enhanced.

Groups of Plants under Special Investigation and Floristic Studies.—Several groups of plants have received intensive study during the year by members of the staff. These special studies for the most part represent investigations which have been under way for some time. The following may be mentioned: lichens by Dr. C. W. Dodge; Apocynaceae and Asclepiadaceae by Dr. R. E. Woodson; Compositae by Dr. J. M. Greenman; *Stephanomeria* by Mr. Charles B. Heiser, Jr.; intensive studies of the Panamanian flora have been continued by Dr. Woodson in cooperation with Dr. R. W. Schery.

Statistical Summary (for the year ending December 31, 1945):

Number of specimens received during 1945:		
By purchase	1,202	
By gift	1,056	
By exchange	3,737	
By transfer	4	
Total	5,999	
Number of specimens mounted and incorporated in 1945		12,004
Number of specimens carried forward from 1944		1,413,320
Total		1,425,324
Number of specimens discarded during 1945		35
Total number of specimens in herbarium		1,425,289

LIBRARY

The most noteworthy happening in the library during 1945 was the resumption of relations with European institutions. In normal times, many hundred foreign publications are received at the Garden, most of which are in exchange for the ANNALS and the BULLETIN. During the War, however, the only European periodicals received were those from England, Spain, and Portugal, and even some numbers of these were lost in shipment. Apparently the European institutions were just as impatient as we were to take up the exchange relationship, for it was only a matter of weeks after mail service was resumed that a shipment from Russia and Sweden arrived. After peace, packages began to come in from the Netherlands, France, Belgium, and Denmark, almost all containing requests that the missing Garden publications be mailed them at the earliest possible moment. Fortunately, the Smithsonian Institution International Exchange Service resumed its service in September to all European countries except Germany and Italy, so we were able to make a first shipment of our publications in November. Already packets from about twenty European institutions have been received through this service. As soon as they come in the institutions sending them are reinstated on our exchange list, and back-numbers of our publications are made ready to ship to the Smithsonian which forwards them to the foreign countries.

Word has been received from our foreign bookdealer, M. Nijhoff, of the Hague, that he is holding for us the publications purchased during the war years, and that they will be sent as soon as conditions permit.

The foreign book catalogues were beginning to be received in greater numbers too. Few contain many of our *desiderata*, but what does impress us about them is the increase in value of our own books. In checking over one such catalogue, the librarian found that the value of one botanical work had increased ten times, and many had more than doubled. It might be argued from this that now is not the time to make purchases. However, the rise in value of such books is due to their scarcity, and if we do not order them as soon as advertised the chances are that we will never be able to obtain them.

Publications.—Volume XXXII of the quarterly ANNALS and Volume XXXIII of the monthly BULLETIN were issued during the year. The volume of the ANNALS contains 467 pages, 19 plates, and 147 text-figures. Contrary to the usual practice of publishing in the ANNALS only theses of graduate students and articles by members of the Shaw School of Botany staff, the April number was devoted to the papers given at the conference on "Gene Action in Micro-organisms," which was held at the Garden in February. Extra copies of this number were printed, the majority of which have already been sold to hospitals, laboratories, and other scientific institutions.

Beginning with 1945, the style of the BULLETIN was completely changed. The gray cover bearing the Garden seal was replaced by a white cover which carried an illustration either of an interesting plant or a Garden scene. The size was increased from an average of about 20 pages an issue to 24, and all articles were signed by author's names instead of merely the initials. The "Questions-and-Answers" feature was also inaugurated in May. This volume of the BULLETIN contains 240 pages and 101 illustrations. Among the articles which have attracted special attention or have been reprinted in other magazines were: Fairburn and Pring's "Light Requirements for Orchids in the Midwest," which was reprinted by Rodney Wilcox Jones, president of the American Orchid Society, to be distributed to the members of the Society; Cutak's "The Night-blooming Cereus and Its Allies," reprinted in several magazines; Cutak and Pring's "Bromeliads are Fascinating Plants"; and Kohl and Fairburn's "Growing Plants." The last was first published in the BULLETIN in 1928, and after the edition was exhausted it was reprinted in 1941. That edition too was soon out of print, and now the article has been revised and printed again for the November BULLETIN.

In September the Garden contributed the "Schedule of Exhibits" for the Greater St. Louis Victory Garden Harvest Show.

About 550 ANNALS reprints were mailed out during the year to the botanists with whom we have exchange relations. In addition to the publications sent in exchange the receipts for ANNALS, BULLETINS, "Spring Floras," etc., in 1945 were $4,018.58.

New Accessions.—Although not many valuable botanical things have been listed in European catalogues during the year, even the ones ordered were often sold before our order arrived. However, a few rare things were obtained, among them Pallas's "Flora Rossica." This work was published under the auspices of Catherine II of Russia in 1784-88. The library already owned Part I but lacked all of Part II, and since it is a classic, with beautiful hand-colored plates, it was thought advisable to have the complete work. Another purchase, Darwin's "Origin of Species," was described in the May BULLETIN. It is a bibliographical oddity because it is the first issue of the first edition and contains some statements and typographical errors which were changed in the following issue.

In addition to the current books on various phases of botany which one would expect to find in a library such as ours, the following are a few of the more noteworthy purchases during the year: Babington, C. C. Flora Bathoniensis, 1834; Briggs, T. R. A. Flora of Plymouth, 1880; Cunningham, G. H. The Gasteromycetes of Australia and New Zealand, 1944; Exell, A. W. Catalogue of the vascular plants of S. Tomé (with Principe and Annobon), 1944; Fritsch, F. E. Structure and reproduction of the Algae, Vol. 2, 1945; Houck, L. History of Missouri. 3 vols., 1908; and Spanish Regime in Missouri, 2 vols., 1909; Kanysi, G. Elements of bacterial cytology, 1944; Mott, Carter, Finch & Cooper, Flora of Leicestershire, 1886; Orchid Culture in Ceylon, 1944; Osborn, F. The Pacific World, 1944; Pacific Science Congress, 5th and 6th Reports, 1934, 1940; Dupre, H. Rafinesque in Lexington, 1945; R. Istituto d'Incoraggiamento di Napoli Atti. ser. 6, vol. 57, 1906; Musee Royal d' Histoire Naturelle de Belgique. Flore et Faune Houilleres de la Belgique. 2 vols., 1938; Painter, W. H. A contribution to the flora of Derbyshire, 1889; The Herbal of Rufinus. Edited from the unique manuscript by L. Thorndike and F. S. Benjamin, Jr., 1945; Salter, T. M. The genus *Oxalis* in South Africa. (Jour. S. Africa Bot. Suppl. vol. 1, 1944); Santamaria, F. J. Diccionario general de Americanismos, 1942; Science in the University, by members of the faculties of the University of California, 1944; Scott, D. H. Studies in fossil botany. 3rd ed. 2 vols., 1920-23; Spruce, R. On *Cephalozia*, (A genus of Hepaticae), its subgenera and some allied genera, 1882; Stone, Hugh E. A flora of Chester County. (de luxe ed.). 2 vols., 1945; Thoroddsen, Th. Die Geschichte der Islandische Vulkane (Kgl. Danske Selsk, Skrifter, Nat. og Math. Afd. 8 Raekke IX), 1925; Thom, C. and K. B. Raper. Manual of the Aspergilli, 1945; Walker, R. The flora of Oxfordshire, and its contiguous counties, 1833.

Many valuable accessions, principally reprints, are also received through exchange.

Visitors.—In addition to the faculty and students in the Henry Shaw School of Botany, the following out-of-town visitors have made use of the library during the year: Dr. Ernst Abbe, of the University of Minnesota, Minneapolis; Mrs. Paul H. Allen, of Bogotá, Colombia, S. A.; Mr. Paul H. Allen, Field Technician, U. S. Rubber Development Corporation, Colombia, S. A.; Dr. Edward H. Anderson, of Vanderbilt University, Nashville, Tenn.; Dr. Fred A. Barkley, of the Phanerogamic Herbarium, Chicago (Field) Museum of Natural History; Dr. G. W. Beadle, of Stanford University, California; Dr. Norman Boke, of the University of Oklahoma, Norman; Sgt. Louis J. Brenner, of the U. S. Army; Rev. Robert R. Brinker, of Quincy College, Quincy, Ill.; Sr. Raul Briquet, Jr., of Belo Horizonte, Minas Gerais, Brazil; Dr. William L. Brown, of the Pioneer Hi-Bred Corn Co., Johnston, Iowa; Dr. Arthur Cronquist, of the New York Botanical Garden, Bronx Park, N. Y.; Dr. Hugh C. Cutler, of the Botanical Museum, Harvard University; Dr. Max Delbruck, of Vanderbilt University, Nashville, Tenn.; Dr. M. Demerec, of the Carnegie Institution of Washington, Washington, D. C.; Mrs. W. D. Diddell, botanist and plant collector, Jacksonville, Florida; Prof. Erling Dorf, of the Department of Geology, Princeton University, Princeton, N. J.; Dr. Francis E. Drouet, of the Chicago (Field) Museum of Natural History; Dr. Sterling Emerson, of the California Institute of Technology, Pasadena, Calif.; Dr. Ralph O. Erickson, of the University of Rochester, Rochester, N. Y.; Mr. James G. Esson, Editor *Gardeners' Chronicle,* New York City; Mr. T. H. Everett, of the New York Botanical Garden, Bronx Park, N. Y.; Dr. H. I. Featherly, of Oklahoma A. & M. College, Stillwater; Mr. Grail O. Fernwood, of the New York Botanical Garden; Pvt. Cedric Flewellyn of the U. S. Army; Sr. Cooracy M. Franco, of the Inst. Agronom., Campinas, São Paulo, Brazil; Dr. Harry J. Fuller, of the University of Illinois, Urbana; Dr. David R. Goddard, of the University of Rochester, Rochester, N. Y.; Dr. George J. Goodman, of the University of Oklahoma Norman; Dr. John W. Gowen, of Iowa State College, Ames; Dr. Jesse P. Greenstein, of the U. S. Public Health Service, Bethesda, Md.; Sgt. Richard P. Grossenheider, of the U. S. Army; Dr. Ada Hayden, of Iowa State College, Ames; Dr. Ralph S. Hervey, of the U. S. Dept. Agr., Washington, D. C.; Mr. Anton Hogstad, of the University of Grand Rapids, Grand Rapids, Mich.; Dr. Alexander Hollaender, of the U. S. Public Health Service, Bethesda, Md.; Capt. (Dr.) George Thomas Johnson, of the U. S. Army; Mr. J. W. Johnston, Horticultural Editor, *New York Herald-Tribune;* Dr. Walter Kiener, of the Conservation and Survey Division, University of Nebraska, Lincoln; Dr. Mary Maxine Larisey, of Judson College, Marion, Ala.; Dr. Harlan Lewis, of the University of California, Los Angeles; Mr. H. W. Li, of the Rice and Wheat Improvement Institute of Szechuan Prov. Agr. Improv. Inst., China; Dr. S. E. Luria, of the University of Indiana, Bloomington; Mrs. James McClure, writer on horticultural subjects, Kirkwood, Mo.; Dr. I. E. Melhus, of Iowa State College, Ames; Dr. Rogers McVaugh, of the U. S. Dept. Agr., Beltsville, Md.; Dr. Luys de Mendonça, of Rio de Janeiro, publisher of the Brazilian orchid journal, *Orquidea;* Dr. H. J. Muller of Amherst College, Amherst, Mass.; Dr. A. H. Musick, of the University of Tennessee School of Pharmacy, Memphis; Mr. Julian Neill, of the East St. Louis High School, Ill.; Miss Jean Nicholson, of the McKee Jungle Gardens, Vero Beach, Fla.; Dr. E. F. Paddock, of Ohio State University, Columbus; Mr. Rouhollah Rahmani, of the Dept. of Agr., Tehran, Iran; Dr. Kenneth B. Raper, of the U. S. Dept. Agr., Washington, D. C.; Mr. Donald Richards, of the Chicago (Field) Museum of Natural History; Prof. Pablo Martinus del Rio, of the Universidad Nacional de Mexico, Mexico, D. F.; Dr. R. R. Roepke, of the American Cyanamid Co.; Dr. Carl O. Sauer, of the Department of Geography, University of California, Berkeley, Calif.; Mrs. F. W. Schoettler, of Louisville, Ky.; Dr. E. R. Sears, of the University of Missouri, Columbia; Dr. J. M. Severens, of the University of Illinois, Urbana; Dr. Lloyd H. Shinners, of the Milwaukee Public Museum (on leave), Research Fellow, Southern Methodist University, Dallas, Tex.; Lt. (Dr.) H. H. Smith, of the U. S. Naval Reserve; Capt. Smith, of the University of California, Berkeley; Mr. Ray Snider, of the Pioneer Hi-Bred Corn Co., Yellow Springs, Ohio; Dr. T. M. Sonneborn, of the University of Indiana, Bloomington; Dr. L. J. Stadler, of the University of Missouri, Columbia; Dr. Curt Stern, of the University of Rochester, Rochester, N. Y.; Dr. Julian Steyermark, of the Chicago (Field) Museum of Natural History, Chicago; Dr. A. H. Sturtevant, of the California Institute of Technology, Pasadena; Miss Peggy Sullivan, of Cornell University; Dr. E. L. Tatum, of Stanford University, Calif.; Miss Martha Thurlow, Librarian Department of Biology and Chemistry, University of Texas, Austin; Dr. W. L. Tolstead, of the Conservation and Survey Division, University of Nebraska, Lincoln; Dr. P. C. Trexler, of the University of Notre Dame, Notre Dame, Ind.; Dr. R. M. Tryon, of the University of Minnesota, Minneapolis; Maj. Richard Walker, graduate student, department of botany, University of California, Berkeley; Dr. Norbert Wiener, of the Massachusetts Institute of Technology, Boston.

Among the groups visiting the Garden were: botany students of Southern Illinois Normal University, Carbondale, accompanied by their professor, Dr. Walter B. Welch; students in biology of the Wood River High School, Wood River, Ill., accompanied by their instructor, Mr. W. C. Hopper; students in botany from Washington University, accompanied by Dr. Robert E. Woodson and Mr. Charles B. Heiser, Jr.; students in biology of the Pattonville High School, Pattonville, Mo., under the leadership of their teacher, Mr. M. C. Shauver; members of the Little Gardens Club, of Clayton, Mo.; members of the Ferguson Garden Club, Ferguson, Mo.

The library also loans books on the interlibrary loan plan, 104 such loans having been made to 30 institutions during the year.

Statistical Information.—There have been donated to the library or received in exchange during the year 282 books valued at $757.05 and 1243 pamphlets valued at $169.95. There were 182 books bought at a cost of $877.66, and 27 pamphlets at a cost of $21.99. The library now contains 56,366 books, 93,613 pamphlets, and 355 manuscripts. The number of index cards now totals 1,101,307, of which 3,861 were added during the year, 865 having been written by Garden employees and 2,996 purchased at a cost of $69.14. Two hundred and fifty-one books were bound and 18 were re-bound or repaired.

ANNUAL BEQUESTS

The annual flower sermon "On the goodness of God as shown in the growth of flowers, fruits, and other products of the vegetable kingdom," provided for in the will of Henry Shaw, was preached at Christ Church Cathedral on April 15, by Dr. Douglas V. Steere, Professor at Haverford College, Haverford, Pa.

The gardener's banquet fund was used to provide turkeys for employees at Christmas.

ATTENDANCE FOR 1945

(Not including visitors to Arboretum)

	Week-days	*Sundays*
January	2,848	3,223
February	4,551	8,315
March	6,372	6,431
April	8,243	17,384
May	10,653	12,530
June	9,613	5,130
July	11,029	6,997
August	13,110	6,363
September	8,569	21,518
October	9,901	13,698
November	15,613	20,752
December	2,904	5,611
	103,406	127,952
		103,406
Total		231,358

GEORGE T. MOORE, *Director.*

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MISSOURI BOTANICAL GARDEN BULLETIN

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Cover: Primroses in the Spring Flower Show at the Garden.

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Please: Do not discard a copy of the Bulletin. If you have no further use for yours pass it along to a friend or return it to the Garden. Return postage will be guaranteed.

Missouri Botanical Garden Bulletin

Vol. XXXIV FEBRUARY, 1946 No. 2

BREEDING YEASTS FOR THEIR NEW ROLE IN NUTRITION*

CARL C. LINDEGREN

Yeasts in Ancient Times.—Both baking and brewing are very old processes, having their origins in prehistoric times. The yeast from the beer vats was used for baking, and in the ancient Egyptian households the same steward had charge of both baking and brewing. Beer used to be turbid and contained a thick sediment of yeast. Some kind of beer with a low alcoholic content has been used as a beverage in practically all civilizations.

Beer was an important adjunct to primitive dietaries because it supplied a beverage free from parasites and disease-producing bacteria. Most primitive communities settled around a body of water which soon became badly polluted, and the drinking of a mild alcoholic beverage enabled the people to continue to live in the same locality in spite of the increasing pollution of the water supply. The long steeping process which preceded the brewing was important in making the grain digestible, and many primitive beers contained large amounts of undissolved grain in addition to the yeast sediment. The yeast found in bread and beer was often the main source of B vitamins, which are the water-soluble vitamins essential for human nutrition.

Pure-Culture Technique and Pasteurization.—About 80 years ago specialized bakers' yeast was first manufactured, starting an intensive program of selecting yeasts for this and other purposes. This work was made possible by the discovery of the pure-culture method of growing microorganisms—a method first used by Dr. Emil Christian Hansen in the Carlsberg Brewery at Copenhagen. In growing yeasts on a solid medium, such as gelatin or agar, a single yeast colony forms at the point where a single cell is planted. This colony represents a pure culture, for all the cells are descended from the original one.

The discovery of the pure-culture method made possible the preparation

* This work is supported by a grant from Anheuser-Busch, Inc., St. Louis.

of a yeast free from bacteria, which were the main causes of irregularities and accidents in brewing. It eventually led to the establishment of the Carlsberg Laboratories, an institution engaged in pure scientific research and endowed by the Carlsberg Breweries. By the pure-culture technique tremendous advances were also made in the study of disease-producing bacteria. Brewing began to be a scientific process when Dr. Louis Pasteur was commissioned by the French government to investigate the spoilage of beer in France. He devised a method of heating the beer at a low temperature, thus killing the bacteria responsible for spoilage. Both pure-culture techniques and pasteurization are standard practices to-day.

Yeasts of Modern Times.—Many of our modern industries are based on the use of yeast. There are many kinds of yeasts, and specific ones have been developed for each of the different industrial processes. No modern manufacturer of bakers' yeast uses any of the great variety of beer yeasts which is available to-day.

The ordinary cake of compressed yeast is a mass of living yeast cells filtered from the fluid in which they grew. The cells stay alive for a long time if refrigerated, and as soon as they are placed in a solution containing sugar and a few other nutrients they begin to grow. The sugar serves as a source of energy for growth, during which process carbon dioxide and alcohol are given off. The ability of yeast to transform sugar into carbon dioxide forms the basis for its use in bread-making. The bubbles of gas produced by the growth of yeast in the dough make the bread a light fluffy palatable food; without the yeast it would be a hardtack or a cracker.

The ability of yeast to transform sugar into alcohol is the basis for its use in making beer, industrial alcohol, and distilled liquors. The early steps in brewing and distilling are essentially the same. The grain, or fruit, or molasses, is fermented with yeast in a closed container, because the absence of air favors the production of a maximal quantity of alcohol. When yeast is grown for baking or vitamins the culture is aerated vigorously with the result that no alcohol is produced and more yeast is obtained. After fermentation without air, the alcohol is distilled from the fluid, and the non-fermentable residue, together with the yeast, is dried down and sold for cattle feed. This feed is an excellent source of protein and B vitamins. As a matter of fact, hogs, chickens, and cattle usually get the vitamins that they need, which is not always true with people.

The effect of a dietary that does not supply adequate B vitamins may be seen in the poor people in the southern United States, who have been wrongly called lazy and shiftless. Their difficulties, however, arise from the fact that their diet consists almost exclusively of corn-bread and fat pork.

Varieties of Yeasts.—About 2,000 different species of yeasts are listed in various indexes. However, this only begins to indicate their variability, for we have in our laboratory at Washington University a collection of nearly 1,000 different types of a single species, *Saccharomyces cerevisiae* (fig. 1). Cultures of this species, collected from vineyards, spoiled fruit, soil, fresh figs and apricots, etc., differ as much among themselves as do human beings. This is the species used for wine making, baking, brewing, and also the one that produces the industrial alcohol and distilled liquors. Most of the vitamins synthesized by yeasts on an industrial scale are produced by special hybrids derived from *S. cerevisiae.* The meat flavor in many dehydrated and canned soups is obtained by the addition of specially processed yeast derived from the species *S. cerevisiae*, specially bred for this purpose.

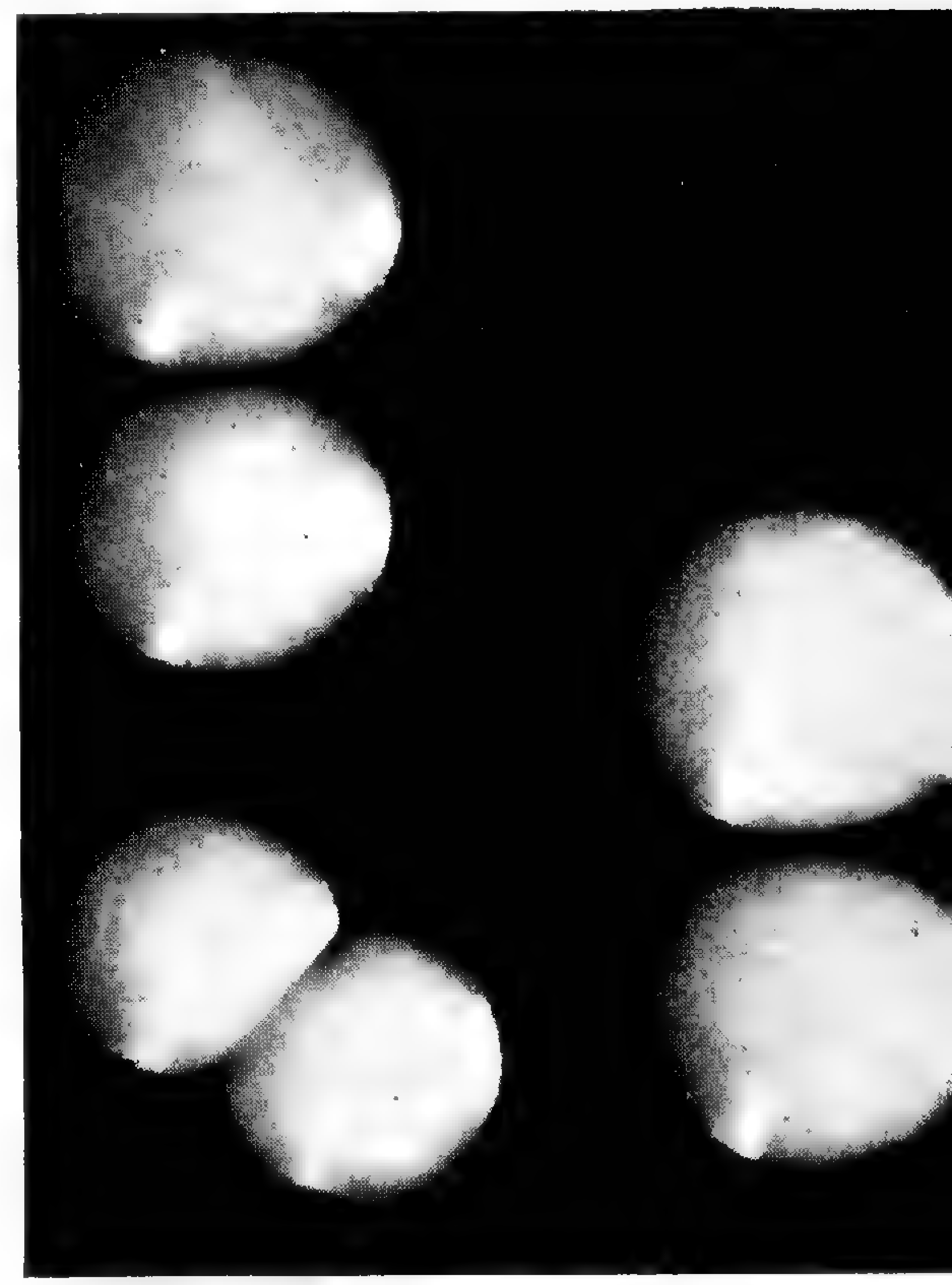


Fig. 1. Normal colonies of yeast *(Saccharomyces cerevisiae)* growing on agar.

Vitamins in Yeast.—The fact that yeasts are able to synthesize vitamins was discovered only within the last few decades. Like carbon dioxide and alcohol, vitamins are a by-product of yeast growth. Recognition of this fact led to the use of yeast as a source of the B vitamins for people. At first only the yeast remaining after brewing beer was used for the manufacture of yeast tablets, but now there is a considerable industry in which yeast is grown only for its vitamin content. Thousands of tons of yeast, bred and selected especially for high vitamin content, are sold annually in the United States to-day. While vitamin tablets and pills were formerly used only by sick people, at the present time many people very commonly take them as a supplement to their normal diets.

Amino Acids in Yeast.—Yeasts are an important source of high-quality protein and thus can be used to produce amino acids. These amino acid concentrates speed up recovery from starvation, burns, amputations, ulcers and wasting diseases. While most yeasts in this country are grown on mixtures of molasses, grain extracts, and ammonia, it is well known that, by selecting the proper yeasts and growth conditions, good yields can be obtained on almost any sugar. Among products that have been converted to fermentable sugars and used for yeast nutrients are agricuultural wastes, including corn, wheat, oat, rye, barley and other grains, stalks, citrus pulp and peel, sul-

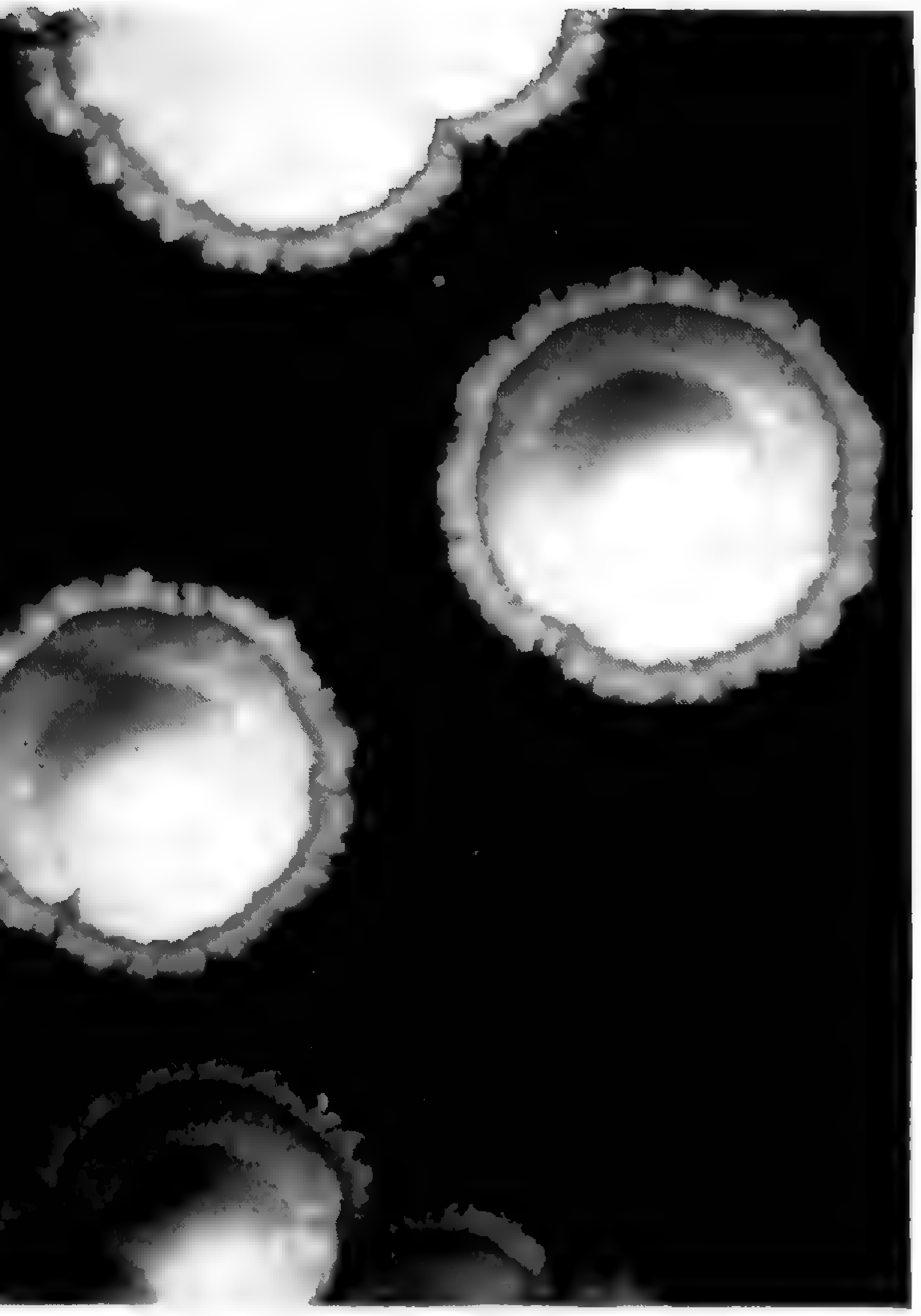


Fig. 2

Figs. 2 and 3 are yeast colonies showing variations in shape and size due to genetical differences.

fite liquors (a waste product from paper making), and even sawdust. In fact, the Germans, by making extensive use of sugar from wood pulp for growing yeast, produced 200,000,000 pounds of food yeast during the Second World War. This was an important source of both proteins and B vitamins.

Selection and Hybridization.—The first method of obtaining the specific yeasts used for special fermentations was to test a large number of pure cultures from a variety of sources; when a culture that produced high yields of the desired product was found, selections from it were made periodically, much as plant breeders select favorable variants. With higher plants, though, the breeders were able to produce hybrids at will, while *Saccharomyces cerevisiae* at first was supposed not to have a sexual cycle and therefore not amenable to hybridization. However, in 1935, Dr. O. Winge, who worked in the Carlsberg Laboratories where Dr. Hansen had preceded him fifty years before, discovered that S. *cerevisiae* has a sexual cycle. Mr. O. Laustsen, working with Dr. Winge, developed a method of picking spores out of the sac. He placed two of the spores side by side, and watched them fuse to produce the new hybrid. Once a hybrid has been produced, it continues to multiply as a hybrid. Dr. Winge and Mr. Laustsen made a number of hybrids between different strains of S. *cerevisiae* as well as with related species. At least one of these was an improvement over standard bakers' yeast and was used industrially.

Yeast Inheritance.—Chromosomes are the carriers of the hereditary factors in

Fig. 3

yeasts just as they are in human beings. Reproductive cells, like the sperm and the egg in humans, each contain 24 chromosomes. The fertilized egg, however, contains 48 chromosomes, 24 of which came from the male and 24 from the female. In the same way yeasts exist in two phases. Their reproductive cells, which are derived from the spores, contain a single set of chromosomes, while the large cells contain a double set. The single set of chromosomes is called the n number, while a cell with the double number of chromosomes has the $2n$ number.

Sex in Yeast.—In our laboratory at the University, we have invented a new method of producing hybrids. We dissect individual spores from a sac and grow them separately. (Each cell in these cultures has a single set of chromosomes.) When we mix two cultures together, in the right combination, we can see them fusing to form cells with the double number of chromosomes. In the course of this study, we discovered that the n cells are of two sexes. Although we do not know which is male and which is female, the end result is the same. When two cultures of opposite sexes are mixed, hybrids are obtained, but when two cultures of the same sex are mixed, hybrids cannot be produced.

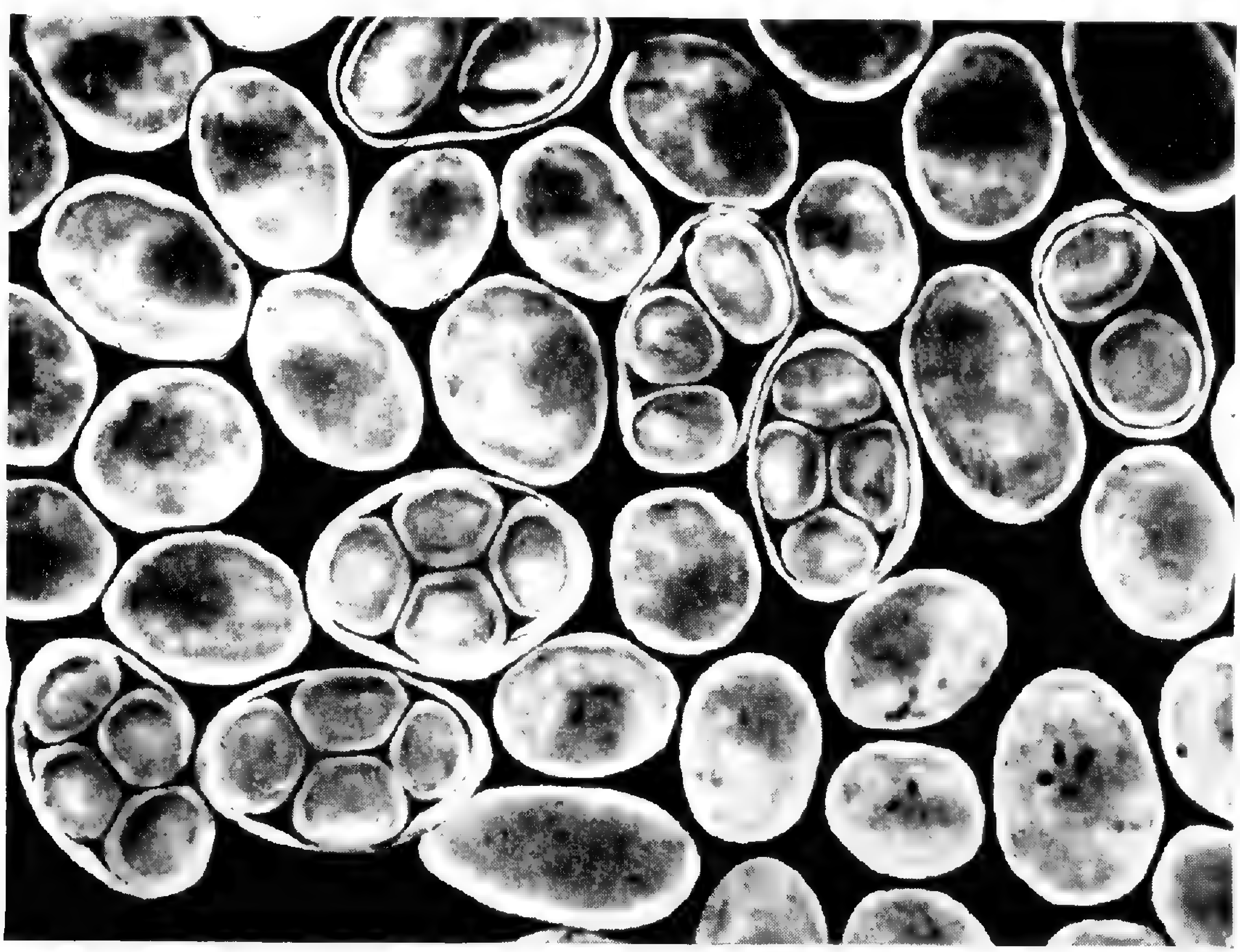
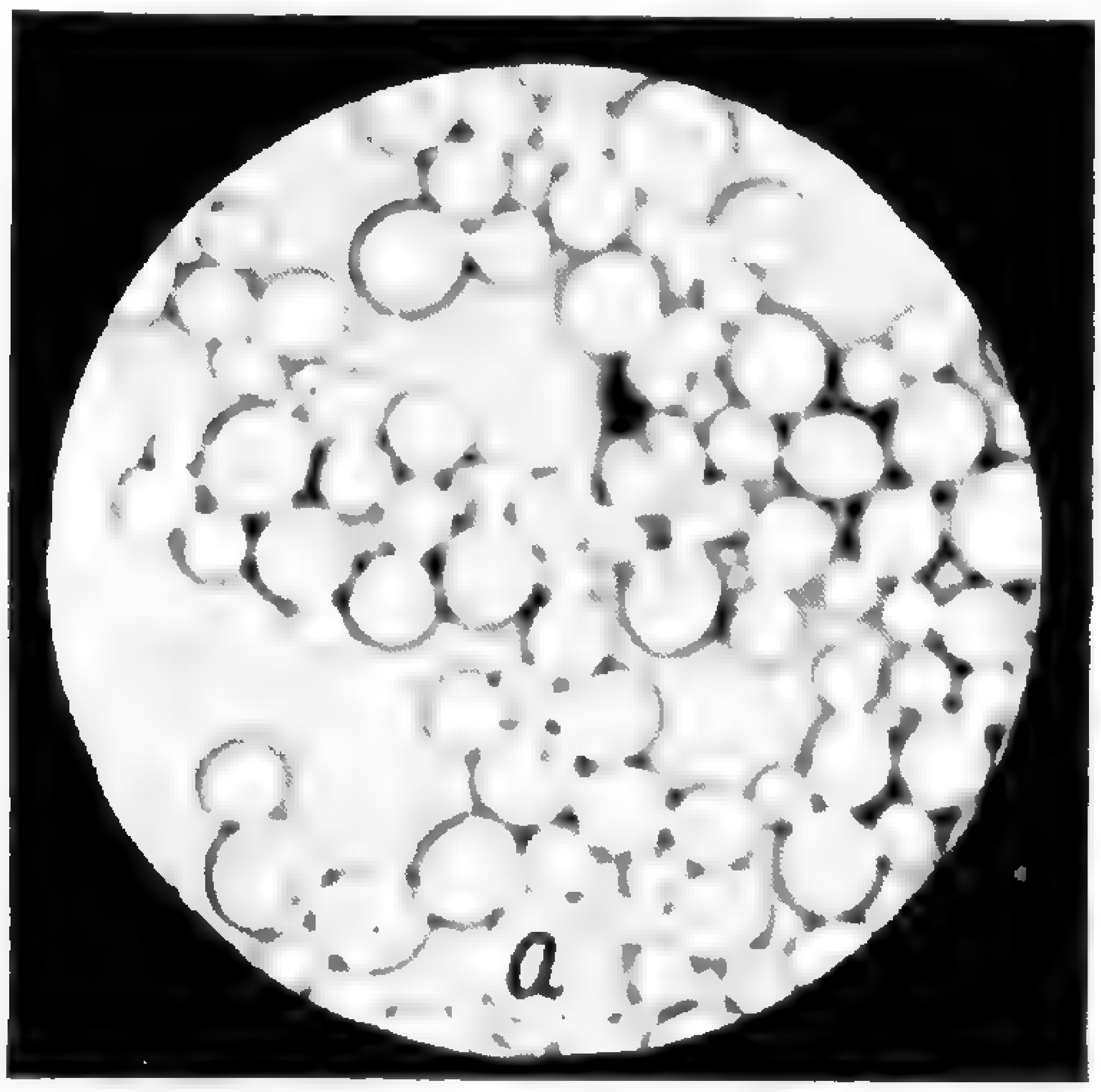
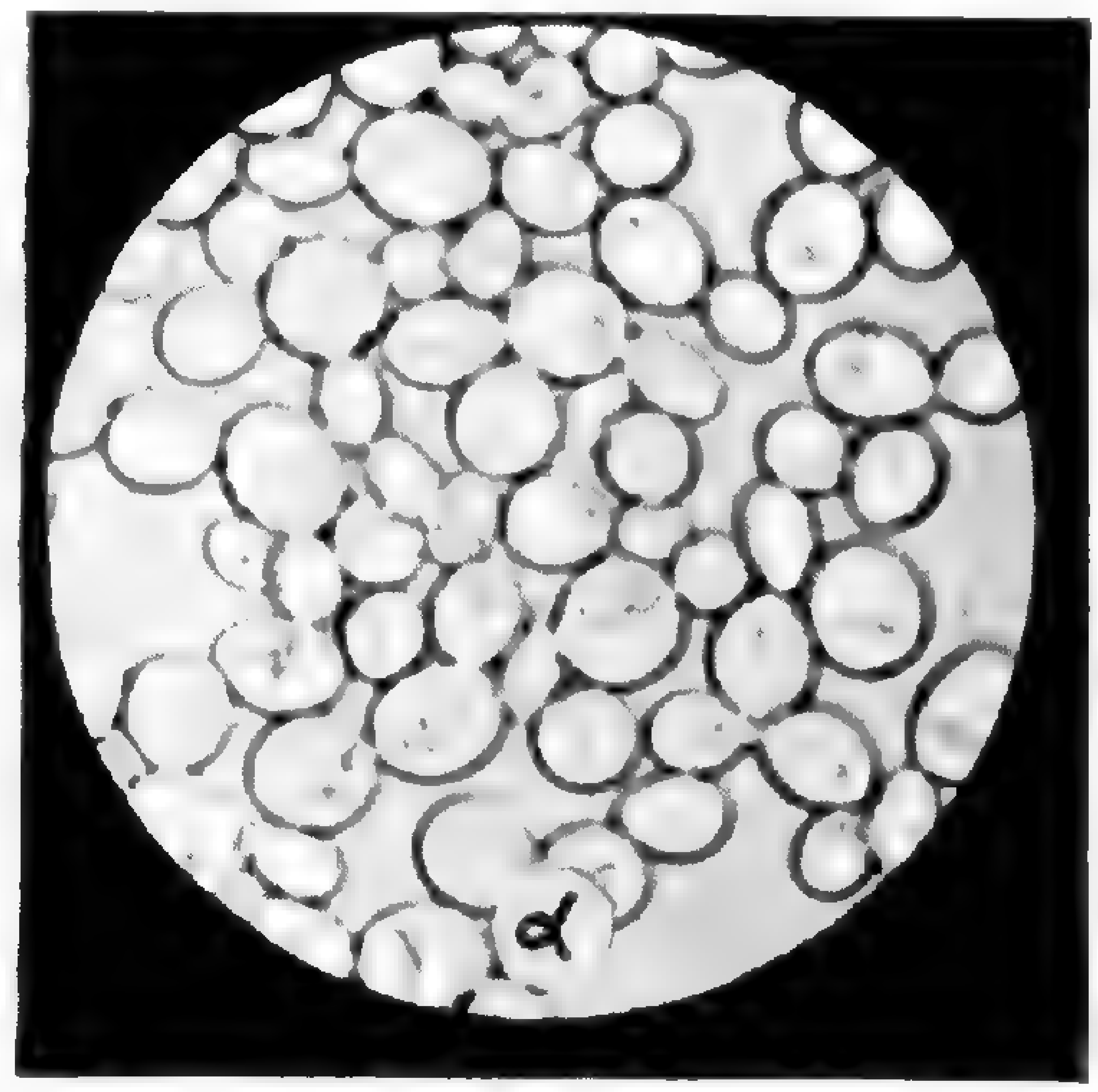


Fig. 4. Large ellipsoidal hybrid cells with the $2n$ chromosome number which grew from the fusions shown in fig. 5a and α. The sacs containing 2, 3, or 4 small cells are those which have sporulated. Two of the spores in the sac containing 4 spores are sex a and two are sex α.

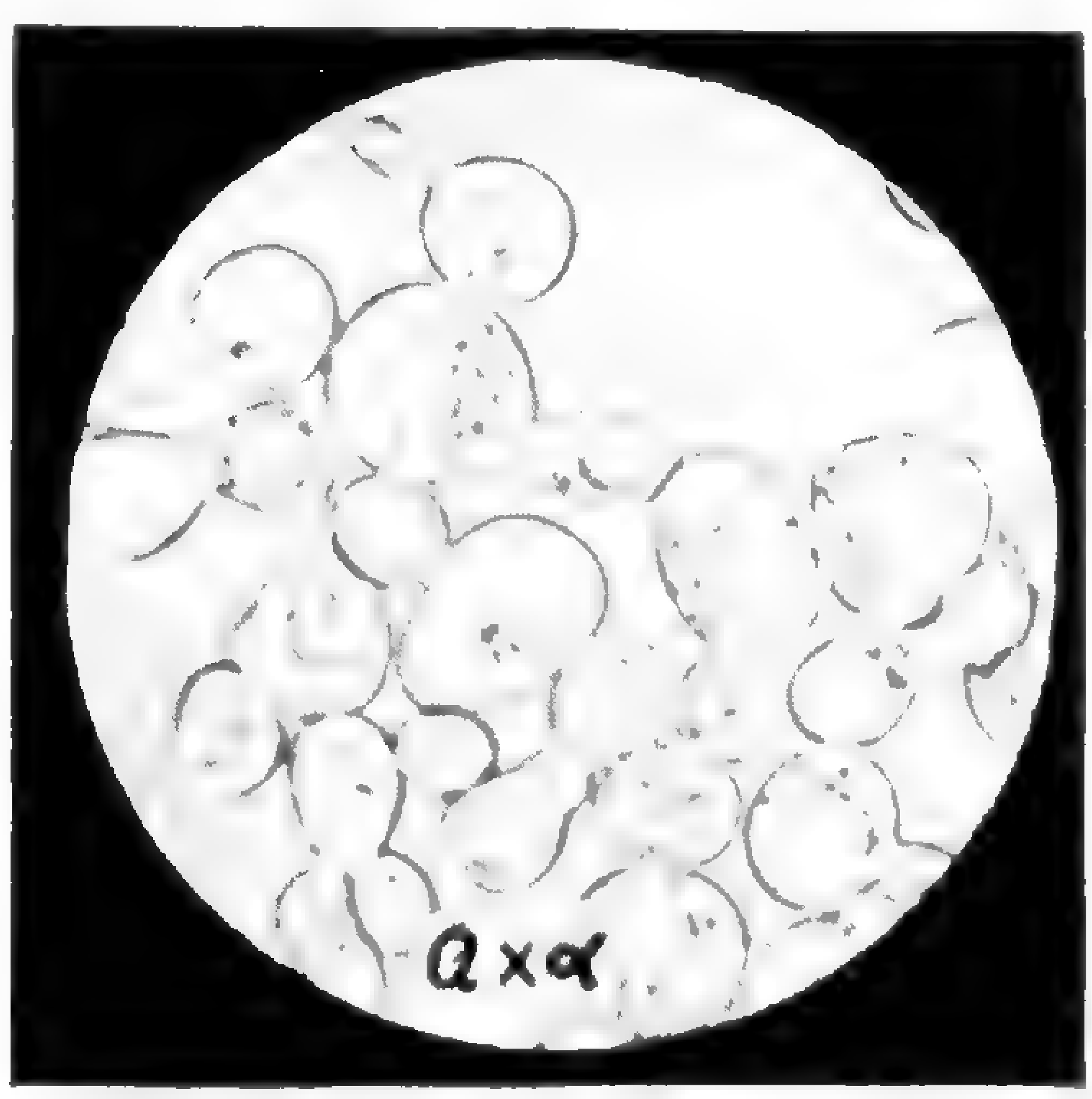
The *n* cells, being usually small and round, are easy to distinguish from the hybrid 2*n* cells which are large and ellopsoidal. Figure 4 shows the large yeast cells with the double number of chromosomes changing into a sac containing four spores, each of which has a single set of chromosomes. It is possible to cut this sac up under the microscope and pick out the four spores separately. When these are planted in broth or on solid medium a culture develops in which all the cells contain the single number of chromosomes. Two of these cultures are always of one sex, which we call *a* sex, while the other two are always of the opposite or *α* (alpha) sex. By dissecting the spores from several different yeast species we have obtained a large



Yeast cells containing the *n* (haploid) chromosome number whose sex is *a*. The cells are round and small, and the entire culture has originated from a single spore.



Yeast cells containing the *n* number of chromosomes whose sex is *α*, which means that they are able to fuse and form a hybrid with cells of sex *a*. The *α* cells otherwise are indistinguishable from the *a* cells.



A mixture of *a* and *α* cells shown above revealing the fusions which occur in the formation of the hybrid with the 2 *n* (diploid) number of chromosomes.

Figure 5

number of cultures which can be mated with each other to produce new hybrids.

When two cultures of opposite sex are mixed together, the cells fuse as shown in figure 5. Shortly after the fusion, a large normal cell with a double number of chromosomes develops from the fusion cells. It continues to grow as a large cell maintaining the double set of chromosomes, and thus a permanent new hybrid has been established.

New Hybrids.—Natural yeasts differ in their ability to ferment cane sugar (sucrose), malt sugar (maltose), milk sugar (lactose), dextrose, and several other types of sugars. It is sometimes desirable in industry to obtain yeasts which ferment combinations of sugars different from the ordinary natural yeasts. By hybridization, we are able to deal with the factors responsible for each fermentation like separate units and thus produce yeasts "made to specifications."

In order to achieve success in a breeding program, it has been necessary to make a very elaborate scientific study of the yeast cell. Practically all this work has a wide and general significance concerning the mechanism of life itself, for anything that is discovered about one living cell applies to all. As an example of what can be done in hybridization of yeasts, we obtained a culture of S. *cerevisiae* with a single set of chromosomes. This species was not able to synthesize two of the important B vitamins, namely, pantothenic acid and biotin, although it was able to synthesize pyridoxine. From another species of yeast, S. *carlsbergensis*, we obtained a culture of the opposite sex which was unable to synthesize pyridoxine, although it could synthesize pantothenic acid and biotin. The hybrid made by mixing these two cultures was able to synthesize pyridoxine, pantothenic acid and biotin, and was consequently superior to either of the strains from which it had arisen.

WHAT IS A TETRAPLOID?

EDGAR ANDERSON

Ten years ago, any one who happened to be an authority on polyploidy lived in a world which took little interest in his specialty, other than to smile at the strange terminology—*tetraploids, diploids, polyploids*. These terms came so trippingly off the tongue that those who were among the first to use them were smiled at not only by the man in the street but by their fellow scientists as well. The year 1946 finds this all changed. Polyploidy is accepted as a dull and every-day fact in biological circles. Its practical value is already well established, and an authority on polyploidy often finds in the morning mail requests from practical plant breeders for detailed technical information. A few years ago the terminology of the subject began to creep into the seed business. This year the word *tetraploid* is boldly flaunted on the front cover of at least one catalogue, and rare indeed is the firm which does not employ it in some of its literature.

But though the man in the street no longer smiles at the mention of polyploidy, most intelligent gardeners are still pretty much in the dark as to just exactly what the term implies. What is a polyploid anyway and what are diploids and tetraploids? Can these technicalities be explained in the everyday vocabulary of an intelligent amateur? This is asking a good deal of an authority on polyploidy; he must lay aside the precise technical terms he uses as tools for his own thinking and for discussion with other experts. He must somehow re-think the facts of polyploidy in everyday language; translate his own thoughts, so to speak. This is difficult but it can be done after a fashion, though, to do it well, we must begin by talking about matters which are seemingly a long way from nursery catalogues or tetraploid marigolds or snapdragons.

You, dear reader, are a vertebrate, though you may not be accustomed to thinking of yourself in that light, and, like nearly all vertebrates, you are also a diploid. This exotic-looking word is merely a precise technical way of saying that you are "two-fold." It means that you have two sets of hereditary factors. You got one of them from your mother's side of the house and one from your father's, as did each of them in their turn. Indeed, you come from a family of diploids. The whole human race is made up that way. Caesar was a diploid, and so was Charlemagne, and so too are alley-cats and elephants and pigs and sheep and even canary birds. Among nearly all the higher animals and many of the flowering plants, diploidy is the rule. Lettuce, like you, is a diploid and so are peas and rye. But modern wheat is not and cultivated strawberries are not, nor are chrysanthemums, nor dahlias, nor European plums. They are all polyploids of one kind or another.

Polyploid means "many-fold," and it refers to the hereditary factors which in these plants are not in two sets like yours and mine, but in many sets. Bread wheats, for example, have six. Each little wheat plant gets three whole sets of hereditary factors from the maternal side of its family tree and three more sets from the paternal one. *Polyploid* is the general term covering all cases where whole sets have been duplicated; tetraploid means that there are four sets; hexaploid, that there are six; octoploid, that there are eight, as in the common garden Dahlia.

Polyploidy is pretty common among the flowering plants, and understanding it has given us the key to various puzzles. Polyploids are now being produced artificially in the laboratory and the plant breeding plot since the discovery that the drug colchicine could be used to induce doubling. Previous to that time the doubling took place in much the same kinds of ways but under natural conditions. The blue spiderwort or Tradescantia, which grows in such abundance along sunny railroad tracks in the Middle West, is a natural tetraploid. Down in Texas one can find the diploid strain from which the tetraploid arose. Put the diploid and the tetraploid spiderwort side by side and there is little outward difference between them, except that the latter is somewhat huskier; but look at them through the microscope and you can actually see that the hereditary factors in the diploid are in sets of two while in the tetraploid they are in sets of four. Grown in the garden or the greenhouse, other differences appear. The tetraploids are indeed quite a little hardier. They stand transplanting better; they are less affected if the garden is overrun by weeds; they are a little slower to come into blossom but stay in bloom much longer and bear more flowers. It is probably for such reasons as these that the diploids are restricted to a small area in the South while the tetraploids are found from Nebraska to North Carolina and from Mississippi to Michigan.

Not all polyploids have this added vigor but many of them do; it is, on the whole, a characteristic feature of polyploids, and it is one of the reasons why they are of commercial importance. A tetraploid snapdragon or a tetraploid carnation may be expected to be a little larger, a little more tolerant of poor growing conditions, a little longer to stay in bloom.

Though these characteristics are important, they are not the only reasons why the production of polyploids is becoming of increasing economic importance. For one thing, polyploidy increases variability. When all the hereditary factors are in sets of fours or sixes rather than in sets of twos, many more combinations are possible. Let us take the color of spiderwort flowers as an example. Suppose we begin with a diploid strain in which there are only blue-flowered plants and albinos. Since there are only two sets of factors there are only three possible kinds of plants:

(1) Those which have two sets of blue
(2) Those which have two sets of white
(3) Those which have one set of white and one of blue.

Now blue is a stronger kind of factor than white and one dose of blue and one of white will look practically like blue, so that in this particular strain of spiderworts all that we can hope for are blues and whites. Some of the blues will be true-breeding and some will throw whites among their seedlings, but the blues will all look pretty much alike. Turn these into tetraploids, however, and there are five possible kinds:

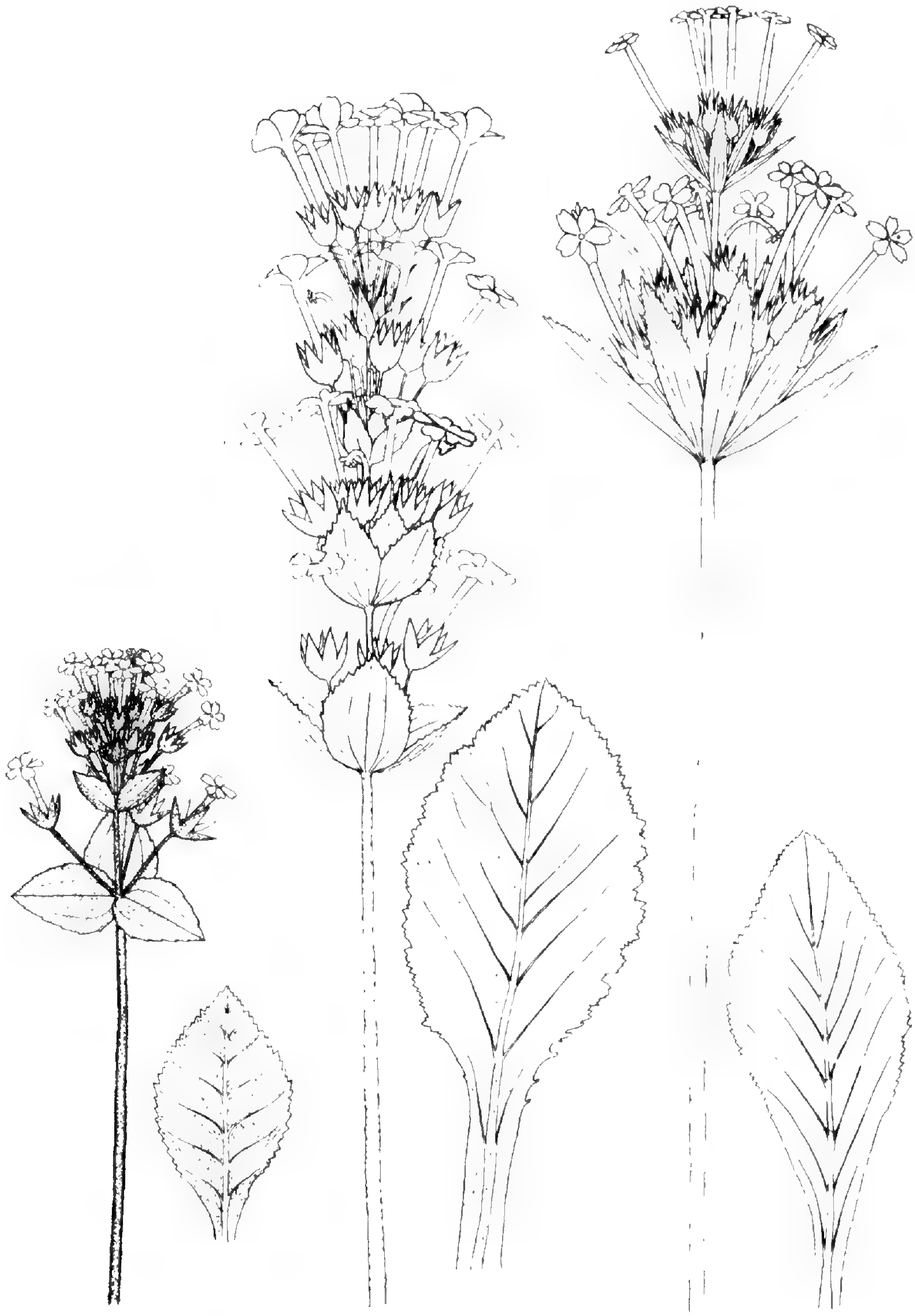
(1) Pure-breeding blues
(2) Pure-breeding whites and the following intermediates
(3) Three sets of blue and one of white
(4) Two sets of blue and two of white

(5) One set of blue and three of white.

This last class we may confidently expect to look somewhat different. Though blue is so much stronger a factor than white that it can cover up the lack of blue in *one* other set, *three* doses of white are too much for it. Such a plant will be pale blue instead of a deep shade. In our tetraploids therefore we shall have many more delicate shadings than in the diploids, for this same multiplicity of intermediate types will be true of all the factors, not merely for those of blue versus white. This is particularly important in flower breeding, where soft and delicate shades are eagerly sought after. One of the reasons why so much has been accomplished in Dahlia breeding is that the Dahlia is an octoploid. Its hereditary factors are in sets of eight, and various intermediate states are possible for each hereditary difference.

The polyploids which we have talked about up to this point are "auto-polyploids"; that is they are built up by replications of the same original set of factors. There is another class of polyploids known as "allo-polyploids," in which the sets are not all the same. Some of them are pretty complex in their make-up, and they are not so simple to describe. Many of them are now in the making, and they are going to play an increasingly important role in plant breeding.

One of the easiest ways to explain alloploids is to describe one of the first cases to be studied scientifically, the Giant strain of the Kew Primrose. The English public loves the yellow primroses which grow wild along the hedge rows in the springtime. English florists have for years been attempting to produce a winter-flowering variety that could be marketed commercially. The Kew Primrose is the result of one of these attempts. It started as a hybrid at Kew Gardens, a hybrid between two quite dissimilar yellow primroses. One was *Primula verticillata* and the other was *Primula floribunda,* and both were diploids. The original hybrid was also a diploid; it had two sets of hereditary factors, one from *verticillata* and one from *floribunda.* These two sets were very different, not too different to get together and form a plant, but different enough so that the little hybrid set no seed and was absolutely sterile. However, the English public liked yellow primroses, and so gardeners managed to multiply the original stock by dividing the individual plants. Eventually a very occasional plant was found to send up a strong sturdy shoot which bore slightly larger flowers. On these shoots, seeds were borne which germinated and produced plants very much like the hybrid from which they came. It was a double mystery. The sterile plant had become fertile, and though it was a hybrid it bred true. Examination with a microscope solved the puzzle. Both parent species and the original hybrid were diploids. One could look through the microscope and determine that fact. The fertile branch and its seedlings were tetraploids, that is, they



Left, *Primula floribunda;* right, *Primula verticillata;* center, Giant strain of × *Primula kewensis*, their tetraploid hybrid derivative.

had four sets of hereditary factors, two from *verticillata* and two from *floribunda*. That explained everything, except as to just exactly how the doubling had taken place. Granted that it did, since we know that it must have, the rest of the story is simple. The tetraploid branch, being a tetraploid, was a little larger and sturdier. There were two sets of factors from *verticillata*, as there had been in that original parent, and there were two also from *floribunda*. Each of the two sets could pair and reproduce its kind just as an ordinary diploid does, and so at one jump *Primula kewensis* became fertile, and true-breeding, and slightly larger and more vigorous. It was a polyploid hybrid, an "allo-polyploid."

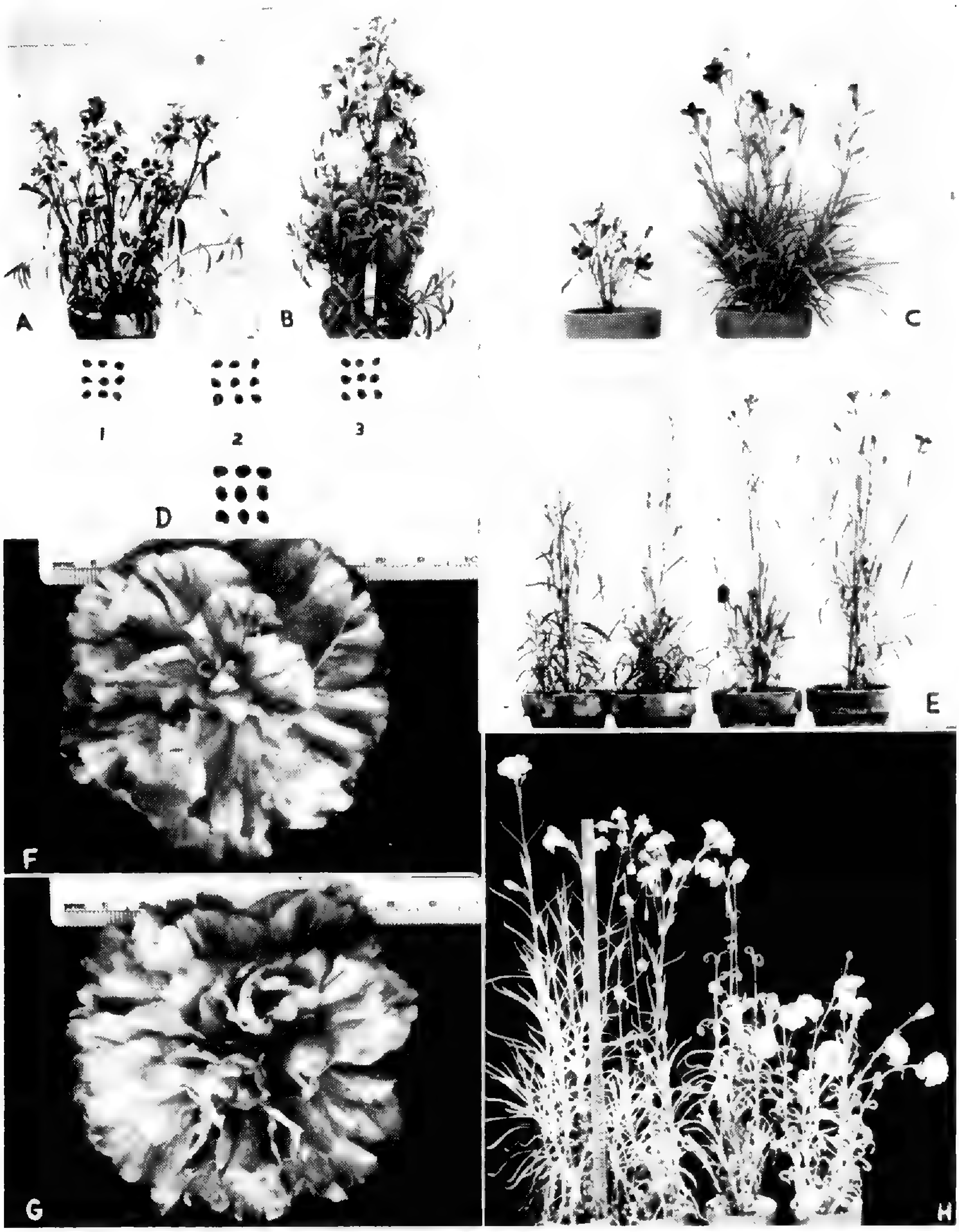
Now that we are learning how to use the wonder-drug colchicine (which, by the way, is a very dangerous substance to handle and should be avoided by the inexpert) we no longer have to sit around and wait for these mysterious doublings to occur. With a sterile diploid we may hope, in a few years' time and with concentrated hard work, to turn it into a fertile allo-tetraploid. Many of these plants have already been produced, and in the gardens and fields of day-after-tomorrow they are going to play a very important role. Quack-grass is being crossed with wheat to produce fertile, true-breeding polyploids that will have the large grains of the wheat and some of the toughness of the quack-grass. It is possible we may even get a kind of perennial wheat to use as a range grass. In California whole new sets of polyploid grasses are already under trial to see if the western cattle ranges can be kept green a few weeks longer in the long dry summer. The cottons of the world are some of them diploid and some tetraploid. Before this business was understood, much of the breeding work came to nothing. Now diploids are being doubled into tetraploids, so that they can be crossed with natural tetraploids; sterile hybrids are being turned into fertile alloploids; and the whole cotton-breeding program has taken on a new spurt.

Many of our cultivated plants are polyploids. Some of them were naturally occurring polyploids before they were brought into cultivation. Others were fortunate accidents in the plots of gardeners and plant breeders. Now that we understand what polyploidy can do and even have techniques for producing it experimentally, plant breeding will make great and rapid advances.

TETRAPLOIDY AND PINKS

GUSTAV A. L. MEHLQUIST

During a visit to the flower seed-fields in Lompoc, California, in the summer of 1936 I observed that varieties of *Dianthus Heddewigii* (fig. 1) and *D. laciniatus* (fig. 2) were in some instances being grown rather close to plantings of *D. chinensis* (fig. 3), the Chinese pink. Both *D. Heddewigii* and *D. laciniatus* are considered to be forms of *D. chinensis*, and it was somewhat surprising to learn that, although these two interbreed freely and therefore had to be grown far enough apart to prevent cross pollination by insects, neither of them interbreed naturally with *D. chinensis*, their sup-



(A) *Dianthus chinensis*, tetraploid. (B) Tetraploid *caryophyllus x chinensis* hybrid. (C) *Thin* and normal diploid carnations. (D) Upper left, seeds of *Dianthus chinensis;* upper right, seeds of carnation; upper middle, seeds from cross; lower middle, seeds from tetraploid hybrid. (E) Four plants of first back-cross to carnation, the two plants on the left being triploids, those on the right tetraploid. (F) Flower of plant from second back-cross to carnation. (G) Flower from seedling from F. (H) Progeny from intercrossed second back-cross plants.

Fig. 1. *Dianthus Heddewigii*

posed parent species. The possibility of occasional natural hybrids was not denied but none could be found. On the other hand, I was told that natural hybrids between *D. chinensis* and many different forms of the common carnation *D. caryophyllus* were often found even when these species were grown quite far apart. This information did not surprise me, for, although *D. chinensis* and the cultivated garden forms of *D. caryophyllus* are quite distinct, both natural and artificial hybrids between them have been reported

Fig. 2. *Dianthus laciniatus splendens*

from time to time. However, the fact that *D. chinensis* did not interbreed with its so-called forms or varieties, *D. Heddewigii* and *D. laciniatus*, did surprise me, for Dianthus species are notorious for their crossability, and one would expect forms or varieties of a species to be readily hybridized with its parental form.

To satisfy myself as to these alleged relationships, seeds of each of these different types were planted in the University of California greenhouses in Berkeley in the spring of 1938. From each variety five plants were selected for hybridization and chromosome studies.

TABLE I—SUMMARY OF HYBRIDIZATION RESULTS

Parentage	No. of crosses	No. of seeds	Av. No. of seeds	No. of hybrids	Per cent germination
chinensis x *Heddewigii*	10	28	2.8	5	18
chinensis x *laciniatus*	6	18	3	2	11
caryophyllus x *Heddewigii*	5	3	.6	1	33
caryophyllus x *laciniatus*	5	2	.4	1	50
caryophyllus x *chinensis*	18	800+	44	693†	86
Heddewigii x *laciniatus*	10	374	37.4	89*	89

† This number covers all the plantings made to date from this cross.
* Only ten seeds of each cross were planted.

As is shown in table I, the results were clear-cut enough. Ten crosses between *D. chinensis* and *D. Heddewigii* produced 28 seeds from which were obtained five hybrids, three of which were highly fertile while two were completely sterile. Six crosses between *D. chinensis* and *D. laciniatus* produced 18 seeds resulting in two hybrids, one fertile and one sterile. Five crosses between *D. caryophyllus* and *D. Heddewigii* produced three seeds giving one sterile hybrid. Five crosses between *D. caryophyllus* and *D. laciniatus* produced two seeds giving one sterile hybrid. On the other hand, 18 crosses between *D. chinensis* and different forms of *D. caryophyllus* resulted in over 800 seeds. Ten seeds of each of these crosses were planted, yielding 163 hybrids of which all but one were sterile. As had been expected, hybridization between *D. Heddewigii* and *D. laciniatus* was easily accomplished. All the hybrids from this cross were fertile.

A cytological examination (microscopic study of the cells) revealed that all the different types of carnations used had 30 chromosomes or two sets of 15. Likewise, all varieties of *D. Heddewigii* and *D. laciniatus* had 30 chromosomes or two sets of 15. In other words, all these were diploids. On the other hand, every plant of *D. chinensis* had 60 chromosomes and was thus tetraploid.

When the hybrids were examined it was found that the one fertile hybrid, *D. caryophyllus* x *D. chinensis*, was tetraploid with 60 chromosomes, while all the others of similar parentage had only 45 chromosomes, that is, they were triploids having three sets of 15 chromosomes. Of the seven *D. chinensis*

Fig. 3. *Dianthus chinensis*

x *D. Heddewigii* and *D. chinensis* x *D. laciniatus* hybrids, the four fertile ones were tetraploids while the three sterile ones were triploids. The two hybrids *D. caryophyllus* x *D. Heddewigii* and *D. caryophyllus* x *D. laciniatus*, however, were both diploids, as were all hybrids examined between *D. Heddewigii* and *D. laciniatus*.

Now, it has long been known that triploid plants (three sets of chromosomes) are usually quite sterile, the explanation being that an odd number of sets prevents the normal pairing of hereditary units necessary for the formation of functional pollen and egg cells, which in turn are required for production of viable seeds. This is generally true with plants having five or seven sets of chromosomes, pentaploids and heptaploids respectively, although in plants with an odd number of sets beyond four partial fertility is sometimes found.

The triploid nature of some of the hybrids obtained in these crosses then explains their sterility. However, all hybrids with an even number of chromosome sets are not necessarily fertile, for example, the hybrids between *D. caryophyllus* crossed to *D. Heddewigii* and *D. laciniatus*. The most likely explanation here is that the chromosomes contributed by the different parents were too dissimilar to function properly. If colchicine or some similar drug had been used to double their chromosome number, it is quite possible that fertility might have been obtained.

The one tetraploid hybrid from the cross *D. caryophyllus* x *D. chinensis* (pl. 2B) must have been due to an exceptional egg cell from the carnation parent carrying a double set of chromosomes, 30 instead of the normal 15. Having received an even number of sets (two) from each parent this hybrid was what plant breeders refer to as an amphi-diploid or allo-tetraploid. Hybrids of this type are usually fertile but do not segregate widely; that is, the seedlings grown from self-pollination of such hybrids tend to resemble their hybrid parent so much that one is tempted to say that a new species has been produced.

This fertile hybrid was from a cross where a peculiar mutant carnation (pl. 2C) had been used as the seed parent. This mutant, a light salmon-colored, single-flowered plant of the type shown in the photograph was of no horticultural value and was used only for genetical reasons. Fate would have it that the only fertile hybrid from the 16 crosses in this group would come in a cross where such a poor type had been used. Repeated efforts using superior forms as parents to obtain another fertile hybrid between these species failed.

Despite its somewhat unfortunate ancestry, this hybrid was quite vigorous and floriferous. In fact, comparing the nine plants of this particular cross with the 154 plants from the other 17 crosses in this group, there was no visible evidence that an inferior seed-parent had been used. Among its sister seedlings, the tetraploid stood out by being more like a carnation in foliage and by its bushier growth and later flowering. It flowered about two weeks later than the other plants of the cross but instead grew into a larger plant. Its flowers were of a nondescript magenta color, definitely not attractive. When self pollinated, it produced an abundance of seeds that were approximately twice the size of carnation seeds (pl. 2D). At this time the project was transferred to the Los Angeles branch of the University of

Dianthus Heddensis "Westwood Beauty"

California (U.C.L.A.) where more space was available.

During the next three years, second-, third-, and fourth-generation seedlings from this hybrid, totaling more than 2,100 plants, were grown and individually recorded. The vast majority were identical with the original hybrid. A few, more attractive reddish-crimson and pink-flowered segregates were obtained, but as they were quite sterile selection led nowhere.

After many unsuccessful attempts, a back-cross between this hybrid and a deep pink, large, single-flowered diploid carnation was finally obtained, resulting in 16 back-cross hybrids, 6 being tetraploid and fertile, and 10 triploid and sterile (pl. 2E). All these 16 hybrids were magenta-purple like their tetraploid parent, except one plant which had deep pink flowers like the carnation parent but otherwise was like the others. This pink-flowered plant and five others were tetraploid and highly fertile, while the other ten were triploid and sterile.

The occurrence of both tetraploids and triploids in this back-cross had been predicted when the seed was harvested, for some seeds were as large as those of the tetraploid parent (pl. 2D), while the others were much smaller. The seeds were planted individually in small pots which were labelled according to seed size. All the tetraploids came from large seeds and the triploids from the smaller ones.

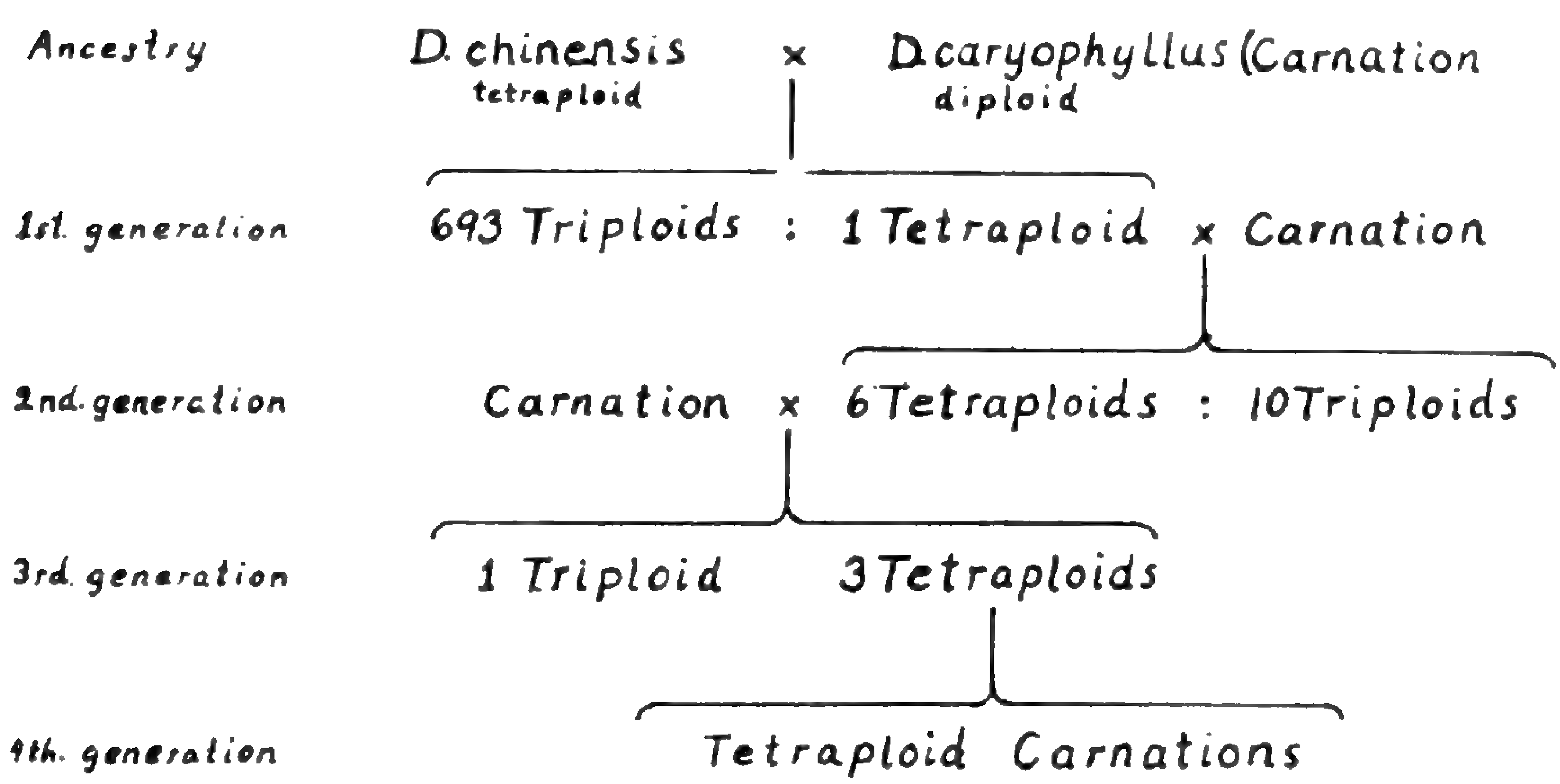
A second generation of more than 500 plants from the fertile back-cross plants was grown the following year, but, aside from segregation for deep pink in all the individual populations, nothing appeared to get excited about.

The pink-flowered plant and one of the magenta plants from the first back-cross were then again pollinated by carnation pollen, this time from good commercial varieties. Several pollinations resulted in only a few seeds from which four hybrids were obtained, three of which were tetraploids, two pink-flowered and one magenta, and one pink-flowered triploid. These second-generation back-cross hybrids looked very much like the ordinary greenhouse carnation except that they had relatively few large petals (pl. 2F). The following year 100 plants were grown from seed obtained from self- and cross-pollination of these two pink-flowered plants. Several plants resulted that were as attractive as the best of greenhouse carnations (pl. 1G, H). In general, these seedlings have somewhat broader and thicker leaves and stiffer growth than comparable diploids. Also, the flower petals are thicker and stiffer, resulting in large, heavy-textured, well-formed flowers. They produce a fair amount of large seeds when selfed or interbred but practically no seed when pollinated by pollen from diploid carnation or the tetraploid *D. chinensis*.

As yet sufficient stock of these tetraploid seedlings has not been available for adequate comparison with known good commercial carnation varieties as to production of flowers, so that all that can be said for them at this time is that they look very promising. Their complete ancestry is shown in diagram I:

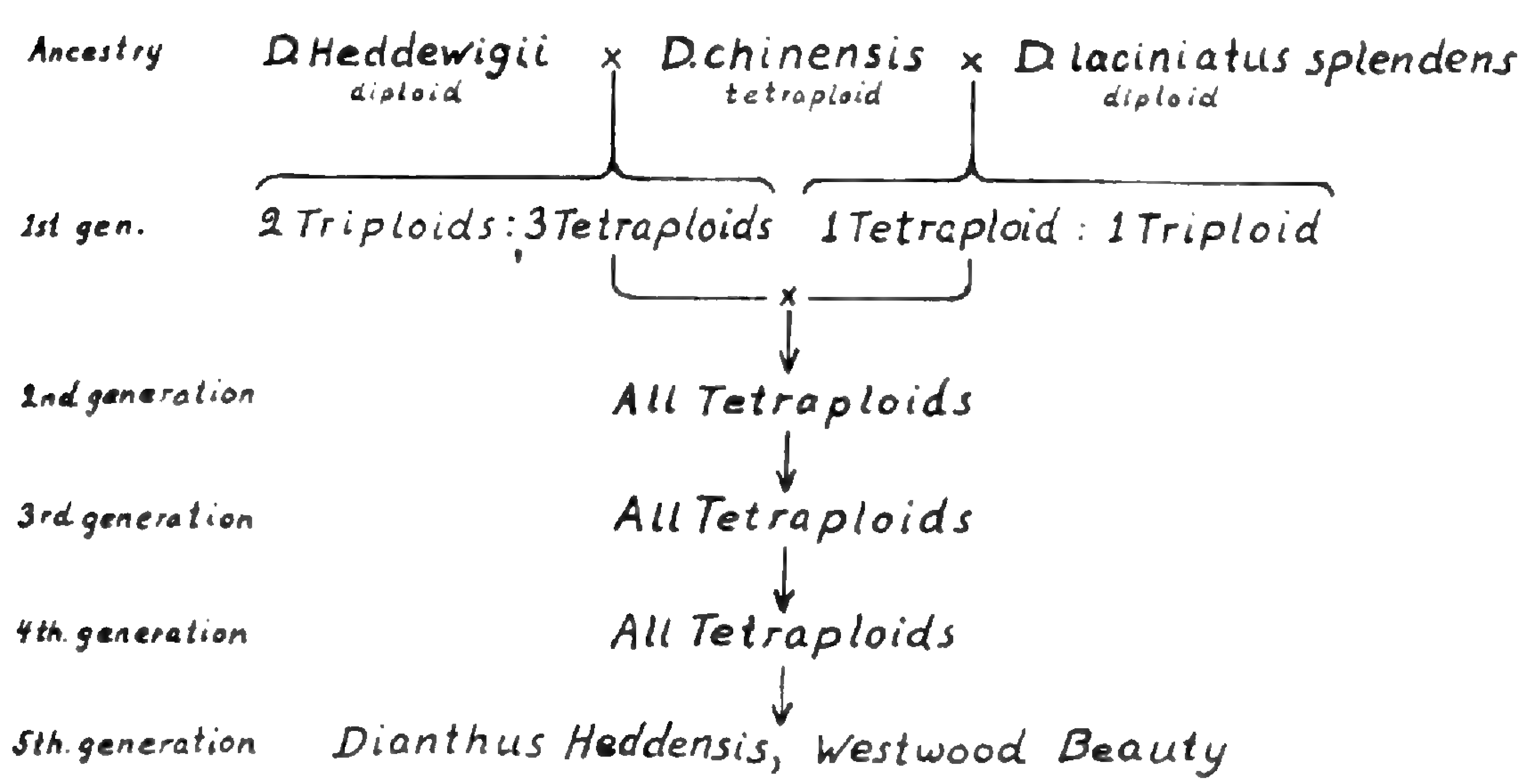
The tetraploid hybrids obtained when *D. chinensis* was crossed to *D. Heddewigii* and to *D. laciniatus* have also been "put to work." Five generations of seedlings totaling more than 20,000 plants have been grown from the original four hybrids. One series of crosses shown in diagram II has resulted in a relatively true-breeding strain of Dianthus offered this year to the garden public by leading seedsmen under the name of *D. Heddensis*, "Westwood Beauty" (fig. 4). The name *Heddensis* was given to indicate

DIAGRAM I



a hybrid between *D. chinensis* and *D. Heddewigii.* Although *D. laciniatus* was also involved, it was not included in the name, because from the results obtained to date I am reasonably certain that further work will show that it is but a form of *D. Heddewigii.* The ancestry of *D. Heddensis* "Westwood Beauty," is shown in diagram II:

DIAGRAM II



Because the *D. Heddewigii* plant involved in the crosses shown in diagram II had smooth-edged flowers of a velvety crimson-red color, while the *D. laciniatus splendens* had highly laciniated (fringed) flowers of a bright cardinal-red color with a narrow white edge, the "Westwood Beauty" is somewhat variable with respect to flower color, though prevailingly in shades of red. The petals vary from nearly smooth to highly laciniated, some with a narrow, white edge, some without. The variety combines the rugged growth habit of *D. chinensis* with flowers almost as large as those of *D. Heddewigii.* In the tests so far given, this variety appears to be more tolerant of high temperatures than its parents, and no doubt future work will lead to the development of more colors in this group and perhaps to the selection of types better suited for specific regions of this country.

These results are typical of many that have been encountered in plant breeding. Of course, it is true that perhaps 90 per cent of all the garden plants grown today were developed by gardeners who never had heard of chromosomes, hereditary units, or such new-fangled terms. However, these men, and women too, possessed qualities which are not easily acquired in any modern school, namely: a genuine interest in plants as living things, and sufficient practical gardening experience with their favorite plants to enable them to recognize a good thing when they had it and to make selections for further combinations in a manner which many times closely approached that of the trained plant breeder of today.

That genetics and cytology are becoming recognized as aids in the production of new and better varieties, is evidenced by the fact that most of the larger seed growers in this country are gradually adding to their staffs young men trained in the fundamentals pertaining to plant culture and plant improvement through hybridization.

For the garden enthusiast wishing to know something about the fundamentals of plant breeding, there is no better source than the book *Practical Plant Breeding* by W. J. C. Lawrence of the John Innes Horticultural Institution in England. This little book is published by George Allen Unwin Company, London, England. An excellent book on Dianthus is L. H. Bailey's *The Garden of Pinks* published by Macmillan Company, New York.

We are indebted to Bodger Seeds, Ltd., El Monte, Calif., for the photographs of *Dianthus Heddewigii*, *D. laciniatus*, *D. chinensis*, and *D. Heddensis* "Westwood Beauty."

"WHO WAS WHO?"

EDGAR ANDERSON

Supposedly it really has nothing to do with gardening as such, but I have always had a lively curiosity about the people whose names are attached to the plants in my garden. Just exactly who was Joe Pye, and who was Dorothy Perkins and what did Frau Karl Druschki look like anyway? Ordinarily one must live a long life and ask many questions if he is going to learn very much about these horticultural immortals, but now and then one may run upon an article which has winnowed the subject pretty thoroughly. In the *Journal of the Royal Horticultural Society* for March 1945, recently received at the Garden library is a fascinating article by A. Simmonds, entitled "Who was Who?", which answers many of these questions. We learn, for instance, that Betty Uprichard was an Irish beauty and that Mme. Caroline Testout was a fashionable London dressmaker, who had the rose named after her as part of a publicity campaign.

For a few of the notables there are even photographs of the original owner of the name. One learns that the so-called pink daffodil, "Mrs. R. O. Backhouse," was named (if the photograph is to be believed) for a woman of gentle beauty and fragile charm. She herself was the plant breeder who produced the variety, though it was not named and introduced until after her death in 1921. The article describes the thrill which went over the Annual Daffodil Show when "they watched her remove the lid of her flower-box and reveal her newest seedlings, with orange-red cups of a brightness surpassing that of the productions of any contemporary raiser." To one who has always thought the daffodil the loveliest of flowers, this photograph of the lady who produced some of the most exquisite daffodil varieties is a real joy. I am not surprised that the Annual Daffodil Show was thrilled. Personally I can think of nothing more exciting than to have seen flowers of such ethereal grace exhibited by a woman of such bewitching charm. It reminds me, by contrast, of another beautiful daffodil which was also named for an outstanding woman, though it is not included in the present article. The variety Daisy Schaffer, in soft lemon-yellow and white, is one of the most feminine of daffodils but, I have been told, that the original Daisy herself, an outstanding feminist lawyer, was scarcely pleased to have her name associated with such a flower.

ONIONS ARE EASY TO GROW

HENRY N. ANDREWS

Provided that they are given a good early start onions should be one of the prize crops of the home gardener. Our experience with the variety "Gigantic Gibraltar" last year is a pleasant memory and one that seems worth passing along to those who have not made its acquaintance.

Seed should be sowed in late January or early February. The following procedure will produce fine seedlings with a minimum of labor: Use wooden trays or "flats" about 2½ inches deep and fill to within about ½ inch of the top with a fairly rich soil; mark off rows 2 inches apart and ¼ inch deep and drop in a seed about every inch; cover the seeds and firm the soil; keep the soil moist but not soggy, and until the first seed-leaves begin to poke up above ground the flat may be covered with a sheet of newspaper to prevent excessive drying of the surface. The seedlings may be set out during the first week of April, allowing a generous 6 inches between plants and two feet between rows.

"Gigantic Gibraltar" Onions

Our Gigantic Gibraltars, shown in the illustration, were ready for harvest the latter part of July, when they averaged a strong ¾ pound each. There seems to be a prejudice against large onions on the score that they will be excessively strong-flavored. Such is far from the case with this variety. They are as deliciously mild as they are gigantic and excellent for all sorts of uses, fresh or cooked. There is one drawback—they are not the best of keepers. It is therefore advisable to grow only enough for use during the summer and early fall, and it will not take many rows of them to fill the needs of the average family.

"Valencia Sweet Spanish" will afford a comparable culinary delight to the home gardener. In fact, in one of our gardens last summer they outclassed the Gibraltars for size, many exceeding one pound.

Storing any kind of onions over the winter is not the easiest task for the amateur farmer. A simple and tasty solution is to grow a supply of onions to last till early winter, and leeks for later use. The latter can be "heeled in" in a convenient place in the garden and dug as needed. See the March 1945 BULLETIN for further details on leeks.

NOTES

Several elm trees at the Garden, victims of the *phloem necrosis*, were removed during January.

The earliest-blooming plants observed at the Garden this year were the witch-hazel *(Hamamelis vernalis)*, on January 8, and the pussy-willow *(Salix discolor)*, on January 18.

Mr. George H. Pring, Superintendent of the Garden, has been appointed a trustee of the Foundation for Floriculture of the Society of American Florists and Ornamental Horticulturists, for the years 1946-49.

Among the orchid growers visiting the Garden orchid collections recently were: Mr. Joseph Urmston, of San Marino, Calif.; Mr. Max Cohen, of Orchidville, Mass.; Mr. Luiz Arriza and Mr. Pierre Villere, of the Dominican Republic, W. I.

Mr. Ladislaus Cutak, in charge of Succulents at the Garden, has been recently reappointed vice-president for District 4a (Missouri, Kansas, Iowa, Arkansas, and Illinois) of the executive board of the Cactus and Succulent Society of America.

Louis J. Brenner, until recently a sergeant in the U. S. Army stationed in Manila, has returned to his former position at the Arboretum. With his return only four of the Garden graduate students at the time of the outbreak of the war are now in military service: Capt. Robert B. Clark, Sgt. Fred G. Meyer, and Lt. Ralph W. Emons, with the Army of Occupation in Germany; and Lt. (j. g.) L. Wayne Lenz, now on the Pacific Coast.

Dr. Louis O. Williams, of the Botanical Museum of Harvard University, who has described the Orchidaceae in the current number of Woodson and Schery's *Flora of Panama* (Feb. 1946 ANNALS) left in February for a short trip to Honduras. Dr. Williams is one of the nine former graduate students at the Garden who was engaged in quinine or rubber investigation in South America during the war.

Dr. Edgar Anderson, Geneticist to the Garden, recently attended the annual W-H-O Corn Show in Des Moines, Iowa, in order to interview a number of "old-timers" in the corn business. Hybrid corn has so completely and so rapidly replaced open-pollinated varieties in the Corn Belt that important facts which used to be a matter of common knowledge will disappear altogether unless a written record is kept.

Regardless of who saw the first robin this year, it is a fact that there were more of them in the Garden in January than are usually seen at this time of the year. The mild weather of the first half of January induced the robins to move a few miles north, and they refuse to go south again even though the temperature has gone down as low as ten degrees above zero. On a cold morning they huddle together in the lee of the greenhouses. When the sun warms them up they drink a little water from the melting ice on the roofs and feed upon holly and hawthorn berries while their favorite worms are sealed beneath the crust of frozen earth. Although birds apparently do not find holly berries very palatable and eat them only when other food is scarce, this year the holly trees were stripped of their berries by the end of January. Two years ago the same thing happened, but at that time there were more cedar wax-wings than robins.

SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date until his death in 1889 it was maintained under his personal direction. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was chosen by Mr. Shaw and he definitely indicated that he wished it called by that name. The Garden passed at his death into the hands of a Board of Trustees, designated in Mr. Shaw's will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provision of the will the immediate direction of the Garden is vested in a Director, appointed by the Board. The Garden receives no support from city or state but is maintained almost exclusively from the estate left by Henry Shaw. Since 1939 many Garden Clubs and interested individuals have contributed to a "Friends of the Garden Fund" which is used in developing the new Arboretum, located at Gray Summit, Mo. The Arboretum (1) serves as a source of plants, trees and shrubs for the city Garden; (2) affords areas for gradually establishing a pinetum, a wild-flower reservation and various other features on a scale not possible in the city; (3) provides greenhouses for some 20,000 orchid plants.

The city Garden comprises 75 acres, where about 12,000 species of plants are grown, both out of doors and under glass. It is open every day in the year except New Year's Day and Christmas; week days, 8:00 a. m. until sunset; Sundays, 10:00 a. m. until sunset. The greenhouses are closed every day at 5:00 p. m.

The main entrance to the Garden is at Tower Grove and Flora Place, on the Sarah car line (No. 42). The Tower Grove bus (No. 21), direct from downtown, passes within three blocks of the main entrance.

THE MISSOURI BOTANICAL GARDEN

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Jesse M. Greenman	Curator of Herbarium
Carroll W. Dodge	Mycologist
Edgar Anderson	Geneticist
Robert E. Woodson, Jr.	Assistant Curator of Herbarium
Henry N. Andrews	Assistant to the Director and Paleobotanist
Robert W. Schery	Research Assistant
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David C. Fairburn	Orchidologist
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Joseph Cutak	In charge of Exotics
Ladislaus Cutak	In charge of Succulents
August P. Beilmann	Manager of the Arboretum, Gray Summit
Gurney Wilson, F.L.S.	Representative in England, Hove, Sussex
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MISSOURI BOTANICAL GARDEN BULLETIN

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DAFFODILS FOR THE GARDEN

EDGAR ANDERSON

The daffodil is not only one of the loveliest of flowers; it can be one of the most accommodating. There are few other plants which look well in so many different situations, which are equally at home in the wild garden, the rock garden, a dooryard patch of flowers, or a formal city garden. It is a pity they are not grown more extensively in St. Louis. A few varieties with iron-clad constitutions, things like SIR WATKIN, for instance, seem really to like our heavy clay soils, and most of the varieties in the trade will give an excellent return for the time and money spent upon them. Previous articles in the BULLETIN (October 1934 and March 1942) have discussed the daffodil as a flower for naturalizing; this one will consider them from their value as a real garden flower in the St. Louis area.

With proper planning we may confidently expect the daffodil season to extend for a full two months, from the first week in March to the first week in May. Only one variety can be counted upon to make a really fine display at the earliest of these dates, the comparatively new hybrid FEBRUARY GOLD. Very rarely, this variety may live up to its name and bloom before the first of March in St. Louis, but for the last five years, in Missouri at least, it has brought gold to early March rather than to late February. It has good form and substance, in spite of coming so early in the season. The flowers have enough finish to look perfectly in place in the most formal garden or in a flower arrangement for the dinner table. It has great vigor and does well even in the dubious puddled loam of a city backyard. If you live in the city and can afford or have room for only one variety of daffodil, this is certainly the one for your money. It will make a fine show of bloom before there is much else to see in your garden, and with a minimum of care it should continue to brighten your early springs for a number of years to come.

In May, at the other end of the season, there is again only one narcissus which is absolutely outstanding in St. Louis. This is the old variety

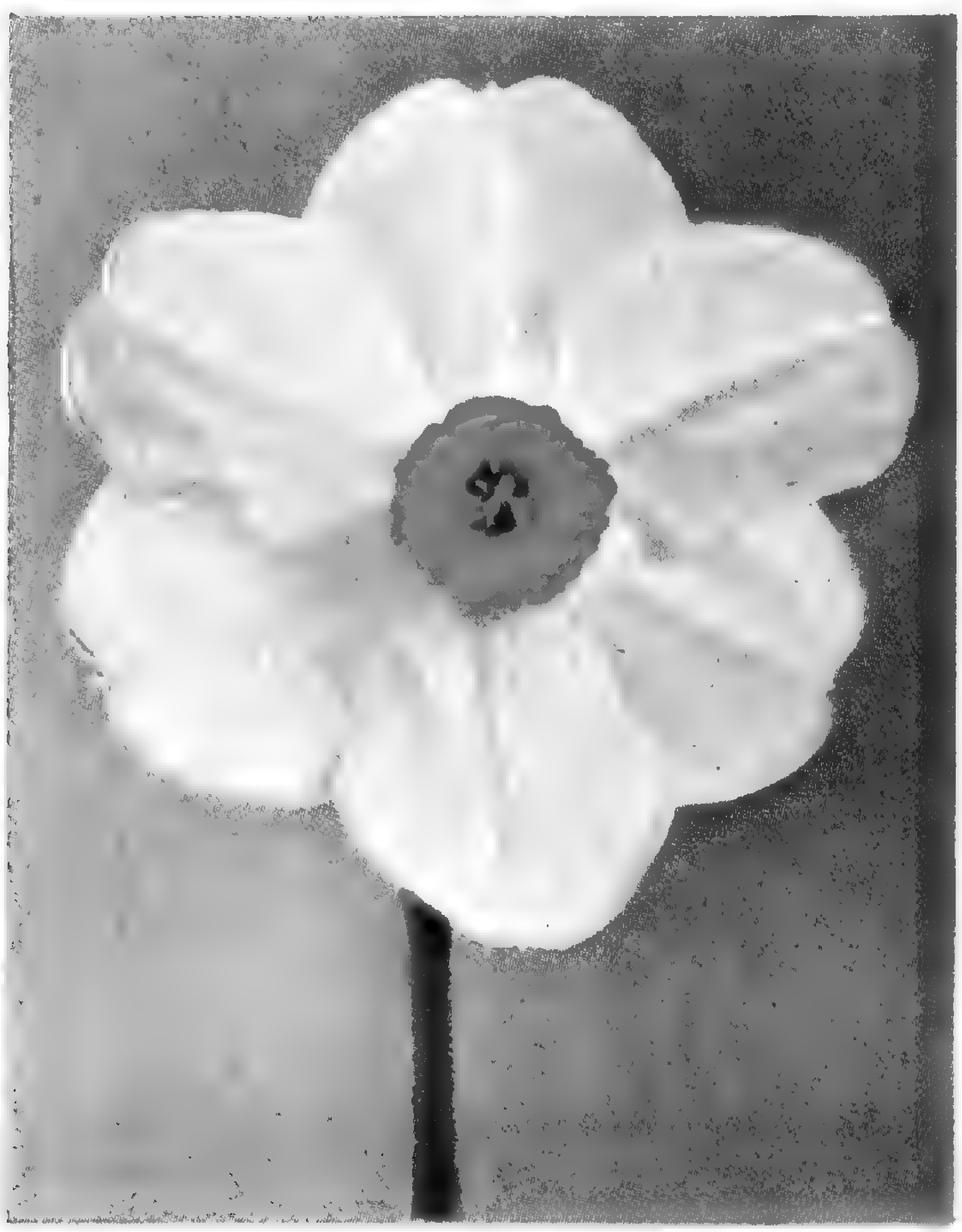
RECURVUS. It is a Poet's Narcissus with flat white petals and a small colored eye in the center of the flower. The name refers to the petals, which are slightly fluted and spread backwards from the center, rather than out at right angles. RECURVUS is an old and fairly cheap variety, sometimes a little hard to obtain, but worth the extra trouble. Like all Poet's Narcissi, it does not really like to be moved and will do better once it has become well established in your garden.

Between these two extremes there are thousands of varieties to choose from, several hundred of which are readily available in the trade. Generally speaking, they are hybrids and trace back by one route or another to early yellow Trumpet Narcissi or late-flowering Poet's Narcissi. This is shown every year as the season advances; the earliest varieties tend to be bright yellow and with long trumpets; the late varieties to be white and with wide, flat blossoms. An early-flowering white variety or a late-flowering yellow one is therefore at a premium since it adds contrast to a collection. Such a one is RED SHADOW, illustrated on an accompanying plate. It is one of the hybrids in which the red of the Poet's Narcissus has been carried over attractively into the larger crown of the trumpet daffodils, and it has the added advantage of a very strong constitution. One of the most striking of such combinations is DICK WELLBAND, which unites a brilliant flaring trumpet with flat, white petals. In Missouri it needs a little protection from wind and sun if it is to look its best. It must be admitted that many of these red cups tend to burn out under middle-western conditions, and for that reason the very expensive variety RUSTOM PASHA should be tried out here. In other parts of the country its brilliant combination of orange-red crown and bright yellow petals has the reputation of standing up better in bright sunlight than any other variety.

Among the long-trumpet daffodils the breeders have been horribly successful in turning out new varieties with enormous flowers, and these will undoubtedly prove very popular with the American public when they become generally known. Some of them are, to my way of thinking, very coarse and ugly with nothing but their size to recommend them. DIOTIMA, however, is a giant trumpet without coarseness, which has kept the grace and charm of a daffodil in spite of really enormous size. AEROLITE is another outstanding largish yellow trumpet. It has stiff stems and fine substance to the petals. In the Garden's Arboretum at Gray Summit it has proved its ability to come through late blizzards and hot, drying winds in fine shape. The flower is so evenly and perfectly formed that it is particularly appropriate in a formal garden, and though it is distinctly yellow the shade is soft enough to combine well with other colors. The large white trumpet BEERSHEBA is also marked by remarkable substance and

DICK WELLBAND

HERA



EDITH

great charm. It has the amazing ability to withstand freezing weather and sleet and snow when it is in full bloom. In using it for garden planting remember that it is so pure white as to be almost green-white; that it has a large flower with a very long trumpet; and it has a tendency to be short-stemmed in some years so that it needs to be planted in front of taller-growing varieties.

Some of the "Leedsii" daffodils are particularly useful in a garden setting because they form good-sized clumps and give a big show of bloom. HERA, shown in the colored plate, is cheap and good, while its dainty coloring, a white cup just barely edged with yellow, makes it fine as a cut flower.

One of the most controversial topics in the daffodil world is the so-called pink varieties. Nearly every-one likes them, but many feel that the term pink was rather ill-chosen, and some will even claim that these varieties never were pink and never will be pink. The color in question is admittedly difficult to describe in a single word. It varies from day to day, from year to year, and from place to place. Even when it shows the strongest it is a curious and baffling shade. The late Canon Engleheart, who did as much for the development of the modern daffodil as any one man, packed it into a long but effective phrase: "pinky-citrony-buffy-apricoty-tawny-topazy-inside-of-a-melony coloring." That last bit comes closest to the shade as we see it in St. Louis. It is indeed the color of a muskmelon, a very yellow muskmelon in hot weather, and a quite pinkish muskmelon on a cool foggy morning. While it takes a cool spring and not too much sun to make such a pink variety as MRS. R. O. BACKHOUSE look its pinkest, the color always changes as the flower ages; it has the deepest undertone of yellow when it opens, and the pink tones increase from day to day, particularly around the edge of the cup. Plant this variety then in quite a group, if you can afford to, and enjoy the delicate play of color between the opening buds and fully opened flowers.

In planting daffodils in St. Louis or anywhere else the most important thing is to get good clean bulbs. There are some nasty virus diseases among the daffodils, that not only streak the leaves and the flowers but weaken the plant. In addition, there are apparently a number of minor viruses, so-called "decline-diseases," which weaken the plant but require a keen eye to recognize in the nursery. If you find a streaky-leaved plant in your garden, dig it out and burn it up; there is no other cure for virus infection. Be doubly sure therefore that you are getting clean bulbs when you make a purchase. Something offered at a bargain price may not be the bargain it seems to be.

Late August or early September is the best time to plant if you can get your bulbs at that season, and a really conscientious dealer will cooperate with you to ship them at that time. For garden planting remember that shallow planting tends to make the bulbs split up too quickly and that deep planting reduces the height of the stem and makes them a little later flowering. About three to four inches deep is the best for most bulbs.

The strongest varieties, like EMPEROR, SIR WATKIN, and FEBRUARY GOLD, will go on and bloom, even in city gardens, for year after year with little special attention. Many of the larger and handsomer sorts will repay as much fussing over as one can provide. If the soil is poor and soggy, dig it out and replace with a good sandy loam with which a little bone meal has been mixed. In any case don't use stable manure; or if you must, try it out on just one bulb and see what results you get. A light mulch put on after the ground has frozen will pay dividends in a cold, open winter. After the bulbs have flowered do not remove their leaves until they have turned completely yellow and are nothing but dry remnants. If there are other flowers in the garden the leaves will be less unsightly and apparently ripen off better if they are taken in a bunch and looped into a knot. This holds them upright and together and when skillfully done introduces an attractive, thrifty note into the flower border.

Finally, just a word about double-flowered varieties. These have been out of style for the last few decades, and many gardeners either don't like them or think they don't, which is the same thing. An open-minded gardener will find that, monstrous or not, they have their points. Most of them stay in flower longer than the single kinds and while a few, such as the double Poet or GARDENIA NARCISSUS, are difficult to grow successfully, many of them are among the hardiest and most dependable of old stand-bys.

GERMINATION PERIOD FOR GARDEN SEEDS

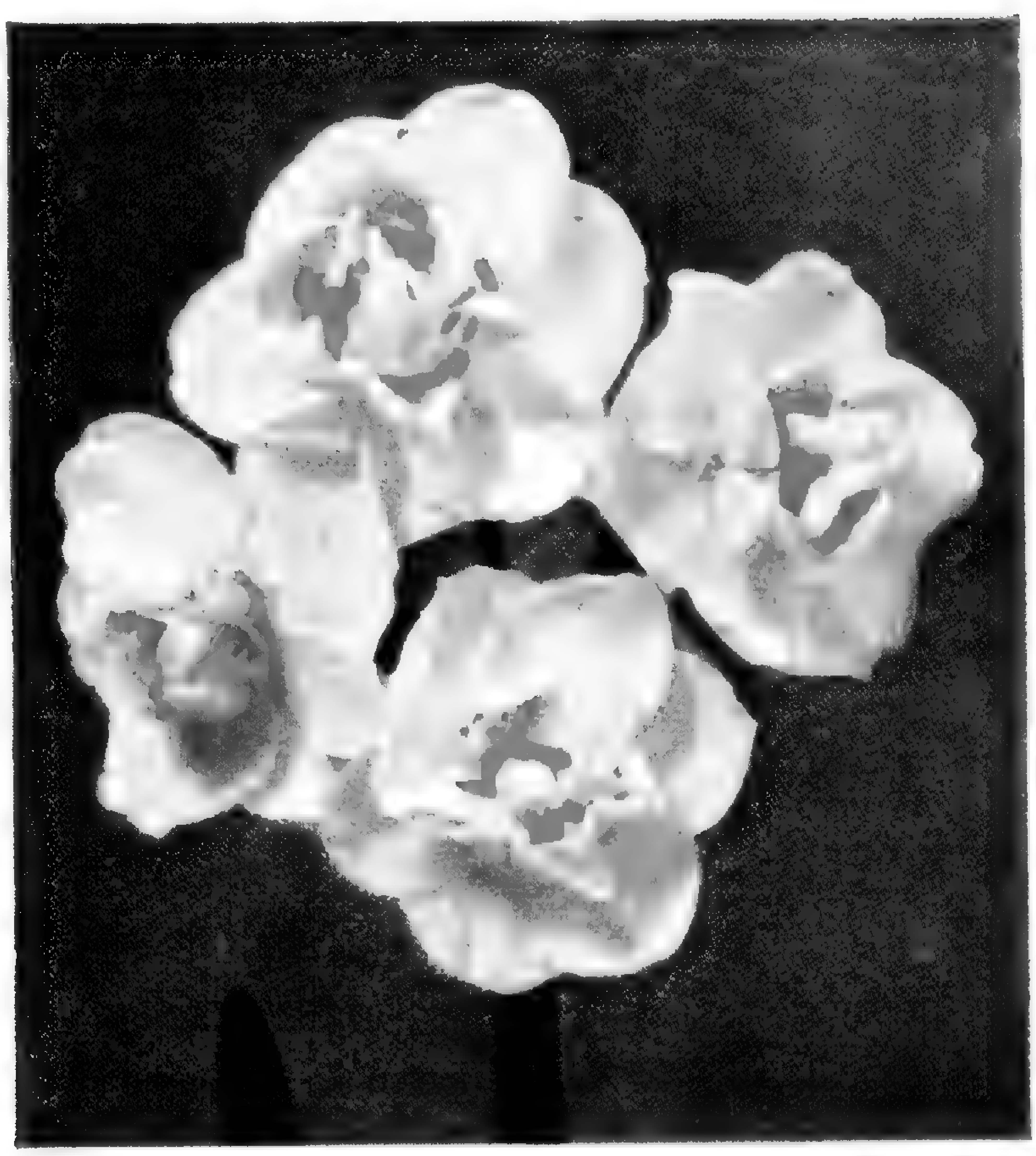
DAVID C. FAIRBURN

With the first signs of spring there comes a strong desire to get out the seed packets and start planting. Whether or not this desire should be curbed depends largely on the kind of seed involved and the facilities available for growing the young plants. Some seeds germinate slowly, others very quickly, so it is necessary to know about what is going to happen before proceeding under forced draft. If started too early indoors or in hot-beds, the quick-germinating kinds develop into large plants that are difficult, if not impossible, to transplant in the garden satisfactorily. Outdoors, the seeds may germinate early in spring all right, but an unexpected spell of freezing weather can immobilize a lot of healthy-looking seedlings and strain garden morale considerably.

During the past three years, data regarding the germination period of many kinds of seeds were obtained in the amateur gardening classes held at

MRS. R. O. BACKHOUSE

RED SHADOW

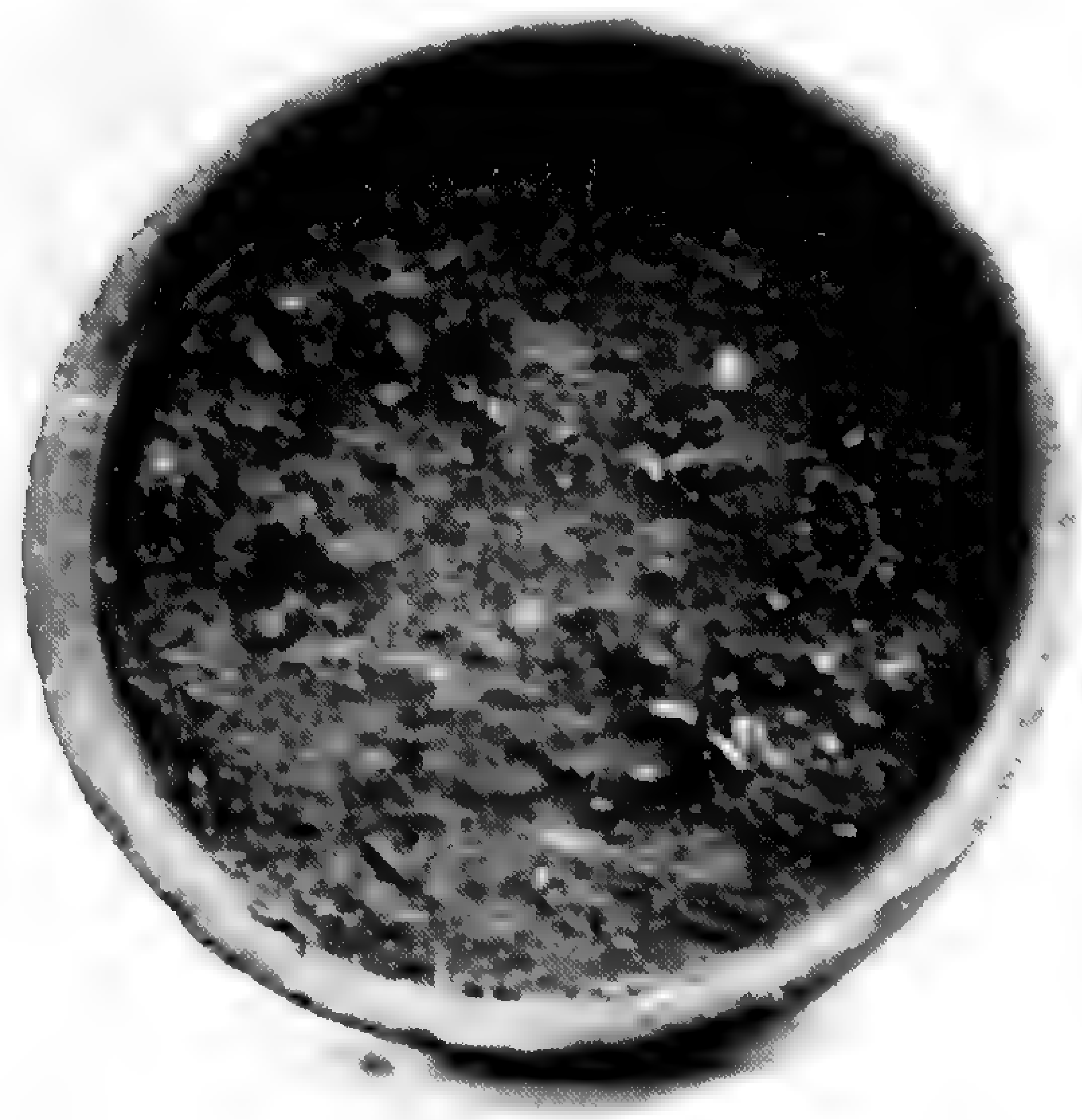


CHEERFULNESS

the Garden each spring. These records were taken in the greenhouse under carefully controlled conditions and are not to be confused with germination of seeds outdoors, which is slower due to variations in temperature and moisture, as well as deeper planting. Since these records represent average results obtained by many students, errors have been reduced to a minimum. The seeds were fresh, the soil specially mixed and steam-sterilized, and all greenhouse conditions favorable for germination were provided. The term "germination" as used here refers to the first appearance of shoots at the surface of the soil. Actually, germination of the seeds takes place in the soil one to several or more days before shoots appear at the surface.

GERMINATION PERIOD FOR GARDEN FLOWERS

NAME	NUMBER OF DAYS
Ageratum	6
Althaea (Hollyhock)	6
Alyssum (Sweet Alyssum)	3
Alyssum (Basket of Gold)	8
Anchusa (Alkanet)	7
Anoda	5
Antirrhinum (Snapdragon)	9
Aquilegia (Columbine)	12
Arabis (Rock-Cress)	6
Arctotis	6
Azalea mollis hybrids	14
Browallia	7
Calendula (Pot Marigold)	4
Calliopsis	4
Callistephus (China Aster)	3
Campanula (Canterbury Bells)	10
Celosia (Cockscomb)	5
Centaurea (Bachelor's Button)	3
Cheiranthus (Wallflower)	4
Chrysanthemum (annual)	5
Chrysanthemum (Korean Mum)	13
Chrysanthemum (Shasta Daisy)	7
Clarkia	7
Cleome (Spider-Flower)	4
Convolvulus (Morning-Glory)	5
Coreopsis (Tickseed)	7
Cynoglossum (Chinese Forget-me-not)	6
Dahlia (dwarf)	5
Delphinium (Annual Larkspur)	6
Delphinium (Perennial Larkspur)	12
Dianthus (Carnation)	6
Dianthus (Pinks)	7
Dianthus (Sweet William)	9
Didiscus (Blue Lace Flower)	8
Digitalis (Foxglove)	9
Dimorphotheca (African Daisy)	3
Eschscholtzia (California Poppy)	5
Gaillardia (Annual Blanket-Flower)	6
Gloxinia	21
Godetia	4
Gomphrena	6
Gypsophila (Baby's-Breath)	5
Helianthemum (Rock-Rose)	14
Helichrysum (Strawflower)	5
Heliotropium (Heliotrope)	10
Iberis (Annual Candytuft)	6
Impatiens (Balsam)	7
Lathyrus (Sweet-Pea)	7
Lilium philippinense	18
Linaria (Toadflax)	5
Linum (Flax)	6
Lunaria (Honesty)	10
Lupinus (Lupine)	7
Lychnis (Catchfly)	21
Mathiola (Stock)	5
Matricaria (Feverfew)	8
Mirabilis (Four-o'Clock)	8
Myosotis (Forget-me-not)	7
Nasturtium	6
Nicotiana (Flowering Tobacco)	10
Nierembergia (Cup-Flower)	7
Ornamental Grass	11
Ornamental Pepper	7
Papaver (Annual Poppy)	6
Papaver (Oriental Poppy)	12
Petunia	8
Phlox (annual)	6
Portulaca (Rose-Moss)	5
Primula (Primrose)	14
Pyrethrum (Painted Daisy)	7
Reseda (Mignonette)	6
Rudbeckia (Coneflower)	7
Salpiglossis (Painted-Tongue)	4
Salvia (Scarlet Sage)	10
Salvia (Mealy-cup Sage)	7
Sanvitalia (Creeping Zinnia)	5
Scabiosa (Pincushion Flower)	5
Schizanthus (Poor Man's Orchid)	7
Tagetes (Marigold)	3
Thunbergia (Black-eyed Susan)	10
Tithonia (Mexican Sunflower)	4
Valeriana (Garden Heliotrope)	7
Verbena (hybrids)	9
Veronica (Speedwell)	10
Vinca (Periwinkle)	10
Viola (Pansy)	8



Damping-off fungi caused death of all the snapdragon seedlings in this pot of unsterilized soil.

Excellent germination and growth of snapdragons in steam-sterilized compost.

NAME	NUMBER OF DAYS	NAME	NUMBER OF DAYS
Viola (Tufted Pansy)	12	Zinnia	3
Xanthisma (Star of Texas)	6	Zinnia (Mexican Zinnia)	6

GERMINATION PERIOD FOR HERBS

NAME	NUMBER OF DAYS	NAME	NUMBER OF DAYS
Anise	6	Lemon Balm	7
Borage	7	Lovage	10
Caraway	6	Rosemary	10
Chervil	6	Sage	7
Clary	5	Summer Savory	5
Coriander	6	Sweet Basil	4
Cumin	10	Sweet Fennel	6
Dill	5	Sweet Marjoram	11
False Saffron	6	Thyme	6

GERMINATION PERIOD FOR VEGETABLES

NAME	NUMBER OF DAYS	NAME	NUMBER OF DAYS
Beans	3	Kohlrabi	3
Beets	3	Leek	5
Broccoli	3	Lettuce	3
Brussels Sprouts	3	Mustard	3
Cabbage	3	Onions	5
California Pepper	9	Parsley	7
Carrots	5	Parsnips	10
Cauliflower	4	Radishes	2
Celeriac	8	Rutabaga	3
Celery	8	Squash	3
Celtuce	3	Sweet Corn	3
Collards	3	Swiss Chard	4
Cress	14	Tampala	3
Cucumber	3	Tomatoes	5
Egg Plant	9	Turnips	2

A SHORT LIST OF RECENT HORTICULTURAL PUBLICATIONS

In response to many inquiries concerning the most useful horticultural books available, the following list has been compiled as a partial answer. To prepare a complete tabulation of even the better and most recent works would require a volume of no modest size in itself; nor do we feel that such a list is wanted by the average home gardener. It is the task of the horticulturist and librarian to know what is, and what is not, of most general use. Yet in such a list some readers are bound to feel that important omissions have been made. If such is the case it is from want of space rather than personal prejudice.

We have tried to select volumes that, for the general and specific fields indicated, are informative and authoritative. There are, of course, many thousands of books and shorter articles that fit these qualifications which of necessity have been omitted. We have also tried to select works that are, for the most part, still in print or that one might expect to find in any large library. In so far as it has been possible to determine, the publication date of the most recent edition has been given.

While any horticultural article or book may be of the first quality it must be remembered that growing conditions are extremely variable through the vast expanses of even our own country. To meet the peculiar demands of St. Louis climatology the Garden has endeavored for the past 33 years to present articles in the BULLETIN that apply particularly to this region. A wealth of information may be found in the many issues that have appeared during these past three decades.

GENERAL HORTICULTURAL WORKS

Encyclopedic.—
Standard cyclopedia of horticulture. L. H. Bailey. The Macmillan Co. (new edition expected in 1946).
Hortus second. L. H. Bailey. The Macmillan Co. 1941.

Reference and Reading.—
America's garden book. Louise and James Bush-Brown. Charles Scribner's Sons. 1939.
Manual of gardening. L. H. Bailey. The Macmillan Co. 1925.
10,000 garden questions answered by 15 experts. Edit. by F. F. Rockwell. Publ. by American Garden Guild. 1944.
The old dirt dobber's garden book. Thomas A. Williams. Robert M. McBride & Co. 1943.
Basic horticulture. Victor R. Gardener. The Macmillan Co. 1942.
Gardening with the experts. Numerous authors. The Macmillan Co. 1941.
The American land, its history and its uses. William R. Van Dersal. Oxford University Press. 1943.

SPECIAL TOPICS

Alpine plants—see Rock gardens.

Annuals.—
Annuals for your garden. Daniel J. Foley. The Macmillan Co. 1938.

Arrangement, flower.—
The arrangement of flowers. Mrs. Walter R. Hine. Charles Scribner's Sons. 1933.
Arranging flowers throughout the year. Katherine Thomas Cary and Nellie Dryden Merrell. Dodd, Mead & Co. 1934.
Flower and table arrangements. Esther Longyear Murphy. Laughing Dragon Press. 1935.
Flower decoration. Constance Spry. G. P. Putnam's Sons. 1935.
Flower arranging—a fascinating hobby. Laura Lee Burroughs. The Coca-Cola Co. Vols. 1–3. 1940–42.

Azaleas—see Rhododendrons.

Begonias.—
Begonias and how to grow them. Bessie R. Buxton. 1939.

Breeding—see Genetics.

Bulbs.—
Garden bulbs in color. J. Horace McFarland, R. Marion Hatton and Daniel J. Foley. The Macmillan Co. 1938.
Adventures with hardy bulbs. Louise Beebe Wilder. The Macmillan Co. 1936.
Bulbs for American gardens. John C. Wister. Stratford Co. 1930.
A handbook of crocus and colchicum. E. A. Bowles. Martin Hopkinson & Co. 1924.
The gladiolus book. Forman T. McLean, William Edwin Clark and Eugene N. Fischer. Doubleday, Page & Co. 1927.
The book of bulbs. F. F. Rockwell. The Macmillan Co. 1927.

Cacti—see Succulents.

Camellias.—
Camellias. G. G. Gerbing. Publ. by the author. 1943.

Chemiculture.—
Plant chemiculture. C. D. Dawson and M. V. Dorn. Publ. by the authors. 1939.
Soilless growth of plants. Carleton Ellis and Miller W. Swaney. Reinhold Publ. Corp. 1938.

Soilless culture simplified. Alex Laurie. Whittlesey House. 1940.
The complete guide to soilless gardening. W. F. Gericke. Prentice-Hall Inc. 1940.

Chrysanthemums.—
Hardy chrysanthemums. Alex Cummings, Jr. Whittlesey House. 1939.

Climbing plants—see Vines.

Colchicum—see Bulbs.

Corn—see Grasses.

Crocus—see Bulbs.

Dahlias.—
A little book of modern dahlia culture. W. H. Waite. A. T. De La Mare Co. 1925.

Daylilies (Hemerocallis).—
Daylilies. A. B. Stout. The Macmillan Co. 1934.

Delphinium.—
Delphiniums, their history and cultivation. George A. Phillips. The Macmillan Co. 1933.
The garden of larkspurs. L. H. Bailey. The Macmillan Co. 1939.

Diseases.—
Manual of vegetable garden diseases. Charles Chupp. The Macmillan Co. 1925.
Diseases and pests of ornamental plants. Bernard O. Dodge and Harold W. Rickett. The Jaques Cattell Press. 1943.
Insects and diseases of ornamental trees and shrubs. Ephraim Porter Felt and W. Howard Rankin. The Macmillan Co. 1932.

Economic plants.—
Edible wild plants of eastern North America. Merritt Lyndon Fernald and Alfred Charles Kinsey. Idlewild Press. 1943.
Edible wild plants. Oliver Perry Medsger. The Macmillan Co. 1939.
Foods America gave the world. A. Hyatt Verill. L. C. Page & Co. 1937.

Evergreens.—
The cultivated evergreens. L. H. Bailey. The Macmillan Co. 1928.
The cultivated conifers in North America. L. H. Bailey. The Macmillan Co. 1933.
The friendly evergreens. L. L. Kumlien. D. Hill Nursery Co. 1946.

Ferns.—
The book of fern culture. Alfred Hemsley. John Lane Co. 1908.
Our ferns, their haunts, habits and folklore. Willard Nelson Clute. Frederick A. Stokes Co. 1938.

Fertilizers—see Soils.

Floriculture.—
Commercial floriculture. Fritz Bahr. A. T. De La Mare Co. 1922.
Commercial flower forcing. Alex Laurie and D. C. Kiplinger. Blakiston Co. 1945.

Fruits.—
Fruits for the home garden. U. P. Hedrick. Oxford University Press. 1944.
Modern fruit production. Joseph Harvey Gourley and Freeman Smith Howlett. The Macmillan Co. 1941.

Fuchsias.—
The fuchsia book. Ed. by Alfred Stettler. Publ. by American fuchsia society. 1944.

Genetics.—
The genetics of garden plants. M. B. Crane and W. J. C. Lawrence. The Macmillan Co. 1934.

Gladioli—see Bulbs.

Gourds.—
First gourd book. Helen M. Tillinghast. Publ. by the author. 1939.
The garden of gourds. L. H. Bailey. The Macmillan Co. 1937.
Gourd seed (A quarterly magazine). Publ. by the Gourd society of America.

Grasses.—
First book of grasses. Agnes Chase. The Macmillan Co. 1922.
Corn and corn growing. Henry A. Wallace and Earl N. Bressman. Wallace Publ. Co. 1937.

Greenhouses.—
Winter flowers in the sun-heated pit. Kathryn S. Taylor and Edith W. Gregg. Charles Scribner's Sons. 1941.

Hedges—see Shrubs.

Herbs.—
Herbs—their culture and uses. Rosetta E. Clarkson. The Macmillan Co. 1942.
Herbs—how to grow them and how to use them. Helen Noyes Webster. Hale, Cushman & Flint. 1939.

House plants.—
Plants in the home. Frank K. Balthis. The Macmillan Co. 1941.
Success with house plants. Jane Leslie Kift and Karin B. Hedenberg. A. T. De La Mare Co. 1932.

Hybridizing—see Genetics.

Insects—see Diseases.

Iris.—
A handbook of garden irises. W. R. Dykes. Martin Hopkinson (London). 1924.
Bulletin of the American iris society. Publ. by American iris society.
Alphabetical iris check list. (Last number in 1939). Publ. by American iris society.

Landscape gardening.—
Planning and planting your own place. Louis Van de Boe. The Macmillan Co. 1938.
Landscaping the home grounds. Leonidas W. Ramsey. The Macmillan Co. 1930.
The design of small properties. M. E. Bottomley. The Macmillan Co. 1927.
Garden planning and building. H. Stuart Ortloff and Henry B. Raymore. Publ. by American garden guild. 1945.
Planting design. Florence Bell Robinson. Whittlesey House. 1940.

Larkspur—see Delphinium.

Lawns.—
Better Lawns. Howard B. Sprague. Latest ed. by American Garden guild. 1945.
Practical lawn craft. R. B. Dawson. Crosby Lockwood & Son (London). 1939.

Lilacs.—
The lilac. Susan D. McKelvey. Publ. by Arnold Arboretum. 1928.
Lilac culture. John C. Wister. Orange Judd Publ. Co. 1930.

Lilies.—
Lilies and their culture in North America. William N. Craig. Florists' Publ. Co. 1928.
Lilies for American gardens. George L. Slate. Charles Scribner's Sons. 1939.
Garden cinderellas: how to grow lilies in the garden. Helen Morgenthau Fox. The Macmillan Co. 1928.

Nursery.—
The modern nursery. Alex Laurie and L. C. Chadwick. The Macmillan Co. 1931.

Orchids.—
American orchid culture. E. A. White. A. T. De La Mare Co. 1942.

Peonies.—
The book of the peony. Mrs. Edward Harding. J. B. Lippincott Co. 1917.
Peonies: The manual of the American peony society. Publ. by American peony society. 1928.
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Pinks.—
The garden of pinks. L. H. Bailey. The Macmillan Co. 1938.

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The book of water gardening. Peter Bisset. A. T. De La Mare Co. 1907.
Garden pools, large and small. L. W. Ramsey and C. H. Lawrence. The Macmillan Co. 1931.
Water gardening. Frances Perry. Charles Scribner's Sons. 1938.

Propagation.—
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Plant propagation for the garden. D. C. Fairburn. Doubleday, Doran & Co. 1936.

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Azaleas and camellias. H. Harold Hume. The Macmillan Co. 1931.
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North American rock plants. W. H. A. Preece. The Macmillan Co. 1937.
Pleasures and problems of a rock garden. Louise B. Wilder. Doubleday, Doran & Co. 1928.

Roses.—

The rose manual, an encyclopedia for the American amateur. J. H. Nicolas. Doubleday, Doran & Co. 1930.

Old roses. Mrs. Frederick Love Keays. The Macmillan Co. 1935.

Modern roses. J. Horace McFarland. The Macmillan Co. 1930.

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How to grow roses. J. Horace McFarland and Robert Pyle. The Macmillan Co. 1937.

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Shade plants.—

Gardening in the shade. H. K. Morse. Charles Scribner's Sons. 1939.

Shrubs.—

Hedges, screens, and windbreaks. Donald Wyman. Whittlesey House. 1938.

Ornamental American shrubs. W. R. Van Dersal. Oxford University Press. 1942.

The book of shrubs. Alfred Carl Hottes. A. T. De La Mare Co. 1931.

Shrubs and trees for the small place. P. J. Van Melle. Charles Scribner's Sons. 1943.

Soilless gardening—see Chemiculture.

Soils.—

Seed and potting composts. W. J. C. Lawrence and J. Newell. George Allen & Unwin Ltd. 1943.

Fertilizers and crop production. L. L. van Slyke. Orange Judd Co. 1932.

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Succulents.—

Our native cacti. Ethel Bailey Higgins. A. T. De La Mare Co. 1931.

The cactus and its home. Forrest Shreve. Williams & Wilkins. 1931.

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Tree experts manual. Richard R. Fenska. A. T. De La Mare Co. 1943.

Maintenance of shade and ornamental trees. P. P. Pirone. Oxford University Press. 1941.

Vegetable gardening.—

The food garden. Edna and Lawrence Blair. The Macmillan Co. 1942.

A manual of home vegetable gardening. Francis C. Coulter. Blue Ribbon Books. 1942.

Grow your own vegetables. Paul W. Dempsey. Houghton Mifflin Co. 1942.

The vegetable garden. Edward I. Farrington. Hale, Cushman & Flint. 1942.

Missouri vegetable planting calendar. Univ. of Mo. Circular 440. 1942.

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Wall shrubs and hardy climbers. W. J. Bean. Putnam. 1939.

Weeds.—

A manual of weeds. Ada E. Georgia. The Macmillan Co. 1921.

Weed control. Wilfred W. Robbins, Alden S. Crafts and Richard N. Raynor. McGraw-Hill. 1942.

Weeds. Walter Conrad Muenscher. The Macmillan Co. 1936.

Just weeds. Edwin Rollin Spencer. Charles Scribner's Sons. 1940.

Wild flowers.—

The wild garden. Margaret McKenny. Doubleday, Doran & Co. 1936.

Pioneering with wild flowers. George D. Aiken. Publ. by the author. 1933.

Spring flora of Missouri. J. A. Steyermark. Missouri Botanical Garden. 1940.

Wild flowers. Homer D. House. The Macmillan Co. 1940.

H. N. A. & E. M.

The home of a *sertanejo* may be but a thatched shelter. Boa Nova, Bahia.

Men of the *sertao*, interior Bahia.

BRAZIL'S OLD "WILDWEST"

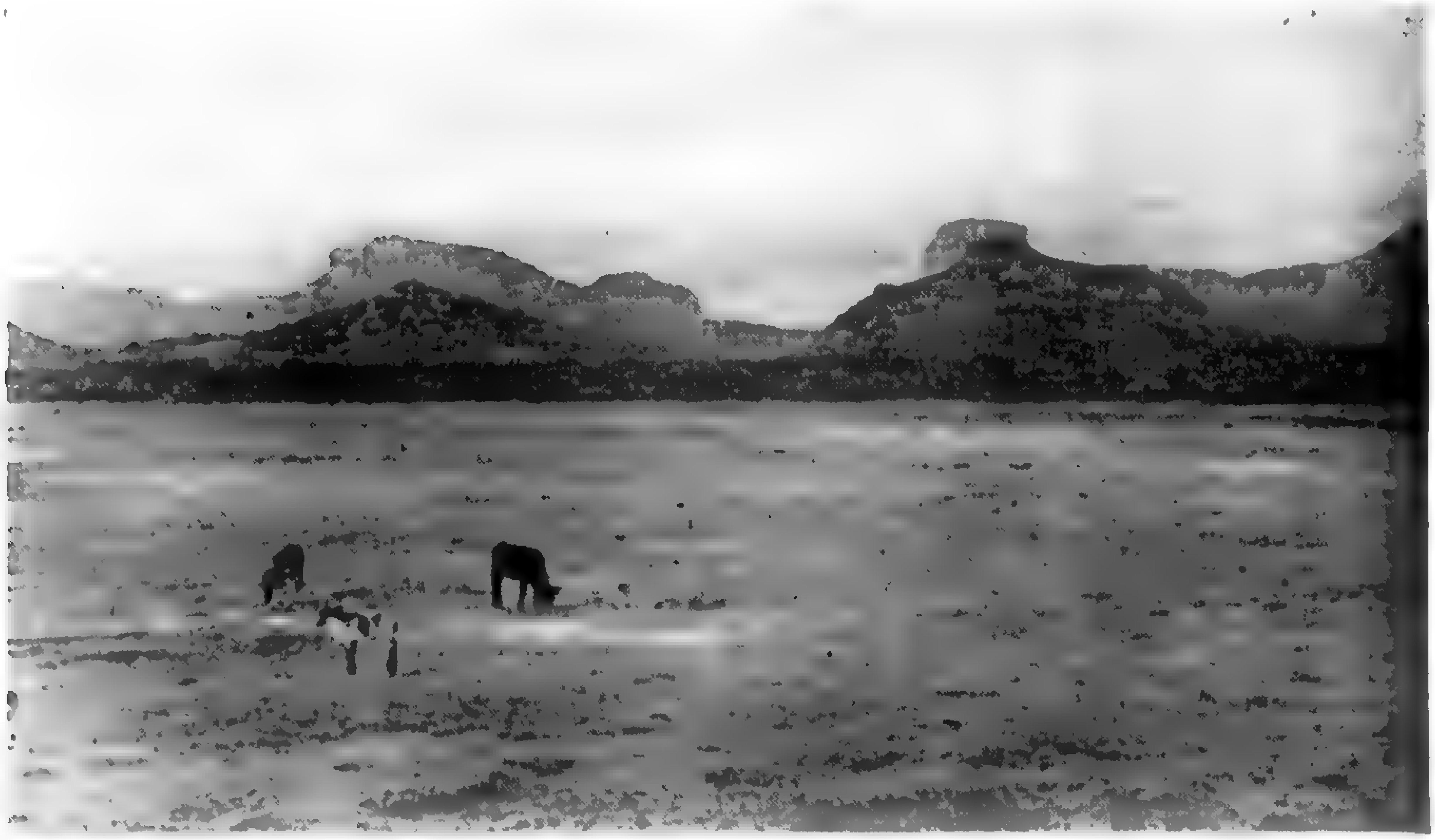
ROBERT W. SCHERY

In spite of the recent trend towards "inter-Americanization," with its promulgation of information on our neighbor countries to the south, many Americans think of Brazil as either jungle-infested Amazon country or play-time, beautiful Rio de Janeiro. The truth is, that between these two places exists an area as vast as our West,—as desert-like as our West, much older than our West, and with its own history and lore as exciting as that of the building of our West. It is Brazil's *sertao,* the northeastern section of the country extending from Piaui through Bahia. Significantly, in the movie houses of small towns of the region, the most popular films are our "westerns."

This is the area where the "mad priest of Canudos," having held his domain in defiance of Federal troops for many years, finally died with his followers,—to the last man; where the bandit Lampeão, killed in Bahia less than a score years ago (his head is still on display at the medical school), is already somewhat of a Robin Hood legend; where Padre Cicero, until his death, held absolute sway over southern Ceará, in contempt of all Government authority; where often a man's gun was for hire more cheaply than his labor, and a contract thus entered into was inalterable.

It is mostly an area of level topography abruptly punctuated by picturesque *serras* (small mountains). Rivers and creeks are few and distant. The soil is often quite sandy. The climate is extremely dry except for a brief annual rainy season during our winter months. The plants reflect the paucity of rains, being of a semi-desert type or losing their leaves during the dry season. Cacti and Bromeliads are frequent and abundant, as are the thorny, scrubby shrubs and small trees of the *caatinga,*—mostly Leguminosae, Euphorbiaceae and Malpighiaceae. As the rains come the impenetrable *caatinga* leafs and blossoms for a few brief months. Then the nights are perfumed, the days resplendent with Cassia, Mimosa and Bignoniaceae in flower. It is like another world from the harsh dry season during which man scarcely dared venture from home, when cattle nibbled even the stem of cacti in hopeless search for green forage, and most plants wisely remained dormant—stark in appearance like those of mid-winter Missouri.

Like our West, the economy of the region is built primarily around cattle. During severe drought many cattle perish, and man may migrate or perish also. Few crops are raised, these mostly beans and mandioc for local consumption, castor seeds for sale. Maize is of surprisingly minor importance. Wax from wild palms, rubber from certain wild trees, and "caroá" fiber from the terrestrial Neoglazovia supplement the income.



Cattle grazing before *serras* near Lage de Alto, Bahia, Brazil.

A government sisal plantation, northeast Bahia: an effort to improve *sertao* economy.

The ebb and flow of humanity through the centuries has left a wiry, fatalistic type individual sparsely populating the *sertao.* In such a marginal area the future is uncertain and life is cheap. All is built about and dependent upon the annual coming of the rains; water is life's limiting factor. Foods are dietarily inadequate and unvaried, being mostly mandioc, with beans, rice, eggs and meat used as available. Bananas are obtainable near water supply but other fresh fruits and vegetables are seldom seen. Housing is often makeshift or rudimentary. Disease and debility are common. Yet a proud type has mastered this inhospitable environment, and few *sertao*-dwellers know of or care for the fate of the rest of the world. To the *sertanejo* the world extends to the horizon and tomorrow will care for itself. Superstition and hearsay are often master of fact. As a result the area is backward, judged by the mechanical and educational progress of the United States. It is to-day mostly the same as it was three centuries past,—unyielding in thought and custom. Yet here and there modern methods are creeping in. Several well-managed *fazendas* exist, and the Government has initiated a few educational and plantation programs. Gradually highways passable to modern trucks are fingering into the hinterland, limiting the dependency on mule and burro for transportation. And the scattered products from this vast arid hinterland funnel to and help support the few large coastal cities, such as sunny Fortaleza, commercial Recife, and picturesque Salvador, of which perhaps more can be said in a later article. Rich in its traditions and above all its tenacity of life, the Brazilian *sertao* remains a world within a country.

A LETTER FROM HOLLAND

The following letter was received recently by Dr. Robert E. Woodson, Jr., from a botanical colleague in Holland. We feel that it should be of lasting interest to BULLETIN readers, as well as to all Americans, as a reminder of the cultural suppression that German occupation brought to so many countries.

Botanical Museum and Herbarium
of the State University
Utrecht, Holland
January 18, 1946

Dear Dr. Woodson,

I was very happy to receive your letter of November 8. Indeed I have been so happy to escape the danger of the german oppression, but you can understand that we have had a terrible time over here. It was a long time before I answered your letter, but that was caused by my bad health during December. I never have been ill so long but such things are very usual here now and caused by the hunger winter of 1945/46,* when we had almost no food, no gas, no electricity and no coal. Moreover, it was impossible to come in the streets for the german "razzias." During the last 4 months of the war I lived and slept in the herbarium, where I cooked my poor meals on a small stove, meals consisting of sugar beets and sugar beets and sugar beets and potatoes (when available) and 400 grams of bread a week. I think you never tasted sugar beets; the first time you do, you will perhaps say: "it is possible to eat the stuff," but afterwards it grows more and more horrible. But we are very happy that our herbarium is safe and most of the Dutch botanists too. Dr. Uittien, collaborator of our herbarium, was shot by the germans for "illegal work." One time only, in 1941, the germans got me, and I was sent to a prison for one week for

* Judging from the latter part of the letter this is a mistake. Dr. Jonker probably means 1944/45.

being a commissioner of the boy scouts association! In 1944, the male staff of the herbarium and botanical laboratory here lived during two days under the floor of the lecture room for the germans searched every house of Utrecht to find men.

During the war the taxonomist Danser and the morphologist Schoute died. We know little from the Dutch botanists in the Netherlands East Indies. Certainly several of them died in the japanese camps, e. g. my former colleage Dr. Eyma. I don't know anything of the german botanists. Dr. Diels is dead,—that was in our papers a few months ago. Nothing is known of Dr. Markgraf, but I know that he was a prominent member of the nazi party.

I am very much interested in your flora of Panama. I hope the copy you promised me will arrive soon. American literature begins to arrive here, and we all welcome the contacts with the U. S. A. that is possible again. We all have almost no time to do any work in tropical botany now, for a great number of students in biology arrived when the university was open again. During the last years it was only possible to visit the university after signing a form of loyalty to the germans, and no honest student did so.

Things are much better now in Holland. Food is sufficient; only butter, meat, fat, etc. are scarce. The great difficulty is clothes, especially underclothes, and shoes. I go to the herbarium on my last pair of shoes, but it is more holes than shoes. There is also tobacco again; during the last years we smoked very bad home-grown tobacco and leaves of Prunus or bracts of Humulus, etc. Now we get rations of 40 cigarettes or 10 cigars or 40 grams of tobacco a week. I don't believe there is anything you can do to help us. Perhaps you can send us for the library of our institute or for our own libraries some reprints or books. It is still impossible for us to buy books made in England and in America, both scientific and other books. The books we could buy during the occupation were "poison for the soul," and scientific books did not appear. And when there are pipes (to smoke tobacco) available in St. Louis, you can do me a great pleasure in sending one. Later on I can pay for it perhaps.

I hope I have given you some news from Holland. There is much more to tell but I must stop now.

With best regards,

Yours truly,
Dr. F. P. Jonker
Head Assistant

A COLORFUL GREENHOUSE VINE

HENRY N. ANDREWS

Regardless of what our special interests in gardening may be the creation of harmoniously colorful effects is usually the first thought. True, there are many plants that we grow primarily for a luxuriance of green or variegated foliage, such as the ferns, Aspidistra, Coleus, and a host of others. Or we may go in for plants whose chief attractions are their exotic forms such as the cacti and other succulents. But what cactus enthusiast does not hope that his spiny charges will one-day reward him with a few blossoms? And when they do come they will make up for the long years of slow and sterile growth.

In the winter and early spring months especially we need a splash of the color that boreal winds and cold have taken away. For the small greenhouse or conservatory *Clerodendron Thomsonae,* sometimes called the Bleeding-Heart Vine, offers a colorful solution and one attended with but little cultural difficulty.

Clerodendron Thomsonae about nine months after having been cut back to ground level.

Clerodendron is a rapid grower and profuse bloomer through the late winter, spring and summer months. In fact a specimen that we have had for some few years in a greenhouse at Washington University is rarely ever without at least a few blooms. The slender, pliable, and easily trained branches bear a rich abundance of oppositely arranged, deep green, almost leathery leaves. After a few years of growth the plant tends to drop its leaves in the lower portions, presenting a rather bare appearance. If such a vine is cut to within a few inches of ground level the rapid new growth will bring it back to a prominent position in the greenhouse flora within a few months. The plant shown in the accompanying illustration is one that represents a little less than nine months growth, having been cut to nearly ground level in March of last year.

A six-month-old cutting well established in a five-inch pot.

At the time the old plant was cut back a number of cuttings were made of both the young and older hardwood growth. These were easily rooted in a sand bench in the usual manner with a loss of not more than a third. They were potted in soil containing a generous admixture of leaf mold and sand, and some of the young plants started to flower within six months. The soil in which the parent plant is growing has received but little attention for years, yet rapid healthy growth continues; an abundance of moisture is necessary, however.

The flowers are borne in dense clusters in the axils of the leaves, and the five crimson lobes of the delicate tubular corolla extending from the inflated snow-white calyx present a contrast to the luxuriant green of the foliage that never fails to attract attention.

The special adaptation of the flower to insect pollination is fascinating in itself. The stamens mature first and carry their anthers straight out for nearly an inch beyond the corolla lobes, while the still-immature style is bent down, offering two-fold prevention against self-pollination. After most of the pollen is shed the stamens are drawn back by a coiling of the

The flower of *Clerodendron Thomsonae* is well adapted to prevent self-pollination: above, the mature anthers extend forward while the style is reflexed; below, the pollen mostly shed, the anthers are drawn back and the style now bends up, opening its two-lobed stigma.

filaments, and the style in turn straightens out, the two-pointed lobes of its stigma opening preparatory to receiving pollen from another flower.

Clerodendron Thomsonae is by no means a new name on the horticultural lists but it is worthy of a place among the "musts" for those who are fortunate enough to have a small greenhouse or conservatory.

YOUR QUESTIONS ANSWERED

When should roses be fertilized?

Roses should be fertilized in late March or early April with any complete plant food which does not have a high nitrogen content. A fertilizer with a 4-12-4 analysis is satisfactory. Use from two to three tablespoonsful around each plant and cultivate it into the soil. Feed again in mid-May and for the last time about mid-July. Fresh cow manure may be applied to the beds during the winter months. Liquid manure water can be used frequently in dilute form but the soil in the rose beds should be moist when it is applied.

Wanted: a list of hardy chrysanthemums to plant outside.

Amelia (Pink Cushion)
Ceres
Dean Kay
Eugene A. Wander
Lavender Lady
Mme. Chaing Kai-shek
Mrs. Pierre S. Dupont
Pygmy Gold
Rembrandt
Lavender Lassie

What fertilizer should be used on peonies?

Any of the complete fertilizers sold under various trade names having an analysis of 4-12-4 may be used to fertilize peonies. A handful of fertilizer placed in a ring around each peony clump early in spring and cultivated into the soil will be sufficient for one or two years.

What should be done with an Easter lily after it has bloomed?

The first thing to see to is that the leafy stem continues to grow, as it is storing food for next year's flowers. As soon as the flowers fade, pinch them off, and then notice whether the roots are coming out of the bottom of the pot. If they are, carefully transfer the plant to a larger pot, using rich sandy soil and taking care not to disturb the roots. Then the plant may be set out of doors (unless there is danger of frost) in a protected, *partially* shaded place. Water throughout the summer and, perhaps once a month, fill the depression of soil about the plant with a solution of about a teaspoonfull of Vigoro dissolved in water. Under this treatment, the Easter Lily will frequently form another flowering stem the same season.

The Easter Lily is partially hardy in this vicinity, and if you want to try it out in your garden, carefully remove the plant from the pot about the first of May and plant a little deeper than in the pot in a sunny, protected place in the garden. Water and feed Vigoro occasionally throughout the season, and mulch with about 3 inches of straw after the ground has frozen.

Unless you have a greenhouse, it would be better to give up the idea of forcing the plant into bloom for next Easter!

What varieties of flowering crabs are well adapted for this region?

Malus Arnoldiana (Arnold's Crab)
Malus floribunda (Flowering Crab)
Malus micromalus (Midget Crab)
Malus Sargenti (Sargent's Crab)
Malus purpurea (Purple-leaf Crab)
Malus theifera (Tea Crab)
Malus toringoides (Cut-leaf Crab)
Malus Sieboldi (Toringo Crab)

NOTES

We are indebted to the Oregon Bulb Farms of Sandy, Oregon, for the colored plates of daffodils used in this issue.

Lt. Ralph W. Emons, formerly graduate student at the Garden, has been discharged from the Army and is spending his terminal leave at his home in East St. Louis.

Plants noticed in bloom at the Garden before the first of March were the following: snowdrops, *Cornus Mas*, Chinese elm, soft maple, hazel, bush honeysuckle, forsythia, and narcissi in sheltered places.

The second number of Fascicle 3 of Woodson & Schery's *Flora of Panama*, containing the "Orchidaceae of Panama" by Louis O. Williams, has recently been issued as the February number of the ANNALS OF THE MISSOURI BOTANICAL GARDEN (vol. 33, no. 1).

Among the groups visiting the Garden recently were the students in botany of Lindenwood College, St. Charles, Mo., accompanied by their professor, Dr. Marion L. Dawson; and a group of botany students from Southern Illinois Normal University, accompanied by their professor, Dr. Walter B. Welch.

Several years ago the Garden obtained bulbs of a very early-flowering variety of Crocus from Mr. Charles Rice. They were planted at Gray Summit near the trail house and have increased from year to year. This February found a number of them in flower on the 23rd, and by the end of the month they made a beautiful and interesting display on sunny days.

Dr. Edgar Anderson, Geneticist to the Garden, spent several days at the Museum of Ethnobotany, of the University of Michigan, where, working with Mr. Volney Jones, the Director of the Museum, he measured their extensive collection of pre-historic maize from North America. He also attended the annual meeting of the American Society of Agronomy, at Columbus, February 26–28.

Recent visitors to the Garden include: Mr. Lloyd L. Smith, Jr., Research Supervisor, and Mr. Raymond E. Johnson, Aquatic Biologist, both of the Bureau of Fisheries, Minnesota Department of Conservation, St. Paul; Mr. James M. Lindsley, Orchid Grower, of Morristown, N. J.; Dr. E. R. Spencer, Consulting Soil Botanist, Lebanon, Ill.; Capt. George Thomas Johnson, who received his doctors degree in the Shaw School of Botany; Mr. Arno H. Bowers, member of the American Amaryllis Society, Pasadena, Calif.; Sgt.

C. G. Wyckoff, Graduate Student, University of California, Los Angeles; Mr. Harold F. Winters, Horticulturist, Federal Experimental Station, Mayaguez, Porto Rica; Mr. George E. McClure, Landscape Architect of Buffalo, N. Y.; Mr. Richard Spears, Graduate Student, University of Louisiana, Baton Rouge; Mr. Charles Gibbs Adams, Landscape Architect, of Pasadena, Calif.; Judge and Mrs. Newhall, Orchid Growers, of Aurora, Ill.; Mr. John Irvine, orchid enthusiast, of Belmont, Mass.

On February 20, Joseph Cutak, one of the oldest and most beloved members of the Garden staff, died. Born in Svatoborice, Moravia, Czechoslovakia in 1882, his early life was spent in gardening in Europe. His first experience was on estates near Kyjov, Czechoslovakia, but eventually he became a gardener at the imperial estate of Schönbrunn, near Vienna. Upon his arrival in America in 1912, he came direct to St. Louis, where an opportunity soon presented itself at the Missouri Botanical Garden. His first assignment was the growing of flowers for display purposes, but later he was transferred to the exotic department, in charge of the main conservatory. He spent many years in the growing of cacti and succulents, and his son Lad says that the seed of his present enthusiasm for these plants was sown by his father. When his son took over the main conservatory, "Joe" as he was familiarly called, was able to devote all his time to orchids and water-lilies. He took great pride in the fact that the "lost yellow tropical water-lily of Africa" was raised from seed and flowered at the Garden by him. Although in failing health during the last years of his life, he could not be kept away from his duties at the Garden, and until his last week was able to give his usual cheery greeting to the florists as they came to buy orchids.

SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date until his death in 1889 it was maintained under his personal direction. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was chosen by Mr. Shaw and he definitely indicated that he wished it called by that name. The Garden passed at his death into the hands of a Board of Trustees, designated in Mr. Shaw's will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provision of the will the immediate direction of the Garden is vested in a Director, appointed by the Board. The Garden receives no support from city or state but is maintained almost exclusively from the estate left by Henry Shaw. Since 1939 many Garden Clubs and interested individuals have contributed to a "Friends of the Garden Fund" which is used in developing the new Arboretum, located at Gray Summit, Mo. The Arboretum (1) serves as a source of plants, trees and shrubs for the city Garden; (2) affords areas for gradually establishing a pinetum, a wild-flower reservation and various other features on a scale not possible in the city; (3) provides greenhouses for some 20,000 orchid plants.

The city Garden comprises 75 acres, where about 12,000 species of plants are grown, both out of doors and under glass. It is open every day in the year except New Year's Day and Christmas; week days, 8:00 a. m. until sunset; Sundays, 10:00 a. m. until sunset. The greenhouses are closed every day at 5:00 p. m.

The main entrance to the Garden is at Tower Grove and Flora Place, on the Sarah car line (No. 42). The Tower Grove bus (No. 21), direct from downtown, passes within three blocks of the main entrance.

THE MISSOURI BOTANICAL GARDEN

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MISSOURI BOTANICAL GARDEN BULLETIN

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Cover: Wood Hyacinths in the Mausoleum Grove at the Garden

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Early winter in the mountains of southeastern Idaho

Fossil hunting in the sage-covered hills near Wayan, Idaho

Missouri Botanical Garden Bulletin

Vol. XXXIV APRIL, 1946 No. 4

ANCIENT PLANTS OF THE WEST
A FOSSIL-HUNTING TRIP IN IDAHO

HENRY N. ANDREWS

To taste sharply of the climatic extremities that these United States are able to offer one need not journey from the sub-tropics of Palm Beach to the Arctic zone of Mt. Washington. After leaving a sultry St. Louis one mid-September afternoon of last fall, to step off the Union Pacific's "Portland Rose" a scant two days later into an Idaho blizzard brought that all too clearly to mind.

Soon after we had crossed the border of Wyoming, in the very early gray dawn of a western morning, I found myself anxiously scanning the weather signs for the coming week. The railroad soon picks up the tumbling Bear River, following its winding course for many miles through eastern Idaho. On either side are the gray-green sagebrush hills with sheep and cattle ranches comfortably nestled in the valleys, and in the distance rise higher peaks for another 3000 feet piled on top of the 6000 that we had already gained. It is ranching country in the true style of the Old West, but with the buckboard replaced by a pick-up truck, while here and there vast fertile fields of grain are springing up where the sagebrush thrived only last year.

My immediate destination was Soda Springs, a small but beautifully located town in these already snow-capped mountains. One may reasonably expect favorable fossil hunting weather into October, but as I gathered up my duffle bags which the porter had gently tossed onto the roadbed it was all too evident that snowshoes might soon be appropriate. Geologically, Soda Springs is, in part at least, a tiny outlier of the Yellowstone country to the north. The name is a living reminder of the volcanic forces that were once so all-powerful in the region. To the west and north are hundreds of square miles of the great Columbia lava flow which in its time surely must have been "the greatest show on earth." But these forces are by no means dead to-day. Soda Springs is the only town that I know of where one may call at one of the two drugstores, obtain the key which turns on the local geyser, then watch a tremendous column of warm water spout up for a hundred feet or more. That is one little item that is still a rarity in the big-city drugstores!

Thirty-five miles to the north is the little ranching community of Wayan, my objective. The three-inch snow storm had brought to town tales of mountainous drifts and impassible roads. The prospects for fossil hunting looked gloomy, but by late afternoon this pre-season harbinger of a mountain winter remained only on the higher slopes. The daily "stage" to

Mr. Henry Thomas and his collection of petrified ferns

Wayan had pulled out ten minutes ahead of my train, but as the result of a lucky contact with a rancher-friend of a former visit I was deposited toward night at the comfortable cabin of Mr. Henry Thomas, one of Idaho's most enthusiastic fossil hunters. After consuming liberal quantities of coffee and a freshly brewed "mulligan" we talked of plans for the coming week.

Scattered across the high plateau lands immediately to the east Mr. Thomas had located the petrified remnants of a great tree-fern forest. I had come to explore further these vestiges of an ancient vegetation that had long since passed from the western landscape. To-day grasses and sagebrush compete for the broad expanses of the valleys, plateaus and lower mountain slopes, while higher up aspens and evergreens take over, with here and there a natural garden meadow of alpine flowers. But in September little remained of the colorful displays of midsummer, and our thoughts were with the woodlands of long ago.

Before the crust of the earth had been crumpled thousands of feet into the air to form the Rocky Mountains, the topography and climate, and consequently the vegetation, of that territory were vastly different. During early Tertiary times, some 50 to 60 million years ago, warm temperate to sub-tropical forests extended as far north as Oregon in the Pacific region; palm trees once graced the shores of a great lake that covered a goodly

Excavating a fossil palm leaf in western Wyoming

portion of southwestern Wyoming and adjacent Colorado; while redwoods flourished in the Yellowstone country and at many other points far to the eastward of their present restricted range along the California Coast.

But back at Wayan—for many years Henry Thomas had been scouring his Idaho hills while riding the range with herds of sheep, a quest that has resulted in the accumulation of hundreds of fine specimens of petrified tree-fern trunks. In their general appearance these plants probably were not greatly unlike modern tropical tree ferns. The trunks varied from a few inches to nearly a foot and a half in diameter. Complete ones have never been found, but in all probability they attained a height of 10 to 20 feet and bore a luxuriant crown of many small leaves.

From their abundance it is evident that these ancient tree ferns formed pretty much of a forest in themselves. But there were other trees associated

Cycads grown in the Main Conservatory at the Garden

with them to a greater or less extent. Scattered among the broken silicified[1] remains of the fern stems we found numerous fragments of petrified wood that disclosed, upon microscopic examination, the presence of evergreens (conifers)—possibly early ancestors of the Sequoia-Cypress alliance. Broad-leaf trees, dominant in size, if not numbers, were also present. Our most unique discovery, however, was a portion of a Cycad trunk—only one, but encouraging enough, for Cycads had never been reported in this region, although fine specimens have been found in the Freezeout Hills of southern Wyoming, the Black Hills of Dakota, and elsewhere in North America. Modern Cycads, of which the Garden has an especially fine collection, are usually unbranched, stout, columnar plants bearing a great crown of palm-like leaves. They are, however, of much greater antiquity than the palms and differ strikingly in many of the detailed points of their structure. To-day they are found from central Florida through the Indies into South America and in a climatically comparable portion of the Old World.

As these ancient plant remains, entombed for so many millions of years in the rocks, gradually emerge from the eroded hillsides we are reminded of

[1] These tree ferns, known under the generic name of *Tempskya*, as well as the other fossil plants discussed, are all petrified by the mineral silica.

the irresistible changes that time and its assemblage of natural forces have wrought with the world of living things. Where luxuriant forests once grew in a vast undulating plain great mountain ranges have come, snow-capped even in late spring and early fall. But they have brought with them these intriguing vestiges of the past which it is our pleasure to struggle to unravel.

MAINTAINING SOIL FERTILITY AT THE ARBORETUM

AUGUST P. BEILMANN

Probably the key to the successful operation of an Arboretum in the Ozark Uplift is soil fertility. It is, of course, possible to charge off any plant which will not grow as being wholly unsuited to the territory. However, if an Arboretum is to be effective as such it must grow a wide variety of plants. Then too, having arrived on the scene some hundred years after the first settlers, we have no true knowledge of the capacity of the Ozark Uplift to grow plants. Too much of our ecology begins with the post-mortem. We must examine the records of some of the shipments which left such towns as New Franklin (destroyed almost a hundred years ago) and Point Labadie (once a great shipping point and now two miles from the river) to obtain some idea of how productive the area once was. Some manifestoes of cargo shipped from such tiny settlements are unbelievable in the light of the present experience. It was not unusual for such small towns to ship as much as $100,000 worth of cargo in a twelve-month period. Translated in terms of the present buying power of a dollar, it is a record we can not approach to-day. Whole barge-loads of tobacco packed in hogsheads and huge loads of everything from barreled honey to salt left these small towns. As late as 1860, one landowner was reported as owning twenty-three slaves. Again interpreted in the light of our present experience in the Ozark Plateau, it would be almost, if not wholly, impossible for a single landowner to raise enough to feed his household and twenty-three additional mouths, even though he had twice the acreage of the landowner of that early day.

Soil fertility is the capital stock in the operation of an Arboretum, and when once dissipated it is most difficult to recover. As erosion follows poor farming and the soil produces less and less, poorer and poorer farming results, and a whole train of other problems arises. Once a soil becomes so unproductive that it lies idle and, for all practical purposes, abandoned, the floristic character of the area changes. Finally the time comes when the danger of fire is a problem secondary only to the underlying cause—a nearly sterile soil. By slow degrees even the poorest piece of ground becomes enriched by plant debris. A fire, however, sets the whole cycle back another five to ten or more years, continuing the chain of events which started with the first poor farmer in the community, that is, poor in his knowledge of land use.

Perhaps some plants do persist, and they might be said to be happy in the soil of the Ozark Plateau as we know it to-day. But periodically we have a winter just a little colder, just a little drier or perhaps a little more changeable than usual, and we encounter the phenomenon called "winter injury" in everyday language. The lack of winter hardiness among the plants, or at least their failure during extreme winters, has been shown by many workers to be partly associated with soil fertility. The Garden BULLETIN has published many lists containing the names of plants which were dead by spring. These plants have run the gamut from those known as unable to stand light frost to those which should have succeeded and have since proven hardy. We have found, for instance, that a heavy mulch of leaves or hay makes plants hardier, and that stable manure is superior to other mulches. Mulching is an artificial way of duplicating the natural duff found in woods and the dead grass stems and accumulated organic matter of the land. Mulching tends to add great quantities of humus to the surface soil and under such a procedure even the worst ground takes on the character of virgin soil. There is reason to believe that while we can increase the organic material and the fertility of the soil, we may never wholly replace those minor elements which play a small and obscure though vital role in nutrition. In his "Plowman's Folly", Edward H. Faulkner has attempted to prove that a near-approach to virgin conditions will produce a high yield. Professor Albrecht, of the University of Missouri, has shown the preference of cattle for parts of a field which have had some of the fertility returned in the form of fertilizers. Plants in a nursery behave in much the same fashion. If by artificial means we add organic matter and fertility, winter hardiness is increased and, most of all, mortality at time of transplanting is very greatly reduced.

The landscape of the Arboretum probably will always consist of open grassy fields and trees. Trees will grow in the ravines, will be planted in systematic groups in the open, and they may be used along fence-rows or roads. But between the trees along the ravines and the nearest planting there will always be some sod land. The maintenance of this sod land in an inviting condition may well occupy a large part of the summer. Mowing, of course, is the biggest seasonal operation, and the removal of the grass or hay ranks a close second. Weather conditions, the harvest of blue grass seed, and the wait until the Narcissi foliage dies down all help in causing a large part of the area to look as though it were uncared for until late July.

If the Narcissi are to continue to be a valuable spring display—and there are millions naturalized now—the fields cannot be mowed until the foliage ripens. If the very fine blue grass we have is to continue to be harvested, again we must wait until late June before mowing. Assuming that harvesting is completed and mowing is well under way, it is then necessary to remove the hay, the grass, or the wild flowers from the field. If a field is not raked after mowing, in a short time the organic matter in the surface soil increases to the point where it favors the weeds and the woody plants at the expense of the blue grass. Blue grass is very important; it is one of the finest backgrounds for floral display, and even an unmowed blue grass field is less a fire hazard than a field full of all the wild flowers commonly found. The Asters, the Goldenrod, and particularly the Candle Grass (Andropogon), furnish much fuel and make a fire hard to control when once started. So far all open field maintenance has been carried on by tractor mowers and hay loaders. The material removed is used for mulching. These tough woody weeds make a fairly satisfactory mulch, but perhaps they have been used for this purpose because it is a simple way to get rid of them. Mowing is one way of controlling the growth of an open field, and using the foliage is a way of disposing of the surplus. However, it takes much expensive equipment to mow six hundred acres or more, and since there are but 500 working hours between the beginning of mowing, in July, and the end, in September, the result achieved will be in relation to the number of mowing units employed. Each mower and tractor costs between \$900.00 and \$1500.00, and only a limited use can be made of the tractors through the rest of the year.

Mulching, as has been shown, is a step toward increasing fertility, and the speed with which this is accomplished is directly related to the kind of organic material available. Sawdust from our own mill and from a nearby stave mill is probably the least valuable as a soil conditioner. Several years must elapse before it disintegrates and becomes part of the soil profile. The hay-and-weed combination decays faster but it is more difficult to handle. The ideal set-up would be the conversion of all hay or grass into manure through the feeding of a herd of cattle. Experimental work through the past six years indicates that this solution is satisfactory both in lowering the costs and simplifying the maintenance of the sod. So far all the material not used as a mulch, in other words, those fields which produced a kind of hay, have been reserved for cattle food. However, cattle will eat hay only in the winter and even then must be fed supplementary quantities of grain if they are to hold their weight. Now, there is a great deal of wastage in the material cut from some fields, the heavier woody plants being usually discarded by cows. Therefore, the fields which do not yield an acceptable hay could be mowed just as soon as blue grass ripens if another method of converting to manure could be found.

Perhaps the solution lies in the use of a silo. This will permit the conversion of material not suitable for hay into another form of cattle feed. If the silage were fed out in a small lot, it would be possible to haul a considerable tonnage of manure back to the fields and the plant groups. Some objection might be made to the building of such a permanent structure identifying parts of the Arboretum as a cattle range, but with the tremendous acreage which must be kept under control for future development there seems to be no alternative than to harvest and convert the crop for future use as manure. We can continue to plant—as we have in the past—thousands and thousands of trees and shrubs only to have the mortality keep in step with our planting effort and at the end of ten years have little more to show than we have right now. We cannot purchase sufficient manure locally, nor is it possible to ship in manure so that it reaches us at a time when we have access to the fields. Thawing weather in winter or a thunder storm in summer may make it impracticable to unload a car or place the material where it is needed.

There remains one method by which we can change the character of the sod so that it will present a less objectionable picture should our mowing be delayed or fail entirely. This requires the application of lime and perhaps such minor elements as boron, manganese, zinc, etc. Some experimental work has been done showing that under either erosion or continued cropping these materials are either utilized or wasted and must be returned to the soil by artificial means. Obviously we do not know all the answers to this phase of the problem. More work is required to determine the soil deficiencies which might exist and the amounts needed of even such common things as lime, phosphorus, and potash. So far we have found that manure pretty well supplies the deficiency, or at least it very rapidly increases the fertility. In this connection some work done July 4, 1940, may be of special interest. At that time four 1/10-acre plots were stepped off. To one, 50 pounds of muriate of potash—50 per cent—was applied; another received 100 pounds 20 per cent super-phosphate; a third, 100 pounds ammonium sulphate—20 per cent; the fourth, 50 pounds of a 10-8-6 fertilizer. These materials were broadcast by hand on a field used by cattle. Ever since that time this has been a favorite grazing ground for cows. Even in the first year, before there was any noticeable improvement in the grass, the cows were always found there and they have since kept the grass closely cropped. Of the materials used, the plot containing the super-phosphate has seemed the most attractive. There have been times when the exact outline of the treated area could be determined by the line of grazing cattle. That part has been cropped as close as a putting green, while the check plots between were grazed only when no grass could be obtained from the fertilized zone.

The primary problem at the Arboretum is increasing soil fertility, for it is only in this way that we can have a greater variety of plants. If the soil fertility of the open fields is increased, then low-growing clovers and blue grass can be grown. Such a meadow is far less a fire hazard than some of the open fields we now have. Commercial fertilizers may supply some of the nutritional deficiencies, but our recent work indicates that they cannot replace organic manure. Mulching with hay has been quite satisfactory and sawdust has given good results for some plants, but no evidence has appeared to indicate that those materials are more than temporary expedients. Stable manure cannot be obtained in the quantities required. Therefore, it is proposed that a step toward the production of ample manure be taken with the erection of a silo. This will permit the conversion of at least some of the very roughest plant growth into an acceptable cattle feed, eventually to be hauled back to the new plantings and to older plantations.

SOIL FERTILITY AND ORGANIC GARDENING

In recent years American landowners have begun to show a genuine interest in the future of our soils. A number of excellent magazines and books have been making a valiant and successful effort to show that our civilization is based on a few inches of good top-soil. When that top-soil is destroyed through ignorant and greedy farming practices the very existence of the farmer, his family, and the nation that depends on them goes with it.

Mr. Beilmann's article is by no means intended as a final treatise on this subject. Much remains to be done, but the results to date indicate the validity of the basic methods employed. We feel that the work accomplished at the Arboretum is a step forward for the Ozark region, and it is in accord with the best modern conservation principles. In spite of the controversies that have centered about such recent books as Edward Faulkner's "Plowman's Folly" there seems to be agreement among amateurs and experts alike that the main problem of soil conservation is to get and keep plenty of organic matter in the soil. It is evident that this cannot always be accomplished in the same way—but it is by now clear that it *can* be accomplished if we have an honest intention of leaving the next generation a better land than the last generation has left for us.

Perhaps it is not out of order to suggest that BULLETIN readers acquaint themselves, if they have not already done so, with Sir Albert Howard's "An Agricultural Testament," J. I. Rodale's "Pay Dirt," and Louis Bromfield's "Pleasant Valley." While one may not agree with them in their entirety these books, and others like them, are pointing the way to a new, better and more permanent agriculture—an agriculture that will harbor fewer abandoned farms and eroded hillsides.

H. N. A.

TRANSPLANTING TREES IN MIDSUMMER

AUGUST P. BEILMANN

In the course of some correspondence with Mr. C. R. Runyon, of the Cemetery of Spring Grove, Cincinnati, Ohio, he wrote that he had been very successful in transplanting Oaks in full leaf in May and June. This experience is not in agreement with what we ordinarily expect (large trees are generally planted in a dormant condition), but since Mr. Runyon was so enthusiastic about late planting we decided to canvas the arborists to learn if they had had a similar experience. Accordingly questionnaires were sent from Minnesota to New York and as far south as Tennessee and Texas. Of those who answered, most had never tried transplanting when the tree was in full leaf. However, several had found it necessary to do such work late in the season, and, contrary to expectation, the transplanting was successful.

We quote excerpts from some of the letters:

Mr. Samuel M. Baxter, of Philadelphia, who ordinarily plants trees with bare roots in a dormant condition, had successfully moved a ten-inch Scarlet Oak in midsummer, and reports that "this is a splendid tree to-day."

Mr. H. N. Van Wormer, Richmond, Va., appears to have had success with Oaks in late spring, and always plants Dogwood, Magnolia, and Apple trees in full leaf in August and September.

Mr. Carl Fenner, City Forester, Lansing, Mich., wrote that, "We have always shied away from Oaks, more or less, even during the dormant season. Now we are encouraged to try again." However, he also reported successfully moving an eight-inch Elm and a seven-inch Sugar Maple in midsummer, and, oddly enough, these trees continued to grow.

Mr. W. S. Speed, Columbus, Ohio, has been very successful in transplanting dormant trees and, wishing to maintain his record of low loss (less than 1 per cent in ten years), he has not felt that he "could afford to gamble that much" by transplanting in full leaf.

Mr. J. Simonsen, Glenview, Ill., has also moved Oaks just as the buds open but has not moved them later in the summer.

Mr. Paul L. Sandahl, Des Moines, Iowa, reported no experience with summer transplanting.

Mr. Andrew F. Bell, Milwaukee, Wis., has been reluctant to plant Oaks at any time but hopes to try moving them in midsummer.

Mr. Walter Flaig, Fort Wayne, Ind., reported moving eight Norway Maples in June because of street widening, and three Sugar Maples in mid-June. Two of the three Sugar Maples died but the Norway Maples are all in good condition.

Mr. C. L. Wachtel, Wauwatosa, Wis., has hesitated to transplant Oaks at any time, but he reports transplanting three 14-inch Elms in full bloom in late spring.

Mr. Norman Armstrong, White Plains, N. Y., has not been moving trees lately, but he has had a few experiences which tend to show that "summer moving is not necessarily fatal." He reported moving a 30-inch Elm in June. The tree was out of the ground nearly a week before being replanted but it has continued to grow. Another Elm, moved in July and then in late August, a 16-inch and a 22-inch Sugar Maple, and a 14-inch Elm were moved about twelve years ago and all are in good condition to-day. He has found that small trees seem to move as well in summer to any other time.

It will be seen from this correspondence that many of these men have hesitated to plant the Oak because of its high mortality, but it will also be noted that they are very willing to plant the better trees if a more successful method can be found. In some regions and under certain conditions, especially where the planter has his own nursery or a close contact with a nurseryman who will root-prune the plants, such work has been more successful. In spite of the best intentions and care, however, it is usually very difficult to transplant an Oak at any time.

At the Arboretum, we have usually had so much trouble transplanting Oaks in the dormant season that we have made no attempt to move them in summer. However, last year we did move a number of small trees as the first step in testing this midsummer planting. At the end of a long dry spell in October we began moving small trees in full leaf, including some species which are notably difficult to transplant. The following list is of special interest:

		Number planted	Number alive
Pond Cypress	*Taxodium ascendens*	6	6
Bald Cypress	*Taxodium distichum*	3	3
Bull Bay	*Magnolia grandiflora*	2	2
Cucumber-tree	*Magnolia acuminata*	30	14
Tulip-tree	*Liriodendron Tulipifera*	5	5
Linden	*Tilia americana*	35	10
Yellow-wood	*Cladrastis lutea*	12	8
Bur Oak	*Quercus macrocarpa*	10	10
Asiatic Willow	*Salix Matsudana*	3	3
Fothergilla	*Fothergilla monticola*	2	2
Pagoda-tree	*Sophora japonica*	4	4

The Bur Oaks stood the transplanting very well, as did both species of Taxodium. *Magnolia grandiflora* did well, but the other Magnolias were very poor. The Tulip-trees all sprouted from the base. Yellow-wood seems perfectly normal, but most of the Lindens have died, and those that lived are very poor. The other species show no ill effects.

These trees were dug in the nursery and moved quickly but without a ball. The soil in which they were planted is tight and very wet in spring. It contains a great deal of iron which oxidizes when exposed by plowing or digging, being a perfect soil for Pin Oak and Sweet-gum. After planting, the trees received no water and no mulch; the soil was very dry and remained so for several weeks. This spring the situation was the opposite; the area in which they were planted had as much as four inches of water on the surface for weeks at a time. After moving, all species slowly lost their leaves long before those of the same lot in the nursery became dormant.

We have a stock of nursery-grown Oaks which are now up to three inches in caliper, to be used for more extensive testing this summer. These trees were allowed to grow beyond the ordinary size because the loss following transplanting has always been abnormally high. Much as we would like to use them, we have found in previous seasons that they could not be transplanted either with bare or balled root during the dormant period.

Since most tree planters would prefer to use a tree with a long life expectancy, such as an Oak, these planting experiments will be continued and reported on at some later time. It is especially important to-day that we find a method of transplanting the better trees. The recent high winds and severe storms have destroyed many of the Soft Maples, Cottonwoods and Sycamores. In addition, the occurrence of phloem necrosis in our area has made the planting of Elms inadvisable. Therefore both for home and street use long-lived trees must be considered. The Oaks are the best shade trees for many situations, and should be more generally planted as street trees. As the general tone of the letters indicates, most arborists would recommend the Oaks, the Hard Maples, and comparable trees if a more dependable time or method of transplanting can be found.

From our experience with late summer planting in this hurried experiment, it appears that a more careful investigation is in order. It is surprising to find Oak and Cypress alive in April when transplanted in October without rain or extra water.

THE CATALPA—AN INTERESTING TREE

AUGUST P. BEILMANN

Missouri has had its share of horticulturists who had a general interest in horticultural science, but only one, John C. Teas, who ever championed the cause of a single tree. Teas was born in Indiana in 1827, and in 1869 moved to Carthage, Mo., where he became engaged in the nursery business. He died in Carthage in 1907.

John Teas was among the first to recognize that there are two kinds of American Catalpas, the Eastern and the Western. The Eastern Catalpa (*C. bignonioides* Watt) was discovered soon after the first European settlement in this country and was introduced into England in 1726. This is a tree with a short trunk, usually wide-spreading branches, and is very beautiful when in flower. It was for a long time the only Catalpa known to planters. The other Catalpa was described by Warder in the *Western Horticultural Review* in 1853, under the title "A New Catalpa," but he was undecided whether it was a new species or a variety of *C. bignonioides*. Thirteen years later Teas listed the tree in his nursery catalogue as Western Catalpa, and in 1880 Dr. George Engelmann described it in the *Botanical Gazette* as *C. speciosa*, a botanical name which had been used by Warder and his friends for some time.

In 1879 John Teas delivered a paper before the Indiana State Horticultural Society wherein he described his efforts toward having a "new" Catalpa accepted by planters. In this paper he wrote that it was "most unfortunate that this tree [Eastern Catalpa] from Georgia and Florida should have occupied the attention of planters and spread over America and Europe, while the superior kind from the Mississippi Valley had been so strangely overlooked and neglected." In his address John Teas spoke of two Western Catalpas which had been planted at Dayton, Ohio, before 1829. These trees had bloomed earlier than other Catalpas and produced so much larger and more beautiful flowers that Dr. Haines a nurseryman of that city, collected the seeds and distributed them. They soon multiplied and became "the glory of the streets of Dayton." Teas believed these to be the parents of most of the Catalpas growing throughout the Prairie Country.

Largely through the efforts of Dr. Warder of Cincinnati, who organized the American Forestry Association, and of Mr. Teas, the tree was brought to the attention of the public. Robert Douglas, of Waukegan, Ill., Mr. E. C. Barry, of Dayton, and Dr. Warder himself became impressed with the durability of the tree. President William Henry Harrison, who had planted and distributed the Catalpa when he was territorial Governor of Indiana, spoke of it with praise at an Agricultural Fair in 1825, and mentioned the fact that the old French settlers at Vincennes, Ind., had regarded the wood as imperishable. John Teas later learned that the western Indians believed the Great Spirit had placed a guard about the Catalpa, making it a crime to use it as fuel although lawful for other purposes.

It appears that those familiar with the Mississippi Valley tree advocated planting the Catalpa for timber while those who knew the Eastern kind could not understand why anyone should use it for such a purpose. In fact, for a long time the Catalpa was classed as a small tree along with Pawpaw and the Redbud.

Many plantings were made as a result of the publicity given the tree. In 1879 the Illinois Industrial University reported that the Catalpa grew faster than any native tree except the Willow and the Soft Maple. About the same time the Kansas City, Fort Scott & Gulf Railroad planted a quarter of a million trees to be harvested for ties, and concluded that the Catalpa was the outstanding species. It was said that not even a mule or goat would eat the bark, although this might be considered less of an advantage now than it was sixty years ago. The Catalpa has been used for fence-posts, cross-ties, shingles, tool handles, cabinet work, and finally, as living fence posts with notches cut for the insertion of rails.

The original range of *Catalpa speciosa* was limited to the swampy sections, at the junction of the four states—Missouri, Arkansas, Kentucky, Tennessee—and the Ohio Valley. Plantings eventually were made in Kansas, Louisiana, northern Illinois, and, quite possibly, over many of the eastern states. Sometimes it is possible to extend the range of a tree by introducing it into new regions. The Catalpa, however, lacked the adaptability and especially the resistance to disease which would make it a fit subject for commercial plantings. Some never grew beyond the fence-post stage, and the bulk were attacked by a wood-rotting fungus which injured or destroyed them in short order. Had these early planters experimented with a tree somewhat more youthful and adaptable they might have succeeded in persuading each farmer to grow his own fence-posts. Fencing was a great problem, and although the Catalpa was reported to "last forever and then turn to stone", seedlings of these just failed to cooperate when they were taken far from their natural habitat.

John Teas and other enthusiasts appear to have been fully justified in their judgment that the Catalpa was remarkably resistant to decay in its natural habitat. In fact, Teas made a special trip to "The Sunken Lands," along the Mississippi River from southeast Missouri to northeastern Arkansas, to observe and study some immense Catalpas growing there. These trees had been killed by the historic earthquakes of 1811-12, which lowered this whole tract from a few feet to over ten feet. The region was changed from a semi-swamp, subject to overflow, to an area in which water stood throughout the year. Sixty-seven years later he found the Catalpa trunks still sound although the tops had long since been destroyed by storms.

In spite of all the efforts to introduce a tree which grew rapidly and had greater durability than any in common use very few Catalpas appear to have been planted in this section of the country. However, there was one planting in the town of Pacific, Mo., which did well and produced the tall straight trunks which delighted John Teas and his fellow enthusiasts. These trees were planted about sixty years ago by Remigius Leber. His son, Albert E. Leber, vividly recalls, as a boy, the hours he spent hauling water to the trees during the three attempts made to establish them. The planting was successful on the third attempt but the hauling of water continued for another two years. Oddly enough, the trees were not planted for fence-posts. They had an altogether different use—they were to be used as part of a setting for a beer garden, along with white-aproned waiters and the necessary music. The trees grew well and in the course of time reached a height of 40 feet and some grew 18 inches in diameter. They became violently disliked by the neighbors because the annual crop of caterpillars heedlessly dropped down the neck-band of many a shirt and shirtwaist. Last year the Pacific Volunteer Fire Department acquired the lot for the purpose of erecting a fire house, and an arrangement was made with them whereby the Arboretum obtained some of the logs. These have since been sawed into rails and posts, and they now form part of the east boundary of the new Box Garden.

THE BLUE OF THE BLUE ASH

EDGAR ANDERSON

Though you can't ordinarily see it, there is a beautiful blue color hidden in the bark of a Blue Ash twig. It takes a little trouble to demonstrate, for it is no ordinary pigment, but the demonstration makes a rather interesting stunt on a week-end in the country.

Blue Ashes are fairly common in Missouri, particularly on dry rocky hillsides. They make a large bush or small tree and are readily told from other kinds of Ash because they tend to have little corky ridges which make the twigs square-sided.

To demonstrate the blue, all that one needs is a fresh twig and a glass of water. Make several shallow cuts through the bark of the twig and stir it around in the water for a few minutes until the blue begins to show. The blue is not a pigment in the ordinary sense; it is a color given off at the surface by the light which is reflected back. In certain lights the solution will look pale yellow-brown like very weak tea. Seen at just the right angle and with just the right background it will be ashimmer with an intense caerulean blue, the brilliant, transparent blue of a deep spring or the wing of a tropical butterfly. To see it at its best pour the infusion into a slightly flaring, clear transparent glass tumbler and stand in a room which is lit only from one side. Hold the glass so that it can catch the light but can be seen against a dark background, then shake the liquid slightly. It will seem to be made up of transparent, living blue which catches more color as it ripples around the glass.

So much for the blue in the Blue Ash; so far as I know there is no pigment there. For another kind of sport look up the books about the Blue Ash, after you have seen the color, and learn what *they* say. Perhaps somewhere you will find a reference which reads as if the man who wrote it had seen the actual phenomenon; most of them say that there is a coloring matter in the inner bark of the twigs from which the tree gets its name. Some of them hint that it is a real dye, and one amazing book comes right out and says that the pioneers used it for dyeing their blankets. This is probably pure rubbish. The blue one sees in the sap water is what is technically known as "surface color"; it is like the shimmer of yellow-green on the surface of old-fashioned red ink. One could no more dye a blanket blue with the Ash water than he could get a green stain by spilling red ink on his handkerchief. Of course it may be that, in addition to this ethereal surface color, the Blue Ash also carries a blue dye which comes out when the wood is boiled or steeped. I have never been able to find traces of any such color and I greatly doubt if it exists at all.

NOTES

Dr. Folke Skoog has been appointed visiting lecturer at the Henry Shaw School of Botany, for two months.

The Snow Trillium bloomed at the Arboretum again this year. On the south side of the road near the bridge there were five plants in flower on March 15th, and it begins to look as if it were really well established there.

Mr. L. Wayne Lenz, graduate student in the Shaw School of Botany during 1941-42, has recently been discharged from the Navy where he served as Lieutenant in the Pacific area, and has returned to the Garden to resume his work toward a doctorate.

An interesting old volume has been added to the Garden library through the interest of Mr. Raymond Baker, of the Pioneer Hi-Bred Corn Co., Des Moines, Iowa. The state of New York, as a part of its natural history survey, published several volumes on the agriculture of the state, and while the Garden has long had a copy of Volume 3, the first and second volumes, published in 1846 and 1849, under the authorship of Ebenezer Emmons, were missing and were difficult to obtain. Mr. Baker recently located a copy of Volume 2 and has presented it to the Garden library. It is of particular interest because it contains, among other things, careful descriptions and accurate illustrations of the varieties of maize being grown.

A hay-fever display, which includes plants and pollen of plants causing hay-fever, was set up in the Floral Display House during March. The exhibits will continue throughout the year, being changed as the various plants come into flower. On March 17 the rotogravure section of the *St. Louis Post-Dispatch* contained a page of illustrations of hay-fever plants, the photographs of which were taken at the Garden Herbarium.

Mr. G. H. Pring, Superintendent of the Garden, visited the International Flower Show, at the Grand Central Palace, New York, March 18–23. Besides acting as one of the judges of gardens in competition for the Bulkley Gold Medal of the Garden Club of America, he broadcast from the show on March 18, speaking principally about the White Redbud, and on March 26, spoke in the N.B.C. studio, on "Orchid Explorations in the Andes." After the show he visited the orchid collections of commercial establishments and private estates in New York, New Jersey and Pennsylvania.

In addition to the many botanists who visited the Garden and Arboretum during the A.A.A.S. meetings, the Garden visitors during March include the following: Mr. Harry Wood, of the Scott Foundation of Swarthmore College, Swarthmore Pa.; Mr. Harry D. Skinner, of the Morris Arboretum, Philadelphia, Pa.; Mr. Roy M. Nordine, of the Morton Arboretum, Lisle, Ill.; Dr. James A. Jenkins, of the University of California, Berkeley; Father Diomede Pohlkamp, of St. Anthony Hospital, Louisville, Ky.; Dr. Lyman Benson, of Pomona College, Claremont, Calif.; Dr. J. Van Overbeek, of the Institute of Tropical Agriculture, Mayaguez, Porto Rico; Mr. Ralph B. Birks, Superintendent of Parks, Mr. Clarence J. Bendle and A. E. Anderson, of Moline, Ill.; Mr. Frank C. Pellett, Editor of the *American Bee Journal*, and Mr. G. H. Cole, of Dadant & Sons, accompanied by several St. Louis County beekeepers.

A reunion of former Missouri Botanical Garden graduate students took place at the Garden during the meetings of the American Association for the Advancement of Science, which were held in St. Louis March 26–29. Among those attending were: Dr. Fred Barkley, of the University of Texas, Austin; Dr. William Brown of the Pioneer Hi-Bred Corn Co., Des Moines; Dr. Alexander F. Bucholtz, of the Union Starch Co., Granite City, Ill.; Dr. Ethel Eltinge, of Mt. Holyoke College, South Hadley, Mass.; Dr. Carl C. Epling, of the University of California, Los Angeles; Dr. Harry J. Fuller, of the University of Illinois, Urbana; Dr. George W. Freiberg, of Anheuser-Busch Brewing Assn., St. Louis; Dr. George J. Goodman, of the University of Oklahoma, Norman; Dr. George B. Happ, of Principia College, Elsah, Ill.; Dr. Joseph C. Gilman and Dr. Ada Hayden, of Iowa State College, Ames; Dr. Maxine Larisey, of Judson College, Marion, Ala.; Dr. Samuel G. Lehman, of North Carolina State College, Raleigh; Dr. Catharine M. Lieneman, of Wisconsin State Teachers College, River Falls; Dr. Morris Moore, of Barnard Skin & Cancer Hospital, St. Louis; Dr. Marion Ownbey, of Washington State College, Pullman; Dr. Jacob R. Schramm, of University of Pennsylvania, Philadelphia; Dr. Julian A. Steyermark, of the Chicago Museum of Natural History (Field Museum); Dr. Robert E. Woodson, Jr., Dr. Henry N. Andrews and Dr. Robert W. Schery, of the Missouri Botanical Garden, St. Louis; Mrs. Emmett J. Layton (Ruth Cornelius), Mrs. William Rosenbaum (Elizabeth Heuser), and Miss Alice Pickel, of St. Louis; Mr. Louis G. Brenner and Mr. Stanley Bettoney, of the Garden Arboretum, Gray Summit, Mo.; Lt. Ralph Emons, of East St. Louis. Ill.; Rev. Robert R. Brinker, O.F.M., of Quincy College, Quincy, Ill.

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Missouri Botanical Garden Bulletin

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PLANTS FOR SHADY GARDENS

DAVID C. FAIRBURN

Shade is essential around the house and in the garden, but with it comes the problem of appropriate planting. To solve this successfully a certain amount of knowledge regarding plant materials and their growth requirements is necessary; otherwise a great deal of time, effort, and expense may yield the total sum of nothing. The inexperienced gardener should read all the available literature on the subject, consult local authorities, formulate a definite planting plan, and then proceed slowly until well padded with practical experience. For extensive plantings a landscape architect of recognized ability should be retained.

Gardening in the shade is not as easy as it might seem. In the first place, what do we mean by the term shade? Is it full shade on the north side of a wall with overhanging branches, half-shade on the west side of a building, or checkered sunlight through trees pruned high from the ground? Does the light exposure change with the seasons, giving full sun in spring and shade during summer? And when we speak of dense shade, just how dense is it? Then there is the soil question—how deep and how fertile? What about the moisture—are surface roots of trees going to absorb most of it along with all the available plant food Or will the soil remain too wet and turn sour? As for the plants, what are their minimum light requirements during the growing season—full sunlight, alternate sunlight and shadow, full shade, partial shade, dense shade? And how will the plants respond to identical conditions in various parts of the country? What plant associations are most compatible as well as appropriate?

These questions indicate some of the vital considerations involved in this rather complicated business of successful planting in the shade. The writer is fully aware of the limitations of a short article on the subject, and will deal freely in generalities even for the state of Missouri.

Classification of Shade.—

It is hardly possible to define or even anticipate all the many types of light exposures that may occur in a garden at different hours of the day. Shifting sunlight and shadow are difficult to estimate even roughly. To be fairly accurate, a person would have to spend spring, summer, and fall in the garden with a suitable light meter and make endless readings. Such data would be of scientific interest but of limited practical value unless "boiled down" to a few average readings similar to those presented in the following table of approximate shade intensities.

1. *Dense shade—100 to 300 foot candles*
   Constant dull light as found under low-hanging branches of evergreens. No sun at any time.
2. *Moderate shade—300 to 1500 foot candles*
   Hazy, with occasional soft, diffused sunlight. The type of light usually found under deciduous trees with branches about 6 to 10 feet from the ground.
3. *Light shade—1500 to 3000 foot candles*
   Scattered sunlight which filters down through the leaves of branches high off the ground. An airy type of shade with alternate, moving sunlight and shadow.
4. *Half shade—500 to 12,000 foot candles*
   Full shade in morning and full sun in afternoon, such as is found on west side of building, or vice versa on east side of building. Also intermittent sun and shade throughout the day.

Measurements up to 1600 foot candles can be made with a Weston Model 735 Universal Exposure Meter. For accurate measurements of stronger light intensities, the Weston Model 603 with a range up to 10,000 foot candles is very satisfactory. A fair estimate of light intensities over 1600 candle power can be made with the Weston Model 735 by measuring at a distance of 12 to 15 inches the light reflected from a sheet of clean white paper placed wherever a reading is desired and then multiplying the result by 6. For example, if the meter recorded a reflected light value of 1000 candle power, then 6000 candle power would be the approximate intensity of the direct sunlight falling on that particular spot.

As far as this shade problem is concerned, however, most of the difficulties with plant growth apparently occur where the direct light intensity is less than 1600 foot candles. The critical low point for plant growth seems to be around 300 foot candles. Anything less than 300 does not give garden plants sufficient light to manufacture the food essential to normal growth.

Hosta growing in Mausoleum Grove

Soil.—

Success with plants in the shade or in full sun depends to a large extent on the soil in which they have to grow. Garden plants obtain chemical compounds from the soil, and, with the aid of sunlight and chlorophyll, convert them into various forms of food that provide energy for all phases of growth. If these chemical compounds are deficient in the soil, normal growth cannot occur. Undoubtedly, a large proportion of the ornamentals planted in home gardens suffer from advanced cases of malnutrition. So fertility should be carefully checked and the soil thoroughly prepared, if necessary, before any planting is attempted. Heavy clay soils will need a liberal application of organic matter (farm manure, leaf mold, peat, etc.) with some fine gravel or cinders mixed in to improve the texture. Sandy soils need about the same amount of organic matter with some clay loam added to increase the water-holding capacity. Most garden soils also require at least a mild treatment with commercial fertilizer such as Vigoro or Loma. About 5 pounds per 100 square feet is the standard application.

One of the controlling factors in plant growth is soil reaction. Soils are acid, neutral or alkaline, the degree of acidity or alkalinity being expressed

Bleeding-heart (*Dicentra spectabilis*) growing in the shade of a tree

Bracken Fern in Mausoleum Grove

in terms of pH values. The neutral point is 7.0; anything less than that is acid, and above is alkaline. Most plants prefer a slightly acid soil with pH 6.0 to 7.0. If there is plenty of organic matter in the soil to act as a buffer, the range of tolerance may extend from about pH 5.0 to 9.0. With certain plants a definite pH must be observed to obtain satisfactory growth. For instance, a handful of lime worked into the soil around the roots of an azalea would give the plant indigestion, whereas peas, beans and clover would thrive on such treatment. Always have the soil tested before trying to adjust the pH. If the soil is too acid, ground limestone used at the rate of 10–25 pounds per 100 square feet will raise the pH about 1 point, say from 5.0 to 6.0. To lower the pH 1 point add 1 to 3 pounds of powdered sulphur per 100 square feet. Repeat these treatments as often as necessary to maintain the desired pH values. For complete details on garden soils and fertilizers refer to the Missouri Botanical Garden Bulletin, Vol. XXXI, No. 4, April 1943.

Plants for Shade.—

It is doubtful if any two experienced gardeners would compile identical lists of plants that would thrive in various degrees of shade. So the following may be considered more or less a personal opinion. Generous reference has of course been made to several excellent publications on the subject.

ANNUALS AND HERBACEOUS PERENNIALS

ense Shade	Moderate Shade	Light Shade	Half Shade
merican Wood-Sorrel	Bleeding Heart	Alkanet	Adams-Needle
Oxalis sp. *	*Dicentra* sp.	*Anchusa azurea*	*Yucca filamentosa*
aneberry	Bloodroot	*Amsonia Tabernaemontana*	Aster sp.
Actaea sp.	*Sanguinaria canadensis*	*Anemone* sp.	Cinquefoil
ugle	False Solomons Seal	*Astilbe* sp.	*Potentilla* sp.
Ajuga sp.	*Smilacina racemosa*	Balloon-Flower	*Clematis* sp.
anada Violet	Greek Valerian	*Platycodon grandiflorum*	Evening Primrose
Viola canadensis	*Polemonium* sp.	Balsam**	*Oenothera fruticosa*
lintonia sp.	*Hepatica* sp.	*Impatiens Balsamina*	Flowering Tobacco**
ommon Blue Violet	May-Apple	Bee-Balm	*Nicotiana* sp.
Viola papilionacea	*Podophyllum peltatum*	*Monarda didyma*	Forget-me-not***
outweed	Meadow-Rue	Black Snakeroot	*Myosotis* sp.
Aegopodium Podagraria	*Thalictrum* sp.	*Cimicifuga racemosa*	Fumitory
ck-in-the-Pulpit	Mint	Bouncing Bet	*Corydalis* sp.
Arisaema triphyllum	*Mentha* sp.	*Saponaria officinalis*	Gas Plant
dy-Slipper Orchid	Monkshood	Bluets	*Dictamnus albus*
Cypripedium sp.	*Aconitum* sp.	*Houstonia serpyllifolia*	*Geum chiloense*
ungwort	*Sedum Sieboldi*	*Campanula* sp.	Globe-Flower
Pulmonaria angustifolia	Speedwell	Columbine	*Trollius europaeus*
antain-Lily	*Veronica* sp.	*Aquilegia* sp.	Goats-Beard
Hosta sp.	Spiderwort	Cardinal Flower	*Aruncus sylvester*
lomons-Seal	*Tradescantia* sp.	*Lobelia cardinalis*	
Polygonatum biflorum			

ANNUALS AND HERBACEOUS PERENNIALS *(Continued)*

Wake-Robin *Trillium* sp.	Spring Beauty *Claytonia virginica*	Coral Bells *Heuchera sanguinea*	Candytuft *Iberis sempervirens*
Wild Geranium *Geranium Robertianum*	Violets *Viola* sp.	Day-Lily *Hemerocallis* sp.	Lambs-Ear *Stachys lanata*
	Virginia Bluebell *Mertensia virginica*	False Dragonhead *Physostegia virginica*	Leopards Bane *Doronicum plantagineum*
	Wild Sweet William *Phlox divaricata*	Foam-flower *Tiarella cordifolia*	*Lobelia Erinus***
	Wild flowers (many kinds not listed here)	Goldenrod *Solidago* sp.	Mullein *Verbascum* sp.
		Monkey Flower *Mimulus* sp.	Musk Mallow *Malva moschata*
		Pansy *Viola tricolor*	Nasturtium** *Tropaeolum majus*
		Primrose *Primula* sp.	*Petunia hybrida***
		Saxifrage *Saxifraga* sp.	*Phlox* sp.
		Shooting Star *Dodecatheon Meadia*	Sandwort *Arenaria* sp.
		Sweet Woodruff *Asperula odorata*	*Sedum* sp.
			Wishbone Flower** *Torenia Fournieri*

* The abbreviation "sp." is used where more than one species of the same genus could be used
** Annual
*** Annual and perennial types

TREES AND SHRUBS

Dense Shade	Moderate Shade	Light Shade	Half Shade
Blueberry *Vaccinium pennsylvanicum*	*Abelia grandiflora*	American Holly *Ilex opaca*	*Azalea* (*Mollis* hybrids)
Ground Pine *Lycopodium obscurum*	Arrow-Wood *Viburnum dentatum*	Andromeda *Pieris japonica*	Black Alder *Ilex verticillata*
Hemlock *Tsuga canadensis*	*Azalea Amoena*	Arbor-Vitae *Thuja* sp.	Boxwood *Buxus* sp.
Leucothoe Catesbaei	Black-Haw *Viburnum prunifolium*	Barberry *Berberis* sp.	Choke-cherry *Prunus virginiana*
Maple-Leaved Viburnum *Viburnum acerifolium*	Dogwood *Cornus* sp.	Beech *Fagus grandiflorum*	*Cotoneaster* sp.
Mountain Laurel *Kalmia latifolia*	Flowering Raspberry *Rubus odoratus*	Buttonbush *Cephalanthus occidentalis*	*Daphne* sp.
	Fragrant Sumac *Rhus canadensis*	Carolina Allspice *Calycanthus floridus*	Firethorn *Pyracantha coccinea Lalan*
	Hornbeam *Carpinus* sp.	Chokeberry *Aronia* sp.	Hawthorn *Crataegus* sp.
	Nanny-Berry *Viburnum Lentago*	*Enkianthus campanulatus*	Honeysuckle *Lonicera* sp.
	Oak-leaved Hydrangea *Hydrangea quercifolia*	*Euonymus* sp.	Hybrid Roses *Rosa* sp.
	Redbud *Cercis canadensis*	Five leaved Aralia *Acanthopanax Sieboldianum*	Hydrangea
	Snowberry *Symphoricarpos albus*	Flowering Currant *Ribes* sp.	Japanese Kerria *Kerria japonica*
	Sweet Pepper Bush *Clethra alnifolia*	*Forsythia* sp.	Japanese Quince *Chaenomeles Lagenaria*
	Viburnum Burkwoodi	Highbush Cranberry *Viburnum Opulus*	Jetbead *Rhodotypos tetrapetala*
			Magnolia sp.

	Viburnum Carlesi Wayfaring Tree *Viburnum alnifolium* Yew *Taxus* sp.	Honey Locust *Gleditsia triacanthos* Inkberry *Ilex glabra* Japanese Boxwood *Buxus japonica* Japanese Maple *Acer palmatum* Mahonia *aquifolium* Moosewood *Acer pennsylvanicum* Mountain Maple *Acer spicatum* Purple leaved Plum *Prunus cerassifera Pissardi* *Rhododendron* sp. Rose Acacia *Robinia hispida* *Sassafras variifolium* Shadbush *Amelanchier* sp. Spice Bush *Benzoin aestivale* *Spiraea* sp. St. Johnswort *Hypericum* sp. Wild Roses *Rosa* sp. Witch-Hazel *Hamamelis* sp.	Meadowsweet *Spiraea latifolia* Mock-Orange *Philadelphus coronarius* Privet *Ligustrum* sp. Sour-Wood *Oxydendrum arboreum* *Weigelia florida*

BULBOUS PLANTS

Dense Shade	Moderate Shade	Light Shade	Half Shade
Crested Iris *Iris cristata* Lily-of-the-Valley *Convallaria majalis*	Calla-Lily* *Zantedeschia aethiopica* *Caladium bicolor** Squill *Scilla* sp. Tuberous-rooted Begonia *Begonia* sp. Vernal Iris *Iris verna* Wild Hyacinth *Camassia* sp.	*Crocus* sp. Dogtooth Violet *Erythronium* sp. Flowering Onion *Allium* sp. Glory-of-the-Snow *Chionodoxa* sp. Grape Hyacinth *Muscari botryoides* *Narcissus* sp. Snow-drop *Galanthus* sp. Winter Aconite *Eranthis hyemalis*	Autumn Crocus *Colchicum* sp. Crown-Imperial *Fritillaria imperialis* Giant Summer-Hyacinth *Galtonia candicans* Lilies *Lilium* sp. Snowflake *Leucojum vernum* Tulips *Tulipa* sp.

* Not hardy

WATER PLANTS

Dense Shade	Moderate Shade	Light Shade	Half Shade
(none)	Ditch-Moss *Elodea canadensis* Parrots-Feather *Myriophyllum prosperpinacoides* Pepperwort *Marsilea Drummondi* Water Hyacinth *Eichhornia crassipes*	Bogbean *Menyanthes trifoliata* *Colocasia antiquorum** Pickerel Weed *Pontederia cordata* Splatterdock *Nymphozanthus advena* Sweet Flag *Acorus Calamus* Water Arum *Calla palustris* Water Plantain *Alisma* sp. Yellow Flag *Iris Pseudacorus*	Water-lily** *Nymphaea* sp. (Should be planted in full sun for maximum flower production)

* Not hardy
** Hardy and tropical types

FERNS

Dense Shade	Moderate Shade	Light Shade	Half Shade
Christmas Fern *Polystichum acrostichoides* Cinnamon Fern *Osmunda cinnamomea* Eastern Bracken *Pteridium aquilinum* Fancy Fern *Dryopteris intermedia* Giant Woodfern *Dryopteris Goldiana* Interrupted Fern *Osmunda Claytoniana* Maidenhair Spleenwort *Asplenium Trichomanes* Male Fern *Dryopteris Filix-mas* Polypody Fern *Polypodium* sp.	Cliff-Brake Fern *Pellaea atropurpurea* Hay-scented Fern *Dennstaedtia punctilobata* Lady Fern *Athyrium Filix-femina* Maidenhair Fern *Adiantum pedatum* Ostrich Fern *Pteretis nodulosa* Rattlesnake Fern *Botrychium virginianum* Royal Fern *Osmunda regalis* Sensitive Fern *Onoclea sensibilis*	Most ferns can be grown in light shade.	In Missouri, ferns will not tolerate full exposure to the hot, mid-day, summer sun.

VINES

Dense Shade	Moderate Shade	Light Shade	Half Shade
Baltic Ivy *Hedera Helix* var. *baltica* Boston Ivy *Parthenocissus tricuspidata*	Climbing Hydrangea *Hydrangea petiolaris* Fox Grape *Vitis Labrusca*	*Akebia quinata* Bigleaf Wintercreeper *Euonymus radicans* var. *vegetus*	Climbing Roses *Rosa* sp. Dutchman's Pipe *Aristolochia durior*

English Ivy *Hedera Helix*	Virginia Creeper *Parthenocissus quinquefolia*	Bittersweet *Celastrus scandens* Hall's Honeysuckle *Lonicera japonica* var. *Halliana* Kudzu Vine *Pueraria Thunbergiana* *Wisteria floribunda*	Fleece Vine *Polygonum Auberti* Grape *Vitis* sp. Perennial Sweet Pea *Lathyrus latifolius* Trumpet Honeysuckle *Lonicera sempervirens* Virgins Bower *Clematis* sp.

GROUND COVERS

Dense Shade	Moderate Shade	Light Shade	Half Shade
Baltic Ivy* *Hedera Helix* var. *baltica*	Box Huckleberry *Gaylussacia brachycera*	Bearberry *Arctostaphylos Uva-ursi*	Maiden Pink *Dianthus deltoides*
Bunchberry *Cornus canadensis*	Creeping Veronica *Veronica repens*	Double Buttercup *Ranunculus repens* var. *pleniflorus*	Snow-in-Summer *Cerastium tomentosum*
Carpet Bugle* *Ajuga reptans*	Japanese Spurge *Pachysandra terminalis*	Forget-me-not *Myosotis scorpioides*	Thyme *Thymus* sp.
Creeping Charlie *Lysimachia Nummularia*	Lily-of-the-Valley *Convallaria majalis*	Kenilworth Ivy *Cymbalaria muralis*	
English Ivy* *Hedera Helix*	*Sedum sarmentosum**	Leadwort *Ceratostigma plumbaginoides*	
Ferns (many kinds)	Spiderwort *Tradescantia* sp.	*Phacelia* sp.	
Goldenthread *Coptis trifolia*	Squill *Scilla* sp.	Sand Myrtle *Leiophyllum buxifolium*	
Ground Ivy* *Nepeta hederacea*	Wild Sweet William *Phlox divaricata*		
Lily-Turf *Liriope* sp.	Yellow Root *Zanthorhiza apiifolia*		
Partridge Berry *Mitchella repens*			
Periwinkle* *Vinca minor*			
Trailing Arbutus *Epigaea repens*			
Wild Ginger* *Asarum canadense*			
Winter-Creeper* *Euonymus radicans*			

* These plants will grow under shallow-rooted trees where competition for moisture and nourishment is very keen. Hardly anything will thrive under Norway Maple.

In conclusion it may be said that practically all garden plants in Missouri would appreciate a bit of shade from noon until 3 p. m. during June, July and August.

THE ANCESTORS OF OUR PRESENT-DAY CYMBIDIUMS

GUSTAV A. L. MEHLQUIST

Until a few years ago the Cymbidium in this country was regarded as a difficult greenhouse subject, hence limited to relatively few wealthy people who possessed the necessary facilities such as greenhouses and lath houses, and to commercial flower growers who grew them for cut flowers. In recent years, however, Cymbidiums have been planted in increasing numbers out-of-doors in milder regions, particularly in California. Some of the choicest hybrids that have been selected on the basis of their performance under glass in Europe have not proved so well suited for this type of culture but others have done exceptionally well, and there is no doubt that, as the cultural requirements of the different types of Cymbidiums become better understood, more and more plants will be planted both for cut-flower production and garden decoration.

Partly because of the high price of imported plants and partly because of the need for improved varieties for specific purposes, many orchid enthusiasts have become interested in Cymbidium breeding. The fact that the seedlings are generally more difficult and time-consuming to raise even than those of other orchids has only served to increase their interest in this genus. Some of these enthusiasts will doubtless be satisfied just to "raise seedlings" regardless of parentage, but many others have already evidenced a desire to ascertain the relative importance and contributions of the different species that have given rise to the present-day hybrids.

Ever since the introduction, in 1889, of the first Cymbidium hybrid, *C. eburneo-Lowianum* (syn. *C. Veitchii*), the result of crossing *C. eburneum* and *C. Lowianum*, there has been a steady improvement in the quality of the hybrids produced. In fact, so many beautiful hybrids have been produced that the parent species now appear rather insignificant. Partly because the species are less attractive, and partly because some of them are rather more difficult to grow than their hybrids, the interest in the species had declined to the extent that several of those that have played an important role in hybridization are no longer available in the trade. Furthermore, at least three of the ten species that have been used in the production of the showy hybrids of to-day never have been collected in any quantity in their native habitat.

Now, with the Cymbidium bidding fair to become a widely grown garden and greenhouse plant and as such exposed to a variety of conditions in which some hybrids do definitely better than others, interest in the parent species has been awakened. An enumeration of the species involved and an evaluation of their relative contributions in the production of hybrids would therefore seem warranted both for the sake of their history and as a basis for planning prospective crosses.

It should be pointed out that because of the long time required to flower Cymbidiums from seed, five to ten years, little or no controlled genetical work has been done with the plants of this genus. However, by comparing the knowledge gained from observations on some of the outstanding Cymbidium hybrids of known parentages with results obtained from controlled breeding work with other genera better suited for such studies, it is possible to get some very interesting and useful information.

Geographically, the genus is limited to an area extending southward from the Himalayan region, China, and southern Japan, through the Netherland Indies to northern Australia. The only exception seems to be a small distinct group of species native to the island of Madagascar. Climatologically the genus is sub-tropical and tropical. With respect to their growth habits, the species vary from terrestrial to strictly epiphytic.

Although some sixty species of Cymbidium have been described, 99 per cent of the hybrids generally grown to-day have involved only ten species. All these are sub-tropical epiphytes or semi-terrestrials and come from the Himalayan-Assam-Burma-Annam area. They are:

Cymbidium eburneum Lindley
Cymbidium erythrostylum Rolfe
Cymbidium giganteum Wallich
Cymbidium grandiflorum Griffith (*C. Hookerianum* v. Reichenbach)
Cymbidium l'Ansoni Hort.
Cymbidium insigne Rolfe (*C. Sanderi* Hort.)
Cymbidium Lowianum v. Reichenbach
Cymbidium Parishii v. Reichenbach (*C. Sanderae* Hort.)
Cymbidium Schroederi Rolfe
Cymbidium Tracyanum Hort.

1. *Cymbidium eburneum* Lindley

Lindley in Bot. Reg. vol. 33 (1847), t. 67.
Colored illustr.: Paxt. Mag. vol. 15 (1849), pp. 145-146; Bot. Mag. vol. 85 (1859), t. 5126.

A rather weak-growing epiphyte with stem-like pseudobulbs and narrow leaves 15–24 inches long. The short upright flowering spikes, each bearing usually only one, occasionally two or three, flowers, appear well up on the pseudobulb in the axils of the second to fourth leaves. Two and sometimes three scapes may be produced by one bulb. The flowers are 3–4 inches across, roundish in outline (fig. 1), with very heavy-textured, usually rosy-white, occasionally pure white, sepals and petals. The lip is usually creamy-white, sometimes dotted rose-amethyst. The keels in the center of the lip are bright yellow. This species usually flowers in late winter or spring. The flowers are pleasantly fragrant.

Cymbidium eburneum was discovered in 1836 by the British botanist Griffith, in the Khasia Hills in North India, at an elevation of 5000–6000 feet, but was later found in the southern foot hills of the Himalayan mountains, also in Assam, Burma, and Annam. It flowered for the first time in cultivation in England in 1847 and became a great favorite among orchid lovers who willingly offered large sums for newly imported plants. Sometimes high prices were paid for plants that supposedly were *C. eburneum* only to prove on flowering to be the earlier introduced, less desirable *Cymbidium Mastersi* Griffith (*Cyperorchis Mastersi* Bentham), which

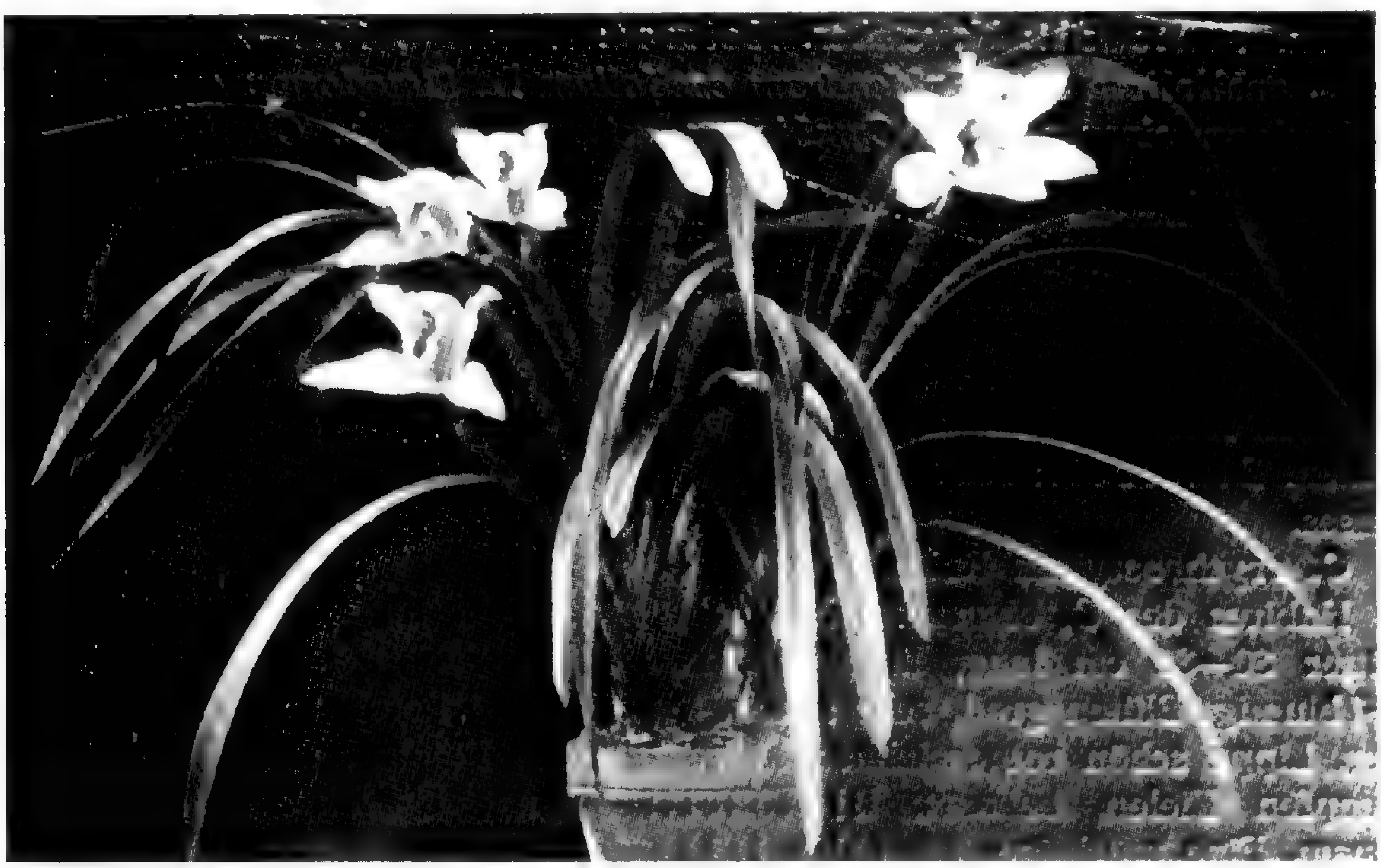

Fig. 1. *Cymbidium eburneum* Lindley
From "Die Orchideen" by von Schlechter

is practically indistinguishable from *C. eburneum* when not in bloom and found in roughly the same area though usually at somewhat higher elevation.

Although there are several illustrations in various English trade journals of grand plants of *C. eburneum*, it is not considered to be an easy one to grow compared to other Cymbidiums. That many growers experienced difficulties with its culture is evident from the numerous complaints and questions raised about it in the very same journals. This species never has been common in this country though offered by the leading American orchid dealers a few years ago, and at present it is very scarce. It does not appear to be a good prospect for out-of-door culture in any part of this country.

The influence of *C. eburneum* can be seen in a majority of our fine hybrids to-day, the broad-petaled, large, rounded flowers of some of our finest whites particularly reflecting the *eburneum* parentage. For the most part, the transfer of this desirable feature to our modern hybrids has been accomplished through crosses with the primary hybrid *C. eburneo-Lowianum*, referred to earlier (fig. 12). This interesting hybrid was first produced by Veitch and Sons, in England. It flowered for the first time in 1889, at which time it was awarded a First Class Certificate by the Royal Horticultural Society. It has been used extensively in the production of hybrids, some of which are ALEXANDERI,* DIANA, FLORYI, LADY COLMAN, and WOODHAMSIANUM. Of these, the hybrid ALEXANDERI, especially the Westonbirt variety (*C. eburneo-Lowianum* FCC X *C. insigne*, Westonbirt variety) raised by H. G. Alexander and awarded a First Class Certificate by the Royal Horticultural Society in 1922, has had an extraordinary influence on Cymbidium breeding. Not only is it an outstanding Cymbidium itself, but it has proved an excellent parent as well, producing a long list of outstanding hybrids many of which have in turn proved themselves excellent parents.

This *eburneo-Lowianum* hybrid is interesting for another reason, for, along with other primary *eburneum* hybrids, it illustrates an important genetic principle relative to quantitative inheritance. For many years, in fact ever since interspecific hybrids were first experimentally produced by the German botanist, Joseph Koelreuter, in 1760, it had been noted that such hybrids were roughly intermediate between the parents regardless of the direction in which the cross had been made. That is, whether a species was used as the seed plant or pollen plant, the resulting hybrids were much the same and usually approximately intermediate between the parents. To be sure, sometimes it was easier to get a "take" when the cross was made one way rather than the other, especially when the prospective parents were extremely different in size. The cross was usually more likely to succeed if the smaller species was used as the seed parent. In cases where the cross could be effected either way there was another important exception. When the size difference between the parent species was extreme, the resulting hybrids were often much more like the smaller parent in flower size, number of flowers, and general stature of the plant. This apparent "dominance" of the lesser parent species was in direct contrast to the results obtained when crosses were made between different forms of the same species, in which case the larger parent usually was found to be dominant.

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*The names of all species and of all hybrids which have been compounded from the names of the parent species involved have been italicized; names of all other hybrids have been written in all capitals.

A few years ago J. W. MacArthur (Jour. of Heredity, vol. 32 (1941), pp. 291–295), studying size inheritance in the tomato, found that hybrids between the very small-fruited currant tomato and large-fruited varieties of the ordinary garden tomato bore fruit which tended to approach the geometrical average or mean rather than the arithmetical mean as had previously been assumed. This important difference had not been established earlier because unless the size differences between the parents are relatively great the geometrical mean is not sufficiently different from the arithmetical mean to enable the investigator readily to distinguish between one or the other, due to natural fluctuations in size caused by environmental conditions. For instance, MacArthur crossed the currant tomato, whose average fruit size is about 1 gram, with a variety of the common garden tomato having an average fruit size of about 100 grams. Now if the hybrid fruits had followed the arithmetical mean or average, they should have weighed on the average $\frac{1 + 100}{2}$ or about 50 grams each.* Instead, they averaged about 10 grams which corresponds to the geometrical mean or average, $\sqrt{1 \times 100} = 10$ or about 10 grams per fruit.

Getting back to the Cymbidiums, we have in *C. eburneo-Lowianum* a hybrid between two species that differ greatly in the number of flowers produced per spike. Counts on *C. eburneum* have shown that this species produces an average of 1.–1.5 flowers per spike, or, let us say 1 for the sake of easy calculations. The other parent, *C. Lowianum*, produces from 15 to 35 flowers per spike when well grown, 25 probably being close to the actual average for the better forms. Now the arithmetical mean would be $\frac{1 + 25}{2}$ or 13 but the geometrical mean is only $\sqrt{1 \times 25} = 5$. If we use the figure 1.5 for *eburneum* then the geometrical mean becomes $\sqrt{1.5 \times 25} = 6-$. Actually, well-grown plants of the hybrid between these species ordinarily produce only from 3 to 8 flowers per spike, with an average close to 6. C. Gottianum, the hybrid between *C. eburneum* and *C. insigne*, averages 4 to 5 flowers per spike, which is about the geometric average for this cross, as 16 appears to be a fair average number of flowers per spike for *C. insigne*. Thus we have $\sqrt{1 \times 16} = 4$, or $\sqrt{1.5 \times 16} = 5-$. Other examples of similar hybrids are C. Holfordianum *(C. eburneum* x *C. grandiflorum)*

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* Arithmetical mean or average = sum of *n* measurements divided by *n*, thus:
$$\text{Ar. Mean} = \frac{a^1 + a^2 + a^3 \ldots + a^n}{n}.$$

Geometric mean or average = n^{th} root of the product of *n* measurements, thus:
$$\sqrt[n]{a^1 \times a^2 \times a^3 \ldots \times a^n}.$$

and C. WIGANIANUM (*C. eburneum* x *C. Tracyanum*, fig. 1). On the other hand, the cross between *C. insigne* and *C. Lowianum* (C. PAUWELSII, fig. 17) does not lend itself to a decision whether one average or the other actually represents the true picture, as the difference between the two averages is less than the fluctuations in number of flowers per spike due to environmental differences. That is, the arithmetical average, $\frac{25 + 16}{2} = 20.5$, is practically the same as the geometric average, $\sqrt{25 \times 16} = 20$.

This is a good illustration of a case where a principle discovered in one plant can be used as the basis for predictions in another plant less suitable for furnishing the necessary data for the formulation of the principle. Undoubtedly, the fact that the geometrical mean is a more accurate basis for estimating the probable number of flowers per spike in hybrids would eventually have been realized by Cymbidium breeders, and perhaps it already has, although, to my knowledge, nothing has been published to that effect. The fact remains, however, that with the greater difference existing between different tomato varieties, it was the better plant to work with, for the greater the actual differences in some measurable features of the parents the greater will be the accuracy of the results.

2. *Cymbidium erythrostylum* Rolfe

Rolfe in Gard. Chron. vol. 38 (1905), p. 427.
Colored illustr.: Bot. Mag. vol. 133 (1907), t. 8131.

A fall- or winter-blooming epiphyte with ovate, slightly compressed pseudobulbs 1½–2 inches long, and narrowly lanceolate leaves 10–15 inches long. The arching flowering spikes, bearing from four to eight flowers 2½–3½ inches across, usually make their appearance inside the second or third leaf on the rather immature pseudobulb in late summer. Depending on environmental factors, the flowers open from September to January. The sepals and petals are white except for a few rose-colored dots at the base. The lip is cream-colored and heavily lined with reddish-purple. The petals do not open widely but remain in a position that gives the flower a more or less hooded appearance (fig. 2). The column of this plant is dark red, hence its name *erythrostylum,* meaning red style or column, from the Greek *erythros* = red. Short aerial roots which protrude straight up from the compost are sometimes produced by this species.

Cymbidium erythrostylum is a native of Annam where it was first collected in 1891 by W. Micholitz for Messrs. Sander and Sons. It flowered for the first time in cultivation in the Royal Botanic Garden, Glasnevin, Ireland, in November 1905.

Fig. 2. *Cymbidium erythrostylum* Rolfe

This species has been used often in recent years in the production of early-flowering hybrids. Most of these tend to be winter bloomers, flowering from December to February. The hybrids strongly resemble the *erythrostylum* parent both in flower shape and general stature of the plant (figs. 14, 16). In crosses between these primary *erythrostylum* hybrids and the other larger species or their hybrids, some of the earliness is lost but larger size both of flower and plant is gained. From the results obtained to date by intercrossing the primary and secondary hybrids of this species, there seems no doubt that early-blooming, large-flowered hybrids in a variety of colors will be forthcoming. To date the flowers from these crosses are a little on the small side but they are rapidly being improved.

Only a comparatively few plants of this Cymbidium appear to have been collected and introduced to culture. At present it is very scarce in the trade.

3. *Cymbidium giganteum* Wallich

Wall. Cat. n. 7355.

Colored illustr.: Bot. Mag. vol. 81 (1855), pl. 4844; Paxt. Mag. vol. 12 (1846), pp. 241–242; Lindley, Sertum Orch. (1837), t. 4.

A vigorous-growing epiphyte or semi-terrestrial with stout pseudobulbs and leaves 24–30 inches long. The arching flower spikes, bearing from five to fifteen flowers 3–4 inches across, arise as in the preceeding species on the immature bulbs inside the first or second leaf. Sepals and petals yellowish-green, longitudinally striped with dull red. The pointed lip is spotted bright red. The sepals and petals do not always expand as widely as might be desired, hence the flowers often do not look as attractive as they should.

This species was first collected by Dr. Wallich in 1821 in Nepal. However, it apparently was not introduced into gardens until 1837, when Gibson found it on the Khasia Hills in northern India "in great abundance in the thick umbrageous forests growing on the trunks of trees and especially upon those which had begun to show tokens of decay; the specimens which occupied the hollows of old trees partially filled up with decomposing vegetable matter always presenting the most luxuriant and healthy appearance." A Burmese variety is offered by some exporters.

Judging from the illustrations cited, this species is quite variable both as to color and quality of the flowers. It is usually a fall or winter bloomer and as such should be valuable for breeding early-flowering hybrids, but due to the fact that it doesn't keep well and also that its hybrids often are of poor quality and drab in color, it has not been used much of late.

4. *Cymbidium grandiflorum* Griffith (*C. Hookerianum* v. Reichenbach)

Reichenbach in Gard. Chron. Jan. 6, 1886 *(C. Hookerianum)*.

Colored illustr.: Bot. Mag. vol. 92 (1866), t. 5574.

An epiphyte or semi-terrestrial, with leaves up to 30 inches long, dilated below into ribbed and grooved sheaths streaked with yellow and green. This species can be distinguished by this feature alone when not in bloom. The pseudobulbs are not very distinct; in fact when the plants are thriving and growing fast there seems to be little tendency for the pseudobulbs to form at all. Instead, growth after growth is produced with great rapidity, all of which retain their leaves for several years, giving the plants a strongly tufted appearance. The pendent flower spikes bear five to fifteen flowers from 4 to 5 inches across (fig. 3), usually arising at the base of the current growths, first growing out at right angles then bending upward and downward. The sepals and petals are generally clear green at opening but turn a little yellow with age. The lip is large, pale yellow, spotted reddish-purple. The flowers have a fragrance similar to that of *C. giganteum* and *C. Tracyanum* but more pleasant, since it lacks the sickening sweetness of that exuded by those two.

Fig. 3. *Cymbidium grandiflorum* Griffith
From "Botanical Magazine," Vol. 92 (1866), pl. 5574

This species, a native of East Nepal, Sikkim, and Bhotan, growing at elevations of 5000–7000 feet, was first described by Griffith in 1851. It was later collected by Thomas Lobb for Veitch & Sons, in whose Chelsea greenhouses it flowered for the first time in cultivation in 1866.

Cymbidium grandiflorum has never been popular in cultivation for, although its flowers are beautiful (to those who like green) and it is one of the easiest species to grow, it appears to be one of the most difficult to bloom regularly. Often the flower buds when about half grown will turn a pinkish-yellow and fall off. Even when they do stay on they are very slow to open, often literally "just sitting" for weeks after reaching nearly full size. When the flowers are fully expanded they amply justify the name of the species (*grandiflorum* = large flowered). After pollination the whole lip turns a bright reddish-pink color, and sometimes this reaction sets in when the stigmatic surfaces merely have been irritated by some foreign material.

Despite its many faults this species has been successfully used in hybridization. The hybrids CONINGSBYANUM *(grandiflorum* x *insigne)*, ERICA SANDER *(Pauwelsii* x *grandiflorum)*, FLORYI *(eburneo-Lowianum* x *grandiflorum)*, HOLFORDIANUM *(eburneum* x *grandiflorum)*, LOWIO-GRANDIFLORUM *(Lowianum* x *grandiflorum)*, PEARL *(Alexanderi* x *grandiflorum)*, and ROSEFIELDENSE *(Tracyanum* x *grandiflorum)* are not only successful in themselves but have been used a great deal in the production of more good hybrids. Nearly all of the green hybrids available to-day owe their color to *C. grandiflorum* and *C. Lowianum*.

5. *Cymbidium I'Ansoni Hort. (C. Mandaianum* Hort.*)*
Rolfe in Orchid Rev. vol. 8 (1900), p. 191.
Illustr.: Orchid Rev. Vol. 8 (1900), p. 209.

The first time that this species flowered under cultivation was in the spring of 1900 at the establishment of Messrs. Hugh Low & Co., Enfield, England (fig. 4). It had been imported with a lot of orchids for that firm collected in Upper Burma by Mr. G. I'Anson. It passed for *C. Lowianum* until it flowered, when some striking differences were noted. The sepals and petals were much broader and distinctly lined with purple-brown reminiscent of the markings of *C. Tracyanum* but paler. The lip was broader and more obtuse with markings as in *C. Lowianum* but much lighter in color. Because of the similarities of this plant with both *C. Tracyanum* and *C. Lowianum*, R. A. Rolfe, the eminent English botanist, suggested that it might be a hybrid between the two. However, hybrids raised from crossing these two species are quite distinct from *C. I'Ansoni*, and furthermore hybrids between it and *C. insigne* (C. CERES) are quite different from any other primary hybrid with *C. insigne*, so whatever the affinities of *C. I'Ansoni* it probably is a valid species.

The plant collected by Mr. I'Anson apparently remained unique until 1912, when W. A. Manda exhibited a second plant under the name of *C. Mandaianum*. The following April Messrs. Sander & Sons, of St. Albans, England, exhibited a third plant of the same species supposedly introduced from Annam. As far as I am aware, this species has never been collected in quantity and is therefore very scarce in the trade at present. Possibly all of the plants now grown represent divisions of these original introductions.

Fig. 4. *Cymbidium I'Ansoni* Hort.
From "Orchid Review," Vol. 8 (1900), p. 209

The outstanding hybrid from this species is C. CERES *(C. I'Ansoni* x *insigne)* which varies from pink to almost red. Many forms of this hybrid have been used in further hybridization and have given rise to a host of hybrids most of which show their CERES parentage very strongly.

6. *Cymbidium insigne* Rolfe *(C. Sanderi* Hort.; *C. insigne Sanderi* Hort.*)*
Rolfe in Gard. Chron. vol. 35 (1904), p. 387.
Colored illustr.: Bot. Mag. vol. 136 (1910), t. 8512.

A semi-terrestrial species with almost globose pseudobulbs and narrow leaves 2–3 feet long. The erect, 3–4 feet tall, flowering spikes bear from twelve to twenty flowers which arise from the base of well-matured bulbs. The broad-petalled flowers are from 3 to 4 inches across (fig. 5). The sepals and petals vary from near white to almost rose-lilac, with deeper-colored dots at the bases. The rounded lip is heavily dotted rose or lilac with the keels bright yellow.

Apparently this is the only species of the group treated here which the collectors definitely say was found growing on the ground. However, an

Fig. 5. *Cymbidium insigne* Rolfe

examination of its roots and growth habit in culture leads one to the conclusion that it is semi-terrestrial at most.

Cymbidium insigne var. *album* Hort.

The flowers of this variety are pure white except for yellow keels and faintly colored dots at the base of sepals and petals.

A native of Annam, *Cymbidium insigne* was first collected there by Mr. G. Bronkhart in 1901. It was again collected in 1904 by Mr. W. Micholitz for Messrs. Sander & Son, who introduced it to the trade under the name of *Cymbidium Sanderi.*

This beautiful species has been used widely in hybridization, perhaps more so than any other species of the genus. Because of its compact growth, upright spikes, and well-formed flowers, it has been the logical counterpart in crosses with the more bulky and space-consuming species such as *C. Lowianum*, *C. grandiflorum* and *C. Tracyanum*. Of the large number of *insigne* hybrids that have not only been milestones in themselves but also contributed toward further progress, perhaps the most outstanding are ALEXANDERI *(eburneo-Lowianum* x *insigne)*, CERES *(I'Ansoni* x *insigne)*, DORIS *(Tracyanum* x *insigne)*, DRYAD *(Parishii* x *insigne)*, GOTTIANUM *(eburneum* x *insigne)*, PAUWELSII *(Lowianum* x *insigne)* (fig. 17). Of these, ALEXANDERI Westonbirt variety and PAUWELSII var. "Compte de Hemptinne" have proved outstanding both as to their own individual qualities as well as their remarkably strong influence on their progeny as evidenced by the large number of superb seedlings raised from them.

Fig. 6. *Cymbidium Lowianum* v. Reichenbach

7. *Cymbidium Lowianum* v. Reichenbach

Gard. Chron. 11 (1879), p. 321, 405.

Colored illustr.: Warner & Will. Orchid Album, vol. 10 (1893), pl. 471; Sander, Reichenbachia, ser. II, vol. 2 (1894), p. 11.

Vigorous semi-terrestrial species with pseudobulbs up to 9 inches long and leaves 2–3 feet long. Flower spikes long, arching, with from fifteen to thirty-five (sometimes even more) flowers. The flowers are large, 3½–4½ inches across; sepals and petals greenish-yellow, with faint reddish or brownish veins; lip rather narrow, pale yellow with a large V-shaped blotch chestnut to reddish-crimson in color (fig. 6).

Collected in Burma in 1877 by Boxall for Messrs. Low, it flowered for the first time in their nursery in 1879. Because it was easily cultivated and grew into superb specimen plants it was a favorite for many years until gradually displaced by its own hybrids. Despite the large number of beautiful hybrids that have been raised from this species, fine forms of it (fig. 7) compare favorably with the better hybrids. It is from *C. Lowianum* that Cymbidiums have established their reputation for good keeping quality, for

Fig. 7. *Cymbidium Lowianum* v. Reich. var. "St. Denis"

flowers of this species often remain in good condition for eight to ten weeks. It blooms from late winter to early summer. It has a strong influence on its hybrids both as to appearance, flowering time, and other characteristics.

C. Lowianum var. *concolor* Rolfe (*C. Low. flaveolum* Linden; *C. Low. viride* Hort.)

Rolfe in Gard. Chron. ser. 3, vol. 10 (1891), p. 187.
Colored illustr.: Warner & Will. Orchid Album, vol. 11 (1897), t. 527 (*C. Low. viride*).

This beautiful form of *C. Lowianum*, corresponding to the albino form of *C. insigne* (*C. ins.* var. *album*), has clear yellow-green sepals and petals, and an orange-buff blotch on the lip instead of the red or crimson as in the typical form (fig. 8).

It is through combinations between this form and the white forms of *C. insigne* and *C. eburneum* that the following *concolor* types have been obtained: *C. eburneo-Lowianum concolor* (*C. eburneum album* x *C. Lowianum concolor*), C. WOODHAMSIANUM CONCOLOR (*C. eburneo-Low. con.* x *C. Low. con.*), C. PAUWELSII AUREUM (*C. insigne album* x *C. Low. con.*), C. BERYL CONCOLOR (*C. Pauwelsii aureum* x *C. Low. con.*), C. PRESIDENT WILSON CONCOLOR (*C. Alexanderi album* x *C. Low. con.*).

Fig. 8. *Cymbidium Lowianum* var. *concolor* Rolfe

Fig. 9. *Cymbidium Parishii* v. Reichenbach
From "Orchid Album," Vol. 1 (1882), pl. 25

8. *Cymbidium Parishii* v. Reichenbach

v. Reichenbach in Gard. Chron. n. s. vol. 1 (1874), p. 338.
Colored illustr.: Warner & Will. Orchid Album, vol. 1 (1882), t. 25; Lindenia vol. 15 (1900), t. 717.

An epiphytic species closely allied to *C. eburneum* from which it differs chiefly in having somewhat more pronounced pseudobulbs with broader leaves. The inflorescence is unlike that of *C. eburneum* in having three to six flowers instead of one to three. The flowers are somewhat smaller with white sepals and petals but the lip has many large purple spots (fig. 9). Its fragrance is like that of *C. eburneum*. It blooms in the summer.

This species was first collected in Moulmein in 1859 by the Rev. C. S. Parish. His first shipment of plants, however, was lost, and apparently no living plants reached England until 1867, when Parish sent two to Messrs. Low. One of these was acquired by Mr. John Day of Tottenham in whose collection it bloomed in 1878. Earlier in the same year, a plant in the possession of Mr. W. Leach at Tallowfield, Manchester, bloomed, thus probably marking the first time this species flowered in cultivation. Presumably the plant in the Leach collection also came from Messrs. Low. The plant owned by Mr. John Day was purchased the following year by Messrs. Warner and Williams of Victoria and Paradise Nurseries for the neat sum of 100 guineas (about $500.00).

C. Parishii var. *Sanderae* Rolfe
Rolfe in Gard. Chron. ser. III, vol. 35 (1904), p. 338, illustr.
Colored illustr.: Flora and Sylva, vol. 3 (1905), p. 150.

This beautiful plant was collected in Annam by Mr. Micholitz. It was first flowered in May, 1904, by Messrs. Sander & Son, who exhibited it at the May meeting of the Royal Horticultural Society under the name of *C. Sanderae*. It received a First Class Certificate under that name, but when the plant was sent to Kew Botanic Gardens for confirmation Mr. R. A. Rolfe decided that it was not a new species but merely a form of *C. Parishii*. That decision has not been seriously contested although one might well be so inclined after comparing the illustrations of the two.

Mr. F. K. Sander has kindly informed me that, despite large importations of what was supposed to be this variety, the true type actually has never been obtained in more than three or four plants, and none of these was exactly like the original. This would indicate that this type as represented by the first introduction in 1904 is either very scarce, or only sparingly present in the areas as yet searched for it. Of course it is not at all improbable that it represents an advanced hybrid between typical *C. Parishii* and some other species of that area. One back-cross of such a hybrid to *C. Parishii* would account for the similarity to that species and yet allow for the greater number of flowers per spike and the pronounced differences in flower form. The main differences between this variety and the typical *C. Parishii*, aside from that of flower shape, are the greater number of flowers per spike (3 to 6 instead of 1 to 3) and much more color in the lip.

In the opinion of Mr. F. K. Sander the *C. Parishii* var. *Sanderae* is the form that has largely been used in hybridization with other species, whether or not it is so stated in the records. This is probably true for in the pro-

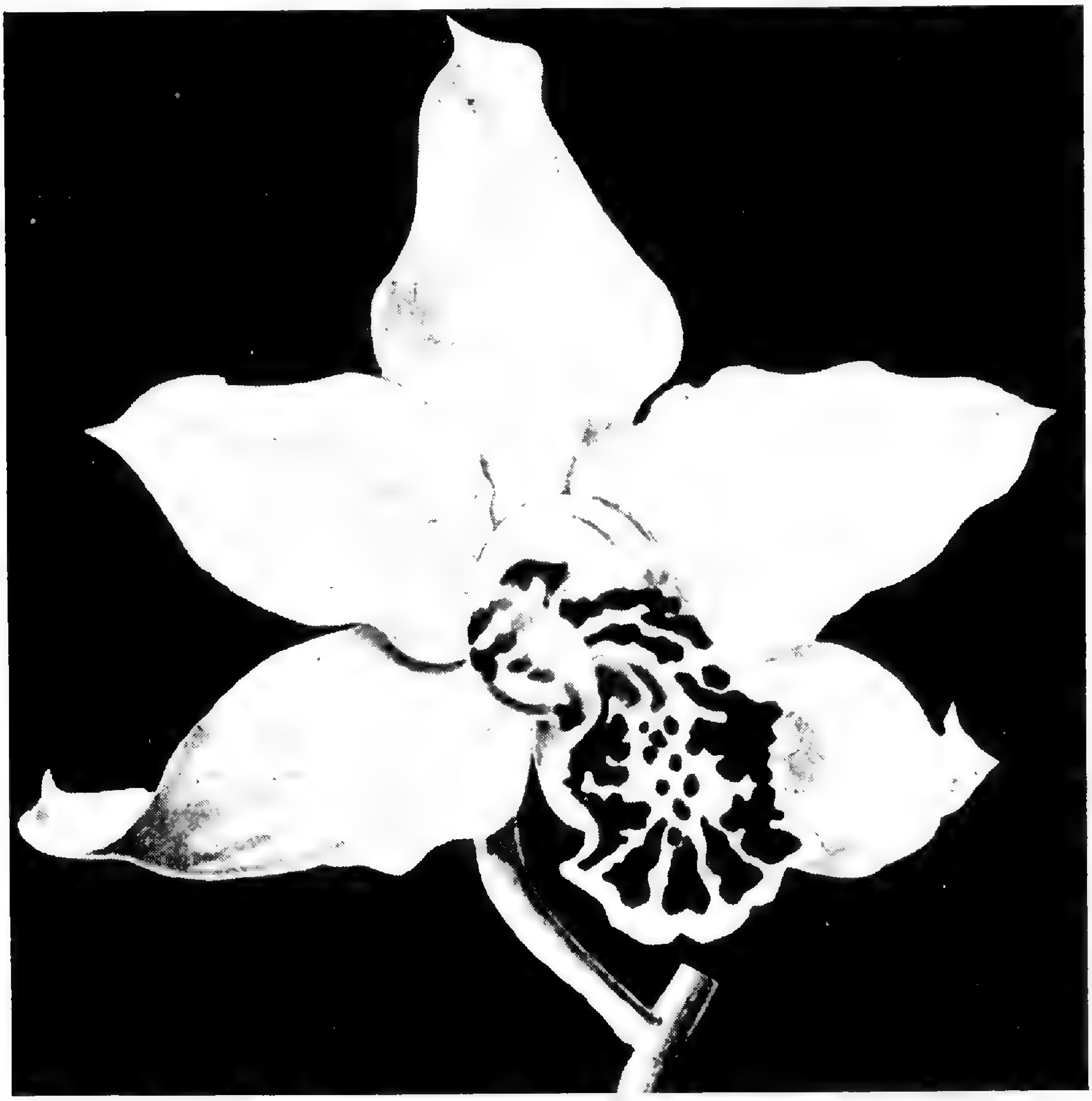

Fig. 10. *Cymbidium Parishii* var. *Sanderae*
From "Gardeners' Chronicle," Vol. 35 (1904), p. 338

ceedings of the meetings of the orchid section of the Royal Horticultural Society or in *Orchid Review,* nearly all of the early hybrids with this species are listed as being with the form *Sanderae.*

This species has entered into the modern fine hybrids largely through the hybrids DRYAD (fig. 18) *(insigne* x *Parishii* var. *Sanderae),* CYGNET *(*PAUWELSII x *Par. Sand.),* GARNET *(Lowianum* x *Par. Sand.)* and SEAMEW *(I'Ansoni* x *Par. Sand.).*

9. *Cymbidium Schroederi* Rolfe
Gard. Chron. vol. 37 (1905), p. 243.

An epiphytic or semi-terrestrial species from Annam where it was discovered in 1904 by Mr. W. Micholitz. It flowered for the first time in 1905 in the collection of Baron Sir Henry Schroeder, after whom it was named. It appears to be allied to *C. Lowianum* and *C. giganteum,* but as an orna-

Fig. 11. *Cymbidium Tracyanum* Hort. Swisher's variety

mental it is inferior to both of these. The shape and color of the flower are similar to *C. Lowianum* except that the dull red color of the lip occurs in many blotches as in *C. giganteum.*

This species was used somewhat in hybridization when first introduced, chiefly with *C. insigne,* but it has never yielded anything startling. *C. Cooperi,* a supposed natural hybrid between *C. Schroederi* and *C. insigne,* has been used more and with somewhat better results, but, on the whole, unless better forms are found, *C. Schroederi* does not warrant further consideration in the breeding of Cymbidiums. The few front-rank Cymbidiums that have it in their lineage probably owe their qualities to the other species involved.

10. *Cymbidium Tracyanum* Hort.

Gard. Chron. ser. 3, vol. 8 (1890), p. 718.
Colored illustr.: Lindenia, vol. 11 (1895), t. 514.

Vigorous epiphyte. Habit of growth and formation of spike as in *C. giganteum* but stronger. The spikes carry from twelve to twenty large flowers (fig. 11). Sepals and petals colored similarly to *C. giganteum* but with brighter red. The lip is large, yellow spotted with crimson, somewhat reminiscent of *C. grandiflorum.* The flowers have a powerful fragrance, as in *C. giganteum.* The species has peculiar upright aerial roots 1–2 inches long, suggesting that it is adapted to an excessively wet habitat.

The first cultivated plant of this species flowered quite unexpectedly in the nursery of Mr. H. A. Tracy, at Twickenham, England, in December, 1890. It was exhibited at the Royal Horticultural Society meetings that month and received a First Class Certificate. A few days later this plant was sold to Baron Sir Henry Schroeder for 75 guineas (over $300).

Cymbidium Tracyanum had been imported with plants of *C. Lowianum* from Upper Burma and had been considered as belonging to that species until it bloomed. Five years elapsed before a second plant appeared, and in the next two years more came to light. Apparently all had been imported as *C. Lowianum* from Upper Burma. During the next few years more plants arrived but always among importations of *C. Lowianum.* It was not until 1911 that one of its localities became known with certainty, at which time the species flowered among a number of orchids collected at Chengmai, Siam, by Dr. Alexander Kerr. It thus appears to be native to Burma and Siam, and perhaps to adjacent areas.

Until it is in bloom this species could pass for *C. Lowianum,* but then the many similarities to *C. giganteum* and *C. grandiflorum* are readily apparent. In fact, soon after the flowering of the first plant in Mr. Tracy's

Fig. 12. x *Cymbidium eburneo-Lowianum*
From "Orchid World," Vol. 5 (1914), p. 4

Fig. 13. x *Cymbidium* Wiganianum
(*eburneum* x *Tracyanum*)

nursery the suggestion was made that it might be a hybrid between the two species. There were only two major objections, namely: the putative parent species were not then known to occur in the area from which this unique plant came; and the peculiar aerial roots at that time had not been observed in any other species. Now that it has been established that *C. giganteum,* and probably also *C. grandiflorum,* occur in the general area where *C. Tracyanum* was collected, the first objection to the suggestion of hybrid origin for this plant has been removed. However, the second still stands and, furthermore, since artificial hybrids between *C. giganteum* and *C. grandiflorum* do not come very close to *C. Tracyanum,* it is now generally agreed that *C. Tracyanum* is a valid species.

Fig. 14. x *Cymbidium* WINDSOR
(*erythrostylum* x LOUIS SANDER)

Fig. 15. x *Cymbidium* WIGANIANUM
(*eburneum* x *Tracyanum*)

Fig. 16. x *Cymbidium* ORION
(DORIS x *erythrostylum*)

Cymbidium Tracyanum is an easily handled, widely grown species and, although many of the later importations have failed to measure up to the first plant, it is still useful. There appears to be somewhat greater variation in keeping quality and texture of the flowers of different forms than is met with in the other common species. In southern California, where it is usually grown outside, it flowers in late fall or early winter, a season during which the weather is often dry and warm. Under these conditions the cut flowers do not always keep well, especially if cut a bit on the green side. This experience has caused many growers to avoid not only the species but many of its hybrids. However, when grown in the greenhouse or otherwise protected against severe changes in humidity the flowers compare reasonably well with most Cymbidiums in keeping quality except, of course, *C. Lowianum*, which far exceeds them all.

C. Tracyanum has been widely used in hybridization largely because of its early flowering habit which it seems to transmit to most of its progeny. Along with this earliness, it also imparts its characteristic red marks and lines to its progeny (fig. 15). Unfortunately, this color is considerably dulled in crosses with other species so that many of the primary hybrids are considered to be dingy in color. Also, unfortunately, the poor keeping quality is often transmitted to its progeny. However, in many advanced crosses these faults are being rectified without an undue loss of earliness. By far the best primary hybrid from this species is DORIS *(Tracyanum* x *insigne)*, which is not only a pretty good early-flowering hybrid in its own right but its good forms have also proved their worth as parents in the production of other early-flowering hybrids.

I am indebted to my colleague Mr. Paul A. Kohl for taking most of the pictures included.

I also wish to thank the following persons and firms for contributions of pictures and useful information relative to this article: Mr. B. O. Bracey, Armacost and Royston Company, Los Angeles, Calif.; Mr. Robt. Casamajor, Pasadena, Calif.; Mr. E. O. Orpet, Santa Barbara, Calif.; Mr. Lovell Swisher, Los Angeles, Calif.; Mr. Fred K. Sander, Sander and Sons, St. Albans, England; The McBeans Orchids Ltd., England; Mr. H. G. Alexander, H. G. Alexander Ltd., Westonbirt, Tetbury, England.

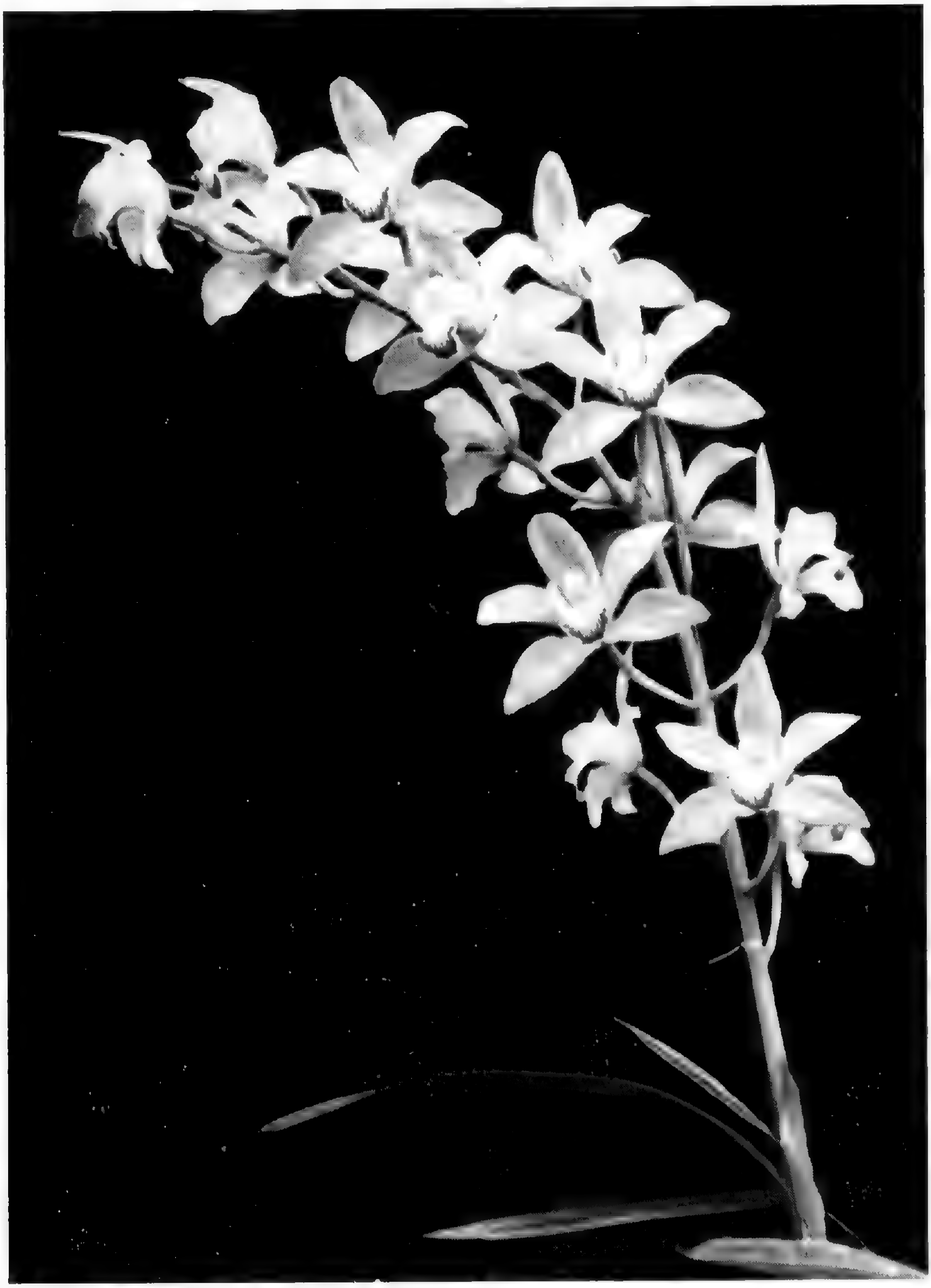

Fig. 17. *Cymbidium* PAUWELSII
(*Lowianum* x *insigne*)

Fig. 18. x *Cymbidium* DRYAD Westonbirt var.
(*insigne* x *Parishii* var. *Sanderae*)

NOTES

Mr. George H. Pring, Superintendent of the Garden, acted as one of the judges at the twenty-second annual flower show given by the Associated Garden Clubs of Kirkwood, May 11.

Mr. Robert B. Clark, having been released from active duty in the Army where he holds the rank of Major, has returned to his former position at the Garden in charge of trees and shrubs.

The annual flower sermon for which Henry Shaw provided in his will was preached at Christ Church Cathedral, May 12, by Dr. Henry Sloane Coffin, of the Presbyterian Church, for many years president of the Union Theological Seminary of New York.

The April number of the ANNALS OF THE MISSOURI BOTANICAL GARDEN (Vol. 33, No. 2) has recently been issued, with contents as follows: Contributions to Our Knowledge of American Carboniferous Floras. VIII. Another Medullosa from Iowa, by Henry N. Andrews and Jules A. Kernen; Maize in Mexico, by Edgar Anderson.

Recent visitors to the Garden include Dr. Hugh C. Cutler, Guggenheim Fellow, Botanical Museum of Harvard University, Cambridge, Mass.; Dr. Carl O. Sauer, Head Department of Geography, University of California, Berkeley; Capt. H. C. Keith, formerly botany major in the Shaw School of Botany; Mr. Walter C. Scholl, orchid enthusiast, of Chicago, Ill.

An Easter sunrise service was held at the Arboretum on Easter morning, over 500 people attending. Participating in the service were the Methodist churches of Labadie, Gray Summit, and Pacific, the Rose Hill Baptist Church, the Negro Baptist Church of Pacific, Assembly of God Church of Pacific, and the Pacific Presbyterian Church.

Mr. Ladislaus Cutak, in charge of succulents at the Garden, spent the month of April in Arizona and California visiting cactus collections and commercial establishments and exploring the desert regions. In Arizona the Boyce Thompson Southwestern Arboretum, the Desert Botanical Garden in Papago Park, and the Experimental Station at Sacaton were included in the itinerary, while in California the Borego Desert, the Joshua Tree Monument, Ord Mountain district, maritime Catalina and other xerophytic regions were explored. Many plants were collected in the field, and through contacts made with commercial growers an exchange of plants was established. While in the desert Mr. Cutak had the opportunity of testing three varieties of the Barrel Cactus as an alleviator of thirst. (See October 1943 BULLETIN.)

SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date until his death in 1889 it was maintained under his personal direction. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was chosen by Mr. Shaw and he definitely indicated that he wished it called by that name. The Garden passed at his death into the hands of a Board of Trustees, designated in Mr. Shaw's will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provision of the will the immediate direction of the Garden is vested in a Director, appointed by the Board. The Garden receives no support from city or state but is maintained almost exclusively from the estate left by Henry Shaw. Since 1939 many Garden Clubs and interested individuals have contributed to a "Friends of the Garden Fund" which is used in developing the new Arboretum, located at Gray Summit, Mo. The Arboretum (1) serves as a source of plants, trees and shrubs for the city Garden; (2) affords areas for gradually establishing a pinetum, a wild-flower reservation and various other features on a scale not possible in the city; (3) provides greenhouses for some 20,000 orchid plants.

The city Garden comprises 75 acres, where about 12,000 species of plants are grown, both out of doors and under glass. It is open every day in the year except New Year's Day and Christmas; week days, 8:00 a. m. until sunset; Sundays, 10:00 a. m. until sunset. The greenhouses are closed every day at 5:00 p. m.

The main entrance to the Garden is at Tower Grove and Flora Place, on the Sarah car line (No. 42). The Tower Grove bus (No. 21), direct from downtown, passes within three blocks of the main entrance.

MISSOURI BOTANICAL GARDEN BULLETIN

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Missouri Botanical Garden Bulletin

Vol. XXXIV JUNE, 1946 No. 6

TWILIGHT FRAGRANCE

PAUL A. KOHL

The customary gesture of almost every person is to stoop to smell a flower; fragrance seems to be second in importance to color. The following notes call attention to three fine plants which are particularly valuable for that part of the garden where one loves to linger on a summer's night.

The white Nicotiana, or flowering tobacco, is the most fragrant annual one can grow. All day its flowers hang limp in the sun, but when evening comes they unfold and spread their sweet perfume. And in addition to the fragrance, the whiteness of the flowers is a delight when the moon is shining brightly, or the garden is lighted. One small packet of seed will yield many plants. The seeds are small, and if sown directly in the garden the seedlings must be helped in their competition with the weeds until they are large enough to be on their own. Perhaps a better way to start the plants is to sow the seeds in a pot in April or May. Transplant the seedlings, when they are large enough to handle, to another pot or box and afterwards set them in the garden. The plants will grow rapidly and in late summer will stand three to four feet tall. Before the flower stalks become too numerous the plants should be staked to prevent them from being blown over or weighed down by rain. This white Nicotiana has no equal in its fine display of fragrant flowers each evening from late May until the first frost.

The moonflower is a fine companion plant to the Nicotiana, also blooming at night. This vine will cover large areas in a short time, and in the early evening one can witness a remarkable sight—the unfolding of the flowers. They gleam in the moonlight and add their perfume to that of the Nicotiana. The seeds of the moonflower are quite large and have a hard seed coat which should be chipped or filed before being planted. Merely cut a notch in the brown covering until the white portion of the seed shows; moisture can then enter and hasten germination. Uncut seeds

Nicotiana alata var. *grandiflora* (*N. affinis*)

will germinate but it takes so much longer. The seeds may be sown directly in the garden, but to insure early flowers start the plants in pots in April and transplant them to the garden in May.

Hall's honeysuckle is a good vine, but it differs from the plants previously mentioned because it is always in bloom and fragrant. This honeysuckle remains green in winter until zero weather browns the leaves, but new growth appears in early March. The interval in mid-winter when the leaves are not green is so brief that the plant can be considered an evergreen. It is an excellent vine for any trellis that is to be covered throughout the year. Hall's honeysuckle should be planted in the spring. It will make moderate growth the first year and in succeeding years will cover any trellis and also creep along the ground. There is little need for pruning the vine unless it becomes too rampant. If pruned to the ground in the winter it will quickly cover the trellis again by mid-summer. Additional plants may easily be secured by cuttings or layers.

In this trio the gardener has an excellent group of plants for the moonlit garden. The fragrance of all three and the gleaming whiteness of the flowers of the Nicotiana and the moonflower can be enjoyed each evening throughout the summer.

Moonflower *(Calonyction aculeatum)*

Hall's honeysuckle *(Lonicera japonica* var. *Halliana)*

Fig. 1. Rumanian Ivy in the Mausoleum Grove

MORE ABOUT BALKAN IVIES

EDGAR ANDERSON

"MBG Bulgaria" and "MBG Rumania," the two new varieties of ivy introduced last year by the Garden,* solve the problem of an attractive ground cover for shady areas. Figure 1 shows how the Mausoleum grounds are now mantled with green throughout the year. This part of the Garden is so shady that it used to look patchy and unattractive in spite of efforts to maintain a semblance of turf. Previous attempts with other ground covers were somewhat successful, yet most of these did not carpet the ground completely and required considerable attention if they were to be kept in good condition.

One advantage of these ivies is that they can be combined effectively with spring-flowering bulbs. In the Mausoleum grounds, wood hyacinths,

*See March 1945 number of the BULLETIN.

camassias, and narcissi are planted in masses. They come up through the ivy and provide a succession of bloom for nearly two months. As soon as their leaves collapse the ivy screens them as they finish the ripening-off process which is essential to the production of good strong flowering bulbs.

Figure 2 shows how these same ivies have been used to transform what used to be an eyesore into an attractive feature of a small city garden. The shady area around the little tool house formerly looked ragged and unkempt. About all that could be done was to keep out the weeds which grew there during the summer months. A brick edging was set along the walks, the

Fig. 2. Rumanian Ivy planted around a tool house

ground in back was well mulched, and Balkan ivies were set out at intervals of two or three feet. While these new ivies look almost exactly like the dark green ivy of a florist's shop they are so very much hardier that maintaining them in good condition out of doors in St. Louis is a very simple matter. After they are once established little needs to be done aside from clipping them around the border once or twice a year. In some gardens squirrels will plant horse-chestnuts among them, and shoots of these will have to be pulled out; after a very severe winter there may be enough winter injury to require a little judicious grooming, but all in all they are as near to automatic as anything we can hope for in a garden.

BONSAI

HENRY N. ANDREWS

The dwarf potted trees, known as "bonsai," so characteristic of the untiring patience of the Japanese gardener, have always held a certain mystic fascination for fanciers of the strange and exotic. They seem to present the same sort of appeal that is transmitted by the dwarfed weather-beaten plants of high mountain summits. Any one who has climbed beyond the timber-line in the Rockies or in our eastern mountains has found himself in a new world —or perhaps it is more appropriate to say a very old world; at any rate a place where the tempo of life is at the same time more extreme and violent yet infinitely more peaceful than even the quiet valleys below.

The Lars Anderson collection of Japanese dwarf trees at Harvard University's Arnold Arboretum—some over 200 years old. Photograph by courtesy of Arnold Arboretum.

On the high mountain tops of Colorado and New Hampshire there are firs, spruces, willows, and birches that, under the extreme buffeting of their arctic surroundings, grow only to a few inches in height. The snows of a nine- or ten-month winter, almost perpetual gales, and the scantiness of soil combine to prevent much growth, and such as it is is horizontal rather than toward the sky. Grow they will but strictly in obeisance to the alpine tempests. Yet under these conditions, where winds may exceed a hundred miles an hour for days on end and the mercury drop to 50° below, these dwarf, matted "forests" thrive undaunted through the centuries. Spruces have been found on the heights of Mt. Washington, only three feet high, four inches in diameter, and over 360 years old. It is sufficient evidence, if such be needed, that adversity breeds the hardy.

No plant lover has ever toiled to these mountain heights and returned to the valleys without the memory of this peculiarly fascinating alpine vegetation lingering on. The Japanese have been more aggressive in their appreciation of these dwarf life forms and have developed a most unique branch of gardening around their culture. The following notes have been drawn from two articles by Shinobu Nozaki, which appeared recently in *The Tokyo Advertiser.*

"The history of Japanese gardening goes back 1,100 years and that of bonsai 800 years . . . The first bonsai was a Japanese apricot tree potted in the Kamakura period. All things considered, the idea seems to have come from China. It was toward the end of the Tokugawa period, however, that the bonsai vogue extended to the general public for the first time. At first young and old apricot trees were used, along with camellia, red pine and others . . . . . ."

The planting and especially the long-continued care of these dwarf potted "bonsais" are typical of the traditional patience of the Japanese. The appeal of the plants lies in both their shape and age. According to Nozaki, they range up to 700 years, while another authority* tells of a specimen 1,000 years old. A few of us shelter with pride the possessions of our grandparents, but to cherish for centuries a plant that has come down through almost countless generations is quite another matter.

"We go to the mountains to find material for bonsai. A good one often entails much difficulty. It is dug up at the proper season, transplanted with great care so it will take root, followed with much bending of branches to get the proper form. A perfect Japanese juniper bonsai requires about ten years to finish . . . . A bonsai is no mere adornment for house or garden; it is a source of immense pleasure to its cultivator and of great satisfaction to all who see it . . . .

"Bonsai gives an enthusiast much to think about. After twenty years culture, it is not unusual for a bonsai devotee to dream of them in his sleep . . . . it may become the essence of life. Through bonsai we may contemplate humanity and nature and the conduct of life. An excellent bonsai is a work of art through which we may see the ideals of mankind. All the poetry of a glorious landscape is represented in one small pot of bonsai . . . .

"A word may be said about the delicate grace of bonsai. . . . . it seems to us that Western horticulturists do not properly appreciate the beauty of bonsai, which is unique in Japan, ... some may say reproachfully, 'a bonsai is a cozy, dwarfed old tree. It grows with restraint and its branches are full of curved lines. It is unnatural, isn't it?'

"Such criticism is wide of the mark. When Japanese regard an excellent and well cultivated bonsai, they see therein an ideal of poetry or nature, they get a 'tree feeling' that has no suggestion of artificiality. It is not a sense of gorgeous beauty but rather a quiet taste of elegance, a fresh refined flavor, a sense of casual innocence."

A considerable variety of plants are "trained" to become bonsai, in all, some 130 different kinds. The evergreens, including the pines, hemlocks, and junipers, seem to be most popular although many others are favored, such as azaleas, forsythias, maples, cherries, silver birches, peaches and plums. Mrs. Anley describes a six-inch orange tree "laden with golden fruit no larger than Peas."

*Anley, Gwendolyn. "Bonsai": The Japanese art of dwarfing. Gardening Illustrated. Vol. 60, pp. 348, 350. May 28, 1938.

Chamaecyparis obtusa, 150 years old, in the Lars Anderson collection at the Arnold Arboretum. Photograph courtesy of Arnold Arboretum.

With reference to the popular conifer bonsai, Nozaki writes:

"It is necessary to expose conifer bonsai to sun and wind often throughout the year. They are sturdy enough to withstand both midsummer heat and midwinter cold.

"Black pines and five-leaf pines must not be watered too often, for they like dry soil. A small quantity of water may be poured on the soil once a day in spring and fall, twice a day in mid-morning and mid-afternoon in summer and once in the morning in winter . . . .

"As to transplanting, it is enough to transplant a tree from one pot to another once in three or four years . . . . Full pruning may be done in early spring and light trimming is safe in March and April . . . .

"Cared for by these rules, no healthy bonsai will die very quickly. In Japan we have a great many bonsai that have lived for eighty or ninety years in pots. One five-leaf pine bonsai, said to have been planted by the third Tokugawa Shogun more than three hundred years ago, is still healthy and sound."

It is not easy to conceive of an American gardener taking to such a long-range horticultural program as that represented by bonsai culture—a course of events that his grandchildren's great grandchildren may be called upon to carry on. Those with sufficient patience and a desire for something quite out of the ordinary may find in bonsai a poetic tranquil contemplation and see in them the refined "ideals of mankind" that are imparted to the Oriental devotee.

CHOCOLATE COUNTRY OF THE AMERICAS

ROBERT W. SCHERY

Cacao, the source of chocolate, cocoa, and certain other commercial products, is one of the New World's most worthwhile gifts to the Old. While originating in the Americas, its exact place and mode of domestication is shrouded in the mystery of prehistoric ages. White man was probably first introduced to chocolate when Cortez invaded the Aztec empire in southern Mexico. Intrinsically more useful and hence, from the primitive utilitarian viewpoint, more valuable than gold, cacao was a tribute zealously exacted by the rulers of that bygone empire. Cacao beans often served as currency in the Aztec way of life and were acceptable for payment of taxes, levied even in those ancient Aztec days. Montezuma himself took as much pride in his wealth of cacao as in that of his metals and finery. The high content of oil, starch, and protein of the beverage made from the cacao bean marked this drink as a valuable and tasty food—one apparently greatly appreciated by the invading Spanish chieftain and his small band. The cacao tree had probably been domesticated in Central or northern South America by some tribe of aboriginals. It spread through tropical America under Indian care and promulgation, and, since the time of Cortez, to most parts of the world tropics, where today it is an item of primary economic importance.

Since that ancient day when the wild and yet unknown ancestor of *Theobroma Cacao* was made partner by man, to be cared-for in exchange for supplying its seed to make one of the very few beverages that is food as well as drink, the Old World has gradually taken precedence over the New in cacao cultivation. Yet approximately 35 per cent of the world's cacao still comes from the New World. The majority of this is from that small southern coastal corner of Bahia, Brazil—favored by the Gods with an unexpected rain-forest climate and a soil on which cacao is able to grow year after year with but the slightest of attention from its human partner. Africa principally, from the Gold Coast, Nigeria and St. Thomas, and to some extent the Far East, combine to outproduce the New World to-day, while Venezuela, Trinidad, Ecuador, and Panama compete with Bahia in this hemisphere. In the Americas, to many, southern Bahia is cacao and cacao is the romance of southern Bahia. Here many fortunes have been made (or less often lost); European capital and exotic buyers have been lured to distant, colorful Bahia; small holdings (rather than large plantations) have progressively dotted the rivers and malarial tidal sloughs, ever invading more the hinterland in spite of pestilence and hardship, while the glamorous history of Brazil's first capital weaves its story about the greedy exploitation of the cacao lands.

Turning now to the picturesque and most important American cacao region, southern coastal Bahia, Brazil, scenes from which appear in the accompanying photographs, we may briefly glimpse "cacao country," from estates of growing cacao to the marketing of the bean. This hilly Bahian area, covered in the remoter uncleared sections with fine virgin rain-forest of exotic and little-known trees, boasts a good soil, often clayey or boggy, the fertile residuum of igneous rock parentage. Streams are frequent, and in those whose headwaters are in the humid forests of the cacao country itself the water is clear and cool. Roads are few and often impassible. Transportation is mostly by river canoe, usually "dugout" from local forest trees, or on the tenuous narrow-gauge railroad line. Suppose we hire a gasoline "scooter" and ride on this railroad from the coastal port, through second-growth forest and palm-studded valleys, by villages of mud-walled, thatched-roofed huts and small banana plantings, to the cacao orchards themselves. A short jaunt by horse will be necessary, through verdant cover, and over ancient stone-lined trails (remnants of Brazil's era of slavery and ephemeral colonial glory), with the drip of the jungle matching the fleck of the hoof-splash as along the frontiers of man's invasion of the primeval his horse struggles against a damp and uncertain footing.

Gasoline motor "scooter" on narrow-gauge line, going to more accessible cacao estates of southern Bahia.

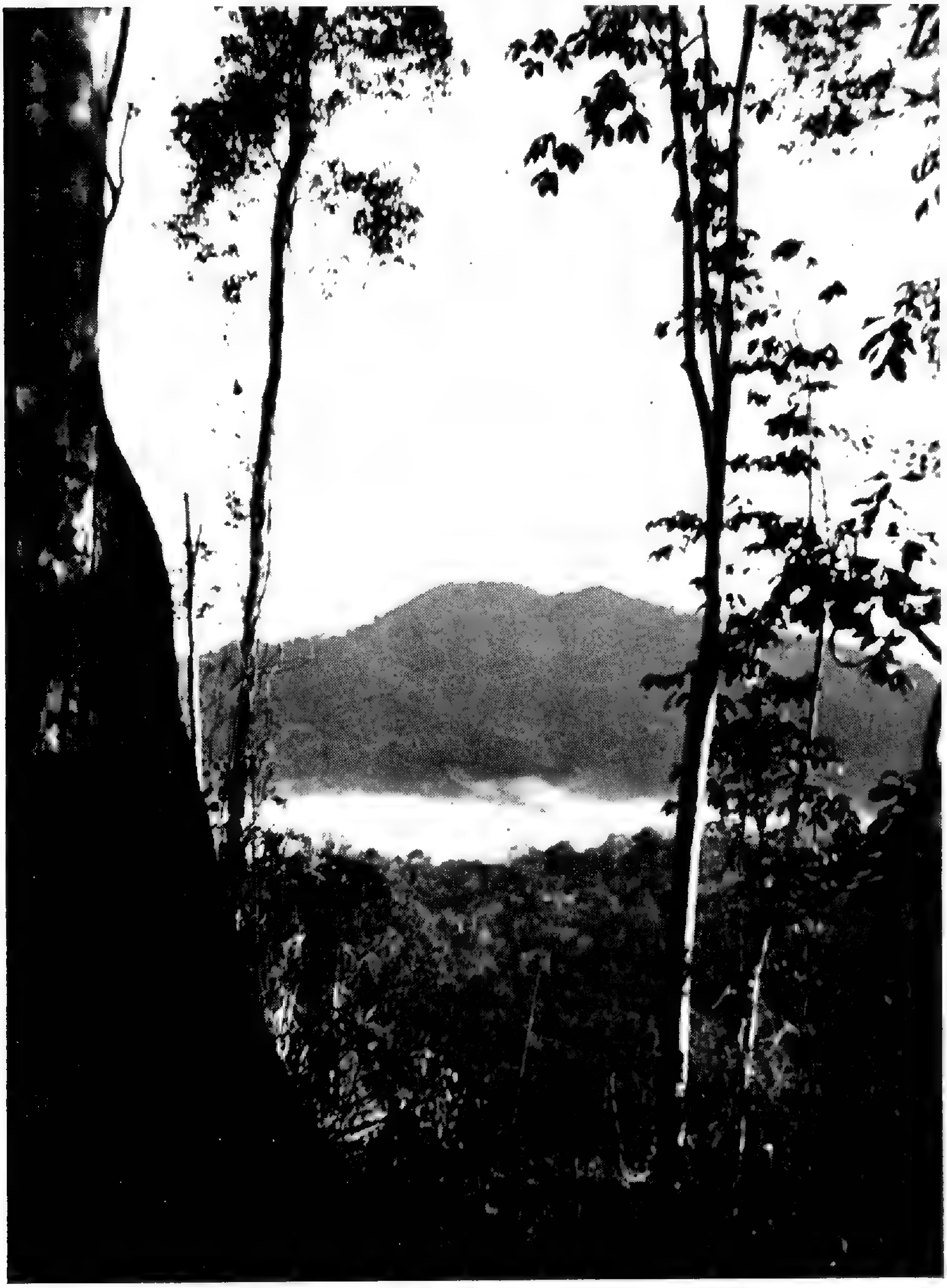
Crossing Una River in southern Bahia to reach trail to cacao plantings in higher hinterlands.

There, in the valleys and along the lower hillsides one suddenly finds himself dodging branches of the small cacao trees—low-crowned and spreading, row upon row but a few paces apart—the ground littered with their fallen foliage. These small trees appear to hide themselves in their jungle environment, camouflaged with lichens, and growing in the shadow of larger, more impressive trees (for cacao trees cannot stand the wind and sun and must be planted with a protective cover of tall trees whose branches arch overhead). Unlike most plants, the cacao bears its small flowers from little "cushions" on the bare trunk and larger branches. Each cushion develops during the year a succession of flowers, many of which are fertilized and give rise to the cacao fruit. The fruits, of which there are several varieties, all shaped more or less like a football, have a woody outer husk and a sweet central pulp containing several seeds. A good tree will bear 70 or more fruits during the year. Riding or walking through a cacao estate one sees at all seasons at least a few large fruits hanging grotesquely from bare trunks or branches.

"Cacao country" of southern Bahia. Uncut rain-forest on far side of Una River.

Now and then a group of laborers is at work at some convenient spot near a trail or transportation. The cacao fruits have been cut down, care being taken not to injure the flower-producing cushions, and are gathered together in one large pile. A man skilled in the use of his bush-knife sits silently by the pile and methodically slashes and splits the husk of the cacao fruits about as fast as they can be picked from the pile. A bevy of dark-skinned women, a cheaper labor source than men, receive the split fruits for the unexacting scraping of seeds and pulp from within the husk. Pulp and seeds are then taken in suitable containers, on the back of man or beast, to the curing sheds.

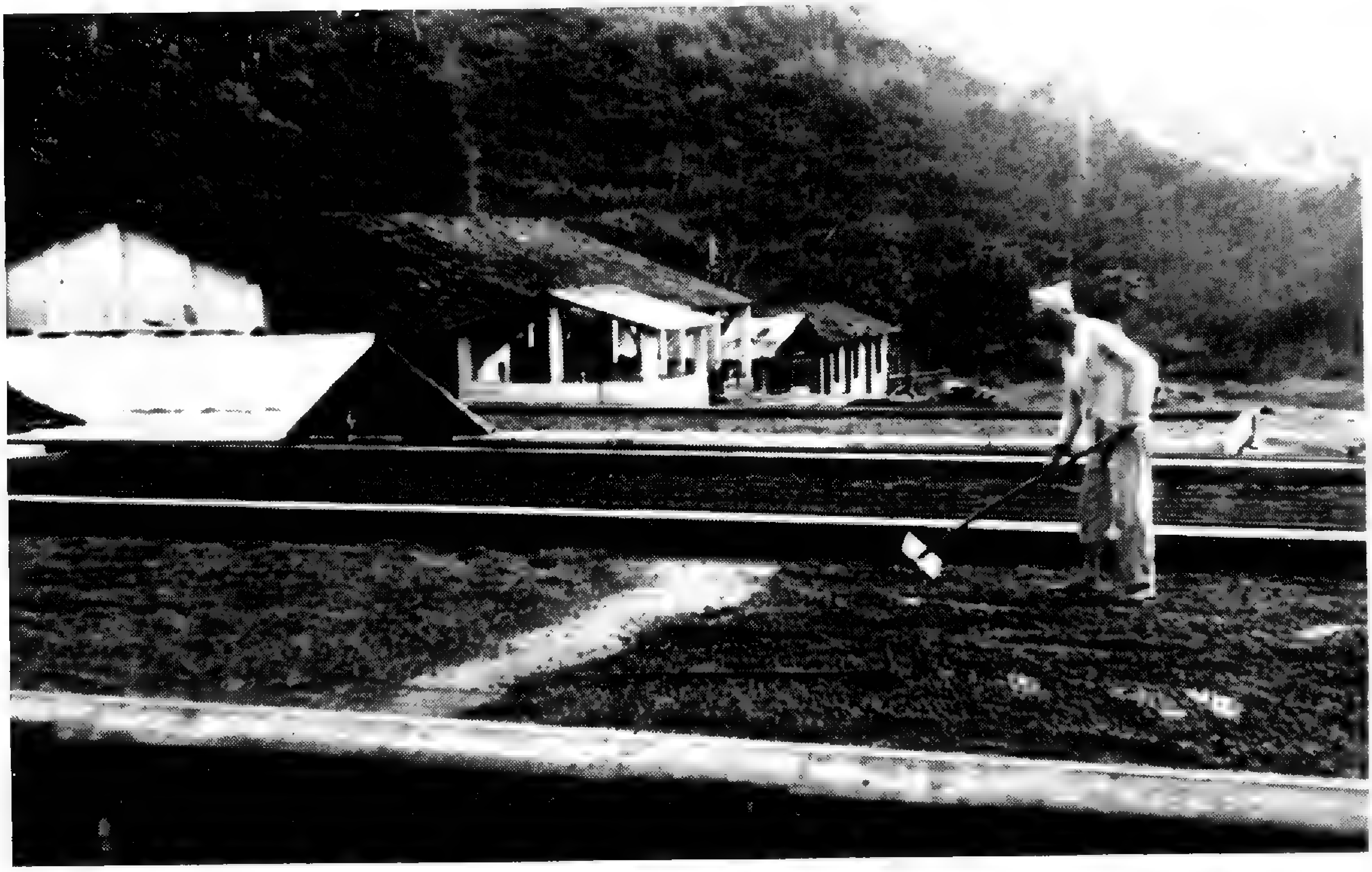
At the curing sheds pulp and seeds are mounded together, or are dumped into large indoor boxes or troughs when available. Omnipresent bacteria



View of high-altitude rain-forest of southern Bahian "cacao country." The cloud in the valley has not yet been dissipated by the morning sun.

and yeasts attack the sweet pulp, causing fermentation and the inevitable foul odors. This fermentation releases heat, raising the temperature of the fermenting mass many degrees above air temperature, a factor of evident importance in effecting proper "cure"—a change of certain ingredients of the seed to a more aromatic and palatable form. For several days such curing

Cacao tree shaded by planted rubber trees (3 large trunks in background). Note fruit on branch of trunk, fallen cacao leaves on ground.



Drying cacao beans after fermentation, southern coastal Bahia. Roof to left is on rollers and can be drawn over spread beans in event of rain.

continues, as occasionally the mass is worked or shoveled over, while a seething liquor drains from below. Then, with the sweet pulp gone in fermentation, the remaining seeds are spread in the sun to dry—carefully watched, stirred at intervals, covered in sheds during rains. Perhaps a final cleaning and polishing is given, and then the seeds, the commercial cacao beans, no longer viable after the curing process, are sacked and ready for marketing.

Once marketed, after a tedious burro-back, train or truck trip to the port, the majority of the cacao goes to Europe or the United States for further processing and manufacture. Some, however, is processed in Bahia, following the typical procedure of cracking the seed shells, separating the shells from the kernels, pressing the kernels to extract the oils and fats—the cacao butter of the trade. Cacao butter is one of the finest and most valuable edible fats known, suitable for a variety of purposes and often used in the finest of chocolates. The "cake" remaining from the pressing offers a source of the alkaloid theobromine, a close relative of caffeine, used in soft drink "colas" and for other purposes. Various treatment of the cacao kernels, with partial or no extraction of the butter, and special compounding with milk, sugar, ground "cake" or shells, produces the chocolate, milk-chocolate, cocoa and related products of commerce and your grocer's shelf.

A CONSERVATIONIST VIEWS THE TROPICS

ROBERT W. SCHERY

Conservation practices, or rather abuses of them, are not the prerogative of any one people. Most of us realize that here at home proper care is not always—indeed is seldom—taken of the heritage nature has deeded us. We burn, we cut, we plant improperly on the slopes, and little realize the progressive degradation of the land taking place with each generation. Few of us know, however, that such a problem is equally, if not more, acute in much of tropical America. Perhaps a glimpse of what is happening in Brazil will assuage that guilty conscience as you burn the leaves or watch the year's potential supply of humus gather before your rake.

The apparently increasing seriousness of drought in northeastern Brazil during the last few centuries may be less due to an inalterable climatic change than to a consequence of deforestation of the land. Before Portugal's golden era, the interplay between dry-season plants and semi-arid *sertão* climate had produced a balanced, stable, scrub forest of small, gnarled trees and shrubs. Later, with European colonization came various increasing demands for wood—for housing, light construction, and especially power. In northeastern Brazil no coal is available; electric plants

Forest of interior Bahia being burnt during the dry season to make way for mandioc planting.

for cities, boilers of the local sugar mills, engines of the trains are fueled by wood. Soon most of the accessible scrub-forest fell before man's voracious demands, and that water-holding, soil-binding cover which nature had taken centuries to perfect was destroyed with scarcely a thought for replacement or the future. Are present generations now paying the price for this—or is a changing climate (comparison of the historical record would seem to indicate such change) due to other causes? Be that as it may, northeastern Brazil now struggles with a depleted wood supply and concurrent climatological problems.

In spite of the scarcity and high cost of wood in eastern Brazil, the forest (where still found away from population centers) is usually burnt down to make room for planting crops. Little effort is directed towards making any use of the timber before burning over the area. The accompanying photographs show a forest being burnt in the dry season to make room for mandioc planting for the wet season. Within a few years the land where the forest had been is impoverished from continuous cropping, eroded, or overgrown with unmanageable weeds. It is then abandoned, while more forest is burnt and the process repeated. Little wonder that much of populated eastern Brazil is bare of trees and given over to fields of matted grasses and Solanum shrubs.

Cattle are allowed to shift for themselves on "open range" over most of South America. In Brazil and elsewhere it is an annual practice to burn over their grasslands. Even on very poor soils with sparse vegetational cover it is seemingly a habit to set all afire, ostensibly to "aid" the forage, but actually more as entertainment in a region where life, though stern, is simple and unvaried. Of course, the new tender shoots that the plants must put forth after the burning, though a drain on plant vigor, are more palatable to cattle. And occasionally burning may be helpful in lush areas of undergrazing where grass may "get away from" the cattle, the animals being unable to consume the coarse lower growth or to reach the upper portions. Yet, on the whole, the practice is harmful. The little humus generally found in tropic soils is thus destroyed; the natural vegetation is thinned and weakened; the soil is opened to erosion; and tree growth is inhibited. Erosion especially becomes a threat since steep slopes are as readily burnt over as the more level areas.

Burning practices may sometimes be justified in either tropic or temperate latitudes to help control insect infestation, but otherwise the organic matter lost in burning is usually badly needed by the soil. Continuously cropped tobacco and sugar lands in Brazil benefit immeasurably from addition of waste organic matter. Here in Missouri we have all seen spring fires set in

Severe erosion of steep slopes in Minas Gerais caused by burning the forests.

woodlands not only destroy humus but hinder desirable seeding, set back trees, discourage animal life, and destroy the beneficial microflora of the soil, as well as leave an unsightly appearance. In the city few folk endeavor to return organic matter (leaves) to the soil via the compost pile. Improved land practices are possible everywhere in the Americas, and the people of the United States, through our vast system of educational facilities, should be leaders in practice as well as theory in conservation of a nation's most valuable resource—the soil.

SOME PLANTS OF DISTINCTION

The Empress Tree.—This spring St. Louis was favored with a fine showing of one of our most handsome, but unfortunately less hardy, flowering trees—*Paulownia tomentosa* (the Empress Tree). Although it resembles the Catalpa, with strikingly similar foliage and growth habit, there is no mistaking the Empress Tree when in bloom. The large, pale lavender, foxglove-like flowers are borne in stiff massive panicles, dozens of them to a panicle, and are covered with a rusty brown wool. The tree is 20–30 feet in height, and when it is successful in bringing its flower buds safely through the winter the event is not readily forgotten.

In St. Louis we are about one hundred miles north of the regular flowering range of the Empress Tree. Seven years ago two large trees on the Washington University campus put forth an unexcelled display, but not until the present year have they again weathered the rigors of winter sufficiently well to produce another good showing. The St. Louis Waterworks Park, at Chain of Rocks, contains some specimens of the Empress Tree that bloom nearly every spring, but that is because of their warm location, being planted near the smoke-stack of the pumping-station. To the south, even as short a distance as Cape Girardeau, the tree is much more common and flowers regularly. However, it will survive, year after year, to the north, even as far north as Montreal, although there it is killed back to the ground each season.

We are indebted to Professor R. E. Torrey for the following notes on a specimen that was planted many years ago in Amherst, in western Massachusetts:

> We owe the Paulownia Tree which stands on the Massachusetts State Campus to the efforts of President Clark who brought it from Japan in 1877 at the time when the Sapporo Agricultural College was established there. It has had a hard time with us, dying back to the earth in severe winters, but always recovering itself from a stump growth. Its present status is about twenty feet and it is nearly a foot through at the base. Every summer it forms clusters of brown flower buds for the coming spring but they rarely live through the winter. Yet I have seen occasional

flowers on the tree and even a few capsular fruits.

Dr. Brooks, who was with Clark in Japan, told me that the Japanese use the spongy wood of the stump sprouts for making small boxes in which to store jewels or other valuables, and that such boxes will pass through a light fire, sustaining only a surface charring.

Paulownia is one of the many exotics that might be expected to thrive more heartily in this latitude with the proper selection and care of especially hardy seedlings. It would be worth the try. (See October 1922 BULLETIN).

H. N. A.

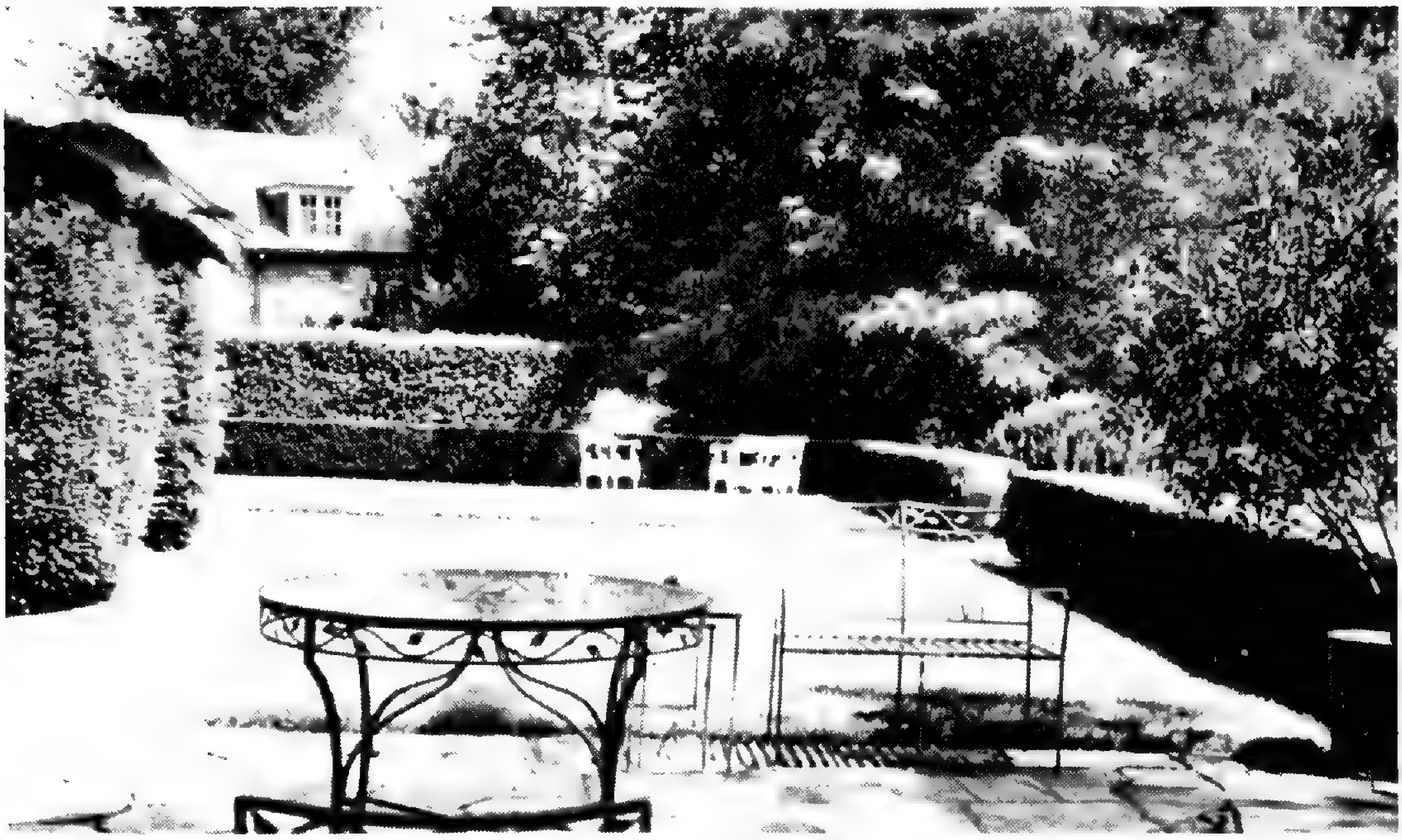
Yews in St. Louis.—Compared to the gardens and gardening of the Old World, or even the eastern portion of the United States, ours in the Midwest are just beginning to emerge from the early experimental stages. In certain respects the climate offers a greater (and sometimes more discouraging) challenge to our efforts. Some plants probably never will meet with great success, while others will yield happier results when handled in the right variety or given the proper cultural conditions. The yews seem to fall within the latter class. Four years ago a few specimens were used as foundation planting around the newly erected Trail House at the Arboretum, and these are doing somewhat better than might have been expected.

One of the finest plantings of yews that have come to our attention, a group that momentarily carries one into an English garden, are those on the Charles H. Morrill estate in Ladue. These were planted eight years ago by Mortimer Burroughs and consist of a hedge of the Hatfield Yew *(Taxus media Hatfieldi)* and three fine specimens of *Taxus cuspidata intermedia.* One could hardly ask for a more lush growth of these fine evergreens, and the plantings give a clear idea of what can be accomplished in this region.

H. N. A.

Amsonias.—Among "ironclad" perennials, the Amsonias merit particular mention, since they will grow satisfactorily in almost any position and in almost any soil and do not appear to be inflicted with any disease or insect pest. Also, they are extremely long-lived and annually increase in the number of stems, each producing from late April until early June billowy clusters of medium-sized, light blue flowers. In their longevity, dependability, and lack of attention by professional "gilders of the lilies," they might be likened to the Baptisias.

Amsonia is offered by nearly every dealer in perennials, but customarily only *A. Tabernaemontana,* a native of the middle-western United States. Numerous other species of this country, however, are superior to *A. Tabernaemontana* in various respects. Among these is *A. illustris,* pictured here, which is a native of our own Missouri Ozarks, where it grows in large shapely clumps on the yellow gravel bars of almost any river or small



Yews in the Charles Morrill garden

Amsonia illustris in the garden of John S. Lehman

stream. When transplanted to a flower garden it is found to be superior to the older species because of its more compact symmetrical growth, greater number of stems (as many as 100), its more compact, shapelier flower clusters, and, above all, for its narrow, thick, lustrous leaves which are attractive even when the plant is not in flower.

R. E. W.

THE DEDICATION OF THE BOXWOOD GARDEN AT THE ARBORETUM

The new Boxwood Garden at the Arboretum, with its enclosing serpentine brick wall modelled after the one built at the University of Virginia by Thomas Jefferson, was completed this spring. Its dedication was part of the program of the thirteenth annual convention of the Federated Garden Clubs of Missouri meeting in St. Louis. On May 9 the members were guests at the Arboretum, their third general assembly taking place in the Orchid Houses in the morning. After a luncheon at the Trail House, Dr. George T. Moore, Director of the Garden, gave the address of welcome. Dr. Edgar Anderson, Geneticist to the Garden, spoke on "The Story of the Boxwood Garden," and Mrs. Robert O. Powelson, as president of the State Federated Garden Clubs, made the speech of dedication. The session closed with a tour of the Arboretum, including the Orchid Houses, where Dr. David C. Fairburn, Orchidologist, gave a talk on "The Orchids at Gray Summit."

State Federated Garden Clubs at the Arboretum Trail House during dedication of the Boxwood Garden.

NOTES

Dr. Robert W. Schery, Research Assistant to the Garden, is teaching at the University of Wisconsin during the summer months.

Mr. G. H. Pring, Superintendent of the Garden, acted as one of the judges at the flower show of the St. Clair County Garden Club, at Belleville, Ill., June 7.

Dr. Henry N. Andrews, Assistant to the Director and Paleobotanist to the Garden, and Mr. Lee W. Lenz, graduate student at the Garden, spent two weeks collecting fossil plants in Idaho during June.

In an effort to obtain more accurate information on the subject, Dr. Edgar Anderson, Geneticist to the Garden, and his assistant, Mr. John J. Finan, have prepared a 15-page mimeographed check-list of popcorn varieties which is being sent for additions and corrections to growers, breeders, and dealers of popcorn.

The cool spring has given us an unusually fine flower display. The climbing roses bloomed well and stayed in flower an unusually long time. The purple cone flower on the glades at the Arboretum was abundant, and the blooms were unusually deep in color, probably a result of the weather.

Yucca glauca (Y. angustifolia) Pursh, the only survivor of a group of yuccas planted by Charles A. Pope in 1860, bloomed again this May. This is an event for it does not produce flowering stalks each year, as does the commonly planted *Y. filamentosa.* The stone tablet which Henry Shaw placed with the group still stands, but it is so weathered that the inscription is almost impossible to be read. (See April 1935 number of the BULLETIN.)

Recent visitors to the Garden library and herbarium include the following: Dr. T. G. Yuncker and Dr. Winona Welch, Professors of Botany, DePauw University, Greencastle, Ind.; Mr. Robert Casamajor, president of the Southern California Horticultural Institute, Pasadena; Capt. Leo Doyle, of the U. S. Army; Dr. Ruth M. Foster, Instructor in Bacteriology, University of Texas, Austin; Dr. Alexander Hollaender, of the National Institute of Health, Bethesda, Md.

During the past few months a considerable number of foreign periodicals have been received by the Library, helping to fill the many gaps of the war years in serial publications. Although the shipments of books from European dealers is still greatly delayed, air-mail connections with some countries are already remarkably efficient. At the request of T. H. Van Den Honert, Director of the Leiden Botanical Garden, several cuttings of *Cissus sicyoides* were mailed from the Garden on April 26, received in Leiden on May 2, and acknowledgment of their arrival reached here on May 7.

THE MISSOURI BOTANICAL GARDEN

SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date until his death in 1889 it was maintained under his personal direction. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was chosen by Mr. Shaw and he definitely indicated that he wished it called by that name. The Garden passed at his death into the hands of a Board of Trustees, designated in Mr. Shaw's will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provision of the will the immediate direction of the Garden is vested in a Director, appointed by the Board. The Garden receives no support from city or state but is maintained almost exclusively from the estate left by Henry Shaw. Since 1939 many Garden Clubs and interested individuals have contributed to a "Friends of the Garden Fund" which is used in developing the new Arboretum, located at Gray Summit, Mo. The Arboretum (1) serves as a source of plants, trees and shrubs for the city Garden; (2) affords areas for gradually establishing a pinetum, a wild-flower reservation and various other features on a scale not possible in the city; (3) provides greenhouses for some 20,000 orchid plants.

The city Garden comprises 75 acres, where about 12,000 species of plants are grown, both out of doors and under glass. It is open every day in the year except New Year's Day and Christmas; week days, 8:00 a. m. until sunset; Sundays, 10:00 a. m. until sunset. The greenhouses are closed every day at 5:00 p. m.

The main entrance to the Garden is at Tower Grove and Flora Place, on the Sarah car line (No. 42). The Tower Grove bus (No. 21), direct from downtown, passes within three blocks of the main entrance.

MISSOURI BOTANICAL GARDEN BULLETIN

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Volume XXXIV September, 1946 Number 7

Cover: Hallowe'en Decoration of Witch's Broom on Hackberry

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Please: Do not discard a copy of the Bulletin. If you have no further use for yours pass it along to a friend or return it to the Garden. Return postage will be guaranteed.

Missouri Botanical Garden Bulletin

Vol. XXXIV SEPTEMBER, 1946 No. 7

MATERIAL FOR WINTER BOUQUETS

BELLE PRING

Like the first direction for cooking a rabbit as given in an old cook-book, "First catch your rabbit," so the first direction for drying plant material for winter arrangements is, "First get your plants." This should not be hard now, since, with gas rationing abolished, you will be on the highways again. No matter in which direction you travel, desirable plants are abundant, sometimes too much so, for you will bring back more than you can use. In that case you might start a "friendship" collection with the same idea as our grandmother's "friendship garden," and exchange, for instance, a seed-pod from the Middle West for one from a friend's garden in Florida or for some berries from the East. That would give you a variety of material without your stirring outside the county. As a matter of fact, though, plants from the Middle West need not be scorned, and there is an abundance of them, some no farther away than our own woods, fields, and gardens. Unless you want to, the plant material need not be painted. Nature herself does a good job in giving you a variety of color. Following is a list of things that could be collected right here and after drying used very effectively in winter arrangements. When the Latin name of the genus (first word in the botanical combination) alone is given, it means that no definite species (second word in the Latin combination) has been used.

PLANTS OF THE MIDWEST FOR DRYING

COMMON NAME	BOTANICAL NAME	
	For Leaves	
Grasses		
Bluestem (for seed-pods also)	*Andropogon furcatus*	Grasses can be picked either green or dry. If dry, leaves have already taken shape; if green, dry some hanging by the roots and some upright so as to have a variety of curves.
Corn	*Zea Mays*	
Rye (for seed-pods also)	*Secale cereale*	
Seed oats (also for seed-pods)	*Uniola paniculata*	
Wheat	*Triticum vulgare*	

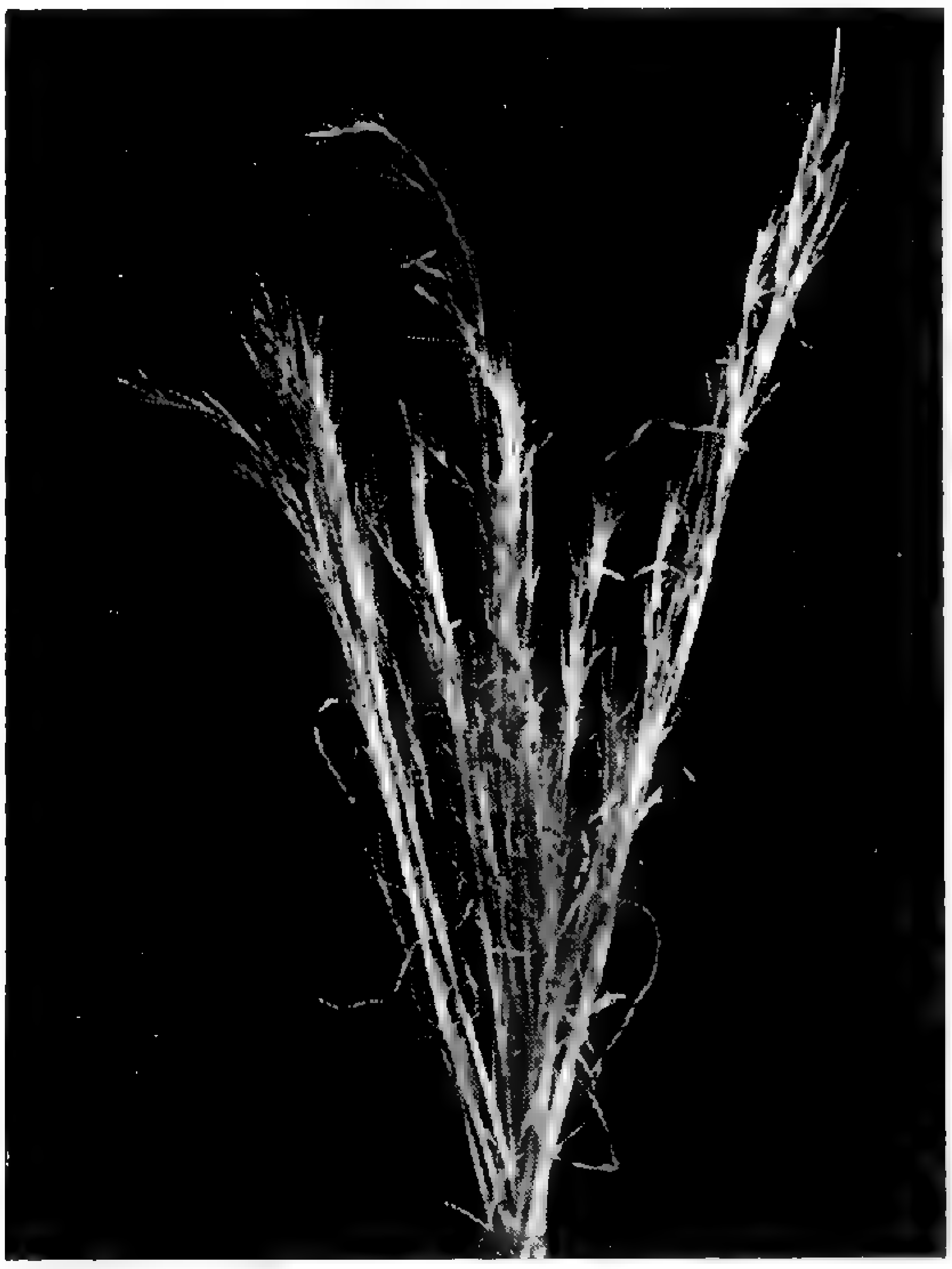
COMMON NAME	BOTANICAL NAME	
Trees and Shrubs		
Dogwood	*Cornus*	Brilliant red foliage
Maple	*Acer*	Red-gold
Oak	*Quercus*	Red-gold
Sassafras	*Sassafras albidum*	Red-gold
Sour Gum	*Nyssa sylvatica* var. *caroliniana*	Red
Sweet Gum	*Liquidambar Styraciflua*	Yellow
Spiraea	*Spiraea* "Anthony Waterer"	For seed-pods also
Sumac	*Rhus*	Scarlet
Vines and Non-Woody Plants		
American Lotus	*Nelumbo lutea*	Leaves look like huge platters and can be used as containers for an arrangement. If the leaves are soaked after they have dried, they can be shaped nicely. See also under Seed-pods.
Leather Flower	*Clematis Fremontii*	Found among rocky glades; used also for seed-pods
Virginia Creeper	*Parthenocissus*	Scarlet foliage

For Berries

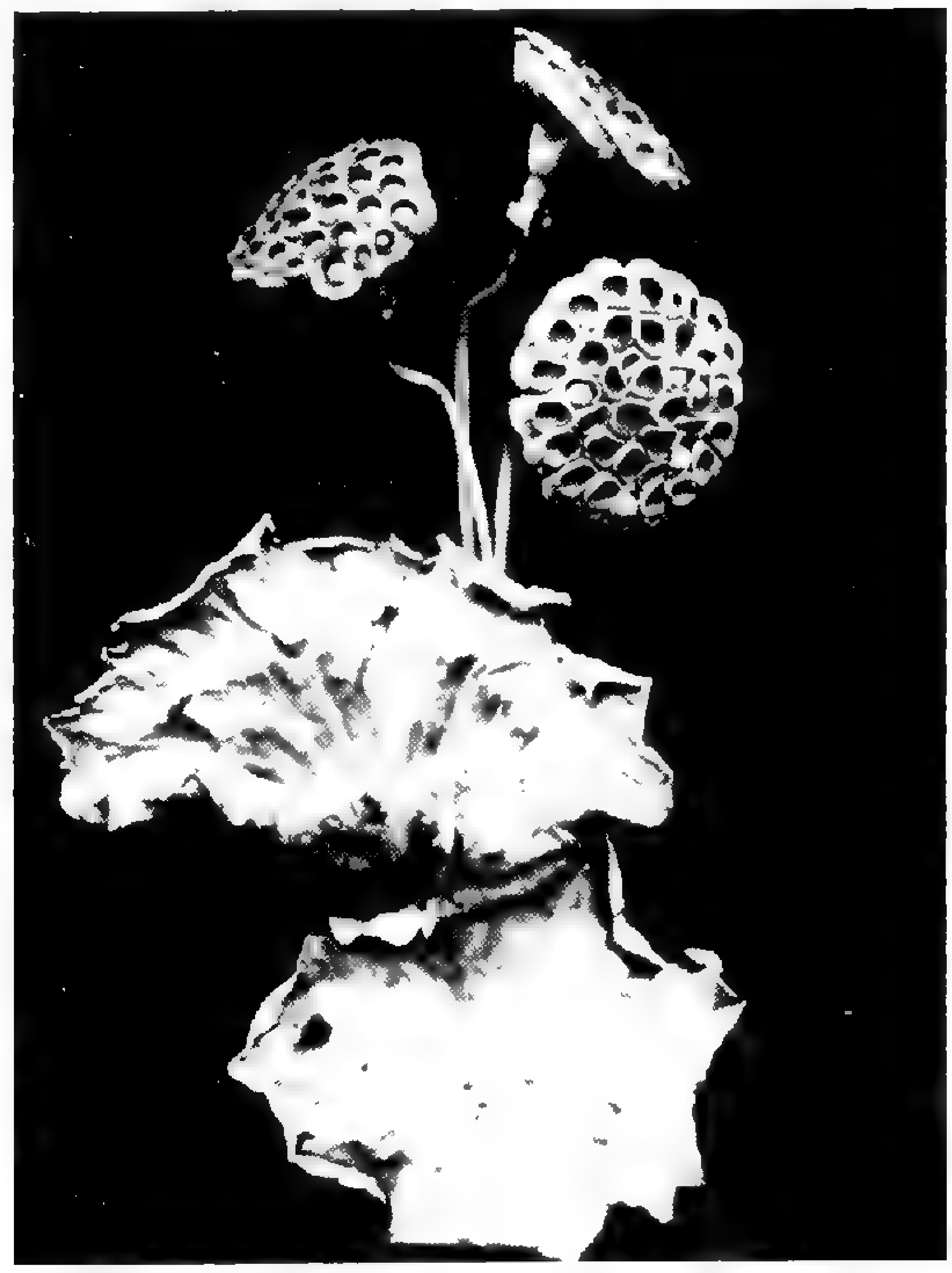
Barberry	*Berberis*	Red berries
Bittersweet	*Celastrus scandens*	Yellow-red berries
Deciduous Holly or Possum Haw	*Ilex decidua*	Bright red berries in clusters
Evergreen Holly	*Ilex opaca*	Bright red berries in clusters
Partridge Berry	*Mitchella repens*	Dries a beautiful red

For Seed-pods

Althaea	*Hibiscus syriacus*	Pods dry beautifully on plant
American Lotus	*Nelumbium lutea*	Just put the pods in your car trunk and when you take them out notice the funny shapes they have dried
Azalea or Wild Honeysuckle	*Rhododendron nudiflorum* var. *roseum*	Dark brown pods
Baptisia or False Indigo	*Baptisia*	Pea-shaped pods in spikes, drying a dark brown on the plant
Blackberry Lily	*Belamcanda chinensis*	Flowers orange-yellow mottled with purple. Pods pear-shaped; when they burst open, central column is seen to be covered with fleshy coated seeds, resembling a blackberry, hence the name.
Butterfly Weed	*Asclepias tuberosa*	Orange flower; slender finger-like pods
Cat-tails	*Typha latifolia*	Gather early and dip tails in shellac to keep them from bursting
Chinese Lantern	*Physalis Franchetii*	Cultivated in gardens. Its yellowish-red pods stay ripe for ages.
Climbing Clematis ("Strawberry Vine")	*Clematis Viorna*	Flowers used also



Bluestem or Firegrass



American Lotus

Climbing Milkweed

Hardy Plume Grass and Giant Reed or Pampas Grass

Rose of Sharon, Azalea, and Tulip Tree

Dill and Onion

Native Hydrangea and Milfoil

Acacia, Bottle-brush, and Schinus

COMMON NAME	BOTANICAL NAME	
Cone-flower	*Echinacea*	Ball-shaped green pods drying brown
Dill	*Anethum graveolens*	Lacy umbrella-shaped pods like Queen Anne's Lace
Goat's Beard or Go-to-Sleep-at-Noon	*Tragopogon pratensis*	Pods resemble those of dandelion, but about 5 inches across. If cut when fully developed and kept out of wind will last for a long time.
Honesty, Satin Flower or Moonwort	*Lunaria annua*	Common in gardens everywhere; grown for its lovely silvery white, papery, moon-shaped pods, hence the botanical name; common name "Honesty" because pods can be seen through. Collect when seed-pod has developed.
Leather Flower	*Clematis Fremontii*	
Magnolia	*Magnolia*	Red-seeded pods
Climbing Milkweed	*Gonolobus*	Empty pod shaped like a canoe
Perennial Milkweed	*Asclepias*	Pods large and in clusters
Missouri Primrose	*Oenothera missouriensis*	Ball-shaped green pods turning brown
Moth Mullein	*Verbascum Blattaria*	Seed-pods small and all on one stem; looks like a torch
Okra	*Hibiscus esculentus*	Pods assume interesting shapes when dried
Onion	*Allium Cepa*	Pods form an odd pompon
Privet	*Ligustrum*	Dark blue, clustered pods
Sedges	*Carex*	
Spanish Dagger	*Yucca filamentosa*	Open pods look like flowers. Pick in spring after seeds have dropped.
Spiraea	*Spiraea*	
Unicorn Plant	*Martynia louisiana*	Pod looks like a devil's claw when it splits open
Wild Rose	*Rosa setigera*	Bright red pips
Trees		
Alder	*Alnus*	Cone-shaped pods in clusters which stay on tree two years, resulting in two shades of brown
Birch	*Betula nigra*	Pendent little seed-pods which look like worms
Box-elder	*Acer Negundo*	Collect pods in spring; grow in hanging clusters.
Bur Oak	*Quercus macrocarpa*	Let pods of all these dry on the tree
Chestnut	*Castanea dentata*	
Cucumber Tree	*Magnolia acuminata*	
Dogwood	*Cornus*	
Elder	*Sambucus*	
Honey Locust	*Gleditsia triacanthos*	Long, flat curled pods
Kentucky Coffee Tree	*Gymnocladus dioica*	Long, flat pods; used as coffee during Civil War
Lady Cigar	*Catalpa speciosa*	
Locust or False Acacia	*Robinia Pseudo-Acacia*	Long, flat seed-pods
Redbud	*Cercis canadensis*	
Sumac (also the shrub)	*Rhus*	Some pods form heads and some are puffy balls. A good red.

Sumac and Tree of Heaven

Alder and Birch (one- and two-year-old pods on Alder)

COMMON NAME	BOTANICAL NAME	
Sweet Gum	*Liquidambar Styraciflua*	Pods in pendent balls suspended from branches
Tulip Tree	*Liriodendron tulipifera*	Pods flower-like; a few drops of nail polish or thin glue will keep them on the stem
Tree of Heaven	*Ailanthus altissima*	
Varnish Tree	*Koelreuteria paniculata*	Clusters of brown, balloon-shaped seed-pods which dry on the tree
	*For Flower-Heads**	
Cockscomb	*Celosia*	Red; dries in lovely shapes
Goldenrod	*Solidago*	Pick on first day of bloom
Heather	*Erica*	Feathery lavender flower
Heliotrope	*Heliotropium*	Purple flowers
Hydrangea	*Hydrangea arborescens*	
Milfoil or Yarrow	*Achillea Millefolium*	
Spiraea	*Spiraea*	
Sea Lavender	*Statice*	
Strawflower	*Centaurea Psilostrophe*	Nature takes care of their drying but pick before they dry
Thistle	*Cirsium*	Purple flowers

*Pick on day when color is deepest.

All through the South you will see wonderful material which you will just have to pick. Tropical trees provide interesting seed-pods which dry effectively, and some of the leaves, especially of palms, make useful "fillers" in an arrangement. Following are some of the things that we collected on one of our southern trips, many of them from gardens.

Seed-pod of Tropical Morning-glory

PLANTS OF THE SOUTH FOR DRYING

COMMON NAME	BOTANICAL NAME	
	For Seed-pods	
Cotton	*Gossypium herbaceum*	Pick when the cotton is exposed
Dutchman's Pipe	*Aristolochia*	A vine. When the seed-pod bursts open it looks like a parachute (see June 1943 BULLETIN)
Magnolia	*Magnolia*	If pod is picked when it first bursts open and dipped in clear shellac, the lovely red seed will be kept intact for a long time
Mexican Pepper	*Capsicum*	Pods keep their red color when dried and are a great asset in a decoration
Tropical Morning-glory	*Calonyction* (?)	Pod looks like a wild rose when open. Plant is an import from Hawaii but grows well in the South.
Poinciana	*Poinciana Regia*	Tree with long, bean-shaped pods which dry beautifully
Powder-puff	*Coccosperma* (?)	Tree with large round pods which burst open, exposing the cotton contained. Stays half open for months.

Seed-pod of Powder-puff plant

COMMON NAME	BOTANICAL NAME	
	For Fruit	
Love Apples (See Vol. 21, pl. 33, BULLETIN)	*Solanum aculeatissimum*	Belongs to the Nightshade Family. Native of France but now grows in the South and West. The apples are a wonderfully brilliant something for an arrangement.
	For Foliage	
Feather-leaf Palm	*Adonidia Merrillii*	Native of the Philippines but grows in Florida. Has a plumose leaf.
Fig	*Ficus pandurata*	When dried can be used as arrangement-container, or as a background-filler
Giant Reed or Pampas Grass	*Arundo Donax*	Can be cleaned with soap flakes.
Indian Fan Palm	*Latania Loddigesii*	An import but grows freely in Florida. Leaf a wierd pronged affair.
Magnolia	*Magnolia grandiflora*	Leaves dry green and gold
Sea-grape	*Coccoloba uvifera*	Tree with a large kidney-shaped leaf which dries a beautiful golden color. Can be used as a plate as well as in an arrangement.

Going West you will find worlds of stuff. If you have room in your car and are curious-minded you might pick everything in sight and see how it dries. But the following have been tried out and found to be interesting to work with.

PLANTS OF THE WEST FOR DRYING

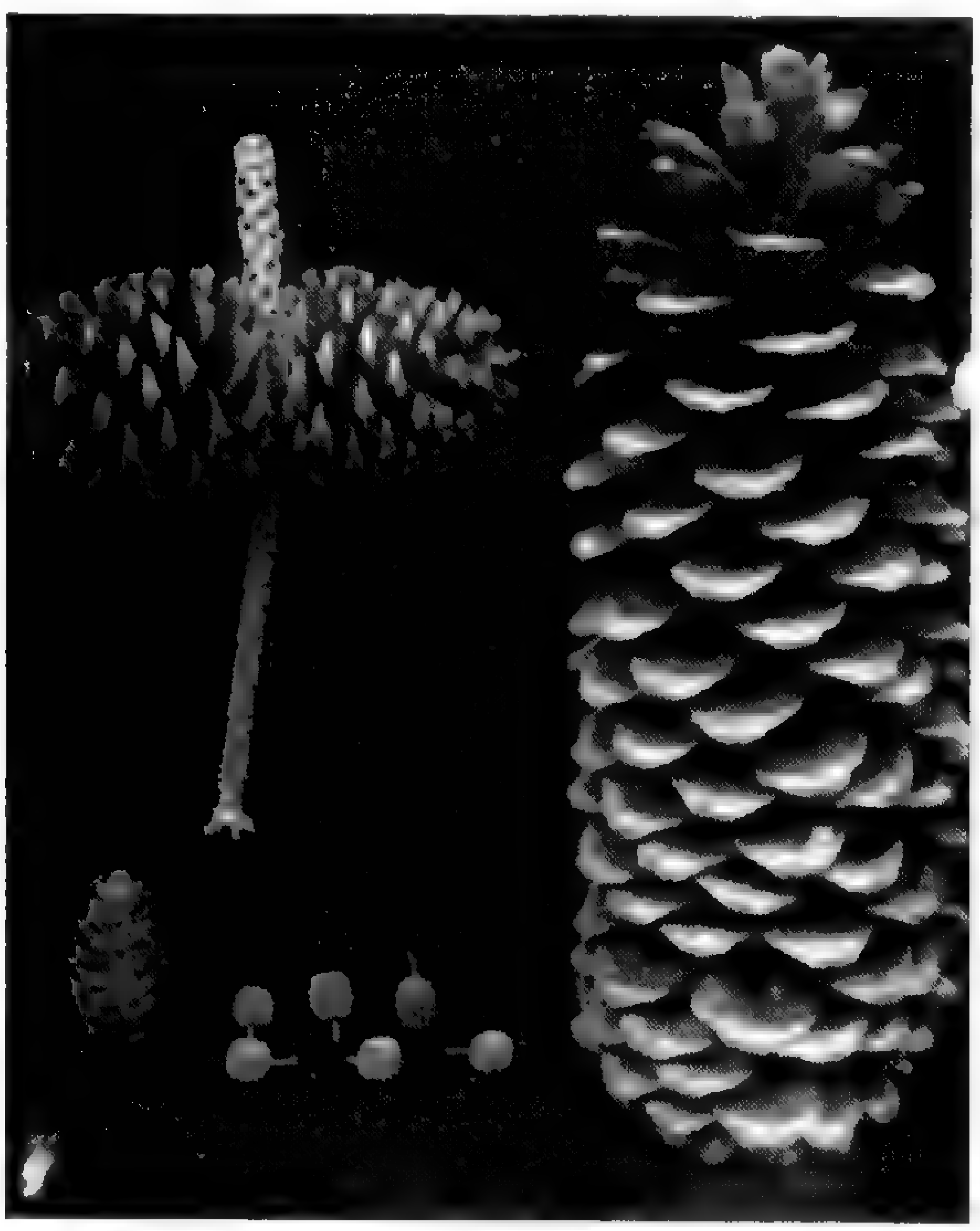
COMMON NAME	BOTANICAL NAME	
Cow's Tongue	*Opuntia linguiformis*	Dried pads of this plant are called "skeletons" and look like a superb piece of lace work. Pieces have been used for collar-and-cuff sets, and they make a nice background for an arrangement.
Desert Holly	*Atriplex hymenelytra*	Gray-white leaves
Spoon lilies from Arizona	*Dasylirion Wheeleri*	Base of leaves fastened to stem by a light cream-colored "spoon"
Chollas	*Opuntia* (cylindrical jointed types)	Slender forms may be used for cactus "lace"; heavier forms used in making furniture, hanging baskets, etc.
Holy Cross Cactus	*Opuntia ramosissima* (?)	Thin dry-looking stems with numerous small branches

COMMON NAME	BOTANICAL NAME	
	For Fruit	
Christmas Berry Cactus	*Opuntia leptocaulis*	Has tiny red fruit which lasts a long time
	Whole Plant	
Century Plant	*Agave*	Dry the rosettes
Cliff Rose	*Cowania mexicana*	All good in an arrangement
Creosote Bush	*Larrea tridentata*	
Mesquite	*Prosopis*	
Sage Brush	*Artemisia tridentata*	

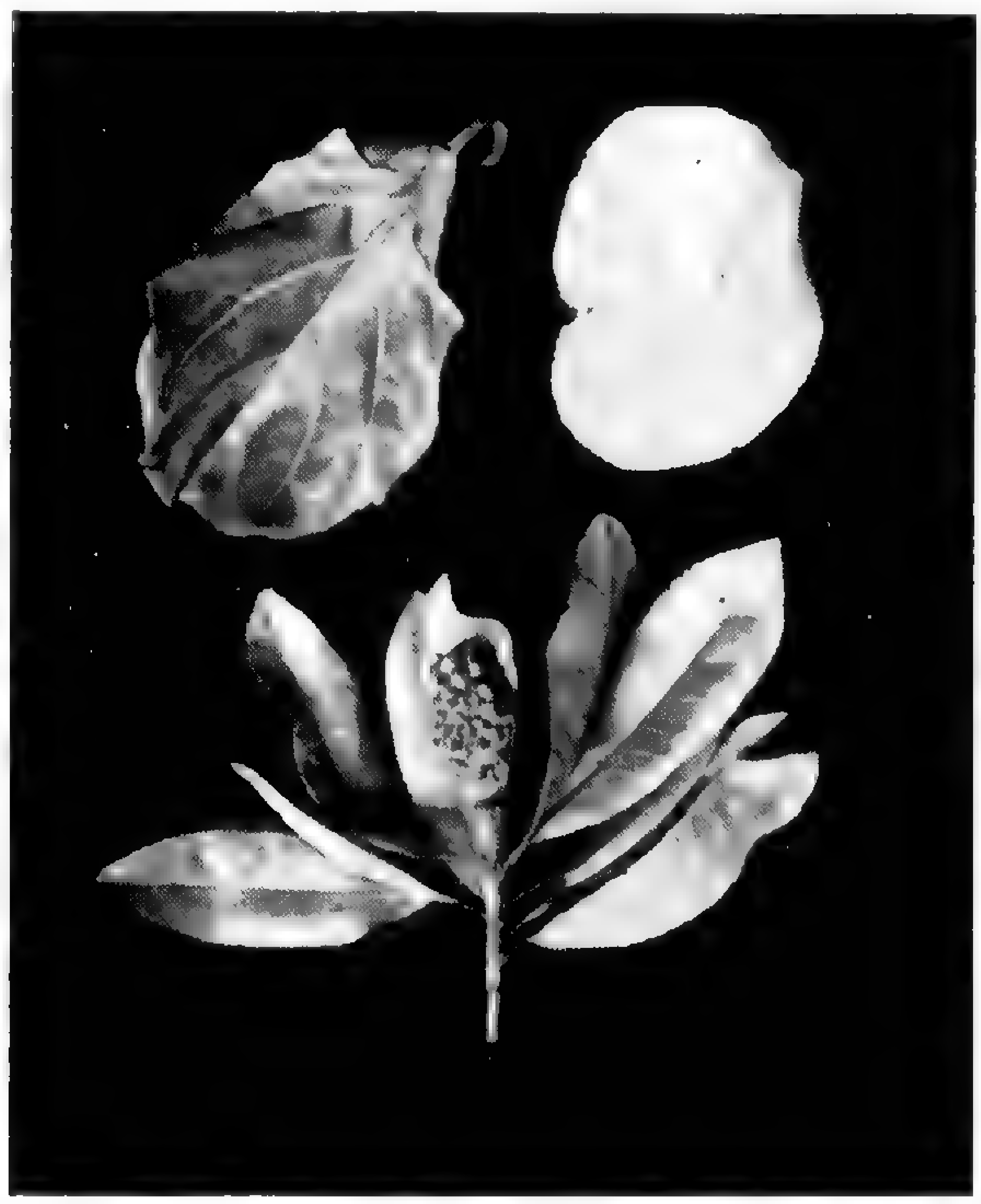
Further North you are in the land of cones. Pick them right off the trees, if you can, before they lose their fresh brown colors. From the large Sugar Pine *(Pinus Lambertiana)* cones down to those of the little Ticklepuss or Beefwood tree *(Casuarina equisetifolia)* they are a "must." When the time comes for Christmas decorating you will be so glad that you have collected all kinds and all sizes—charm strings from the larger cones for the door or mantle, and corsages from the tiny ones.

Plants from the East are not taken up in this article because most of those that we collected there are cultivated in our Midwest gardens. Bayberry, Partridge Berry and Teasel are some of the exceptions and if you have a friendship plant exchange be sure to put them near the top of the list.

Warning.—Wherever you collect, be careful of poison ivy, known by its three-pointed leaves, brilliant red in the early Fall.



Pine cones



Leaves of Ficus, Sea-grape, and Magnolia

DRYING

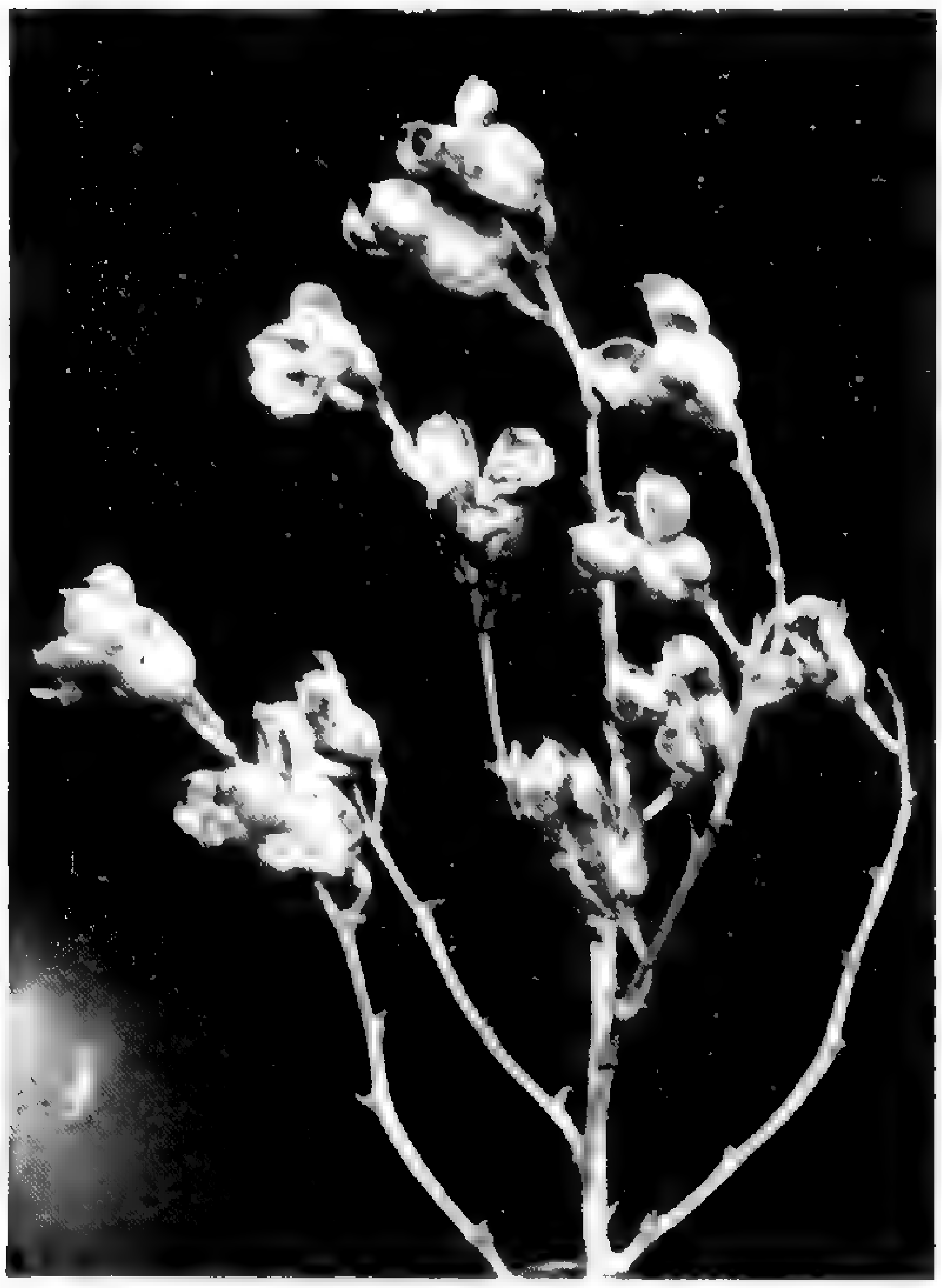
Now that you have collected the plants the next thing is how to keep them until you are ready to use them in an arangement. Nature herself takes care of drying most of your material. Pods, cones, gourds, etc., dry naturally without losing shape; in fact, you will sometimes find that they are dry enough for arranging by the time you take them out of the car if your trip has not been a short one. Most seed-pods are picked after they have dried on the plant, Azaleas, Althaea, Spanish Dagger, Alder, and Milkweed being some examples. The Lotus pods, while drying well on the plant, should be picked when fully developed but before the seeds fall out. Tie them in bundles of about a dozen stems to a bundle and hang them in a warm place to dry. After two or three days the stems may have shrunk to such an extent that the string has become too loose to hold them together. In that case tie them with wires until the drying is completed. Flower-like pods that fall apart easily, like those of the Tulip Tree, should be picked in September, and a few drops of thin glue or, better still, nail polish, applied at the base of the sepals to keep them on the stems. Shellac is good for keeping berries, such as holly berries, on their stems.

The secret of successful drying, if you can call it a secret, is to do it quickly. Leaves and non-woody material may be dried between blotters like those used in an herbarium, but if these are not available try absorbent mats, floor-pads, old newspapers, etc., to lay them on. Then place old rugs on top. Autumn leaves will keep their brilliancy better if put between dry mats. Some leaves, such as those of the Fig and the Sea-Grape, assume a crinkled shape when dried naturally. Most things are just hung up in a warm place to dry. They can be hung from the roof of the attic, garage, or basement, usually by their stems. Sometimes, though, a more graceful effect is obtained if they are dried in an upright position. All these things can be learned only by experience. Besides, what one person wants another might not care for.

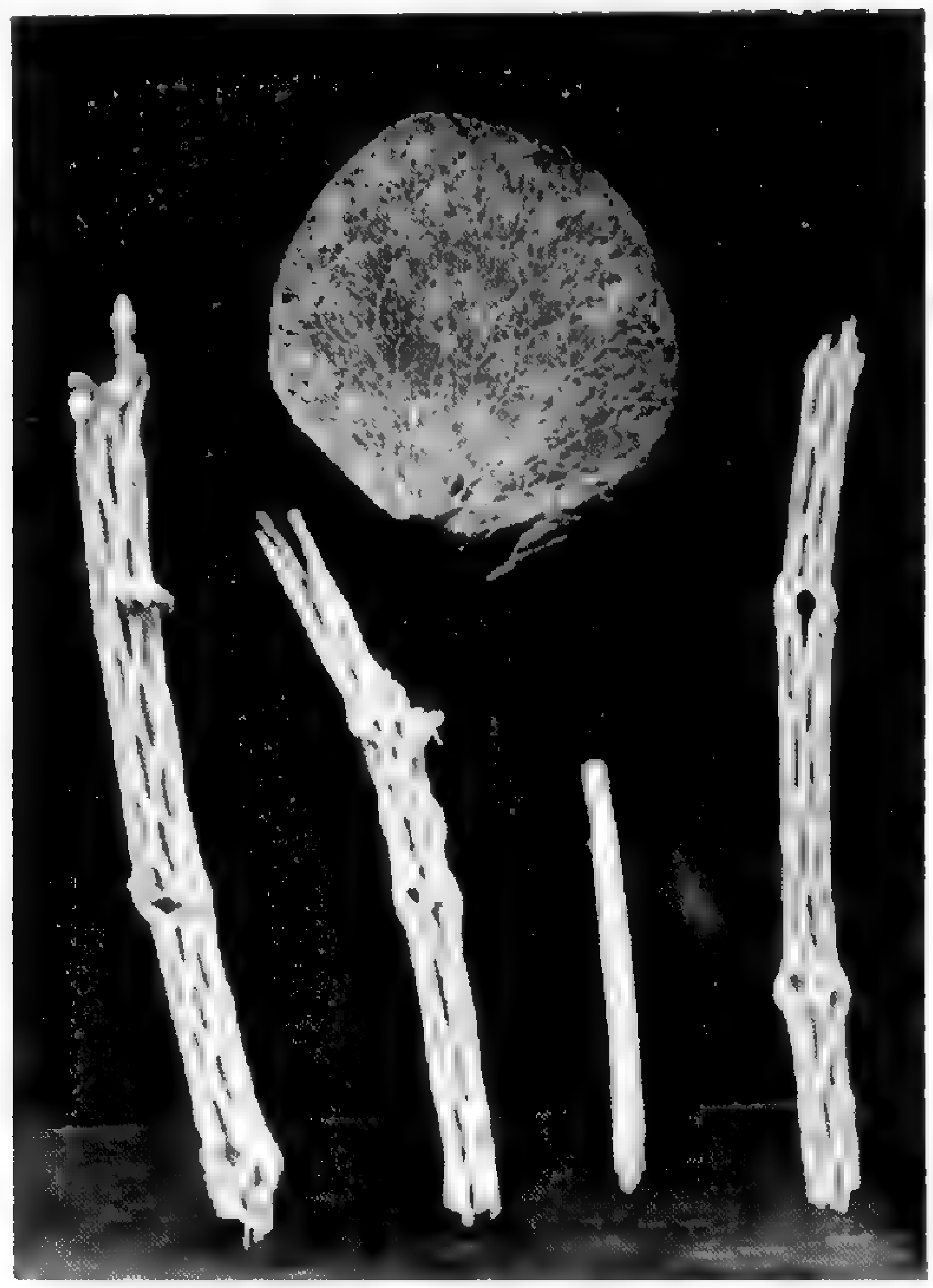
Flowers should be picked at the height of their blooming in order to retain their color. Various methods have been devised for preserving flowers in their natural shape by artificial means. Two of the most successful seem to be borax and dry sand, directions for which follow.

Borax treatment.—The directions for using borax are simple.* Put one-half inch layer of borax in the bottom of a cardboard box. Lay the flower spray on top of this layer and sprinkle the material all around it, using a spoon to get it under the flowers and even in them. Now cover the whole

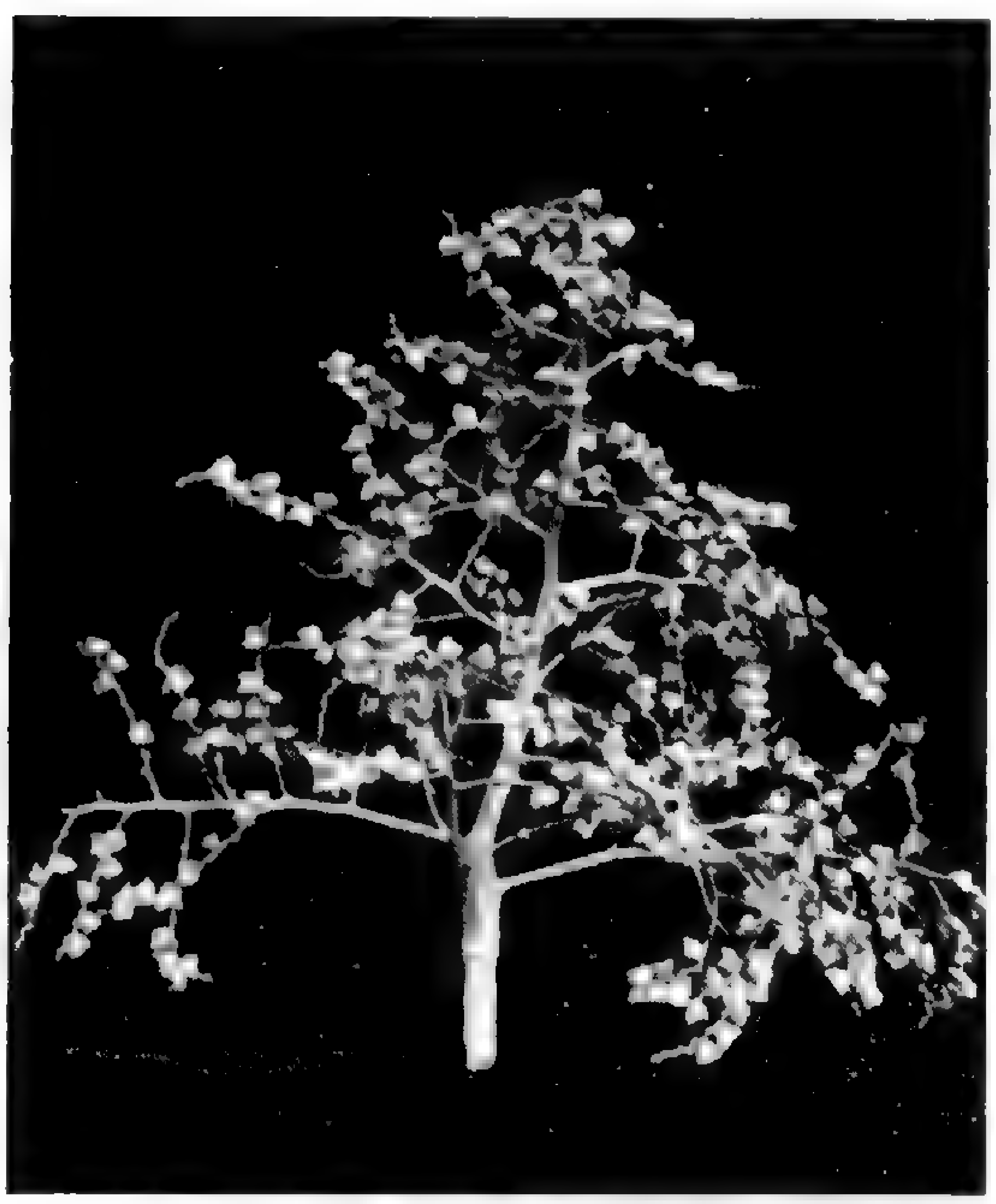
* As given by F. R. Williams in *Horticulture,* June 15, 1940.



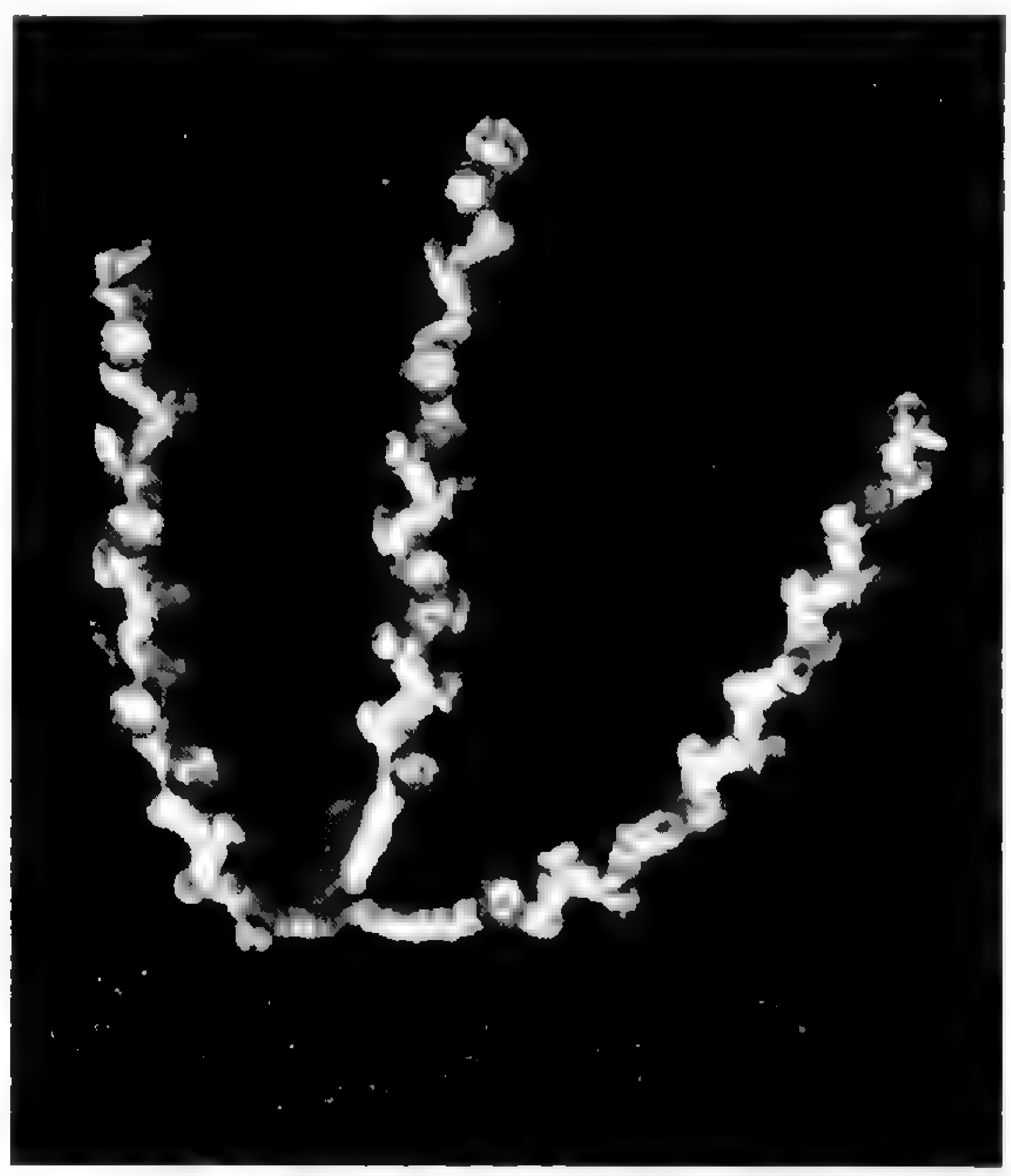
Seed-pods of Spanish Dagger



Prickly Pear and Cholla "skeletons"



Feather-leaf Palm



Indian Fan Palm

spray completely with the borax and add another layer 1/4 inch deep on top. Set the box, still uncovered, on a shelf in a room of average temperature (about 70°) and let it remain there for about three weeks. At the end of that time the flowers will be in their natural shape and their colors will be almost as vivid as when fresh.

Dry sand treatment.—The September 1933 Garden BULLETIN contained an article, "Dry Sand Treatment for Preserving Flowers," by Dr. David C. Fairburn. As this BULLETIN has been out of print for some time the directions are here reprinted:

"No special kind of sand is required, but it must be dry, clean, and not too coarse. Excellent results may be obtained with white sand sifted through a 40-mesh grading screen and heated in an oven to dry off the moisture. Various types of containers may be used, but large clay pots are well adapted for the purpose. The drainage hole in the bottom of the pot should be covered with thick paper and about two inches of sand added. Freshly cut flowers are then placed in the sand, stems downward, not too close together. The stems should be of such length that the tops of the flowers are just below the rim of the pot. It is vitally important that the flowers and foliage be dry when placed in the sand. With proper care the sand can be poured in and around the flowers until they are completely buried without injuring their natural shape. The pot should be labeled with the name of the flower and the date, then placed in a dry room where it should remain undisturbed for five or six weeks. Some flowers require a longer drying period than others.

"In removing the dried specimens gradually invert the pot and carefully pour out the sand. This is the crucial point of the story. If good judgment were used in selecting the flowers and the proper drying conditions provided, one need not hesitate to proceed with the unveiling for usually a delightful surprise follows. On the other hand, if old decrepit flowers and wet sand were used, one is doomed to bitter disappointment as the bedraggled specimens in an advanced state of decomposition are uncovered. Grains of sand which may adhere to dried flowers should be brushed off, being careful not to break the tissue which is very fragile after drying.

"Flowers and foliage preserved by the sand process will retain their color and shape for a long time if not exposed to dampness, sun, wind, or dust. The protection of a Bell jar is often necessary. In selecting flowers avoid those which drop their petals easily. Tulips, flax, poppies, and roses in full bloom are usually satisfactory subjects. Trumpet-shaped and fluted flowers are quite difficult to bury in the sand without ruining their shape, although fine results may be attained with daffodils, orchids, and possibly many others of similar type. Snapdragons, Spanish iris, and large fancy chrysanthemums are practically impossible to manipulate in the sand satisfactorily. Ruffled or crinkled flowers also require special care, since these attractive features are likely to become sadly distorted. Small flowers, such as daisies, lend themselves to the sand treatment far better than large, limber-petaled types such as German iris.

"The color of the flower has much to do with the success of the drying process. Certain colors fade miserably in the sand, while others change but slightly. However, all colors lose some of their original intensity during the drying treatment, and therefore one cannot expect a brilliant showing from delicately tinted flowers. Purple often degenerates into a dull characterless shade. Deep red, pink, blue, orange, yellow, and pure white offer the best possibilities.

"A few of the flowers which respond well to drying are: cosmos, gaillardias, water-lilies, zinnias, corn-flowers, yarrows, cockscombs, narcissus, daisies, small single and double chrysanthemums, orchids, marigolds, carnations, and rosebuds when the petals are just starting to unfold . . . . Iris, poppies, tulips, day-lilies, and portulacas are total failures in the sand. Both of these groups can be greatly amplified . . . ."

ARRANGEMENT

The arrangement of the dried plants is a subject in itself and one that takes much study and skill. This article has to do only with the picking and the drying, but if you are ambitious to continue to the third stage there are numerous good books on the subject. However, there are some arrangements that even the amateur can do. The redwood burl, for instance, makes an odd arrangement without any fixing. The burl, which is part of the swelling of the redwood bark, is simply placed on pebbles in a bowl and a few inches of water poured around it. If kept in a warm place white shoots will sprout forth in a few weeks (see September 1923 BULLETIN). Another arrangement which can be made easily and used for Hallowe'en decoration is with the witch's broom on the hackberry (see cover illustration). The

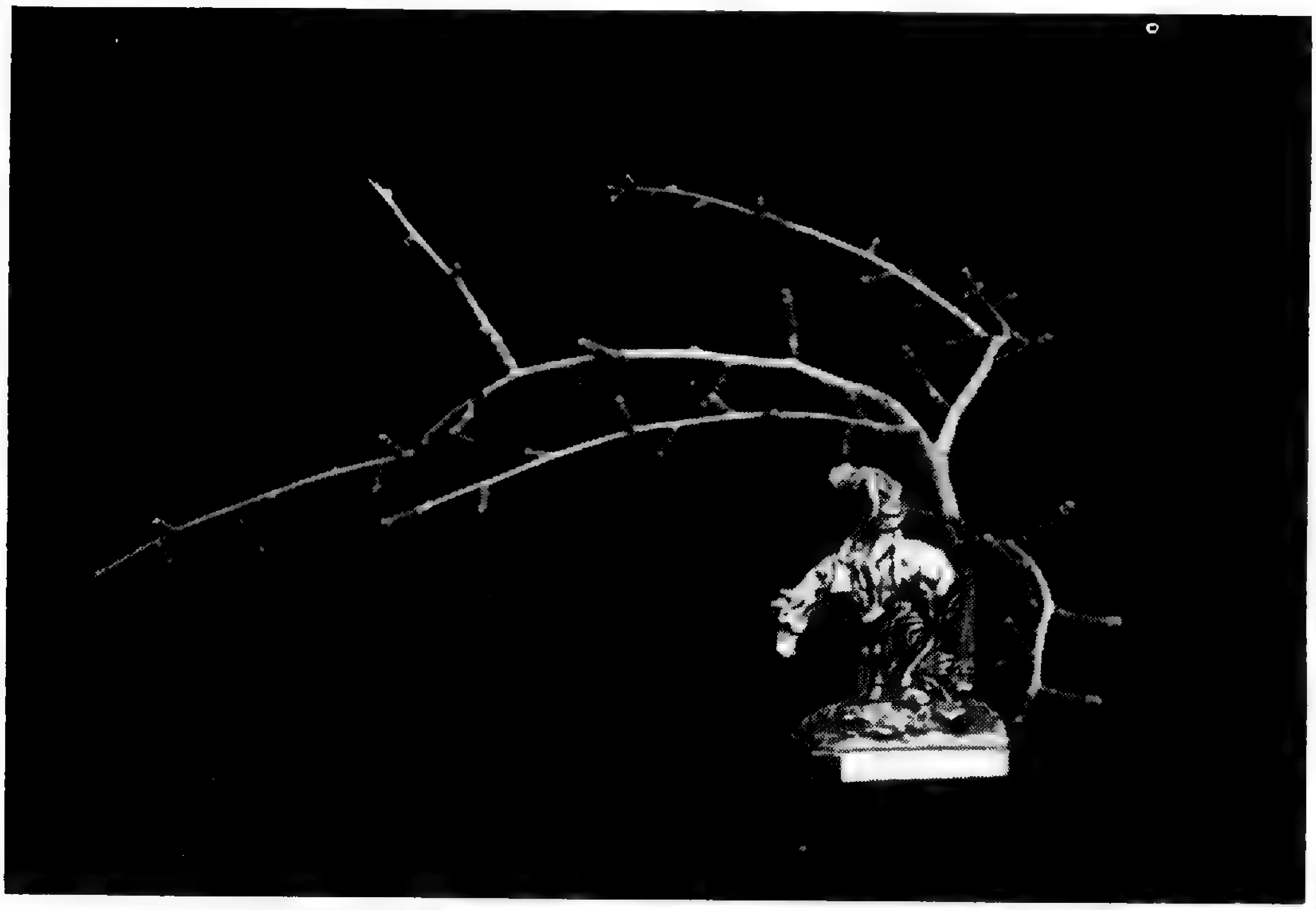
Friendship arrangement of Parachute Flower, Fan Palm, Spanish Moss (container a Cypress Knee)

Friendship arrangement of Feather-leaf Palm, Milfoil, Powder-puff, Soft Maple base.

bunches of spines constituting the broom are really a fungus growth on the tree. It was once believed that trees having this growth had been visited by witches at night, hence the name.

Gourds.—Numerous kinds of gourds can be grown in your garden and when dried make effective decorations. The February 1937 number of the Garden BULLETIN contains an article by Mr. Paul A. Kohl on "Ornamental Gourds" from which the following directions are taken:

Such types as the Acorn and Turk's Turbans should be gathered before



Branch of Maidenhair Tree

frost, but freezing hastens the drying process of the hard-shelled varieties and the dish-cloth gourd. After the gourds are brought indoors they should be wiped with a dry cloth and then hung up or placed in baskets not more than one layer deep. When they are entirely dry the seeds will rattle. If they are to be decorated or painted they should be scrubbed with a brush and dried, and if the surface is still somewhat rough it should be rubbed with pumice or steel wool, but not sandpaper as that scratches. Quick-drying enamels in solid colors should be applied before the designs are painted on. Gourds with clear surfaces may have interesting patterns drawn on them with a pencil and then the design burned in with an electric needle or stylus from one of the popular wood-burning sets. After the pattern has been burned the gourd may be washed or shellacked.

When gourds are to be hung on the walls, individually or in patio strings, they should not be tied by the stem as this frequently breaks off; instead insert a thin wire through the neck of the gourd by which to suspend it. To do this, hold a hat pin, or any large pin, with a pair of pliers over a gas flame and when the pin is red hot slowly push it through the gourd. The patio strings are made by tying the different-sized gourds to a central strand. A larger gourd is usually placed at the end, but this is a matter of taste. Seed-pods of such plants as Milkweed, Baptisia, Lotus, or Pepper, strung along the central strand, greatly improve the appearance of the patio string. For contrast, these should be left natural. The Indians and Mexicans frequently use small clay ornaments and feathers with the gourds. The gourds may be displayed in metal or wooden bowls, under Bell jars, on flat trays or mirrors. They may be waxed with floor wax or automobile wax, then polished.

The above are just suggestions which we hope will inspire you to go ahead and see what you can do. Invent your own methods. Try anything. Your results might surprise you.

GOOD LAWN MANAGEMENT

PAUL A. KOHL

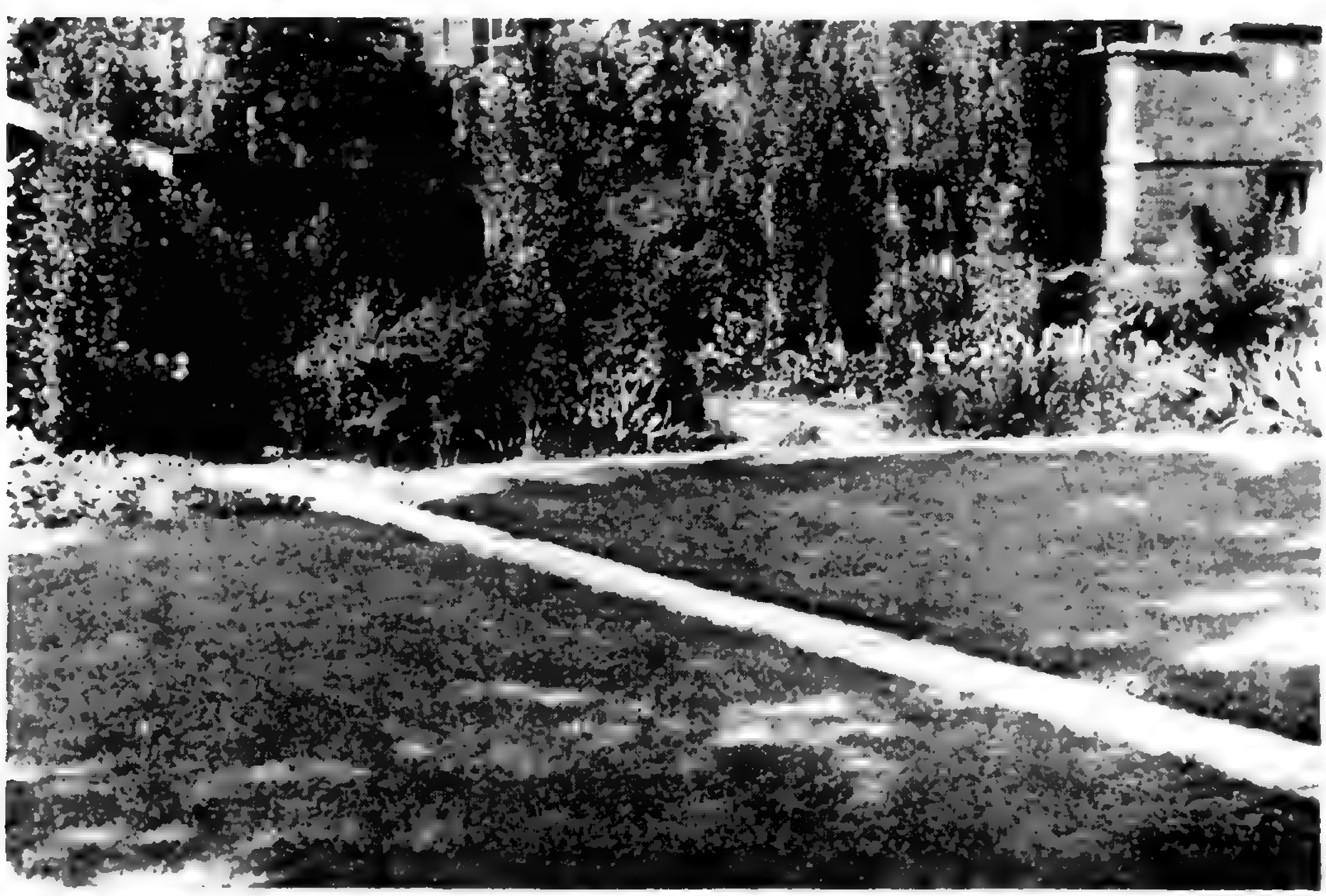
September is the best month of the year to establish or improve the lawn. To the majority of home owners this sounds contradictory, for April and May seem to be the accepted months to "work" the lawn. And how true! The surest sign that spring has arrived is to see the lawns getting their annual raking, seeding, and rolling, but these spring-sown lawns never develop into a bluegrass turf which remains green most of the year. Crab grass always takes over from mid-June until the first frost, and then it turns brown. If the pattern of lawn-making which is so firmly fixed in the minds of the people could be transferred from spring to fall, and if "fertilizing" were substituted for "rolling," lawns would remain green longer than just through the three summer months. Apparently very little thought is ever given to feeding the grass. Much money is spent for seed, tools, rollers, and fancy lawn sprinklers, but fertilizers are seldom purchased. Occasionally itinerant peddlers are able to sell their "fertilizer" to the unsuspecting householder with a little sales talk, and particularly if the material is black, which seems to be the criterion of richness. Such humus, top soil, fertilizer, or whatever it is called, usually does more harm than good and should be avoided. A bag of commercial fertilizer will be much more effective.

It is possible to change a crab grass lawn into one containing mostly blue grass if a definite and persistent program is followed each year. The process must be gradual and cannot be accomplished in one or even three years, but if a regular program is rigidly adhered to each year, the lawn will show marked improvement.

Here is the program:

1. From late August through September, and in early October if the work cannot be done sooner, cut the crab grass as close to the ground as possible by setting the lawn-mower bedknife at its lowest point. Many seed stalks will lie flat and will not be cut with the first mowing. Raise them with the rake and cut the grass a second time, and even a third time if

1943—Very poor grass



1946—Good thick turf

necessary. By all means use a grass catcher on the mower in order to remove as much seed as possible.

2. Rough the remaining grass with a strong-toothed rake and remove all of the wool-like accumulation of dead grass. Most of the new grass seed will then come in contact with the soil, but some will lodge in the stubble and be lost. This cannot be avoided the first year when the crab grass is so thick.

3. Spread a commercial fertilizer, using about 20 pounds to 1,000 square feet of lawn surface. Apply it only when the grass is dry and water it in immediately with the hose to prevent burning of any of the good turf grasses. An interval of thirty minutes between fertilizing and flushing with water would be a safe rule to follow. A fertilizer spreader is very useful for covering large lawn areas and may also be used for seeding and top-dressing. Commercial fertilizers having an analysis of 4-12-4, 5-10-5, 10-6-4, or any similar combination, may be used.

4. A day or two later sow a good grass seed mixture at the rate of 5 pounds to 1,000 square feet. This quantity is for new lawns or those consisting mainly of crab grass. Established lawns need only half of this amount of seed for the same area. If white clover is desired in the lawn, the seed should be sown separately, using from ¼ to ½ pound to 1,000 square feet. Grass seed mixtures give better results than a single kind of grass. Use only the best-quality seed. Poorly cleaned cheap seed will never produce a good lawn. Heavily shaded areas should be sown with a shady-lawn mixture. The major seeding of the lawn is done only once a year, and in the fall instead of spring. Only bare spots which may have developed during the winter are re-seeded in February or March. Sow the seed by hand when there is very little wind. If this is not possible, hold the hand close to the ground to control the flow of seed. Mark a strip six feet wide with a line or some long poles in order to insure uniform distribution of the seed. When one six-foot swath has been sown mark off a second area, and so on. Better still, sow one-half of the seed in one direction and the second half in the opposite direction. Grass seed will germinate in about two weeks. A gentle rain after seeding is the best start a newly sown lawn could have, but this does not always occur. Spray the lawn with a fine mist after seeding to wash off any seeds adhering to the old grass. If the ground is dry spray daily, but if it is moist and the days are cool only an occasional spraying will be needed. Each year a different set of atmospheric conditions prevail and the lawn-maker must adjust his methods accordingly, but, on the whole, any grass seed sown in early September will be growing well by the end of the month. Even if seeding has to be delayed until October it is better

done then than to wait until the following March. During October many leaves will fall, and if they become wet they will mat and smother the young grass. These leaves must be gathered once a week to give the new lawn the best growing conditions. A fan-shaped, metal broom-rake is the best tool for this purpose. An iron-toothed rake tears out the young plants.

6. If the grass grows tall it should be cut before it mats. Set the lawn mower bedknife to 1½ to 2 inches and be sure that it is sharp to avoid pulling out the young grass. A dull mower will spoil the appearance of the best lawn. A well-fed lawn of good grass, cut to a height of two inches and kept free of leaves, is ready for the winter season.

7. In February the lawn becomes green, and this is very noticeable after the first hard rain washes away all the dirt left by the melting snows. Any bare spots should be seeded and the grass lightly fed in spring, but not later than the middle of April. Early feeding stimulates the good grasses and helps them build a solid turf. Late feeding in May only benefits the annual weeds, particularly crab grass.

8. A good lawn must receive its first cutting in March, and during spring the grass must be cut once or even twice a week to keep it in the best condition. Never cut the grass short. A lawn kept at a height of two inches will stand the dry weather better. Cutting the lawn yourself is a chore and to have it done costs money, which probably explains why lawns are cut so short. The closer the lawn is cut the longer the interval between mowings, and that is an advantage from the mowing standpoint but not for the grass. Cut the lawn short and it will revert to crab grass; or, give the grass good care and in a few years secure a fine turf, which will only need renovating once a year in the matter of seeding and feeding. Take your choice.

9. There is a difference of opinion whether grass clippings should be left on the lawn or whether a grass catcher should be attached to the mower. On a small area about the average city home it is better to use the grass catcher. Theoretically, if the grass is cut often the clippings soon dry up and form a fine protective mulch for the grass roots. The spring season is usually the rainy period and grass grows very rapidly when the weather is cool and moist. If all of this grass is left on the lawn it will mat and rot and injure the grass roots. Later in the season, when growth is retarded by heat and dry weather, there is no objection to letting the clippings act as a mulch. Too many grass clippings will, however, interfere with the germination of the seed when it is sown in the fall.

10. July and August are the most difficult months for the lawn. Drouth periods of varying length occur almost every summer, and it is then that blue grass becomes dormant. It is not dead, as might be supposed, but re-

covers within a week after a beneficial rain. Late June and all of July is usually the driest time of the year. To discourage crab grass as much as possible it is better to delay watering the lawn for several weeks. If the drouth lasts more than a month give the lawn a thorough soaking at least six inches deep. Any type of sprinkler may be used but it must distribute the water evenly over the entire surface. Move the sprinkler every hour or two until the entire lawn is watered. Test the soil with a thin rod, and if it has been thoroughly moistened the rod will go down with little effort. A good watering once a week in the driest weather will be sufficient. To water a terrace lay a canvas soaker at the top and leave it in one position two or three hours.

If these notes on lawn management are followed, a reasonably good lawn may be expected. Much effort is put into the lawn each year, but there is little to show for it. The reason for this is poor timing and little or no food for the grass. Try fall seeding and fertilizing and compare the results with the spring-made lawn.

IS THERE PALATABLE WATER IN THE BARREL CACTUS?

LADISLAUS CUTAK

The "stored water" of the Barrel Cactus has been a subject of lively interest for many years. Certain writers have garnished their stories on this topic to such an extent that doubt has crept into the credibility of their tales. This also holds true for those who minimize the thirst-allaying qualities of the Barrel Cactus pulp. This humble writer has always taken a somewhat neutral stand in the matter. He does not believe that the "stored water" is clear, sweet-tasting, and an elixir-of-the-gods; nor that it flows in copious quantity when the plant is dug or cut into. However, he does believe that in case of dire necessity it can be utilized for drinking. The "stored water" should be regarded as a plant juice and taken in moderation, and while it naturally will not be the best in the world, it will prove far superior to anything to be found in the desert.

For several years this writer has been vitally interested in the plant fluid contained in the pulp of Barrel Cacti. He has garnered much valuable and often amusing information, both pro and con, about the watery contents of the Bisnagas, as the Barrel Cacti are often called in the Southwest. The reader may already be familiar with an earlier story on this controversial subject which appeared in the October 1943 BULLETIN, but the additional light that has been shed on the merits of Bisnagas since then seems worthy to record here.

One of the first questions that would-be doubters are likely to ask is, "Why did many of the old-timers on the desert, and an occasional new-timer, die of thirst if they could get water from the Bisnaga?" The only logical answer is that the victims were ignorant of the juice that existed in these watery cactus cylinders, or that there were no Bisnagas in the immediate vicinity. Another question to be expected is, "Are there any instances known whereby lives have been saved by utilizing Bisnaga fluid?" Emphatically "Yes!" One outstanding instance will be mentioned here and, without a doubt, many others could be found if a diligent effort was made towards that end.

Two years ago a young Marine flyer from the El Centro (California) air base parachuted to the ground in the vicinity of Yuma, Arizona, when his plane caught fire. For five days he roamed the hot dusty desert while searchers on foot, in jeeps, and overhead in planes were seeking him. Finally a cruising plane spotted him and relayed word by radio to veteran ground trackers who eventually rescued him. The young airman, after experimenting with various cacti, had broken small Bisnagas with stones for their juicy pulp, which he drank and used to bathe his feet. Since he had no previous knowledge that cactus juice could be used to quench thirst, he should be congratulated on his ingenuity in trying various kinds until he found the one that would serve the purpose. The writer contacted the pilot shortly after his desert encounter and received a very enlightening letter from him. It has every evidence of sincerity and therefore it is published verbatim:

United States Marine Corps
July 31, 1944

Dear Mr. Cutak:

In reference to your letter, I find it no bother, rather an honor, to answer your inquiries. I only hope that some one may profit from my experience.

To begin with, I wouldn't be here today if it weren't for the Barrel Cactus. There's no doubt in my mind that, without it, I could not have survived. I found it a good source of thirst-quenching water. At first, I tried to extract juice from a large cactus, some 30 feet high. However, after obtaining its juice I found it very nauseating. After experimenting for a few hours with the various types of desert cacti, I came across the Barrel type. I had no knife or tools whatsoever in my possession. The only article I had was an army ration can that must have been thrown away months before. With this, I gouged large chunks out of the living cactus, and proceeded to chew the water content out of it. After doing this for a short while, I found my thirst had disappeared entirely. As to the taste of it, I found it pleasing at first, but after a few days it became monotonous. The only nausea I encountered came on the second day when I tried to chew a rotted cactus. I found the Barrel Cactus few and far between, so naturally I ate every one I found. I noticed that they grew among large rocks, and the ones found there were especially full of liquid. I managed to open them with the aid of sharp stones; however, I didn't find the thorns a bother at all. I stored large pieces in my flight suit in case of further need. As I walked across the sand, I constantly kept a piece in my mouth for moisture, and also I continually swabbed myself with the discarded pieces. I rubbed these chunks over my body in order to keep cool with their moisture. This I found very comforting in the desert heat. I hadn't any knowledge beforehand that the Barrel

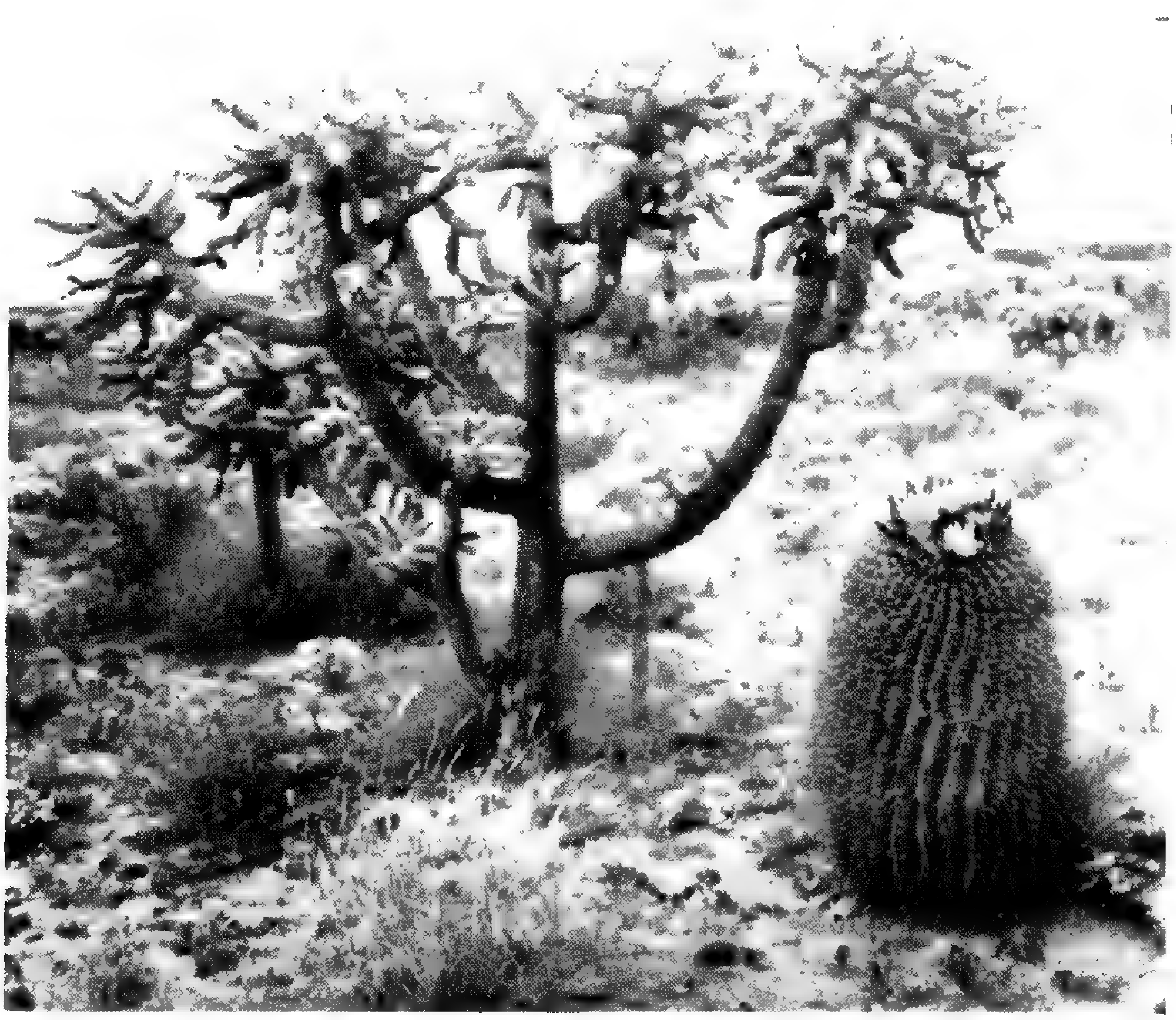
Cactus could sustain life on the desert. I suppose I was lucky to stumble across this find. Upon being found, I had a few chunks of Cactus in my possession; however, the Sheriff, Mr. Newman, took these as souvenirs. I had found them days before, and yet on the day I was rescued they were still full of water. If one is able to carry these along, they serve nicely as a canteen, and a cooling aid. I hope this will help you to convince the "doubters" on the merits of the Barrel Cactus. I OWE MY LIFE TO IT!

Sincerely,
Edwin Wladislaus Zolnier
1st Lieut. U.S.M.C.R.

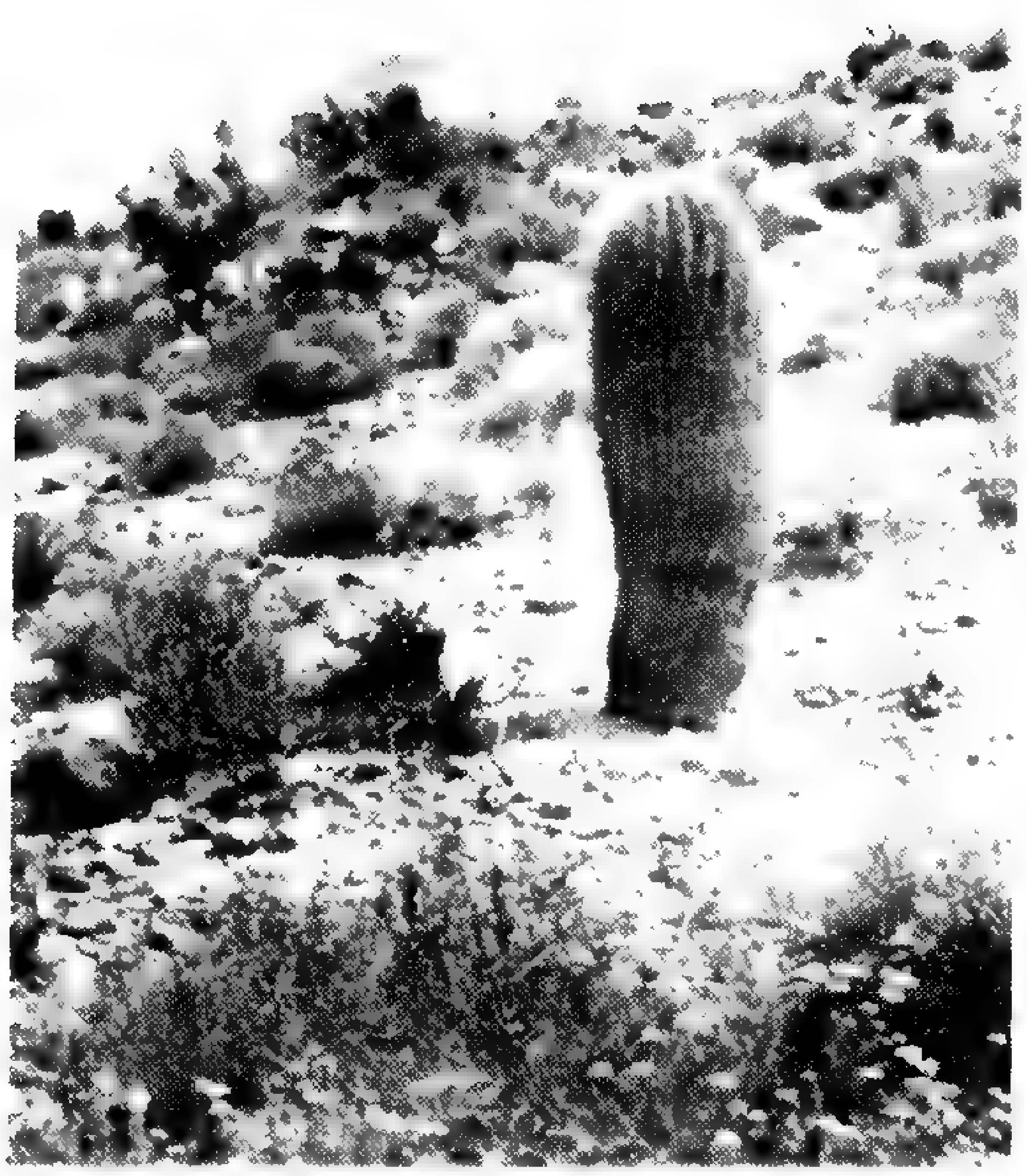
The large cactus from which Lt. Zolnier tried to extract juice at the start was *Carnegiea gigantea,* commonly referred to as the Saguaro or Giant Cactus. The juice of it is simply impossible, having a mucilaginous consistency and a definitely unpleasant flavor. It is dubious whether it could be used for drinking even to stave off death through thirst.

The writer knows another man who made good use of the Barrel Cactus some ten years ago when stranded in the Grand Canyon. There is no doubt but what other people have done the same thing on other occasions. Without any trouble a number of instances could be enumerated where reliable men have tested the Barrel Cactus for its juice although all were not experiencing dire straits. Mr. Edwin D. McKee, well-known geologist of the Southwest, was stranded on a bench known as the Tonto Platform, part way down the Grand Canyon. He was without food or water from noon of the first day until he reached the Canyon rim the following evening. In trying to find a route up to the top, he spent many hours in a hot summer sun and was nearly exhausted from thirst when he came upon a large Barrel Cactus. Having heard various stories of its value in supplying water, he immediately hacked off the top with his geology pick and pushed down the white pulp with the pick handle; however, he was unable to obtain any pool of water. McKee soon found that the pulp could be chewed and sucked, giving a very refreshing, though not exactly tasty, fluid. He sucked quite a lot of this pulp and was so refreshed that he was able to continue his trip with renewed vigor and reached the top a few hours later. It was a most exhausting trip as illustrated by the fact that he was on a liquid diet for nearly a week afterwards. Since then he has felt especially indebted to the contribution of the cactus at a critical point.

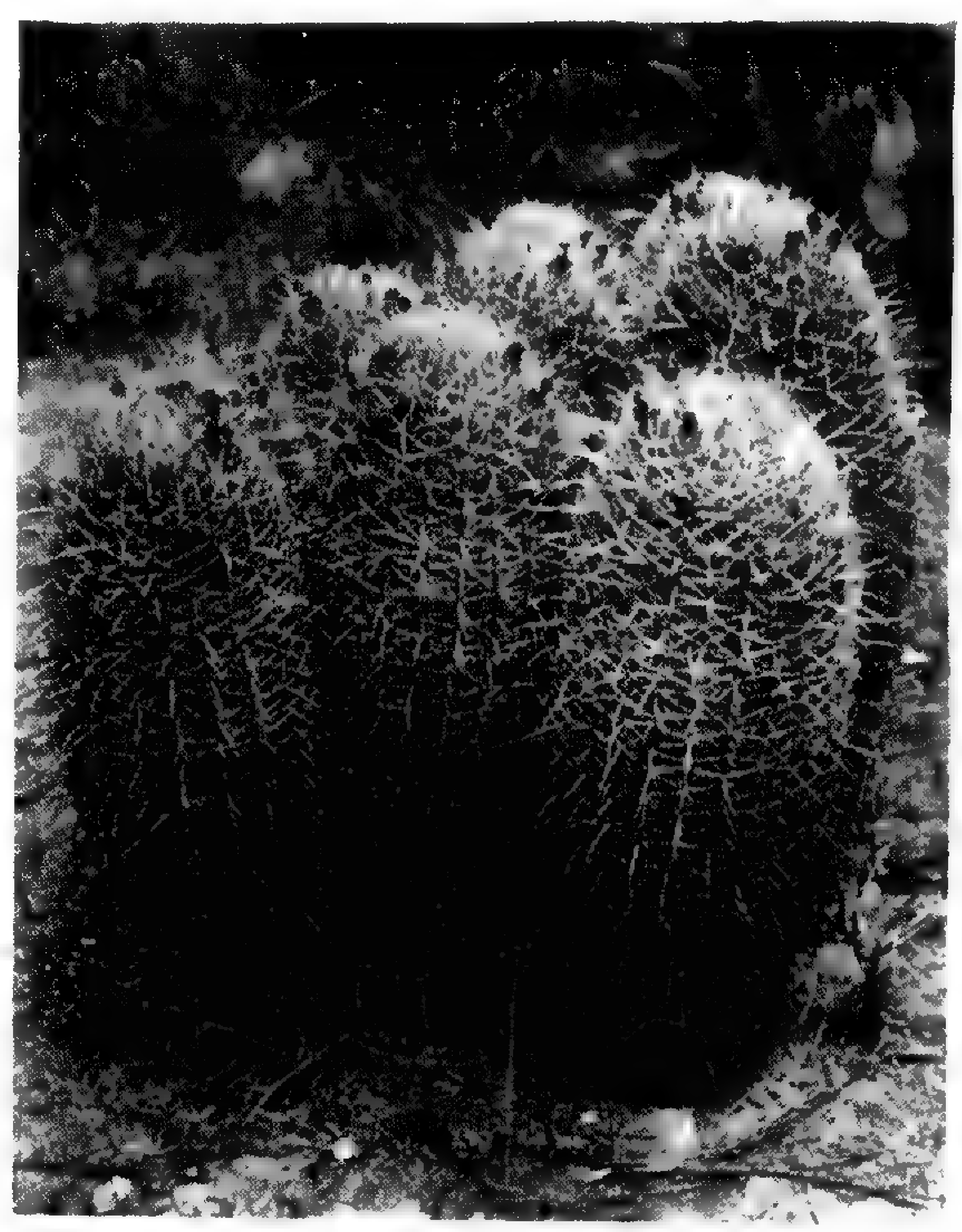
That the cactus fluid has refreshed thirsty travelers on the desert cannot be doubted. Every one who had recourse to use it, whether out of necessity or just for the sake of experience, attests to this fact. Even those who frown upon the good qualities of the cactus juice will admit, when pressed for an unbiased answer, that it has proven refreshing or that it might satisfy a parched throat. Back in the summer of 1936 Gilbert Tegelberg, well-known cactus nurseryman of Inglewood, California, undertook a trip with



Ferocactus Wislizenii in its native habitat
(*Opuntia fulgida* in background)



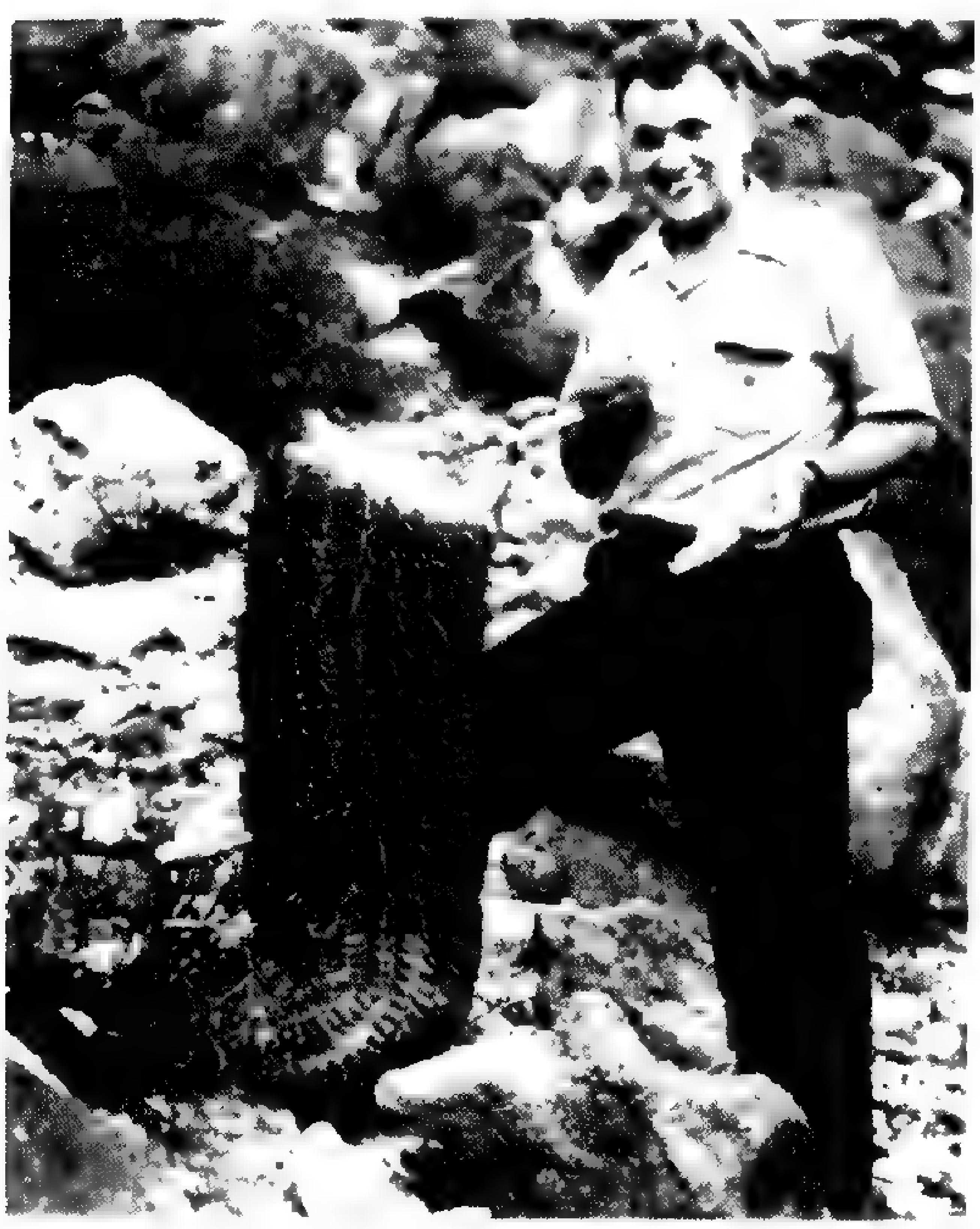
Ferocactus acanthodes



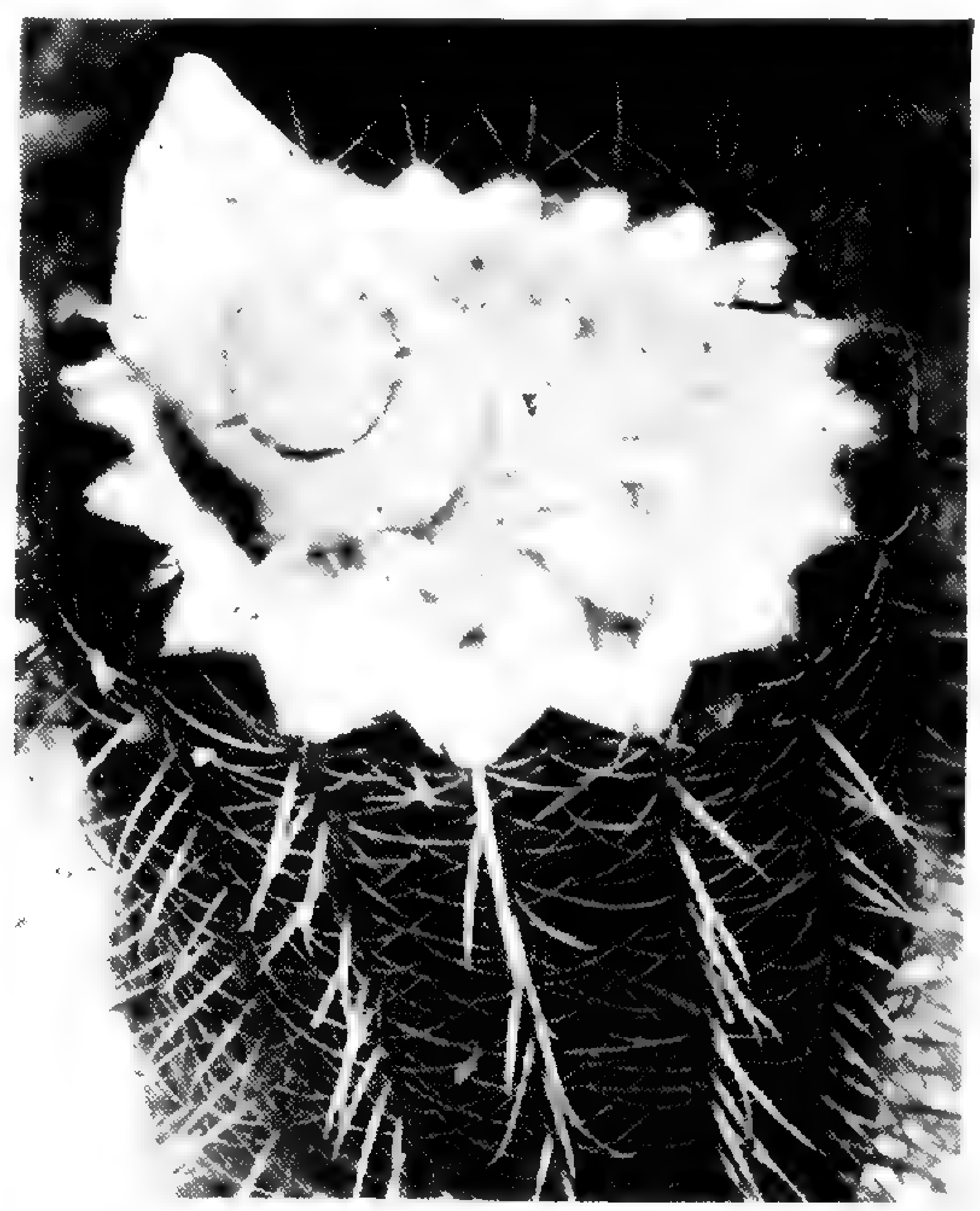
Cluster of nine heads of *Ferocactus Lecontei* a friend to the Clark Mountains near the Nevada line. The day was infernally hot, and by the time afternoon rolled around the two men had used up all of their water. Tegelberg's truck being a good distance away, they decided to make a test of *Ferocactus acanthodes* which grew in the vicinity. With a jack-knife and a small pinch bar they were able to get at the pulpy contents of this California Bisnaga. The spine clusters around the top half of the plant (a specimen about 2 feet high and 16 inches in diameter) were cut away with the knife and then the top portion removed without too great an effort. By using the pinch bar, good-sized pieces or hunks of pulp were gouged out. The chunks were held over the mouth and squeezed with the hands. The juice obtained in this manner proved most satisfying and they did not mind in the least the slightly bitter-salty taste. (More will be said about this flavor later on.) Tegelberg emphatically stated that both he and his partner were greatly refreshed after partaking of the juice and suffered no ill effects from its use whatsoever. Furthermore, he does not hesitate to recommend the use of the juice of Ferocactus whenever an emergency arises, but not as a steady diet however.

It is comparatively easy to gather information from various sources on certain subjects, such as the "stored water" in the Bisnaga, but it is likewise essential for the research student to conduct a test and either convince or invalidate his theories. Since much has been written about the Barrel Cactus, particularly in glowing popular accounts and in debunking yarns, this writer made a trip to the Southwest for the express purpose of testing the juice of several Bisnagas and bring back unbiased information on the subject. Two kinds of Ferocactus were sampled in Arizona and one in California. The three species, *Ferocactus Lecontei*, *F. Wislizenii* and *F. acanthodes*, are the most prominent members of the group in the United States. The first appears to be the slenderest of the three species, being only 1–1½ feet in diameter, and with its central spines more flattened, flexible and less pronouncedly hooked. It grows on the rocky hillsides in the western portion of Arizona. The second species inhabits the lower half of Arizona and is noted for its fishhook-like central spines which are red to white, stout and rigid. The third species is common in California deserts and apparently the tallest of the three, sometimes reaching a height of ten feet. Good stands of it can be found in the Devil's Garden portion of the Colorado Desert.

The first experiment was conducted on a 4-foot *Ferocactus Lecontei* in the Sacaton Mountains of south-central Arizona. Mr. Robert H. Peebles, director of the U. S. Field Station at Sacaton, who accompanied the writer to this abode of the Barrel Cactus, assisted in the experiment. With the aid of a hatchet the top portion was decapitated in three or four strokes. We did not expect to derive a big pool of water from the white pulp because it had not rained in the region for several months. It is to be remembered that Bisnagas cannot store water unless it is available to them. The less it rains the more of the stored moisture will be used up by the plant for its subsistence. However, we were both surprised at the amount of juice which trickled from our hand when the pulp was squeezed. Many small hunks of pulp were chewed and sucked, and the moisture gotten out of them proved quite refreshing. We tried hard to liken the taste to something and to experience any unpleasant after-taste, but there was none. Bob Peebles thought the flavor was neutral, or like drinking distilled water, while I seemed to detect a slight taste akin to raw coconut. Later in the evening, when we subjected some thirteen people to test in the Peebles' home, one of



The author tasting the pulp of *Ferocactus Lecontei*



Top of *Ferocactus acanthodes* chopped off, showing the juicy pulp within

the ladies also thought that the taste reminded her of coconut meat in a mild form. This opinion was expressed without any suggestion from my experience. Among the willing "victims" were two well-known physicians who were asked to express their opinions whether the juice could sustain life on the desert in an emergency. To this both men replied in the affirmative. Upon further questioning, neither of the two thought that the juice would be harmful to the individual, unless perhaps if taken in excessive amounts and even that was questionable.

On the following day, *Ferocactus Wislizenii* was put to the test. A 2½-foot specimen growing in the cactus garden of the Sacaton Experiment Station was chosen. The "vegetable barrel" contained much more moisture than *Ferocactus Lecontei,* simply because it grew in a more ideal location where water was more readily available to the plant. The pulp of this Ferocactus was more like the white rind of a watermelon in water content and possessed nearly identical flavor. No bitter or salty taste was detected while chewing and sucking the pulp (and quite a bit of it was consumed in that manner), but when the juice was expressed into a tumbler it definitely was salty. It is probable that crushing has a tendency to dissolve the salt crystals with the water, thus imparting a saline flavor. Sucking the pulp, however, left no unpleasant taste or caused any ill effects.

Since no displeasing effects were apparent in the Arizona Barrel Cacti, it was thought that perhaps the California kind might be the one that was distasteful and nauseous to so many who have tried it. Thus an excursion was undertaken to the Colorado Desert in Southern California, where *Ferocactus acanthodes* abounds. The trip was made possible by Mrs. Frank Cariss, of La Cañada, who furnished the car, and by Mr. and Mrs. Charles Place, all *bona fide* enthusiasts of the cactus clan. The hot desert sun beat down upon four individuals struggling in the rugged domain of the Ferocactus. Slowly but surely the glaring heat forced my friends to retreat to the car but I was determined to test the California Barrel even to the discomfort of my companions. Having forgotten to bring along the hatchet, I had to break open the Bisnaga the hard way or in the manner that would confront a man lost on the desert without tools. I have often been amused at the quibbling about how the wayfarer dying of thirst is to get at the spine-defended water. Here again was a chance to prove that it could be secured with the use of a rock, stick, or anything that came handy.

First of all, the Bisnaga was pushed over on its side by a well placed kick. Bisnagas, as a rule, are easily dislodged from their moorings because they are shallow-rooted. Next, some sharp stones were picked up with which the ferocious armament was rendered inoffensive. I happened to have along a small, rather dull, pocket knife; with it, spine clusters were cut away and within a half hour I was gouging out chunks of pulp and testing the water content. The fluid slightly puckered my lips—it was like biting into a half-ripe persimmon, although less acrid—but the sensation ceased shortly after. Even though it felt "sandy" in the mouth there was no unpleasant aftertaste or craving for water. Neither was the pulp foul-tasting or slimy as some writers would have you believe. Of course, of the five human senses, taste varies the most in different individuals, and this may account for many of the disparaging remarks hurled at the Bisnagas when the question of their goodness is discussed.

I am thoroughly convinced that Barrel Cactus juice can be drunk to allay thirst and save a life. I know there is palatable water in the Bisnaga, but I do not recommend or encourage travelers to go blithely into the desert, without sufficient water supply and expect to live on Bisnaga fluid. All I'm trying to prove is that *in time of stress* "stored water" of the Ferocacti can be used, and in this, its rightful role, it has all the excellent qualities that have ever been ascribed to it.

A BEQUEST TO THE GARDEN

On June 25, announcement was made in the St. Louis papers of a bequest left to the Missouri Botanical Garden by the late Miss Ellen A. Ricker. An inventory recently filed with the probate court indicated the value of Miss Ricker's estate to be $406,172.67. After a deduction of $25,000 to certain relatives the Garden will receive one quarter of the residue.

This is the first bequest of any great magnitude that has been made to the Garden since it was established with the bulk of Henry Shaw's private fortune. Coming at a time of continually rising costs of operation it is especially appreciated and most urgently needed.

It is not a difficult task to give away an estate such as that of Miss Ricker's. Nevertheless it is not always an easy matter for a philanthropist to leave his or her property in a way that is entirely satisfactory or enduring. Provisions in wills may be openly violated or the policies of the recipient institutions so changed as to distort greatly the benefactor's original intentions.

For three quarters of a century the Missouri Botanical Garden has followed an unwavering course of service and progress, the foundations of which were laid by the founder. Wisely enough Mr. Shaw allowed sufficient elasticity in the policies requested and recommended in his will to provide adequately for expansion and scientific progress. The great growth that has taken place since his decease has been essentially in accordance with his plans, and there can be no doubt that he would be proud and pleased with the advances of the past fifty-seven years.

It is evident that Miss Ricker was convinced of the stability of the Garden's management and objectives. She felt assured that the portion of her estate willed to the Garden would provide a lasting service to the people and stand as an enduring tribute to her name. There are many worthy, tentatively planned projects of expansion at both the city Garden and the Arboretum at Gray Summit that could become reality if other benefactors were to follow her example.

H. N. A.

A POPULAR COURSE IN PLANT BREEDING

In response to requests from interested persons a course in Plant Breeding with reference to ornamental plants will be offered this fall by the Missouri Botanical Garden. The course will be in charge of Dr. Gustav A. L. Mehlquist and will consist of a series of thirteen lectures, beginning Thursday, September 26, and ending on December 19. Outside reading will be assigned in coordination with the lectures and demonstrations. This course is open to any one who is genuinely interested in plants and plant improvement through hybridization.

The proposed schedule of lectures will consider the following subject material:

1. The structure of flowers with reference to pollination and fertilization.

2. The Mendelian laws of inheritance.

3. The physical basis for Mendelism.

4, 5. Polyploidy.

6, 7. The bearing of polyploidy on the problem of inheritance.

8. Sterility.

9, 10. Methods of plant breeding.

11, 12, 13. Illustrations of practical breeding problems in plant genera selected by the class.

Fee: $10.00.

Time: Thursday evenings at 8:00 in the Experimental Greenhouse at the Garden.

Literature: *Practical Plant Breeding* by W. J. C. Lawrence (published by George Allen & Unwin Ltd., London) will be used as a text.

NOTES

Mr. George H. Pring, Superintendent of the Garden, conducted a garden quiz at the meeting of the Men's Garden Club of Webster Groves, August 19.

One hundred and fifty men of Squadron 35 of the Royal Air Forces, who were touring this country on Operations "Good Will", visited the Garden the afternoon of July 22. After being guided through the grounds they were served a supper under the trees by the St. Louis Chapter of the American Red Cross.

Dr. Hugh C. Cutler, Guggenheim Fellow and Research Associate of the

Botanical Museum of Harvard University, spent the summer months at the Garden working on *Zea Mays* and related grasses, and the family Cucurbitaceae. He also studied the plants collected this spring on the San Juan-Colorado River trip organized by Mr. Joseph Desloge of St. Louis.

Mr. Charles B. Heiser, graduate student in taxomony at the Shaw School of Botany during 1943-1945 and at the University of California, Berkeley, during the past year, conducted the course in general botany at Washington University during the summer months. Mr. Heiser recently accepted a position as assistant in botany in the College of Agriculture, University of California, Davis.

Visitors to the Garden during the summer include: Dr. William L. Brown, Geneticist at the Pioneer Hi-Bred Corn Co., Des Moines, Iowa; Dr. Ralph O. Erickson, Instructor in Botany, University of Rochester, Rochester, N. Y.; Dr. H. Emery Moore, Guggenheim Fellow, who stopped over at the Garden several days on his way to Mexico; Dr. Harry J. Fuller, Associate Professor of Botany, University of Illinois, Urbana; Dr. Th. Van Eek, Phytopathologist, General Experiment Station, Buitenzorg, Java; Mr. Leslie Hubricht, of Remington-Rand Co., Detroit, Mich., formerly Research Assistant at the Garden; Mr. Charles Tricker, president, Wm. Tricker, Inc., Waterlily Specialists, Saddle River, N. J.; Mr. Lyman, Horticulturist, of Hilo, Hawaaian Islands; Mr. Robert Evers, Assistant in Botany, University of Illinois, Urbana; Mr. Hothar Paludan, Professor of Horticulture, Royal Veterinary and Agriculture Highschool, Copenhagen, Denmark; Mr. Niels Jacobsen, Carnation Grower, Aabenraa, Denmark; Mr. Paul Mose, Rose Grower, Glamsbjerg, Tyn, Denmark; Dr. Norman Fassett, Professor of Botany, University of Wisconsin, Madison; Dr. Frank P. McWhorter, Pathologist, Oregon Agricultural Experiment Station, Corvallis; Dr. and Mrs. Louis O. Williams, who stopped over for several days on their way to Tegucigalpa, Republic of Honduras, where Dr. Williams has recently accepted a position at the Escuela Agricola Panamericana; Prof. A. D. Moore, professor of electrical engineering, University of Michigan, Ann Arbor; Miss Josephine Antonini, student in botany at the University of Iowa, Iowa City.

Summer Botanical Trips of Staff Members and Students—

Dr. Henry N. Andrews, Paleobotanist to the Garden, and Mr. W. Lee Lenz, a graduate student who recently returned from nearly four years' service with the Navy, spent three weeks during the latter part of May and June collecting fossil plants in the Northwest. The primary purpose of this trip was to continue a study of the petrified tree ferns found in Chalk Age rocks of that region (see April 1946 BULLETIN), and a number of fine specimens from Wayan, Idaho, were added to the previously acquired collections. In the desert regions of southwestern Idaho and adjoining Oregon petrified cones of evergreens and foliage specimens of more recent forests, including sycamores, oaks, aralias and many others were collected. Two days were also devoted to a study of the little-known petrified forests in the Gallatin corner of Yellowstone Park. (An article about these forests will appear in the September issue of the ANNALS.)

Dr. Robert E. Woodson, Assistant Curator of the Herbarium, Mr. Richard Holm, Assistant in botany in the Shaw School of Botany, and Mr. George Richardson, undergraduate major in botany, spent from June 24 to July 10 in the South and Southwest making collections of local populations of Butterfly Weed *(Asclepias tuberosa)*.

Mr. Gerald B. Ownbey, Fellow in the Shaw School of Botany, with his brother, Dr. Marion Ownbey, Associate Professor of Botany, Washington State College, Pullman, made a two-months collecting trip throughout the West. Special attention was given to specimens of the genera Corydalis and Allium.

Herzog School Honors Garden—

The Peter Herzog School chose the "Missouri Botanical Garden" as the central theme for its graduating exercises on June 11. The program included a recitation by the graduating students covering the history and development of the Garden and an address by the Director of the Garden, Dr. George T. Moore. It is probable that this appreciation of plants is largely due to Miss Clara Heising, who for many years conducted St. Louis school children through the Garden. In a world whose future seems especially precarious, it is most important that our young people be guided along paths that will lead them to a fuller appreciation of the lasting and lovely things in life. Any boy or girl who acquires an enduring love of gardens is apt to make a pretty fine citizen.

Increase in Bulletin Subscription List

The annual spring "Friends of the Garden" drive was aided this year by the greater St. Louis Kiwanis clubs to whom we wish to express our sincere appreciation for increasing the fund materially. We are especially indebted to Mr. John W. Nies, Chairman of the Kiwanis Agricultural Committees, for his personal efforts to aid the Garden. Largely as a result of Mr. Nies' work our mailing list to prospective Friends was more than doubled.

Since those who donate \$5.00 or more to the Friends fund automatically receive the BULLETIN for one year the subscription list has increased by some

300 members since April 1, while the number for the past year and a half has been nearly 800. It is reassuring to know that some of our new readers are sufficiently well pleased with their investment to volunteer a word of praise. We hope that the spirit of the following excerpt is felt by all and that their appreciation will be further expressed by telling other gardening friends about the BULLETIN.

> "This issue of the Garden BULLETIN is the first I have recevied following a small contribution which I sent to further the Garden's work. I want you to know that I thoroughly enjoyed it. In fact, I enjoyed it so much that I feel that I haven't really made any contribution but that I simply have had the privilege of buying a very interesting publication. . . . . . "
>
> [A new Kirkwood Friend].

SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date until his death in 1889 it was maintained under his personal direction. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was chosen by Mr. Shaw and he definitely indicated that he wished it called by that name. The Garden passed at his death into the hands of a Board of Trustees, designated in Mr. Shaw's will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provision of the will the immediate direction of the Garden is vested in a Director, appointed by the Board. The Garden receives no support from city or state but is maintained almost exclusively from the estate left by Henry Shaw. Since 1939 many Garden Clubs and interested individuals have contributed to a "Friends of the Garden Fund" which is used in developing the new Arboretum, located at Gray Summit, Mo. The Arboretum (1) serves as a source of plants, trees and shrubs for the city Garden; (2) affords areas for gradually establishing a pinetum, a wild-flower reservation and various other features on a scale not possible in the city; (3) provides greenhouses for some 20,000 orchid plants.

The city Garden comprises 75 acres, where about 12,000 species of plants are grown, both out of doors and under glass. It is open every day in the year except New Year's Day and Christmas; week days, 8:00 a. m. until 7:00 p. m.; Sundays, 10:00 a. m. until 7:00 p. m. The greenhouses are closed every day at 5:00 p. m.

The main entrance to the Garden is at Tower Grove and Flora Place, on the Sarah bus line (No. 42). The Tower Grove bus (No. 21), direct from downtown, passes within three blocks of the main entrance.

THE MISSOURI BOTANICAL GARDEN

STAFF

George T. Moore	Director
Hermann von Schrenk	Pathologist
Jesse M. Greenman	Curator of Herbarium
Carroll W. Dodge	Mycologist
Edgar Anderson	Geneticist
Robert E. Woodson, Jr.	Assistant Curator of Herbarium
Henry N. Andrews	Assistant to the Director and Paleobotanist
Robert W. Schery	Research Assistant
Nell C. Horner	Librarian and Editor
Gerald Ulrici	Business Manager
George H. Pring	Superintendent
Paul A. Kohl	Floriculturist
David C. Fairburn	Orchidologist
Gustav A. L. Mehlquist	Horticulturist
Robert B. Clark	Arboriculturist
Ladislaus Cutak	In charge of Succulents
August P. Beilmann	Manager of the Arboretum, Gray Summit
Gurney Wilson, F.L.S.	Representative in England, Hove, Sussex
Paul H. Allen	Tropical Plant Collector

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Published in February, April, September, and November. Subscription price, $10 per year.

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Garden Views. Price 25 cents for set of 8.

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MISSOURI BOTANICAL GARDEN BULLETIN

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Please: Do not discard a copy of the Bulletin. If you have no further use for yours pass it along to a friend or return it to the Garden. Return postage will be guaranteed.

Missouri Botanical Garden Bulletin

Vol. XXXIV OCTOBER, 1946 No. 8

KEEPING THE SOIL WHERE IT BELONGS

AUGUST P. BEILMANN

The basic principles of soil conservation have been practiced by some peoples for thousands of years. Confucius long ago laid down the principle that national resources, including everything from trees to fish, would remain plentiful if "taken at the proper time." A great many individual landowners and operators must have understood and practiced these principles long before the birth of the Chinese philosopher. King Solomon is reported to have had 80,000 lumberjacks and 70,000 "skid road bums" working in the immense forests around Mount Lebanon. To-day this is a blighted land given over to the pasturing of goats by nomadic tribes.

Our recent national activity aimed at the conservation of top soil comes somewhat late. A very great deal of harm has already been done, and technological progress depends upon the quality of the top six inches of soil. In the midst of an Atomic Age, we are likely to forget the precarious toe-hold the human race has on this planet, not because a chain reaction might destroy the whole world but rather because an appreciable drop in soil fertility will kill off a nation as surely as an atomic bomb. We are so prone to point to our great strides in engineering and physics and the development of supersonic speeds in air-craft that we forget all these things hinge on six inches of fertile soil. Destroy the top soil, and this program will stop within a generation. Certainly the generation fed from poor soil will not have the mental or physical equipment necessary for further investigation, nor will it be capable of using what has been developed.

As has been shown, the need for conserving the soil is well established, if only by those races who failed to care for the soil and have long since passed away. The method to be followed, however, is a controversial subject. There are those who favor the erection of dams and other man-made checks on water run-off and erosion, and then there are those who believe that the greatest good will follow a system which is more according to the laws of Nature. At the Arboretum both methods have been tried, with the Brush Creek watershed as the laboratory.

That part of Brush Creek with which we are concerned drains about 3,000 acres and is typical farm land for this section. There are patches of woods on the rougher land, old gullies partly grown up with trees, and the usual number of fence-rows and abandoned fields allowed to go to brush. The portion of the valley on which we experimented comprises the head-water and the first three miles downstream. Brush Creek is typical of Ozark farm streams as we know them to-day. It is either carrying a tremendous volume of water during and immediately after a rain or it is a series of disconnected pools which dry up during the rainless periods. Flash floods roar down such a watershed and are capable of washing out bridges. The underlying rock is Cotter-Powell dolomite, with lenses of St. Peter sandstone usually occurring as very regular blocks and often exposed in the creek bed. In most places the creek has cut down to bed rock, although the old ox-bows indicate that a hundred or so years ago it was a minor drainage way with a bed some fifteen feet higher than to-day. The soil is classed as Clintonia silt loam but is generally badly eroded.

A flash flood in July, 1938, destroyed a wooden bridge over Brush Creek just at a time when a bridge was badly needed. Two new bridges were planned, and with the disastrous dry years of 1930 to 1936 fresh in mind the plans specified the damming of the creek at both bridge sites in order to create two small lakes as supplementary water reservoirs. There was some question at the time about the advisability of damming such a creek, but it was felt that a dam might be the easiest method of obtaining the much-needed water for irrigation and fire-fighting. The West Bridge is approximately 1,800 feet from the property line and the East Bridge about 3,600 feet farther east, but the meanderings of the creek make the distance at least twice as great.

The portion of the watershed which lies within the Arboretum is well protected by grass; there is virtually no erosion since the steepest slopes were terraced fifteen years earlier. The part west of the Robertsville Road, however, is typical farm land, and the amount of erosion depends entirely on the state of the crop, the weather, and all the other factors which enter into this problem. In other words, upstream from the West Bridge the land is partly timber and brush and partly in crop land. The watershed between the bridges is either timber, grass cover, or terraced with permanent sod. In the space of four miles we have two extremes, the protected watershed and the portion devoted to farming. Since all the water drains past the two bridges, it is possible to measure the amount and kind which is being carried away. In the construction of the bridge, considerable excavating was done to find a suitable bearing for the piers. To keep this excavation dry, pumps

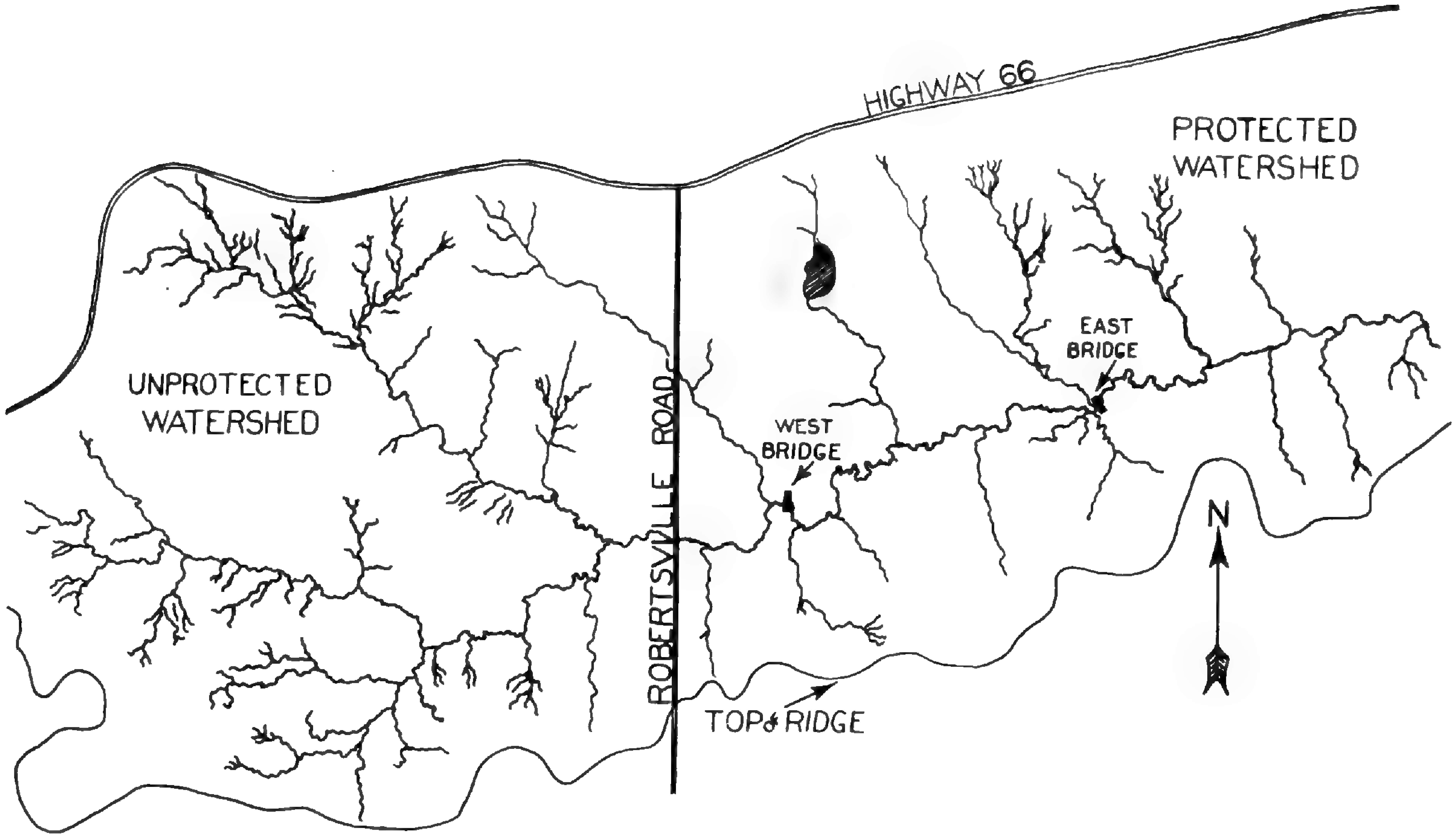


Diagram of Brush Creek Watershed

were used to lift the water past the footings. At the East Bridge, which has a protected watershed, 55,000 gallons of water per hour were handled by a battery of pumps, day and night for weeks at a time. At the same time the excavation at the West Bridge required a pump of only 1,500 gallons per hour capacity. This was actually the amount of water being drained from the watershed during the fall and winter months. The greater portion of the watershed (above the West Bridge) was dry and was losing just a trickle of water. The better-protected watershed below this point was so filled with soil water that 55,000 gallons were being released. The upstream uncovered plow-land was not retaining water for any length of time, while

Sedimentation at West Bridge, July, 1943

the downstream area was carrying optimum soil moisture and releasing the surplus. From this it is possible to see why flash floods are of such common occurrence. Rain does not soak and penetrate the unprotected watershed. Most of it runs off and carries along some top soil, leaving the creek dry a few hours later. The protected watershed, on the other hand, retards runoff and favors percolation. In this manner the maximum moisture is stored and the surplus released over a long period of time.

After the completion of the bridges and dam, the flood gates were closed on May 22, 1940, creating two lakes from 45 to 60 feet in width, from

250 to 555 feet long, and with a maximum of $4\frac{1}{2}$ feet in depth. The two lakes held about $1\frac{1}{4}$ million gallons of water, but in three years they have become completely filled with sediment. The amount of material which had lodged behind the dams was roughly equivalent to 55-acre inches, or one inch of top soil from 55 acres. This is not all of the erosion from the watershed, since only the heavier portions settled in the lakes. Possibly three or four times as much top soil was carried along to be emptied into the Meramec River.

This visual demonstration of the harm that erosion can do prompted Mr. Spencer Groff, who owns and operates a portion of this watershed, to terrace and re-seed the steeper slopes of his land to grass. Much of the work was finished by the spring of 1945, and in spite of record floods in the Meramec (just one mile south) and the rainiest spring in many years Brush Creek has never since been bank full. Previously, any very heavy rain of several hours duration caused the creek to overflow and become a raging torrent. Nothing else has been done to the watershed except terracing and reseeding to grass, but floods appear to have been almost completely stopped.

Brush Creek has been harnessed through the usual conservation practices. Mr. Groff has constructed about $4\frac{1}{2}$ miles of terraces, and in his opinion the cost of this work is justified by the increase in production and the greater dependability of the crops regardless of what is planted. He proposes to do more work, particularly the construction of farm ponds. It will be interesting to observe the effect of these small ponds on the upper watershed. Since the water they contain is evaporated during the summer and used by cattle as well, they usually have considerable capacity when the rains begin in spring. Needless to say, the building of many farm ponds, as proposed by the Conservation Commission, will do more for recreation and hunting than the largest lake ever constructed.

The results achieved on this watershed, first with a dam and second with accepted conservation practices, seem worth while in evaluating the possible benefits to be derived from any valley-wide program. Small watersheds differ from large ones mostly in the matter of size. A river is merely a large creek and may be so large that it drains several states. Dams are proposed as the most satisfactory way of holding back floods. If a dam is to be used solely for flood control, then the reservoir must be nearly empty before the next rainy season. This is a little like the traditional fire barrel which was to be filled just before the next fire. No matter what use will be made of the water behind the dam, sedimentation will usually destroy the reservoir. If the dam is large enough to create a lake 150 miles long, then the gravel will be deposited at the upper part of the lake or where

Over-grazed pastures become weedy, bare, and eroded

Terraced hillside with a thick grass sod will conserve the land. Photograph taken following a mowing late in September.

the velocity is checked. In these little lakes with low dams the velocity of the flood was not checked until it reached the dam and there deposition began. Of course, if the water is to be used for recreational purposes and a high and constant level is necessary, then a dam is of no value from the flood-control angle since there is no room for storage.

It is noteworthy that on this watershed the engineering approach was tried first; that is, two dams were constructed. However, they had no effect on flood crests and were finally rendered worthless through sedimentation. After this, the biological method was tried which consisted mostly in terracing, some change in crop routine, and a great deal of re-seeding. This method produced astonishing results. It has lowered the flood crest about ten feet from the maximum, has permitted a trickle of water to enter the creek at all times, and has reduced the amount of mud in the flood water very noticeably. The exact kind of soil conservation required on any farm depends a great deal upon the kind of soil, but it has been shown on the Brush Creek watershed that conservation is in itself a successful flood-control measure. Flood crests were reduced only when soil-conserving practices were put in operation. From the performance of the Brush Creek watershed, it appears that small headwater dams are doomed to failure and that a biological problem cannot be solved with an engineering formula. Nor is it possible to erect an "all-purpose" dam which will impound floods, furnish hydro-electric power, provide irrigation water, favor navigation, and at the same time supply the proper conditions for recreation.

"BOOSTER" AND "STARTER" SOLUTIONS FOR POT PLANTS

GUSTAV A. L. MEHLQUIST

Now that several experiment stations have shown that weak solutions of fertilizers applied to tomato plants immediately after transplanting give the plants a boost which is reflected not only in better early growth but better yield as well, many gardeners are apt to chuckle up their sleeves and announce that they have been doing just that for years not only with tomatoes but with many other plants. Others are likely to ask "how come," since thay have been taught that fertilization of plants which were not well established is of little benefit and is often even injurious. Still a third group will take no sides in the issue, but simply ask whether the fertilizer solution recommended for, say tomatoes, will be equally useful on other plants, including house plants, grown in pots or other containers.

Before these questions are answered it might be well to consider the conditions under which "booster solutions," generally speaking, might be expected to prove helpful. Gardeners in Europe, as well as in this country, have found that plants of the type generally regarded as easy to transplant were usually benefited by weak fertilizer solutions applied at or shortly after transplanting to the open ground. On the other hand, plants of the type regarded as difficult to transplant usually showed injury. The same was generally true for house and greenhouse plants.

This variation in behavior of plants is not surprising if we bear in mind the mechanism by which they take up the different materials they need from the soil or medium in which they are growing. In the first place, all substances, organic or inorganic, that the plant takes up from the soil must be in solution, that is, dissolved in water. Second, not all roots of a plant take up water with equal facility. In most plants by far the greatest amount of water and substances dissolved in it are absorbed through the smallest roots, the so-called root hairs, and the majority of these small roots are usually lost in the process of transplanting. Even though the little plants are carefully knocked out from the pots or similar containers many of the smallest rootlets stick to the edges of the pots, which may be a little too dry, or are lost upon contact with the new soil, which may be too dry or contain too much of some substance to which the roots are not adapted. Now, some plants re-establish themselves very rapidly; that is, new roots are produced under favorable conditions within a few hours in the new soil, whereas others often require days or weeks before any new roots are produced. Although herbaceous plants usually become established much more quickly than do woody plants, they sometimes fail to do so if the new soil is too rich. For instance, greenhouse men have found that carnations and chrysanthemums which normally require fairly large amounts of fertilizers for best production do not establish themselves anywhere nearly as quickly in a rich soil as they do in one moderately fertile. The applications of a "booster solution" under such conditions would not be likely to be of benefit but would even delay the start of the plants. On the other hand, when tomatoes and many other vegetables and flowering plants which normally produce new roots very rapidly are planted out of doors in a soil that is usually none too rich, then such a solution might well produce excellent results.

With pot plants the problem is a little more complex. Because only a relatively small quantity of soil is available to the potted plants, it has to be well prepared and moderately rich in organic matter. The organic matter not only improves the physical quality of the soil but also, through decomposition, furnishes the plant with a small but steady amount of nitrogen and other substances. The use of a fairly rich soil to start with means that an application of fertilizer immediately after planting would not be beneficial but might even retard root production and growth. On the other hand, when the plant is well established in the pot a supplementary solution containing those elements that are used up rapidly is not only recommended but is often well nigh necessary for normal growth under conditions that, at best, must be admitted to be restricted and artificial.

The elements necessary for plant growth are: carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, calcium, magnesium, sulphur, iron, manganese, and a few others that are required in such minute amounts that a sufficient quantity is nearly always present either in the soil or as impurities in materials added to furnish the other elements. The first three named elements are automatically provided when aeration and watering are properly tended to, and of the remaining eight all but nitrogen, phosphorus and potassium are usually contained in sufficient quantity in any properly prepared potting soil. On the other hand, these three ordinarily are used in greater quantities than can be sustained by the soil in a small pot; also, nitrogen and potassium are to some extent leached from the soil because of their being so readily soluble. Most commercial fertilizers are therefore designed to add chiefly nitrogen, phosphorus, and potassium, and are sold and rated on the basis of their content of these elements. As most states require that the concentration of these elements be given on the packages, the formulas 4-12-4, 5-10-5, etc. are often used as means of describing the product. The first figure in the formulas gives the per cent of nitrogen content, the second the phosphorus, and the third potassium. Usually, such fertilizers are rated "complete" as compared to "incomplete" mixtures that contain only one or two of these elements. These fertilizer mixtures are often advertised as "balanced" as well as complete, but since the "balanced" refers to the requirement of the plant for the elements involved and different plants do not have the same requirements it follows that such terms should not be taken too seriously. As a rule, balanced mixtures have a phosphoric acid content approximately equal to or slightly greater than the nitrogen and potassium content combined.

Usually any of the commonly offered, so-called "complete" fertilizers of a concentration of 4–6 per cent nitrogen, 8–12 per cent phosphoric acid and 4–6 per cent potassium can be used as a "booster" or "starter" solution on newly transplanted plants out of doors. The recommendations vary from one "tablespoonful" to a "handful" of the dry mixture dissolved in one or two gallons of water and the same quantity applied as if water alone would be used. More specific directions are not given for the reason that different brands or makes of fertilizer mixtures vary not only in actual strength but also in solubility and availability, making the effective concentration hard to estimate. Manure water made in the usual fashion from either dry or fresh manure probably would be as useful although more messy to handle.

Most of the fertilizer mixtures that are offered for garden use are not well suited for house plants except when added to the soil at the time of preparation, partly because their lower solubility makes it difficult to estimate the effective concentration in the solution and partly because, on decomposition, they give off disagreeable odors. Numerous fertilizers specially designed for use on pot plants are now on the market either in liquid form or as dry powders or tablets to be dissolved in water. Most of these, when used according to the manufacturer's directions, are good and reasonably priced.

In response to numerous requests for a suitable formula that could be prepared at home, the following solution which I have used in experimental work on potted plants in St. Louis for the past year and for five years previously on similar materials in California is offered: 300 grams (about 10 oz.) of potassium nitrate (KNO_3) and 60 grams (about 2 oz.) of monobasic ammonium phosphate ($NH_4H_2PO_4$) are dissolved in one gallon of tap water. (Either chemically pure salts or fertilizer grade may be used.) This stock solution is diluted 125 to 375 times for use on potted plants when needed. The 125 dilution *(one fluid ounce* of stock solution to *one gallon* of water) has been successfully used on fast-growing plants such as carnations, chrysanthemums, cinerarias, snapdragons, and many others. A dilution of *one ounce* stock solution to *two gallons* of water (250 dilution) has been beneficial on such plants as many types of Begonia, Gardenia, Calceolaria, Primula, and foliage plants. Plants that are normally slow-growing, such as Camellia, many orchids, and most foliage plants or plants not in very active growth, have responded best to the 375 dilution (1 oz. to 3 gallons). Used in the 125 dilution the concentration is approximately:

500 parts per million (PPM) of nitrogen expressed as nitrate $^{-}NO_3$
100 " " " " " phosphorus " " phosphate PO_4
235 " " " " " potassium " " K^{+}

It should be borne in mind that as this solution contains only the three elements N, P and K—except as other elements are present in minute quantities as impurities—it is suitable only for plants grown in properly prepared soil or some other medium that furnishes the other required elements. If the plants are grown in water solution, gravel, or pure sand, a solution containing all the required elements should be used. For information relative to such solutions consult your favorite state experiment station.

No definite schedule as to how frequently the solution should be applied can be given. As a rule, the "125 solution" should not be applied more often than every two weeks in the active season and at longer intervals during seasons unfavorable to rapid growth. The soil should always be moist when any fertilizer solution is applied. To be sure of this it is best to give the plants a thorough watering and then apply the solution as soon as the surplus water has drained away. If any of the solution strikes the foliage it should be washed off.

Remember that neither this nor any other solution is a cure-all and that the judgement of the person growing the plants is just as important with "booster" solutions as without, if not more so.

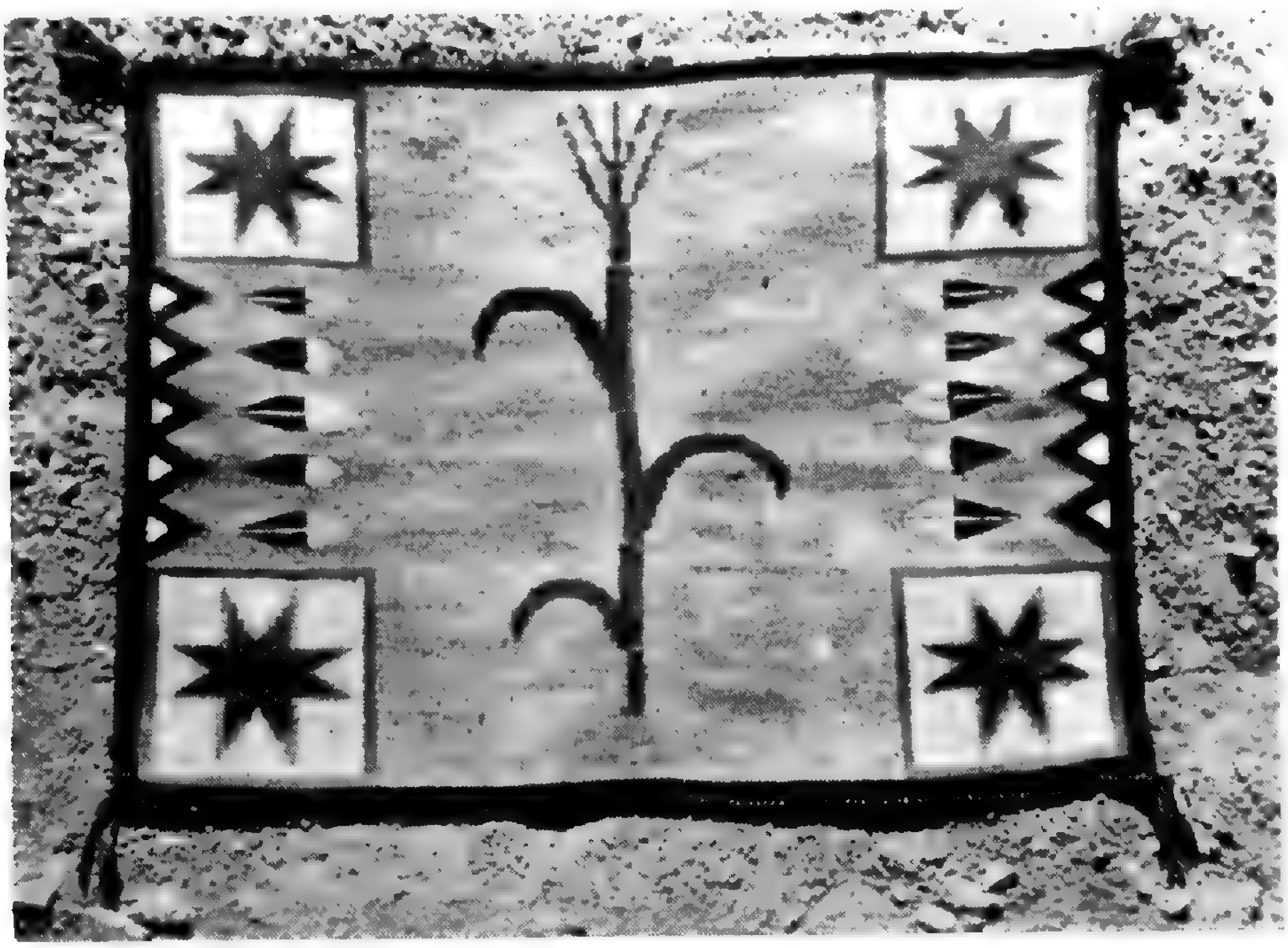
EXPLORATION FOR PREHISTORIC INDIAN FOODS

HUGH C. CUTLER

Apartment houses in desert canyons? And villages on arid plains? It seems absurd, but there they are—the cliff houses of Mesa Verde and Canyon de Chelly, the towers and mound ruins of Hovenweep and Chaco Canyon. But how could anyone find food among the rocks and sands of southeastern Utah and northern Arizona? One of the projects of an expedition organized by Mr. Joseph Desloge, of St. Louis, was to answer this question and to find out whether the region could still support inhabitants if they were not able to rely upon cattle for most of their food.

The easiest and quickest way to investigate rough country is to study series of aerial photographs, but even though these served to locate the rare springs and streams with their lush vegetation, we had to fall back upon pioneer methods to collect specimens of the plants. Jeeps or special cars could not enter the canyon country we were to investigate; on foot we could not carry the necessary equipment and food; and for mules and burros there was little forage even if they could cross the bare rocks which separate the many canyons. So, like Major Wesley Powell, who made the first complete trip by boat on the upper Colorado River in 1869, we rowed down the fast and silty waters of the San Juan and Colorado rivers through the most scenic and least-known area of the United States.

From Shiprock, New Mexico, to Bluff, Utah, the San Juan River flows rapidly, except for a wide flat near the "Four Corners" where the water spreads thinly over a wide shallows. There are no real rapids in this stretch, but large "sand waves," caused by the fast-moving silty water, make it necessary to use some caution. Sagebrush and cottonwoods cover small strips of fertile land which line the banks, and small mounds littered with pottery fragments are common. It is likely that much of this good soil was formerly cultivated, for near the ruins of a prehistoric tower and several ancient houses we found a rock picture of a corn plant, and in the refuse heap of another ruin beside the river we saw hundreds of corn cobs and some squash stems, together with fragments of old baskets, clay pots, and fiber sandals. The refuse heap had been dug up by curio seekers who had destroyed nearly all the archeological value of the site in their quest for the ancient pottery frequently found in such ruins. Many of the pots which are found intact were carefully buried hundreds of years ago to store food or seeds. From some of these caches the archeologists have obtained entire



A Navajo saddle blanket from southeastern Utah, showing a corn plant.

ears of corn so well preserved that museum mice often prefer them to fresh ears. Careful research has shown that the varieties of corn have changed slightly in the past 1,000 years, but corn was even more important for food then, when the cattle and horses of the white man had not been introduced, than now, when the nomadic Navajo considers it valuable enough to be given a leading part in his ceremonies or even to decorate a saddle blanket.

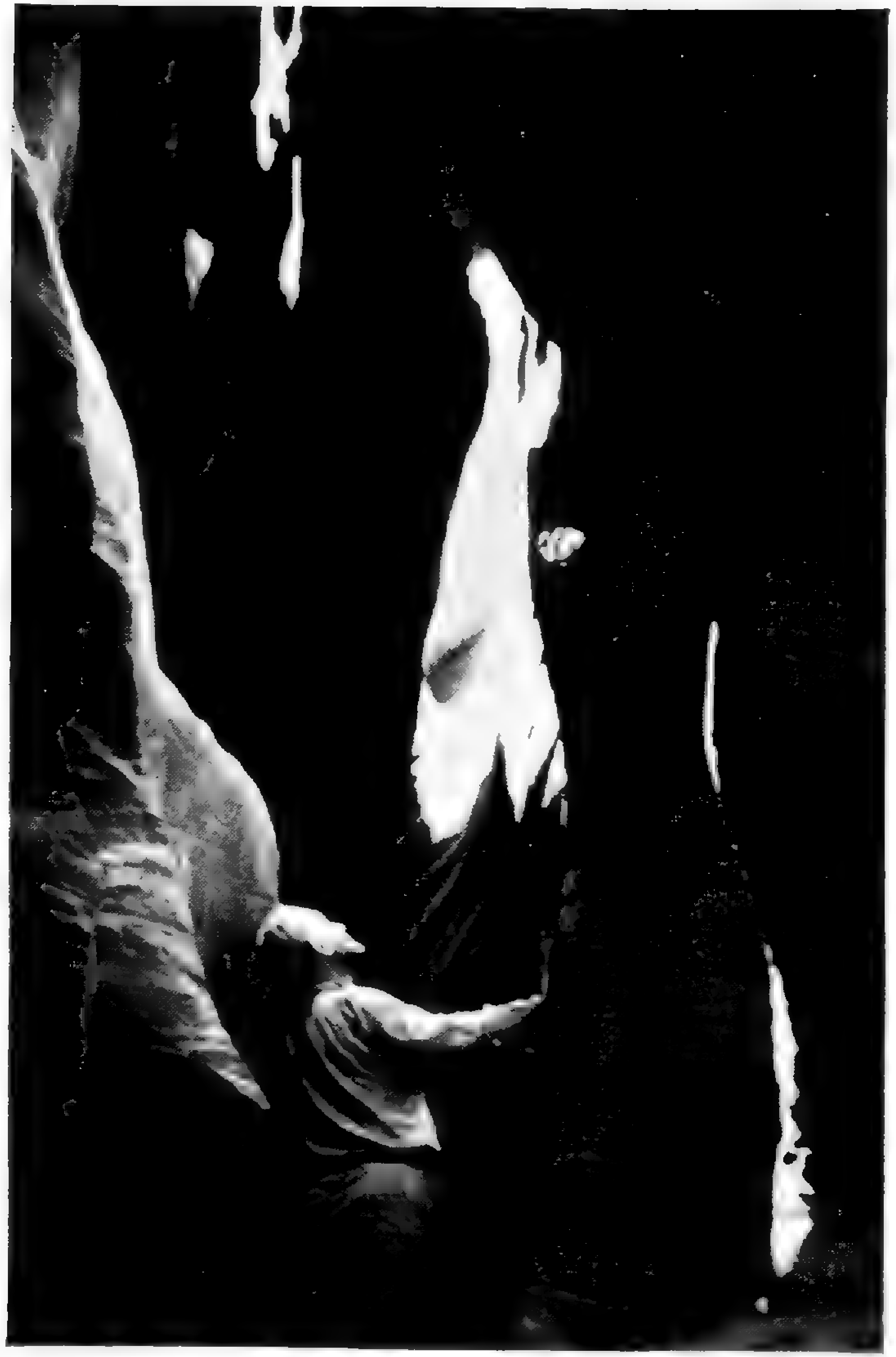
As we drifted down the San Juan we saw abundant evidence of rapid change in the countryside. Monstrous old cottonwoods floated and rolled downward to the Colorado River until they became water-logged and sank, trunk first, leaving their branches waving on the surface. Buried potsherds were frequently exposed in fresh cuts as the river ate away the fertile margins, and on the sandstone cliffs above were ancient drawings and granaries which could no longer be reached. Even the old Mormon trail along the river to Bluff is no longer passable.

Fifty years ago travellers could drive their wagons across small permanent trickles of water bordered by perenial grass cover on many parts of the Little Colorado River, Moenkopi Wash, and Chinle Creek. Now the grass is gone and the streams are dry except after heavy rains, when the ephemeral floods scour the bed so deeply that it is necessary to dig a ramp to reach the stream bed twenty feet below. With the streams entrenched the ground water-level dropped, and many of the banks no longer can support the plants they once did.

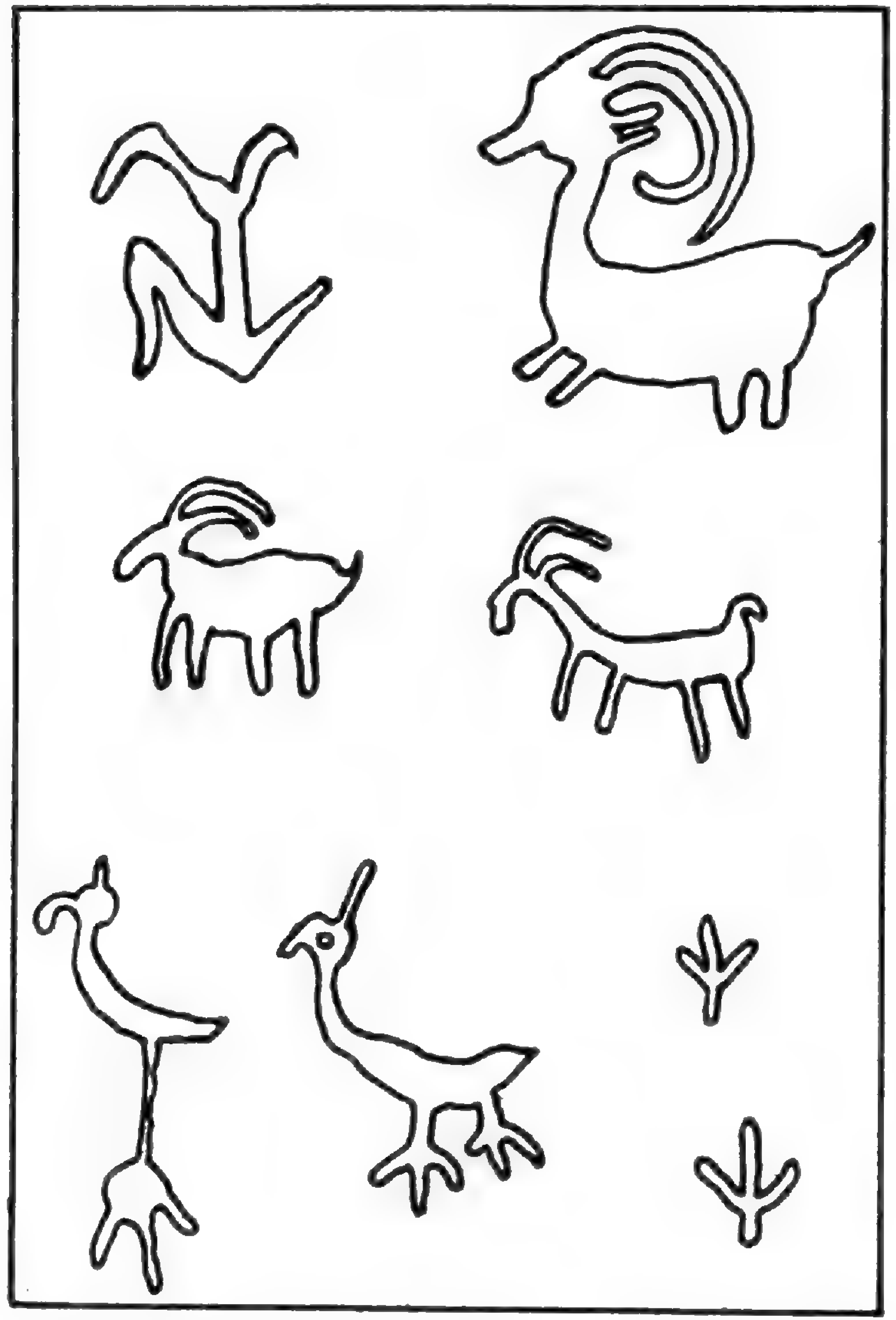
Much of this damage is the result of overgrazing, of destruction of plants which would hold the soil in place and keep the water from rushing madly to the nearest watercourse. Fortunately, there are many weeds, plants which even goats do not relish, and these have prevented the land from becoming an absolute desert. Blackbrush, greasewood, and several species of saltbush and sagebrush are the most valuable here. They are helped by the Russian thistle, or tumbleweed, which man has accidentally introduced. Throughout the West this plant rolls about and spreads the seed which grows into a very palatable plant for cattle in the early spring and into a spiny protector of the landscape throughout the summer and fall. Along the banks of the rivers where the cottonwoods, willows, and sagebrush lost ground slowly to the floods, the Asiatic tamarisk has spread. A new tamarisk plant will root from even a fragment of the leaves, and there are plants spreading up and down most of the southwestern canyons.

It is probably unjust to blame all the recent accelerated erosion on overgrazing or faulty farming practices, for there is evidence that dry periods come in cycles and that during such periods many plants die and erosion increases. Studies of tree rings show that there have been several long periods of drought, and it is likely that an especially severe period in the thirteenth century caused the Pueblo Indians to abandon Mesa Verde.

When the San Juan River enters the deep canyons below Bluff, its character changes. Here the river is compressed between high walls of rock, with long stretches where the water is always rough and exciting. Very few people ever enter these canyons, and even signs of early man are not abundant. Yet, although some of the canyons are only bare rock and land suitable for farming is restricted to a few patches in side canyons or on small bars in the bends of the river, there are many edible wild plants. The sego lily and onion are abundant in sandy areas, and their bulbs formed much



Catacomb Canyon, which enters the Colorado River above Lee's Ferry, is so deep and narrow that the sun only enters parts of it for a few minutes each day.



Copies of figures in petroglyphs, or rock carvings, made by the prehistoric Indians on the San Juan and Colorado Rivers, about 700 years ago. These represent a corn plant, mountain sheep, turkeys, and turkey tracks.

of the food of the Ute Indians who formerly occupied the land to the north of the river. After early summer, when their flowers and stems dry up and disappear, they are difficult to locate, but then there is the yucca, with fleshy petals which serve as a vegetable, and the Indian rice grass. This grass is not the wild rice of our northern swamps and lakes, but a small-seeded grass which is so abundant in clumps over the sands that several pounds of grain may be gathered in a morning. Later in the season the Indian families probably moved to the mesas for a few weeks to gather pinyon nuts. Modern Indians don't bother to shell the nuts but crack them with their teeth and maneuver with their tongues so that a constant stream of discarded shells trickles out of one corner of the mouth without interfering with the frequent intake of fresh material in the other corner or the even downflow of kernels.

Sego lily bulbs, rice grass, and pinyon nuts probably provided the principal wild foods centuries ago, but if one can judge from the numbers of mountain sheep we saw along the river and the abundance of rock pictures, these sheep must have been caught often. Turkeys were kept, for their refuse is commonly found and drawings of the birds and their tracks are second only to sheep in their frequence in some areas. The old Indians secured additional food by drying and grinding the starchy roots of several rushes and cattails, and it is likely that almost any succulent plant was used for greens in the early spring. Some of the cacti, especially the relatives of the barrel cactus, provided excellent food, either cooked or fresh. One night we tried a salad of cactus, lemonade from the squawbush or desert sumac, and tea from the Mormon tea bush. After that, although some of us were still enthusiastic enough to try washing with the pounded root of a yucca in Indian fashion, our companions emphatically declared that, while living off the the country was not too unpleasant, our canned and dried foods and soap in bars were very convenient.

Before we reached the end of our trip, at Lee's Ferry, Arizona, we had collected evidence that small groups of people could survive in the canyon country under present conditions. The life, however, would have been difficult, and in order to allow the leisure necessary for the development of population centers with the ceremonial life and art shown in the ruins we must believe that the environment of the past was more favorable, the arable lands more extensive, and useful wild plants even more abundant than now.

NARCISSUS "MOONSHINE" AS A VARIETY FOR FORCING

EDGAR ANDERSON

More by accident than design a few bulbs of the white narcissus MOONSHINE were forced in the winter of 1944-45. They showed such superlative qualities that a comprehensive test of the forcing qualities of the same variety was carried out the following year. The bulbs were potted up in the usual way in the fall in a good sandy loam, in bulb pans, five-inch pots, and long copper trays of window-sill width. They were set in a somewhat protected cold-frame, given a thorough watering, and were buried in sand. Beginning in early February they were dug out, a few at a time during warm spells, brought into a cool greenhouse where they were left beneath the benches until the leaves began to grow vigorously, and were then put on the bench.

Narcissus MOONSHINE

The variety MOONSHINE is no ordinary daffodil, and it begins to show its peculiarities as soon as it is brought into the greenhouse. It forces very slowly as if reluctant to come into bloom ahead of its normal date. Pans of KING ALFRED brought in at the same time had come into flower and withered and were completely gone by before MOONSHINE showed even a single bud. Yet when the flowers eventually appeared they were well worth waiting for. MOONSHINE is a hybrid with *Narcissus triandrus*, the "Angel's Tears" daffodil, and it resembles that variety in its clustered, drooping flowers, of a clear, glistening, greenish-white. A tray in full bloom is airy and graceful. It looks as if a large flock of white butterflies had suddenly settled down for a moment among a group of grassy leaves. Each flower is perfect in shape, its texture like an alabaster vase. Though they are quite large there is nothing coarse about them. They have the perfection, finish, and design of a little white and green baroque chapel. Just as MOONSHINE was slow to come into flower, so is it phenomenally slow to go out of flower. Like any daffodil, its span of life as a house plant will depend upon the temperature of the room in which it is displayed. By comparison with other varieties, it lasts twice as long, and under very cool conditions it may last even longer. In the ordinary living-room a pot of these daffodils will stay in flower, in excellent condition, for at least a week. On a cool sun-porch they will give an exquisite display for over a fortnight. If brought in early in the season they come into flower a little unevenly, so that some of the bulbs will have finished before others are well under way. Then, too, they have flowers in clusters, and the cluster does not open all at once and the flower clusters on the offshoot bulbs will be later than those on the main bulb. One pan of bulbs brought to a cool porch when its first flowers were beginning to open was, by actual record, showing bloom from the 20th of February to the 18th of March.

While MOONSHINE is too expensive and too difficult to force to interest the ordinary amateur or the ordinary commercial florist, our experience with these bulbs has convinced us that they could be used effectively by both of these groups. The experienced amateur who wants a beautiful winter flower a little out of the ordinary, the commercial florist who caters to a discriminating clientele and expects to be well paid for superlative material, would both find this variety appropriate to their needs.

The Chinese Scholar Tree *(Sophora japonica* L.)

THE CHINESE SCHOLAR TREE

ROBERT B. CLARK

For the garden-maker who wants something different and distinctive but not difficult to grow, the Chinese Scholar Tree or Pagoda Tree *(Sophora japonica* L.) is recommended. The tree belongs to the legume family, and possesses the characteristic pea-shaped blossoms of that group. These flowers, which are borne in clusters at the tips of the leafy branches, are creamy-white and contrast exquisitely with the glossy dark green foliage. During the hot days of mid-July the tree is laden with blossoms, and their petals, falling almost continuously, cover the ground like a cloth of gold. It remains in flower until August and is a conspicuous note in the landscape. In the autumn its fruits hang in bead-like strings, for the seeds are separated in the pod by constrictions. This species should not be confused with the Golden-chain Tree *(Laburnum anagyroides* Med.), which also is a member of the legume family but which never attains the size of the Scholar Tree and has pendulous flowers that appear in the spring.

Until recently, a fine example of *Sophora japonica* was to be seen in the Garden immediately north of the Administration Building. Unfortunately it was ruined by the storm of September 1, as were many other beautiful and rare trees and shrubs. This *Sophora,* planted some fifty years ago, had attained a height of nearly fifty feet, and its branches spread sixty feet to form a gracefully rounded head. The circumference of the trunk four feet from the ground was six feet. At eight feet above the ground the trunk formed a crotch, and it was at this point that the huge branch which bore the weight of the crown broke off. There are other younger specimens in the Garden, but it will be many years before they will become as attractive as was this older tree.

A native of China, the Scholar Tree was introduced into Europe, in 1747, from seed collected in the region of Peking by the Jesuit Father d'Incarville and sent to his former instructor, Bernard de Jussieu, Sub-demonstrator of Plants in the Garden of the King, Louis XVI. According to Desfontaines, the tree remained unclassified until it produced flowers for the first time, in 1779, in the garden of Maréchal de Noailles at Saint Germain en Laye and in Queen Marie Antoinette's garden at the Trianon, Versailles. It was soon identified as *Sophora japonica* L. Linnaeus had originally described the plant in 1767 from specimens collected by Kleinhoff *apparently* in Japan, ascribing it to *Sophora.*

The *Cyclopaedia* of Abraham Rees, 1816, explains how Linnaeus came to use *Sophora* for the name of this genus: "*Sophera* is, according to Prosper Alpinus, the Egyptian denomination of a species of *Cassia,* the Linnaean

C. Sophora, nearly related to the genus before us. Linnaeus, in his *Hortus Cliffortianus,* spelling it *Sophora,* calls it a *genus sophorum,* or of wise men," implying that it requires the wisdom and admonition of wise men to distinguish between members of this family. This undoubtedly accounts for the use of the popular name, Scholar Tree.

George Nickolson, writing in *Garden and Forest,* 1888, mentions the large specimens in the Royal Botanical Garden at Kew as being among the original plants of Aiton's Arboretum and among the earliest introduced into Britain. (First plants of this species were introduced into England by the nurseryman, James Gordon, of Mile End, in 1763.) A later author states that there is a "still larger and more shapely tree near the palace of the Petit Trianon at Versailles." Could this latter specimen be one of those first plants to have produced flowers in Europe? If so, it would now be nearly 200 years old!

The Chinese Scholar Tree was most probably grown in this country for the first time in the ill-fated Elgin Botanic Garden (on the present site of Rockefeller Center, New York), for in the second edition of the catalogue of that garden, published in 1811, *Sophora japonica* is recorded as a shrub growing in the greenhouse!

In its native China, *Sophora japonica* and also *Gleditsia sinensis* form, according to the renowned "Chinese" Wilson, "a characteristic feature of the vegetation of the more arid river-valleys of the west," and he stated elsewhere that trees of this species "80 feet tall with a trunk 12 feet in girth and an abundance of gnarled, wide-spreading roots are frequently to be seen." In cultivation, especially in the latitude of St. Louis, these trees do not reach such large proportions nor do their roots become exposed in the silty loam, yet, as Wilson maintained, they seem "to withstand city conditions better than the average tree."

Another explorer of northern China, Reginald Farrer, in 1917, described how effective the Scholar Tree was on the landscape of a little town of Kansu Province. He writes in part:

> "The days were glorious and without cloud; only the enforced idleness of the situation prevented one from fully appreciating the beauties of Wen Hsien which assuredly . . . . must be one of the most delightful spots of Central Asia. In a wide hot bay of the torrid barren hills it lies, a little irregularly shaped walled city, beyond which, down below, lies yet a more irregular walled enclosure of strange shape, filled, as it seemed, with temples and palaces interspersed in the plumy darkness of ancient Cryptomerias. The cobbled streets are neat and picturesque, the wall in fine repair; but the essential beauty of Wen Hsien lies in the voluminous Acacias *(Sophora japonica)* which envelop all the main street in delicious green shade. No town I know in China has such umbraginous alleys, or gives such a picture from afar of a city sunk in woodland."

It was also noted in *Garden and Forest,* in 1888, that "*Sophora japonica* is now used in Italy to a considerable extent as a street tree, notably in

Milan, where some of the new boulevards have been successfully planted with it. Its habit adapts it for such a purpose, as do the lightness of the shade, which its pinnate leaves produce, and its habit of flowering late in the summer when flowers are more valuable than they are earlier in the season. Young plants, however, do not flower very freely, and this tree requires age before it develops all its flowering capacity."

The Chinese Scholar Tree is propagated from seeds and cuttings. The seeds germinate slowly and unevenly. The young tree has a tendency to form a low-forked trunk; however, with attentive care this objection may be overcome and a shapely specimen may be realized. This species is relatively free from diseases and pests, and is hardy as far north as Boston.

To be displayed at greatest advantage, this tree is best planted as a specimen on the open lawn where its massive branches may develop into a wide-spreading tree. The delicate and lacy foliage casts an interesting tracery on the lawn. Moreover, after other plants have lost their foliage, this tree remains in leaf—often into November, thus extending the season of shade by a full month. In winter the young branches are green, contrasting well with the cinnamon-brown, scaly bark of the larger branches.

Sophora japonica is seldom cultivated in this country, but it has many points in its favor. It is able to withstand city conditions, is medium-sized and disease-free, with glossy, dark green foliage and pale yellow, summer-blooming flowers. Perhaps the impatient home-owner is reluctant to plant this species because it requires from fifteen to thirty years from propagation before it begins to flower. Once the Chinese Scholar Tree has borne flowers, however, no other flowering tree can surpass its summer elegance.

AN EXPLANATION

An English correspondent recently pointed out that the article on Cymbidiums in the May issue of the BULLETIN gives the impression that the firm Sander & Sons, St. Albans, England, introduced *Cymbidium insigne* under the name of *C. Sanderi* despite its having been described earlier under the name of *C. insigne* by R. A. Rolfe.

Mr. Rolfe described this species in June, 1904, from herbarium specimens prepared by Mr. G. Bronkhart in 1901. At that time this species apparently had not been flowered in culture, for Mr. Rolfe then wrote: "The flowering of this fine species in cultivation will be awaited with interest." On February 14, 1905, Sanders exhibited a plant in bloom from a collection made by their collector, W. Micholitz, in 1904. Apparently the exact connection between these two separate collections was not recognized, for although the Royal Horticultural Society awarded the Micholitz specimen a First Class Certificate under the name of *C. insigne* var. *Sanderi* (see Jour. Roy. Hort. Soc. vol. 31, 1906, p. clviii), the species became generally known in the trade as *C. Sanderi.*

There was no intention to imply that the Sander firm had intentionally ignored the name given this species by Mr. Rolfe. When a supposedly new species is collected in its native habitat before a previous collection (which later turns out to be the same species) is properly named and described, mistakes such as this are easily made and are nobody's fault.

NOTES

The September number of the ANNALS OF THE MISSOURI BOTANICAL GARDEN has recently been issued, containing the following papers: A Cytological Study of Yeast *(Saccharomyces cerevisiae)* by Lillian Nagel; Contributions to Our Knowledge of American Carboniferous Floras. IX. Some Petrified Seeds from Iowa, by Ellen M. Kern and Henry N. Andrews; The Gallatin Fossil Forest, by Henry N. Andrews and Lee W. Lenz.

Mr. Russell J. Seibert and Mr. Fred G. Meyer, former graduate students in the Shaw School of Botany, have returned to the Garden where both will resume their work toward a doctorate. Mr. Seibert has been engaged in rubber investigation for the U. S. Department of Agriculture in Latin America for the past few years, and Mr. Meyer has been serving with the Medical Department of the United States Army, in England, France, and Germany.

Recent visitors to the Garden include: Dr. Carl C. Epling, Professor of Botany, University of California, Los Angeles; Dr. Hamilton H. Card, Teacher Fillmore Community High School, Fillmore, Ill.; Dr. A. W. Dimock, Associate Professor of Plant Pathology, Cornell University, Ithaca, N. Y.; Dr. Ledyard Stebbins, Associate Professor of Botany, University of California, Berkeley; Mr. George Kelly, of Littleton, Colo., editor of *The Green Thumb,* the publication of the Colorado Forestry and Horticultural Association at Denver; Mr. Roger Gautheret, Professeur à la Faculté des Sciences, Nogent s. Marne (Seine), France; Mr. Byron E. Starr, of the Clinton Corn Products Co., Clinton, Iowa; Dr. A. E. Murneek, Associate Professor of Horticulture, University of Missouri, Columbia; Miss Elinor Cooley, Librarian at the U. S. Dept. Agr., Washington, D. C.; Mrs. Iva Newman, of San Mateo, Calif., Garden Editor of *Peninsula Life* and member of the American Rose Society.

For the second time in the last ten years the "Glade Susans" *(Rudbeckia* *missouriensis*) at Gray Summit are appearing as autumnal flowers rather than in midsummer. These attractive flowers, similar to the closely related Black-eyed Susans in general appearance, are native to the limestone glades or barrens at the Garden's Arboretum. Ordinarily they come into flower in July and provide an attractive mass display during midsummer. This year, as in 1936, they were held back by the very dry weather of early summer and did not bloom until well into September. The beautiful rosy-pink *Allium stellatum* is also in full bloom in the same glades, as it is every year at this time. The yellow flowers of the Rudbeckia provide an attractive contrast for the rosy-pink Alliums, but in normal seasons the former is through blooming before the latter begins.

Dr. Thomas W. Whitaker, of the U. S. Department of Agriculture, is spending several months of a Guggenheim Fellowship working at the Garden. Dr. Whitaker is in charge of the U. S. Horticultural Field Station at La Jolla, California, where he has been conspicuously successful in breeding new varieties of lettuce and melons. During his Guggenheim Fellowship he plans to study two theoretical problems which have arisen in connection with his practical experience: the origin of the cultivated cucurbits; and the analysis of quantitative inheritance. For the first of these projects the Garden not only has an outstanding collection of books relating to the history of cultivated plants but they are more accessible for scholarly work than in most big libraries. His second project involves a field of genetics (the inheritance of such so-called quantitative characters as yield, maturity, etc.) which has been very much neglected but in which Dr. Edgar Anderson, Geneticist to the Garden, has taken a particular interest. Dr. Whitaker and Dr. Anderson plan to work together on the preliminary problem of analyzing the morphological nature of some of these quantitative characters, so that their inheritance can be studied in an exact fashion.

SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date until his death in 1889 it was maintained under his personal direction. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was chosen by Mr. Shaw and he definitely indicated that he wished it called by that name. The Garden passed at his death into the hands of a Board of Trustees, designated in Mr. Shaw's will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provision of the will the immediate direction of the Garden is vested in a Director, appointed by the Board. The Garden receives no support from city or state but is maintained almost exclusively from the estate left by Henry Shaw. Since 1939 many Garden Clubs and interested individuals have contributed to a "Friends of the Garden Fund" which is used in developing the new Arboretum, located at Gray Summit, Mo. The Arboretum (1) serves as a source of plants, trees and shrubs for the city Garden; (2) affords areas for gradually establishing a pinetum, a wild-flower reservation and various other features on a scale not possible in the city; (3) provides greenhouses for some 20,000 orchid plants.

The city Garden comprises 75 acres, where about 12,000 species of plants are grown, both out of doors and under glass. It is open every day in the year except New Year's Day and Christmas; week days, 8:00 a. m. until 7:00 p. m.; Sundays, 10:00 a. m. until 7:00 p. m. The greenhouses are closed every day at 5:00 p. m.

The main entrance to the Garden is at Tower Grove and Flora Place, on the Sarah bus line (No. 42). The Tower Grove bus (No. 21), direct from downtown, passes within three blocks of the main entrance.

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Missouri Botanical Garden Bulletin

Vol. XXXIV NOVEMBER, 1946 No. 9

A SELECTION OF TREES FOR ST. LOUIS AND VICINITY

ROBERT B. CLARK

There is a rather long list of desirable trees available for this area, but it would be well first to review the several factors which influence the choosing of hardy woody plants. Broadly speaking, these factors are climate, geology and topography. The climatic factor embraces the elements of extremes of temperature and the degree of change, the length of growing season, the amount of rainfall and incidence of humidity, the occurrence of high winds and also the condition of the atmosphere. Among the geological factors are included the chemical and physical properties of the soil; and the topographical features involve drainage and exposure.

The climatic factors have been discussed so thoroughly by E. J. Palmer and J. A. Steyermark in their "Annotated Catalogue of the Flowering Plants of Missouri" that it seems best to quote from their work extensively:

"The climate of Missouri, like that of all the central Mississippi Valley, is marked by great extremes and is subject to sudden changes of temperature. Cyclonic storms and occasionally destructive tornadoes, the latter generally very local*, occur throughout the spring and summer months. These sometimes terminate periods of extreme heat and humidity, and are followed by longer intervals of mild, pleasant weather. The storms are frequently attended by electrical discharges and by rain, which falls in torrential quantities; and there is sometimes also hail, that may do great damage over limited areas. The winters are generally mild and open for the most part, but they are interrupted by occasional severe storms or 'blizzards' that originate in high altitudes and sweep down across the plains, bringing sudden drops of temperature, sometimes of 30° or 40° or more in a few hours. The total annual rainfall averages from 40 to 45 inches over the southern part of the state, and diminishes to 30 to 35 inches in the northwestern part. However, it is often too unevenly distributed throughout the season to be of greatest value to plant life. Most of it falls during the spring and early summer months, and there is sometimes a short rainy season in September and October; but protracted droughts, that often occur in the late summer and sometimes earlier, have a destructive or limiting effect upon many plants. And this is one of the causes for the absence of some species found in similar or more northern latitudes nearer to the coast or where more equable conditions prevail.

* * *

"The winds influence the flora [of Missouri] in several ways. As carriers of moisture or as agents in its evaporation, their effects are most important. The strong dry winds are

*In the past 50 years four destructive storms have visited the Garden: cyclone of May 27, 1896, hailstorm of May 28, 1927, cyclone of September 29, 1927, and severe storm, with wind and hail, of September 1, 1946.

at least one of the factors that have prevented the spread of forests and have kept the western plains and prairies as open grass lands . . . . The generally small size and stocky character of trees on open uplands is at least in part due to the strong winds.

". . . . One of the most unfavorable climatic influences upon the flora of Missouri is the comparatively late dates at which killing frosts occur. Sometimes these come as late as the first week in May, and their effect then upon tender plants is most disastrous, often destroying the [flower buds and therefore the possibility of] fruit or the entire plant for the season and in some cases killing them outright. This has probably been one of the most effective barriers to the northward spread of many tender or less hardy species."

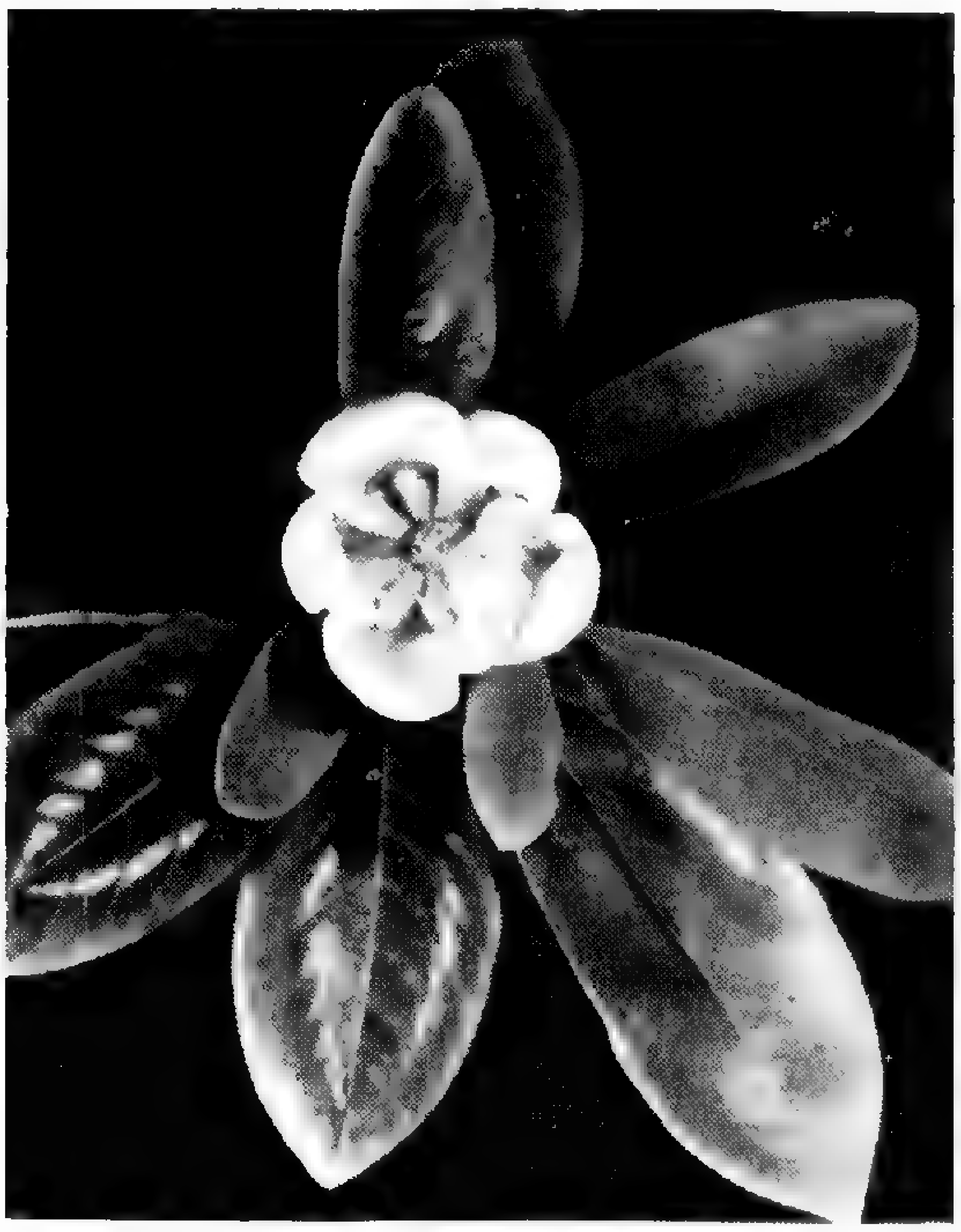
In summing up the climatic features of St. Louis and vicinity it will be

Flower of
Aesculus Hippocastanum Baumannii

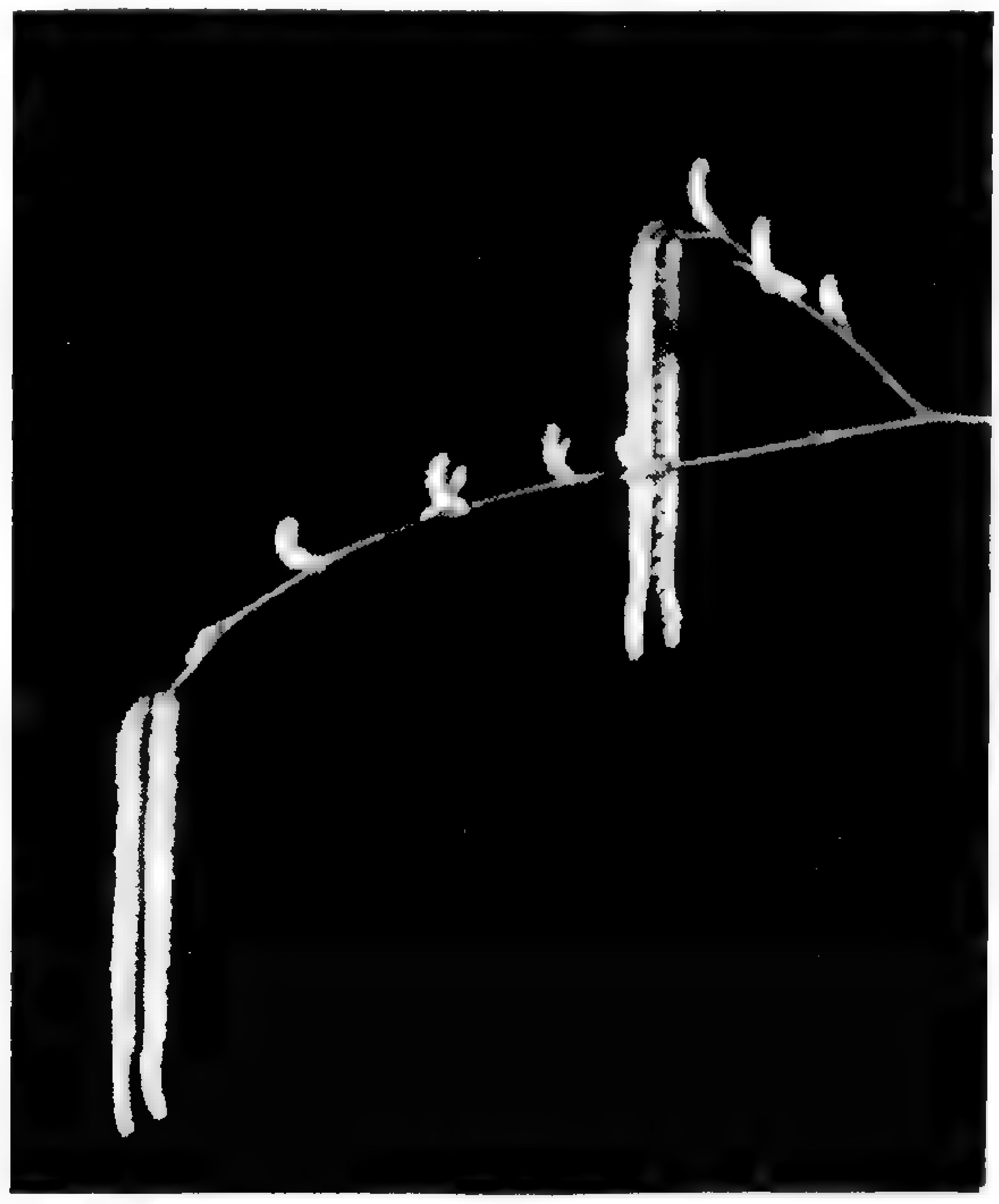
Fruit of
Aesculus Hippocastanum

noted that the average length of the growing season is 200 days, extending from the first week in April to the third week in October, that the latest recorded killing frost in spring has been as late as May 14, and the earliest in autumn on September 30. The temperature in the summer usually reaches 95° F., though occasionally it exceeds 100° F., while that of winter scarcely ever touches zero, but has been known to fall as low as —22° F. The average annual precipitation is 37.2 inches, with 15 inches of snow. The rainfall of the growing season is considerably more than half the annual precipitation, with the greatest variability occurring in June and July. The mean relative humidity is 70. The wind of greatest frequency is south, while storm winds are prevailingly from the northwest and southwest.

The geological aspect of St. Louis and St. Louis County is important because it reveals what types of soi's are to be found. This region is situated immediately south of the confluence of the Missouri and Mississippi Rivers. Geologically, this area is composed of gray-brown podsolic (ash-like) soils of aeolian derivation. Such a soil is called *loess* because it was built up in ages past through the sustaining action of the wind, and is characterized as a fine silty loam. Six principle types of silty loam occurring over large areas in St. Louis and the county are recorded by H. H. Krusekopf and D. B. Pratapas, who were in charge of the Soil Survey of St. Louis County made by the U. S. Dept. Agr., Bureau of Soils, in 1919. The following paragraphs



Sweet Bay *(Magnolia virginiana)*



Catkins of River Birch

describing the types of soil found in this locality originally appeared in the BULLETIN (pp. 70–71, Apr. 1937), in an article by A. P. Beilmann, entitled "The Soils of St. Louis and St. Louis County."

"The area which includes the Garden and Tower Grove Park and a section north of Chouteau Avenue has soil known as Muscatine Silt Loam. Only these two sections of about four thousand acres belong in this type. It differs from the Tama Silt Loam, found in the Florissant Basin, in the character of the subsoil. Muscatine is more plastic. This was presumably due to the level topography which favored the slow percolation of very fine clay, and thus the subsoil became heavier than most other loess loams. Hard-pan can be found about thirty inches deep.

"The Tama Silt Loam is essentially the same soil, except for the more open texture and better drainage of the deeper portions. Drainage has favored the rapid reduction of organic

Flowers of Sugar Maple

matter. In a dry season it is probably even drier than the Muscatine, but nevertheless an excellent gardening soil.

"Memphis Silt Loam covers the greatest portion of the eastern half of the county and includes most of the truck garden areas. It differs from the Muscatine and Tama in the very open subsoil. In many sections there is no change in texture even to considerable depths. Hard-pan occurs infrequently.

"Perhaps most of the ornamental plantings grow on Clinton Silt Loam. This is an extensive deposit beginning in Forest Park and continuing west to Ellisville. It differs from Memphis in the lower humus content, as shown by the generally lighter color, and represents a much more weathered phase of loess.

"Marion Silt Loam is centered around Kirkwood. Its general lack of productiveness is best indicated by the common name of 'post oak land'. It is the oldest and most weathered soil in the county and apparently the driest. There is a rolling phase south of Clayton which may have a friable subsoil. Such portions may exhibit the characteristics of a much younger soil.

"The last type is a rather narrow strip called Knox Silt Loam extending in an unbroken line along the tops of the Missouri River bluffs. This is the typical loess deposit. It is characterized by great depth and uniform texture clear to the underlying rock. There is no impervious subsoil to interfere with root penetration or water percolation."

All the foregoing types are good "gardening" soils and with careful management are capable of being developed into a high state of productivity. It should be noted, however, that soil excavated from the basements of buildings and subsequently used in grading is not necessarily of the original type or quality; therefore, in the more densely populated areas it is necessary to investigate its physical and chemical properties. The soils are generally acid, the alkaline materials having leached out in the course of their development.

Foliage and fruit of Sugar Maple

The principle topographical feature of St. Louis County is the uplands, which slope generally to the east and west onto the flood plains of the Meramec and Missouri Rivers. The upland regions comprise three distinct topographical entities: the eastern uplands, the Florissant Basin, and Meramec Highlands. A large proportion of the county is gently rolling plain with virtually no extensive level areas. The drainage of the entire county flows through short streams into the Meramec, Missouri and Mississippi Rivers. The streams have broad shallow valleys bordered by gentle slopes. In general, the uplands have reached maturity, the process of dissection being essentially complete. The divides are narrow, and minute dissection is prevented by ready percolation and the relatively low altitude of the uplands above the large stream valleys.

Plants that are inclined to be tender (i. e., their hardiness is not established) ought to be planted on an easterly or southerly exposure. Such a locality should afford protection from the strong winds. Moreover, when drainage is a factor, trees ought not to be located in low-lying situations where surface water does not run off readily.

In Table I, one hundred deciduous trees are listed as being worthy of cultivation for different situations in St. Louis and vicinity:

TABLE I

Selected list of 100 deciduous trees, with size, landscape effects and tolerances indicated.

BOTANICAL NAME	COMMON NAME	SIZE		LANDSCAPE EFFECTS								TOLERANCES							
		Over 20 ft. high	Under 20 ft. high	Coarse foliage	Fine foliage	Dark green leaves	Light green leaves	Leaves remain late in autumn	Autumn color	Attractive flower	Attractive fruit	Heavy clay soil	Dry places	Wet places	Poor soil	Shade-tolerant	Wind-resistant	Smoke-tolerant	Disease & insect resistant
Acer campestre	Hedge Maple		X	X		X		X					X			X			
Acer Ginnala	Amur Maple		X		X		X		X				X				X		
Acer palmatum	Japanese Maple		X		X		X		X							X			
Acer platanoides	Norway Maple	X		X		X		X		X					X		X	X	X
Acer rubrum	Red Maple	X		X			X		X	X	X			X			X		
Acer saccharum	Sugar Maple	X		X		X			X	X						X	X		
Aesculus carnea	Red Horse-chestnut		X	X		X				X	X								X
Aesculus glabra	Ohio Buckeye	X		X		X				X	X			X					X
Aesculus Hippocastanum	Common Horse-chestnut	X		X		X				X	X				X			X	
Aesculus octandra	Sweet Buckeye	X		X		X				X	X			X					X
Aralia chinensis	Chinese Aralia		X		X	X			X	X				X					
Betula lenta	Cherry or Sweet Birch		X		X	X								X					
Betula lutea	Yellow Birch		X		X	X								X					
Betula nigra	River Birch	X			X	X						X		X	X			X	X
Betula pendula	European White Birch		X		X		X												
Bumelia lanuginosa	Woolly Buckthorn		X		X		X	X		X	X	X	X		X		X		X
Carpinus Betulus	European Hornbeam		X		X	X		X						X	X	X	X	X	X
Carpinus caroliniana	American Hornbeam		X		X	X		X						X	X	X	X	X	X
Carya Pecan	Pecan	X		X		X			X		X								
Catalpa ovata	Chinese Catalpa		X	X			X		X	X	X								
Cercidiphyllum japonicum	Katsura Tree		X		X	X			X										X

Cercis canadensis	Redbud		X	X		X				X		X	X		X				
Cladrastis lutea	Yellow-wood	X			X		X		X	X	X		X						
Cornus florida	Flowering Dogwood		X	X		X			X	X	X		X	X	X	X			
Crataegus mollis	Red Haw		X	X		X			X	X	X	X		X			X	X	
Crataegus Oxyacantha	English Hawthorn		X		X	X		X		X							X	X	
Crataegus Phaenopyrum	Washington Thorn		X		X	X			X	X	X							X	
Fagus sylvatica	European Beech	X		X		X										X	X		
Franklinia alatamaha	Franklinia		X	X		X				X									
Fraxinus excelsior	European Ash	X		X		X													
Ginkgo biloba	Maidenhair Tree	X			X		X		X		X						X	X	X
Gymnocladus dioicus	Kentucky Coffee-tree	X			X	X			X	X	X			X		X			X
Halesia monticola	Mountain Silver-bell Tree		X	X		X				X	X					X			X
Ilex opaca	American Holly		X	X		X		X			X			X		X		X	X
Koelreuteria paniculata	Golden-rain Tree	X		X			X			X	X							X	X
Liquidambar Styraciflua	Sweet Gum	X		X		X			X		X	X		X				X	X
Liriodendron Tulipifera	Tulip Tree	X		X		X						X		X				X	
Magnolia acuminata	Cucumber Tree	X		X		X				X	X		X						X
Magnolia denudata	Yulan Magnolia		X	X		X				X									X
Magnolia Fraseri	Ear-leaf Umbrella Tree	X		X		X				X	X								X
Magnolia Kobus	Kobus Magnolia		X	X		X				X									X
Magnolia obovata	Silver Magnolia	X		X		X				X									X
Magnolia salicifolia	Anise Magnolia		X	X		X				X									X
Magnolia tripetala	Umbrella Tree	X		X		X				X	X								X
Malus adstringens	Cultivated Crab		X		X	X				X	X						X		X
Malus Arnoldiana	Arnold Crab		X		X		X			X	X								X
Malus atrosanguinea	Carmine Crab		X		X	X				X	X						X		X
Malus baccata	Siberian Crab		X		X		X			X	X						X		X
Malus floribunda	Japanese Flowering Crab		X		X	X				X	X						X		X
Malus hupehensis	Tea Crab		X		X	X				X	X								X
Malus ioensis	Prairie Crab	X		X		X				X				X			X		
Malus micromalus	Midget Crab		X		X	X				X	X								X
Malus purpurea	Purple Crab		X		X	X				X	X						X		X
Malus robusta	Cherry Crab		X		X	X				X	X						X		X
Malus Scheideckeri	Scheidecker Crab		X		X		X			X	X								X
Malus Sieboldii	Toringo Crab		X		X	X				X	X						X		X
Malus spectabilis	Chinese Flowering Crab		X		X	X				X									X
Malus toringoides	Cutleaf Crab		X		X	X				X	X								X
Malus Zumi	Redbud Crab		X		X	X				X	X						X		X
Nyssa sylvatica	Sour Gum or Tupelo	X		X		X			X		X	X		X					X

TABLE I—*Continued*

BOTANICAL NAME	COMMON NAME	SIZE: Over 20 ft. high	SIZE: Under 20 ft. high	LANDSCAPE EFFECTS: Coarse foliage	Fine foliage	Dark green leaves	Light green leaves	Leaves remain late in autumn	Autumn color	Attractive flower	Attractive fruit	TOLERANCES: Heavy clay soil	Dry places	Wet places	Poor soil	Shade-tolerant	Wind-resistant	Smoke-tolerant	Disease & insect resistant
Ostrya virginiana	Hop-hornbeam		X		X	X						X	X			X	X		X
Paulownia tomentosa	Royal Paulownia	X		X		X				X	X	X	X						X
Phellodendron sachalinense	Sachalin Cork Tree	X		X		X					X		X						X
Pistacia chinensis	Chinese Pistache		X	X		X													
Planera aquatica	Water Elm	X			X	X						X		X					
Platanus acerifolia	London Plane-tree	X		X		X					X							X	
Populus alba	White Poplar	X		X		X							X	X			X	X	
Prunus avium	Sweet Cherry		X	X		X				X	X								
Prunus cerasifera	Cherry Plum		X		X	X				X	X								
Prunus Munsoniana	Wild Goose Plum		X		X	X				X	X								
Prunus Padus	European Bird Cherry		X	X		X				X	X								
Prunus Sargenti	Yama Cherry		X	X		X			X	X	X								
Prunus serrulata	Japanese Flowering Cherry		X	X		X			X	X	X								
Prunus subhirtella autumnalis	Higan Cherry		X	X		X			X	X	X								
Prunus triloba	Flowering Almond		X	X		X				X	X								
Prunus yedoensis	Yoshino Cherry		X	X		X			X	X	X								
Quercus alba	White Oak	X		X		X			X		X			X			X		
Quercus bicolor	Swamp White Oak	X		X		X					X	X		X					
Quercus borealis maxima	Red Oak	X		X		X			X		X		X				X		
Quercus coccinea	Scarlet Oak	X		X		X			X		X		X						
Quercus imbricaria	Shingle Oak	X		X		X					X								
Quercus palustris	Pin Oak	X		X		X					X	X		X			X	X	

Quercus Phellos	Willow Oak	X			X		X				X			X					
Quercus Prinus	Basket Oak	X		X		X					X		X						
Quercus Robur	English Oak	X			X	X		X			X								
Quercus Shumardii	Shumard Oak	X		X		X					X								
Quercus velutina	Black Oak	X		X		X					X		X						
Salix babylonica	Weeping Willow	X			X		X							X				X	
Sapindus Drummondii	Western Soapberry		X		X		X				X	X	X						X
Sophora japonica	Chinese Scholar Tree	X			X	X		X		X	X		X					X	X
Sorbus alnifolia	Alder-leaved Mountain-ash		X	X		X				X	X								
Sorbus Aucuparia	European Mountain-ash		X	X		X				X	X								
Syringa amurensis japonica	Japanese Lilac Tree		X	X		X				X									
Tilia cordata	Small-leaved European Linden	X			X	X				X	X						X	X	
Ulmus glabra	Wych or Scotch Elm	X		X		X													
Ulmus parvifolia	Chinese Elm		X		X	X		X			X								
Ulmus procera	English Elm	X		X		X												X	
Viburnum prunifolium	Black Haw		X	X		X			X	X	X								
Viburnum Sieboldii	Siebold Viburnum		X	X		X				X	X								
Zelkova serrata	Saw-leaf Zelkova	X			X	X													

Flowers of Purple Crab-apple

Flowers of Catalpa

Flowering branch of Slippery Elm

Heavy clay soils tax the capacity of trees to survive. They have two important characteristics, namely, acidity and poor drainage. The following trees are able to grow in spite of such conditions:

TREES FOR HEAVY CLAY SOIL

Acer Negundo, Box-elder
Ailanthus altissima, Tree of Heaven
Betula nigra, River Birch
Broussonetia papyrifera, Paper Mulberry
Bumelia lanuginosa, Woolly Buckthorn
Carya cordiformis, Bitternut
Carya ovata, Shagbark Hickory
Catalpa bignonioides, Common Catalpa
Catalpa speciosa, Western Catalpa
Celtis occidentalis, Hackberry
Cercis canadensis, Redbud
Crataegus mollis, Red Haw
Diospyros virginiana, Common Persimmon
Fraxinus americana, White Ash
Fraxinus pennsylvanica lanceolata, Green Ash
Gleditsia triacanthos, Honey Locust
Juglans nigra, Black Walnut
Leitneria floridana, Corkwood
Liquidambar Styraciflua, Sweet Gum
Liriodendron Tulipifera, Tulip Tree
Maclura pomifera, Osage Orange
Nyssa sylvatica, Sour Gum
Ostrya virginiana, Hop-hornbeam
Paulownia tomentosa, Royal Paulownia
Planera aquatica, Water Elm
Platanus occidentalis, Sycamore
Populus deltoides, Cottonwood
Prunus serotina, Black Cherry
Quercus bicolor, Swamp White Oak
Quercus macrocarpa, Burr Oak
Quercus palustris, Pin Oak
Quercus stellata, Post Oak
Sapindus Drummondii, Western Soapberry
Sassafras albidum, Sassafras
Ulmus americana, White Elm
Ulmus fulva, Slippery Elm

Only a limited number of trees are adapted to dry situations. These trees must have roots that are able to penetrate deeply into the soil or venture far in search of moisture. Although the surface of the soil seems dry, nevertheless there must be a source of water within a reasonable distance.

TREES FOR DRY SITUATIONS

Acer campestre, Hedge Maple
Acer Ginnala, Amur Maple
Acer Negundo, Box-elder
Ailanthus altissima, Tree of Heaven
Broussonetia papyrifera, Paper Mulberry
Bumelia lanuginosa, Woolly Buckthorn
Carya cordiformis, Bitternut
Celtis occidentalis, Hackberry
Cercis canadensis, Redbud
Cladrastis lutea, Yellow-wood
Cornus florida, Flowering Dogwood
Diospyros virginiana, Persimmon
Elaeagnus angustifolia, Russian Olive
Fraxinus quadrangulata, Blue Ash
Gleditsia triacanthos, Honey Locust
Juglans nigra, Black Walnut
Maclura pomifera, Osage Orange
Magnolia acuminata, Cucumber Tree
Ostrya virginiana, Hop-hornbeam
Paulownia tomentosa, Royal Paulownia
Phellodendron sachalinense, Sachalin Cork Tree
Populus alba, White Poplar
Quercus borealis maxima, Red Oak
Quercus coccinea, Scarlet Oak
Quercus Prinus, Basket Oak
Quercus stellata, Post Oak
Quercus velutina, Black Oak
Sapindus Drummondii, Western Soapberry
Sassafras albidum, Sassafras
Sophora japonica, Chinese Scholar Tree
Ulmus fulva, Slippery Elm

Many trees will survive in moist localities, but do not grow well where water stands for protracted periods. The following list comprises those species which only tolerate temporary wet situations:

TREES FOR WET SITUATIONS

Acer Negundo, Box-elder
Acer rubrum, Red Maple
Acer saccharinum, Silver Maple
Aesculus glabra, Ohio Buckeye
Aesculus octandra, Sweet Buckeye
Aralia chinensis, Chinese Aralia
Asimina triloba, Pawpaw
Betula lenta, Cherry or Sweet Birch
Betula lutea, Yellow Birch
Betula nigra, River Birch
Carpinus Betulus, European Hornbeam
Carpinus caroliniana, American Hornbeam
Celtis occidentalis, Hackberry
Cornus florida, Flowering Dogwood
Crataegus mollis, Red Haw
Diospyros virginiana, Common Persimmon
Fagus grandifolia, American Beech
Fraxinus pennsylvanica lanceolata, Green Ash
Gleditsia aquatica, Water Locust
Gymnocladus dioicus, Kentucky Coffee Tree
Ilex opaca, American Holly
Juglans nigra, Black Walnut
Liquidambar Styraciflua, Sweet Gum
Liriodendron Tulipifera, Tulip Tree
Malus ioensis, Prairie Crab-apple
Nyssa sylvatica, Sour Gum
Planera aquatica, Water Elm
Platanus occidentalis, Sycamore
Populus spp., Poplars
Quercus alba, White Oak
Quercus bicolor, Swamp White Oak
Quercus palustris, Pin Oak
Quercus Phellos, Willow Oak
Salix spp., Willows
Tilia americana, American Linden
Ulmus americana, White Elm

Infertile soils support few species of plants except those commonly referred to as "weeds." The following list contains trees that will grow despite poor soil conditions:

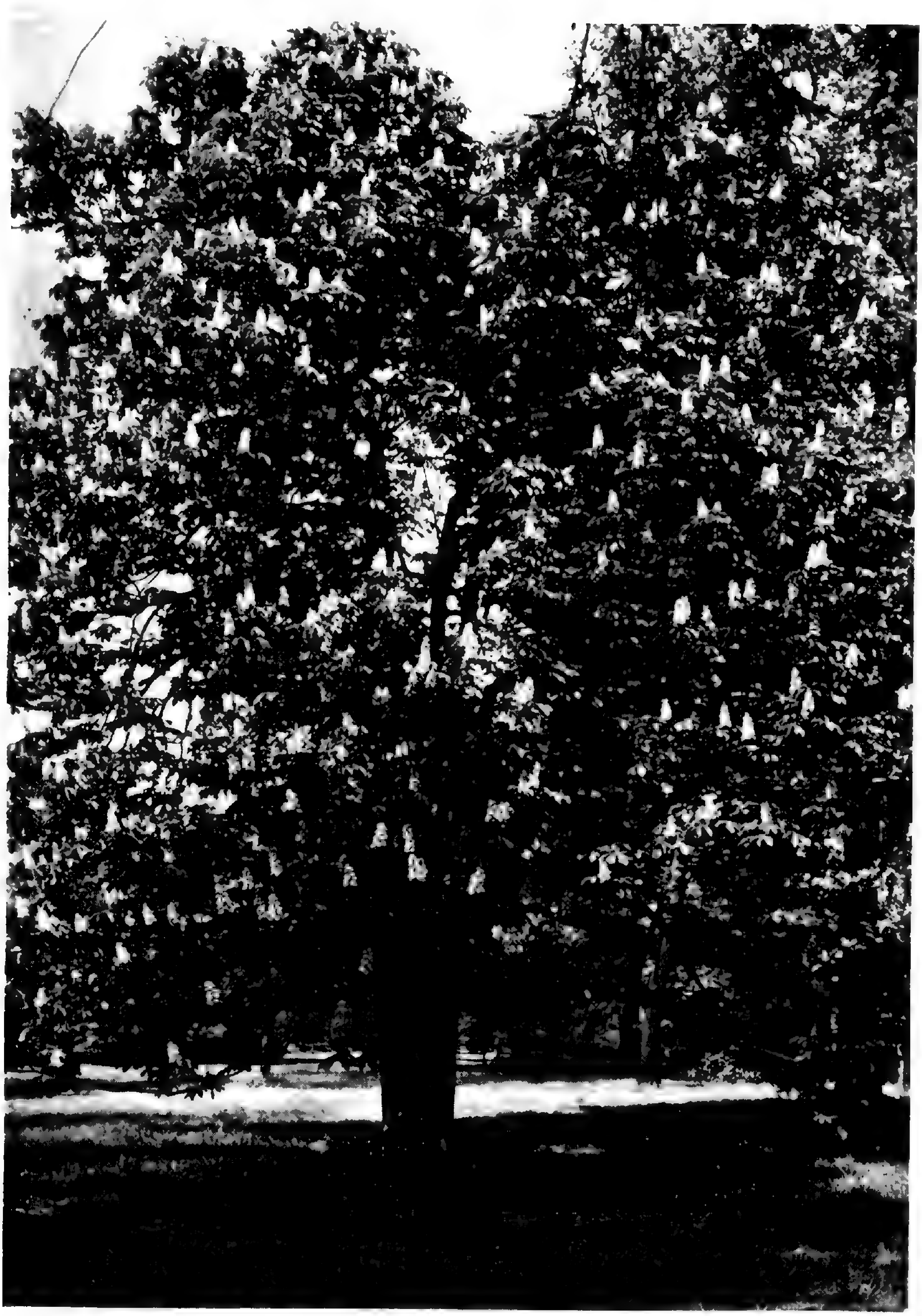
TREES FOR POOR SOILS

Acer Negundo, Box-elder
Acer platanoides, Norway Maple
Acer saccharinum, Silver Maple
Aesculus Hippocastanum, Common Horse-chestnut
Ailanthus altissima, Tree of Heaven
Betula nigra, River Birch
Broussonetia papyrifera, Paper Mulberry
Bumelia lanuginosa, Woolly Buckthorn
Carpinus spp., Hornbeams
Carya cordiformis, Bitternut
Carya ovata, Shagbark Hickory
Catalpa bignonioides, Common Catalpa
Catalpa speciosa, Western Catalpa
Celtis occidentalis, Hackberry
Cercis canadensis, Redbud
Cornus florida, Flowering Dogwood
Euonymus Bungeana, Common Winterberry
Maclura pomifera, Osage Orange
Morus alba, White Mulberry
Morus rubra, Red Mulberry
Phellodendron amurense, Amur Cork
Platanus occidentalis, Sycamore
Populus nigra italica, Lombardy Poplar
Pyrus communis, Common Pear
Robinia Pseudoacacia, Black Locust
Sassafras albidum, Sassafras
Ulmus americana, White Elm
Ulmus pumila, Siberian Elm

Shade presents a difficult condition for the growing of plants. A few trees are able to withstand shade and competition from the roots of larger, well-established trees. In nature, the shade-tolerant trees generally form the under-story of hardwood forests.

SHADE-TOLERANT TREES

Acer campestre, Hedge Maple
Acer palmatum, Japanese Maple
Acer saccharum, Sugar Maple
Asimina triloba, Pawpaw
Carpinus Betulus, European Hornbeam
Carpinus caroliniana, American Hornbeam
Cornus florida, Flowering Dogwood
Cornus Kousa, Chinese Flowering Dogwood
Fagus grandifolia, American Beech
Fagus sylvatica, European Beech
Gymnocladus dioicus, Kentucky Coffee-tree
Halesia monticola, Mountain Silverbell Tree
Ilex opaca, American Holly
Leitneria floridana, Corkwood
Ostrya virginiana, Hop-hornbeam
Sassafras albidum, Sassafras



THE HORSE-CHESTNUT *(Aesculus Hippocastanum)*

Owing to their tolerance to strong winds, the following trees may be used for screens or windbreaks:

WIND-RESISTANT TREES

Acer Ginnala, Amur Maple
Acer Negundo, Box-elder
Acer platanoides, Norway Maple
Acer rubrum, Red Maple
Acer saccharum, Sugar Maple
Bumelia lanuginosa, Woolly Buckthorn
Carpinus Betulus, European Hornbeam
Carpinus caroliniana, American Hornbeam
Crataegus mollis, Red Haw
Crataegus Oxyacantha, English Hawthorn
Fagus sylvatica, European Beech
Fraxinus spp., Ashes
Ginkgo biloba, Maidenhair Tree
Maclura pomifera, Osage Orange
Malus spp., Crab-apples
Ostrya virginiana, Hop-hornbeam
Populus alba pyramidalis, Abele
Populus nigra italica, Lombardy Poplar
Pyrus communis, Common Pear
Quercus alba, White Oak
Quercus borealis maxima, Red Oak
Quercus palustris, Pin Oak
Salix alba, White Willow
Sassafras albidum, Sassafras
Tilia cordata, Small-leaved European Linden
Ulmus americana, White Elm
Ulmus pumila, Siberian Elm

Smoke-resistant trees are perhaps the most admirable group of plants that man can raise, because in return for poor living conditions they give oxygen to the air and shade to the ground, as well as a touch of green against the austere walls of the busy city. As industries expand and populations become denser, natural conditions become unbalanced. Vegetation is limited to those plants that can withstand a gaseous atmosphere. A list of smoke-tolerant trees follows:

SMOKE-TOLERANT TREES

Acer Negundo, Box-elder
Acer platanoides, Norway Maple
Acer saccharinum, Silver Maple
Aesculus Hippocastanum, Common Horse-chestnut
Ailanthus altissima, Tree of Heaven
Betula nigra, River Birch
Broussonetia papyrifera, Paper Mulberry
Carpinus Betulus, European Hornbeam
Carpinus caroliniana, American Hornbeam
Catalpa bignonioides, Common Catalpa
Catalpa speciosa, Western Catalpa
Celtis occidentalis, Hackberry
Crataegus mollis, Red Haw
Crataegus Oxyacantha, English Hawthorn
Crataegus Phaenopyrum, Washington Thorn
Elaeagnus angustifolia, Russian Olive
Euonymus Bungeana, Common Winterberry
Fraxinus americana, White Ash
Ginkgo biloba, Maidenhair Tree
Ilex opaca, American Holly
Koelreuteria paniculata, Golden-rain Tree
Liquidambar Styraciflua, Sweet Gum
Liriodendron Tulipifera, Tulip Tree
Platanus acerifolia, London Plane-tree
Platanus occidentalis, American Sycamore
Populus alba pyramidalis, Abele
Populus canadensis Eugenei, Carolina Poplar
Populus deltoides, Cottonwood
Populus nigra italica, Lombardy Poplar
Prunus serotina, Black Cherry
Pyrus communis, Common Pear
Quercus palustris, Pin Oak
Robinia Pseudoacacia, Black Locust
Salix babylonica, Weeping Willow
Sophora japonica, Chinese Scholar Tree
Tilia cordata, Small-leaved European Linden
Ulmus americana, White Elm
Ulmus procera, English Elm
Ulmus pumila, Siberian Elm

Trees that are relatively free from disease and insect pests are often preferred because they do not require the constant expense of spraying or removing large branches year after year. A few trees in this category are listed below:

TREES FREE FROM DISEASE AND INSECT PESTS

Acer platanoides, Norway Maple
Aesculus spp. (except *A. Hippocastanum*)
Ailanthus altissima, Tree of Heaven
Asimina triloba, Pawpaw
Betula nigra, River Birch
Broussonetia papyrifera, Paper Mulberry
Bumelia lanuginosa, Woolly Buckthorn
Carpinus Betulus, European Hornbeam
Carpinus caroliniana, American Hornbeam
Cercidiphyllum japonicum, Katsura Tree
Diospyros virginiana, Persimmon
Elaeagnus angustifolia, Russian Olive
Ginkgo biloba, Maidenhair Tree
Gymnocladus dioicus, Kentucky Coffee-tree
Halesia spp., Silverbell Trees
Ilex opaca, American Holly
Koelreuteria paniculata, Golden-rain Tree
Liquidambar Styraciflua, Sweet Gum
Magnolia, spp., Magnolias
Malus (Oriental species), Crab-apples
Nyssa sylvatica, Sour Gum
Ostrya virginiana, Hop-hornbeam
Paulownia tomentosa, Royal Paulownia
Phellodendron sachalinense, Sachalin Cork Tree
Sapindus Drummondii, Western Soapberry
Sassafras albidum, Sassafras
Sophora japonica, Chinese Scholar Tree

One of the glories of autumn is the highly colored landscape. In part this "atmosphere" is achieved by trees whose foliage has "turned" by taking on hues of scarlet, yellow, purple and reds. The following list contains species which may be expected to produce brightly colored autumn effects:

TREES WITH ATTRACTIVE AUTUMN FOLIAGE

Acer Ginnala, Hedge Maple
Acer palmatum, Japanese Maple
Acer rubrum, Red Maple
Acer saccharum, Sugar Maple
Aralia chinensis, Chinese Aralia
Betula pendula, European White Birch
Carya spp., Hickories
Cercidiphyllum japonicum, Katsura Tree
Cladrastis lutea, Yellow-wood
Cornus florida, Flowering Dogwood
Crataegus spp., Hawthorns
Franklinia alatamaha, Franklinia
Fraxinus americana, White Ash
Ginkgo biloba, Maidenhair Tree
Gymnocladus dioicus, Kentucky Coffee-tree
Juglans spp., Walnuts
Liquidambar Styraciflua, Sweet Gum
Liriodendron Tulipifera, Tulip Tree
Magnolia acuminata, Cucumber Tree
Nyssa sylvatica, Sour Gum
Prunus Sargenti, Yama Cherry
Prunus serrulata, Japanese Flowering Cherry
Prunus subhirtella autumnalis, Higan Cherry
Prunus yedoensis, Yoshino Cherry
Quercus alba, White Oak
Quercus borealis maxima, Red Oak
Quercus coccinea, Scarlet Oak
Quercus palustris, Pin Oak
Sassafras albidum, Sassafras
Viburnum prunifolium, Black Haw

Flowering trees, especially those species with conspicuous flowers, are much preferred by gardeners. Of course, all trees produce "flowers" of one kind or another, yet the value of the tree is enhanced if the flowers are numerous, large or brightly colored.

TREES WITH CONSPICUOUS FLOWERS

Acer platanoides, Norway Maple
Acer rubrum, Red Maple
Acer saccharum, Sugar Maple
Aesculus spp., Horse-chestnuts
Aralia spp., Devil's Walking-stick
Bumelia lanuginosa, Woolly Buckthorn
Catalpa spp., Catalpas
Cercis canadensis, Redbud
Cladrastis lutea, Yellow-wood
Cornus spp., Dogwoods
Crataegus spp., Hawthorns
Franklinia alatamaha, Franklinia
Gleditsia spp., Honey Locusts
Gymnocladus dioicus, Kentucky Coffee-tree
Halesia spp., Silverbell Trees
Koelreuteria paniculata, Golden-rain Tree
Magnolia spp., Magnolias
Malus spp., Crab-apples
Paulownia tomentosa, Royal Paulownia
Prunus spp., Peaches, Plums, Cherries and Almonds
Pyrus spp., Pears
Robinia Pseudoacacia, Black Locust
Sophora japonica, Chinese Scholar Tree
Sorbus spp., Mountain Ashes
Syringa amurensis japonica, Japanese Tree Lilac
Tilia cordata, Small-leaved European Linden
Viburnum spp., Viburnums

Fruits are exceedingly variable in shape and color. Some become highly colored early in autumn while others persist on the branches late into winter and become very ornamental. A few trees with outstanding fruits in either category are listed below:

TREES WITH ATTRACTIVE FRUITS

HIGHLY COLORED FRUITS	ORNAMENTAL FRUITS
Acer rubrum, Red Maple	*Ailanthus altissima*, Tree of Heaven
Cornus florida, Flowering Dogwood	*Cladrastic lutea*, Yellow-wood
Crataegus mollis, Red Haw	*Ginkgo biloba*, Maidenhair Tree
Crataegus Phaenopyrum, Washington Thorn	*Gleditsia* spp., Honey Locusts
Euonymus spp., Winterberries	*Halesia* spp., Silverbell Trees
Ilex opaca, American Holly	*Koelreuteria paniculata*, Golden-rain Tree
Magnolia spp., Magnolias	*Phellodendron* spp., Cork Trees
Malus (Oriental species), Crab-apples	*Sapindus Drummondii*, Western Soapberry
Nyssa sylvatica, Sour Gum	*Sophora japonica*, Chinese Scholar Tree
Prunus spp., Plums and Cherries	*Ulmus parvifolia*, Chinese Elm

Certain plants produce fruits that are eagerly sought after by birds and animals. The gardener who wishes to encourage visits by such wild life would do well to plant a few of the following trees:

TREES THAT ATTRACT WILD-LIFE

Betula spp., Birches	*Planera aquatica*, Water Elm
Bumelia lanuginosa, Woolly Buckthorn	*Platanus* spp., Sycamores
Carpinus spp., Hornbeams	*Populus* spp., Poplars
Carya spp., Hickories	*Prunus* spp., Plums, Cherries and Almonds
Cornus florida, Flowering Dogwood	*Quercus* spp., Oaks
Ilex opaca, American Holly	*Salix* spp., Willows
Magnolia, spp., Magnolias	*Sapindus Drummondii*, Western Soapberry
Malus spp., Crab-apples	*Sorbus* spp., Mountain Ashes
Nyssa sylvatica, Sour Gum	*Ulmus* spp., Elms
Ostrya virginiana, Hop-hornbeam	*Viburnum* spp., Viburnums

SOUTH AMERICAN ARROW POISONS

PAUL H. ALLEN

The headlines were electric: "South American Snake Poison Used in Medical Science." My wife handed me the paper in disgust. "Even I know that *curare* isn't made from snakes, so why do they keep printing such foolishness?" The answer is probably that we all enjoy a marvelous tale, but in the case of the once-mysterious jungle poison, which is today helping injured veterans back to health, the truth far overshadows all fiction. Primitive South American Indian tribes, by that sheer genius dictated by necessity, have evolved a poison so powerful and sure that the slightest scratch by the dart or arrow will bring paralysis and death to the bird or animal without injuring the meat for human consumption.

The origin of the famous blowgun, with which the poisoned darts are most frequently used, has been a fruitful source of dispute by specialists.

One school links this weapon in the Americas with the Malayan blowgun, while another believes that necessity is the mother of invention and that similarity of circumstance and surroundings might well have led to its independent invention by the American Indian. Arrow poisons of various types are known to have been of ancient and widespread distribution, and there is no question, for example, that Aconite-based poisons were independently invented and used by the Moors in Spain.

While the origins of the use of *curare* and the blowgun in South America are irretrievably lost in the mists of pre-history, some inquiry into forest conditions there will at least show the tremendous advantages of their combined use. Since the development of systematic agriculture relieves the food problem in its most acute form, it would seem reasonable to suppose that the discovery of *curare* preceded any such fixed means of livelihood. It is noteworthy that all present-day Uaupes Indian tribes living and having permanent plantings in Malocas obtain *curare* by trade from the primitive bands of forest Macusis, who have no agriculture and are as a consequence almost entirely dependent on the use of *curare* to obtain meat.

Contrary to general belief, the vast forested areas of the Amazon and the Río Negro have relatively few large land mammals; in fact the only kinds occurring in any abundance are the Collared and White-lipped Peccaries. It has been the writer's experience that deer, tapir, and even peccaries, become exceedingly scarce and tend to be nocturnal in their habits in areas of Indian occupation. Tribes dependent on these would soon deplete an area to the point of starvation if it were not for the fact that a most abundant store-house of animal life exists in the tree tops. The great majority of animals and birds which inhabit the tremendous unbroken South American rain forests are arboreal, spending nearly their entire lives in the jungle top and relying on their relatively small size and agility for survival. The advantage of a powerful poison used with silent darts blown through a tube would be very obvious to folk dependent on the life zone eighty feet above their heads for a living.

Blowguns in the American tropics are of various types, and all display a considerable amount of ingenuity in their construction. Their length varies considerably, but most are from 9 to 12 feet, the longer guns being unwieldy but accurate. The use of the blowgun in the Americas extends roughly from the Amazon drainage basin of South America northward to Mexico, Central America, and parts of the West Indies. Clay pellets are, or were, used instead of darts on the fringes of its range, and since small tubes using such pellets are frequently seen in the Uaupes where young boys kill cockroaches with them it seems possible that the more complicated weapon might have had its origin in such small beginnings.

In blowgun construction, the problem is to combine a slender bore of about .45 cal., 9–12 feet in length, with the extreme rigidity needed for an accurate shot. These conflicting needs have been admirably solved in several ways. On the Río Uaupes, the area with which the writer is most familiar, two basic blowgun types are in use. Both are illustrated in figs. 1 and 2. It will be noted that the right-hand gun is constructed of a solid tube, fitted with a mouthpiece. This tube is made of a common, slender palm (*Iriartea setigera* Mart.) which has a straight trunk averaging ¾–1½ inches in uniform diameter. The piece to be used is soaked in water for a few days to soften the pith, which is then removed by means of a long rod, the bore

Fig. 1. South American blowguns and quivers

being polished by repeatedly drawing through it tufts of rough tree-fern root. Since a palm trunk slender enough to give the proper bore would be too frail to provide proper rigidity, it must be trimmed and polished, and inserted in another section of the same palm, of larger diameter, the curves of the one being made to counteract those of the other to obtain a straight instrument. The mouthpiece, of a dark, heavy red wood known as *Mirapiranga*, is carefully cemented in place with a black pitch obtained from the nests of the Melipona bee. A variation of this method is found in the hinterlands of the Guianas, where the inner tube consists of a long, unjointed section of a remarkable reed (*Arundinaria Schomburgkii* Benth.) found only in the Alto Parima, a major western tributary of the Río

Branco, and perhaps also in the adjacent headwaters of the Orinoco. These tubes, called "Reeds of Esmeralda," are trade items among the Indian tribes, and are found widely distributed in the Guianas, far from their place of origin. They are enclosed in sections of the same species of palm previously described when made up into blowguns.

The second general type of blowgun, shown at the left in figs. 1 and 2, is used in the Uaupes area by the Carijonas and other tribes living on tributaries of the Río Apoporis. This type is tremendously more difficult to manufacture, being made of two separate lengths of wood averaging 9–12 feet in length, each carefully channeled for its entire length, the two halves forming a symmetrical tube when joined together (see fig. 2-A). This patient labor is performed with the most primitive tools, usually the incisors of the *Paca* or *Agouti*, and the greatest care must be exercised to assure an accurate weapon. The writer saw one in the process of manufacture in the

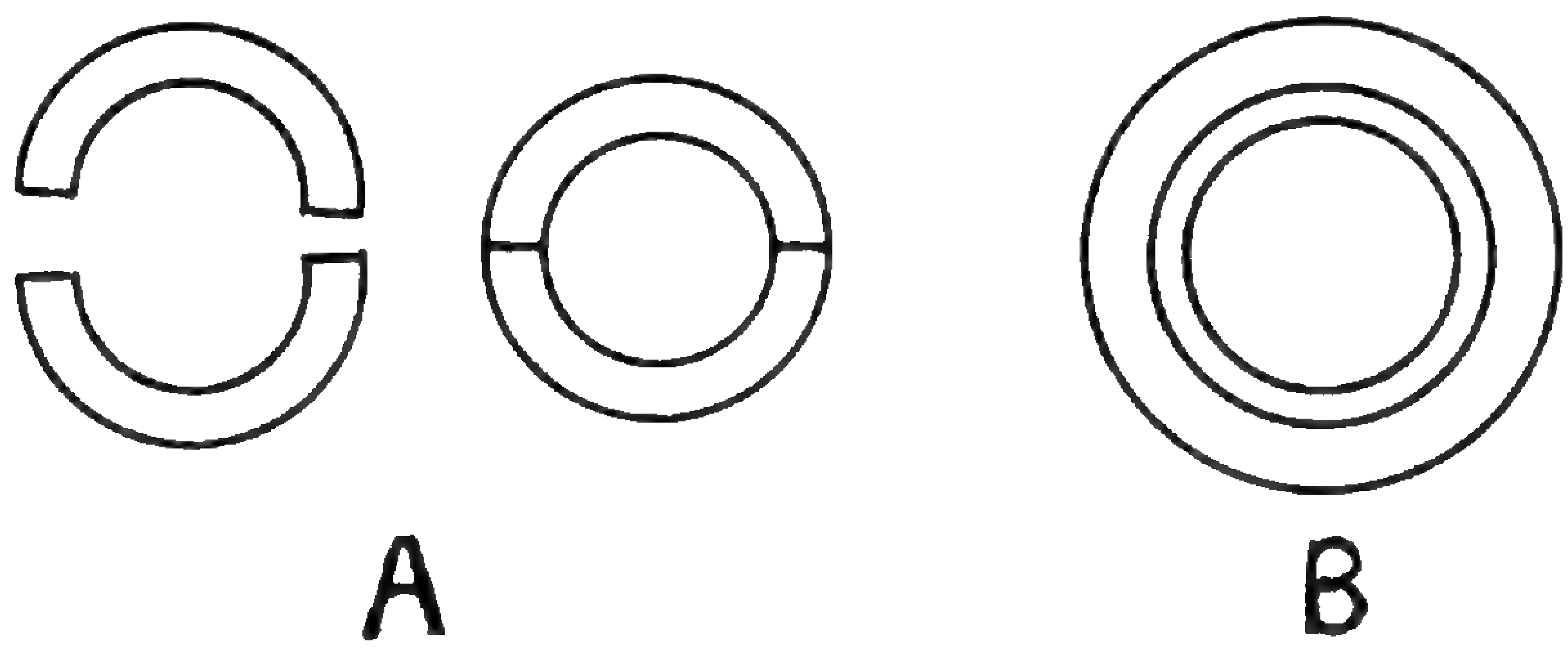


Fig. 2. Showing construction of blowguns

Inambu Igaripe in Brazilian territory, and was told that several months' work was still needed to produce the completed article. Although an Indian rarely works very steadily at such a project, a great deal of labor goes into its making. Since he considers a blowgun in the same light as we do a prized firearm, an implement usually lasting for the user's lifetime, it is not surprising that he is willing to put so much time and effort into its manufacture. The two halves, when adjudged as nearly perfect as possible, are bound together with carefully selected strips of bark, and fitted with a mouthpiece of hard wood similar to that already described. These guns taper slightly toward the muzzle, and are quite heavy, so that considerable practice is needed for their effective use. Indian tribes on the Alto Putumayo (Ica) on the boundary between Colombia and Peru cover the spiral binding with black pitch, as waterproofing.

As would be expected, quivers for carrying the poisoned darts fall also into two general groups, corresponding to the two major types of blowguns. In the writer's experience, the blowguns constructed of whole sections of

Fig. 3. Kubeo boy demonstrating use of blowgun—Yararaca, Alto Cuduyari, Uaupes region.

palm trunk are accompanied by quivers made of two separate layers of closely woven basketry, with an intervening layer of pitch for waterproofing, and topped by a cap (see fig. 1). These vary somewhat in shape from tribe to tribe, but are all made on the same general principle. The darts are constructed from the long spinous processes attached to the fronds of a common palm (*Oenocarpus Bataua* Mart.), one end being sharpened and poisoned with *curare*, the other having a spindle-shaped tuft of brown kapok held in place by a bit of Bromelia string. A considerable degree of skill is required to gauge the diameter of these tufts exactly to the bore of the blowgun with which they are to be used.

Blowguns constructed of two halves, with spiral binding, have been accompanied by quivers of a section of bamboo tubing, with a small round gourd attached to the side filled with extra cotton (see fig. 1). The darts are relatively short, averaging eight inches in length, often made from the dried mid-rib of a palm leaf, and poisoned for about an inch and a half from the poisoned tip. They have a tuft of cotton (Gossypium) twisted on the shaft in the form of an inverted cone, considerably less in diameter than the bore of the blowgun. When in use, an additional tuft of cotton is taken from the gourd, and placed behind the dart for added compression.

A tremendous mine of conflicting misinformation has accumulated since the first Europeans came in contact with *curare*. The earliest Spanish chronicler, Oviedo[1], an honest man reporting things as best he could in the light of his times, apparently believed that it was manufactured from the juice of the common poisonous *manzanillo (Hippomane Mancinella* L.*)*, which sometimes may actually have been one of the minor ingredients. The good Padre Gumilla[2], although long resident in the country of its manufacture and use, readily ascribes its discovery by the Indians to information given them by the Devil, and says that elderly slave women were employed in its manufacture, since one, and often two, died from the poisonous vapors. The finished product was tested, according to his account, by bringing an arrow dipped in the poison near an open wound made for the purpose in the arm or thigh of one of the younger men; if the blood flowed back into the cut the poison was considered ready, but if bleeding continued further concentration was necessary. He believed the effect to be instant coagulation of the blood, and describes, as an eye witness, the experiment on a monkey in which the animal fell instantly dead and the blood was found to be entirely congealed when the body was opened for examination[3]. For the benefit of his flock, we must hope that the good missionary was better suited to his spiritual duties than he was in his observation of worldly matters. Charles Waterton[4], although dubiously adding ants and snake fangs to the ingredients, gives a clear, straightforward account of experiments presumably conducted by himself, in which he demonstrated that large animals up to the size of an ox could

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[1] Gonzalo Fernandez de Oviedo y Valdez. Natural Hystoria de las Indias. 1526.

[2] El Orinoco illustrado y defendido. Madrid, 1745.

[3] "y tomando yo un indio aparte le rogué que flechase uno de aquellos monos, el cual, parado en pie sobre una hoja de palma, con la mano izquierda tenía otra hoja más alto; dióle la punta de la flecha en el pecho, levantô la mano derecha que tenía colgando e hizo ademán de querer arrancar la flecha (como lo hacen cuando las tales no tienen curare); pero al mismo tiempa de hacer el ademán, y sin acabar de llegar la mano a la flecha, cayó muerto al pie de la palma; corrí aunque estaba cerca, y no hallándole calor en lo exterior del cuerpo, lo mandé abrir desde el pecho hasta abajo; oh, prodigio grande de las causas ocultas que ignoramus!; no le hallé rastro alguno de calor ni aun en el mismo corazón. Al contorno de este tenía mucha sangre cuajada, negra y fría; etc. [Cap. XII].

[4] Wanderings in South America. London, 1891.

be killed with *curare,* the length of time required being in proportion to the quantity of the poison used. While the ox died after an interval of twenty-five minutes and chickens in five, Waterton was correct in his deduction that the chicken had received much more poison in proportion to its body weight than had the ox. Rudolf Virchow and Julius Munter, experimenting in Berlin with *curare* supplied by Richard Schomburgk, concluded that death resulted from paralysis of the respiratory movements. It is interesting in this connection that Waterton claims to have conducted experiments on a donkey in England, about 1815, in which the animal was apparently killed with *curare,* then successfully revived by pumping air into its lungs for some four hours with a hand bellows. Humboldt was the first actually to witness the preparation of the poison at Esmeralda, on the Orinoco, and Robert Schomburgk secured herbarium specimens in Guiana in 1835 of the principal ingredient, which he subsequently described as *Strychnos toxifera.*

Although a great variety of other plant and animal substances seem to be used in various parts of South America, the basic principle in each case is some species of *Strychnos,* the bark of the roots or stems being the portions used. Some tribes use as many as five species of *Strychnos,* while others use only one but often added other plants[5] or such extraneous ingredients as the milky exudate obtained by toasting small frogs *(Dendrobates)* over a slow fire.[6] The purpose of some of these, particularly of a milky latex, may be to thicken and coagulate the product, since the juice of the roots of Strychnos alone, no matter how concentrated, is not of proper consistency to adhere to the points of the darts. Apparently some twelve species of Strychnos are definitely known to enter into the composition of *curare*[7], of which the three most important are *Strychnos toxifera* Schomb., S. *guianensis* (Aubl.) Mart., and S. *Castelnaeana* Wedd. All are giant woody lianas, often climbing to the tops of the largest forest trees. The writer was shown sterile material, probably of *Strychnos guianensis,* on the Río Macu-Parana, a tributary of the Río Papuri, which was reported by a friendly Desano Payé as being the principal ingredient used by the Macusis in the manufacture of *curare* in the Uaupes. All of the finished product actually seen had been obtained by

[5] A Amazonia Brasileira—Arvores e Plantas Uteis. By Paul le Cointe. Plant materials other than Strychnos entering into the composition of *curare* in Brazil. Principle listed as: Bark of *Abuta imene,* root of *Piper geniculatum,* bark of *Ficus atrox,* bark of *Lonchocarpus rariflorus,* fruits of *Capsicum pendulum,* milk of *Hura crepitans,* milk of *Euphorbia cotinifolia,* fruits of *Guatteria veneficiorum,* roots of *Ottonia waracabacoura,* bark of *Caraipa angustifolia,* root of *Abuta candicans,* juice of leaves of *Petiveria aliacea* and *Diffenbachia seguine.*

[6] Used by the Cuna-Cuna Indians in the Choco of Colombia, and Darien Province in adjacent Panama.

[7] *Strychnos toxifera, S. javarienensis, S. solimoesana, S. Jobertiana, S. Peckii, S. pedunculata, S. Mitscherlichii, S. guianensis, S. subcordata, S. cogens, S. Melinoniana, S. Castelnaeana.* [The American Species of Strychnos. B. A. Krukoff and J. Monachino in Brittonia, Vol. 4, No. 2, 1942.]

barter from Macusis living inland from Guainambi Cachoeira on the Macu-Parana, or in the forests north of Guaracapuri Cachoeira on the Uaupes proper. The poison was always found in tiny black clay jars, such as is shown in fig. 1, which were kept suspended in the dryest part of the *malocas*. Kept in this way, the *curare* becomes, dry, brown and hard, reputedly retaining its toxicity for many years. It is softened by the addition of water when it is to be used for the poisoning of darts or arrows, after which it is again dried to preserve its strength. Darts of the types described will kill birds or small animals within five minutes, while heavier arrows, often with detachable warheads, are used for larger game, which, on occasion, may include men. These heavier arrows, for use with a stout bow, are kept in special bundles of six or eight. The poisoned points, each of which carry a quarter ounce or more of *curare*, are covered with a protective sheath of basketry when not in use.

The relaxing properties of *curare* have long been recognized by medical research men as a potential solution to many problems involving muscular tension, but further research on the subject was hindered by the extremely diverse composition of the native product. In the years just preceding the past war, scientists at the University of Nebraska and in the laboratories of E. R. Squibb & Sons succeeded in standardizing the product as a pure, straw-colored fluid which could be used with confidence by the physician. Injected in minute quantities, it relieves rigidity and many types of muscular spasms which complicate treatment or training. Deep ether anaesthesia is dangerous for individuals with weak hearts, making major abdominal surgery all but impossible since complete relaxation of the muscles must be obtained for successful work. Injections of *curare*, given just before the operation, give the patient the proper degree of relaxation, so that he can be treated under completely safe light or local anaesthetics. Either metrazol or electric shock is often the only effective treatment for certain types of insanity, but the violent convulsions thus produced frequently result in muscular injury. It has been found that such treatments can be made entirely safe in conjunction with *curare*. The initial spasms of tetanus and the dread infantile paralysis respond, as by magic, to this wonder drug, and while in no sense a cure it provides blessed relief for the patient. Modern medicine has confirmed Waterton's early experiments, and any tendency to an overdose is promptly checked with oxygen and artificial respiration. Veterans who have sustained brain or spinal injuries cutting the lines of normal muscular coordination are finding in *curare* intervals of relaxation during which they are learning to walk, and live again. Just as Aconite traveled the long road from a Moorish arrow poison to its place in the modern Pharmacopoeia, so *curare* has left its jungle home to work for the benefit of mankind.

LETTER FROM PAUL H. ALLEN

The publication of the "Flora of Panama" in the Garden ANNALS is proceeding according to schedule, the third fascicle of Part III (Orchidaceae) being now in press. This work is greatly enhanced by the field activities of Paul H. Allen, the Garden's Representative in the Tropics, which are so colorfully described in the following letter:

"Gamboa, C. Z.
"October 2, 1946

"Dear Dr. Moore:

"After a long period of our usual fall rains, we are today enjoying our second consecutive morning of bright sun, light breezes, and tall, white fleecy clouds. Though it is too early to expect such weather to last, it is particularly welcome since we have on hand a very large and choice collection of specimens for drying, gathered on a recent three-day junket to my favorite collecting ground north of El Valle.

"This weather, as usual, was productive of many wonderful things not previously seen, and served also to renew acquaintance with many others rare in collections and not seen in several years. The house is gay, for example, with several fine flowering plants of *Columnea arguta*, with magnificent scarlet blooms. This is a plant of which cuttings were recently sent, and is well worth every attention. We also have in bloom the rare and curious *Oncidium globuliferum*, which has clusters of thumbpot-sized pseudobulbs, separated by long, wiry, vine-like stems. It twines through the tops of trees at high elevations and produces charming golden-yellow flowers very reminiscent of *Oncidium ampliatum* var. *majus*, but, I must hasten to admit, only one at a time. I have often wondered, however, if this, and some of the other midget Oncidiums, such as O. *crista-galli* and O. *pusillum*, might not be interesting subjects for a novelty display at your orchid shows.

"On the first day of the trip I was fortunate enough to find two countrymen in the process of felling a tract of climax forest, giant buttressed trees a hundred feet tall, whose tops were loaded to the breaking point with epiphytes of every description. It was an awesome sight to stand below and watch these veterans, each wreathed and festooned with a perfect epiphytic microcosm, crack warningly once or twice under the axe, and then, with a bursting report, describe a giant arc downward through the foggy air and roar to earth with a thunderous crash. And all this to cultivate the lowly chayote *(Sechium edule)*, but on this occasion also affording a rich harvest of dried and living plant specimens. A full list of the epiphytes alone would fill many pages, but it may give some idea of the wealth of the place when a single large tree-top may contain, besides orchids and hepatics, such diverse ferns as Trichomanes, *Oleandra costaricensis* in hugh colonial cascades, or the creeping stems and fantastic myrmecophyllous tubers of *Polypodium Brunei.* Orchids were in profusion: handsome species of Sobralia, Stanhopea, Lycaste, Huntleya, Oncidium, Epidendrum, including the rare and beautiful *E. Schumannianum* with its sprays of blue and tan flowers, and wonderful Columneas with their red, pink, yellow or scarlet flowers and wooly coats. There were also epiphytic Ceibas, Hydrangeas, Ericaceae in abundance, and dozens of species of Bromeliads many of which have either flowers or foliage worthy of any conservatory. And this does not even mention the legion of Peperomias, or Aeroids, or handsome epiphytic shrubs such as the Scheffleras, or *Solandra brachycalyx,* whose huge golden trumpets litter the trails, or the lianas, or for that matter, the trees themselves. Of these last, two of the finest were a great Matisia, with platter-like orbicular leaves, the branches loaded with russet fruits, and a tall, common Rheedia, with axillary clusters of blood-red flowers, which had eluded me for years.

"The older of the two men, a pure Guaymi Indian type, became quite interested in my scramblings over the fallen trees, and was properly impressed when I explained that a great Instituto Cientifico in the United States was publishing an account of the plants of his native forests. We both agreed that such a project deserved to be as complete as possible, and he volunteered to accompany me on the following day on a long-cherished project of opening a collecting trail along the high, wet, knife ridge of Cerro Pajita, on the Continental Divide.

"The morning dawned clear, and we rapidly climbed through cut-over lands, planted to coffee and plantains, enlivened by gay wayside shrubs of the golden yellow-flowered *Jacobinia aurea* and the common, scarlet spikes of *Razisea spicata.* Above the clearings, some trail cutting brought us to the main ridge at about 3400 feet along which we opened a trail for about a mile, to a maximum elevation of about 3600 feet. This proved to be a perfect botanical paradise, with low, stout trees, averaging 30 feet or less, wearing thick blankets of wet green Trichomanes, out of which peeped a myriad of tiny *Utricularia Endresii.* Much to my surprise, mingled with the common Dicranopteris and tree ferns, much of the undergrowth consisted of thickets of a tall, sedge-like Bromeliad having attractive, slender, branching scapes clothed in red bracts and bearing yellow flowers. One had the feeling of walking in the tree-tops, seeing at eye-level the dozens of species of Bromeliads, peering into their tanks of cold water, and gathering those in flower with the slightest of effort. Hundreds of orchids were also at arm's reach, anchored in wet moss, each looking as though the pseudobulbs and leaves had been carefully sponged that very morning.

"A break in the trees gave us a fine view of both oceans. "Que maravilla" my friend Anastasio exclaimed, "El Mar del Norte, y el Mar del Sur, en el mismo momento." Far to the north and west, forested ridge rose upon forested ridge to rocky, dome-like peaks, with level, plateau-like projecting ridges, a fine white cascade of foaming water breaking the somber green in the middle distance. To the south at our feet, was the floor of the Valle, with its straight roads and tiny houses, followed by the jumbled grassy waves of the minutely dissected volcanic badlands, a far hazy blue line marking the eastern coast of the Azuero Peninsula. A cool breeze stirred the leaves of near-by branches, displaying rich red-brown under-surfaces to broad handsome leathery leaves. In a moment I realized that I was looking at a new, and exceptionally striking highland Magnolia, and I fairly tumbled down the steep slope to gather fruiting specimens. Although most of our other finds were less spectacular, many other plants had an odd or unfamiliar look, so it seems that further trips to the same place should continue to produce good material.

"Since I'm knee deep in presses and bundles of specimens, this had better be all."

(Signed) PAUL H. ALLEN.

ANNUAL COURSE IN HORTICULTURE FOR AMATEURS

A course in horticulture for amateurs, designed to acquaint the participants with principles and practices of gardening, with particular reference to the culture of herbaceous plants, will be given from February 1 to May 3, 1947. The classes will be held in the experimental greenhouse on *Saturdays* from 9:00 to 12:00 a. m. The course will be in charge of Dr. Mehlquist.

REGISTRATION: It is desirable that registration be made by letter, with check enclosed payable to the Missouri Botanical Garden, as soon after January 1 as possible. Tickets will be distributed at the experimental greenhouses on day of first lecture.

FEE: The registration fee is $15.00 per student, and tickets are not transferable.

SUBJECT MATTER OF THE COURSE

I. Fundamentals of plant growth.
   - The role played by light, temperature, water and air.
   - The soil and associated materials.
   - Mineral nutrition.

II. Practical points in successful gardening.
   - Choice of location and soil; preparation and improvement of soil.

The nature and use of fertilizers.
Practical plant propagation: seed sowing, cuttings, and division.
Potting and transplanting of seedlings and cuttings.
Planting and handling of bulbous plants for forcing during winter.
Selection and general care of house plants.
Identification and control of common garden pests and diseases.
Landscaping the home grounds; design, choice of suitable plants and their care.
Preparation and care of lawns.
Demonstration of various phases of garden work.

(About ¼ of the time will be devoted to theoretical discussions outlined in Section I; the remainder of the time will be devoted to subjects of Section II.)

FURTHER INFORMATION ON THE BRUSH CREEK WATERSHED AT THE ARBORETUM

The diagram of the Brush Creek watershed which appeared on page 197 in the October BULLETIN requires additional explanation. The area west of the Robertsville Road was called an "unprotected watershed." Actually much of the southern part of this area is partly protected. Mr. Firmin Desloge, who owns and operates the watershed on the south fork of Brush Creek, has been building terraces since 1930. Mr. Wilfred Beumer, superintendent for Mr. Desloge, states that the first terracing reduced the flood stage in Brush Creek by some six or more feet. In fact, before they began conservation work, flood crests often topped bridge railings, which meant a rise of about twenty-five feet at the Robertsville Road.

This additional information permits us to explore the history of soil conservation in this valley as far back as 1930. It indicates that as farming practices improved and the value of the top soil became appreciated the terrific floods of the 1920's were reduced (although still capable of destroying bridges) somewhat by 1938 and appear to be under control in 1946.

NOTES

Among the visitors to the Garden during the month were: Dr. E. R. Spencer, Consulting Botanist and Plant Pathologist, of Lebanon, Ill.; Dr. Pierre Larroque, of the Institut des Recherches Agronomiques de l'Indochine; Mrs. Gretchen Harshbarger, author of horticultural works and Garden Editor *Household;* Mrs. Charles B. Elder, of the Lead Belt Garden Club, Arcadia, Mo.; Dr. J. L. Collins, Geneticist, Pineapple Research Institute, University of Hawaii, Honolulu, H. I.; Mr. Richardson Wright, Editor *House and Garden;* Mr. Walter D. Bellingrath and Mr. Walter K. Smith, of Bellingrath Gardens, Mobile, Ala.; Prof. S. Luigi Fenaroli, Director Stazione Sperimentale di Maisocultura, Bergamo, Italy; Col. Farlow Burt, of the U. S. Army.

The autumn of 1946 has been unseasonably mild. The first killing frost did not occur until November 12—almost three weeks after such frost can usually be expected. This condition, plus the severe wind, rain, and hailstorm which struck the Garden on September 1, forced many spring-blooming plants into flower. The following list includes some of the species seen in bloom at various times during October.

TREES

Aesculus Hippocastanum, Common Horse-chestnut
Cercis canadensis alba, Whitebud
Malus Arnoldiana, Arnold Crab
Malus atrosanguinea, Carmine Crab
Malus baccata, Siberian Crab
Malus floribunda, Japanese Flowering Crab
Malus purpurea, Purple-leaf Crab
Malus pumila Niedzwetzkyana, Redvein Crab
Malus Scheideckeri, Scheidecker Crab
Malus Sieboldii, Toringo Crab
Malus Zumi calocarpa, Redbud Crab
Prunus cerasifera atropurpurea, Purple-leaf Plum
Prunus Padus commutata, Mayday Tree
Rhamnus cathartica, Common Buckthorn

SHRUBS

Aesculus parviflora, Dwarf Horse-chestnut
Berberis Thunbergii, Japanese Barberry
Cornus sanguinea, Dogwood
Calycanthus floridus, Strawberry-shrub
Chaenomeles lagenaria, Flowering Quince
Deutzia gracilis, Slender Deutzia
Forsythia spp., Goldenbells
Kerria japonica, Japanese Kerria
Lonicera fragrantissima, Fragrant Honeysuckle
Lonicera Morrowi, Morrow Honeysuckle
Lonicera tatarica, Tatarian Honeysuckle
Philadelphus spp., Mock Oranges
Prunus tomentosa, Nanking Cherry
Rhododendron molle, Japanese Azalea
Rhodotypos scandens, Jetbead
Rubus idaeus, Raspberry
Spiraea prunifolia plena, Bridalwreath
Syringa microphylla, Little-leaf Lilac
Syringa nanceiana "Floréal", Nancy Lilac
Syringa vulgaris and varieties, Hybrid Lilacs
Viburnum Lantana, Wayfaring-tree
Viburnum Opulus roseum, Snowball
Viburnum tomentosum sterile, Japanese Snowball.

VINE

Clematis Jackmanii, Purple Clematis

HERBACEOUS PERENNIALS

Althaea rosea, Hollyhock
Hemerocallis spp. and vars., Day-lilies
Iris pumila, Dwarf Iris
Phlox subulata, Moss Phlox

BULB

Hyacinthus orientalis praecox, Roman Hyacinth

THE MISSOURI BOTANICAL GARDEN

STAFF

George T. Moore	Director
Hermann von Schrenk	Pathologist
Jesse M. Greenman	Curator of Herbarium
Carroll W. Dodge	Mycologist
Edgar Anderson	Geneticist
Robert E. Woodson, Jr.	Assistant Curator of Herbarium
Henry N. Andrews	Assistant to the Director and Paleobotanist
Robert W. Schery	Research Assistant
Nell C. Horner	Librarian and Editor
Gerald Ulrici	Business Manager
George H. Pring	Superintendent
Paul A. Kohl	Floriculturist
David C. Fairburn	Orchidologist
Gustav A. L. Mehlquist	Horticulturist
Robert B. Clark	Arboriculturist
Ladislaus Cutak	In charge of Succulents
August P. Beilmann	Manager of the Arboretum, Gray Summit
Gurney Wilson, F.L.S.	Representative in England, Hove, Sussex
Paul H. Allen	Tropical Plant Collector

SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date until his death in 1889 it was maintained under his personal direction. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was chosen by Mr. Shaw and he definitely indicated that he wished it called by that name. The Garden passed at his death into the hands of a Board of Trustees, designated in Mr. Shaw's will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provision of the will the immediate direction of the Garden is vested in a Director, appointed by the Board. The Garden receives no support from city or state but is maintained almost exclusively from the estate left by Henry Shaw. Since 1939 many Garden Clubs and interested individuals have contributed to a "Friends of the Garden Fund" which is used in developing the new Arboretum, located at Gray Summit, Mo. The Arboretum (1) serves as a source of plants, trees and shrubs for the city Garden; (2) affords areas for gradually establishing a pinetum, a wild-flower reservation and various other features on a scale not possible in the city; (3) provides greenhouses for some 20,000 orchid plants.

The city Garden comprises 75 acres, where about 12,000 species of plants are grown, both out of doors and under glass. It is open every day in the year except New Year's Day and Christmas; week days, 8:00 a. m. until 7:00 p. m.; Sundays, 10:00 a. m. until 7:00 p. m. The greenhouses are closed every day at 5:00 p. m.

The main entrance to the Garden is at Tower Grove and Flora Place, on the Sarah bus line (No. 42). The Tower Grove bus (No. 21), direct from downtown, passes within three blocks of the main entrance.

MISSOURI BOTANICAL GARDEN BULLETIN

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Cover: An Arboretum trail in Winter.

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Please: Do not discard a copy of the Bulletin. If you have no further use for yours pass it along to a friend or return it to the Garden. Return postage will be guaranteed.

Missouri Botanical Garden Bulletin

Vol. XXXIV DECEMBER, 1946 No. 10

ABOUT GLOXINIAS

ROBERT E. WOODSON, JR.

If you can grow African Violets (Saintpaulias), the chances are good that you can grow Gloxinias, too; and if you have not grown them, you had better try. The two have much in common. They both belong to the same family of plants, the Gesneriaceae. Both have much the same cultural requirements. But, although African Violets, well grown, are beautiful in a way that is dainty and demure, Gloxinias are downright glamorous. I can think of no word that fits them better. And if your window sill lacks *glamor*, a Gloxinia will supply it.

You will see what I mean. African Violet leaves are beautiful, aren't they? Thick, dark green on top and light green below, and covered all over with a beautiful, soft fuzz. Well, Gloxinia leaves are much larger, frequently over a foot long and half as broad, and they seem to like to curve down to cover the crockery pot in which the plant is growing. African Violet flowers are beautiful, too, in their cool shades of blue, pink, or white. But, after all, they seldom will be more than an inch in diameter, while Gloxinia flowers are spectacular trumpets as much as six inches long and five inches in diameter. And they come in practically every color except the yellows: from burning crimson to peach-blossom pink; from deepest midnight purple, almost black, to the faintest baby blue. They may be as white as Carrara marble, or any combination of color with white: white trumpets with colored rims, or colored trumpets with white rims. Or the whole flower may break out with a rash of polka dots. "Trumpet" is such a descriptive word for a Gloxinia flower! Now do you see what I mean by their glamor? The only thing that they lack is a fragrance in keeping with their size and color. Perhaps we should be glad that they do.

Gloxinias are so easily grown that it is strange we see them so seldom, even in florist shops. It must be because they are a little difficult to wrap up and deliver to a customer. After all, I suppose, those enormous, thick,

Polka-dotted Gloxinia

crisp leaves, as well as the wide trumpet-flowers, simply defy the usual rolling up in paper and clipping or tying at stem and stern provided at most florist shops. But it seems to me that a special box could be made, such as those for men's silk hats, which would keep the leaves and flowers from being crushed in transit. I suppose the same problem confronts the commercial handling of tuberous-rooted Begonias.

Of course, I know perfectly well that some florists do display and sell Gloxinias. That's why I happened to learn about them in the first place.

There was a little florist shop on Harvard Square in Cambridge, when I was a student. On my way to the cafeteria next door I used to pause each day to see what the florist had in his window. I was a bit lonesome, and that window helped me a lot. One cold, snowy New England evening I could see across the busy, slush-filled street that something special was in the brightly lighted window. When I finally pressed my nose against the frosty glass, there were my first Gloxinias! Five dollars a pot, alas, but I learned their name, and I never forgot them. "Just like Wordsworth and his daffodils," you will laugh. And maybe William and I are brothers under the skin. You will have to ask him about that. But there is this difference: I didn't want to put myself to sleep thinking about Gloxinias. I wanted to grow my own.

Well, at last I've done it, and now I want to make some fellow converts. It happened in this way. About four years ago I accidentally happened upon a florist's catalogue with pretty pictures. I had nothing better to do at the time, so I placidly day-dreamed page after page until suddenly BONG! there was a picture of a Gloxinia, and my nose was again pressed against the frosty window-pane on Harvard Square. Now was the time to fulfill at least one ambition of my student days! I sat right down and ordered six "bulbs" at seventy-five cents each. And while they were on their way, I looked up in Bailey's *Standard Cyclopedia of Horticulture* to see what sort of soil they would prefer: "Two parts leaf mold, one part good fibrous loam, one part peat." To make reminiscences a bit shorter, my six "bulbs" came. I planted them, and they were a complete vindication of my memory. I astonished my friends.

Now, after four years, I can be completely surrounded by *my own* Gloxinias, and I consider myself something of an amateur expert. Before I get down to brass tacks I must tell you why I say "*my own* Gloxinias." I mean that I have raised them from seed or from leaf cuttings. Plants like that now seem to be much more "flesh of my flesh" than the ones I used to buy as mature plants. And all paternal pride aside—*my own* are better than those that are "boughten."

I suppose I can't persuade every one to start their first Gloxinias from seed. Buy your first "bulbs" from a seedsman, if you insist. But they aren't *bulbs:* they are little telescoped stems, like Crocus "bulbs," which botanists call *corms.* They are very different, after all, from true bulbs such as those of onions or lilies or tulips. All technical quibbling aside, your Gloxinia corms will look a bit more like a flattened Irish potato tuber than an onion bulb with its fleshy scale leaves. Bulbs, corms, and tubers are all specialized underground shoots that help to propagate the plant. But in bulbs the accent is on the fleshy leaves and the stem is relatively unim-

Group of variously colored Gloxinias

portant, while in corms and tubers the emphasis is on the stem part itself and the leaves are virtually lacking.

When you get your Gloxinia corm it will be a little, more or less dried-up, brown thing probably about as big as the end of your thumb, and shaped something like it, too. For on the bottom it will be rather rounded with a few traces of the past roots, while the top will be more flat or a bit concave, and perhaps will show where the stem used to rise. Best of all, perhaps a couple of tiny, fuzzy, pinkish leaves will show that the Gloxinia has had enough rest and is eager to start growing. Before I forget it, let me say that you probably can grow much larger corms of your own than the ones you are paying seventy-five cents for at this stage in the game. I have grown corms of my own that would just comfortably fit in a large teacup, and I have heard of others that were much larger. But you can't buy them like that. Would you want to sell yours?

A Gloxinia corm about the size of the end of your thumb can be planted in a four-inch flower pot, but it might as well go into a six. After three years of experiment, I have decided that the best mixture of soil is the unusual combination of one-half ordinary loam (just plain "dirt" to most of you, my friends) to one-half of brown, granulated peat. A bit of yellow sand may be a good idea, and leaf mold can be substituted for the peat. But my plants definitely prefer peat, and I believe that the reason is at least two-fold. To be sure, peat is retentive of moisture, but at the same time, it aerates the soil and makes the mixture somewhat acid. Both of these conditions, I feel, are very important in growing Gloxinias well. For one thing, corms which are put in poorly aerated soil tend to mold, and the molds also seem to be restrained by slightly acid conditions.

When you have mixed the peat and loam thoroughly, pack it rather firmly in the pot, and plant the corm with the flat or concave side barely at the soil surface. Don't bury it. Now water the pot thoroughly and place it in a moderately warm place, preferably not in direct sunlight. The most luxurious Gloxinias that I have ever seen were not in the University greenhouse where I grow my stock, but in a northeast window of my mother's bedroom, where the temperature, except in summer, usually ranges between 65° and 70° F. My mother doesn't like it to be too warm in her house, and that seems to be an important reason why plants like her house so well.

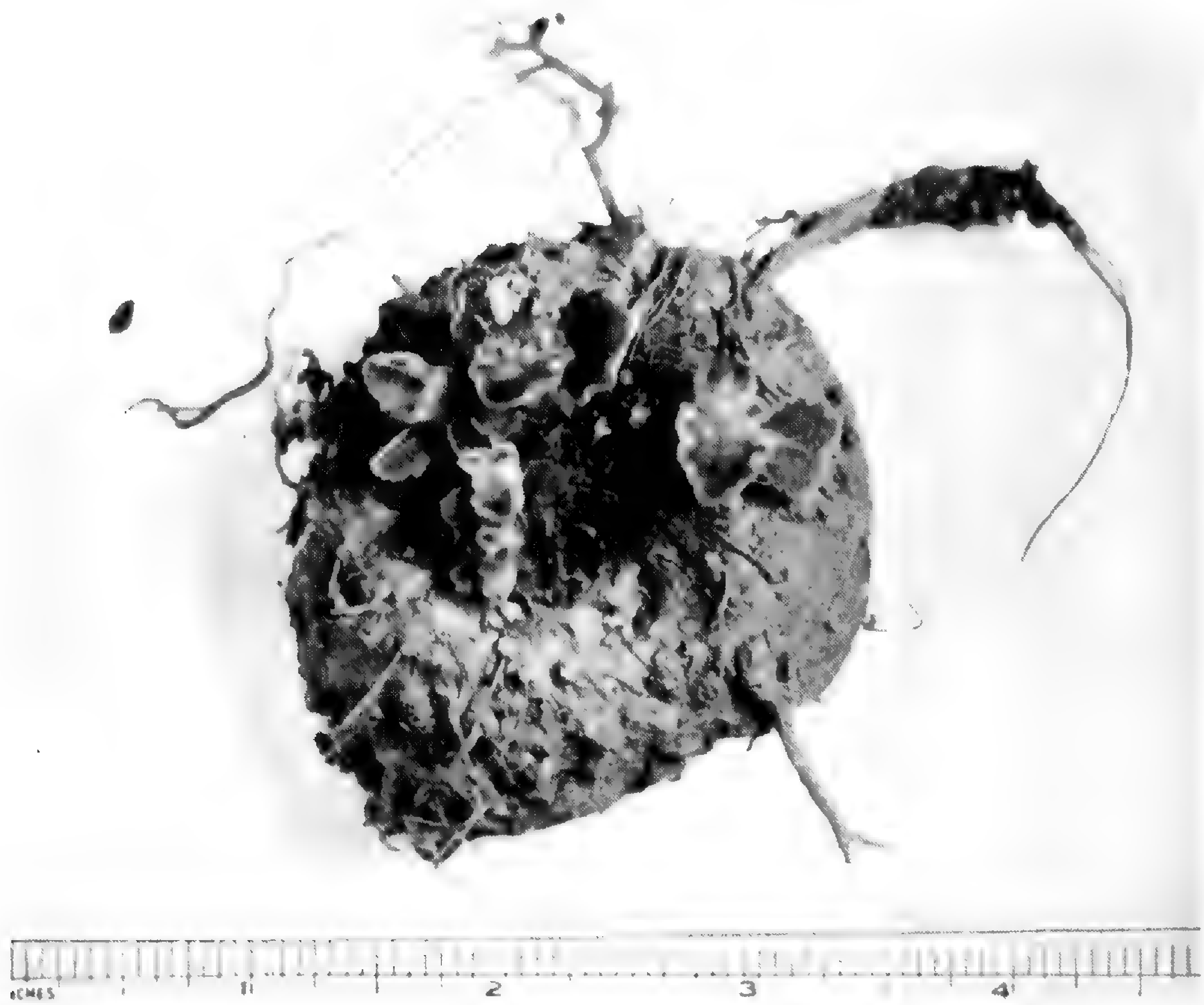
It seems to me that Gloxinias are more tolerant of an amateur's good intentions than are African Violets. For example, I believe that they don't have to be watered as regularly as Saintpaulias. They actually seem to like you to forget them one day out of several. They definitely prefer to have their soil "on the dry side" if the alternative is to be soggy.

The reason I mentioned my mother's northeast window is that direct sunlight seems to produce less luxuriant plants with somewhat discolored leaves and flowers. People who grow African Violets learn not to wet the leaves when giving the plants a drink. I have found that Gloxinias are less exacting in this respect, although it is better to be on the safe side and to water between the leaves.

Then there is the question of insect pests. Gloxinias seem to take care of themselves remarkably well. I have had a losing fight to keep mealy bugs from my African Violets on some occasions, but the Gloxinias never seem to attract them. And the same goes for aphids and red spiders.

Some day, after you have planted your Gloxinias, you will notice that fuzzy, pinkish little leaves are starting to grow up from the corm. Growth will continue until from such small beginnings you will have a pot full of crispy, velvety foliage. Then look down amongst them to see the first buds, growing from little green knobs to plump, colored balloons. Then, miracle! They will burst open into those glamorous trumpets! Clap your hands! Snap your fingers! And call the neighbors to admire them. Over night you find that you have become a Gloxinia expert!

But don't let yourself be blinded by your first gorgeous flower. Look past it again, down between the big green leaves, and you will get a preview of glory to come, because there probably will be other little buds waiting



Three-year-old corm of Gloxinia

the cue to take their bow in the limelight. A single three-year-old plant has produced as many as seventy-two blossoms for me, and the individual flowers may last for more than a week. So your Gloxinia will make quite a spectacle of itself for two or three months.

It is only natural, I suppose, that after such flamboyance the plant feels that it needs a rest. The last flower will open and at length fade, and only the green leaves remain. Here is where the different temperaments of Gloxinias and African Violets are particularly apparent. The Gloxinia, you will remember, has a corm, while the Saintpaulia has not. A bulb, tuber, or corm apparently is a provision for the plant to take a resting period each year, thus preventing it from "blooming itself to death," a very real possibility to some plants.

When your plant has flowered all its buds, don't think any the less of it. Keep taking care of it in its own favored place on the window sill, but purposely start giving it a little less drinking water. Never, however, let the soil get really dry. Because it is to your own selfish interest, as well as to your Gloxinia's, to keep those big leaves crisp and green. They are setting the stage, so to speak, for the next crop of trumpets, which will show whether you have measured up to be the expert that you fancy yourself.

Gloxinia plant at second season of bloom

Keep those big green leaves crisp and fresh, for they are busy making food to swell out that plump brown corm down there in the soil. But don't over-water! If anything, give a trifle less all the time. After a month or so, the leaves will become a little faded. This means that your Gloxinia is getting ready for its resting period. So now see how sympathetic you can be in caring for it over its dormant season.

Take it down into the basement, or if you have a greenhouse just move it down under its bench and turn the pot over on its side away from the light. Now the little corm won't want to dry into a hard brick of soil, but neither will it want to get *wet*. After two or three months of this happy state of in-between, some day you will notice a little bunch of fuzzy pinkish leaves at the top of the corm, and you and your Gloxinia will be ready to climb to still dizzier heights of horticultural accomplishment.

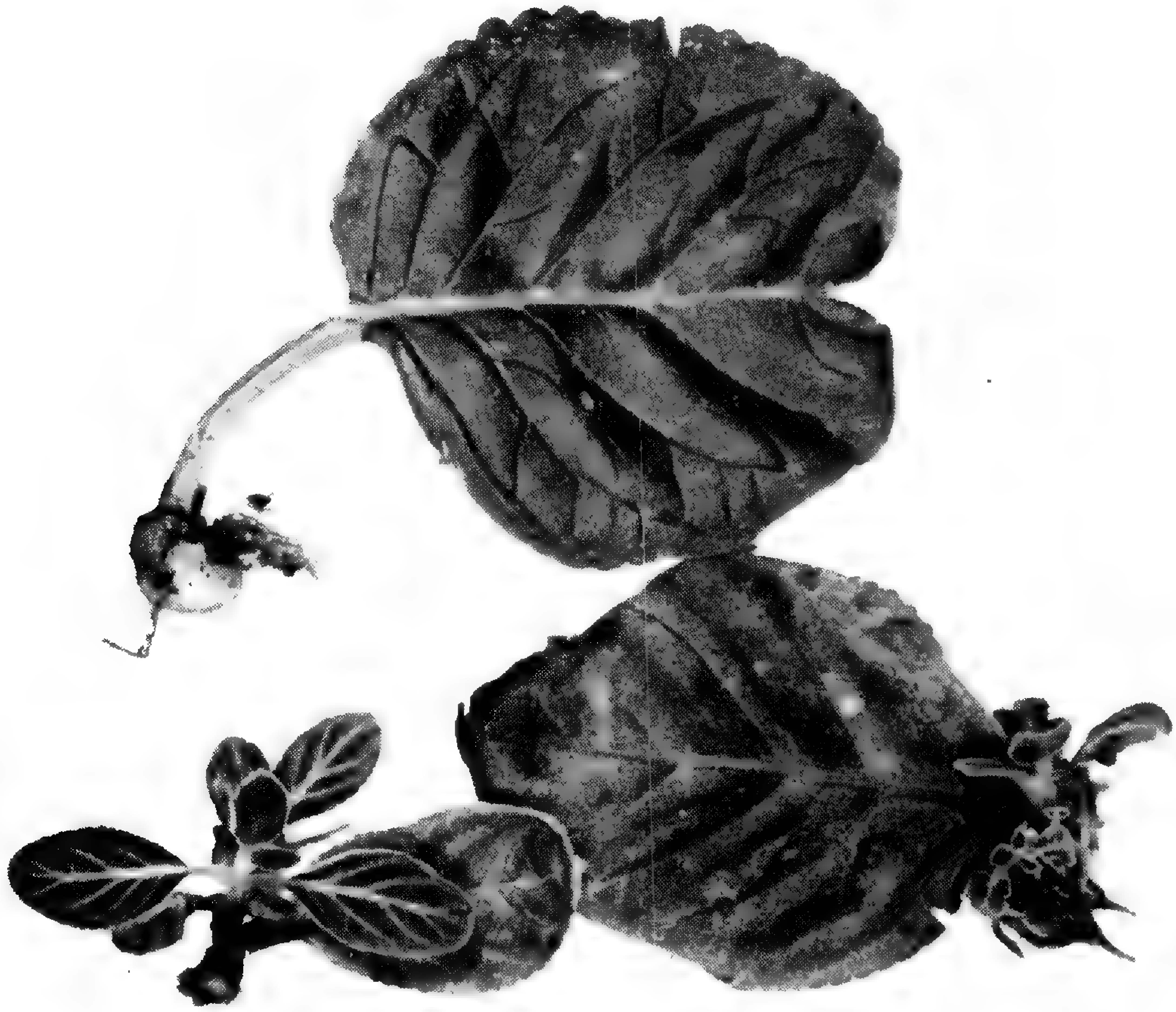
Some people I know just take their pot of Gloxinia up into the light, give it water, and grow it another season in the soil of the previous year. I am sure that it is much better to tap it out of the old pot, carefully remove the corm from the old soil, discarding the latter, and make a fresh mixture of half-peat, half-loam. You might try adding about a tablespoonful of horn meal to a six-inch potful of soil. Another way you can try the advantage of fertilizer, once your plant is well started, is to put about a tablespoonful of Vigoro in about a quart of water. I keep my fertilizer-water in a milk bottle, and about once every other week I give my Gloxinias a special treat in place of the usual watering.

But to get back to the repotting procedure. One object of repotting, aside from the all-important one of changing the soil, is to see how much larger the corms have become. If you have been giving your Gloxinia what it needs, you will be delighted. And again you will go around showing people what a good parent you have been. Bigger and better corms mean, Providence willing, bigger and better, and *more* flamboyant trumpets. What is the limit? I don't know, but my goal is a corm as big as a wash tub. I'll let you know if I succeed.

There are two ways to build up a collection of *your own* Gloxinias: by seed and by cuttings. Both have distinctive advantages. If you want different kinds of flowers, grow them from seed. If you want replicas of some particularly pleasing variety, grow them from cuttings. Cuttings, literally, are "chips off the old block," and you make them very much as you do for your African Violet. I made my first cuttings last year, and am so pleased that I must tell you how I did it.

The most economical way to make cuttings is to wait until the leaves are "ripened," that is, at about the time the last flowers are open. Then cut a good-sized leaf close to the stem, and dip the cut end of the stalk in a mild rooting chemical such as "Hormodin #1," or not, just as you choose. (It doesn't seem to make much difference.) Then prepare a little potful of moist, granulated peat, or a mixture of half peat, half sand. But it seems to me that the peat is very essential, because year before last I tried just sand, which was a complete failure. I think, here again, that the aeration of the peat, and its acidity, are what the plant needs. This time, saturate the peat with water, and keep it that way. You will soon know whether your experiment will work or not. Because if it doesn't mean business, the big leaf will become limp and die. But if it stays crisp and green, you are almost assured of success. Just be patient, for the leaf has a lot of work to do.

After about a month I became impatient with my first ones, and gently started to pull one up. To my amazement, what should come up with it



Leaf cuttings of Gloxinia showing young corms

but a little corm which had been formed down at the cut end of the leaf stalk. And that little corm was almost as big as the ones I used to pay seventy-five cents for! It was the funniest-looking thing, sticking there on the end of the leaf! I whistled, and chuckled, and went hunting for some one to show it to. After every one within reach had whistled and chuckled at it, I harvested the rest of the young corms, allowing the parent leaf to remain attached, and potted them up into their own little two-inch pots of half peat, half loam. They should bloom for me this year.

The beauty of growing Gloxinias from seed is the kaleidoscope of colors that you produce. But be sure that you get fresh seed. Why not try harvesting your own, for then you will know that it is fresh. If you have a husky parent plant, don't pick off the old flowers, but let them wither on the plant. Some of them may present you with little knob-like seed pods which turn brown at length and then open to show you how packed full of tiny brown seeds they are. Hundreds of them! If you doubt the "intentions" of your flowers, play the matchmaker. Simply scatter some of the opalescent pollen from a cluster of stamens onto the stigma of the same or another plant.

When it is ripe, carefully pick the pod, taking care not to spill the little brown grains, for each is a surprise package, and the one that is lost may contain the First Prize. You can save the seed in an envelope kept in a dry, cool place. But the best thing to do is to sow them right away. And what kind of soil do they like?—half peat and half loam, sifted rather fine. Or you can substitute sand for the loam.

Be sure that you sow the seed very carefully, because it is so fine. Don't sow it too thickly, for germination of fresh Gloxinia seed is just about 100 per cent. Every little seed is apt to grow into a husky little plant. Man alive! What a lot of little plants. Unless by this time you've decided to go into the business, you won't be able to plant them all. But remember that your friends probably would like to share them with you. Pass them around and you won't have to throw them away.

It is astonishing how quickly seedling Gloxinias grow. When I started my first seedlings it was about the middle of February. By the first of May they were all in four-inch pots, and some were showing a flower bud or two. All through that summer they were in gorgeous bloom, and I had the pleasure of introducing them to my friends. But the greatest satisfaction was to give each friend who saw them a pot of his own, for the highest ambition of a convert is to make a fellow convert.

All modesty aside, I know that my Gloxinias really are pretty good Gloxinias. I have been told so by real horticulturists, all the way from England to California. But still it seems to me that the most beautiful of all were those behind a frosty window on Harvard Square.

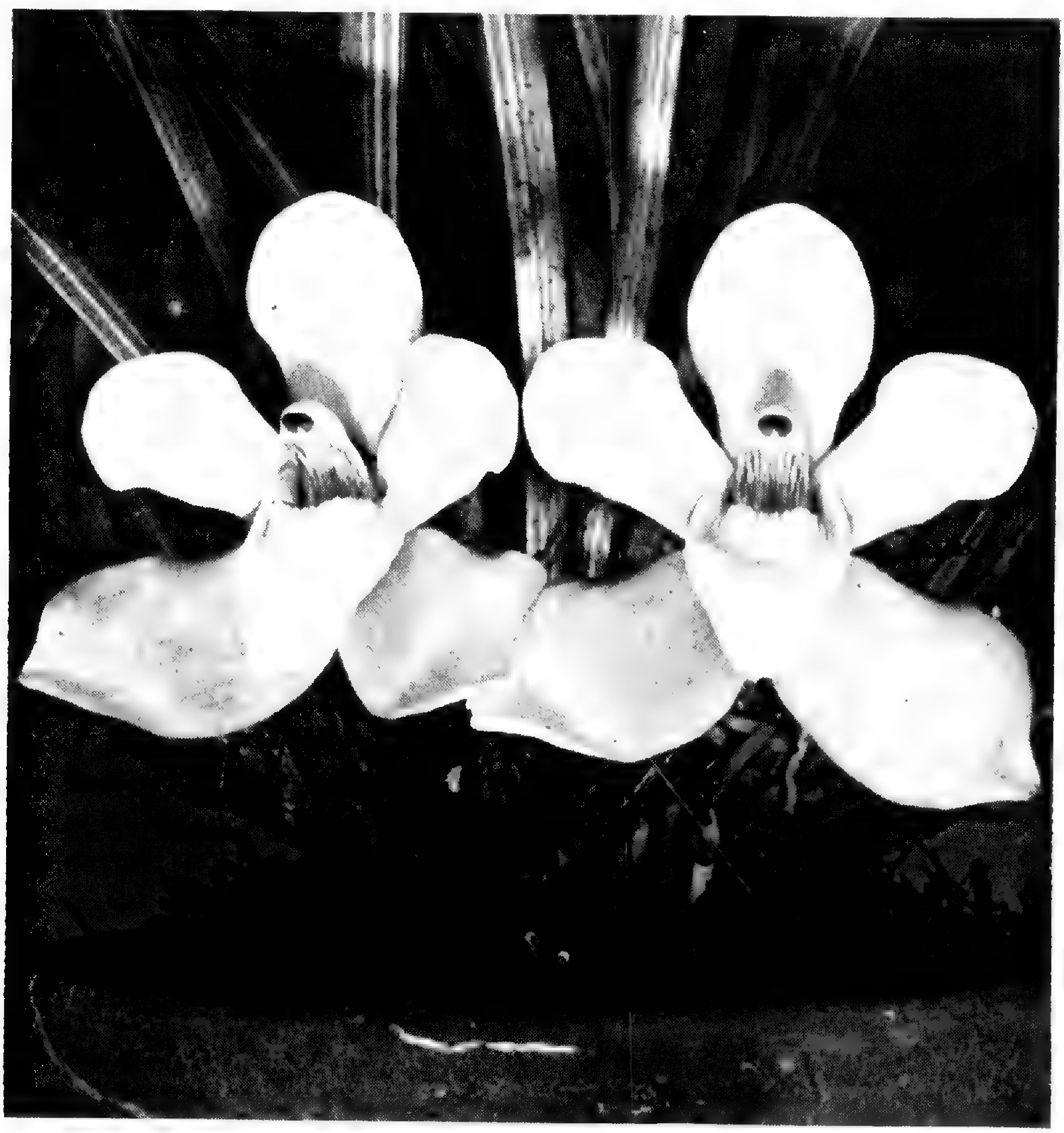
The Smallest Flowering Plant in Missouri.—

The spring of 1946, with its cool weather and abundant rain, saw as great a development of our tiniest flowering plant as has occurred in recent years. *Callitriche deflexa* var. *Austini* has no common name, and nearly every one who sees it assumes that it is some kind of a moss. It has flowers, however, though they are smaller than the head of a pin, and they are succeeded by tiny seeds about the size of a grain of sand. This species of Callitriche starts growing in the early spring and looks like a little dab of moss in wet places; if water covers the place where it is growing it develops long internodes between the leaves and then looks almost like an alga. In cool and damp springs these plants spread out vigorously and may cover large patches of uncultivated soil with a thin mossy carpet.

PESCATOREA CERINA

PAUL H. ALLEN

This beautiful species is found in Panama in wet highland forests at elevations from 3,000 to 8,000 feet. The first plants were collected by von Warscewicz in Chiriquí Province, in the same area which produces *Trichopilia suavis.* Annual rainfall throughout the range averages well over 100 inches. Day temperatures are in the sixties, and the nights are very cold at the higher elevations, sometimes near freezing during the dry season in January and February. The plants are entirely without pseudobulbs, the tufted leaves forming a loose fan, and the long-lasting, fleshy flowers being produced on short peduncles from the lower leaf axils. Sepals and petals are



Pescatorea cerina

pure white, except for the lower sepals which often have a long greenish-yellow blotch near the base. The lip is a rich yellow, the basal crested callus with its red-brown markings contrasting handsomely with the white column and deep lavender anther cap.

Although strictly highland orchids, the plants are very adaptable to higher temperatures if proper shade and moisture are provided, as may be seen from the accompanying photograph of a magnificent specimen flowered in the Canal Zone, in the collection of Mr. Harry Dunn. In the United States, a shaded situation in the Cattleya house should suit them well, care being taken that the plants are never allowed to become dry.

RABBITS AND PINKS

GUSTAV A. L. MEHLQUIST

That rabbits are at times very destructive to garden plants is nothing new to people who garden in rabbit-infested areas, and that the rabbits show distinct preferences for some plants is likewise well known to observant gardeners. This fall a small planting of pinks here at the Garden provided an interesting illustration as to the preferences of rabbits for certain species and varieties.

This planting consisted of two beds of about 200 plants each and a larger block of about 800 plants. One of the beds contained three varieties of *Dianthus caryophyllus*, four varieties of *D. Heddewigii*, and several rows of *D. chinensis;* and the other, different selections of *D. Heddewigii.* The larger block was planted to about 200 plants, resulting from different crosses between *D. caryophyllus* and *D. chinensis*, and about 600 plants of *D. "Heddensis,"* a hybrid between *D. chinensis* and *D. Heddewigii.*

When the plants were set out in late May the rabbits nibbled here and there in all the beds but they kept the *D. caryophyllus* varieties chewed off until special precautions were taken to keep them away. However, it was toward fall, when food elsewhere in the garden became scarcer, that the rabbits' preferences became so distinctly apparent. All three varieties of *D. caryophyllus* were so closely eaten off that they could make no growth whatever (fig. 1). On the other hand, the four varieties of *D. Heddewigii* were barely touched, and the several rows of *D. chinensis* had only a few leaves eaten off when first set out in the spring. In the large block were no *D. caryophyllus* but several rows of hybrids between *D. chinensis* and *D. caryophyllus.* One row of tetraploid[1] hybrids (½ *D. chinensis*, ½ *D. caryophyllus*) was completely chewed off (fig. 2). Two rows of triploid

[1] For a discussion of Tetraploidy see February 1946 issue of the BULLETIN.

Fig. 1

Fig. 2

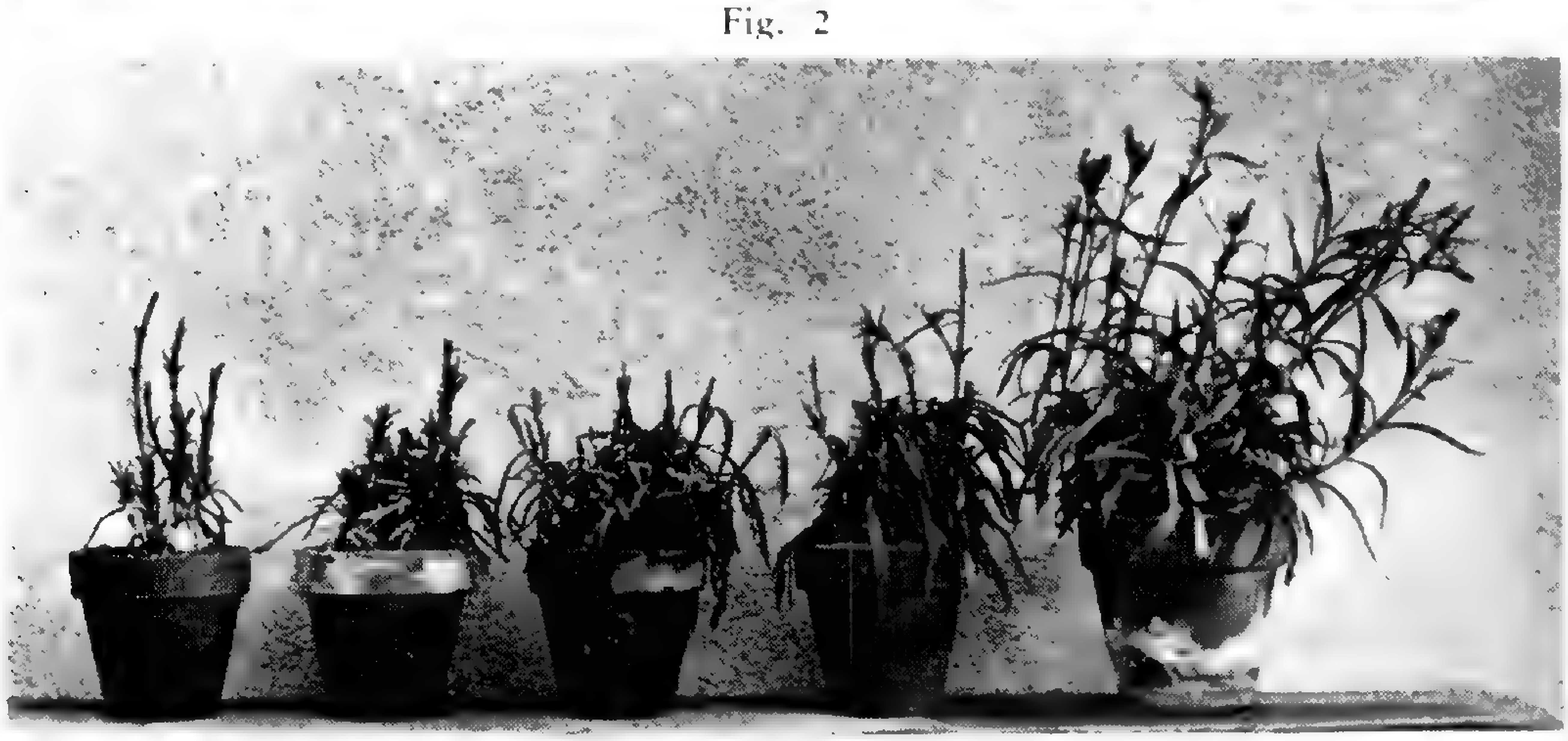


Fig. 3

Fig. 1. *D. caryophyllus* "Grenadin"; *D. c.* "Giant Marguerite"; *D. c.* greenhouse type; *D. Heddewigii; D. Heddewigii* var. *laciniatus; D. chinensis.*

Fig. 2. *D. Heddewigii; D. "Heddensis"; D. chinensis. D. "Heddensis"* shows extreme hybrid vigor such as is often obtained in crosses between unrelated plants.

Fig. 3. Plants 1 and 2, hybrids (½ *D. caryophyllus* + ½ *D. chinensis*); plant 3, hybrid (⅓ *D. caryophyllus* + ⅔ *D. chinensis*); plants 4 and 5, hybrids between No. 1 and *D. chinensis* (about ¼ *D. caryophyllus* + ¾ *D. chinensis*).

hybrids from the same cross (⅔ *D. chinensis* and ⅓ *D. caryophyllus*) were eaten off nearly as badly. But, in the next two rows, consisting of back-cross hybrids between one of the tetraploid hybrids and *D. chinensis*, some plants were badly eaten and others much more lightly, as if genetic segregation had occurred for some substance affecting their palatability (fig. 3). The next two rows of *D. chinensis* were not even touched nor was any of the 600 plants of "*D. Heddensis*" (*D. Heddewigii* x *D. chinensis*), which were planted on the other side of the *D. chinensis-caryophyllus hybrids*. In the third bed, planted entirely to selections of *D. Heddewigii*, some plants were badly eaten off, while others were not touched. On examination it was found that only the glaucous[2] plants had been eaten off, the non-glaucous (green) plants having been rarely touched.

This preference of the rabbits for certain plants of *D. Heddewigii* may be related to the botanical status of this *Dianthus*. Botanists generally have classified *D. Heddewigii* and *D. laciniatus* as forms of *D. chinensis*. Seedsmen and nurserymen, on the other hand, usually regard *D. chinensis* and *D. Heddewigii* as distinct species, and *D. laciniatus* as a form of *D. Heddewigii*. This nurserymen's classification has many points in its favor, but the main point of interest here is that the typical *D. chinensis* is always green whereas *D. Heddewigii* and *D. laciniatus*, whether forms of *D. chinensis* or not, are usually glaucous though green plants occur in most plantings. Now this glaucous condition in *Dianthus* is apparently due to a waxy material covering the leaves and young stems. Dianthus species with a well-developed glaucousness ordinarily stand drying winds and low atmospheric humidity much better than do the green species, such as *D. chinensis*, which often wilt badly in warm, low-humidity weather as at times occurs in this area in the summer.

Now the question naturally arises: is it possible through selective breeding to develop varieties of pinks that will be of little attraction to rabbits and yet of maximum usefulness to the gardener? On the basis of the evidence at hand, that question cannot be answered with any degree of certainty. If, as it would appear, the glaucous condition of some Dianthus plants is what attracts the rabbits, it will be a difficult problem to solve, for glaucousness is definitely a desirable feature from a horticultural point of view. If, on the other hand, the rabbits' preference for some plants is due to the amount of some substance not directly correlated with glaucousness or some other desirable horticultural feature, then hybridization followed by selection might solve the problem.

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[2] Covered with a waxy "bloom" as a plum or cabbage-leaf.

SCENTED GERANIUMS

DAVID C. FAIRBURN

For something unusually interesting in the window garden or in the flower border try scented geraniums. They come in a wide variety of odors, shapes and sizes, and some produce attractive flowers if exposed to the proper environmental conditions.

Scented geraniums belong to the genus Pelargonium, which also includes the common free-flowering zonal geraniums, Martha Washington geraniums and ivy-leaved geraniums. There are about 250 species and many horticultural varieties. Most of these species are native to South Africa, so they are not hardy in Missouri. The flowers are irregular in shape, the two upper petals differing in size and color from the other three petals. True geraniums belong to the genus Geranium, which includes over 250 species, chiefly native to the northern hemisphere. There are both annual and perennial species to be found growing wild in Missouri. The flowers are regular in shape with all the petals equal in size.

Scented geraniums were brought to England in 1690 by the British fleet which was helping the Dutch defend their colonies around the Cape at the southern tip of Africa. These geraniums won immediate favor in England, and horticultural varieties increased rapidly as hybridists crossed different kinds to obtain new odors. A mild "geranium craze" developed early in the 19th century. About 1820, when scented geraniums were at their peak of popularity, there were over 200 species and countless varieties in circulation. Due to such extensive hybridization a great deal of confusion existed regarding names of the new varieties. We have the same problem today.

The flowers of scented geraniums are small and, for the most part, inconspicuous. Consequently, when the zonal geraniums with their showy blossoms began to appear, the scented kinds gradually lost favor. Eventually, most of the large collections disappeared, and there has not been much effort made since to revive interest in their culture. Scented geraniums grow well in garden loam of average fertility and require full sunlight. The variegated kinds are generally weak growers and are not as well adapted to outdoor culture as the plain green-leaved ones. Aphids and mealy bugs are the main insect pests, but they can be controlled with nicotine sulphate spray, using one teaspoonful of the nicotine to one quart of water.

Leaves of scented geraniums can be cut along with various herbs in late fall before frost, and they should be placed in a warm room for drying. The pulverized leaves make good sachets and can be used with herbs to flavor cooked foods. Leaves of rose geraniums are often put in the bottom of jelly glasses to add flavor, and may be used to advantage with roast lamb in place of mint sauce. In Europe the rose geraniums are used in making perfumes. Scented geraniums interplanted with hybrid tea roses make a good combination. The leaves work in nicely with bouquets of mock-orange, nasturtium and pinks.

Some of the most popular species and varieties of scented geraniums are as follows:

Apple.............*P. odoratissimum*
Almond...........*P.*, "Pretty Polly"
Balm...............*P. vitifolium*
Cinnamon........*P. gratum*
Cocoanut.........*P. parviflorum*
Filbert.............*P.*, "Schottesham Pet"
Lemon.............*P. crispum, limoneum*, "Clorinda," "Dr. Livingston"
Mint................*P. triste, rapaceum*
Nutmeg...........*P. fragrans*, "Lady Mary"
Orange............*P.*, "Prince of Orange"
Peppermint......*P. tomentosum*
Pine.................*P. fragrans turpintha*
Rose.................*P. capitatum, graveolens*

Varieties with miscellaneous odors:

P. altrum
P., "Attar of Roses"
P., "Brilliant"
P., "Capri"
P., "Dale Park Beauty"
P. denticulatum, denticulatum tomentosum ("Pungent Peppermint")
P. filicifolium odoratum
P. filtrum
P. graveolens ("Rober's Lemon Rose")
P. grossularioides
P., "Kew Gardens"
P., "Lady Heytesbury"
P., "Lady Scarborough"
P., "La Mortuola"
P., "Lothario"
P., "Long Petiole"
P., "La Fiesta"
P., "Mrs. Douglas"
P., "Mrs. Kingsley"
P., "Mrs. Taylor"
P. nervosum ("Lime-scented")
P., "Pretty Polly"
P. quercifolium ("Beauty")
P. quercifolium ("Fair Ellen")
P., "Rollison's Unique"
P. scabrum ("Apricot")
P., "Scarlet Unique"
P., "Snowflake"
P. terebinthinaceum ("Little Gem")
P. torento ("Ginger-scented")
P. viscosum

Variegated varieties:

P. graveolens ("Lady Plymouth")
P. crispum ("Prince Rupert")

Where to obtain scented geraniums:

Roy A. Baird, Route 3, Box 255, Oklahoma City, Okla.
W. A. R. Clifton, Cherry Orchard Nurseries, Chichester, England
Havalook Gardens, Fowlerville, Mich.
Rare Plant Gardens, Arcata, Cal.
R. W. Stiles, South Sudbury, Mass.
W. A. Toole, Baraboo, Wis.
Mrs. Virginia W. Vandivert, Colonia, N. J.
Weathered Oak Herb Farm, Bethesda, Md.
The Yew Gardens, Sierra Madre, Cal.

Flax in Missouri.—

There are several species of Linum (Flax) native to Missouri. One of them is a little yellow-flowered annual, *L. sulcatum*, which is fairly common on glades in Franklin County and which may be found every summer in the Garden's Arboretum at Gray Summit. Its stem is slender and the leaves are inconspicuous so that the pale yellow flowers, about the size of one's thumb nail, seem to float above the other plants on the glades.

NOTES

Dr. Edgar Anderson, Geneticist to the Garden, spent the first three weeks of December in Guatemala studying variation in corn.

The fourth number of Vol. XXXIII of the ANNALS OF THE MISSOURI BOTANICAL GARDEN, which constitutes the third fascicle of Vol. 3 of the *Flora of Panama* by Robert E. Woodson, Jr., and Robert W. Schery, was issued during the month. This issue contains the second part of the Orchidaceae by Louis O. Williams.

The Higan Cherry, *Prunus subhirtella* var. *autumnalis*, was seen in bloom on December 7, and should be added to the list in the November BULLETIN of late-blooming plants. Forsythia and the Fragrant Honeysuckle *(Lonicera fragrantissima)* were still in flower despite the cold spell of the first week of December.

Recent visitors to the Garden library include: Dr. William L. Brown, Geneticist, Pioneer Hi-Bred Corn Co., Des Moines; Dr. H. Mather, Head Department of Genetics, John Innes Horticultural Institution, Merton, England; Mr. and Mrs. Mungo Park, of Los Angeles, orchid enthusiasts, formerly of Kuala Lumpur, Federated Malay States.

"Parks and Recreation" group visits the Garden.—

During the week of November 17 the American Institute of Park Executives and the American Association of Botanical Gardens and Arboretums held their convention, this year, in St. Louis. On November 18 the Missouri Botanical Garden acted as host to the members of the latter group, taking them on a tour of the City Garden, followed by a luncheon and afternoon program at the Garden's Arboretum in Gray Summit. The orchid ranges were inspected under the guidance of Dr. Fairburn, and after lunch Mr. Beilmann discussed some of the outstanding features of the Arboretum while Dr. Anderson spoke on the recently dedicated Box Garden. The occasion was fortunately favored with one of the finest of late fall days, and it seemed to have been taken as a most agreeable climax to the convention meetings. Those attending, in addition to the members of the Garden staff, were: Mr. Joseph W. Adams, of the Morris Arboretum, Philadelphia, Pa.; Mr. Gordon C. Cooper, of Cleveland, Ohio; Mr. C. W. Fenninger, of Tyler Arboretum, Philadelphia, Pa.; Mr. Clarence E. Godshalk, of Morton Arboretum, Lisle, Ill.; Mr. E. L. Kammerer, of Morton Arboretum, Lisle, Ill.; Mr. B. Y. Morrison, of U. S. Nat'l. Arboretum, Washington, D. C.; Mr. Robert Pyle, of Conard & Pyle, West Grove, Pa.; Dr. H. A. Senn, of Dominion Arboretum, Ottawa, Canada; Mr. Henry Teuscher, of Montreal Botanical Garden, Montreal, Canada; Mr. Harry Wood, of Arthur Hoyt Scott Foundation, Swarthmore, Pa.; Dr. Donald Wyman, of Arnold Arboretum, Jamaica Plain, Mass.

GENERAL INDEX

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SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date until his death in 1889 it was maintained under his personal direction. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was chosen by Mr. Shaw and he definitely indicated that he wished it called by that name. The Garden passed at his death into the hands of a Board of Trustees, designated in Mr. Shaw's will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provision of the will the immediate direction of the Garden is vested in a Director, appointed by the Board. The Garden receives no support from city or state but is maintained almost exclusively from the estate left by Henry Shaw. Since 1939 many Garden Clubs and interested individuals have contributed to a "Friends of the Garden Fund" which is used in developing the new Arboretum, located at Gray Summit, Mo. The Arboretum (1) serves as a source of plants, trees and shrubs for the city Garden; (2) affords areas for gradually establishing a pinetum, a wild-flower reservation and various other features on a scale not possible in the city; (3) provides greenhouses for some 20,000 orchid plants.

The city Garden comprises 75 acres, where about 12,000 species of plants are grown, both out of doors and under glass. It is open every day in the year except New Year's Day and Christmas; week days, 8:00 a. m. until 7:00 p. m.; Sundays, 10:00 a. m. until 7:00 p. m. The greenhouses are closed every day at 5:00 p. m.

The main entrance to the Garden is at Tower Grove and Flora Place, on the Sarah bus line (No. 42). The Tower Grove bus (No. 21), direct from downtown, passes within three blocks of the main entrance.

THE MISSOURI BOTANICAL GARDEN