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Pomona College Journal of Economic Botany

As Applied to Subtropical Horticulture

Volume Two FEBRUARY 1912 Number One

PUBLISHED QUARTERLY BY THE
DEPARTMENT OF BIOLOGY OF POMONA COLLEGE
SPONSOR, A. J. COOK, D. Sc., STATE HORTICULTURAL COMMISSIONER
CLAREMONT, CAL., U. S. A.

Pomona College Journal of Economic Botany

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Subscription price $1.00 to domestic and $1.25 to foreign postal countries. Reprints of *any of the articles* can be obtained at a nominal price.

The pages of this quarterly are at the service of active workers in Economic Botany, as related to Subtropical Horticulture, from any part of the World.

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This Journal owes its existence first and foremost to the hearty material support extended to it by The Ontario-Cucamonga Fruit Exchange, The Call Fruit Company, The A. C. G. Fruit Exchange, The Covina Fruit Exchange, The Semitropic Fruit Exchange, The Arlington Heights Fruit Exchange, The Santa Paula Fruit Exchange, and Mrs. E. H. Spoor.

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Pomona Journal of Economic Botany
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POMONA COLLEGE JOURNAL
of ECONOMIC BOTANY

Volume II FEBRUARY 1912 Number 1

Feijoa Sellowiana; Its History, Culture and Varieties

BY F. W. POPENOE
WEST INDIA GARDENS, ALTADENA, CALIFORNIA

Among the fruits which have been offered as commercial possibilities in California there are few which possess such intrinsic merit as the one here considered.

The Feijoa is comparatively new to horticulture. It has been in cultivation but twenty years, and in this country scarcely ten. Therefore our knowledge of the plant and its requirements is as yet elementary, and the important subject of varieties, in particular, is in a chaotic state.

But here is a shrub, unusually valuable as an ornamental—so much so that it is grown as a pot plant for the beauty of its foliage and flowers in European conservatories. To this attractiveness, and greatly overshadowing it, is added the value of the fruit—of oval shape, greenish in color, highly perfumed, and with a flavor indescribably delicate and delicious. Supplementing these qualities, and augmenting them, is its hardiness. The Feijoa will grow and thrive not only in California, but throughout the entire coast region, and across the continent from the Pacific to the Atlantic, in the southern belt embraced within the Gulf States. Certainly few plants can offer such an appeal to public favor. Everyone who is familiar with the Feijoa to a sufficient degree, has the greatest confidence in its future. It is a fruiting shrub of sterling excellence. As a commercial fruit it offers great promise. Its admirable shipping and keeping qualities justify for it an expectation that it will become a market fruit of the first class.

History of the Feijoa in Europe and North America

Upon returning from South America in 1890, the late Dr. Edouard Andre, one of the most noted French botanists and horticulturists of his day, brought with him from La Plata, Brazil, a layered plant of Feijoa Sellowiana. This specimen was set out in his garden, Villa Colombia, on the Riviera, and bore fruit in 1897. In the following year Dr. Andre published in the Revue Horticole, of which he was editor, a description of this plant, together with a colored plate showing the foliage, flowers, and fruit. From the behavior of his plant at Villa Colombia, he felt justified in strongly recommending the Feijoa for southern France and the entire Mediterranean basin, and described the merits of the fruit

in the most favorable terms. He announced that layered plants, propagated from his bearing specimen, would be obtainable the following year from a nurseryman at Lyons.

Coming from such an authority as Dr. Andre, this article created a considerable demand for plants, and a number of them were disseminated during the following year, the majority being planted on the Riviera, but not a few going to Italy and Spain, and some to conservatories in more northern countries, where it was thought the climate was too severe to permit of their being grown in the open. The next three or four years saw a considerable number of Feijoas planted along the Mediterranean, and the cultivation of the plant fairly established.

As far as is definitely known, Dr. Andre was the first to introduce the Feijoa into Europe; certain it is that he was the first to realize its horticultural possibilities and to give attention to it from this standpoint. It is possible, however, that an introduction antedating that of Andre by several years may have been made in Switzerland. A plant is growing in the Botanic Garden at Basle which is believed to be twenty-five years old. Definite date in regard to the introduction of this plant is lacking, but previous to its cultivation in the Botanic Garden it was cultivated by M. de Wette, and there seems no reason to doubt that it is as old as it is claimed to be. Andre introduced the plant twenty-two years ago. As far as is known, he did not bring from South America any other specimen or specimens than the one planted in his own garden, and there is no record of any plants having been propagated from this until 1898—fourteen years ago. This makes it almost certain that the plant at Basle was a separate introduction, and while there is no actual proof that it was introduced previous to Andre's plant, there is a considerable possibility that it was.

In 1899 Besson freres, well known nurserymen at Nice, decided to propagate the Feijoa extensively and made an importation of seed direct from Montevideo, Uruguay, from which several thousand plants were raised. These were disseminated almost as widely as those from Andre's plant. The particular interest of this importation lies in the fact that the plants turned out to be of an entirely distinct type from the Andre bush.

One or two other small importations of seed from South America were made by French nurserymen, but no large number of plants were raised, and they were not widely disseminated, so that practically all of the Feijoas in both Europe and North America can be said to have originated from either Andre's introduction or the importation of seed by Besson freres.

In 1901 Dr. F. Franceschi of Santa Barbara, California, obtained a number of seedlings from Andre's original plant through M. Naudin of Antibes, France. These plants were disseminated at once, and were set out in several different locations in Southern California, notably Orange, Redlands, and Altadena, as well as those planted at Santa Barbara by Dr. Franceschi himself. Two years later, in 1903, Dr. Franceschi obtained from F. Morel of Lyons, who was authorized by Andre to sell layered plants from the parent bush, a number of these layered plants, of which the majority were sent to Florida, although one or two were planted in Santa Barbara.

Figure 87. The first Feijoa planted in Europe. This plant was brought from Uruguay in 1890 by the late Dr. Edouard Andre and planted at the Villa Colombia, Golfe-Juan. It is the parent of the majority of Feijoas in both Europe and North America. Mr. Paul B. Popenoe in foreground.

These plants introduced by Dr. Franceschi, which it is seen were all seedlings or layers from Andre's original plant, are the parents of nearly all the Feijoas which have been propagated in California up to the present time. An importation of seeds from Argentina was made by H. Hehre of Los Angeles, at an uncertain date, and while the plants which were the result of this importation have not been widely disseminated, one of them has proved to be of an entirely distinct form from any of the Andre seedlings, and has resulted in the Hehre variety.

Botanical Description and Affinities

Feijoa Sellowiana was named by Berg after material collected by Friedrich Sellow in the province of Rio Grande do Sul, Brazil, not far from the frontier of Uruguay. Berg's description was published (in Martius, Flora Brasiliensis, XIV, 1, p. 616) in the year 1858, under the name of *Orthostemon Sellowianus*. The generic name *Orthostemon* had already been preempted by Robert Brown for a genus of Gentianas founded by him, and it is evident Berg soon discovered his mistake, for in the same volume of the Flora Brasiliensis (the work was originally issued in small parts) he records the change and dedicates the genus to Joam de Silva Feijo, Director of the Museum of Natural History at San Sebastian, Brazil.

While Berg's description was the first one published, it is somewhat inadequate for the reason that it had to be made from the meagre herbarium material collected by Sellow, in possession of the herbarium of Berlin; and particularly, as pointed out by Andre, that no mention was made of the form of the petals, nor of the color of the corolla. Dr. Andre, having the living material at hand in the form of the adult plant growing in his garden, undertook to draw up a complete and accurate description of the species. This was published in the Revue Horticole (Vol. 70, p. 265) and a translation of it is as follows:

A bushy shrub, 3 to 4 metres in height, with rounded branches swollen at the nodes, covered with light gray bark, the young branches tomentose, as is the whole plant except the upper surface of the leaves, and the corollas.

Leaves opposite, obtusely elliptical, shortly petiolated, thick and coriaceous, the upper surface glossy and of a fine green lustre, the margins slightly recurved, veins scarcely noticeable above, but fine, prominent, and in arcuate reticulations below, re-uniting before reaching the margin of the leaf; the lower surface canescent and finely puberulent. Buds globular, puberulent, constricted above the ovary. Flowers solitary or in clusters, in the axils of the leaves; peduncle straight, then recurved, 20 to 25 millimetres long, whitish and velvety. Calyx tube turbinate, sepals four, unequal, obtusely elliptical, recurved, pubescent, ciliated. Corolla outspread, petals four, cupped, oval or obovate, entire or marginate, obtuse, fleshy, glabrous, ciliated, white outside, violet red inside, 15 to 18 millimetres long and 8 millimetres wide, recurved after anthesis. Stamens numerous, perigynous, erect in a large cluster, 20 millimetres long, filaments filiform, deep purple, anthers globular, yellow. Style longer than the stamens, filiform, slender, stigma capitate; ovary quadri-locular, oblong, turbinated. Fruit a berry, oblong or ovoid, with 4 polyspermous loculaments, 4 to 6 centimetres long and 3 to 5 centimetres wide, green even when ripe, surface first tomentose, later smooth, slightly furrowed, rough, crowned by the thick disk and cupped sepals of the persistent calyx. Seeds small, oblong.

Flesh thick, white, pulpy and watery, of a sweet and highly perfumed taste, suggesting pineapples and guavas and exhaling an extremely bland and penetrating odor, even before the maturity of the fruits.

The genus *Feijoa* is a member of the Natural Order *Myrtaceae*. Among the well known economic members of the order are the Guavas (*Psidium*), numerous

species of *Eucalyptus,* the Brazil Nut (*Bertholletia excelsa*), Allspice (*Pimenta officinalis*), Nutmeg (*Myristica fragrans*), and several species of *Eugenia,* notably the Rose Apple (*E. jambos*), and Clove (*E. caryophyllata*). All are natives of tropical or subtropical regions.

Feijoa is quite closely allied to *Psidium,* from which it differs only, according to Nicholson (Dictionary of Gardening) in the elongated ovary, in the filaments being erect in bud (in which respect it differs from all other members of the order), and in its hairy anthers. The foliage of *F. Sellowiana* gives it a false

Figure 88. Foliage, flowers, and fruit from the original Andre tree (after Revue Horticole, 1898).

appearance of *Eleagnus,* and it is also somewhat similar in appearance to the Olive (*Olea europaea*), except for the larger size of its leaves.

While *F. Sellowiana* is the only species that has been given any horticultural attention, two others have been described. These are:

F. obovata Berg (Martius, Fl. Bras. XIV, 1, p. 616), which was named after specimens collected by Sellow in the same province of Brazil as *F. Sellow-*

iana (Rio Grande do Sul), and presumably collected at the same time. According to Andre, *F. obovata* differs from *F. Sellowiana* in its lesser height, its compressed branches, and its pointed and pellucid leaves. It has probably never been introduced to horticulture, and its fruit is unknown.

F. Schenckiana (Kiaersk, Enum. Myrt. Bras., p. 186, t. 26, fig. A) is a species much more recently described (1891). From a copy of the original description kindly furnished by the Director of Kew Gardens, it appears that the species differs from *F. Sellowiana* in having oval leaves, and white petals, with other minor differences. It occurs in the highlands of the province of Santa Catharina, Brazil. Its fruit is unknown.

F. Sellowiana appears to be of common occurrence in the wild state in certain parts of Brazil, Uruguay, Paraguay and Argentina. See under "The Feijoa in South America" for more definite data in this connection.

Common Names

During the few years in which it has been cultivated in California the Feijoa has had at least three names applied to it by nurserymen and horticulturists. These are "Pineapple Guava," "Brazilian Guava" and "Fig Guava." The first can not be said to be objectionable, but the other two are somewhat inappropriate. The fact that the Feijoa is called "guayabo" and "guayabo del pais" by the natives of Brazil and Uruguay denotes that it is considered as a guava by them, and its close relationship to the guavas makes the use of this name allowable. But if the Feijoa is to be considered as a guava, and called by this name, some additional term should be used which will distinguish the Feijoa from the more or less inferior guavas. The distinct pineapple flavor of the Feijoa has suggested the appellation "Pineapple Guava" and as this name is fairly attractive, and conveys a correct idea of the nature of the fruit, no objection can be raised to its use. "Brazilian Guava" implies but little, and is not sufficiently distinctive, since there are many species of guava which are natives of Brazil. "Fig Guava" is probably founded on some slight similarity, real or otherwise, between the Feijoa and the fig, but as this similarity is extremely slight this name can hardly be accepted as the best.

In Europe no common name appears to have been given the Feijoa, and as a matter of fact, the use of the generic name is much more general in California than any other. While this name is somewhat difficult for those not familiar with it, to pronounce, there can certainly be no objection to its use. And as it is under this name that the plant has become established in California, it is probable that it will continue to be known under the same name.

There has been considerable difference of opinion in regard to the pronunciation of "Feijoa" in California. These differences seem to have been the result of a misunderstanding of the derivation of the word. Many have been misled by the belief that the name "Feijo" from which the generic name is derived is Spanish, and consequently have given j the sound of h. But the name is Portuguese, and according to the very best authorities is pronounced Fay-zho-a, accenting the middle syllable. This is the pronunciation that is used in France and in the Botanic Gardens in other parts of Europe.

The Feijoa in California

The seedlings which formed Dr. Franceschi's introduction in 1901, and which are scattered over the southern end of the state, have been notably successful. They have been grown under widely different climatic conditions, from Santa Barbara to Redlands. Being seedlings, some of them have produced fruit of indifferent quality, and while only a few have proved to be really superior, they

Figure 89. A seedling of the Andre Feijoa at Villa Valmer, Marseilles, France. Note size of fruit in basket in foreground. Back of basket stands Alfred Rivier, head gardener at this place.

have demonstrated that California is admirably adapted to the Feijoa—doubtless much better adapted to it than southern France, where it has been grown so successfully.

Outside of its trial in the southern part of the state, it has been tested at Santa Rosa, and even as far north as Eugene, Oregon, at both of which places it

has proved perfectly hardy. And from our knowledge of the hardiness of the plant, gained from the experience of the European growers, it is safe to say that it will be hardy in practically all parts of California, except at very high altitudes where low temperatures are experienced.

Since the first importation of plants has come into bearing, many seedlings have been raised, some of which are now in bearing. While the variation which is natural to all seedling fruits has been exhibited by the Feijoa, and many of the seedlings have been disappointing, where good care has been bestowed upon the plants the results have, in the great majority of cases, been highly gratifying.

During the last few years several thousand seedlings have been raised and disseminated by the nurserymen. Most of these have gone into private gardens, although several small plantations have been made, the largest of which is that on the Henry E. Huntington estate near Pasadena, and consists of about four acres. The plant has been used in a few instances as an ornamental hedge, for which purpose it has proved to be admirable.

During the past season a small quantity of the fruit was placed on the Los Angeles market and retailed at fifty cents per pound.

California soils, if properly handled, seem to be particularly adapted to the Feijoa, and the climatic conditions of most parts of the state have proved to be most favorable to the development of the plant and the perfection of the fruit. It has not been tried as yet in strictly desert regions, but it has been grown as far into the interior as Redlands. There is no doubt but that when the requirements of the plant are thoroughly understood and supplied it will reach a high degree of perfection in this state.

The Feijoa in France

In southern France the Feijoa has been given more attention from a horticultural standpoint than in any other country. Yet almost nothing is known of its requirements or varieties, except by a few horticulturists, and there are but a few dozen good bearing plants in the entire country. Dr. Andre considered it "one of the most important and most useful to horticulture of the hard-wooded plants which he introduced into Europe on his return from La Plata in 1890." Why this valuable fruit, in the fourteen years that have elapsed since it first came into bearing, and in which it has been offered by the trade, has not assumed a greater importance and become more widely planted, may perhaps be explained by the statement of Viviand-Morel (Lyon-Horticole, XXXII, 1, p. 16): "Exotic fruits do not please everybody—we have so many in our own country that are worth more than the mango, banana, pineapple and avocado of the tropics." The French attitude toward horticultural novelties of this character is certainly not like the American. Not knowing the value of the Feijoa from their own personal observation, and being satisfied with the fruits they already have, the French gardeners are content to leave the culture of this fruit to someone else. It is only through the persistent efforts of those broad-minded horticulturists who have the perception to realize the value of such a fruit as the Feijoa, of which may be mentioned such men as Dr. Robertson-Prochowsky of Nice, M. Clement Nabon-

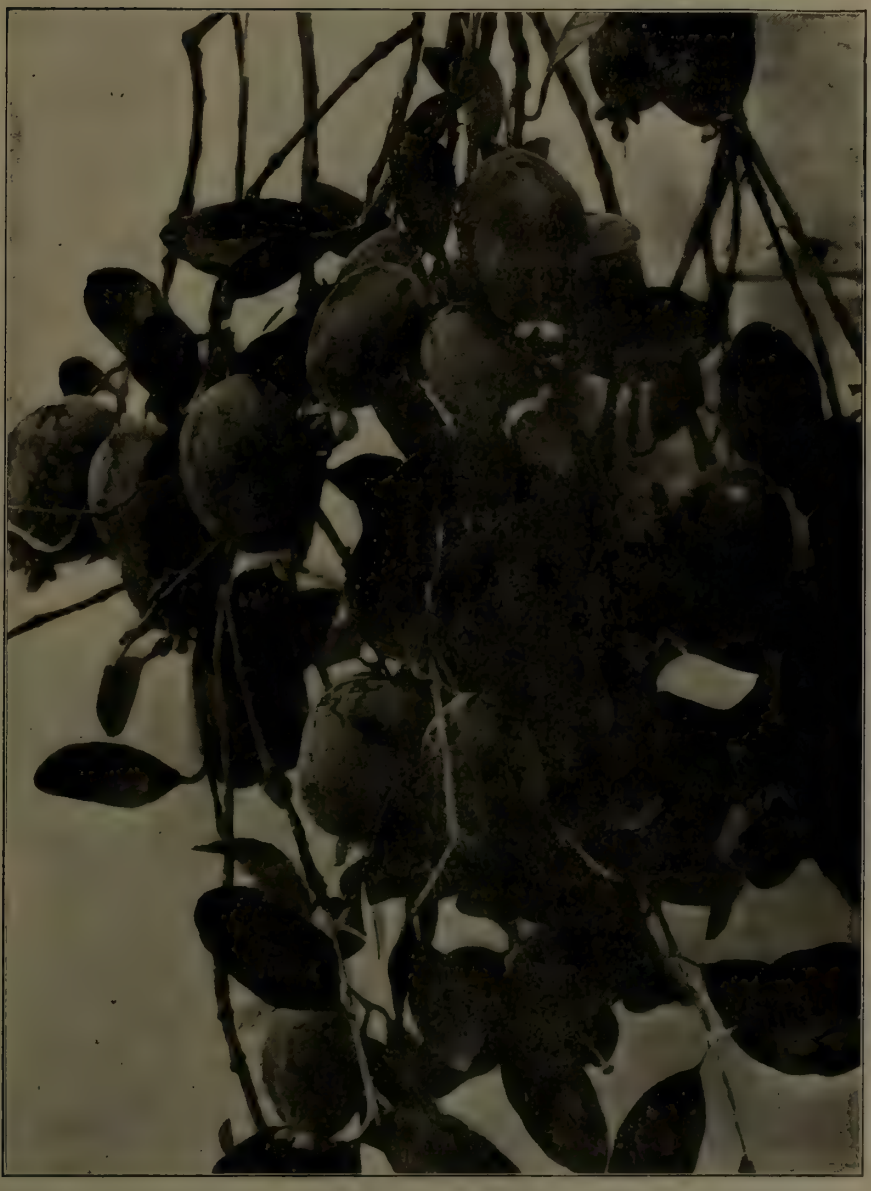

Figure 90. Fruiting branch of a seedling Andre Feijoa at Marseilles, France, showing an average productiveness. These from trees shown in Figure 89.

nand of Cannes, and M. Viviand-Morel, editor of the Lyon-Horticole, that this fruit can ever be established on a commercial basis in France.

My data in regard to the Feijoa in France and other European countries, and some of the illustrations presented herewith, are the result of the investigations of my brother, Paul B. Popenoe, who devoted a month to the study of the subject, in the interests of the West India Gardens.

The Riviera has proved to be well adapted to the culture of the Feijoa. Although the winters are cold, the temperature sometimes getting as low as ten degrees (Fahr.) above zero, unprotected plants are not injured, and produce abundantly. The twenty-year-old plant at Villa Colombia, Golfe-Juan, brought by Dr. Andre from South America, is now an immense bush, fifteen feet in height, covering a space of ground eighteen feet in diameter, and with a trunk eight inches thick at the base. The crop is estimated by M. Clement Nabonnand at two thousand fruits. The winds coming from the Mediterranean frequently blow off part of the fruit before it is mature, and although it can be ripened in the house, it is not as good as though allowed to reach full maturity on the tree.

One of the most successful cultivators of the Feijoa is Alfred Rivier, *chef du culture* at Villa Valmer, near Marseilles. The plants grown by M. Rivier are seedlings from Andre's bush, and are even better than the parent. Among other successful growers may be mentioned Abel Gorre at Menton, who grows both the Andre and Besson types; Francois Mangan, also at Menton, and Dr. Robertson-Prochowsky, the well known systematic botanist at Nice. Occasional bearing plants are found in the gardens along the Riviera in Italy as well as in France. There are also a few in Spain.

M. Viviand-Morel believes that the Feijoa will in time take an important place among the commercial fruits, not only on the Mediterranean coast, but also in Provence, and the South and West of France. Certainly there is no reason why it should not do so, other than the difficulty in establishing any new fruit upon a commercial basis, and although progress toward such a state has been anything but rapid, it is to be hoped that the horticulturists of southern France will devote more attention to the Feijoa in the future than they have in the past.

The Feijoa in England

As a fruiting shrub, the Feijoa does not seem to be a success in England, but its cultivation in a limited way as an ornamental is possible, and this alone speaks volumes for the hardiness of the plant. The following extract is taken from an article on the subject by A. C. Bartlett, published in the Gardeners' Chronicle (Ser. 3, XLVIII, p. 242): "The best plants I have seen were grown in yellow loam, and were trained against a southern wall. Under these conditions the species made fine, healthy branches. They require liberal waterings during hot, dry weather, until the beginning of August, from which time attention should be paid toward ripening the growth already made; otherwise the plant is almost certain to be injured by the first heavy frosts. Although the natural habit of the Feijoa is that of a shrub or small tree, there are few places in these islands where it could be grown in this way with any likelihood of success, therefore the protection of a

Figure 91. Fruits of an Andre seedling grown at Marseilles, France, natural size. These from trees shown in Figure 89.

wall is essential." Mr. Bartlett goes on to state that the fruit does not seem to ripen under cultivation in that country. He recommends it strongly as a wall shrub, however, and considers it well worth growing for its handsome foliage alone.

The Feijoa in Florida

Reports on the behavior of the Feijoa in Florida are not encouraging. While as yet it has been tested at very few points, and some parts of the state may prove to be adapted to it, past experiments do not promise extensive future development.

At Gotha, the Feijoa has been grown for several years by Dr. H. Nehrling. Regarding the behavior of his plants he writes under date of October 16, 1911: "The Feijoa has fruited with me this year as well as last season. It grows beautifully, has fine flowers, and would be a great ornament to any collection of exotic plants. I have two specimens, both coming from the Department of Agriculture. The fruit is about the size of a *small* walnut, entirely glossy green and only slightly fragrant when ripe. Both of my plants grow in half shade in my Caladium shed, and perhaps for this reason the fruits drop when still unripe. The flavor is not very good, and after having dropped the fruit immediately begins to rot, assuming a dark brown or blackish color and becoming soft and tasteless. The plant thrives splendidly, though we have had no great cold since I began to grow these plants, the thermometer never going below about 28 degrees Fahrenheit."

The Feijoa has also been grown at the Subtropical Garden of the U. S. Department of Agriculture at Miami, but so far has not done as well as at Gotha. The plants bloomed last season but did not set any fruits, according to the statement of Edward Simmonds, gardener.

It will require a more thorough test to definitely decide the matter for any part of the state, but it seems quite probable that the Feijoa has greater chances of being a success in the more northern sections than under the almost tropical conditions of the east and west coasts.

The Feijoa in the West Indies

So far as known to the writer, the only point in the West Indies where the Feijoa has been grown for any length of time is at Columbia, Isle of Pines. Two plants set out by Dr. F. R. Ramsdell in 1906 have made a growth of four feet in height and six feet in spread, but have not yet bloomed or fruited.

The Feijoa in Hawaii

At the Hawaii Experiment Station in Honolulu is a Feijoa several years old, which is reported by J. E. Higgins, Horticulturist, to be in a thrifty condition, but has given as yet no indication of fruiting.

The Feijoa has not been tested for a sufficient length of time in Florida, the West Indies, and Hawaii, to fully determine its adaptability to these localities, but experience seems to indicate that strictly tropical conditions such as are suited to the mango and the pineapple are not so well suited to this fruit.

The Feijoa in South America

In regard to the Feijoa in its native country, the following notes kindly furnished by Dr. J. Arechavaleta, Director of the National Museum at Montevideo, Uruguay, are of interest: "This plant is known here under the name of 'guayabo del pais.' Regarding its occurrence in a wild state in Brazil, Argentina and Paraguay I have no exact data, but in Uruguay it is quite common in the forests. It

Figure 92. Feijoa trained against a wall at Villa Niobe, Golfe-Juan, France.

is cultivated on an extremely small scale. It flowers in November and ripens its fruit in January and February. By cultivation the fruits are greatly increased in size. They are aromatic and of a flavor very agreeable to the taste."

Prof. Carlos Thays, Director of the Botanic Garden at Buenos Ayres, Argentina, gives the following notes: "This plant is found commonly, in the wild state,

in western Paraguay, in southern Brazil, and in some parts of the Territorio de Misiones, Argentina. The common name is 'guayabo.' The fruit is used for the manufacture of 'dulces' (i. e., jams, jellies, etc.) and is mixed with those of the Psidium (guava). * * * Cultivation for improvement of the fruits is very limited."

Methods of Propagation

BY SEED: While there are several methods by which the Feijoa may be propagated, the majority of plants, both in Europe and California, have been grown from seed. Propagation is readily effected by this means, in fact it has been found in France that when the fruits which fell to the ground were allowed to lie until spring, a large number of volunteer seedlings would spring up.

It is well to emphasize the point that when best results are desired, it is absolutely necessary to use great care in the selection of seed. Much disappointment has resulted in the past from the planting of seeds from inferior fruits. Plants for seed should be selected with a view to desirability in every character, not only in the size and quality of the fruit, but in precocity of bearing, and productiveness as well. Propagate from those plants which possess all these characters in as great a degree as possible. It is not a matter of planting seeds from an extremely large and fine fruit, which may have come from a plant whose bearing habits were very poor, as the seedlings would be very likely to perpetuate this undesirable characteristic.

The seeds are but slightly larger than those of the fig, and for this reason, although they germinate readily, they should be planted with care and given the best of attention.

For starting the seeds a good medium has been found to be a mixture of two-thirds clean sand, and one-third redwood sawdust. Both these materials are easily obtained. This provides a practically sterile mixture in which there is little danger from the fungus known as "damping-off." The sawdust should be kept wet and allowed to rot for two or three months before it is used.

The seeds should be sown in flats three or four inches in depth, and covered with the mixture of sawdust and sand to a depth of not over one-fourth of an inch. They may be planted quite thickly, if they are promptly pricked off after germinating.

It is best to plant the seeds as soon as possible after their removal from the fruit. If kept dry, however, they will retain their powers of germination for several weeks at least, probably longer, but it has not yet been determined just how long they may be kept and still give a good rate of germination.

If the seeds are started under glass, germination will take place in twenty to twenty-five days. If no artificial heat is provided, a somewhat longer period will be required, but not over four or five weeks at most.

Waterings should be frequent, but not copious. As soon as the plants have made their second leaves they may be pricked off into flats, or potted into two-inch pots, preferably the latter. When they have attained a height of three or four inches in the twos, they should be shifted into threes, where they can be

carried until they have reached a hight of ten or twelve inches, when they are ready to go out into the field.

M. Clement Nabonnand of Cannes, France, a noted rosarian and horticulturist, who has been very successful in raising the Feijoa, and to whom I am indebted for much valuable information, gives the following account of his method: "Provide some good leaf mold, preferably that gathered under trees in the forest. It must be thoroughly decomposed. Mix the leaf mold with equal parts of clean sand, and sow the seeds upon this compost, covering them to a depth of three-eighths or one-fourth of an inch, with the same material. Either boxes or clay pans may be used, and they should be placed in glass-covered frames, quite close

Figure 93. A large Feijoa at Golfe-Juan, France. On the left, M. Clement Nabonnand, one of the noted rosarians and horticulturists of Southern France; on the right, M. Amalberti, Dr. Andre's head gardener.

to the glass. It is necessary to have the glass whitewashed so that the young plants will not be burned. See that the soil is constantly kept slightly moist. Do not raise the sash until after the seeds have germinated."

BY CUTTINGS: From the many attempts which have been made to propagate the Feijoa from cuttings there have been varying results. But judging from the sum of past experience, it will be no more difficult to grow this plant from cuttings than it is many other hard-wooded shrubs which are commonly propagated by this means. In many of the Botanic Gardens in Europe the Feijoa is considered not at all difficult to grow from cuttings, and several of the French gardeners have also been very successful. In California several attempts to root cuttings have resulted unsuccessfully, but this would imply a lack of proper knowledge on the

part of the operator rather than any inherent difficulty in propagating the plant in this way, since we know that it can be, and has been, done in Europe.

It is essential, if the cuttings are to be rooted at all promptly, that bottom heat be supplied, and that the work be carried on under glass. There has been little difficulty in rooting the cuttings when these two conditions have been recognized and supplied. The cuttings should be made of half-ripened wood—that from the ends of the branches, and three or four inches in length. It is probably not essential that the cuttings be made at any particular season, but it has been advised to do the work during June, July or August. The time required for the formation of roots is longer than with many other plants, and a greater percentage of cuttings may be lost, but under favorable conditions a good percentage has been successfully rooted.

A rather novel method of rooting cuttings of the Feijoa as well as other hard-wooded shrubs, is that practiced by Mr. Stewart, foreman of the glass department of the Royal Botanic Gardens at Edinburgh, Scotland. This method as discovered and successfully practiced by him has been named the Stewart Sun Method, and although the difference in climatic conditions will necessitate its being modified considerably in California, it should prove of great assistance in perfecting a method of quickly and successfully rooting Feijoa cuttings in this climate. The cuttings are placed in pure sand in a glass-covered box and placed in full sun. The heat inside the box becomes intense, so much so that an amateur would expect the cuttings to be promptly killed; but if they are kept liberally supplied with water—during hot weather they must be watered every half hour—they will form roots within ten days. Shrubs that are considered impossible to be propagated from cuttings Mr. Stewart has successfully rooted by this method, and those that ordinarily require two or three months to form roots can be struck in ten days.

BY BUDDING: Attempts to bud the Feijoa do not seem to have resulted successfully up to the present time. Many propagators consider the wood too hard and dry to bud successfully. However, the fact that guavas can be budded leads to the belief that the Feijoa can be budded as well. Both patch and shield budding have been found to be practicable with the guava, and it is quite reasonable to believe that one of these methods will be practicable with the Feijoa.

BY LAYERING: This is the simplest method of asexually propagating the Feijoa. By it the majority of plants in Europe, other than seedlings, have been grown. It requires no skill on the part of the operator, and though not so desirable for nursery work, it is an almost infallible method, and can be practiced to advantage by those who have a superior plant and desire to propagate it.

Layers may be rooted either in the ground, or in flats of soil supported by a platform erected close to the bush. In layering in the ground it is only necessary to bend down those branches which are most easily brought to the position, make a shallow cut at an angle, on the branch, and cover a portion of the branch including the cut, with soil to a depth of two or three inches. A small trench should be dug for the purpose at the most convenient place, and if necessary the branch may be held down with wire or wooden pegs. The layers require no further care

except to see that the soil is kept reasonably moist, and at the end of six months roots will have formed, and the plants can be severed from the parent.

In layering in flats supported by a platform, the operation is the same. The soil should contain plenty of humus, and be watered as often as necessary to keep it moist.

BY GRAFTING: This method of propagation has not been extensively practiced, but has been found to be successful. So far, the work has been done exclusively under glass. The stock used has been seedling Feijoa, of a diameter slightly less than that of a lead pencil. Both whip-grafting and veneer-grafting have been employed with equal success. The scions should be of about the same diameter as the stock, and the operation should be performed during March and April or

Figure 94. A ten-year-old Feijoa on place of Walter Nordhoff, at Redlands, California.

August and September. After the graft has been made, the plants must be kept under bell jars or in a tight glass frame, to exclude the air as far as possible, for a week or more. It is likely that some other myrtaceous shrubs or trees may prove more desirable for stocks than seedling Feijoas. Dr. Trabut of Algiers suggests *Eugenia jambolana,* on account of its hardiness and vigor.

BY INARCHING: The Feijoa lends itself readily to inarching, but this method is too slow and laborious to permit of its being widely practiced where any other is successful. Layering gives the same results with less labor, and cuttings should be more expeditious than either.

Inarching may be practiced advantageously upon seedlings in pots, by placing them upon a platform erected around the tree it is desired to perpetuate. A branch of the tree of about the same diameter as the stem of the seedling should be chosen, and a thin slice of bark, taking as little of the wood under it as possible, removed from both the stock and scion. The two cut surfaces should then be bound together with raffia or other soft tying material. After two months have elapsed, the scion may be gradually severed from its parent by cutting away a little of the wood just below the point of union, every few days. Care should be taken that the union is not severed too suddenly—it should be a month or two before it is entirely severed. The stock may then be trimmed down close to the union, and the plant is ready to set out.

Climatic Requirements of the Feijoa

At this date it is impossible to make a completely definite statement as to the different climatic conditions under which the Feijoa will thrive. The meagre data that is obtainable regarding its behavior in tropical countries is not sufficient by any means to prove that it will be a failure under such conditions as obtain within the tropics; still, there is no doubt but that a climate like that of Southern California is more eminently suited to it. Dr. Andre remarked that the native home of the Feijoa was the region of *Cocos australis*, which sufficiently indicated the climate in which it would thrive. It is, then, distinctly sub-tropical in nature, and can be expected to do well in localities whose climatic conditions closely approximate those of Uruguay and southern Brazil. Furthermore, the fact that it is a success in the Mediterranean basin shows that it is considerably hardier than the majority of subtropical plants which are in cultivation, and will thrive in localities where the avocado and other fruits more strictly tropical in nature can not be grown.

Whether it is adapted to desert regions such as the Colorado and Imperial valleys cannot be stated at this time, but the fact that it does well at Redlands indicates that it will tolerate a considerable amount of heat.

The Pacific Coast is pre-eminently adapted to the Feijoa—its successful cultivation at many points from San Diego north to the state of Oregon prove this beyond the possibility of a doubt. And the fact that it has withstood without injury temperatures of ten degrees above zero warrants the belief that it will be a success in the milder portions of the Gulf States.

Culture

While the Feijoa cannot be said to be particular in its cultural requirements, yet best results in both growth and fruit can only be obtained by giving careful attention to the needs of the plant and supplying them in as great a degree as possible.

In California the Feijoa has been successfully grown in soils of at least two kinds—sandy loam and heavy clay or adobe. And while it has succeeded in both, there is little doubt but that the lighter soil is the best. And it is of paramount importance that the soil contain an abundance of humus. Alfred Rivier of Marseilles, one of the most successful French growers, believes many failures in that country

are due to the presence of too much chalk in the soil, and advises as a remedy a small amount of iron sulphate worked in around each tree. He emphasizes particularly the importance of a light soil and an abundance of humus.

That the Feijoa is drought-resistant has been thoroughly demonstrated. A ten-year-old plant in Dr. Franceschi's garden at Santa Barbara has never had a drop of water except from the skies, and yet it has made a fair growth and is bearing regularly. And while the fruit grown without irrigation is probably of very fine flavor, it is probably not advisable to subject the plant regularly to such severe conditions. A liberal supply of water during the first few years results in much greater growth and more fruit. After the fifth or sixth year a large

Figure 95. Showing an eight-year-old example of the upright type of Feijoa raised by Mrs. J. Murietta in Los Angeles.

amount of water is not required, but for best results it is necessary to irrigate the Feijoa as frequently as citrus fruits. During the blooming season water should be withheld as much as possible, and until after the fruits have set, when it may be applied liberally to assist in the development of the fruits.

Fertilizers of all kinds must be applied with caution, or they will stimulate the growth of the plant at the expense of the fruit. A small quantity of bone meal, or some other form of commercial fertilizer not too rich in nitrogen, may be advantageously applied each year, as it increases both the quantity and size of the fruit. Well rotted manure can be used to supply the much-needed humus, and should be used liberally, but any manure that greatly stimulates the growth of the plant

should be avoided, unless it is in the case of young plants which have not yet come into bearing.

Practically all Feijoas observed in Europe which have arrived at the proper age to bloom have flowered profusely, whether grown in the open ground or in pots in a conservatory. But there are some plants which bloom regularly that are habitually unproductive, and this condition appears to be due in the main to imperfect fertilization of the flowers.

French growers have tried to overcome this failure of the plant to fruit by hand pollination. The results have been varied, some stating that it has been eminently successful, others that it appeared to have no effect and the plants were as barren as before, but this may have been due in a large measure to lack of skill or knowledge of conditions on the part of the operator.

In California there are quite a few plants of mature size which are habitually unproductive, although blooming regularly. It scarcely seems probable that this condition can be due entirely to unfavorable soil or other cultural conditions, although these have an extremely important effect. As practically all of the unproductive plants are isolated specimens, it seems likely that the lack of foreign pollen may have much to do with the matter, and experience with a number of seedlings during the past few years bears out this belief. Some thirty seedlings, planted in a row, bloomed for the first time in 1911, at the age of two years, and every one set several furits and brought them to maturity, although it is quite common for the plant to fail to set any fruits for the first two or three years in which it flowers. An older plant in the same location did not set any fruits until the same year, though it had bloomed for two years previously, and was in a healthy condition.

But the fact that many isolated specimens are producing abundantly shows that the plant is naturally not dependent on foreign pollen. The difficulty may be due in many cases to a weakened condition of the plant, caused by unfavorable soil or culture, and it is probable also that it is due in some instances to atmospheric conditions. Certain it is that the culture of the plant exercises a certain amount of control over its productiveness. Those which are subjected to harsh treatment or unfavorable conditions are invariably sparse bearers.

There is little likelihood that any difficulty will be experienced from this source when several plants are grown together, and their cultural requirements are supplied to a reasonable degree.

The Feijoa requires but little pruning. A judicious use of the shears is of course necessary to keep the bush in good form, and when it is desired to train it to any particular shape a more liberal pruning may be necessary. But as the fruit is produced on the young wood, pruning of a mature bush must be done at the expense of fruit, although it will naturally result in increased size of those produced. As the bush is frequently of open and spreading growth, and inclined to be somewhat straggling in the young stage, it is necessary to prune sufficiently to make it shapely. This point should be kept constantly in mind and the shears not withheld from an unshapely plant. The tips of long shoots should be pinched out to induce the plant to branch and form a compact body. The fact that the

Feijoa is found in two distinct forms of growth, one upright and the other spreading, makes it necessary to prune according to the individual character of the plant, the spreading form requiring much more attention than the upright.

For permanent cultivation the plants should not be set closer than fifteen to eighteen feet. While it may not be desirable to let the bush spread to an unlimited size, this distance will be necessary when the plants are mature, if any cultivating is to be done between them. Andre recommended that the plant be grown against a wall. This is undoubtedly a good practice in countries where the weather is cold at the time of ripening, as the shelter of the wall and the heat reflected from it assists materially in ripening the fruits.

Seedlings will come into bearing at three or four years of age if good cultivation is given them. Plants propagated asexually bear somewhat earlier, two years being the usual age for layered plants. It is not known just how long the plant will continue in profitable bearing—Andre's twenty-two-year-old bush seems to be increasing rather than decreasing in production.

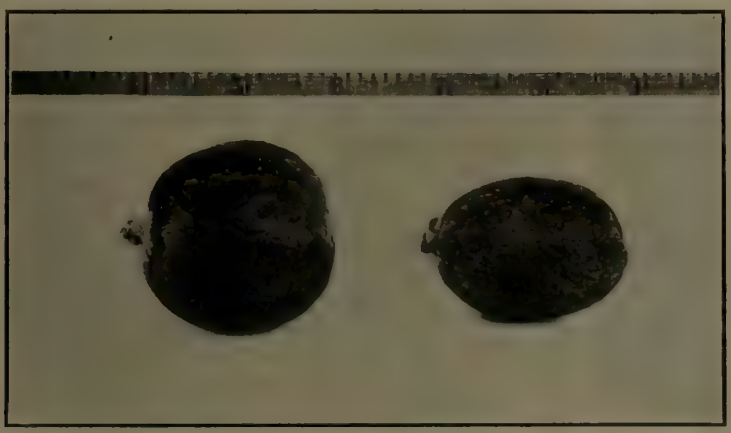

Figure 96. Showing variation in form and size among fruits from the same seedling tree. These probably represent bud variations.

Season

The season of ripening varies with different varieties, but can be said in general to be November and December. The Hehre variety matures much earlier, September and October being its season. The locality in which the fruit is grown also exercises a certain amount of control over the season in which it ripens, as would be expected.

In most instances the fruits fall when mature, but are not then ready for eating. They should be laid away in a cool place until they are in condition for use, which can be detected by their becoming slightly soft, and also by the odor, —a fragrance that is most delightful.

The fruits should be allowed to hang on the bush as long as they will do so, as they increase in size up to the moment they fall, and their growth during the last few weeks is much more rapid than at any other time. If picked before

fully mature they will ripen sufficiently to be eatable, but lack much of the delicate flavor which characterizes a perfect fruit.

There is usually considerable variation in size among the fruits, those which are the result of the latest blossoms never reaching their full development.

The Fruit and Its Uses

Very few people in California have as yet had an opportunity to taste the Feijoa. Those who have become thoroughly familiar with it, while invariably holding it in the highest esteem, are aware that there is a vast difference in quality among the fruits from different seedlings. And to be fully appreciated, the fruit must be eaten at just the proper moment. If allowed to become a trifle overripe, or if eaten a little before it is fully ripe, it lacks much of the delicate and aromatic flavor of a perfect Feijoa. Commenting on this point, Viviand-Morel says (Lyon-Horticole, XXXII, 1, p. 16): "Everyone knows that the finest pears are only turnips if eaten a trifle too soon or a trifle too late." And also, it has been found that the fruits produced by young bushes, as well as being inferior in size to those produced by a mature plant, are greatly inferior in flavor.

It is well to consider what some authorities have said of the flavor and value of the Feijoa. Dr. Andre, writing in the Revue Horticole in 1899, said: "I must slightly modify for the better what I said before (referring to his article of the previous year). The pulp is abundant, clear, of the consistency of a 'Butter Pear,' of a creamy white, and the savor approaches very much that of the strawberry, according to everyone who has tasted it. There are some seeds, but rare. The fruits, almost all falling slightly before maturity because of a damaging wind, were good. Their aroma was so intense that it filled the whole room in which they were placed, and the basket which held them is perfumed to this very hour."

Viviand-Morel says: "I find those that I have eaten pared, with sugar, delicious. I compare them in a certain measure to our large garden strawberries. The odor is very agreeable."

H. Dauthenay, writing in the Revue Horticole, says: "The flavor is slightly acid and very agreeable, rather vinous, and the odor something like that of the banana and also the strawberry. It is certainly a good exotic fruit to add to tables richly served."

These opinions of French authorities are quoted to verify the belief of all Californians who are intimately familiar with the Feijoa, that it is a fruit of rare merit. A few people have become prejudiced against it because of having sampled inferior specimens, but those who have been privileged to taste a perfect specimen, of which many have been grown in this state, have nothing but commendation for the Feijoa and confidence in its future.

The fruit can be used in many ways. Although it has been too scarce as yet to permit of much culinary experiment, delicious jams and jellies have been prepared, and when crystallized it is excellent. The French confectioners are experimenting with it for the preparation of bonbons. The general use of the

fruits in France is that mentioned above by Viviand-Morel,—pared, with the addition of a small amount of sugar.

Keeping and Shipping Qualities

Two strong points in favor of the Feijoa are its remarkable keeping and shipping qualities. Many fruits which have been grown in California have been kept in the house for three or four weeks, at the end of which time they were in perfect condition for eating.

As the fruits ordinarily fall when mature, and must be laid away for several days before in condition for eating, they can be shipped to a considerable distance and arrive in perfect condition, having ripened up in transit.

According to Alfred Rivier of Marseilles, the fruit can be kept from the time it is harvested, November or December, until spring, if stored in a cool, moist place. It is essential that the place of storage be cool, as otherwise the fruit will soon decay.

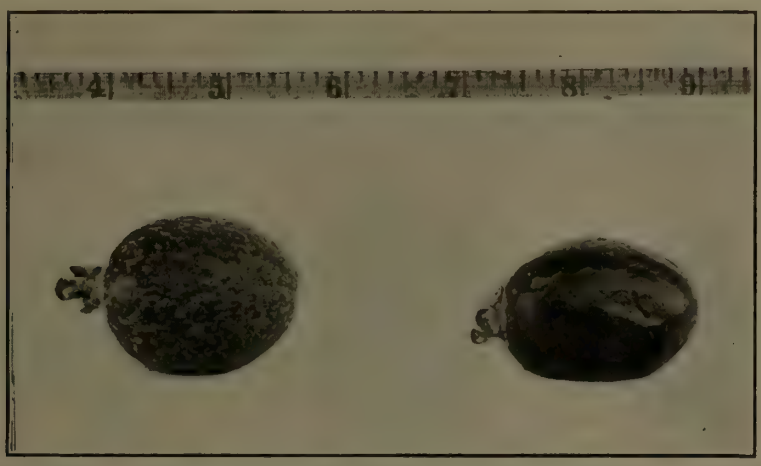

Figure 97. The Andre (at left) and Besson (at right) varieties, grown by Abel Gorre, at Menton, France.

Fruits have been shipped from France to California, and arrived in perfect condition after having been over a month in transit.

Diseases and Insect Pests

The hard, dry wood and tough, leathery foliage of the Feijoa render it almost immune from the attacks of insects or fungus growths. So far as has been observed, the only insect that attacks it is the Black Scale (*Saissetia oleae*), and instances of a thorough infestation of the plant by this species are extremely rare, even though Feijoas be planted in close proximity to other trees which are badly infested.

Variation and Varieties

With the Feijoa, as with practically all other cultivated fruits, the question of varieties is one of the most important that comes up for consideration. The

fact that this fruit has been in cultivation for but a few years, and that in this time no effort whatever has been made to obtain superior forms by either selection or breeding, shows that it is as yet practically in the wild state, and the question of varieties is still in an embryonic stage.

Andre did not, apparently, consider this question. At the time his plant came into bearing it was the only bearing specimen in Europe, so that no opportunity was given for comparison with others, and he makes no mention of having observed any marked variation among the plants in South America. Yet later writers have stated that among the wild plants in Uruguay there is a wide range of differences in form, quality and other characteristics.

Among the bearing plants in Europe it is possible to distinguish between two entirely distinct forms, and the minor variations exhibited by individual plants are almost innumerable. The only discussion of this subject, so far as known to the writer, is that made by Viviand-Morel (Lyon-Horticole, XXXII, 1, p. 16) in which he calls attention to the marked differences exhibited in a basket of fruits sent him by Abel Gorre of Menton, and discusses the subject at some length, but his data was not sufficient to enable him to reach any definite conclusions.

Of the first introduction to Europe, that of Dr. Andre, at least one hundred seedlings have been grown and fruited. These seedlings all exhibit the distinguishing characters of the parent to a greater or less degree, and even in the second and third generation these characters are maintained by the majority of individuals. Allowance must be made for an occasional "break," or departure from the type, but these seem to be less frequent than with most other fruits.

The second importation that was made to Europe was that of Besson freres of Nice, and consisted of seeds from Montevideo, Uruguay. This stock has proved to be of a distinct type from that of Andre, the seedlings uniformly exhibiting one or two characters that render the type immediately distinguishable from that of Andre.

In California, apart from the seedlings of the Andre type, which maintain their distinguishing characteristics here as well as in France, the only other distinct type, so far as known to the writer, is that originating in an importation of seed from Argentina made by H. Hehre of Los Angeles. Among the seedlings grown by Mr. Hehre, which were, in the main, not unlike those of the Andre type, was one which exhibited a peculiar characteristic, consisting of a marked departure in form from the normal. This variety has been named the Hehre. As yet it is impossible to say whether this characteristic is going to be transmitted to the progeny or not, but the variety appears to be much more vigorous than any other forms grown here thus far.

It is thus seen that three separate importations from South America have produced different types of fruit.

In general, it may be said that seedlings perpetuate the characteristics of the parent. But the fact that different types exist in South America shows that the species is as variable as most other tree or shrub fruits, and the matter of varieties must be given attention. Among the seedlings grown in California and

Europe the variations are many, but these are ordinarily so slight that it is not advisable to consider them as distinct varieties and establish them as such, or the subject would be involved in needless confusion. While among the seedlings of the Andre type there are many that are inferior to the original, and many which are slightly different from it in form and other characteristics, in general they approach the type so closely that they could not be considered as varieties. And it is noteworthy also, that the variation among fruits on the same tree, presumably due to bud variation, is so great that it is necessary to distinguish the variety by only those characters which hold good in the majority of the fruits produced.

Key to the Varieties

A. Form oblong to round.
  B. Surface more or less rough; usually self colored; size large. *Andre*
  BB. Surface smooth; one side overspread with red or maroon; size small to medium. *Besson*
AA. Form slender pyriform. *Hehre*

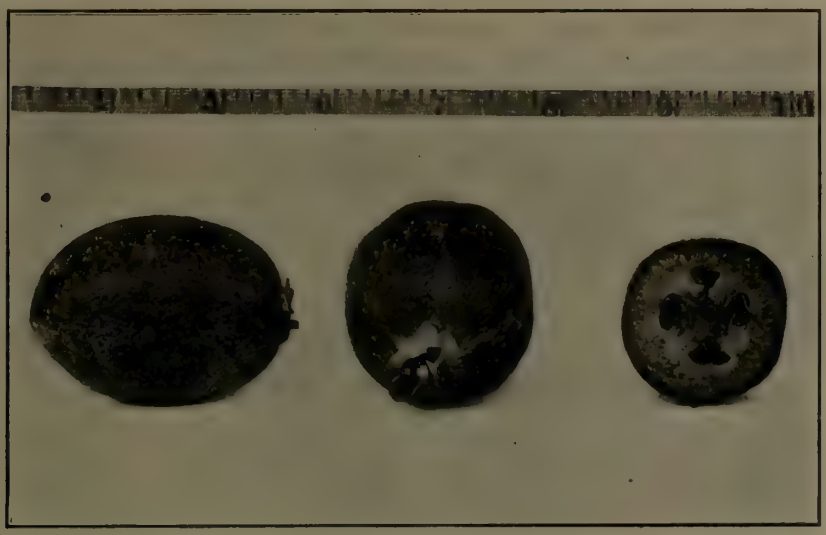

Figure 98. A seedling of the Andre at Marseilles, France.

Andre

(Figures 97 and 99)

The origin of this variety is unknown. It was brought as a layered plant from some point in Brazil, Argentina or Uruguay to France in 1890, by Dr. Edouard Andre. It is one of the largest of the varieties and is excellent in every respect.

Description: Form oblong to oval; size large; base rounded, sometimes slightly flattened; cavity none; apex rounded, sometimes slightly flattened; calyx sepals large, cupped; surface more or less rough; color green; skin thin; flesh whitish, very thick, granular, pulp fairly abundant, juicy; seeds very few, small; flavor spicy and aromatic, distinctly resembling the pineapple and also the straw-

berry, strongly perfumed; quality very good; season November to December at Golfe-Juan, France.

Shrub exhibiting two principal forms of growth, upright or spreading, with many intermediate forms; growth very vigorous; foliage abundant, healthy; productiveness excellent. So far as known to the writer, this is the first description of this variety.

Besson

(Figure 97)

This variety is the result of an importation of seeds from Montevideo, Uruguay, made in 1899 by Besson freres, of Nice, France. While considerably smaller than the *Andre*, it is equally as fine in flavor, and its brighter color makes it more attractive in appearance.

Description: Form uniformly oval; size small to medium; base rounded; cavity none; apex rounded; calyx sepals small, recurved, cupped; surface smooth; color green, one side overspread with red to maroon; skin thin; flesh whitish, medium thick, soft, fine grained, pulp abundant, very juicy; seeds rather numerous, large; flavor very spicy, aromatic, similar to *Andre;* quality very good; season November at Nice, France.

Shrub exhibiting two principal forms of growth, as in *Andre;* growth moderately vigorous, open; foliage fairly abundant, healthy; productiveness said to be fairly good. This is the first description of this variety.

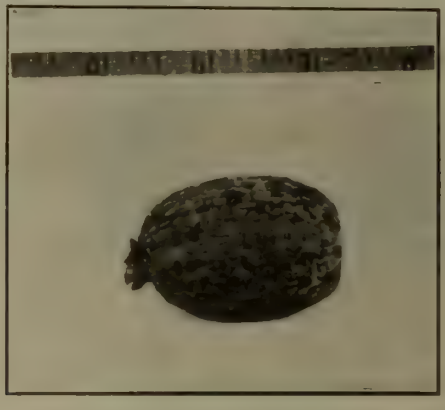

Figure 99. A fruit from the parent Andre tree, crop of 1911.

Hehre

This variety originated with H. Hehre of Los Angeles, California, from seed imported from Argentina. It is a distinct departure in form, but is probably of not as good quality as *Andre* or *Besson.* The variety is of exceptional vigor.

Description: Form slender pyriform, sometimes curved; size large; base tapering, slender; cavity none; apex slightly tapering; calyx sepals small, recurved; color yellowish green, self colored; skin thin and delicate; flesh whitish, finely granular, pulp abundant, very juicy; seeds rather numerous, large; flavor sweet, rather lacking in aroma, melting; quality fairly good; season September at Los Angeles, California.

Shrub upright; growth very vigorous and close; foliage abundant, large, healthy; productiveness fair. Here first described.

Plans and Plants for Small Places III

Slopes and Terraces

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We now come to that treatment of grounds whose irregularity of surface or relative position to the street makes terracing or sloping of the yard necessary; a difficult problem at its best. The terrace is naturally a part of the architectural scheme and should correspond with the house, forming, as it were, a broad, substantial foundation for the safe support of the dwelling. The ground should never slope directly away from a building, as that gives the structure a balancing,

Figure 100. Instead of the more formal terracing, natural slopes may be frequently used in very pleasing fashion.

unstable appearance. The width of the terrace, should, however, be determined by the size and style of the buildings and by the general sorroundings, as no fixed rules can be applied. The terrace should be given a slight fall to allow for drainage. Never permit it to have a hollowed or dished appearance, but rather crown it ever so slightly. If the size of the place permits, the terrace may follow the contour of the land, but in the small, city plot, the street is generally the determining factor for the line of conformity. Terraces should not end

Figure 101. Showing three different uses of terraces of verdure in breaking an abrupt height.

Figure 102. Originally an uninviting swale, this is now a beauty spot with its terraces and graceful trees.

abruptly, but should be given a gradual, convex-concave slope which allows of greater ease in watering and mowing, aside from the fact that it makes a more pleasing impression upon the mind of the observer. Neither should the terrace form an abrupt angle with the front walk, but should slope down gradually, nearing a level as it approached the walk. Where the steepness of the grade makes this impossible, it is often necessary to construct a retaining wall of masonry at the edge of the lot. Clinging vines, planted at its base, will soon cover the stonework, greatly softening and beautifying its appearance. It is well to avoid climbers of the bright flowering sorts as subdued colors create better harmony with the dull tone of the wall.

Figure 103. Showing successful treatment of a difficult problem in grading.

Let me here state that the heart and essence of success, in any line of work, is to fully grasp the situation that is before one; understand, in detail, the conditions as they exist, and then to determine the method of procedure best suited to the conditions *before any actual work is begun.* Too many home sites are spoiled by haphazard grading and planting, and by failure on the part of the designer, to fully grasp the situation with its possibilities and limitations, before beginning his work.

Simplicity is the key note of perfection. Let the grading, as well as the planting, be done as easily and naturally as possible. By that, I mean, not to expend unnecessary energy and expense attempting to alter natural conditions and thus create an artificial appearance; but to utilize the suggestions that nature

Figure 104. There is a satisfying harmony here between the stone retaining wall and the old style architecture.

Figure 105. The conditions of a large house near the street and a difficult piece of grading, have been met here in rather formal but very satisfactory fashion.

has already presented, and by reason and sense of fitness to blend, as artistically as possible, the artificial with the natural. Follow the line of least resistance. One cannot create a natural landscape upon a fifty foot lot; but what he does create can be made a much more harmonious portion of the surroundings than is often displayed.

Again, simplicity in planting is much to be desired. Especially is this true in Southern California, where the vegetation needs so little encouragement from man to form a jungle of foliage and color. Were climatic conditions such as to retard plant growth, so much emphasis upon this phase of planting would be unnecessary. A small variety of common plants, thoughtfully arranged, is far

Figure 106. Showing conditions similar to those in Figure 105 but with still more formal treatment. An addition of background on the right as on the left would greatly improve this place.

more pleasing than a florid group of antagonistic novelties all fighting for personal recognition. Unusual plants, if harmoniously grouped in proper environment, so as to lose something of their individuality, become indispensable in landscape art, but the individual should be sacrificed for the benefit of the whole.

Terraces should be devoted largely to lawn. The plantings, as on level spaces or uniform slopes, should be grouped along the sides and at the rear, leaving the central view open. On a small place, of any description, shrubs or dwarf trees should be used largely to the exclusion of tall growing trees, which because of their size, give a cramped, over-grown appearance to the yard, and often exclude sunlight, becoming an obstacle to perfect sanitation.

Terraces belong to formal gardening and, for the ordinary home, should be avoided. A gently sloping or rolling lawn is far more restful and natural in appearance than one built of enormous grass-covered steps, and should be given the preference, except in formal styles. Where the home is built on a rugged hillside, as is often the case in our rough districts, the grading and planting should be given especial consideration. Terracing becomes absolutely necessary in many cases, and often masonry is required. Personally, the writer does not favor stone work except as it becomes an unavoidable part of the construction; and then he would clothe it in clinging vines and soften its angles by shrubbery.

Steep banks can often be treated to great advantage by a covering of Mesembrianthemum, Vinca, ivy geranium or any of the numerous trailing things that love to spread over the ground unmolested. Such a treatment is far superior, in the mind of the writer, to a formal retaining wall that reflects the heat and constantly reminds one of the architectural skill needed for its construction.

The Hendersonia Disease of Eucalyptus Globulus

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As far as the writer has been able to ascertain there have been no species of the genus *Hendersonia* as yet described on California eucalypts. Prof. Smith, pathologist of the State Experiment station at Whittier, makes mention as far back as 1909 of a *Hendersonia* on *Eucalyptus globulus,* but beyond a few words as to its minor importance as a parasite, does not describe it. The fungus herein worked out is probably the same as that observed by Prof. Smith and others, although we cannot of course be certain. There are a number of fungi on this particular species of eucalyptus and many of them are as yet undescribed; some are parasitic, most of them fortunately saprophytic in their mode of life. With

Figure 107. Leaf of Eucalyptus globulus affected with Hendersonia.

the *Hendersonia,* however, there is hardly a doubt as to its parasitic tendencies; a detailed cultural study was made of it, its method of germination, growth of hyphæ, re-inoculation of healthy leaves, etc.

The fungus is distributed over quite an area in Southern California, the full extent of which cannot be fully known until further observations are reported. Of a number of trees in and around Claremont the writer has found but few that were not affected to a greater or less extent. The damage actually done by the fungus seems at present to be slight. It confines its attack exclusively to the young, broad leaves, breaking down the leaf tissue and thus preventing a flow of sap. Deprived of its food, the leaf soon dies and falls off. This latter is only true in extreme cases of infection. After the tree has passed the broad leaf

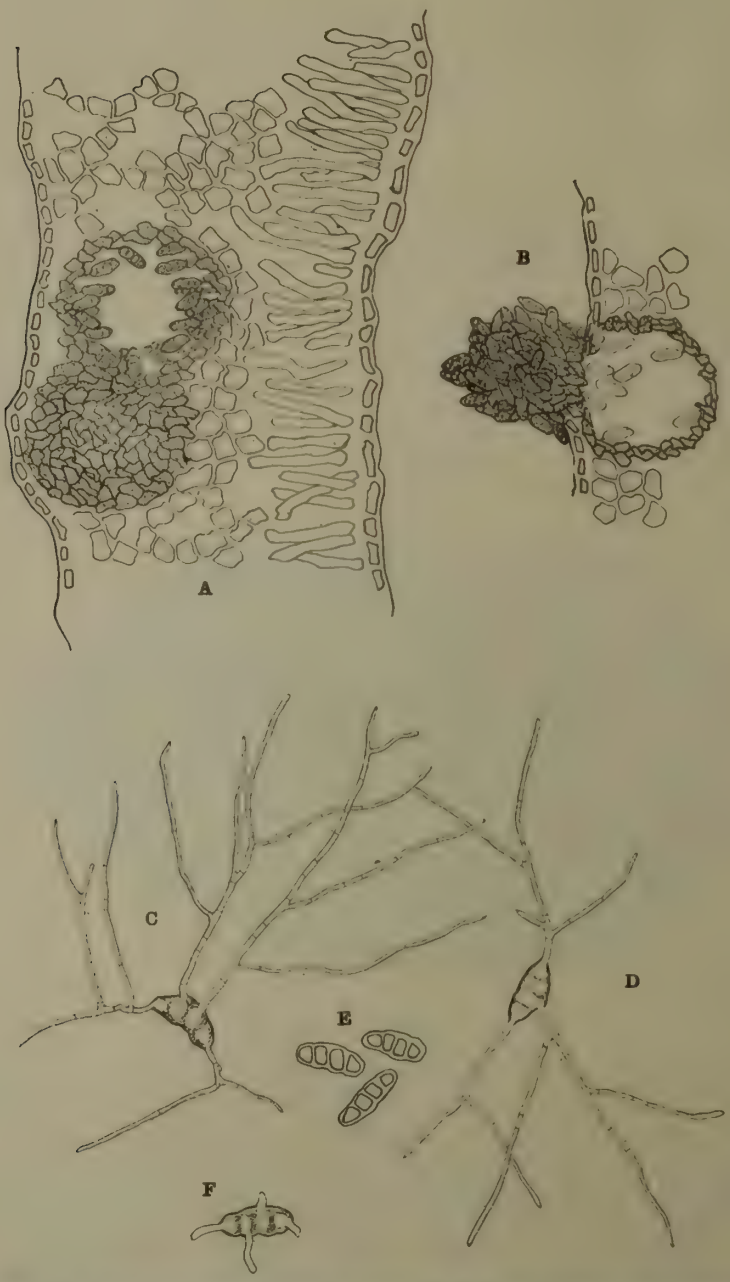

Figure 108. A, section of leaf showing pycnidia of Hendersonia still enclosed; B, the pycnidia erumpent and giving out the adherent hypophyllous spore mass; C, D, F, germinating spores; E, showing the thick walled spores.

stage and develops tougher and longer leaves it is, as far as I have been able to observe, immune. The infection has been found to be especially noticeable upon the tender leaves of the shoots and sprouts from old eucalyptus stumps and here perhaps it works its greatest damage. There have come to my notice such shoots twenty feet in height on which there seemed not to be a single leaf that has escaped the infection. Many of the leaves had turned yellow except where the great blotches of diseased tissue were bearing their harvest of countless spores. In a five acre Blue Gum stand just south of Claremont there was not a tree to be found on which the young leaves were free from the fungus. In spite of this general infection the actual damage caused was not great. The number of young, broad leaves were few in comparison to the tougher ones and the trees did not seriously miss their failure to function.

The infection probably takes place through the stomata on the under side of the leaf and with the spread of the mycelium the leaf tissues are killed. The presence of the fungus is first noticed by the appearance of small circular or irregular purplish-brown patches on the lower epidermis. As the mycelium spreads the diseased area extends from epidermis to epidermis and in case of bad infection the areas merge together in large irregular shaped blotches. In the older spots the color of the center changes to grayish-brown, while the edge retains the characteristic purplish-brown marking. At this stage the pycnidia are formed just beneath the lower epidermis (Figure 108 A). The pycnidia are black granular bodies, globular in shape and ranging in diameter from .06 to .12 mm. They appear at times in pairs and again solitary. In one small diseased area 1 mm. across occurred ten of these pycnidia in all stages of development. At times they attain large size extending fully three-fourths the distance through the leaf, crowding and distorting the palisade cells. The pycnidial wall is made up of a rather thin but quite tough granular membrane (Figure 108 A).

The spores vary noticeably in size though but little in their general shape (Figure 108 E). They are borne upon short, simple, hyaline sporophores (Figure 108 A) ranging from 6 to 10 microns in length. The spores themselves vary in size from 8 to 11 by 22 to 32 microns and have three transverse septa, the wall of the spore being depressed at each septum. In color they are olivaceous to smoky brown.

When the pycnidium is mature the epidermis is ruptured and the spores emerge in a compact, naked, black mass which adheres loosely to the epidermis, and these masses are noticeable as minute black dots upon the surface of the diseased area (Figure 108 B).

This apparently undescribed species may be called *Hendersonia eucalypticola.*

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Pomona College Journal of Economic Botany

As Applied to Subtropical Horticulture

Volume Two MAY 1912 Number Two

PUBLISHED QUARTERLY BY THE
DEPARTMENT OF BIOLOGY OF POMONA COLLEGE
CLAREMONT, CAL., U. S. A.
SPONSOR, A. J. COOK, D. Sc., STATE HORTICULTURAL COMMISSIONER

Entered at the Claremont, Cal., Post-Office as second-class matter

Pomona College Journal of Economic Botany

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POMONA COLLEGE JOURNAL
of ECONOMIC BOTANY

Volume II MAY 1912 Number 2

The Palms Indigenous to Cuba, I

ODOARDO BECCARI
FLORENCE, ITALY

The palms that up to the present day are known to grow wild in Cuba and in the small islands, its dependencies, amount to twenty-five species. Of these only two belong to the tribe of *Cocoineae,* and six to that of the *Arececae;* the greater bulk of the remaining species being furnished by the *Corypheae.* This fact shows, I think, that the Cuban palms are derived only in very small measure from the southern part of the American Continent, for there the *Corypheae* are very scantily represented, whereas almost all the members of the *Cocoineae* are native to South America. The Cuban *Areceae,* however, show affinities with species or genera growing on the continental shores of the Caribbean Sea. On the American *Corypheae* I have already published a study,* where I make it evident that the Cuban palms belonging to this tribe are mostly related to and at times quite identical with, species growing in Honduras, the Yucatan peninsula, in Texas, and Florida.

The most peculiar of the Cuban palms is certainly the *Pritchardia wrightii,* not only because of its affinity to its remote parents in Hawaii, but also on account of its singular bottle-shaped stem, which is very well shown in one of the fine photographs taken by Prof. C. F. Baker in Cuba. And indeed it has been the desire of publishing this fine set of pictures, which so well illustrate the palms inhabiting the largest island in the West Indies, the "Regina Antillarum" to use the words of Grisebach, that has induced me to undertake the present study. Moreover, I hope that this small contribution to the knowledge of the Palm Flora of Cuba will stimulate fresh researches into, and the collecting of new herbarium specimens of those species, which are as yet imperfectly known, or of which the precise habitat is uncertain, as for the most part are also those gathered by Wright in the east of the island.†

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*Le Palme americane della Tribú delle Corypheae in "Webbia" di U. Martelli.—Firenze Vol. II (1907).

†Prof. Asa Gray in the Introduction to the "Plantæ Wrightianæ" in Mem. Acad. Amer. Scient. etc. N. Ser. v. VIII (1860) p. 153, gives the following information: "The specimens were mainly gathered in the high country and mountains behind Santiago de Cuba and Cobre (mostly within a moderate distance of Filantropia, the

Cocos nucifera is also frequently met with in Cuba; about this palm Mr. O. F. Cook writes: "Columbus himself recorded the finding of coconuts on the north coast of Cuba, near Puerto Principe, only a little over a month after his first landing in the Bahamas,"‡ an assumption, however, which in my opinion is open to serious objections.

It is a remarkable fact that amongst the twenty-five palms indigenous to Cuba, three of them (*Oreodoxa regia, Acrocomia fusiformis, Pritchardia wrightii*) perhaps even a fourth (*Pseudophoenix vinifera?*) possess bulging or fusiform trunks, whereas amongst the several hundreds of species inhabiting the Old World, only two or three are endowed with this peculiarity. Other Cuban palms are noteworthy for the great mass of roots at the base of their trunks, but this is a far more common phenomenon than the bulging of the trunk.

These deviations from the normal and more common structure in palms, has suggested to me some observations, which I hope will not be found quite out of place, as an appendix to the systematic part of this study.

For the present monograph of the Cuban palms I have been able to study a rather extensive material, for which I am largely indebted to Prof. C. F. Baker; other valuable specimens I have found in the Herbarium de Candolle. But I must especially thank Prof. I. Urban for the loan of the entire set of palms gathered in the Caribbean Islands by numerous collectors, forming part of the Herbarium Krug and Urban, and now incorporated in that of Berlin.

Conspectus of the Genera

I. Leaves pinnate, pinnatisect, or simply pinnately veined.

Tribe I—ARECAE

Ovary 1-3 celled. Fruit with 1-3 seeds; endocarp membraneous, fibrous, or thinly woody; not marked by pores on its outer surface.

1. Female flowers with valvate petals, more or less united in their basal part.

a. Flowers in groups of 3, one female between two males, at least in the lower part of the branchlets. *Oreodoxa*

aa. Flowers pedicellate in small bunches at the end of the branchlets. Male flowers numerous. Female flowers few, having the perianth smaller than the male ones, but equally well developed stamens. *Pseudophoenix*

aaa. Flowers approximate in linear groups of 2-5, one above the other, of which the lowest is usually female and the others male. *Gaussia*

2. Female flowers with imbricate petals.

a. Male flowers with 6 stamens having free filaments. *Euterpe*

---

hospitable country residence of George Bradford, Esq.) and especially in the elevated district back of Santa Catalina de Guantanamo, where the collector's principal station was Monte Verde, a coffee plantation, residence of the most estimable and hospitable M. Lescaille; from which place, as a centre, Mr. Wright is still prosecuting and extending his herborizations."

‡History of the Coconut Palm in America, in Contrib. U. S. Nat. Herb. v. XIV. II., p. 280.

aa. Male flowers with 6 stamens, the filaments united to form a columnar body within the corolla, free and radiating above, anthers sagittate. *Calyptrogyne*

Tribe II—COCOINEAE

Ovary 3 celled (in the species here described). Fruit with 1-3 seeds, often 1-2 of the cells obliterate; endocarp bony, marked by 3 pores, each corresponding to the position occupied or which ought to be occupied (morphologically) by the embryo in the cells.

a. Flowers in numerous glomerules of 3, one female between two males, at least in the lower part of the branches. Female flowers having a gamopetalous corolla. *Bactris*

aa. Female flowers considerably larger than the males and placed on the lower part of the branchlets; corolla with imbricate petals. Male flowers in notches, approximate in the upper part of the branchlets. *Acrocomia*

II. Leaves flabellate, and radiately divided (never pinnate).

Tribe III—CORYPHEAE

Sub tr. I—Eucorypheae

Ovary formed by 3 carpels, free from the base, or more or less united together.

a. Ovary formed by 3 carpels, completely united together, and with 3 distinct uniovulate cells. The fruit usually formed by the development of only one cell and with the remains of the style lying close to its base. Leaves with unarmed petioles. *Sabal*

aa. Ovary formed by 3, more or less independent carpels.

1. Petiole more or less spinous on the edges. Seed with homogenous albumen. *Acoelorhaphe*
2. Petiole spinous on the edges. Seed with ruminate albumen. *Copernicia*
3. Petiole smooth on the edges. Seed with homogenous albumen. *Pritchardia*

Sub. tr. II—Thrinaceae

Ovary formed by a single carpel, unicelled and uniovulate.

a. Seed having an even surface; albumen equable but penetrated from its basal part, more or less deeply, or even completely transversed, by an intrusion of the integument.

b. Stamens 6 with almost sessile reversed anthers. *Hemithrinax*

bb. Stamens 6 (or 5-7), with slender subulate filaments. *Thrinax*

aa. Seed marked by 5-6 vertical grooves and more or less distinctly lobed-cerebriform. *Coccothrinax*

OREODOXA Kunth

(Non Willd.) Kunth in Humb. et Bonpl. Nova gen. et sp. Pl. I, p. 244, edit. min. p. 305 (1815); Mart. Hist. nat. Palm. III, p. 166. *Roystonea* O. F. Cook in Bull. Torrey bot. Club, 1901, p. 549.

For the old and familiar name of *Oredoxa* Mr. O. F. Cook (Bull. Torrey bot. Club, 1901, p. 549) has substituted that of *Roystonea*, on the ground that the type of the genus *Oreodoxa* is *O. acuminata* of Willdenow, a palm referred to *Euterpe* by Wendland, but which, according to Cook, is the type of a distinct genus, for which the name of *Oreodoxa* must be maintained.

Wendland has recognized Willdenow's *O. acuminata* in the flowering specimen of a palm, collected by Moritz at Tovar in Venezuela (N. 1670 in the Berlin, Herb.) My own independent researches have led me to the same conclusion, with regard to a fruiting specimen, collected by Fendler (n. 2462 in Herb. de Cand.) also at Tovar, and consequently in a region not remote from Buenavista, from whence came the original specimen of *O. acuminata* (Figure 109).

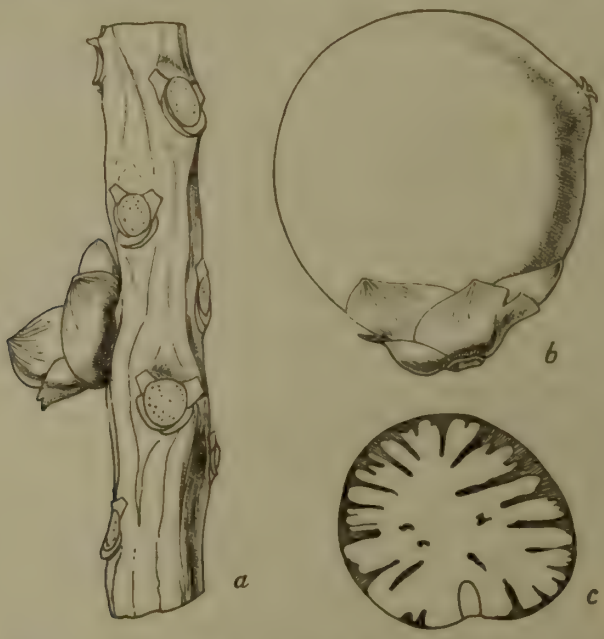

Figure 109. Euterpe acuminata. a, portion of a fruit-bearing branchlet; b, fruit; c, seed cut longitudinally through the embryo. (From Fendler No. 2462).

The above mentioned Fendler's specimen corresponds exactly to the description of *O. acuminata* given by Willdenow, and most certainly belongs to a typical *Euterpe*, having the seed with a ruminate albumen. Now as the genus *Euterpe* Gaertner is very well identified at present, as I shall demonstrate later, when speaking of this genus, and as this genus was published in the year 1788, and *Oreodoxa* Willd. in 1804, the name of *Oreodoxa acuminata* was rightly changed by Wendland to that of *Euterpe acuminata*, and accordingly the name of *Oreodoxa*, applied to *O. regia* by Kunth, remains unattached.

The accurate study I have made of the Cuban *O. regia* has led me to make a rigorous revision of all the other members of the genus *Oreodoxa*, which I consider to be composed of the following species only:

Conspectus of the Species of Oreodoxa

Male flowers having, when in bud, the stamens entirely enclosed in the corolla. Fruit globular-ovoid, more or less gibbous, not more than one-third longer than broad.

1. Fruit 11 mm. long, 9 mm. broad. Pericarp on the whole 1-1.5 mm. thick; mesocarp grumose when dry. *O. regia*
2. Fruit 13 mm. long, 10-10.5 mm. broad. Pericarp on the whole 1-1.5 mm. thick; mesocarp grumose when dry. *O. charibaea*
3. Fruit 17 mm. long, 13 mm. broad. Pericarp on the whole about 3 mm. thick, subinflate, the mesocarp being very lax when dry and, apparently, very juicy when fresh. *O. princeps*

Male flowers having the petals open, and with the stamens protruding beyond them long before the anthesis. Fruit oblong, more or less curved, nearly twice as long as wide. *O. oleracea*

Oreodoxa regia Kunth in Humb. et Bonpl. l. c.; Mart. Hist. nat. Palm. III, 168, t. 156, f. III, IV, V; Griseb. Cat. pl. Cub. 222; Sauvalle Fl. Cub. 153; Combs, in Trans. Acad. St. Louis, VII (1897) 471, Becc. Reliq. Scheff. in Ann. Jard. bot. Buit. II (1885) 147, t. 11; Sargent, Silva N. A., X, 31, t. DV; Hemsley in Biol. Centr. Amer. Bot. 401. **O. oleracea** (non. Mart) Griseb. Pl. Wright, 531 et Pl. Cub. Wright n. 1467,

Roystonea regia O. F. Cook, l. c. 531.

I do not think it necessary to spend many words in describing the general aspect of this palm, which is a favorite ornament in the tropical gardens of every part of the world. I have, however, to remark that the bulging of its stem cannot be absolutely taken as a specific character, witness Figure 110, which reproduces the Royal Palm in the wild state, growing in Western Cuba, and Figure 111 taken at Santiago de las Vegas. In both of these figures some individuals have stems almost regularly cylindrical from base nearly to summit, while others have a more or less fusiform appearance in the intermediate portion.

The Royal Palm is a rather variable plant, not only as to the bulging of its trunk, but also in regard to the shape, size, and small peculiarities of the fruit, and to some other small characters. On this account it exhibits several forms, difficult to define and apparently localized to the different regions where this palm grows. This is the case with the *Oreodoxa* of Porto Rico, which has been distinguished as a species (*O. charibaea*) but which, I think, would be much better considered as a simple variety.

O. regia is a very widely diffused palm, as it is not only frequently met with in the savannahs, and along streams and rivers in Cuba, especially in fertile soil, but is naturally dispersed in almost all the other Antilles; it is also found in Panama, where Hemsley writes that it is common about Cruces, Gorgona and San Juan.

The *Oreodoxa* growing in Florida was identified by Prof. Sargent (i. c.) as *O. regia,* but of this palm Mr. O. F. Cook has made an *O. floridana.*

O. regia is also reported from the Bahamas. (Gardiner in Proc. Acad. Phil. 1890, p. 358), (non. vidi).

Several notes about *O. regia* have been already published by me in the "Annales du Jardin botanique de Buitenzorg" v. II (1885), but I think it convenient to give here a detailed description of the Cuban *O. regia*, which may be considered as the type, for establishing its specific characters on solid bases.

The *leaves* of *O. regia* are very large, have an elongate leaf sheath, tightly enveloping the vegetative cone, and one after another drops off at every fresh

Figure 110. Oreodoxa regia growing on high, stony ground in Western Cuba in the shade of a huge ceiba tree. Note varying form of trunk.

emission of a spadix, leaving the trunk quite clean, but more or less distinctly ringed. The leaflets are alternately inserted in contrary ways along the rachis, and stand in four different planes, at least in its lower and intermediate part, but are more regularly set, and almost on one plane towards the end. The leaf-rachis is at first more or less sprinkled with small, appressed, orbicular, tobacco-colored, deciduous scales, and by age acquires a glabrous appearance.

Figure 111. Oreodoxa regia as it grows with aguacates and sapodillas in the rich Partidos tobacco district of Cuba.

The *leaflets* are firmly papyraceous, ensiform, quite straight and very gradually narrow above from below the middle, to a very acuminate, rather rigid, briefly bifid apex, generally more deeply split by age, they are attached to the rachis by a narrow base and have here the margins strongly reduplicate; they are green on both surfaces, but on the lower are rather densely sprinkled with very numerous, very small dots visible only under a strong lens; they have a strong mid-costa, very prominent above, and covered below by an almost continuous line of elongate chaffy scales; the secondary nerves are 2-3 on each side of the mid-costa; the tertiary nerves are very numerous and not very prominent; margins acute, not or very slightly thickened; transverse veinlets obsolete. The intermediate leaflets are 70-95 cm. long and 3.5-4 cm. broad.

The *spathes* are two; the exterior spathe is tubular, pervious at its upper end, considerably shorter than the interior one, which completely envelops the spadix before the anthesis, and is at that time flattened-fusiform and biconvex, later deciduous.

The *spadices* in number 3-4 are erect at the same time, when not yet open, at the base of the lowest leaf-sheath, are spreading when in flower, and when in fruit form dense subglobose panicles around the summit of the trunk, under the shade of the magnificent crown. The spadices have a very short, broad peduncular base, and are twice branched; the primary branches are conspicuously swollen at their bases and are divided into several alternate flowering branchlets; these are slender, terete, 1.5-2 mm. thick at the base, 15-25 cm. long or shorter, more or less sinuous between the flowers, and narrow very gradually above to a subulate apex; while still enclosed in the spathes they are covered by a curious kind of trichomes, formed by vesicular, acute cells, grouped at the end of a small, simple or branched, pedicel; after flowering the groups of vesicular cells are detached from their pedicels, and are dispersed in the form of a fine granular powder, while the pedicels remain to render the surface of the branchlets more or less puberulous-papillose.

The *flowers* are light colored even when dry, are ternate almost to the end of the branchlets and are inserted on very superficial flat orbicular pulvinuli. The *male flowers* are at all times considerably larger than the female, are irregularly ovoid, obtuse, 5-6 mm. long, 3.5-4 mm. broad; the calyx is very small, with slightly imbricate, scarious, subpellucid, subdeltoid, obtuse or acute, and more or less carinate, sepals; petals considerably longer than the sepals, concave, thinly pergamentaceous, irregularly ovate-oblong or oblong-elliptical, bluntish or subacute, striately veined, have internally at the base a nectariferous swelling. Stamens usually 6-7, occasionally 8-9, about as long as the petals also during the anthesis, about 5 mm. long on the whole; anthers relatively large, 3 mm. long, erect when in the bud, slightly shorter than the filaments, ovate-elliptical or ovate-sagittate, obtuse, the cells united by a broad conspicuous connective, dark colored in the dry state, inserted on the filament about their middle, from which the cells remain separated in their lower part; filaments 4 mm. long, linear subulate at apex, somewhat flattened; rudimentary ovary globose, with three short, acute, stigmatic points.

The *female flowers* open a short time after the male, are horizontal, 4 mm. long when full grown but not yet open, broadly conical and apiculate; sepals reniform, entire, smooth, slightly callous at their bases; corolla four times as long as the calyx, urceolate-campanulate when open, divided down to a little below the middle into three triangular briefly acuminate, valvate divisions; the staminodes form a cup, lining the undivided part of the corolla, and crowned by six obtuse lobes of which three peep forth between the divisions of the corolla; the lobes, which represent the filament, do not show usually any rudiment of the loges of the anthers, though at times faint traces of these may be found. Ovary globose, usually unicelled, with rudiments of the two other cells, more rarely with two of these perfectly developed, producing then a didynamous fruit; ovule attached along one side of its cell; stigmas fleshy, triangular-subulate, recurved.

Fruit globose-obovoid and somewhat gibbous, 11 mm. long, 9 mm. broad (when dry) or thereabouts, with a perfectly round top and with the remains of the stigmas placed a little above the base, on the less convex side; pericarp on the whole 1-1.5 mm. thick; the epicarp is smooth outside, thin and brittle in the dry fruit; the mesocarp is scanty, softly parenchymatous, and apparently slightly fleshy when fresh, grumose when dry; it has a layer composed of a few fibro-vascular bundles in its innermost part, which form a net work very adherent to the endocarp. The endocarp is thinly woody and forms a shell or putamen to the seed, and is 8.5-9 mm. long, 7 mm. broad, and its inner wall remains adherent to and almost connected with a large portion of the antiraphal side of the seed, but is brittle and removable on the side of the hilum; the putamen presents also on the median line of its antiraphal side a conspicuous vascular strand, which leaves on the seed a more or less distinct sulcus, at times, however, quite obsolete.

The *seed* is broadly ovoid-elliptical, rounded at both ends, slightly compressed and flattish on the raphal side, 7.5-8 mm. long, 7 mm. broad, 6 mm. thick; the raphal side is conspicuously marked by a circular central area in which, a little below the centre, is placed the hilum, whence numerous, very apparent, vascular ramose, whitish venations radiate. Albumen homogeneous, very slightly excavate on the raphal side, because of a very superficial thickening of the integument in that place, which corresponds to the external circular area spoken of above. Embryo, obliquely basal, penetrating deeply into the substance of the albumen. (Figure 112).

Fruiting perianth explanate, not accrescent. (Figure 112).

The description of the fruit given above is from the specimens numbered 3516 in the Herbarium C. F. Baker, which were collected near Santiago de las Vegas; that of the flowers from Curtiss n. 432, who gathered the specimens at Nuova Gerona in the Isla de Pinos. In these specimens the fruit is very slightly smaller than in those from Santiago de las Vegas, and the branchlets of the spadix are glabrous, whereas they are puberlous-papillose in those of the other locality. The specimens of the "Plantæ Cubenses Wrightianæ" (n. 1467) distributed under the name of *O. oreodoxa oleracea* are certainly *O. regia*.

Of *O. regia* I have examined the following specimens:

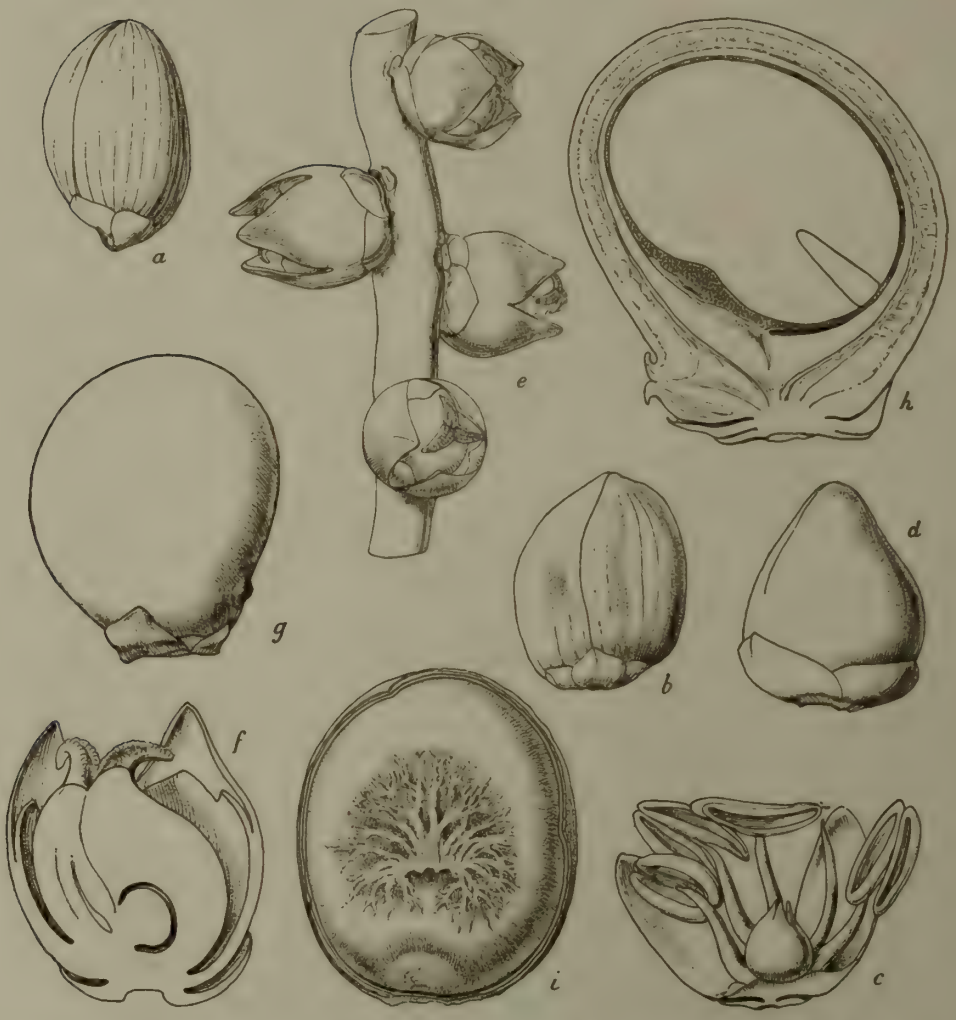

Figure 112. Oreodoxa regia. a, b, male flowers in bud; c, male flower during anthesis, from which one of the petals and two stamens have been cut out to show the interior; d, female flower in bud; e, portion of a flowering branchlet with female flowers during anthesis; f, female flower cut longitudinally; g, fruit, side view; h, fruit cut longitudinally through the embryo; i, seed seen from the raphal side (h and i from Baker No. 3576; all the other figures from Curtiss No. 432).

CUBA: Province of Santa Clara, district of Cienfuegos, Cieneguita, *Combs* n. 694 (Herb. Berol.) Neighborhood of Santiago de las Vegas, Prov. de Habana, *Wilson* n. 3516 (Herb. Berol. and Becc.) Near Nueva Gerona, Isla de Pinos, *Curtiss* n. 432 (Herb. de Cand.)

JAMAICA: Near Castleton, Aug. 1902, Herb. Bot. depart. n. 8, in Herb. Berol. (In these specimens the female flowers are almost globular and very slightly or not apiculate. The male flowers are slightly smaller than in the plant of Cuba (4-4.5 mm. long). The fruit as in the type, but with the intrusion of the integument more pronounced. (Figure 113, d, e, f).

S. DOMINGO: Mouth of the Yuna River, *Taylor* n. 61 (Herb. Berol.) Fruits as in the type from Cuba (12 mm. long, 9 mm. broad) but with the seed almost completely free from the inner wall of the endocarp; intrusion of the integument of the seed rather deep. (Figure 113, f).

ST. CROIX (Danish Antilles): *Rev. J. J. Ricksecker* n. 103 (Herb. Berl.) Apparently not different from the plant of Cuba.

PANAMA: Fruits indistinguishable from those of the Cuban specimens, but with the seed adherent to the inner wall of the endocarp over a very small area only.

Oreodoxa charibaea (Spreng) Damm. et Urb. in Symb. Antill. IV 129. **Roystonea Borinquena** O. F. Cook in Bull. Torrey Bot. Club, 1901, p. 552, t. 45 f. 2 a dextera. **Euterpe charibaea** Spreng. Syst. II (1825) p. 140 (excl. **Areca oleracea** Jacq.)

The type of *Euterpe charibaea* of Sprengel is apparently a specimen collected by Bertero in Porto Rico, but doubtless Sprengel also included in his diagnosis the characters of *Oreodoxa oleracea,* for he describes the fruits as "subincurvatis." I have examined one of Bertero's specimens in the Berlin Herbarium, and another in that of De Candolle; both consisting of small portions of the spadix with male and female flowers only. The male flowers have 6-7 stamens with anthers slightly larger than in the flowers of *O. regia* from Cuba. The female flowers have the teeth of the staminal urceolum furnished with sufficiently distinct anther cells; but little importance is to be attached to this character as rudimentary anther cells exist also in the female flowers of Wright's n. 1467 from East Cuba, whereas they are altogether absent in the flowers of the specimens coming from the opposite end of the island.

I have examined of *O. charibaea* the flowering specimens of Sintenis n. 1605, and the fruits numbered VII of the same collector (Herb. Berol.) and also complete specimens in flower and fruit from plants cultivated in the botanical Garden at Buitenzorg (Figure 113, a, b, c). The main differences between *O. charibaea* and *O. regia* consist in the fruit, which is somewhat larger in the first than in the second, and in the seed, which remains almost entirely free from the inner wall of the endocarp. The fruits in Sintenis n. VII are 13 mm. long, 10-10.5 mm. broad. In the fruits from the plants cultivated at Buitenzorg the intrusion of the integument of the seed into the mass of the albumen is considerably deeper than in

O. regia, and has the form of a cone with a broad base. This same character is offered by fruits I have received under the name of *Roystonea borinquena* by Dr. Franceschi from Porto Rico; this intrusion, however, is less pronounced in the fruits from n. 1605 of Sintenis, and in those of Sintenis VII is not more pronounced than in the seeds of *O. regia* from Cuba.

On the whole, *O. charibaea* is so closely related to *O. regia* that it seems to me only a geographical form of that plant, or in any case nothing more than a second degree species.

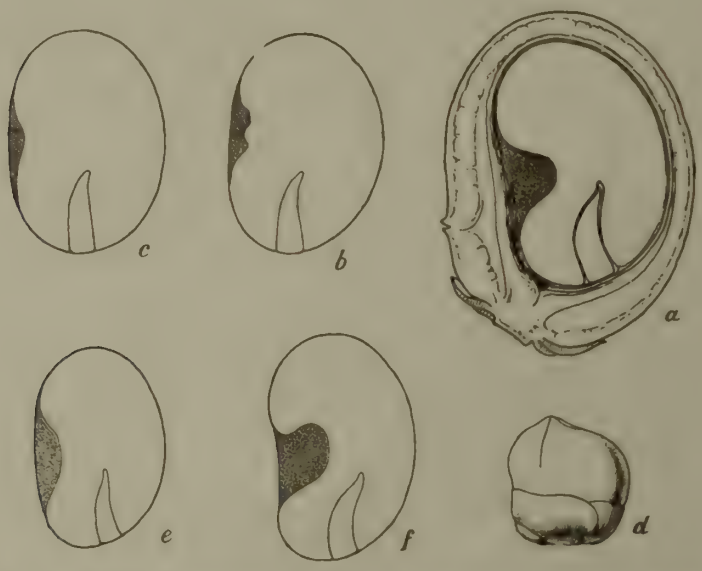

Figure 113. Oreodoxa charibaea. a, longitudinal section of a fruit (from a plant cultivated in the Botanical Garden at Buitenzorg); b, longitudinal section of a seed from Sintenis No. 1605; c, longitudinal section of a seed from Sintenis No. VII. Oreodoxa regia. d, female flower, and e, longitudinal section of a seed (both figures from the specimen No. 8, Bot. Dep. Jamaica); f, longitudinal section of a seed from a plant collected in S. Dominga (Taylor No. 61 in Herb. Berol.).

Mr. Cook has observed that on the roots of this palm exist tubercles, produced by bacterioids, analogous to those of the *Leguminosae* and other plants. The same kind of tubercles I have observed on the roots of another palm, the common *Trachycarpus excelsa.*

To *O. charibaea* is referrable the Genus *Ignotum,* Urban Symb. Antill. IV, 131; Sintenis n. 6512 in Herb. Krug et Urban (Berlin Herb.) collected at San André near Usuado in Porto Rico. The specimens consist only of very juvenile and tender flowering branchlets with flowers very imperfectly developed; the branchlets are entirely covered by the characteristic trichomes, which I have described in *O. regia,* and which has enabled me to settle the question of the identification of these specimens.

Oreodoxa oleracea Mart. Hist. nat. Palm. III p. 166 t. 156. f. 1, 2, et tab. 163; Becc. Reliq. Scheff. in Ann. Jard. bot. Buit. II 150 t. 12; Drude, in Mart. Fl. Bras. III, II, 474.

This species is peculiar to the smaller Antilles and is quite distinct from *O. regia* and its near ally, *O. charibaea,* not only by its quite cylindrical, never bulging stem, and by the curved, rather elongate fruit, but also by the quite different male flowers.

The stamens in the *male flowers* of *O. oleracea* spring beyond the corolla a long time before the anther cells are apt to open, and emit the pollen grains; perhaps they never remain entirely enclosed in the corolla, even when very young. On account of this circumstance the branchlets of *O. oleracea,* when covered with male flowers, as are those distributed by Glaziou under n. 8055, have an aspect quite different from those of *O. regia and O. charibaea.*

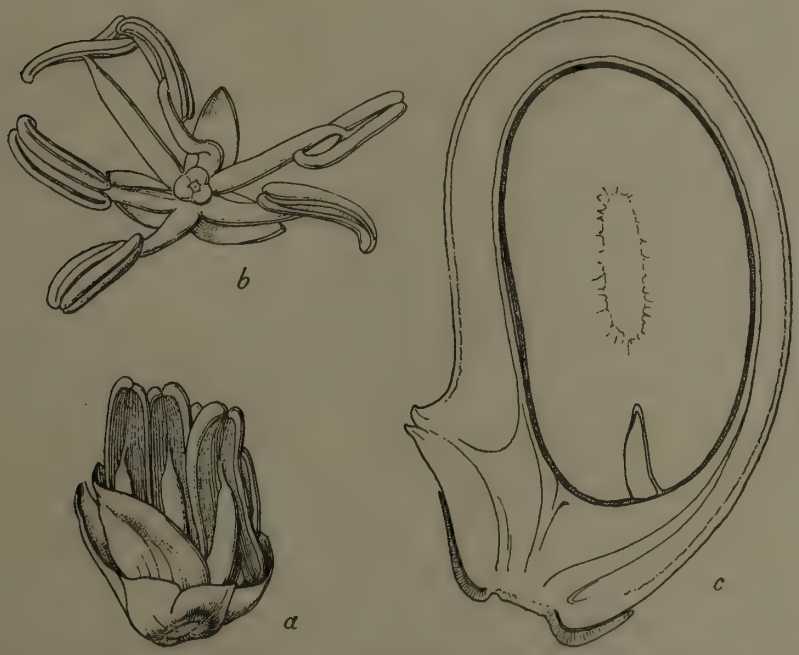

Figure 114. Oreodoxa oleracea. a, male flower before anthesis; b, male flower during anthesis; c, longitudinal section of a fruit.

The *female flowers* are globular, apiculate, similar to those of *O. regia;* the lobes of the staminal urceolum have rather distinct rudimentary anthers.

The *fruit* is oblong, slightly curved and concave on the side of the stigmas, it is 14-15 mm. long and 9 mm. broad; at complete maturity the mesocarp leaves the endocarp free, which forms a thin and fragile shell or putamen to the seed, and has an even, dull surface, upon which, however, the internal fibrous vascular net of the mesocarp remains adherent. The putamen has the general form of

the fruit, but it tapers a little towards the base, which is acute or shortly caudiculate. The *seed* is oblong-elliptical, 11 mm. long and 6 mm. broad, rounded at both ends, flattish or slightly concave on the raphal side, where two-thirds of its surface is covered by the oblong areola formed by the vascular ramification of the raphe; the hylum is linear. On the more convex or antiraphal side I have observed a small papillæform point about its centre, where at times the endocarp adheres to the testa of the seed; otherwise the seed remains entirely detached from the internal wall of the endocarp. The albumen is homogeneous, and without any intrusion of the integument. The embryo is slightly obliquely basilar. (Figure 114).

There is a rather good representation of this palm in "Descourtilz: Flore medicale des Antilles" v. IV (1827) plate 265, which is not mentioned by Martius.

The young flowering branchlets of *O. oleracea* are, when still enveloped by the spathe, covered by an abundant white cottony matter, which remains free when the spadix expands, and is composed of a very curious kind of trichomes, composed of inflated acuminate cells of the same nature as those existing in *O. regia,* but much more abundant, and with more elongate cells.

Of *O. oleracea* I have examined in the Berlin Herbarium complete specimens, collected by Pére Duss in Guadaloupe (n. 4173), where it is said to be abundant at Basse-Terre.

Pére Duss describes the *trunk* of *O. oleracea* as 30-36 m. high, rarely more, and measuring about 2 m. in circumference at its base, but it soon grows more slender and remains cylindrical throughout. The *leaflets* are equidistant, all on one plane, 3-3.5 cm. apart in the intermediate portion of the rachis; are of a rather herbaceous texture, lanceolate-ensiform, very long acuminate, shortly bifid at the apex, with the point in prolongation of the upper margin subulate and longer than the other; the intermediate leaflets are 70-75 cm, long and 5.5-5.8 cm. broad; those near the base are narrower and slightly shorter, the uppermost are smaller and less acuminate.

The inner *spathe* is thickly coriaceous, glabrous, of a reddish color inside, brown externally, from 70 cm. to 1.24 m. in length in vigorous young specimens.

The *spadix* is much branched, its peduncular part is 15-18 cm. long. The primary branches are as much as 90-95 cm. in length, form several partial panicles and are divided into several secondary and tertiary branchlets; the ultimate flowering branchlets are flexuose, 15-20 cm. long, carry ternate flowers on their lower part, but higher up only germinate male flowers.

Oreodoxa princeps Becc. sp. n.

A tree about 18 meters high (Harris). *Leaves* apparently similar to those of *O. regia.* Rachis dotted by very minute rusty scales. *Leaflets* pointing different ways; the two seen by me, belonging to the intermediate portion of the leaf, are lanceolate-ensiform, gradually acuminate above, somewhat larger than the largest of *O. regia* seen by me, about 80 cm. long, 6.5 cm. broad about their middle; have the mid-costa covered with chaffy scales a long way up from the base, but naked above. *Spadix* ultra compound; flowering branchlets more slender than in *O. regia,* up to 40-45 cm. long, 1.5-2 mm. thick at the base, the lowest divided

into 2-3 secondary branches, very gradually narrowing above to a very fine and acuminate point, slightly sinuous between the flowers; they carry glomerules of three flowers (one female between two males) on the lower two-thirds, and only germinate male flowers on the remainder; when bearing the fruits they are glabrous, but they appear to have been covered by the same kind of trichomes as in *O. oleracea* and *regia,* though of a somewhat different form (they are almost sessile and formed by a glomerule of very inflated and suddenly acuminate radiating cells). *Male flowers* considerably smaller than in *O. regia* and very irregular, when full grown in bud 3 mm. long, ovoid; sepals deltoid, hyaline; petals five

Figure 115. Oreodoxa princeps. a, fruit, side view; b, longitudinal section of the same fruit; c, the kernel of the above fruit; d, seed as seen from the raphal side; e, seed, side view.

times as long as the calyx, membranous, ovate, rather acute, concave. Stamens six, filaments terete, subulate, slightly longer than the petals during the anthesis; anthers broadly ovate, 1.5-2 mm. long, rounded at the apex, having the cells separated at the base nearly to the middle; the connective is broad and of a dark color. *Fruiting perianth* flattened, 5 mm. broad between the points of the petals; sepals hyaline, very narrow, form a very narrow ring round the scar at the base of the fruit; petals deltoid, bluntish. *Fruit* globose-obovoid and slightly asymmetrical or gibbous, 17 mm. long, 13 mm. broad, with the remains of the stigmas

placed a little above the base, very small and not prominent. Pericarp on the whole about 3 mm. thick and almost inflate, having the mesocarp almost empty in the dry state, and apparently very juicy when fresh; epicarp thinly pellicular, brittle; endocarp very thinly woody, it forms a shell to the seed 13-14 mm. in length and 8 mm. in breadth, rounded above, narrowing towards the base, which is rather acute and slightly bent; its outer surface is marked by a rather close net of fine fibers. *Seed* 10-11 mm. long, 6 mm. broad, entirely free from the inner wall of the endocarp, elliptical in outline on the front view, and subreniform when seen laterally, being slightly excavate on the side of the hilum and convex on the other side; it is rounded above, and rather acute at the base, has a dull brown surface, the vascular area of the raphe is suborbicular, and the hilum is in the middle of it; the intrusion of the raphe is broadly conical; the embryo is at the base, but a little apart from the point of the seed. (Figure 115).

The specimens upon which I have based the species were sent to me by Prof. Urban of the Berlin Botanical Museum and were collected by Mr. Wm. Harris (n. 9843) in Jamaica, in the Morass at Middle Quarters, 23 IX 1907.

Probably the plant has the appearance of *O. regia*, but it is not known if the trunk is cylindrical or has a tendency to take a fusiform shape. It differs from *O. regia* by its broader leaflets, by the spadices being more loosely branched and with longer and more slender branchlets, which bear female flowers accompanied by two males only in the lower two-thirds of the half part; but it differs especially by its small male flowers, and by its larger fruit, having a watery mesocarp (reduced almost to nothing in the dry fruit), and finally by its subreniform seed rounded above and subacute at the base.

PSEUDOPHOENIX H. Wendl.

H. Wendl. in Bot. Gaz. XI (1886) et in Gardn. Chr. IV (Ser. 3) Oct. 1888 p. 408 f. 56. *Sargentia* Wendl. (nomen) ex Nich. et Mott. Dict. Hort. et ex Sprenger in Bull. Soc. tosc. Ort 1889 p. 341. *Chamaephoenix* A. H. C. in Florida Farmer and Fruit Grower, Jacksonville, Febr. 22, 1887 (with a fig.). *Cyclospathe* O. F. Cook in Mem. Torrey Bot. Club, XII (1902) p. 25.

Sterile specimens of a *Pseudophoenix* distributed from the New York Botanical Garden, under the name of *Pseudophoenix sargentii*, were collected by Mr. J. A. Shafer (n. 6801) in March, 1909, at Cayo Guajaba, Camaguey on the north coast of Cuba. I have seen of these only some fragments of leaves, from which alone it is difficult to decide if they really belong to *Pseudophoenix sargentii*, or to an allied species. I make this observation because a species of *Pseudophoenix* different from that of Florida, was really in past times found in Haiti; this being the *Palma dactylifera et vinifera* of Plumier, which palm has not been as yet found again by modern botanists, but which may very possibly be the same plant as that collected by Shafer at Cayo Guajaba.

Pseudophoenix vinifera Becc. **Euterpe ? vinifera** Mart. Hist. Nat. Palm, v. III, p. LXXXV, t. morf. Z, II, fig. XVIII-XIX. **Cocos ? vinifera** Mart. l. c. v. III, 324. **Gaussia vinifera** Wendl. in Kerch. Palm. p. 245. **Palma dactylifera et vinifera** Plum. Gen. Amer. 3 Icon. t. 29, 30. ms.

I have seen in the Herbarium at Berlin a copy of the unpublished plates of Plumier's *Palma dactylifera et vinifera,* upon which Martius based his *Euterpe ? vinifera,* a palm, which up to the present day had remained an enigma. The accurate study hereafter reproduced, which I have made of *Pseudophoenix sargentii* has, however, enabled me to recognize in Plumier's palm a typical species of *Pseudophoenix,* which is quite distinct, however, from *P. sargentii.*

From the picture, the trunk of *Pseudophoenix vinifera* appears considerably more ventricose than that of *P. sargentii;* the spadix is more diffuse, and its branchlets more elongate, while the fruits, although distinctly pedicellate, are all represented as monospermous, but in them the traces of the other two sterile or empty locules are always well reproduced; in the analyses the perianth with six stamens is well shown, and in the seed, apparently somewhat enlarged, the few characteristic branches of the raphe are very apparent. If to these characters we add those of the spadices interfrondales, of the pinnate leaves with fascicled leaflets, and the relatively long leaf sheaths, the generic position of this palm appears to be positively certain.

Evidently this palm was once common in Haiti, where it was known under the native name of "Cacheo," but now it must have become very scarce or perhaps it has been destroyed, in consequence of the custom of the natives of felling the trees to extract the saccharine juice contained in the inflated part of its trunk, from which a kind of palm wine was obtained by fermentation.

Pseudophoenix sargentii H. Wendl. II cc.; Rev. Hort. 1887 p. 34, et 1888 p. 482 et 574, f. 140, 141; Bull. Soc. Tosc. Ort. 1887, p. 64; Garden and Forest, 1888, p. 352; Sargent, Silva N. A. v. X t. DV. **Chamaephoenix sargentii** A. H. C. l. c. **Sargentia aricocca** Wendl. l. c. et in Bull. Soc. Tosc. Ort. 1889, p. 341. **Cyclospathe northropi** O. F. Cook, l. c.

This palm, which was discovered by Prof. Sargent in Florida near the eastern end of Elliot's Key, is described as a tree with the general habit and appearance of *Oreodoxa,* 6-7 m. in height, with a trunk 25-30 cm. in diameter. From the figure in Gardener's Chronicle reproduced from a photograph taken in its native district in Florida, the *trunk* appears only very slightly fusiform. The leaves are said to be 1.20-1.50 m. long. An entire *leaf* detached from a plant cultivated at Miami, forwarded to me by Mr. A. T. Hudson, is 1 m. long in the pinniferous part; the *petiole* is very deeply channelled above and rounded beneath; the *leaflets* are numerous on each side, very approximate in the lower part of the rachis and distinctly approximate in groups of 2-3 on each side in the remainder, with vacant spaces 2-4 cm. long; the leaflets are firm in texture or thinly coriaceous, green above, glaucous beneath, linear-ensiform, strongly reduplicate at the base, gradually acuminate above; the largest leaflets, those of the middle, are 45 cm. long, 20-25 mm. broad; those near the base shorter; the mid-costa is very slender, not stronger than the secondary nerves, these are in number of 2-3 on each side of it; transverse veinlets obsolete.

The *spadix* is interfoliaceous, and it is described as about 1 m. in length, diffuse and much branched; the secondary (or tertiary?) branches are short,

and usually triparted; the flowering branchlets are glabrous, short, 2-4 cm. in length, and carry 8-14 flowers alternately and not very regularly inserted round the axis spreading and borne on a conspicuous pedicel 2.5-3 mm. long; the axes of the branchlets and the pedicels are terete and glabrous; the bracteoles at the base of the pedicels are inconspicuous. The *male flowers** in bud are broadly ovoid, with a perfectly round top, and slightly narrow towards the base; they are 5 mm. long and 4 mm. broad; the calyx is shallowly cupular, deeply parted into three deltoid acute lobes. Petals several times longer than the calyx, thickish, fleshy, ovate, concave, valvate. Stamens six; filaments terete, thickish, filiform, free from the base; anthers relatively very large, as long as the petals elongate-rectangular; their cells parallel, introrse, deeply separated at the base; rudimentary ovary conspicuous, elongate-conical, with three subulate stigmas, on the whole these are a little shorter than the anthers. In each branchlet the male flowers are far more numerous than the female. I have found only one female flower on a branchlet, while several other branchlets had only male flowers. The *female flowers* differ from the male resting on the same branchlet, in having the corolla apparently not fully developed, and by being only twice as long as the calyx, its divisions are deltoid, not connivent, but spreading with the stamens protruding beyond the corolla, and about twice as long as that; otherwise the stamens are identical with those of the male flowers; apparently they are perfectly developed, and we may suppose, fertile. The ovary is conical, and has three subulate stigmas, it is very similar to the ovary of the male flowers, only it is larger with a broader base, three-locular, and with a very minute ovule in each cell, situated in the lowest part of the ovary.

Fruit usually 2-3 lobed, bi- or tricoccous, similar to a fruit on an Euphorbiaceous plant, about 18 mm. broad (when dry), or it is monococcous and globose (and then 9-10 mm. in diam.) when two of the carpels remain sterile; the fruit is borne by a pedicel about 3 mm. long, and is suffulted by the deflexed petals, upon which at the base still remains visible the hardened filaments of the stamens. In the regularly developed three-lobed fruits, the remains of the stigmas are apical and central, but when only one or two or the carpels develop, they may be more or less shifted towards the base. The pericarp in the fresh fruit is fleshy, bright orange or red; when dry it is wrinkled, the epicarp being thin, pellicular, and adherent to the mesocarp; this is apparently mucilaginous, and devoid of fibrous strands; endocarp thinly woody, hard, and brittle, one-fourth of a millim. thick; it forms a globose kernel, 8.5-11 mm. in diameter, with dull blackish even surface marked only by a slightly raised straight crest on the axial side. *Seed* free from the wall of the endocarp, globular, 7-8.5 mm. in diameter, at times slightly longer than broad, attached laterally on the axial side; it has a dull even surface, and is marked on each side by only two rather conspicuous arched branchings of the raphe. Albumen homogeneous. Embryo basilar on the axial side (Figure 116).

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*I have studied the flowers preserved in formol, kindly forwarded to me by Mr. Ernest A. Bessey from Miami.

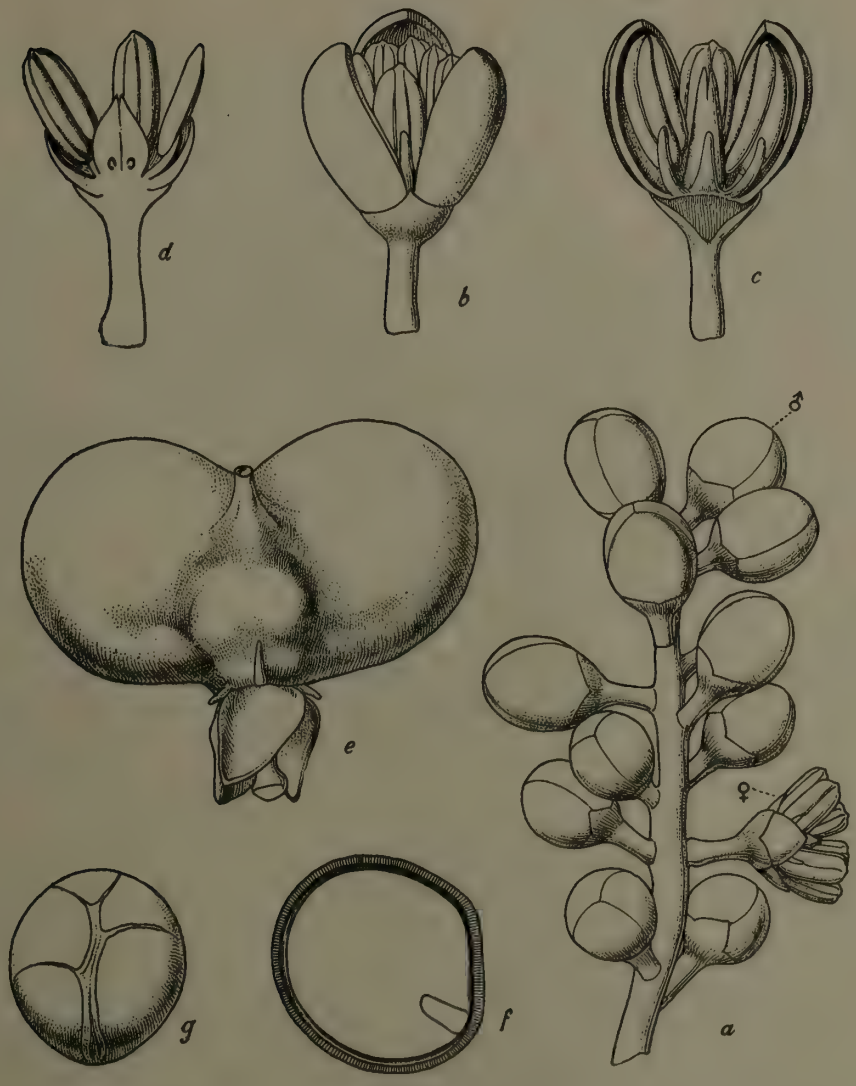

Figure 116. Pseudophoenix sargentii. a, branchlet with several male flowers in bud, and a female flower; b, male flower just before anthesis; c, male flowers from which a petal has been detached to show the interior; d, longitudinal section of a female flower; e, dry fruit containing two seeds; f, longitudinal section of a kernel and of its seed; g, seed seen from the raphal seed.

GAUSSIA H. Wendl.

H. Wendl., in Gottinger Nachrichten, 1856, p. 327; Benth. et Hook. Gen. pl. III, p. 912. *Aeria* O. F. Cook in Bull. Torrey bot. Club, 1901, p. 547.

Gaussia princeps* H. Wendl. l. c.; Griseb. Cat. pl. Cub. p. 221 (Wr. 3224); Sauvalle, Fl. Cub. n. 2383; G. Maza, Nociones etc. (1893) p. 50; **G. splendens** Becc. in Ann. Roy. Bot. Gard. Calcutta, v. XII, I, p. 9.

Gaussia princeps is not apparently a tall plant; the stem is rather stout, more or less inclining or bent at its base, and then ascendent and columnar; it has a smooth surface marked by very approximate ring-like scars, almost obsolete in the basal, but sufficiently distinct in the upper part of the trunk. The base of the trunk is raised from the ground by a very remarkable dense mass of roots, thickish, cylindrical, frequently dichotomically divided, covered by very small prickly warts, and, on the whole, similar to the ærial roots of a *Pandanus*. Here it is quite plain that the last formed roots are the more external, they are placed above all the others, and have of course made their way through the outer bark-like cylinder, appearing higher up on the stem, as this becomes older. This facility of producing epigeous roots in these palms is no doubt due to the great amount of aqueous vapour resting on the summit of the highest mountains, whereon they, too, find their proper home.

The *leaves* are also very remarkable; they are regularly pinnate, and have numerous very approximate leaflets, which are spreading almost horizontal; and are not arranged exactly on one plane, but point in different directions somewhat, and are furnished at their bases with a very conspicuous cushion-like swelling or callus. In the dry specimens this callus is much reduced and shrivelled, but in the fresh state it is certainly much swollen, and is probably fleshy. Several palms have leaflets with an axillary callus, but in none have I seen one so large as in *Gaussia*.

The *leaflets* are papery, ensiform, quite straight, open flat (not folded lengthwise), attached to the rachis by a broad base, where they are very suddenly contracted, and have the margins very briefly reduplicate, otherwise they have parallel margins a long way up, are gradually but excentrically acuminate above and, at times, are slightly indented a little below the apex; both surfaces are almost equally green, and very finely and sharply striately veined by secondary and tertiary nerves; the secondary nerves (5-6 on each side of the mid-costa) being only slightly stronger than several others; the mid-costa is rather strong, prominent and quite smooth on the lower surface, but is superficial and narrow in the upper, and towards the apex broadens and flattens considerably in a peculiar way; the margins are slightly and narrowly thickened and polished; there are no transverse veinlets visible; the intermediate leaflets are 50-55 cm. long and 2.5 cm. broad; the upper leaflets are shorter and narrower, more suddenly acuminate, briefly and often also obsoletely bidentate. The petiole is elongate

*While he lived in Cuba, Prof. Baker made an extensive introduction of this fine palm to horticulture, through Dr. Franceschi and others.

and gradually broadens at its base into a short, very broad leaf-sheath, which in the old and functionless leaves splits into two parts at the back. These leaves do not apparently remain long hanging down below the crown.

The *spadix* is apparently rather large and diffuse and is twice branched; glabrous throughout and quite destitute of bracts at every branching. The branch I have seen is 50 cm. long, it is divided into several alternate, spreading, filiform, gradually subulate, very elongate, flower-bearing branchlets, and has the lower portion of its axial part strongly flattened and 4-5 mm. broad; the lower branchlets are 20-25 mm. long and 1.5-2 mm. thick at their bases, subterete, but considerably wrinkled in the dry state; the upper gradually becoming shorter. The spadix has a long peduncular part, about 60 cm. in one specimen, sheathed rather tightly in a very thin, finely-striate marcescent spathe, which is split open laterally above and terminates in a hair-like acuminate point.

The *flowers* are horizontal, quite sessile, clustered in small linear series of 3-5 longitudinally around the branchlets; the flowers in each group are placed immediately one above the other and in contact; the lowest in each group is usually female and the others are males; the elongate superficial scrobicules have no bracts and are edged by a slightly elevated rim.

The *male flowers* in full grown buds are broadly or very briefly obovoid, 3 mm. long, 2 mm. broad, with a rounded top and flattish base; the calyx is cupular, truncate at the mouth; the sepals are imbricate, quite free, thick and fleshy especially at the base, with blackish margins. The corolla is nearly four times as long as the calyx; petals concave, spreading during the anthesis, ovoid, obtuse, strongly striately veined, rather thick and fleshy; stamens six, slightly shorter than the petals; filaments free from the base; the anthers inserted about the middle of the dorsum, are large, ovoid, and subcordate at the base; rudimentary ovary conspicuous, elongate-conical, slightly shorter than the stamens, terminated by three short blunt stigmas.

Female flowers at the time that the buds of the males are fully developed, are smaller than these, conical and more acute than the males; when fully developed 3.5 mm. long; sepals small, fleshy, orbicular-reniform; petals much larger than the sepals, deltoid, bluntish, thickly fleshy; ovary broadly pyramidate-trigonous; stigmas obtuse; ovules three, very minute, attached to the base at the inner side of the cells. Staminodes very minute, short and thickish. The fruits are obovoid, with a rounded top and taper somewhat towards a slightly asymmetrical or bent base, where a little above the torus remain the relics of the small conical stigmas. They (when dry) are 10-11 mm. long, by 7 mm. broad, and have the pericarp contracted and wrinkled; in the fresh state they certainly are somewhat fleshy; the pericarp has a thin resistant epicarp, a slightly pulpy mesocarp quite devoid of fibers, and a very thin membranous hyalin endocarp. The *seed* is obovoid, rounded above, and narrows to an acute, almost pungent, slightly bent base; its surface is dull and marked by few loosely anastamosing vascular branches of the raphe; the embryo remains on the more convex side of the seed, a little below the middle; the albumen is homogeneous, and of a not very hard texture.

The *perianth* apparently is not accrescent after flowering, is spread under the fruit, and is about 5 mm. in diameter; the sepals are subreniform; the petals are considerably larger and longer than the sepals, deltoid, bluntish, thickish, and obsoletely striately veined externally; the remains of six filaments are still visible in the shape of six very small conical bodies. (Figures 117, 118).

I have seen of *Gaussia princeps* Wright's typical specimens with fruit only (n. 3224 Herb. Berol.) upon which the species was founded, and I had the opportunity of examining very good specimens with flowers, collected by Britton, Earle and Gager (n. 6792 in Berl. Herb.) at San Diego de los Baños, Province Pinar del Rio; others with fruits were gathered, I think, in the same locality by van Hermann (n. 3463 in Herb. Becc. and Berol.)

In my monograph of the Genus *Daemonorops* (Vol. XII of the "Annals of the Royal Botanic Garden of Calcutta," p. 9) I have published some observations on the peculiar cushions or callosities, so frequently found in the axillas of the leaflets in palm leaves, and have also mentioned those of a *Gaussia splendens*, which name, however, is only an oversight for *Gaussia princeps*.

Figure 117. Gaussia princeps. a, portion of a flowering branchlet; b, male flower in bud; c, male flower during anthesis; d, longitudinal section of a young female flower; e, longitudinal section of a young fruit.

Gaussia attenuata Becc. **Aeria attenuata** O. F. Cook in Torrey bot. Club, 1901, p. 548, t. 47.

Dr. U. Dammer and Prof. I. Urban have already expressed the opinion (Urban, Symb. Antill. IV, 129) that the Genus *Aeria* might, possibly, be reduced to *Gaussia*. I am now able from inspection of the flowers and fruit of the type of *Aeria* (Cook No. 1040) to confirm this opinion, and I have, moreover, found *A. attenuata* to be rather closely related to *Gaussia princeps*, from which it differs in its more elongate stem, and in the somewhat larger fruit and seed. The flowers are very similar in arrangement and form in both plants; those of *G. attenuata*

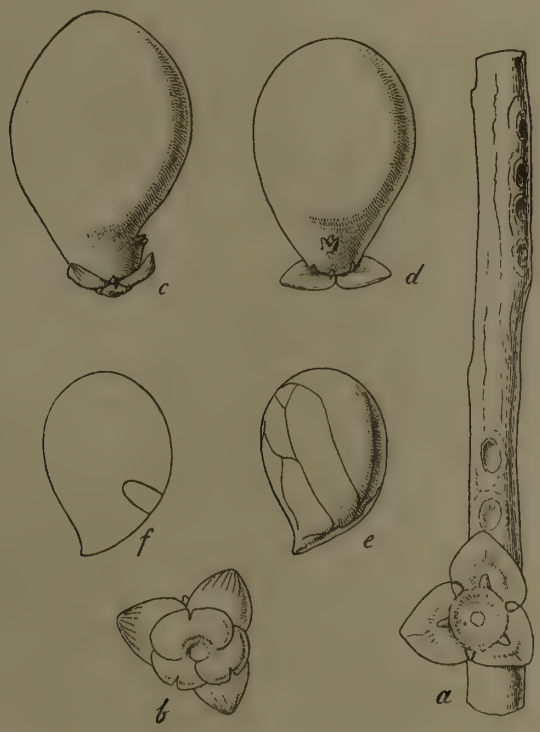

Figure 118. Gaussia princeps. a, branchlet with a fruiting perianth; c, fruit, side view; d, fruit, front view; e, seed, side view; f, seed cut longitudinally through the embryo.

are, however, more globose than those of *G. princeps*, have the petals less distinctly striately veined, and are also marked by fewer veins than those of the latter.

According to Cook, *G. attenuata* has the leaflets without basal cushions, the fresh fruit of a deep orange color, 16 mm. long by 12 mm., and the seed flattened-oval. The only dry fruit I have seen is obovoid, 15 mm. long, 11 mm. broad; the seed is 11 mm. long, 7.5 mm. broad, regular obovoid, not at all flattened, it has a round top and narrows at the base to a symmetrical, bluntish (not bent) point;

the albumen is homogeneous, entirely solid, without central cavity. The embryo is lateral, a little below the middle.

Other mentioned species of *Gaussia* are:

G. ghiesbreghtii H. Wendl. in Kerch. Palms 245. *Chamaedorea ghiesbreghtii* Hort. and *Oreodoxa ventricosa* Hort. It is a very problematic palm.

Gaussia portoricensis Wendl. l. c. (nomen): is supposed to correspond to *Gaussia* (*Aeria* O. F. Cook) *attenuata* Becc.

Gaussia vinifera Wendl. l. c., is *Pseudophoenix vinifera* Becc.

The Cherimoya in California

With Notes on Some Other Anonaceous Fruits

F. W. POPENOE
WEST INDIA GARDENS, ALTADENA, CALIFORNIA

The Cherimoya has not yet assumed an important place among the cultivated fruits of California. This cannot be attributed to any fault in the fruit itself, since in its better varieties it is one of the finest known to horticulture. Neither can it be said that the climate and soil of Southern California are not adapted to it, as forty years of cultivation have shown the tree to be hardy here, and fruits of fine quality have been produced.

The real cause of this regrettable state of affairs is not hard to determine. It does not lie deep below the surface, but is plainly apparent upon investigation. The fact is, we have been perpetuating only inferior seedlings. Thus the fault lies with our horticulturists and not with California or the fruit.

Had the precaution been taken to propagate from the best of our local seedlings, to say nothing of introducing better varieties, we would have many good Cherimoya orchards in our state at this time. Had the most desirable varieties been searched out from the countries to the south of us, or from other parts of the world wherein our own climatic conditions are paralleled, it is not assuming too much to say that the Cherimoya would now be regarded as one of the important fruits of this region. In other parts of the world where it has reached a high state of perfection, as in Madeira and the Canary Islands, it has become an important product, and vineyards are being replaced by Cherimoya orchards.

Where grown to perfection the Cherimoya is classed as one of the three finest fruits of the world, the other two being the Pineapple and the Mangosteen, —a royal trio indeed! A fully ripe Cherimoya is so delicious that it is safe to say not one out of a hundred on first tasting it would be other than delighted; in fact, this was exactly the case at a recent flower show at Pasadena, where a number of fine Cherimoyas from Mexico were exhibited and visitors permitted to sample them. In flavor and character the flesh may be likened to a delicious sherbert or ice cream. When prepared as it is in the tropics—thoroughly chilled on ice—there are few desserts that equal it.

On the great central plateau of Mexico, under climatic conditions almost identical with those of Southern California, it is not uncommon to find trees bearing two or three hundred of these delicious fruits. Why, then, should not the attention of our horticulturists be more earnestly addressed to the reproduction of such conditions here?

That so little is known in California of this superb fruit—its culture, its value, and its possibilities for this state—has seemed to warrant the preparation of this preliminary paper on the subject.

History and Cultivation in California

As far as is definitely known, the Cherimoya was first introduced to California in 1871, by the late Judge R. B. Ord of Santa Barbara. Dr. Franceschi, who has investigated the subject thoroughly, is unable to learn of any earlier introduction than this, and although it would seem natural that the early Mexican settlers should have brought this fruit with them, such does not seem to have been the case.

From the trees brought from Mexico by Judge Ord, many seedlings have been raised and planted in Santa Barbara and vicinity. Further south, some of

Figure 119. A fifteen-year-old seedling Cherimoya in the A. Z. Taft grove at Hollywood, California, showing what the tree will do in California under proper cultivation.

the first trees planted were on the Jacob Miller place in the Cahuenga valley, just outside of Hollywood, where the Cherimoya grows to perfection and is found in larger numbers than in any other locality in the state. The early impetus here given it has resulted in it being quite common in the gardens of Hollywood, and along the slopes of the valley to the west. Certainly it could not be more at home anywhere than it is here, the tree reaching a large size, and the fruit ripening perfectly. While it fruits well at Santa Barbara and in many other localities, there seems to be something peculiarly suited to it in the conditions of soil and climate of the foothill regions.

The superior hardiness of the Cherimoya has made it one of the most widely planted of the lesser-known subtropical fruits. The number of mature specimens is not more than a few hundred, but their wide distribution and success go to prove the adaptability of the tree to an extensive area in this state. Of these seedlings scattered throughout the gardens of Southern California, practically all have been successful so far as growth is concerned, but a large percentage are scantily productive. A study of the habits of the tree shows this to be nothing unusual and not due to anything unfavorable in our climate or soil. The Cherimoya is never enormously productive. But there are occasional seedlings much more prolific than the average, and this is the case in California as well as other countries.

Figure 120. A seven-year-old budded tree of the Golden Russet Cherimoya grown by C. P. Taft at Orange, California.

Cultivation on a commercial scale has been undertaken in but few instances, and with unsatisfactory results in practically all of them, the trees failing to produce sufficiently to make their culture profitable. For this difficulty a single, and exceedingly simple, remedy suggests itself—asexual propagation—making possible the perpetuation of productive and otherwise desirable seedlings, true to type. This is already practiced in other countries, and here to a very limited extent.

The largest grove of Cherimoyas in California is that owned by A. Z. Taft of Hollywood, consisting of some eighty fifteen-year-old seedlings. No finer specimens could be desired than some of these, but the majority of them are deplorably unproductive,—if the five best trees were taken out, a bushel of fruit

could not be gathered from the lot. One tree alone, more prolific than the others, produces about one-fourth as many fruits as the remaining trees taken together. It is easily seen that such a grove does not pay for the care bestowed upon it, but if worked over to a prolific variety it could be transformed into a very profitable holding.

It has been questioned by some whether the climate of California will produce a Cherimoya of the best quality. This query arises from the fact that many of the fruits produced here are of poor flavor. The explanation is that seeds from inferior fruits have been planted, and a lot of degenerate seedlings produced. Experience leaves no doubt on this point, since some of the fruits grown here are all that could be desired in flavor and quality.

Botanical Description

The genus *Anona* comprises about sixty species, indigenous to tropical America and Africa. Several members of the genus are cultivated for their fruit, notably the Sugar Apple (*A. squamosa*), the Sour Sop (*A. muricata*), and the Custard Apple (*A. reticulata*).

The Cherimoya, *Anona Cherimolia* Miller, while not so widely cultivated as the above mentioned species, is nevertheless one of the most noteworthy and valuable. It is a small tree, fifteen to twenty-five feet in height, much branched and spreading, with grayish bark, the branches rounded and the young growth scurfy-pubescent.

Leaves alternate, ovate, acuminate, sometimes obtuse, bright green and sparsely hairy above, grayish-pubescent beneath; petiole five-eighths inch long. Flowers solitary, axillary, small and very fragrant, peduncle short. Calyx composed of three small, valvate sepals. Petals six, arranged in two series: the three exterior valvate, fleshy, greenish outside and whitish within, oblong-linear, keeled on the inner side; the three interior minute, sometimes wanting. Stamens indefinite, inserted on the hemispherical receptacle. Carpels, also indefinite, distinct but cohering loosely among themselves and containing a single ovule; style oblong. Fruit compound, made up of the individual fruits (berries) derived from the separate carpels, sunk in and united with the fleshy receptacle, sometimes eight inches in length, conical, ovate, or globose, frequently irregular, greenish, brownish or yellowish in color; the surface sometimes smooth, but frequently covered or partially covered with more or less prominent protuberances, one arising from each pentagonal carpellary area. Seeds three-eighths to three-fourths inch in length, oblong or oval, more or less compressed, brown, containing the characteristic ruminated endosperm.

The Natural Order *Anonaceae*, to which the Cherimoya belongs, includes 46 genera and 620 species, according to Dr. Willis, the majority being found within the tropics, both in the old world and the new world. The order includes numerous fruit-producing shrubs and trees, of which may be mentioned in particular, besides the genus *Anona, Rollinia orthopetala* and *R. emarginata*, natives of South America and among the finest of the anonaceous fruits; *Asimina triloba*, the "Papaw" of eastern and central United States; and several species of

Uvaria, natives of Mexico and southern Asia. The Ylang-Ylang (*Cananga odorata*), a native of southern Asia, from which a perfume is distilled, is also a member of the order.

Origin

DeCandolle, in his monumental work "Origin of Cultivated Plants," discusses this subject at length, and states in conclusion, "I consider it most probable that the species is indigenous in Ecuador, and perhaps in the neighboring part of Peru." This statement was based mainly upon the opinions of early botanists who had collected in South America. That he was not certain in his conclusion is plainly expressed in the conclusion itself, but until recently his verdict has been generally accepted as correct. Some few, however, have held to the belief that the species is indigenous in Mexico and Central America as well as Peru and

Figure 121. A prolific Cherimoya tree at the C. W. Mitchell residence in Sierra Madre, California.

Ecuador, and recent researches by Prof. Gabriel Alcocer of the Mexican National Museum seem to prove that it is exclusively Central American, having been introduced to South America from Guatemala. In a Spanish work entitled "Historia del Nuevo Mundo," it appears that the author, P. Bernabe Cobo, while traveling from Peru to Mexico in the year 1629, found the Cherimoya in Guatemala City, and was so pleased with it that he despatched some seeds to his friends in Peru, where it was unknown at that time. Upon returning there thirteen years later,

he found that a number of trees had been raised and were in bearing, but the fruit was still scarce and sold in the markets from eight to twelve reales each. It was more than one hundred years later that the first Cherimoya seeds found their way to Europe, and having come from Peru it was naturally supposed that the tree was a native of that country. Later, when European botanists found the tree in an apparently wild state in the mountains of Peru and Ecuador, this belief was more firmly established, but it is plainly apparent that the tree might have become naturalized in the two hundred years that had elapsed since its introduction, even to such an extent as to lead to the belief that it was native. Prof. Alcocer points out that the work, "Historia del Nuevo Mundo," was unknown to DeCandolle, and he also presents much other evidence in favor of a Central American origin, with the result that little room is left for doubt.

Figure 122. Fruits of Cherimoya on a young tree at Hollywood, California.

Common Names

In Mexico the common name of this fruit is spelled "Chirimoya." Evidently a different spelling is used in Peru, giving rise to the specific name *Cherimolia* and the English adaptations "Cherimoya" and "Cherimoyer," the latter most commonly used in the British colonies. Though the fruit came to California from Mexico, the spelling "Cherimoya" has been generally adopted by horticulturists in this state and will, in all probability, eventually supersede all others.

Some authorities have termed all members of the genus *Anona* "Custard Apple" individually and collectively, it is extremely undesirable that the Cherimoya be known under this name, which properly belongs to the West Indian *Anona reticulata,* a fruit similar to the Cherimoya in many characteristics,

but greatly inferior in quality. The listing of the Cherimoya under the name "Custard Apple" has already led to much confusion among nurserymen and horticulturists in this state, some, knowing that this name was applied to *A. reticulata* going so far as to list this species and *A. Cherimolia* as synonymous. Furthermore, the Cherimoya suffers a certain loss of prestige through this confusion—sufficient in itself to merit careful discrimination on the part of all those describing or listing it.

Climatic Requirements

That the Cherimoya is not highly successful in strictly tropical countries is conclusively shown by the fact that even when it has been grown for some time in such regions and is comparatively well known, it is not held in high esteem. It is reported that it succeeds in some parts of Ceylon, and is popular with the

Figure 123. A Cherimoya tree in the A. Z. Taft grove at Hollywood, California, probably one of the finest specimens in the State.

natives. Obviously it is not at its best or it would call for a greater degree of enthusiasm. In Jamaica it is only a success in the coolest and dryest parts of the island. Writers in other parts of the West Indies, and in Reunion, have remarked that it is not as fine a fruit as some other members of the genus.

But a glance at its popularity in the Mexican highlands, Madeira, the Canary Islands, and Peru shows a contrary state of affairs. It has reached a degree of perfection never attained in tropical lowlands, and is esteemed as one of the finest of all fruits.

The great central plateau of Mexico may be taken as an example of climatic conditions best suited to this fruit, since it is there found in perfection, and has been cultivated from the remotest antiquity. Comparatively high temperatures accompanied by a very low degree of humidity are the rule during the dry season, the winters being cool and the annual precipitation not great—a climate very similar on the whole to that of Southern California. And indeed it is not necessary to search elsewhere to determine the requirements of this fruit, since forty years' successful cultivation in this state has proved them to be fulfilled here to a very satisfactory degree. Two factors which seem to be particularly important are freedom from excessive humidity or precipitation, and cool (but not frosty) weather at the time of ripening.

Figure 124. Trunk of Cherimoya tree shown in Figure 123, almost a foot and a half in diameter.

Prof. Foex, in "Algunas Anonaceas Frutales de Mexico" (Bulletin No. 9 of the Estacion Agricola Central, Oaxaca), says: "Of the Anonas grown in Mexico the Cherimoya is the most resistant to cold, and suffers most from excessive heat. * * * When grown in a region of moderate temperatures it is considered the best of all the Anonas; grown in a hot climate it is not superior to *Anona squamosa.*"

The hardiness of the tree has been so thoroughly tested in this state as to leave no room for dispute, and it can be relied upon to succeed in locations suited to citrus fruits, with the same amount of protection. The same provision must be made as with the citrus fruits, however, that some localities will produce finer fruit than others. And it must be recognized and remembered that varieties intro-

duced from other countries will not necessarily be successful here—if from climates widely different from our own—without undergoing a process of acclimatization.

Propagation

Although the majority of Cherimoyas in this state are seedlings, the tree can be readily budded. It is only through this or some other asexual means of propagation that desirable forms originated as chance seedlings can be perpetuated, and Cherimoya culture on a commercial scale made profitable.

Figure 125. Parent tree of the Mammillaris Cherimoya, at Altadena, California, on the property now owned by A. C. Calkins.

Seeds are sometimes obtainable in the fall, but more frequently during early spring. If a glass-house or hot-bed is available they may be planted at any time, but if no artificial heat can be supplied it is best to defer planting until the advent of warm weather, usually in April or early in May. For germinating the seeds an excellent medium is a mixture of two-thirds silver sand and one-third *old* redwood sawdust; lacking this, any light, well-drained soil can be used with

Figure 126. Showing one of the very best types of Cherimoya, this being five inches in length and weighing a pound and a half.

good results. The seeds should be covered to a depth of half an inch, and if conditions are favorable they will germinate within four or five weeks. The young plants should be potted off when they have attained a height of three or four inches, using pots of a diameter not less than two and a half inches. The plants are not particular as to soil, it only being necessary that it is light and porous.

Budding is best done in early spring, shortly after the sap has begun to flow. In some seasons this will be as early as the first of March, but more frequently late in March or early in April. The trees should be watched and the work begun as soon as it is found the bark will slip readily.

Figure 127. A plate of Cherimoyas as grown at an altitude of 7000 feet in the highlands of Mexico.

The most advantageous method of budding the Cherimoya is that known as shield budding, the operation being practically the same as with the citrus fruits. Mr. C. P. Taft of Orange obtained excellent results from his first attempt, but later found that even though the work was done under favorable conditions the buds would sometimes fail to grow. The stocks used by Mr. Taft have been seedling Cherimoyas; in Florida Mr. Wester has budded on *Anona glabra, A. squamosa,* and *A. reticulata,* finding *A. glabra* the most vigorous and satisfactory. It is not certain that this species will be equally satisfactory in California, however.

The stocks should be from three-eighths to one-half inch in diameter—seedlings of this size being usually from a year to a year and a half old. Wood from which the leaves have dropped and of about a year's growth is the most desirable for budwood, and Mr. Wester advises cutting the buds not less than an inch and

a quarter in length. If cut smaller than this, on account of the rapid callousing and thick bark of the Anonas, the buds have difficulty in starting and are choked out. Insert the buds exactly as in budding citrus fruits, and tie with waxed tape. At the end of three or four weeks they should be unwrapped, and if alive, the tree should be lopped back and the bud rewrapped loosely, leaving the "eye" exposed so that it may start into growth. The buds of the Cherimoya are sunk into the bark tissues, and there is not the danger of their dropping and leaving a "blind" bud that there is with the avocado.

In Madeira and the Canary Islands grafting is extensively practiced. Dr. Trabut, in the Bulletin Agricole de l'Algerie et de la Tunisie, advises grafting as being much more successful than budding. Two-year-old seedlings are used, the operation itself being a simple cleft-graft.

Figure 128. Showing a collection of the different types of seedling Cherimoyas occurring in Southern California—these from one grove at Hollywood.

Culture

Experience in California has shown that the Cherimoya thrives under the same treatment accorded the Citrus fruits. The seedlings grow to much larger size than any of the Citrus trees, however, and should be planted at least twenty-five feet apart. Budded trees will probably require less room, as budding dwarfs the tree to a certain extent.

The tree has proved to be about as hardy as the orange—though this must be largely a matter of variety—and is semi-deciduous in nature, the extent being dependant upon the severity of the climate.

Whether seedling or budded, the tree ordinarily comes into bearing about the fourth year. The fact that large trees are quite frequently unproductive, though blooming profusely, has led to a series of investigations by P. J. Wester of the U. S. Dept. of Agriculture, which throw considerable light on the matter, although there is still much to be learned. Mr. Wester found that the flowers of the Cherimoya were unable to fertilize themselves because of the pistils maturing before the stamens, and consequently not receptive to the pollen when

it was liberated, thus necessitating the assistance of some outside agency for fertilization. The pollination of the mature pistils with pollen from another flower was attributed to insects. Mr. Wester believed the sterility of the Cherimoya in Florida to be due to a scarcity of flowers and an insufficient number of insects to assist in pollinating them. He further states that "the extraordinary productivity of a few individual trees suggests a change in regard to the pollination of the flowers of these trees, possibly due to synacmy and self-pollination."

In Madeira and the Canary Islands the cultivation of the Cherimoya is carried on systematically, the trees being pruned and manure regularly supplied.

Figure 129. Showing what the Cherimoya may be in Southern California. A fine specimen from Hollywood, weighing 18 ounces.

Diseases

In California no diseases affecting the Cherimoya have been observed; if they are present, they do not seriously interfere with growth, and have not been of sufficient importance to become evident. In other countries, however, the tree seems to be subject to certain fungus diseases, probably unknown here.

Jumelle (Les Cultures Coloniales, p. 176) remarks: "It is well to replace the trees when they commence to get old, as they are subject to the attacks of a blight."

In a paper read before the Cuban National Horticultural Society, and published in the Society's report for 1910, H. A. Van Hermann says: "The cultivation of Anonas for commercial purposes will need some careful attention. The fruit when young is affected by both fungi and insects, which disfigure it. Spraying may be necessary to grow perfect fruits in some localities."

Mr. R. H. Johnston of the hacienda "La Queseria" in the state of Jalisco, Mexico, reports that many of the trees, which are given practically no cultivation in that vicinity, are subject to a serious disease somewhat similar to the pear canker.

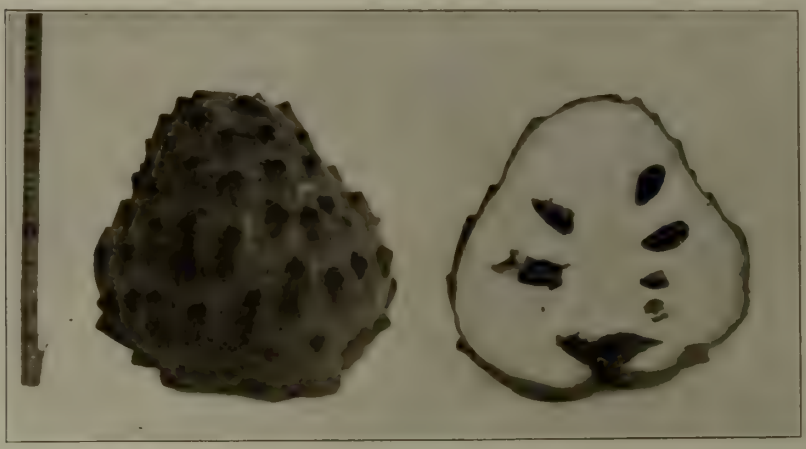

Figure 130. The Mammillaris Cherimoya as grown at Altadena, California.

Insect Pests

Even though in close proximity to infested citrus and other trees, none of the local Cherimoyas appear to be bothered by any insect pests. But it is evident that the species is not immune from the attacks of pernicious insects. The Bulletin Agricole de l'Algerie et de la Tunisie for March 15, 1908, contains an account of the Cherimoya in Algeria by Dr. L. Trabut, in which he states that old trees are nearly always infested with the "Cochenille blanche" (Mealy Bug) requiring stringent combative measures. Fumigation is advised, the work to be done during the winter months. In Southern California, the work of Essig and others has shown that the Mealy Bug can be most effectively handled by the use of carbolic emulsion.

Throughout the warmer parts of America there are small chalcid flies related to the wheat joint-worm and the grape-seed chalcid which infest the seeds of anonaceous fruits particularly those of *Anona squamosa*. These are so widely distributed that they will be practically certain to appear eventually in Southern

California. All seed from southern sources should be carefully examined on being received.

Season

In this state the main season for Cherimoyas is March and April, although in favorable weather a few fruits may mature in the fall. The entire crop does not ripen at one time, the fruits maturing individually and extending the season over six or eight weeks.

The fruit does not ripen on the tree, and must be picked when mature—to avoid its dropping to the ground and becoming bruised—and laid away for three or four days before it is in condition for eating. That it is difficult for some to judge when the fruit should be picked is evidenced by the fact that mature, and sometimes half-grown, fruits are often found in the markets. These immature fruits are easily distinguished by their becoming dark brown upon softening, accompanied by a hardness of the surface that is never present in the ripe fruit.

Figure 131. The Golden Russet Cherimoya as grown at Orange, California.

When fully ripe and ready to pick, the fruit assumes a yellowish tinge, more pronounced in some varieties than in others, and yields slightly to pressure of the thumb.

In certain states of Mexico Cherimoyas are obtainable throughout the year. The season has not been greatly extended by seedling variation in California, since fruit can not be obtained in quantity for more than three months. Doubtless by introducing varieties from other countries it would be possible to greatly prolong the period.

Unfavorable weather at the time of ripening has a pronounced effect on the flavor and size of the fruit, both suffering considerably in severe seasons.

Shipping

That the Cherimoya could be successfully shipped to any part of the country without difficulty is shown by the fact that numerous shipments to this state from southern Mexico have arrived in excellent condition, even though no care was

used in packing. After picking, the fruits do not soften up sufficiently to be easily bruised within three or four days, and this time can be greatly extended by refrigeration. With the selection of the toughest-skinned varieties for this purpose, there should be no difficulty in placing the Cherimoya on the markets of any part of the country.

A more complete treatment of this subject will be found in Prof. Foex' bulletin "Algunas Anonaceas Frutales de Mexico," already referred to.

Nature and Extent of Seedling Variation

Notwithstanding some statements to the effect that the Cherimoya comes true from seed, the variation exhibited by the seedlings in Southern California, many of which have sprung from a common parent, demonstrates conclusively that asexual propagation must be resorted to in order to perpetuate a variety absolutely true to type. Although the distinct departures from the parent type which are frequently shown by seedlings of some other cultivated fruits do not appear to exist in this species, in variation of seedlings, and particularly in variation of fruits on the same tree, it is peculiar and extraordinary.

As observed among the local trees, the most important characteristics in which variation is shown, and the extent of variation in each, are briefly as follows:

A. Variations Affecting the Tree.

1. *Productiveness.* A large percentage of seedlings are so unproductive as to be of no value. Many produce moderately, and an occasional tree is so exceptionally productive (comparatively speaking) as to make it of great value for propagation, provided it is otherwise desirable. These productive trees are quite frequently isolated specimens, showing that the difference is not due to cross fertilization, or an abundance of pollen supplied by other trees. Mr. Wester suggests that the flowers of these trees may be self-fertile, as opposed to the majority of Cherimoyas which are dependent on insects for pollination. Whether this be the case or not, it is certain that the bearing habits of a tree are perpetuated by asexual propagation, and thus all danger of trees turning out to be shy bearers can be eliminated.

It is quite possible that the productiveness of many of the local trees could be increased through better attention to culture, since many of them have been subjected to severe neglect.

2. *Foliage.* On one plantation in the Cahuenga valley there are a few trees whose leaves are uniformly two or three times the ordinary size, being eight to ten inches in length and five to six inches in breadth. It is not rare for seedlings to show this variation, and the fruits produced by such trees do not appear to differ from the ordinary in any respect.

B. Variations Affecting the Fruit.

1. *Surface.* In respect to surface, the local seedlings may be broadly divided into two classes; those with more or less prominent protuberances over the greater portion of the surface, and those without protuberances, in which the

surface is smooth and the carpellary areas are defined by raised lines, or in which the carpellary areas are individually concave. There are, of course, many forms intermediate between these two, and extreme forms of each. While both smooth and rough fruits are sometimes produced by the same tree, and some trees produce fruits which are covered with protuberances when young but become smooth at maturity, there are many which uniformly produce fruits of one type. Thus in the Mammillaris variety the mammiform protuberances are present on all specimens, and in the Golden Russet the protuberances near the base, which disappear towards the apex and are replaced by concavity of the carpellary areas, are characteristics which are almost always present.

2. *Size.* In this respect the Cherimoya is extraordinary, it being possible to find mature fruits all the way from an inch to six inches in diameter on many trees, whether seedling or budded. Ordinarily, only a small percentage of the fruits

Figure 132. On the left a view in the huerta of Herman Evers, at Mazatlan, Mexico, showing a young Cherimoya in bearing; on the right, a large tree near Colima, Mexico, photographed during the winter season and showing the deciduous nature of the tree in cold climates.

attain large size, although some trees are more uniform in this respect than others.

3. *Form.* The commonest form is conical or oblong-conical, but some varieties are normally cordate and there are many seedlings among whose fruits it would be difficult to determine a normal form. Rarely is there a tree whose fruits are all of uniform shape. Even among perfect specimens there is considerable variation, and many malformed fruits are produced, due, without doubt, to imperfect fertilization of the flowers.

4. *Color.* Although commonly a dull green, there is considerable variation in coloring, some varieties being light russet at maturity. Since any other color than green is only assumed in favorable weather, it is evident that coloring is largely a matter of weather conditions, becoming most pronounced in the hottest seasons.

5. *Seeds.* Among the seeds of different varieties there are no great differences. The average number of seeds, while greater in fruits of some varieties than others, is largely a matter of the individual specimen. Slight differences in the form of the seeds are frequently noticeable.

6. *Quality.* It is natural that some seedlings should produce fruits of inferior quality. Occasionally a very superior one is found.

Varieties

In general characteristics of fruit many of the local seedlings are practically identical; furthermore, as has already been noted, the variation existing among fruits on the same tree is great. This makes it impracticable to distinguish between any large number of varieties, and renders difficult the describing of a variety in such a way that every fruit produced will answer to the description, without entering at length into the range of variation exhibited within the variety.

When the most prolific and desirable of the local trees come to be propagated by budding or grafting, and are offered by the nurserymen, it will be essential that each one be given a name and that accurate descriptions and illustrations be placed on record for the guidance of prospective planters. As yet only two named varieties have been offered. Both these are desirable, but it is highly probable that much finer forms will be introduced within the next few years from other countries where this fruit has been given more attention that it has here. In Madeira, seedling selection has resulted in the production of varieties weighing as much as sixteen pounds, and with very few seeds. Choice forms, adapted to varied conditions of soil and climate and bearing at different seasons of the year, have been produced in several countries, and it will be much more expedient to direct our efforts toward obtaining as many of these as possible, rather than to the production of superior varieties through seedling selection,—necessarily a slow and laborious process at best.

Mammillaris

This variety originated as a seedling at Altadena, California, on the property now owned by A. C. Calkins. In flavor it is greatly superior to the majority of local seedlings, and its exceptionally tough skin renders it of value for shipping. Although not a fruit of large size, it must be ranked as one of the best which have originated locally.

Description—Form distinctly conical, more uniformly so than with most other varieties; size medium; weight up to one pound; length up to four and a half inches; width up to four inches; base flattened; cavity shallow, broad, flaring, regular; apex rather pointed; stem short and very stout; surface covered with more or less prominent conical protuberances, one arising from each carpellary area over the entire fruit; color dull green; skin thick and very tough; flesh clear white, soft, fine grained; seeds rather short and blunt, plump, not very numerous; flavor very aromatic and rich, strongly resembling the pineapple; quality excellent; season February-March at Altadena, California.

Tree upright; growth close, moderately vigorous; productiveness very good; seems to be hardier than many other Cherimoyas. This is the first description of this variety.

Golden Russet

A variety of obscure origin, received in the form of two budded trees from London, England, by Mr. Burgess of Villa Park, California, some years ago. It was under this name when received. It has been propagated by C. P. Taft of Orange, who has a number of budded trees in bearing. A very good variety, but as produced at Orange it is inferior in flavor to *Mammillaris.*

Description—Form normally oblong-conical, but extremely variable; size medium large; weight up to a pound and a half; length up to seven inches; width up to five inches; base flattened; cavity deep, rather narrow, rounded, regular; apex rounded, broad; stem short and stout; surface near base giving rise to a rounded and not very prominent protuberance from each carpellary area, toward apex the protuberances disappear and the carpellary areas are concave; color light green, usually shaded with, or varying to, golden russet; skin rather thin, tender; flesh white, of good texture; seeds oblong, slightly compressed, not very numerous; flavor resembling the pineapple but not so rich as in *Mammillaris;* quality good; season February-April, occasional specimens ripening in the fall, at Orange, California.

Tree upright, broad topped; growth vigorous, rather open; productiveness fairly good.

OTHER SPECIES OF ANONA FRUITED IN CALIFORNIA

Anona macrocarpa

Considered by some authorities to be a horticultural form of *A. Cherimolia,* but believed by Dr. Franceschi, who introduced it to California, to be distinct.

The most marked characteristic of the species is the large size of the leaves, which causes Dr. Franceschi to note that it might better be called *macrophylla,* the fruits being proportionately not so large, although larger than the ordinary Cherimoya, and of excellent quality. The seeds are distinct from those of *A. Cherimolia.* It is believed to have originated in Orotava, Teneriffe, and has proved hardy at Santa Barbara.

Anona reniformis

Also introduced by Dr. Franceschi, who describes it as of dwarf habit and more spreading than the Cherimoya, with smaller and more coriaceous leaves. The flowers are very fragrant, and are produced in great profusion over a longer period than with other species. A sparse bearer, the fruits reniform, of small size, and indifferent quality. Not authentic, but for its distinctiveness in foliage, in fruit, and particularly in seeds, considered by Dr. Franceschi to rank as a distinct species.

Anona suavissima

Also considered a horticultural form of *A. Cherimolia* by some authorities. It was described about 1820 by Prof. Tenore, Director of the Botanic Garden at

Naples, Italy, from whence it was introduced to California by Dr. Franceschi. Similar to *A. Cherimolia* in most characteristics, but quite distinct in its seeds. The fruit is of indifferent quality.

ANONACEOUS FRUITS INTRODUCED TO CALIFORNIA

The most important members of the genus *Anona*, and several members of other genera of the *Anonaceae*, have all been introduced to California, but so far as known, none of them have yet attained sufficient size to produce fruit except the Cherimoya and the three doubtful species *Anona macrocarpa, A. reniformis* and *A. suavissima*. The following list includes all others known to have been introduced, some being of such recent introduction that they have not yet been tried out in the open, others, like the Sour Sop (*Anona muricata*) and the Sugar Apple (*A. squamosa*) have been repeatedly planted in various locations, only to succumb to the cool winters. It may yet be possible to fruit them by obtaining the hardiest types and planting them in the most favored locations.

Anona Cherimolia Mill., var. pyriformis

Indigenous to Chile.

Described as being hardier than most other Cherimoyas, and bearing pear-shaped fruits of large size and excellent quality. Recently introduced by the Bureau of Plant Industry.

Anona glabra Linn.

(*A. laurifolia* Dunal)

Southern Florida, Mexico, and the West Indies.

Known as *"Anona"* in Mexico; *"Cachiman Creme"* in the French West Indies; *"Pond Apple"* in Florida and the British West Indies.

A vigorous tree up to thirty feet in height, the trunk up to two feet in diameter. Leaves ovate-lanceolate, deep green above, pale green beneath, glabrous, coriaceous, persistent.

Fruit ovate-conical in shape, flattened at the base and rounded at the apex, two and a half to five inches long. Skin yellow or brownish yellow, sometimes reddish. Seeds conical, few. Pulp of a buttery consistency, very sweet, sometimes cloying.

Prof. Foex says this is the commonest anonaceous fruit on the markets of Mexico City, with the exception of the Cherimoya. It ripens throughout the year in the Mexican states of Chiapas, Guerrero, Jalisco, Michoacan, Oaxaca and Vera Cruz; from January to June in Puebla and other central states; from July to December in those states along the Pacific coast.

Although esteemed by the Mexicans, this fruit is not highly valued in Florida, where it is found in both fresh and salt water swamps. While it is found in Mexico at considerable altitudes it is not as hardy as the Cherimoya. Introduced to California by Dr. Franceschi. Only small plants are to be found as yet.

Anona montana MacFayden

Porto Rico, and other islands of the West Indies.

A small tree, bearing a sub-globose, muricate fruit, of little value. Introduced to Florida by Bureau of Plant Industry for trial as a stock for other Anonas.

Seeds sent to California in 1911 by Bureau of Plant Industry. Young plants raised by Dr. Franceschi were all killed during the first winter.

Anona muricata Linn.

(*A. asiatica* Linn.)

Cuba, Santo Domingo, Jamaica and several of the smaller islands of the West Indies, according to DeCandolle.

Known as *"Cabeza de Negro," "Catucho," "Guanabano,"* and *"Anona Amarilla"* in Mexico; *"Corossolier," "Cachiman Epineux,"* and *"Sappadille"* in the French colonies; *"Sour Sop"* in Florida and the British colonies.

Figure 133. A grove of Cherimoyas in the hacienda of "La Queseria," at the foot of the volcano of Colima, in Mexico, showing the conditions under which the Cherimoya frequently exists in that country.

A tree of about the same size as the Cherimoya. The leaves are ovate-lanceolate, acuminate, and glabrous. The foliage possesses a peculiar and distinctive fragrance.

Fruit very large (sometimes as much as ten pounds in weight), oblong, conical, or oval, and dark green in color. The skin is covered with short, pointed, recurved protuberances or weak spines. Pulp soft and juicy, but frequently fibrous or wooly and tasting of turpentine. Seeds slightly larger than those of the Cherimoya. The juice is acid or subacid, of pineapple flavor, and is widely used in the West Indies and other parts of the tropics for the preparation of a refreshing drink. The fruit matures throughout the year.

In many parts of the tropics choice varieties have been obtained, prolific and of fine flavor. It is well known that there is a great difference in quality in the produce of different trees.

The Sour Sop is one of the tenderest species of *Anona*, and is not known to have ever become established in California, although plants have been imported from Florida at numerous different times. Dr. Franceschi has raised seed from different sources, but with poor success. An importation from Paraguay in 1911, however, appears to be more robust and hardier, and may result in plants becoming established here. It is only by obtaining the hardiest varieties and planting them in the most favored localities that anything can ever be expected of this species.

Anona palustris Linn.

West Indies and South America, from Cuba to Rio Janeiro.

Known as *"Corcho"* in Mexico; *"Pomme de Serpent"* in the French West Indies; *"Alligator Apple"* and *"Cork Wood"* in the British West Indies.

An arborescent shrub, 10 to 15 feet high, the leaves ovate-elliptic or oblong, with short narrow point or sometimes bluntish, smooth on both sides, rather thick. The wood is sometimes used in place of cork.

Fruit two inches in diameter, yellow, somewhat roughened and scaly. Said to be narcotic, and for this reason not much used. Grows in swamps and along the seashore.

Of not much value as a fruit, but used in Florida as a stock for other Anonas. The difference in climatic conditions makes it doubtful if it will prove of value for this purpose here. Introduced from Florida in 1910 by Dr. Franceschi.

Anona reticulata Linn.

West Indies and tropical America.

Known as *"Anona," "Ananhtzapotl," "Anona Colorada,"* and *"Llama"* in Mexico; *"Cachiman," "Cachiman Coeur de Boeuf," "Corossol Reticule," "Corossol Sauvage,"* and *"Mamilier"* in the French colonies; *"Custard Apple"* in Florida; *"Custard Apple"* and *"Bullock's Heart"* in the British colonies.

One of the largest members of the genus, growing up to twenty-five feet in height. Leaves oblong-lanceolate, glabrous above, slightly pubescent and reddish below.

The fruit is described by Dunal as ovate-globose in form, but is better described by Prof. Foex as "the shape of an enormous strawberry." In color it is reddish brown or brownish yellow. The skin is not covered with protuberances or scales, the carpellary areas being defined by more or less distinct reticulations. The pulp is grayish or pinkish, and adheres to the rather numerous seeds. In flavor the Custard Apple is similar, but inferior, to the Cherimoya.

Prof. Foex remarks that by selection and crossing it would be possible to obtain varieties with pulp not adhering to the seeds, and of superior flavor and texture.

This species is common in the warmer parts of Mexico and in the West Indies. It is cultivated quite widely and has become naturalized in some places in southern Asia and western Africa. In Florida it has been grown for many years.

This species and *A. Cherimolia* have been greatly confused by California nurserymen and horticulturists in general, probably because of the fact that the Cherimoya has been commonly called "Custard Apple" in this state, and because the two species are somewhat similar, although they are entirely distinct in foliage and readily distinguishable by this means. *A. Cherimolia* has been listed under the name *A. reticulata* by some nurserymen, and others have listed the two as synonyms; but the plants disseminated have been of the species *Cherimolia* probably without exception.

Not as hardy as the Cherimoya, but might succeed in favored locations in this state. No plants of any size are known.

Anona squamosa Linn.
(*A. cinerea* Dunal)

According to DeCandolle, this species is indigenous to tropical America, and the West Indies in particular.

Figure 134. Another small grove of Cherimoyas in the hacienda "La Queseria." Note the similarity of the country to the dry foothill regions of Southern California.

Known as *"Anono," "Chirimoyo," "Saramuyo," "Texaltzapotl,"* and *"Anona Blanca"* in Mexico; *"Pomme Canelle"* and *"Attier"* in the French colonies; *"Sugar Apple"* and *"Sweet Sop"* in Florida and the British West Indies; *"Custard Apple"* in British India.

An arborescent shrub or a small tree, ten to fifteen feet in height. Trunk ashen gray, branches light gray. Deciduous in climates having a more or less marked dry or winter season. The foliage is strongly scented, and is sometimes used as an insecticide.

The fruit is normally round or conical, about the size of a small orange, and greenish in color. The surface is covered with prominent rounded protuberances, imbricated like the scales of a pine cone. The pulp is creamy, very sweet, and surrounds the rather numerous, medium sized, seeds.

The Sugar Apple is one of the finest of the Anonas, and is widely grown in tropical countries, in some of which it has become naturalized. It is ordinarily a more prolific and regular bearer than other species.

It has been planted in Southern California, but has not become established, having proved too tender for this climate. By obtaining the hardiest varieties from the Mexican highlands it may be possible to successfully grow it in favored localities. Dr. Franceschi believes it was first planted in this state about 20 years ago, having come from Florida.

Asimina triloba Dunal

United States, as far north as New York, and west to Michigan and Kansas; Mexico, south to the state of Jalisco.

Known as *"Papaw"* in the United States; *"Anonillo"* in Mexico.

A tree thirty to forty feet in height. The leaves obovate or oblong, acute, six to twelve inches long. Flowers 2 inches broad, purplish red.

Fruit oblong, two to six inches in length. Skin yellowish green, covered with a whitish bloom. The fruit greatly resembles the banana in its lack of acid and its fine grained pulp, but is of a peculiar and distinctive flavor. The pulp is light yellow in color, and contains two rows of seeds extending the length of the fruit.

The Papaw is occasionally found in cultivation, and has proved hardy as far north as Ontario. It is the hardiest of the anonaceous fruits, and the only one found in cold climates. Among the wild trees seedlings of superior quality are occasionally found, and the fruit could doubtless be greatly improved by selection. It offers a wide field for hybridization with other less hardy anonaceous fruits, and should also prove of value as a stock upon which to graft the more tender Anonas and Rollinias.

The Papaw was planted at Goleta, Santa Barbara County, many years ago by Joseph Sexton, one of California's pioneer nurserymen, but failed to establish itself. Repeated attempts to grow it were made, but with no success, due, as Mr. Sexton believes, to the hot and dry summers. Further attempts to grow it should be made, especially in cool and moist mountain canyons, where it should feel at home. Its greatest value probably lies, however, in the possibility of obtaining hybrids with other anonaceous fruits, or as a stock for them.

Rollinia emarginata Schlecht.

Brazil, Paraguay, and the northern part of Argentina.

"Aratacu-quatu." This is a small bush growing here in the open campo in almost any soil. The fruit is large and the best class of all, according to my thinking.—*T. R. Gwynn.*

Recently introduced, under S. P. I. No. 27610.

Rollinia orthopetala A. DC.

Paraguay, Brazil and Argentina. *"Biriba."*

A tree, thirty to forty feet in height. Leaves oblong, acuminate, acute at the base, corolla one inch in diameter, greenish yellow.

Fruit size of an infant's head, greenish yellow. The flesh white and sweet.

Described by Prof. C. F. Baker as "the finest anonaceous fruit of tropical America."

"This is, as Prof. Baker wrote, the finest anonaceous fruit of tropical America. It is the only one of those which I have tasted that I liked, and on first trial I immediately pronounced it delicious. The seeds are embedded in a large quantity of pulp, which is of a custard-like consistency and of a very agreeable acidulous taste. I do not know what fruit it resembles most in taste."—*Fischer.*

Introduced under S. P. I. Nos. 22512 and 27609. Rather tender, but may succeed in favored localities, where it is now being tested.

Wanted: A Genuine Southern California Park

RALPH D. CORNELL
LANDSCAPE GARDENER
LONG BEACH, CALIFORNIA

What could be more interesting and educational, to the people at large, than a public park devoted to plants indigenous to our dry and semi-arid lands, and representative of the many forms of plant life that are found along our coast slopes? A dry ground park, planted only to native trees, shrubs and flowers, would be one of the greatest possible assets to Southern California, and especially to the community whose park board was sufficiently aggressive and far seeing to establish such a system of planting. Not in all California can one find a collection of the native flora of sufficient consequence to warrant its recognition as such. Europe is far in advance of us in the cultivation of plants that grow wild on our dry hillsides, and unnoticed by us evolve, at our very doors, their wholesome lives of purity and beauty. Instances may be commonly cited where, unable to obtain reliable seeds at home, plant propagators have sent to Europe for seeds of flowers and shrubs growing wild on our own hills. It is true that many native plants and seeds are found in our markets, accessible to those who know, but the masses of people are unaware of the abundant wealth of flower and foliage, lying on all sides of us, inviting recognition and adoption.

Wild plants, when brought under cultivation, are prone to change their habits and appearance to a greater or less degree. The dignity of the move seems to demand that they put forth stronger efforts toward the perfection of their already inimitable charms. There are very few plants that do not improve under the more favorable conditions afforded them by protection and cultivation. The change is often so great that one familiar with a plant, in its native environment, will not recognize it in a new home.

Eastern residents, coming to California, find our parks quite similar to those which they are accustomed to seeing. With the exception of palms and a few things of more pronounced individuality, our evergreens, in general appearance, are not greatly unlike eastern plants, during their growing season, especially when planted in park form. The first mental impression upon visitors is the lasting impression, and there is little strikingly or distinctively characteristic in the landscape effect produced in our average park. A park should present a series of living pictures, in plant life, executed along the lines of greatest possibility. Not one person in a hundred distinguishes between a broad and a narrow leaved evergreen, or is sufficiently impressed by the individual specimen to give the name of a plant ten minutes later, had he recognized it at the time. It is the general tone of harmony or discord that leaves its effect upon the visitor, and that he remembers long after the details have been forgotten.

It seems to be our general tendency to make parks as artificial as possible, although one or two very commendable projects for developing natural parks are

Figure 135. Where in all the artificial surroundings of the conventional park can so inviting a path be found?

in progress locally. A city very often purchases dry hillsides or rugged slopes for park purposes. No sooner is this done than an elaborate water system is installed at enormous expense, and plants entirely foreign to such an environment are grotesquely perched where they must serve a life-long sentence of struggle for existence under conditions entirely adverse to their best development. Perhaps such productions are beautiful. They occur frequently enough. But surely they are far from natural, and do not produce a restful effect upon visitors. They act as a living advertisement of what man can do if he has time, water and ample funds, in sharp contrast to nature's own creations.

Now, why not plant dry hillsides in such a manner that they will produce maximum results at minimum expenditure? Plant a *dry ground park*. Use

Figure 136. A driveway through a grove of native oaks.

native plants already accustomed to the semi-arid conditions of our soil and climate. Such a park would be at once unique and individual; it would be decidedly typical and distinctive of California; it would be a garden spot of nature, a mecca for birds, a plant paradise; it would be a delight alike to the student, the botanist, the sight-seer and nature lover, each in his own way. If properly handled, it would become of world renown both among tourists and botanists; it would be the one place where those interested might go and see a collection of California plant life in its native environment; might study the habits of the individual, and see its fullest development under favorable conditions. There is no limit to the end that might be attained with such a park, if it were properly conducted. A descriptive booklet, obtainable on the grounds, would reveal to

Figure 137. Nature's wild abandon is well worthy, though difficult, of imitation.

all a life history of each plant. And this great possibility lies conveniently near, waiting only for a guiding hand.

Such selection of varieties could be made as to insure continual masses of flower or fruit. Spring would undoubtedly be the most gorgeous season, but by judicious selection and arrangement, a continuous wealth of color might be assured. By proper grouping, wonderful effects could be produced, while seeds of wild flowers sown broadcast among the larger plantings, would, each spring, form a gorgeous carpet of natural weave.

The moving of plants from their native haunts to the garden has not generally proven satisfactory, due probably to the extreme readjustment that becomes necessary. The easiest way is to raise the young plants from seed, thus assuring easy handling of the young stock and giving better opportunity for the proper

Figure 138. This beautiful creation—a credit to its designer—well illustrates the attractiveness of some of the more natural methods.

establishment of the root system. Little trouble is then experienced and success is practically assured. It does not stand to reason that these little seedlings could establish a foothold in dry soil, but if watered when planted, or set out during the rainy season and given a little attention for the first year, they would continue to thrive with the minimum of care, always responding, however, to cultivation of the soil.

Following are enumerated some few of the native trees and shrubs that should prove suitable for a dry ground park. The writer wishes to acknowledge the use of Abram's "Flora of Los Angeles and Vicinity" in his compilation of this list, and to thank Professor C. F. Baker, of Pomona College, for kind suggestions.

Figure 139. The sycamore is ever a picturesque feature of the Southern Californian landscape, with its intricate outline in winter and soft foliage in summer. One would like to tarry here and revel for awhile in the play of lights and shadows.

Adenostoma fasciculatum—Shrub 1-4 m. high, reddish branches and grayish bark. Common in the chaparral belt of our mountains. Flowering from April to June.

Arbutus Menziensii (Madrono)—Commonly 5-10 m. high. Found on Mt. Wilson and Sturtevant trails to 3000 feet, and in Los Tunas canyon of the Santa Ana Mountains.

Arctostaphylos (Manzanita)—Evergreen shrubs or small trees, all producing an abundance of bloom.

Arctostaphylos manzanita—Shrubby or arborescent, 2-8 m. high, bark mahogany red. Found in upper chaparral belt of our mountains.

Figure 140. A view into the Promised Land, a farm in the bosom of the hills, and surrounded by the choicest of "God's Acres."

Arctostaphylos patula—Diffusely branched shrub 1-1.5 m. high. Occasional on dry ridges and in open pine woods of San Antonio and San Bernardino mountains, 5000-8000 feet elevation.

Arctostaphylos tomentosa—Shrubby, erect, 1.5-3 m. high. Common in all our mountains in the upper chaparral belt.

Arctostaphylos glauca—Shrubby, erect, 3-6 m. high. Occasional in San Gabriel mountains, but more common in the San Antonio and San Bernardino ranges.

Arctostaphylos pringlei—Erect, branching shrub, 1.5-2 m. high. Occasional in the pine belt of the San Bernardino, San Jacinto and Cuyamaca mountains.

Figure 141. All the creative genius of man could not improve on some of the scenes along this delightful driveway.

Arctostaphylos bicolor—Shrub 1-2 m. high. Frequent in the foothills of western San Diego County, and also reported from Catalina.

Amorpha californica (Wild Indigo)—Shrub 1-3 m. high. Common in the chaparral belt.

Berberis dictyota—Shrub, 4-12 dm. high, with blue-black berries and attractive flowers. Found on the dry ridges near Glendale, Switzer's Trail and the San Gabriel mountains.

Berberis nevinii—Shrub, 2-3 m. high. Racemes are 4-7 flowered.

Ceanothus (California Lilac)—Common desert shrub with small but very showy flowers, generally fragrant and white, blue or purple.

Ceanothus integerrimus—Tall, loosely branching and sometimes arborescent. Flowers blue, varying to white. Frequent in the pine belt of all our mountains, and in the uppermost portions of the chaparral belt.

Ceanothus spinosus—Tall shrub or somewhat arborescent. Flowers pale blue. Found in the Santa Monica and Santa Ana mountains and north to Santa Barbara, in the canyons.

Ceanothus divaricatus—Shrub 1-2 m. high, flowers pale blue. Very common in the chaparral belt.

Ceanothus tomentosus—Shrub 2-4 m. high, flowers deep blue, or rarely white. Occasional in the chaparral belt of San Gabriel, San Bernardino and Cuyamaca mountains at an elevation of 3000-5000 feet.

Ceanothus sorediatus—Shrubby or somewhat arborescent, 2-4 m. high, flowers deep blue.

Ceanothus hirsutus—Shrubby or arborescent, 3-5 m. high, flowers deep blue to purplish. Frequent in the chaparral belt of the San Gabriel mountains, at an elevation of 2500-4500 feet.

Ceanothus macrocarpus—Shrubby, 2-3 m. high. Frequent in the Santa Monica and Santa Ana mountains.

Ceanothus cuneatus—Much resembles the last, but the branches are more rigid. Occasional along the southern rim of the San Gabriel and San Bernardino ranges.

Ceanothus crassifolius—Shrub 2-3 m. high. Common in the chaparral belt of all our mountains.

Cercocarpus betulaefolia (Mountain Mahogany)—Shrub or small tree, 2-5 m. high. Flowers in March, fruit in July.

Cupressus macrocarpa (Monterey Cypress)—Tall tree attaining a height of 100 feet.

Diplacus glutinosus (Common Yellow Monkey Flower)—Often called *Mimulus glutinosus*, but incorrectly so.

Diplacus longiflorus—Low, 5-10 dm. high. Common on all the foothills and in the chaparral belt.

Diplacus puniceus—Resembles the last in habit, but has scarlet corolla. Common on dry hillsides about San Diego and ranging northward to the Santa Margarita River.

Figure 142. Hesperoyucca whipplei. This is one of our most gorgeous desert plants, whose flower clusters would grandly illuminate a native park.

Eriodictyon californicum (Yerba Santa)—Shrub, 10-20 dm. high. Occasional in the chaparral belt of the San Gabriel mountains. More common on the dry plains east of our ranges, where it extends up to the pine belt. May-August.

Eriodictyon tomentosum—Shrub, 25-35 dm. high. Frequent in the chaparral belt of the San Gabriel and Santa Ana mountains.

Eriodictyon parryi—Stems, 8-18 dm. high. Occasional in the San Gabriel, Santa Ana and San Bernardino mountains, in the upper chaparral and lower pine belt. June-August.

Eriogonum fasciculatum (Wild Buckwheat)—Shrubby, 5 dm. or more high.

Fremontodendron californicum (Slippery Elm)—Branching shrub, or arborescent, 2-7 m. high. Frequent in the upper altitudes of the chaparral belt of our interior regions. June-July.

Garrya veatchii palmeri (Silk Tassel Tree)—Erect, branching shrub, 18-25 dm. high. Frequent in the upper portions of the chaparral belt of the San Antonio and Cuyamaca mountains. January.

Garrya veatchii undulata—Occasional on Mt. Wilson and Mt. Lowe.

Garrya pallida—Santa Ana mountains.

Heteromeles arbutifolia (Christmas Berry)—3-6 m. high. May-June.

Hesperoyucca whipplei (Spanish Bayonet)—Common in the chaparral belt of all our mountains.

Holodiscus discolor—Shrub 1-2 m. high, branches short, rigid, bark grayish brown, more or less shreddy. Sometimes called *Spiraea discolor*. Common in the chaparral belt.

Isomeris arborea—Widely branching shrub, 1-3 m. high, hard yellow branches and puberulent branches, yellow flowers, from February to July. Found along the bluffs and hills of the coast.

Isomeris arborea globosa—Similar to the above but with globose capsules.

Juniperus californica—Shrub, usually much branched. Common on the desert slopes.

Lepidospartum squamatum—Branching shrub, broomlike, 6-12 dm. high. Frequent in the dry washes of the interior valleys. July-October.

Libocedrus decurrens (Incense cedar)—A rather small tree of shapely habit, and great drought resistance.

Lotus glaber (Hosackia)—Tree 5-10 m. high, long yellow flowers, turning reddish. Common on our dry ranges, flowering the year around.

Lyonothamnus floribundus var. *asplenifolius* (Iron-wood)—Medium sized tree of beautiful foliage and great drought resistance. Found on Santa Cruz Island.

Lyonothamnus floribundus (Catalina iron-wood)—Similar to the last, but having a less serrated leaf. Also drought resistant. Native to Catalina Island.

Malvastrum davidsonii—Tall shrub, or arborescent, 2-4 m. high. Found in the San Fernando valley, and the La Canada washes.

Figure 143. The Monterey Cypress on its native heath, showing its appearance in full development.

Malvastrum fasciculatum—Tall shrub, or somewhat arborescent, 2.4 m. high, Common in the lower portions of the chaparral belt.

Mimulus brevipes—3-6 dm. high, corolla yellow. Flowering on our dry foothills from March to June.

Mirabilis californica (Four-o'clock)—3-6 dm. long. March-June.

Penstemon spectabilis—6-12 dm. high. Frequent on the dry hill sides. May-July.

Pinus torreyana (Del Mar or Torrey Pine)—Small tree, 6-10 m. high.

Pinus coulteri (Coulter's Pine)—Middle sized trees.

Pinus monophylla (Nut Pine)—Small tree, 5-8 m. high, with irregularly spreading branches and pale flaky bark. Frequent on the dry desert slopes of the San Gabriel and San Bernardino mountains.

Pinus attenuata—Small tree less than 10 m. high. Found on the southern slope of the San Bernardino mountains at 2500-4000 feet elevation.

Prunus demissa—Shrub, 1-4 m. high. Found in the chaparral and pine belt.

Cerasus ilicifolia (Evergreen Cherry)—Sometimes called *Prunus ilicifolia*. Shrubby or arborescent, 3-6 m. high. Flowering from May to June.

Prosopis juliflora (Mesquit)—Shrub or small tree, common on the Colorado Desert and along the river bottoms near San Bernardino.

Prosopis pubescens (Tornilla or Screw Bean)—Shrub or small tree. River bottoms about San Bernardino, with the last.

Quercus engelmanni—Middle sized tree. Altadena to Monrovia.

Quercus agrifolia (Common Life Oak)—Medium sized tree of spreading habit.

Quercus dumosa (Scrub Oak)—Shrub or small tree. Common in all the chaparral belt.

Quercus wislizeni—Spreading shrub or small tree. Common in the chaparral belt of all our mountains except the Santa Monica range.

Ramona nivea—Shrubby, below 9-12 dm. high. Occasional in the foothills of the Santa Monica and San Bernardino mountains. April-May.

Ramona stachyoides (Black Sage)—Common on the low hills throughout our range. April-June.

Ramona polystachya (White Sage)—Shrubby, below 1 m. high. Very common on the dry plains towards the foothills, and ascending these to about 3000 feet. April-July.

Rhamnus crocea—Low, much branched; flowers reddish. Occasional on the dry plains and in the chaparral belt of our interior regions.

Rhamnus crocea ilicifolia—Shrub, sometimes arborescent, foliage closely resembling *Cerasus ilicifolia*. Common throughout the chaparral belt.

Rhamnus californica (Wild Coffee)—Shrub, sometimes arborescent, 1-4 m. high. Common in the chaparral belt of all our mountains.

Rhus laurina—Shrub 2-4 m. high. Very common. June-July.

Rhus integrifolia—Low evergreen shrub, 1-2 m. high, flowers white or rose colored, drupes very viscid and acid. Bluffs along the sea-shore. February-March.

Rhus ovata—Erect or spreading evergreen shrub, 1.5-3 m. high. Occasional in the chaparral belt. March and April.

Senecio douglasii—Usually about 1 m. high. Common on the dry plains and foothills, mostly below 3000 feet. July-November.

Sphacele calycina wallacei—Shrubby at base, 6-9 dm. high. Occasional on all our mountains, especially in the upper portions of the chaparral belt, on the shady sides. May-June.

Symphoricarpos mollis (Snowberry or Wolfberry)—Low, much branched, about 3 dm. high. Chaparral belt of all our mountains and foothills.

Tetradymia comosa—Branches erect, elongated, 4-8 dm. high. Dry washes of the interior valleys. July-August.

Xylothermia montana—Shrub 1-2 m. high, branches widely spreading.

Yucca arborescens (Joshua-tree)—Large yucca of the Mohave Desert.

Zauschneria californica microphylla (Wild Fuchsia)—Frequent on dry hillsides, mostly below 3000 feet.

In addition to the plants listed above might be mentioned many varieties of the fleshes, such as the Cacti, stone crops, and Mesembrianthemums.

Most of the photographs used in this article were taken near the coast in middle western California, by J. M. Garrison, Palms, California.

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Pomona College Journal of Economic Botany

As Applied to Subtropical Horticulture

Volume Two SEPTEMBER 1912 Number Three

PUBLISHED QUARTERLY BY THE
DEPARTMENT OF BOTANY OF POMONA COLLEGE
CLAREMONT, CAL., U. S. A.

Entered at the Claremont, Cal. Postoffice as second-class matter.

Pomona College Journal of Economic Botany

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Pomona Journal of Economic Botany

Pomona College, Claremont
California, U. S. A.

POMONA COLLEGE JOURNAL
of ECONOMIC BOTANY

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A Stem Rot Disease of Carnations Due to a Species of Fusarium*

CLAYTON J. WIGHT

INTRODUCTION

In August, 1911, Mr. James McDonald of Alameda sent to the University Laboratory of Plant Pathology a diseased carnation plant (*Dianthus caryophyllus* L.) and reported that his plants were dying from some unknown cause. The stem of this diseased plant was placed in a box of moist sand and long curved spores of the Fusarium type developed upon it. This experiment formed the incentive which led to the investigation of the stem rot disease among the carnation growers in the vicinity of Oakland, Berkeley, and Richmond, and to a review of the literature upon the subject. The studies described in this paper have been carried on for the purpose of determining the nature of the disease, its extent, its remedy, and the relation of the disease organism to *Fusarium oxysporum*, a fungus which causes the dry rot of potatoes and is so fully described by Erwin F. Smith and Deane B. Swingle in Bulletin No. 55, of the Bureau of Plant Industry.

HISTORY OF THE "STEM ROT" DISEASE OF CARNATIONS

The carnation stem rot disease has been known among growers for many years, but it was not brought to the attention of plant pathologists until the latter part of the nineties, and comparatively little has been written about it.

In 1897 Wm. C. Sturgis, of the Connecticut Agricultural Experiment Station, observed the disease attacking the variety William Scott, which appeared to be more susceptible than others. He stated that the disease appeared first as a yellowing of the lower leaves and spread until it involved the whole plant. The cause of the disease was determined to be due to a species of *Fusarium* which gains access to the tissues at, or just below, the surface of the soil. The mycelium accumulated in the water ducts of the stem, thus preventing the free transfer of water. It was thought probable that the

*Prepared from Thesis submitted in partial fulfillment of the requirements for the Degree of Bachelor of Science, University of California, May, 1912. The original thesis is preserved in the Department of Agriculture, University of California, and contains two colored plates and other illustrations not included here.

disease could be communicated by cuttings and that the spores of the fungus were capable of retaining their vitality for several months. Sterilization of the soil when convenient, the use of cuttings from sound plants, and the immediate removal of diseased plants from the beds were recommended to prevent attacks of the disease. The Fusarium causing the disease was isolated in pure cultures, but only one form of spore developed, and it was fusiform, pointed at both ends, hyaline, slightly curved, 3-5 septate and measuring 25 u.*-38 u.$\times$3.5 u.-4 u. These spores were borne singly or in small clusters, on the tips or sides of short branches of mycelium and, when seen in mass, they present a pale salmon pink color. A few inoculation experiments were tried. No infections were obtained by injecting Fusarium spores into incisions made on the plant. The inoculations made through the soil were indefinite.

In the same year the disease was brought to the attention of F. W. Card and J. E. Adams, of the Rhode Island Station. In 1898 they performed an experiment with fifteen hundred cuttings of a very susceptible variety (Flora Hill). Cuttings were grown in clean sand and in sand on which carnations had been previously grown. Chemical fertilizers and stable manures were compared, and the effect of dipping cuttings in Bordeaux mixture before planting was tried. The most marked results were obtained in the use of fresh, clean sand. Dipping the cuttings in Bordeaux mixture resulted in considerable loss. The general belief that the stable manure in the soil favors the progress of the disease was not sustained.

A more complete account of the disease and the organism causing it is given by L. Mangin and M. G. Delacroix of the Paris Academy of Science in No. 19, Vol. 129, and No. 23, Vol. 131, of Comptes Rendus.

In the fall of 1899, the disease was reported to be causing considerable damage to the fields of carnations at Nice, Provence, and Antibes. Mr. L. Mangin describes the disease as starting in the young stem and spreading out to the leaves, causing a serious decomposition of the stem, and a wilted and yellowish appearance of the leaves. The roots appear to be healthy. In a microscopical examination of the diseased stems, a large number of organisms were found in the decomposed, brown, and rotted areas, but only one was persistently found in the green tissues. This was a colorless mycelium extremely well developed in the cambium layer, and best observed in a thin longitudinal section of the stem. Parts of affected stems placed in a moist chamber became covered with a white mycelium and formed two varieties of conidia. The larger conidia were fusiform, curved, and often pointed; they are divided by transverse septa from 1-5, but ordinarily 3 in number. Their dimensions vary between 20 u. and 30 u. in length, by 2.5 u.-5 u. in width. The smaller spores were observed in the crevices of the stems and in the white areas of the rotted spots. These conidia were almost cylindrical, slightly curved, and rounded at the ends. They were 5 u.-12 u. in length by 2 u.-3 u. in width, and without septa. Chlamydospores developed in cultures fifty days old. These

*u used by typist for micromillimeters.

were most often formed at the extremity of short, thin, lateral branches of mycelium, but sometimes they were formed sessile on a filament. The mature chlamydospore is distinguished by its roughened surface; it is either white or of a light, yellow, brown color. In cultures exposed to the cold of winter certain mycelium filaments developed an elongated chlamydospore 30 u.-35 u. in length by 18 u. in diameter and with three or four cross septa. These chlamydospores germinated in sixteen hours in distilled water at a temperature of 22° C. In germinating they produced one or perhaps two filaments which perforated the exospore and were covered by the endospore. Very rarely a germinating chlamydospore produced a secondary spore which was round, yellow, thin walled and 9 u.-10 u. in diameter. No further studies of the secondary spores were made. The life of a chlamydospore does not appear to exceed a year. In one culture upon potato eleven months of age, the minority of the chlamydospores germinated. Mr. L. Mangin and Mr. E. Prillieux gave to this imperfect Ascomycete the name *Fusarium dianthi.* Later Mr. L. Mangin made further studies in which he demonstrated the parasitism of several species of Fusarium, including *F. roseolum, F. commutatum, F. roseum, F. aurantiacum, F. oxysporum* and *F. pyrochroum.* He concluded that the Fusarium of the carnation so closely resembled these other species that it should not be given a separate name.

Further observations in the field revealed that the disease was not of an infectious character, for diseased plants were often found isolated among healthy ones. The disease appeared to be a constitutional one, and some horticulturists made the remark that their plants were suffering from tuberculosis. The disease appeared to develop most rapidly at the time when the plant began to flower. In the examination of plants where the disease had just started, Mr. L. Mangin found mycelium bearing conidia in shoots absolutely healthy in appearance. Carnations grown under glass were more subject to infection than those grown in the free air, but plants grown under any condition were more or less subject to the disease.

The ordinary method of propagating the carnation was by means of cuttings and these seemed to be a source for the transmission of the disease. To prevent the spread of the disease in this way only cuttings from healthy plants should be used. In order to recognize these the prepared cuttings may be placed in the holes of a perforated board or metal plate and suspended over a vessel of water in such a way that the base of the cuttings will be two or three centimeters from the surface of the water. At the end of twenty-four hours at a temperature of 50° C., the ends of the diseased cuttings will be covered with a white mycelium, while the healthy ones will not show any infection. But to prevent the growth of any spores which may have lodged upon them, they should be washed in a weak solution of copper sulphate; one or two grams per liter may be used.

Another source of infection was by means of wounds, in which nematodes and spiders had an important part. The discovery of chlamydospores

in the soil, where diseased plants had grown, gave evidence that the fungus was also a soil fungus and might easily enter the plant through a wound. To avoid infection from the soil all diseased plants should be destroyed before the appearance of the conidia, a three-year rotation practiced, or the soil disinfected. The latter method was suggested for small farmers who would not be able to carry out a rotation of crops or for those who grew carnations under glass. Experiments were conducted with carbon bisulphide, sulphate of iron, formaldehyde and naphthol, from which it was found that all, with the exception of the last, would prevent the germination of the spores and the spread of the disease. Sulphate of iron cannot be used in soils containing much calcium carbonate, for it decomposes too quickly and does not kill the chlamydospores. Carbon bisulphide does not act very well in clay soils. Formaldehyde may be used under varying conditions.

FIELD OBSERVATIONS

In making the field observations thirteen nurseries were visited where carnations are being grown on a commercial scale. These nurseries are situated in Elmhurst, Melrose, Berkeley, and Richmond, and are owned by Americans, Germans, Japanese, and Italians. The data obtained largely corroborate that given by Mr. L. Mangin in the foregoing pages. The activity of the disease appears to be directly dependent upon cultural conditions, and it is necessary to have a complete knowledge of the propagation of the carnation in order to understand the relation of the disease to the plant.

The carnation is commonly propagated by means of cuttings. The cuttings are obtained by removing suckers or shoots, three or four inches in length, from mature plants: the base or heel of a cutting is cut off squarely beneath a node, the lower leaves are entirely removed, and the ends of the longer ones are usually clipped. In this locality cuttings are started between the first of January and the first of March; they are rooted by being placed about one inch apart in boxes of sand, and kept in the propagating house until a root system has developed, which is about one month. The cuttings are then transplanted to other boxes or pots containing ordinary soil, where they are set four to six inches apart each way. They are kept under glass until April or May, then they are moved outside, either in boxes or transplanted to the ground, where they remain until moved into the houses used for the production of cut flowers. The final transplanting is done in July or August, and the plants are placed from ten to fourteen inches apart each way. During the colder months the houses are heated by steam; a temperature of 65 degrees to 70 degrees F. is maintained during the day and 45 degrees F. to 55 degrees F. during the night. On very warm days the temperature may rise above 70 degrees F., but the grower makes every effort to keep it below 80 degrees F., by the use of ventilators and overhead irrigation. Carnations will not thrive well

in a hot, humid atmosphere. Each year the growers change the soil in their green-houses so as to secure soil rich in plant food and freer of disease organisms.

The stem-rot disease, which is due to a species of Fusarium, may make an attack at any time during the life of the plant, but it is more serious at certain stages in its propagation, that is, at such times when the plant has to submit to rather sharp changes in conditions of moisture or temperature, thus weakening its natural vitality. There are three such periods in the life of the plant which are well marked. The first and probably the most critical one comes when the plant is "benched," that is, when it is transplanted from the outdoor beds into the green-house. A few warm, cloudy days, on over-moist soil, or too deep setting of the plants are conditions which favor the development of stem-rot. The second critical period comes when the steam heat is turned on in the autumn; again the plants may be subjected to a rather sharp change in temperature. The third and last critical period comes in the spring, when the temperature gets abnormally high and the plant is low in vitality from having been forced during the year in the production of flowers.

As Mr. L. Mangin has observed, the diseased plants are recognized by the wilted, yellowish, drying-up condition of the foliage and a softened condition of the stem at the surface of the ground. In the early stages of the disease the roots and upper portions of the branches are sound, while the intervening portion will show brown and blackened areas. Frequently one or two branches become affected and wilt before the remainder of the plant shows any signs of the disease (Plate 1). However, it eventually spreads upward and downward until the whole plant is in a more or less advanced stage of decay. The roots become thoroughly decomposed and rot off: the stem and its branches become dry and brittle, characteristic of dry rot. Upon a plant where the disease is fairly well advanced, small flesh- or salmon-colored clusters of spores are often found. A microscopical examination of them reveals the presence of the characteristic curved Fusarium macroconidia. A similar examination of the tissue of the affected stems shows the presence of abundant mycelium in the parenchyma cells, although the upper branches and the roots of the plants are apparently in a perfectly healthy condition. The progress of the disease is normally slow, but in an exceptionally warm and moist atmosphere, the disease organism may destroy tissue very rapidly, as pointed out by the descriptions of inoculated plants in another part of this paper. It is probable that some diseased plants continue to produce flowers for months after they are infected. Growers report that some varieties are more susceptible than others, and the following kinds have been mentioned by several as being among the most susceptible:—Enchantress, Prosperity, Winsor, Perfection, and Nelson Fisher.

PLATE I

The method by which the fungus obtains entrance into the plant stem has not been entirely determined, but it doubtless gains entrance through a wound or by first establishing itself upon dead or inactive tissue and then penetrating the living tissue. At every stage in the growth of the carnation there is more or less idle tissue upon it. The cutting in starting its growth develops new leaves from the center, the outer ones remain green for a time and finally die. These outer leaves, if at all moist, afford an excellent means for the entrance of the fungus into the inner tender tissues of the plant. The carnation stem frequently checks, thus forming easy passageways to its interior and deadened areas formed on the margins of the checks may give the fungus a foothold. When the flowers are cut they are not necessarily cut at a node, and if they are not the portion of the stem extending beyond the node dies; in fact, such a stem often dies back to a main branch. All of these dead parts and bruises afford an opportunity for the disease organism to enter the plant. The fungus is undoubtedly parasitic under favorable conditions.

Stems of diseased carnation plants placed in moist chambers rapidly develop tufts of mycelium on their surfaces which originate from filaments which have broken through the epidermis of the stem or from clusters of spores formed on the outside of the stem. These tufts of mycelium are 5-10 mm. high, usually white, but sometimes they are pink or yellow in color. Macroconidia develop in them, and a pure culture could be easily obtained by simply touching one of these tufts with a sterile platinum needle and transferring the spores to a poured plate.

DESCRIPTION OF THE FUNGUS

The mycelium found in diseased plants is colorless, slightly more slender than that grown in cultures, much branched in the parenchyma and with frequent septa. The septa are 5 u. to 10 u. apart and the mycelium varies in width from 3.5 u. to 6 u. No microconidia have ever been found, either borne within the host, or developed in cultures. The fungus was obtained in pure cultures from three different sources: Alameda, Richmond, and Elmhurst. One strain was established from a single spore, this spore was taken from the Elmhurst culture. A careful study of each strain was made in drop cultures of beef extract bouillon (M1). The Van Tieghem cell was used for these studies. The macroconidia germinated in less than twenty-four hours; some germinated from the end cells and some from the central cells of the spore (Plate V, Figures 6 and 7). In forty-eight hours quite a profuse mycelium had formed, and it had grown across drops two and three millimeters in diameter. At the end of seven days the formation of macroconidia began; these were the only variety of spores developed in drop cultures. They were formed most rapidly in places where the mycelium came in contact with the glass outside of the drop; such contact seemed to stimulate the formation of spores. The macroconidia

are formed by being cut off from the ends of hyphal branches. Sometimes a spore is cut off from the end of a terminal branch, but more commonly from the ends of short lateral branches by a constriction furrow. As soon as one macroconidium is cut off, the hypha begins to elongate, pushing past it and soon forming a second constriction furrow, which cuts off a second macroconidium. This process continues until sometimes eight or ten macroconidia are formed from a single branch and lie side by side in a little group. Sometimes the septa are formed in the macroconidia before they are cut off but more frequently afterwards (Plate V. Figures 1, 2, and 3).

The exact time required for the formation of the macroconidia has not been determined, but the process must be very rapid, for hundreds will develop in a single spore drop within two or three days after they have started to form. The macroconidia vary in length from 25 u.-60 u. and in width from 4 u.-5 u. When these conidia are first formed they are cylindrical in shape, rounded at the ends and nearly straight. With age they become much more pointed at the ends and more curved. They are from one to six septate, usually three or four; they are seldom constricted at the septa. Macroconidia formed upon the plant in the open are

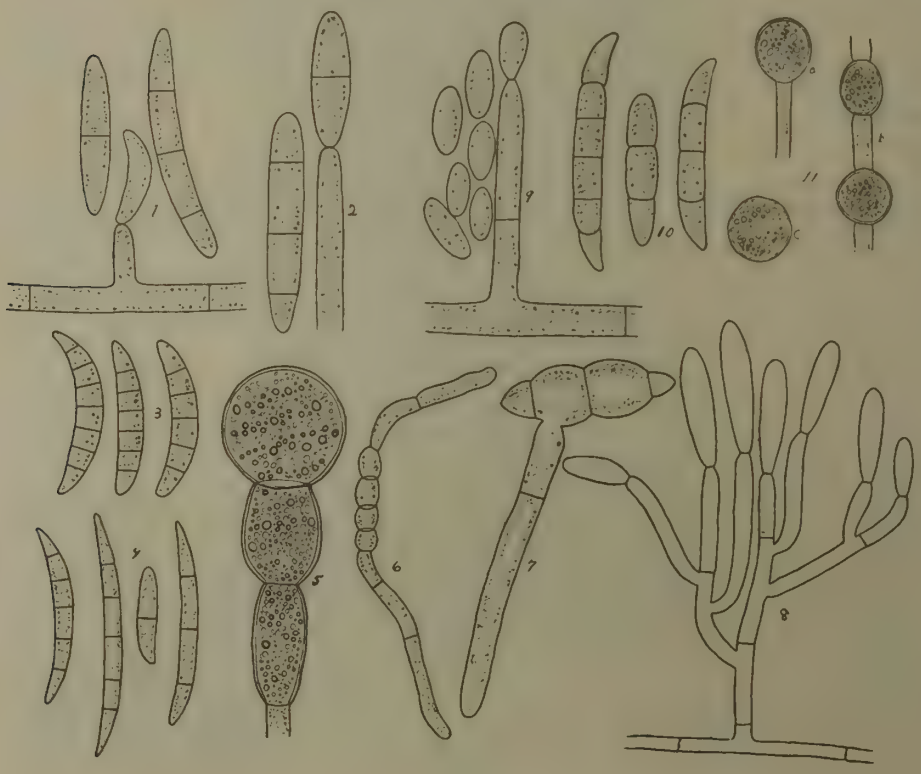


PLATE V

much more slender than those developed in cultures (Plate V. Figure 4).

The chlamydospores are produced as swellings of the mycelium, usually intercalary, and there are often several on the same hypha close together like a string of beads. They are circular or ovate cylindrical and appear to have two walls; those which are ovate cylindrical in shape are sometimes divided by transverse walls. They have a slightly uneven surface and are yellowish brown in color. The size of the spherical ones varies from 10 u. -20 u. in diameter, and the oblong ones from 8 u.-10 u. in diameter by 20 u.-25 u. in length. They were filled with very large granules of protoplasm. (Plate V. Figure 5.) Strain (E) formed an abundance of them in nutrient agar in thirty days.

GROWTH ON DIFFERENT MEDIA

In making a study of the cultural characters the three strains of carnation Fusarium previously mentioned were used, and in addition two strains of potato Fusarium have been studied in parallel cultures, for the purpose of making comparisons between the carnation and potato strains. One of the potato strains was received from Dr. M. T. Cook of the Delaware Experiment Station, and considered by him to be *Fusarium oxysporum;* morphologically it corresponds to the description of *F. oxysporum* given by Erwin F. Smith and Deane B. Swingle in Bulletin No. 55 of the Bureau of Plant Industry, but in cultural habits it differs from the descriptions given, for it has a depressed growth on most media and the *F. oxysporum* described in the bulletin has an aerial growth on most media. The other potato strain was isolated from the stems of diseased potato plants growing in the horticultural garden of the University. All of the cultures of it have originated from a single spore, and in cultural and morphological characters this Fusarium corresponds very closely to *F. oxysporum,* as described in the bulletin mentioned above. Its parasitism has not, however, been satisfactorily confirmed, either by observation in the field or by inoculation experiments. For convenience in describing the cultural characters and the accounts of inoculation experiments with the different strains, symbols will be used. The symbols (R), (E), and (IV) refer to carnation strains obtained from Richmond, Elmhurst, and Alameda, respectively; (H) refers to the potato strain received from Delaware, and (VII) to the potato strain isolated from potato plants in the University garden.

A detailed description of the various culture media used appears in another part of this paper. P. 330. Three kinds of glass vessels were used: 200 c. c. Erlenmeyer flasks, 70 mm. in diameter through their widest part, test tubes 20 mm. in diameter, and petri dishes 90 mm. in diameter. All transfers were made with a sterile platinum needle and the plantings were made as nearly as possible in the center of each container. The cultures were always made in duplicate and often in series of four or six. In almost every instance growth was apparent to the naked eye in forty-eight hours.

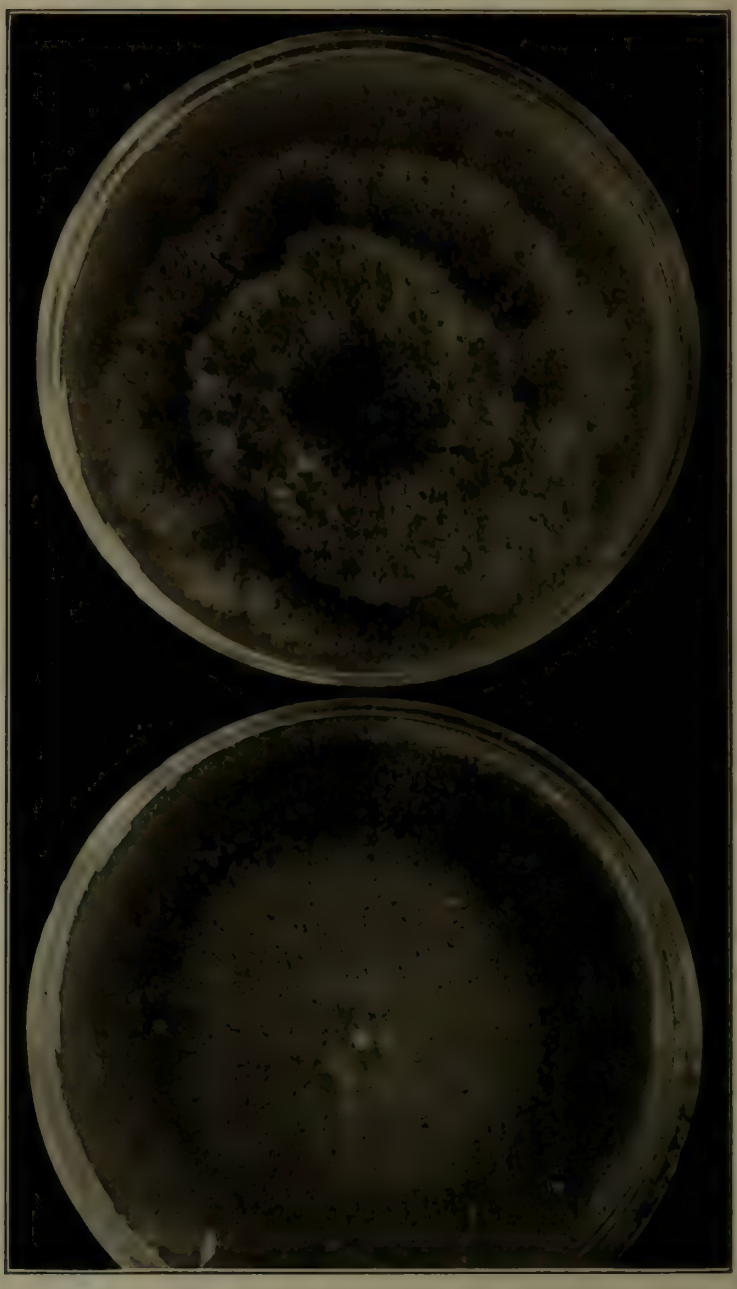


PLATE II. Figures 1 and 2.

PLATE III. Figures 1 and 2.

PLATE IV

Unless otherwise stated the cultures were kept in a glass case in the interior of the laboratory. The descriptions are given for reflected light and a white ground.

Nutrient agar (M4). The descriptions are given for plate cultures. Carnation strains of Fusarium grew vigorously, developing a light cottony growth. A culture normally increased its diameter 10 mm. each 24 hours. Growth was always accompanied by the development of color of varying density. Strain (E) developed color more profusely than the other strains; first a wine red color developed which appeared most intense in the two concentric zones corresponding to the zones of greatest mycelium growth. (Plate II. Figure 2 and Plate IV, e.) Older cultures developed a sulphur yellow color irregularly over the plate. Strain (R) developed the same colors in a less degree, and strain (IV) sometimes produced the red or pink tinges, but usually only a slight yellow coloration was observed. (Plate III. Figures 1 and 2, and Plate IV, b.)

The potato strains grew less rapidly; a culture increased its diameter about 7 mm. per day. A slight yellowish color appeared about the twelfth or fifteenth day. Strain (H) always formed a depressed growth and concentric and radial lines were often prominent. (Plate II, Figure 1.) Strain (VII) always formed a cottony growth about 4 mm. high and sometimes sufficiently uneven to give the effect of concentric rings.

Nutrient agar (M3). Growth of the various strains on this medium closely resembled the growth on (M4), except in color which developed less readily.

Beet agar (M2). The descriptions are given for slant tube cultures. The carnation strains closely resembled each other in growth; each produced a vigorous cottony mycelium, accompanied from the beginning by the development of a wine red color, and in three to five days by the development of a sulphur yellow color. Cultures thirty days old developed a copper green amidst the yellow. A dense pellicle formed on the surface of the slant. This was deep blood red below and shaded into lighter tints of wine red above. The center of the culture was yellow and green, and the aerial growth extending above the tip of the slant remained white. (Plate IV. Figures a, d and e.)

The potato strains differed in their growth. Strain (H) formed a depressed growth, very pale salmon in color, except for a slight cottony growth extending above the upper tip of the slant. (Plate IV. Figure f.) Strain (VII) formed a cottony mycelium about 4 mm. high, slightly rose pink, and a thin pellicle shading from rose pink below to creamy yellow above.

Prune juice and bread (M5). The descriptions are given for flask cultures. Carnation strains were very similar in growth, each producing an even cottony mycelium about 10 mm. high and spreading over the surface of the medium in ten or twelve days. Color developed about the tenth day.

In most cultures the lemon yellow color appeared first, although in some, yellow and red colors developed almost simultaneously. In cultures thirty to forty days old the red tones became more pronounced than the yellow. A thick pellicle formed over the surface of the medium, and wherever it touched the glass its color was very striking, being a deep crimson below and shading into the lighter tints of wine red above.

The potato strains grew only one-half as rapidly as the carnation strains on this medium, and it required about twenty days for a culture to spread over its surface. Strain (VII) developed a dense cottony growth 4-6 mm. high. In a direct north light a rose red color began to appear in ten days; in an interior glass case, the rose red color did not appear until the cultures were thirty days old. No distinctive color developed in cultures kept in darkness. Strain (H) grew depressed or with a cottony growth of a ropy nature. Cultures kept in north light developed a rose red color, but those kept in darkness did not develop any color.

Steamed white corn meal (M6). The descriptions are given for flask cultures. The carnation strains resemble each other in cultural characters on this medium also. In ten days the surface of the medium became covered with a cottony growth 10 mm. in height. The usual wine red color began developing in three or four days, which was followed by the appearance of the lemon yellow tints. The two colors became mingled throughout the culture, and they gradually increased in intensity with age, until reaching a maximum intensity in cultures thirty days old. Numerous rich salmon-colored bodies developed in cultures of that age. A thick wine red pellicle formed over the surface of the medium. In places the mycelium penetrated beneath the pellicle between the glass and the medium, and it is probable that the mycelium is capable of penetrating all through the substratum.

The potato strains grew less rapidly, requiring twice as much time for a culture to spread over the medium. The growth of strain (VII) was dense, cottony, and 5-7 mm. high; no coloration could be detected until the cultures were twenty-five days old, then a faint rose pink color appeared which developed slowly. A thin pellicle formed at the surface of the medium, and no mycelium had penetrated any part of the substratum in cultures sixty days old. The growth of strain (H) was mostly depressed, the little cottony growth that appeared was of a ropy character. A deep lilac color developed from the beginning which later became overspread with a yellowish brown, but if any secondary growth developed the lilac color again appeared. In cultures thirty to forty days old the surface stratum became wrinkled and the mycelium did not penetrate the substratum.

Steamed rice (M7). The descriptions are given for 200 c. c. flasks. The carnation strains all grew vigorously on this medium, developing a cottony growth 10 mm. high, and particularly delicate colors. Strains (E) and (R) began developing a lemon yellow color and strain (IV) a wine red color in three days. A few days later all strains developed both colors;

strains (IV) and (R) developed them in equal intensity, but in strain (E) the pink was scarcely noticeable. This difference in the formation of color gave the (E) strain a distinctly different appearance from the other two.

The potato strains grew more slowly than the carnation strains. Strain (VII) produced a dense cottony growth about 4 mm. high and began forming a rose pink color in twenty-five days, but this color did not become very intense even in cultures sixty days old. The growth of strain (H) was mostly depressed, the ropy cottony character appeared only in the secondary growth. The first growth was accompanied by the development of an intense lilac color, which later faded to a pale salmon. A pellicle formed over the surface stratum and folded itself about the rice kernels in such a way as to give the culture a very wrinkled appearance. The mycelium filaments of both potato and carnation strains penetrated the substratum and developed their characteristic colors.

Steamed potato plugs (M8). The carnation strains developed a vigorous cottony growth covering the entire plug of each culture in seven days. The usual wine red color appeared the fourth or fifth day, being densest in the pellicle covering the plug and shading to lighter tones in the aerial growth. A sulphur yellow color began developing in twelve to fifteen days and various shades of green appeared in cultures about fifty days old. The colors developed in darkness as readily as in light. The mycelial filaments often extended 20-25 mm. above the tip of the plug, but were without color.

The potato strains grew more slowly, and the cottony growth did not attain such a height as in the carnation cultures. Both strains formed a dense even growth 4-6 mm. high. A rose pink color appeared in eight to ten days in cultures kept in a north window; this color increased in density until it became a rich salmon. Small green sclerotia were observed in a culture of strain (VII) fifty days old. No appreciable color developed in darkness. Both the potato and carnation strains were capable of penetrating through the plugs.

Steamed beet plugs (M9). The growth of the different strains on this medium was very similar to the growth of the respective strains on steamed potato plugs. The carnation strains developed color a little more rapidly and with a little greater intensity. The potato strains did not grow so well; strain (VII) was less dense and only 2-3 mm. high, and strain (H) was always depressed or in ropy masses.

Raw potato plugs (M10). Only one carnation strain and one potato strain were grown upon this medium. The growth of each was very similar to the growth of the respective strains on steamed plugs. The same colors developed in both light and darkness. Strain (H) grew less rapidly than on steamed plugs, but developed color equally well. It should be noted that the method used in preparing these plugs probably killed many of the surface cells of the potato, thus facilitating the growth of the fungi.

General culture characters. No disagreeable odor developed in any of the cultures; whenever any odor could be detected, it was of a pleasant rather than of a disagreeable nature. Some coloration appeared in all cultures kept in the light. All cultures formed spores; they were most abundant in old cultures or in cultures with little available food. Very few chlamydospores formed in the flask cultures.

COMPARISON OF THE CARNATION AND POTATO STRAINS

The description of the cultural characters for the different media have shown that the carnation Fusarium is a much more vigorous grower than the potato Fusarium, producing a stronger stroma, a higher aerial mycelium and also in producing a distinctive yellow color differing from any which appeared in the potato Fusarium cultures. A morphological difference occurs in the spores. The carnation strains develop very few conidia which could be classified as microconidia. The four- to six-celled curved macroconidia is the type universally found. On the other hand the potato strains develop oblong to cylindrical microconidia in great abundance, and comparatively few of the true Fusarium macroconidia. The potato and carnation strains form chlamydospores differing greatly in appearance. The carnation strains form large yellowish brown chlamydospores 10 u.-20 u. in diameter; some are spherical, others are oblong and divided by transverse walls. All contain very large granules of protoplasm. The potato strains form light brown chlamydospores, most of which are spherical and only 6 u.-12 u. in diameter. They are filled with much smaller granules of protoplasm and all are one-celled. (Plate V. Figures 5 and 11, a, b, c.)

CULTURE MEDIA USED

The composition of the different cultural media used in the studies of the various species of Fusarium fungi are given in the following descriptions.

Beef extract bouillon (M1). This medium consisted of the following materials:

Peptone	1%— 5 grams
Beef extract	0.5%—2.5 grams
Common salt	0.5%—2.5 grams
Distilled water	500 c. c.

These ingredients were dissolved in nearly the full amount of water, boiled a few minutes, enough distilled water added to make the total 500 c. c., and filtered twice through absorbent cotton.

Sugar beet agar (M2). A large, sound sugar beet was thoroughly scrubbed, washed in distilled water, pared, and cut up in fine pieces. To 400 grams of beet was added 1000 c. c. of distilled water, and the whole was heated until the pieces of beet could be easily crushed into a pulp, then filtered through a clean towel. Four grams of thread agar were dissolved and added to the beet liquid with enough distilled water to bring the total up to 800 c. c. The medium was then filtered through absorbent cotton,

heated in the steam sterilizer for one hour, and sterilized for thirty minutes on three successive days.

Nutrient agar (M3.) This medium consisted of the following materials:

Agar-agar	1.2%—3 grams
Peptone	1.0%—2.5 grams
Salt	0.5%—1.25 grams
Beef extract	0.5%—1.25 grams
Distilled water	250 c. c.

Thread agar was soaked in tap water for thirty minutes, washed in distilled water and boiled in nearly the full amount of water until thoroughly dissolved. The other ingredients were then added, the whole made up to 250 c. c. with distilled water, filtered through absorbent cotton, and sterilized for twenty minutes on three successive days.

Nutrient agar (M4). This medium consisted of the same materials as (M3), prepared in the same manner except 1.25 grams of dextrose was used in place of 1.25 grams of beef extract.

Prune juice and bread (M5). Seventy grams of dried prunes were washed carefully in tap water, rinsed in distilled water and cooked slowly in distilled water until the prunes were thoroughly softened. The fleshy part of the prunes was mashed into a pulp, enough distilled water added to bring the total up to 500 c. c., strained through a clean towel and the liquid filtered through absorbent cotton. About 25 c. c. of this liquid was put into each 200 c. c. flask and sufficient bread crumbs added to soak up the liquid. The flasks were sterilized for twenty minutes on three successive days.

Steamed white corn meal (M6). Ten grams of meal and 35 c. c. of distilled water were used for each 200 c. c. flask. This medium was sterilized for thirty minutes on three successive days.

Steamed rice (M7). Ten grams of rice and 40 c. c. of distilled water were used for each 200 c. c. flask. This medium was sterilized for thirty minutes on three successive days.

Steamed potato plugs (M8). Large, sound potatoes were thoroughly scrubbed, washed and cut into cylinders about 1½ inches long and one-half inch in diameter with a large cork borer. These cylinders were cut lengthwise diagonally, thus each cylinder made two plugs with slant surfaces. These plugs were washed in running water twelve hours, rinsed twice in distilled water and sterilized for twenty minutes on three successive days.

Raw potato plugs (M9). These plugs were prepared in the same manner as the steamed plugs, except they were washed in 4% formalin solution, rinsed several times in distilled water and not sterilized.

Steamed beet plugs (M10). A large, sound beet was thoroughly scrubbed, washed and prepared in the same manner as the steamed potato plugs, but not washed in running water.

INOCULATION EXPERIMENTS

These experiments were carried on in order to determine the parasitic nature of the different strains of Fusarium studied; and to determine if strains isolated from the carnation were capable of producing disease in the potato, and vice versa to determine if potato strains were capable of producing disease in the carnation. The plants used in the experiments were kept in one of the University of California greenhouses, and unless otherwise stated, they were given ordinary treatment. Two methods of inoculation have been tried. The first consisted in simply burying pure cultures of the strain under investigation in the soil, and in contact with the stem of the plant. The second consisted in making a narrow slit, with a sterile knife, in the stem of the plant, even with the surface of the ground, placing the spores and mycelium of a pure culture in it, and sealing the wound with paraffin. The details of each experiment follow:—

February 5th—Two Prosperity carnation plants, about six weeks old, were inoculated by the first method. One plant was inoculated with a pure culture of strain (IV) and the other with a pure culture of strain (VII). Neither plant became infected with the disease. Two other plants of the same variety were kept under similar conditions for control.

February 21st—Two Enchantress carnation plants, twelve weeks old, were inoculated with strains (IV) and (VII), respectively, by means of the "slit" method. In eleven days the plant inoculated with strain (IV) wilted, its foliage had a yellowish cast, and its stem was affected with the disease. An examination of the stem beneath the paraffin revealed the presence of freshly developed spores and mycelium. The plant inoculated with strain (VII) remained normal. Two plants of the same variety were used for control and given the same treatment, except that their stems were not cut and sealed with paraffin.

February 21st—Three carnation plants of the Estelle variety, about one year of age, were inoculated with pure cultures of strains (IV), (VII), and (H), respectively, by the "slit" method. These inoculations were not successful.

March 7th—An Enchantress carnation, about one year of age, was inoculated with a pure culture of strain (R) by the "slit" method. The progress of the disease in this plant was slow, and no signs of injury were noticed until April 5th, then the lower branches became yellowish and one side of the stem was affected with a dry rot. On April 15th the plant, although it was not dead, was removed from its pot and a microscopical examination made of the diseased tissues of the stem. One-half of the stem was decayed at the point of infection, and, with the exception of a slender brown streak, consisting of broken-down parenchyma tissue, the decay extended only about one and one-fourth inches above and below this point. An abundance of mycelium could be observed in cross sections of the decayed and partially-decayed areas. Segments of the affected stem

placed in a moist chamber developed from their ends a profuse white mycelium bearing Fusarium macroconidia. Another plant of the same variety was used for control; it was given the same treatment except for the slit and paraffin seal. It did not become diseased.

March 7th—Two Enchantress carnation plants, fourteen weeks of age, were inoculated with pure cultures of strain (R) by the "slit" method. The pots containing these plants were placed in larger pots and covered with window glass, thus providing a more humid atmosphere for the development of the fungus. Within four weeks one of the plants became seriously diseased, an abundance of flesh-colored clusters of spores developed on the outside of the stem and mycelium was found in the tissues. The other plant became infested with various organisms, and no definite result was obtained. Control plants kept under the same conditions did not become diseased.

March 3rd—A one-year-old Enchantress carnation plant was inoculated with a pure culture of the (R) strain by the "slit" method and kept under a bell jar. On April 2nd the lower branches of the plant became wilted and pale yellow in appearance. On April 5th the entire foliage of the plant presented a wilted yellowish appearance, very characteristic of the stem-rot or wilt disease. Its stem, for a distance of one inch above and below the point of infection, was thoroughly decomposed. An examination of a cross-section of the diseased portion showed the presence of abundant mycelium and for the first time Fusarium macroconidia were found borne in the living cells. This stem also contained a small brown streak of broken-down parenchyma cells, extending above the zone containing mycelium. The continued presence of such brown areas without mycelium in both artificially and naturally diseased plants seems to indicate that the plant tissue is destroyed in some way in advance of the mycelium. Segments of the diseased stem of this plant, placed in a moist chamber, developed a profuse white mycelium at their ends also. A plant of the same variety and receiving exactly the same treatment, except for the inoculation, did not become diseased.

April 3rd—Two Prosperity carnation plants, about twelve weeks old, were inoculated with strains (IV) and (VII), respectively, by putting an abundance of the pure culture material into the soil and in contact with the stems of the plants. These plants were kept under bell jars and control plants were kept under similar conditions. These plants gave no indications of disease on May 1st.

April 3rd—Three potato plants, which were just beginning to form potatoes, were inoculated with strains (IV), (VII) and (H), respectively, by the "slit and paraffin" method. Each pot contained two plants, one being used for a control. These plants were kept under bell jars. These inoculations were not successful.

March 4th—Inoculation of mature, sound potatoes. These potatoes were prepared by being thoroughly scrubbed in tap water, washed in a four per cent solution of formalin, rinsed several times in distilled water, placed in sterile glass chambers and kept one week before being inoculated. Three chambers were prepared in this way and inoculated with strains (R), (VII), and (H) respectively, by means of an incision in the potato. The potatoes were examined April 20th. The fungus grew in each instance, but none of the strains were able to penetrate the potato any appreciable distance.

REMEDIAL MEASURES

The field observations have shown that the carnation stem-rot disease is not serious, probably not more than one-half of one per cent, or one per cent loss occurs from it; yet almost every grower who has been growing carnations for ten or fifteen years remembers a time when the disease was of a serious nature. A reason for the lesser activity of the disease has not been determined, but it is probable that more resistant varieties are now grown and that the methods of culture have been improved. At present the control of the disease can almost entirely be obtained by observing the most improved cultural methods. Many of the suggestions given here are those practiced by the most intelligent growers in this vicinity. They are simple and do not involve any extra expense in their application. Always select vigorous cuttings from thrifty, healthy plants. Use a sharp knife in preparing the cutting, in order to secure clean cuts; carefully remove all leaves from that portion of the cutting, which, when planted, comes in contact with the soil. Do not use the same soil more than one season. A change of soil is not only a preventive measure against disease, but favors the growth of a more vigorous and productive plant. Avoid, as far as possible, sudden changes in temperatures and moisture, particularly high temperatures and extreme dampness. Provide for a free circulation of air about the plants. When transplanting, be careful not to injure the plants and do not set them too deep, i. e., do not allow any part of the stem to come in contact with the soil which was not formerly in contact with it. Irrigate the beds in the morning, in order that the leaves of the plants and the surface soil may become dry before night. When infected plants are observed, remove them from the beds and destroy them. Grow the varieties which experience in a given locality or soil has shown to be the most resistant, provided such varieties meet the demands of the market. The disease is not serious enough to warrant the selection of a variety which is not of the best market type. The grower who observes these simple but essential rules in culture need not fear any serious trouble with the stem-rot disease.

SUMMARY

1. The carnation Fusarium differs in cultural and morphological characters from *Fusarium oxysporum.*

a. It does not form microconidia, its chlamydospores are more deeply colored, and twice as large as those of *F. oxysporum.*

b. It is a more vigorous grower than *F. oxysporum* and in cultures a distinct yellow color appeared which did not appear in cultures of *F. oxysporum.*

2. This fungus is capable of invading a carnation plant through a wound and causing disease.

3. This fungus is not likely to cause injury to a sound plant through soil infection.

4. It is evident that the infected plant dies as a result of the invasion of the fungus, but not from having its water ducts clogged by the mycelium.

5. The disease of carnation stem-rot or wilt is widely distributed in this vicinity but not serious.

6. The disease may be adequately controlled by the application of the proper cultural methods.

a. Use only cuttings from healthy plants.

b. Change the soil in which the plants are grown each year.

c. Guard against extreme heat and moisture conditions.

d. Be careful not to injure the plant when transplanting it.

BIBLIOGRAPHY

Britton, W. E.: American Florist, Vol. 14 (1898); No. 545, pp. 431-432.

Britton, W. E.: Gardening, Vol. 7 (1899), No. 153, p. 138.

Card, F. W. and Adams, G. E., Rhode Island Report:
1899, p. 131-135—Extract E. S. R., Vol. 12, p. 763;
1900, p. 249-251—Extract E. S. R., Vol. 12. p. 966;
1901, p. 233-234—Extract E. S. R., Vol. 13, p. 763.

Scribners, Vol. 19, p. 313.

Current Literature, Vol. 29, p. 214.

Current Literature, Vol. 37, p. 478.

Stone, G. E., and Smith, R. E.: Mass. Reports for 1901, pp. 66-69.
Extract E. S. R., Vol. 14, p. 157.

Sturgis, W. C.: Conn. State Station Report (1897), pp. 175-181.
Extract E. S. R., Vol. X, p. 262.

Stewart, F. C.: Botanical Gazette. No. 27 (1899), No. 2, pp. 129-130.
Same E. S. R., Vol. X, pp. 1054-1055.

Duggar, B. M., Text: Fungous Diseases of Plants, p. 321.

Atkinson, Geo. F.: American Florist, 8; pp. 720-728 (1893).

Mangin, L.: Comptes Rendus, Academy Science, Paris, Vol. 121 (1900), pp. 1244-1246.
Extract E. S. R., Vol. 13, p. 154.

Description of Plates

PLATE I. Carnation plant in which the shoots on the right appear healthy, and those on the left are affected by the Fusarium disease, showing difference in the condition of the affected part, particularly in the appearance of the leaves.

PLATE II. Photographs of poured plate cultures twelve days old growing on nutrient agar (M4). Natural size. Fig 1, Culture of Fusarium oxysporum strain (H). The mycelium is depressed and slightly yellow in appearance. Fig 2, Culture of Fusarium (E) isolated from a diseased carnation. The concentric zone effect is due to the different degrees of density and height of the aerial growth. The mycelium corresponding to the inner light zone is purple (Saccardo Chromotoxia).

PLATE III. Photographs of poured plate cultures twelve days old growing on nutrient agar (M4). Natural size. Fig 1, Culture of Fusarium (R) isolated from a diseased carnation. The growth is cottony and has a very slight pink coloration in the central part of the plate. Fig 2, Culture of Fusarium (IV) isolated from a diseased carnation. The growth is cottony and has a slight yellowish tinge.

PLATE IV. Photographs of tube cultures twenty-three days of age. Tubes a, d, e, and f are growing on beet agar (M2). Tubes b and c are growing on nutrient agar (M4). Natural size. The tubes labeled (IV), (R3), (E3), and (E2) represent different strains of carnation Fusarium. The tube labeled (H) is a culture of F. oxysporum. All the strains from the carnation show a vigorous aerial growth and an abundance of color. The clearly defined pellicle at the surface of the slant is due to a deep wine-red coloration of the medium. This color shades into a lighter pink immediately above, but the central parts of the cultures have a sulphur yellow coloration and the upper portions remain white. The tube containing the F. oxysporum culture shows a depressed growth and a very pale salmon coloration in all parts except in the slight growth extending above the upper point of the slant; this is cottony and white.

PLATE V. Drawings to show various stages in the development of the Fusarium fungus.

Figures 1-8 represent various stages in the development of the carnation Fusarium. Figure 1, Macroconidia being cut off from a short lateral hypha. X1000. Figure 2, Macroconidia being cut off from a terminal hypha. X1000. Figure 3, Typical macroconidia developed in cultures on rice. Length 40 u., diameter 5 u.-7 u. X500. Figure 4, Typical macroconidia taken from a cluster of spores that developed on the stem of a diseased carnation in the field. Length 25 u.-60 u., diameter 4 u.-5 u. Their most common length is 35 u.-50 u. X500. Figure 5, A typical chlamydospore formed by the terminal swelling of a hypha. X1000. Figure 6, A germinating macroconidium forty-eight hours old. X500. Figure 7, A germinating macroconidium twenty-four hours old. X1000. Figure 8, A simple sporodochium showing the formation of spores. X500. Figures 9-11, Drawings to represent various stages in the development of the potato Fusarium. Figure 9, Microconidia being formed on a short lateral hypha. They vary in size from 5 u.-10 u. in length by 2.4 u.-3.4 u. in diameter. X1000. Figure 10, Typical macroconidia formed in a culture on potato; they vary from 15 u.-35 u. in length by 3.2 u.-5 u. in diameter. They are commonly 20 u.-30 u. in length. X1000. The constrictions at the septa are often conspicuous. Figure 11, a, Chlamydospore produced by a terminal swelling of a hypha. b, Chlamydospores produced by intercalary swellings of the hypha. c, A mature chlamydospore. X1000. The chlamydospores are usually 10 u.-12 u. in diameter.

The Botanic Garden of Oaxaca, Mexico*

By Prof. C. Conzatti, Director Oaxaca de Juarez, Mexico

Located on the grounds of the Agricultural Experiment Station, which was recently established in the State of Oaxaca, the Botanic Garden was started at the beginning of the year 1910. It did not, however, obtain official recognition until somewhat later, when the very moderate appropriation of $3,328.00 (Mexican) was granted by the government to defray the expenses of preparing the grounds, etc.

When I was appointed to organize and to manage the new Botanic Garden, my first step was to select, in perfect harmony with the direction of the Agricultural Experiment Station, the ground which seemed most appropriate. I chose the depression along the eastern side of the railway line, which runs through the station lands from north to south. This plot is of very good quality and is easy of access.

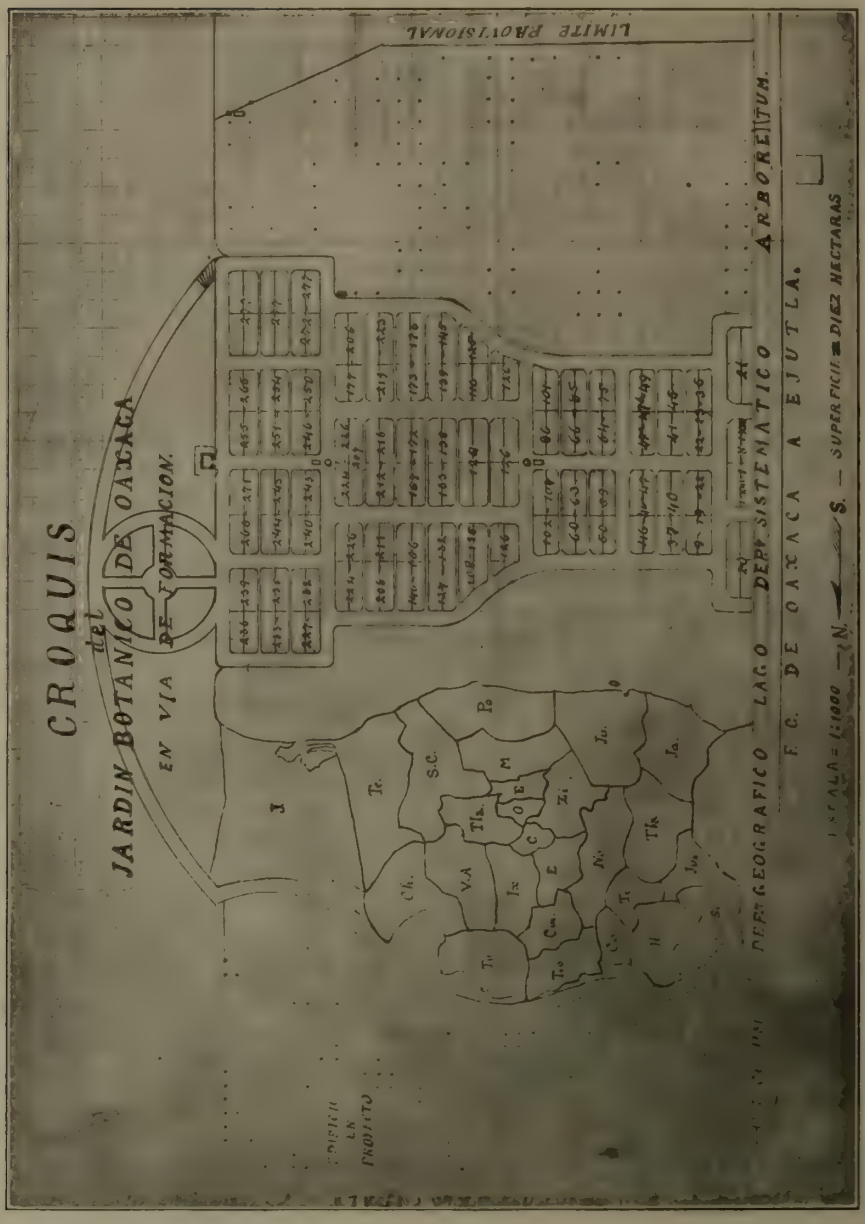
I must confess that the preliminary work of grading and putting the ground into proper condition was a remarkably difficult undertaking, the more so that during the first nine or ten months the only help I could have was seven or eight ordinary laborers (peones). For this reason, as well as for other troublesome circumstances, the garden is not yet in a position to furnish scientific material to the various educational institutions, or live plants to the public gardens of the near-by capital of the state, but I am sure that it will soon become able to do so.

The ground selected is in the shape of an almost perfect quadrangle, and covers an area of about 10 hectares (25 acres), there being the possibility of increasing this area, when needed, both on the eastern and on the southern side, but not on the two other sides, one of which is limited by the right-of-way of the Oaxaca-Ejutla Railway, and the other by the main avenue, which leads to the central building of the Agricultural Station.

This appears to be the second attempt in Mexico to launch an institution of this kind, which meets much favor in other countries, though it does not obtain much consideration in ours. The very first attempt was the establishment of a botanic garden at Guadalajara, which, since 1889, has had the good fortune of being promoted and protected by the illustrious Mexican scientist, Ign. D. Mariano Barcena, who was at that time the governor of the State of Jalisco.

It is certain, beyond all doubt, that the permanent establishment of a botanic garden in Mexico will be susceptible of a supremely ideal development, in view of the inexhaustible wealth of our national flora, the vast area of the republic, and the wide differentiation of climates characterizing it. That our central government must take positive and effectual interest

* Translation by Dr. F. Franceschi, Santa Barbara, Cal.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del
JARDIN BOTANICO DE OAXACA
EN VIA DE FORMACION.
LIMITE PROVISIONAL
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DEPT. GEOGRAFICO
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in the institution of botanic gardens is now made imperative by the incontestable progress of civilization in Mexico. In fact, all countries most advanced in civilization number their botanic gardens by the dozens. How does this happen? It must be acknowledged that the botanic garden is an institution of highly progressive and civilizing influence. If it were not so, the oldest leading civilized nations—Italy, France, England and Germany—would not devote so much care to them. Furthermore, not very deep thought is required to perceive that the botanic garden is the most efficient auxiliary of general agriculture on account of its great variety of cultures, and on account of the multiplicity of experiments which it makes possible. In the same way, no one will deny that the botanic garden will furnish the best means for the practical study of the biology of plants, with the priceless material for demonstration that it supplies. At the same time, without doubt, our botanic garden will become more and more a powerful incentive to the public to visit and take interest in the Agricultural Station. This will make more urgent the contemplated construction of about three kilometers of road between the capital of the state and the Agricultural Station.

The appropriation for the new institution being very limited, it was necessary for me to put aside all ideas of greatness, and of "showing off," to stick to the vital points, and to supplement, as far as possible, the insufficiency of labor with my personal and continuous superintendence, for the best advancement of the work.

I am proud to say that, from my point of view, nothing has been overlooked. The main object is to display, in a methodical manner, the greatest possible number of botanical species, preference being given to the native Mexican. The preparation of material for our educational institutions, and the laying of the foundation for a resort of instruction and recreation for the general public have also been taken into account.

With these objects in view it became necessary to divide the garden into different sections. as they are outlined in the sketch published herewith. The most prominent section is, of course, that of the systematic department, occupying the central part of the garden, and having the shape of a gigantic cup or bowl. This is subdivided into forty-five large squares of almost uniform area, on which the 277 families or orders of phanerogamous plants are distributed. according to the "Syllabus" of Engler, which, as I consider it the most perfect and modern classification of plants, I have adopted for the arrangement of the entire garden.

In each square, by setting plants two meters and a half apart, the number averages 48, thus making a total of 2,160 specimens for the whole section. It must be remarked, however, that from this section all annual and all arborescent species are intentionally excluded, and that it contains only perennial plants of small or of medium size. The reason of such exclusion is obvious. If regular trees were mixed together, their shade and their powerful system of roots would impair and even destroy the growth

of smaller plants. Annuals, on the other hand, after a short cycle of life, would disappear, and leave unpleasant vacancies in the beds.

In this systematic department, all plants are arranged strictly in accordance with their affinities, the three lower squares being occupied by vascular cryptogams, Cyperaceae, Graminaceae, Palmaceae and Cycadaceae. The six squares that follow comprise the balance of the monocotyledonous plants up to family 49. Dicotyledonous plants start with the fiftieth family, their subdivision Polypetalae taking 24 squares, up to family 226. The remaining 50 squares (family 227 to 277) are occupied by the subdivision Gamopetalae, which, according to the latest scientific views, are endowed with most perfect organization.

Including roads and paths between the beds, this department covers an area slightly inferior to two hectares (about five acres). Two wells have been dug along the central road, which runs from east to west, and supply all needs of irrigation. On the upper end of the systematic department, there is a miserable shanty which affords some protection to the laborers during stormy weather. All around this were sown seeds of various climbing plants, belonging mostly to the genera Maurandia, Tecoma, Bignonia, Distictis, Pithecoctenium, Gouania, and Passiflora.

Parallel to the main avenue of the station, on the northern side of the grounds, lies the fruticetum, the section which must receive the subarborescent flora of all countries, preference always being given to the native Mexican. Here the plan is to arrange, in a methodical order, species of shrubs or small trees, at a distance of five meters from each other. There are about 100 species planted already, the names of which I shall omit for the sake of brevity; and also because I hope to be able to issue, within a short time, a complete catalogue of all plants already in cultivation in this new botanic garden.

This fruticetum has an area of about one hectare and a half (3¾ acres), and will contain some 535 specimens, making a most interesting collection. At the northwestern corner, on rising ground, it is planned to build a small propagating house, as well as rooms for the herbarium and for a small reference library; also a place for tools and storage. Adjoining the above, a small conservatory will also be built for such plants as are essentially tropical, and for those which require a good deal of shade and moisture. The watering of this department will be easily provided by a pump, run by a small aermotor.

The arboretum occupies all the southern part of the garden, being particularly sheltered by a series of low hills which run from east to west. It covers an area of 3½ hectares (8¼ acres), upon which trees will be planted 7½ feet apart. Trees of all countries will be set here, preference being given to those of the American continent, and more especially to those which are natives of Mexico. The black dots on the adjoined plan mark the species already set out, which are distributed according to methodical

order of affinities, that is, from palms, conifers, etc., at the base up to Sapotaceae, Bignoniaceae, etc., at the top. About 700 species will find place here.

In a small enclosure of about 100 square meters, and well sheltered by groves of native shrubbery, the apiary of the Experiment, Station was recently installed, quite appropriately, in view of the mutual interdependence of bees and flowers.

It remains for me to illustrate the geographical department, which reproduces in its main lines the political map of the State of Oaxaca. It is my most intense desire to make known as well and as completely as possible the vegetal wealth which is typical of our state. As far as botanic science is concerned, it is safe to say that the State of Oaxaca has been but scantily explored. When, to this circumstance, is added the wide expanse of its area, and the great variability of its climate, owing to its very high ranges of mountains, and deeply sunken valleys, with corresponding, widely diverging extremes of atmospheric pressure, this country cannot help being a particularly interesting botanical region. In this geographical department there are represented already the most prominent features of our native flora.

The extreme eastern side corresponds to the district of Juchitan, and offers a collection of 108 species of Cactaceæ, mostly of the genus Opuntia, with representatives also of Cereus, Echinocactus, and Mammillaria, which are so plentiful in that region of the isthmus.

The extreme northwestern side, corresponding to the district of Huajuapan de Leon and of Silacayoapan, displays already a small collection of Agave, Beaucarnea, Hechtia and Yucca. This is sure to be much increased.

From the central districts the most characteristic conifers of our state, Abies religiosa, Pinus montezumæ, Juniperus flaccida, etc., will be represented, the nucleus consisting of a fine specimen of Taxodium mucronatum, planted on July 1st, 1910, and raised from seed which I gathered myself on the colossal and historic "sabino" of Santa Maria del Tule.

From the southern coast districts of Tehuantepec, San Carlos, Pochutla, Juquila, and Jamiltepec, the most conspicuous palms and cycads of our state will be represented, nearly all belonging to the genera Acrocomia, Chamaedorea, Zamia, Dioon and Ceratozamia.

In this same department, room will be reserved for special groups of economic and of morphological interest, to be set out in due time.

I must not fail to mention the lake for the proper cultivation of aquatic plants, which will be supplied with running water from the Rio de San Antonio, by means of an electric pump.

The Culture of Citrus Fruits, Dates, and Other Crops in the Coachella, Imperial and Yuma Districts*

R. D. CORNELL

But few of the farms and orchards of the Coachella, Imperial, and Yuma districts have really been cared for in a scientific manner, have been made to produce all that could be expected of them under the most favorable management. Cultivation seems generally to have been neglected. The conditions of temperature and soil are such that by merely planting and watering the crop or orchard, it produces far in excess of most localities where much more careful attention is given to tillage and fertilization.

In the Coachella Valley, the soil is generally light, and care must be taken in the selection of land, that it is not too sandy and light for the best growing of crops. Alkali is general throughout the valley, and should always be avoided.

In the Imperial Valley the soils are divided into three types; soft, medium, and heavy. The soft soil is undoubtedly the best for orchard and farm work, as it consists of a light sandy loam, easily worked and handled. The heavy soil is of a stiff, clayey nature and will grow only a fraction of the crop that can be raised on the soft soil. It is very difficult to till, and causes constant trouble in cultivating after irrigation. The medium soil is a compromise between the other two in quality, ease of tillage, and productivity. Alkali and salt are found throughout the valley in varying quantities and should be avoided.

At Yuma are the mesa lands and the bottom lands. Here, both soils vary somewhat, the light soil being generally the best. On the river bottoms is to be found a silt loam, rich and medium soft. Salts and alkali vary from nothing up to one per cent.

CITRUS FRUITS

In no place visited in the three valleys was there any indication of scale or pest on the citrus trees. Gum disease, due to improper handling, was the only apparent ailment, and this had been overcome in most instances. The trees were all hardy and thrifty in appearance, and generally of good color. In no instance had the trees received proper care as to

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*This article was written by Mr. Ralph D. Cornell, landscape gardener, as the report of an expedition to the vicinities mentioned. The expedition was made during the summer of 1912, under the direction of the Chuckawalla and Palo Verde Irrigation Association of Los Angeles, and the report is published here by the permission of Dr. George Wharton James.

irrigation, fertilization, tillage, and pruning, such as is given our orchards along the coast. It is thought by many that the absence of scale and spider is due to the extreme heat, and that citrus trees will ever be free from these pests in these localities. The same was said of the Riverside and Redlands districts, in their early history, when they were isolated from the scale-infested coast orchards, and grew clean without fumigation. Time has changed the view. Scale will live wherever orange trees live. The only thing that will keep it from our hot interior valleys is careful guarding and inspection by the Horticultural Commission, and co-operation on the part of those bringing trees into the country.

At Palm Springs are some 200 odd trees, varying in age up to eighteen years. It is said that trees, here, were twice cut back to the bare stump in order to save them at all, when the supply of irrigation water gave out. Today these trees are thrifty in appearance and produce three to four boxes of fruit from eighteen-year seedlings and Washington Navels, ripe and sweet for the Thanksgiving market, at a price of $3.50, f. o. b. Orange trees are here conceded to be shy bearers.

The grape fruit produced on the desert side of the mountains has a fine sweet flavor and a medicinal quality that is unequaled elsewhere in California. The grape fruits of this section vie with those of Florida. One five-year-old tree, at Palm Springs, growing in a yard with no cultivation, no pruning, and scant fertilization, produced three and one-half boxes of fruit for the Thanksgiving market, when prices were about $7 a box. No frost protection has been exercised in this locality, and there has been very slight frost damage.

At Indio, the advice is not to plant oranges, as the heat and winds cause the crop to fall. Also, the fruit produced is said to be dry and open-celled. All growers questioned, however, stated that oranges bade fair to become a profitable crop, but so much more profit is possible from date and fig culture that there is no object in bothering with citrus fruits. One rancher has 2,000 thrifty orange trees, that were grown and budded by him in the nursery rows, now ready to plant in orchard form.

Near Mecca are two orchards of note. One is a three-year-old, ten-acre grove that is too young to serve as a test, but has made a remarkable growth for three-year trees. The other comprises some sixty to seventy acres south of Mecca, that have been planted for six years. The story of these trees is as follows: The trees were planted when two years from the bud, and set with the bud two to four inches below the surface of the ground. This caused gum disease that was later cured by uncovering the crown, and by proper care in watering. After having been tended for a year, one orchard was practically abandoned for fear of inundation from the Salton Sea. Only one Indian was left to care for the whole place. At the end of the second year it changed hands, and was given water and cultivation for two years. Then the surface roots were all uncovered and chopped off,

through some mistaken idea that this operation would help the trees by causing them to take deeper root. Thus, the feeders were largely destroyed. The following year, when the trees were five years old, the orchard produced its first carload of fruit, which topped the New York market by 85c per box above any other California fruit, and 75c above any Arizona fruit. When six years old, the trees produced five carloads of fruit that sold for $2.66 a box on the trees. This orchard is about 185 feet below the sea level, planted on a loose, sandy loam, with apparent traces of salt and alkali. It now receives fortnightly irrigation in the summer, with double cultivation after each irrigation. It has had some fertilizer and pruning. The trees are thrifty in appearance, of good size, and have set a fair crop of fruit this season. Pomeloes in the same orchard are producing good crops of excellent fruits.

In the Imperial Valley are oranges, lemons, tangerines, and pomeloes, though very little has been done in the way of orchard planting. The Washington Navels, Valencias, Mediterranean Sweets, and tangerines have generally proved to be shy bearers, though the early season, high coloring, and superior quality rather offset this character. One horticulturist at Brawley thinks that the Navalencia is the coming orange for that locality, as it produces three times the crop that the navel does, and is of excellent flavor. Lemons thrive, if in a frostless locality, but produce only one crop a year. Near El Centro one Villa Franca lemon tree, five years old, produced, in one crop, over seven boxes of fruit that sold for over $30. The grape fruit seems to be more productive than other citrus fruits. There are several young orchards started in the valley, and high hopes for the future of the industry are entertained by many of the ranchers.

At Yuma are fifty-five acres of eighteen-year-old citrus trees. Here Washington Navels, Mediterranean Sweets, Valencias, and pomeloes have been planted. The trees were set too deeply when planted, the buds being put some 2-3 feet below the surface, and they have since had irregular and unskilled care. They have had some fertilizer and water, but poor cultivation and pruning. At present a cover crop of weeds and grass is thriving, as it is thought that this keeps the ground cool, and protects the roots from the hot summer sun. In the winter cultivation is practiced. Here, as elsewhere, salt and alkali can be traced in the soil. Of these trees the Mediterranean Sweets, Valencias, and pomeloes are fairly prolific, but the navels are shy bearers. Accurate reports on the number of boxes produced were unobtainable. The fruits all ripen for the Thanksgiving market, and have never been injured by frost, with the exception of leaf damage to some lemons in the winter of 1911-1912. The trees are thrifty, clean, and of good color.

In general, citrus trees show remarkable possibilities and seem well adapted to these localities, provided that proper selection of soil is made where there is no frost damage, and that wisdom is shown in the planting and subsequent care. Little scientific work has been done as yet; no frost

protection has been given; the matter of soil humus has been absolutely ignored. By proper experimentation, varieties might be found that would bear prolifically. The industry is in an embryonic stage, but has developed to that point where fairly accurate conclusions may be drawn as to its future. Modern methods of culture, with the choice of the interior situations, should make a combination hard to beat.

DATES*

About 7,000 date off-shoots have been imported into the United States since the beginning of the date industry. Dr. Coit says that all of the requisite conditions for the successful growing of dates may be found in many places throughout the Imperial, Coachella, and Colorado Valleys, and the country around Palo Verde and Blythe, Riverside County. The Imperial, Coachella, and Colorado Valleys, are the regions in which date culture has proved its worth, and where are now to be found bearing orchards and thousands of newly-planted off-shoots. Dates are so far subject to pests, only as imported on the young plants and subsequently scattered. This infestation is in the form of scale of two distinct varieties—the Marlatt and Parlatoria. A spray has been found that will kill these scales, thus eliminating all future danger from outside infection and making possible its eradication. Spraying and burning with a gasoline torch have proved to be effective means of destroying scale on old and established palms.

The date is not particular as to the soil in which it grows, and will thrive in considerable alkali. Light and heavy soil alike seem to produce dates. While the date is a desert palm and requires a long period of intense heat for proper development and ripening, the roots require an abundance of water. Dr. Coit says that one miner's inch of continual flow is sufficient to maintain a five-acre orchard of bearing dates.

The off-shoots are set 25 feet by 30 feet apart, or about 60 trees to the acre, and begin to bear at the ages of from three to five years. Seedlings are somewhat uncertain, but off-shoots always come true to the parent. A conservative estimate of the bearing capacity of a ten-year-old tree would be 100 pounds. Some will bear as high as 400 pounds to the tree. A leading Los Angeles grocer has placed the retail price for fresh California dates at from 50c to 75c a pound. They bring from 15c to as much as $1 a pound to the grower. Fruit matures here from September through December, some varieties ripening on the trees, others requiring artificial heat. The Deglet Noor is very popular among growers at present, as it will ripen on the tree before the cold weather comes, and is of unusual delicacy of flavor.

A palm reaches its maximum bearing capacity at ten years and will continue to produce for one hundred. One palm sometimes bears as high as

*The portion of this article which treats of the date has already been published with other articles on the same subject and with many illustrations, by Out West, of Los Angeles, and may be purchased at half price by subscribers to this Journal.

twenty bunches in a season. Off-shoots are produced between the ages of three and fifteen years, after which no more appear. During this period, one palm will produce ten or twelve off-shoots, sometimes more. The importer's price for off-shoots is $8 apiece; those grown locally cannot be had for that.

Palm Springs can boast of a few young date palms that have come into bearing, but has nothing on a commercial scale, nor any palms of great age.

At Indio is located one of the government experimental stations, where date culture is being forwarded. On an adjacent ranch are four Deglet Noor trees that produced 300 pounds last year that sold for $1 per pound on the average. Twelve imported trees on the same ranch will produce this season, at the age of seven years, about 750 pounds of fruit, as they are now laden with 75 bunches of dates. An offer of $25 apiece for off-shoots from these Deglet Noor trees was refused, as the owner wished to set more plants, and considered them worth that much to himself.

At Mecca is the largest experimental date garden in the valley. These trees are growing on soil containing three-tenths of one per cent alkali and have been fertilized regularly each year, with one yard of manure to a tree; and have received frequent and abundant irrigation, with prompt cultivation after each watering. The trees have been sprayed for scale. All of the old palms are heavily laden with fruit and are in splendid condition.

Situated a few miles southwest of Mecca is an orchard containing 5,000 date palms. Of these between 300 and 400 are of bearing age, running from three to five years. The crop on them is estimated at 2,000 pounds, and should average 75c a pound. From one three-year-old Deglet Noor tree the owner took 90 pounds of fruit. When four years old, this tree produced no fruit. This season, at the age of five, the crop is estimated at 250 pounds, of which 150 pounds are engaged at $1.50 a pound. In addition, the palm has already produced three off-shoots. This grower expects to net from $300 to $600 an acre from his dates when they have become ten years of age. These trees are growing in soil that contains from one to six-tenths per cent of alkali, and some salt. They are fertilized with manure once a year, and trees producing fruit are fertilized with potash, phosphates, and cotton seed. Several other ranches in this vicinity have trees producing excellent fruit.

The Imperial Valley is sprinkled with date plantings and has several experimental farms where dates are grown. The trees thrive and fruit here very readily, as the date is well adapted to such climatic conditions as exist here.

One of the Arizona experimental farms is situated at Yuma, where seven-year-old dates may be seen in full bearing. These trees have never been fertilized. Cultivated crops have been grown between the rows, through

which the dates have received their only tillage. In the spring of 1912, the palms were pruned severely and burned with a gasoline torch, to kill the scale. After this harsh treatment, one seven-year-old palm, that already had eight off-shoots, produced ten bunches of fruit. Some palms did not bear at all.

Thrifty fruiting palms are also to be found on the mesa near Yuma. These have had little care but the water necessary to keep them growing. One nine-year palm produced, in 1911, 210 pounds of fruit that sold for 10c per pound, f. o. b. Yuma.

The date industry seems to be a coming thing for these valleys, and while the results so far obtained are largely problematic, there seems to be no reason why the future shall not witness great commercial success of date culture. The seedlings are uncertain as to sex, quality of fruit and age of bearing, but by proper selection and propagation from off-shoots, standard varieties can soon be produced in abundance. Scale is under control, and the climatic conditions are proved. Time will do the rest.

FIGS

One grower has had black figs on the market by the first week in May, and was the only shipper on the market in America, for three weeks. He has also shipped figs for the month preceding Christmas. He sold his first box, in May, for $2.00 a pound. The next went at $7 a box. Then prices gradually dropped to $5, $4, and $3, one box going for $2.50. The second crop ranged from $2 to 50c a box. The last crop is profitable at 50c a box, but cannot be made to pay at less. The express and commission charges on a 50c box are 12c, after the fruit has been grown, picked, packed, and delivered to the station. In this especial locality, cuttings planted in the open ground, have been known to produce figs within eighteen months from the time of planting.

Figs do equally as well lower in the Coachella Valley, although especially favored localities, such as the above-mentioned, produce fruit slightly earlier than others. Around Mecca are to be found many figs, bearing abundantly and growing on soils of varying composition.

In the Imperial the crop is generally two to four weeks later, although the quality is equally as good. One grower shipped black figs during the first week in June. Another claims to have produced Smyrnas in May, by the aid of the wasp from the new capri, and says that three crops a year will thus be possible.

The Yuma figs ripen about the same time as those in the Coachella, and are equally as productive and sweet.

The fig seems second only to the date as a commercial fruit for these warm valleys, and produces fruit of such quality and at such an early season that it has no outside competition. Refrigeration of fresh figs, for

eastern markets, is as feasible here as at Fresno, and could be carried on much earlier in the season.

GRAPES

Grape culture is one of the first experiments in the reclamation of hot and arid lands. Here it has been exploited to quite an extent and has netted big returns in many instances, although as yet there seems to be considerable difference of opinion as to the best varieties. The Malaga has been planted more than any other grape and is being shipped in refrigerated cars to the eastern markets, both from the Coachella and Imperial Valleys.

At Palm Springs, Malagas have been injured by rain coming at the time of ripening, but growers in the valley stated that they had not been troubled in this way.

An Indio grower who raises fancy table grapes says that only early grapes are suited to that locality, as fruit that is not ripened by the time the thermometer reaches 115 degrees is scalded by the sun. Here Blue Portuguese ripen the first week in June, and Thompson Seedless on the first week of July. In 1911, three-quarters of an acre produced $375 worth of fruit that averaged $1.60 a crate. Another shipper sold his first grapes for $3.25 a box, in 1911, with a high market throughout the season. In 1912 the first fruit brought $4, but the price slumped and dwindled immediately to $1.25.

A rancher near Thermal netted $200 an acre on Malagas, at an average price of $2.50 a crate gross, some going as high as $5.15. He marketed his crop the first week of July, at a cost of $30 an acre, delivered to the packers. The third year from planting, the crop more than paid for all upkeep. In 1906 another planter set 8 acres of heavy land and 16 acres of sandy land to Malagas. The heavy land has never produced a grape of quality. When 3½ years old, the 16 acres on sandy soil produced $1600 worth of fruit; when 4½ years old, they brought $3165; when 5½ years old, $5720. Another 30 acres of Malagas 5½ years old netted above every expense, including salary of caretaker, $9600. A vineyard, 2½ years old, brought, including picking and hauling, $700 from 2½ acres. When 3½ years old, it brought $1100.

In the Imperial Valley, Malagas are a paying crop, at present, but the prospects for the future are that Persian grapes will be the more profitable, as they ripen a week to two weeks earlier.

MISCELLANEOUS FRUIT TREES

Apricots are profitable, generally, though not so commonly planted as the fruits previously mentioned. Near Indio, the Newcastle ripens during the first week in May, the Royal on the last week. From two Newcastles and one Royal, 7 years old, were picked, in the spring of 1912, 660 pounds of fruit. The Newcastles brought $3 a crate of 20 pounds; the Royals,

$1.50. From one 6-year-old tree, in 1911, was sold $23 worth of fruit. In the Imperial, "cots" ripen during the month of May, and bring very good prices. One orchard of Blenheim "cots," near El Centro, which has had excellent care, bore 100 pounds to each 5-year-old tree. These "cots" ripened on the first of June, and sold for from 3c to 10c a pound to the canners, as they are too late a variety to command a good price on the fresh markets. They bore some fruit at three years, but were not self-supporting until the fifth year, although crops of milo maize and cotton, raised between the rows, paid an income. It cost 35c a crate of 20 pounds to prepare the fruit for the market, besides growing and hauling.

Plums, peaches, nectarines, cherries, apples, almonds, and pears have all been tried with varying success. The almond does splendidly in locations that are frostless. Otherwise it is unsuccessful. One 7-year tree of the paper shell variety, near Indio, produced 65 pounds of shelled nuts that brought from 15c to 25c a pound. The Wickson plum and some varieties of peaches seem to thrive, but it remains for the horticulturist to solve the problem of varieties. The Winter Bartlett pear has proved itself well adapted to the arid climatic conditions. It begins to bear at the age of three years, and is self-sustaining at five. The fruits ripen in the latter half of December and will average 20 pounds to a 5-year-old tree. The market price averages 10c a pound. The pomegranate is very prolific, producing a large fruit of excellent quality. Wherever tried, the olive has borne prolific crops of large-sized fruit such as highly recommend its culture as one of the future industries. The trees are of rapid growth and absolutely clean. The pistachio nut and jujube have borne fruit on specimen plants, and may some day be developed into something of worth.

TRUCK GARDENS

Probably in no place in California are vegetable garden crops produced earlier than in the Coachella Valley. The light soil, mild winters, abundance of heat, and plentiful irrigation seem to be the reasons for their almost phenomenal growth. Truck gardening has proved profitable where the owner was willing to get into the field and do the work himself, and was content to plant only what he himself could care for. On a large scale there is a much greater risk, as such crops require prompt attention and thorough care. One grower cleared $1200 on an acre of tomatoes, and was so encouraged that he attempted a much bigger planting the following year, with the result that he could not handle so much, and lost the whole. Beans, squashes, cucumbers, onions, asparagus, melons, cantaloupes, peppers, peanuts and sweet potatoes have all proved themselves profitable crops in these valleys, when rightly handled.

One property owner near Thermal cleared, above every expense, including 7 per cent on $250 per acre, $3000 on 9⅓ acres of onions. On this land he raised a second crop of nine bales of cotton. On 10 acres of 2-year-

old asparagus he netted $600. In all, he made 40 acres of productive land carry 15 acres of unproductive grapes and net $4600, after hiring all labor, including a manager.

Four and forty-three hundredths acres of Yellow Bermudas produced 1500 crates of No. 1 onions that netted 63c a crate of 50 pounds. They brought from 90c to $2 gross, averaging $1.13 per crate.

Cantaloupes will produce 350 crates to the acre. Fifteen tons of watermelons are considered a good crop.

An acre of asparagus in Imperial Valley netted $150 on the January and February markets. Eighty-six hundredths of an acre, at Yuma, three-fourths of which were yearling plants, the rest being 2-year-olds, produced for the May market $200 worth of shoots at an average price of 10c a pound.

In the Imperial are 10,000 acres of cotton this summer. The crop brings from 8c to 15c a pound. At Coachella, cotton was not picked because the market price was only 8c. Short staple cotton is grown mostly now, but the opinion is that the long staple is the coming crop for the valley.

FUNDAMENTAL AGRICULTURE

After all is said and done, it remains a fact that here, feed is the basis of agriculture. One resident has truly said, "Alfalfa will make the homes." Without it all else would be impossible. Alfalfa is cut from five to eight times a year, and produces from five to twelve tons per acre, per annum. By proper management, it should be made to produce, regularly, ten tons to the acre. This is the most staple crop of the valley.

Kaffir corn and milo maize are both grown for their seed, the latter producing somewhat the greater tonnage. Milo maize will sometimes make two crops to the season, producing from one to two tons of seed to the acre, each crop. This seed sells at about $20 a ton and is used for poultry and stock food. Indian corn is grown some, but does not produce as well as the Egyptian corn.

The fattening of cattle and hogs, in alfalfa pastures, and the dairy and poultry industries, are all profitable, and are sure to grow with the country and become basic factors in the wealth of the community.

Alfalfa and stock fattening are the foundation upon which the homes are to be built. Next in importance comes the culture of dates, perhaps the best of the horticultural possibilities. After dates, figs will be given recognition, then citrus culture, and so on down the list of fruits, vegetables, and grains. The horticultural possibilities of these desert lands have been, as yet, only partially explored. What may lie beyond is at present merely a dream of the idealist, but a dream which modern scientific methods will cause to come true.

The publication committee of Pomona College regrets that certain changes in the personnel of the faculty have made necessary the delay in the issue of this Journal. The committee wishes to thank the subscribers for their patience in the matter.

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Pomona College Journal of Economic Botany

As Applied to Subtropical Horticulture

Volume Two DECEMBER 1912 Number Four

PUBLISHED QUARTERLY BY THE
DEPARTMENT OF BOTANY OF POMONA COLLEGE
CLAREMONT, CAL., U. S. A.

Entered at the Claremont, Cal. Postoffice as second-class matter.

Pomona College Journal of Economic Botany

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Pomona College Journal of Economic Botany
Pomona College, Claremont
California, U. S. A.

POMONA COLLEGE JOURNAL
of ECONOMIC BOTANY

Volume II DECEMBER 1912 Number 4

The Palms Indigenous to Cuba II*

ODOARDO BECCARI
FLORENCE, ITALY

EUTERPE Gaertn.

Gaertn. Fruct. et Sem. I, p. 24 (excl. cit Rumphii) t. IX f. 3 (**E. globosa**) Mart. Hist. nat. Palm. II, p. 28. **Catis** Cook in Bull. Torrey Bot. Club, 1901, p. 556. **Acrista** Cook l. c. 1901, p. 555, and 1904, p. 353. **Prestoea** Hook f. in Benth. et Hook. Gen. pl. III, p. 899 (partim?).

The generic name *Euterpe* was first proposed by Gaertner (De fructibus et seminum, Vol. I 1878, p. 24) for two palms, *E. globosa* and *E. pisifera,* evidently not congeneric, according to our modern views. Of these the fruits were figured in Plate IX. Later, in Vol. II (1791), Plate CXXXIX, was figured the fruit of the *E. pisifera,* which is in fact a palm quite different from the other two; nevertheless *E. globosa* must be considered as the type of the Genus *Euterpe* as being the first so named.

Martius (Hist. nat. Palm. II, p. 28) made use of the generic name *Euterpe* for another palm (*E. oleracea*) which had a fruit so similar to that figured by Gaertner for *E. globosa* that he, evidently suspecting the identity of his plant with that of Gaertner, added, doubtfully, however, to his own diagnosis, the synonym of *E. globosa.*

Bentham and Hooker (Genera plantarum, III, p. 896) have apparently considered as the type of the Genus *Euterpe* the second species figured by Gaertner, the *E. pisifera;* but in this I recognize now, with scarcely a shade of doubt, the *Heterospatha elata* Scheff., a palm common in the Moluccas and the Philippines, and in the *E. pisifera* B. the *Dictyosperma rubra,* of which Gaertner received the fruits from Hermann, who also sent him those of *Hyophorbe indica,* another palm inhabiting the same region with *Dictyosperma rubra.*

Blume, Miquel, and Martius, in considering *E. globosa* Gaertner as corresponding to *Calyptrocalyx spicata,* had regard only to the quotation of Rumph: *Pinanga silvestris globosa* (Herb. amb. I, p. 38, t. 5 f. 1 A), not to the figure of the fruit given in Gaertner's Plate IX.† Mr. Cook, however, holds this identification to be certain and says that "The name *Euterpe* has no true place in American botany, having been proposed originally for an unrelated East Indian palm." Accordingly, he calls the American *Euterpes, Catis,* and con-

*The first part of this monograph appeared in this Journal in May, 1912.

†Martius l. c. on this regard writes: *Euterpe globosa* Gaertn. Fruct. I p. 24, quoad Rumphii citatum, nec vero quoad fructum descriptum et t. g. illustratum.

siders the *Euterpe oleracea* as the type of the Genus, and makes of it a *Catis martiana*.

For my part I maintain that Martius has correctly referred his *E. oleracea* to the Genus *Euterpe* of Gaertner, but I consider that species to be specifically distinct from *E. globosa* Gaertner. Moreover, I think it quite certain that Gaertner's *Euterpe globosa* corresponds to the species of this genus very widely distributed in the Greater and Lesser Antilles, and known under several other more recent names. The only character in Gaertner's description apparently not corresponding to this identification is the "bacca cum brevi acumine", but it is precisely this circumstance that supports me in the belief that the said Plate IX, f. 3, represents the *Euterpe* so common in the Antilles and not another of the more diffuse Brazilian species, because these have the remains of the stigmas very plainly apparent on one side of the fruit; whereas in the Antillean *Euterpe*, when the fruit is deprived of the perianth (as in the fruit represented by Gaertner) these remains may appear just like a small apical acumen.

To *Euterpe globosa*, I think, also, referable the *Acrista monticola* O. F. Cook, as I have not been able to discover any diagnostic character by which it may be distinguished from the common *Euterpe*, so largely diffused in all the Antilles. In conclusion, according to my views, the genus *Euterpe* remains as understood by Martius, Scheffer, Bentham et Hooker, Drude, Barbosa-Rodrigues, etc., *Catis* and *Acrista* being synonyms.

I have, however, to observe that the genus *Euterpe* is not perfectly homogeneous, as some of the species described under this name have fruits with ruminate albumen, while the fruits of others have homogeneous albumen. The true *Euterpes* must be considered those which, like the type (*E. globosa*), have a seed with a ruminate albumen. *E. oleracea* Mart. (H. n. Pal. t. 29, 30) and *E. acuminata* (Willd.) Wendl. belong, also, to this group. Among those known to me, *E. edulis* Mart. (l. c. t. 32), *E. praecatoria* Mart. and *E. catinga* Wall. have a non-ruminate seed, and for these I propose the name *Euterpopsis* as a subgenus. I have not, however, discovered in the flowers of the species of the two groups any correlative characters by the help of which, when the fruits are not available, it may be decided to which of the two groups a given species belongs. Barbosa-Rodrigues (Contr. Jard. Bot. Rio de Jan. 1 (1901), p. 11, and Sertum Palm. p. 37) has divided the genus *Euterpe* into two sections: those with simply bilobed primordial leaves, and those having these leaves radiately divided. This certainly is not a very practical division for herbarium work, but I would observe that *E. oleracea* and *E. globosa*, which have a ruminate seed (true *Euterpe*) certainly produce a bilobed primordial leaf; while *E. praecatoria* and *E. catinga* (*Euterpopsis*), which have homogeneously albuminate seed, have, according to Barbosa-Rodrigues, radiately-sect primordial leaves.* There is, therefore, apparently a correlation between the nature of

*I must warn the reader that in the "Sertum Palmarum" by Barbosa-Rodrigues and in his Contr. l. c. I, *E. edulis* corresponds to *E. oleracea* Mart., and vice versa *E. oleracea* to *E. edulis* Mart. as the author himself acknowledges in Contr. IV, 115.

the seeds and the form of the primordial leaves. But there are yet several species of which the fruit is unknown, and probably it will be a long time before the nature of the primordial leaves of all of these is ascertained.

Euterpe globosa Gaertn. Fruct. et Sem. t. 24 (excl. syn. Rumphii) t. IX. **E. brevivaginata** Mart. Hist. nat. Palm. III, p. 309. **E. montana** Graham in Bot. Mag. t. 3874.† **E. manaele** Gris. et Wendl. ex Gris. Pl. Wright. 530 n. 1468, et Cat. pl. p. 222. **E. oleracea** (non Mart.) Gris. Fl. Brit. W. Ind. 517. **Acrista monticola** O. F. Cook in Bull. Torrey Bot. Club, XXVIII (1901), p. 557, t. 46; Urban, Symb. ant. IV, p. 129. **Prestoea montana** Nichol. Dict. III (1886), p. 216 (ex Ind. Kew); Nich. et Mottet, Dict. d'Hort. (1895-96), IV, p. 319. **Oreodoxa manaele** Mart. Hist. nat. Palm, III, p. 310.

I consider as belonging to the typical *E. globosa of* Gaertner the specimens collected by Wright in the East of Cuba (n. 1468) and distributed under the name of *E. manaele* Gris. et H. Wendl. I have seen a specimen of these in the Herbarium de Candolle, consisting of only two leaflets and of one branchlet of the spadix with quite ripe fruits. The *leaflets* are apparently taken from about the middle of an adult leaf (which was certainly a large one), are broadly ensiform or very elongate-lanceolate, of a firm papery or thinly coriaceous texture, 90 cm. long, 6-6.5 cm. wide, obliquely inserted on the rachis by a rather narrow base, the margins there being strongly reduplicate; they narrow gradually upwards from about the middle, then taper rather suddenly to a slight asymmetrical apex, are green on upper surface and slightly paler underneath; the mid-costa is robust, considerably prominent and acute on both surfaces and is interruptedly covered on the lower by appressed brown scales; on each side of the mid-costa are 4-5 unequal and more or less distinct secondary nerves; of these one or two, also on each side, are often stronger than the others, so as to render the leaflets sub-3-5-costulate, especially in their terminal portions; the tertiary nerves are not very numerous and not very sharp; the margins are considerably thickened; the transverse veinlets are barely visible or quite obsolete.

The branchlet of the *spadix* is 45 cm. long, and apparently furnished with a basal axillary callus; it has the glomeruli of flowers disposed all round in 4-5 longitudinal series; it is 6 mm. in diameter in its lower part, and gradually narrows above; is rigid, terete, glabrous, reddish brown, finely wrinkled, very slightly sinuous between the glomerules, and bears the flowers superficially, and not inserted in pits or scrobiculi.

The *flowers* appear, from the scars left after their fall, to be three-nate (the central flowers being female and the side ones males) in the lower part; they are geminate above but only male. The pulvinuli or scrs left by the fallen female flowers (or fruits) are quite superficial and flat, oblong and surrounded by the usual bracteoles, which are small and form a very narrow membranous ring around the scars; the lower general bract is small, also membranous, rounded and very similar to the floral bracteoles; the scars of

†Plate 7797 of the "Botanical Magazine" is possibly a representation of this species; in this it bears the name of *Exorrhiza Wendlandiana* Becc.

the two male flowers are situated at the sides above those of the female, and are not prominent.

The ripe *fruit* is exactly spherical, 12-13 mm. in diameter when dry, and has the remains of the stigmas placed, in the form of a small three-lobed tubercle, in about the middle of one of the sides, and may be easily overlooked. The pericarp is on the whole, very little over a millimeter thick; the epicarp is pellicular and in the dry condition is rendered minutely and rather obsoletely granulose by small punctiform, or very shortly linear sclerosomes; under the epicarp is found a very thin layer of fleshy tissue, then another layer grumose or granulose, and within this lie several flattened fibres, which form a kind of sac, covering the entire seed; they are coarse and interlacing, or net-like anastomising, on the upper part of the seed, and remain independent, parallel and disposed in 2-3 layers in the remainder; in time, when the pericarp falls into decay the fine and very acuminate ends of these fibres form a kind of brush at the base of the fruit. Some of the innermost fibres of the mesocarp are very thin, flattened, almost hyaline, and remain adherent to the surface of the seed, or more correctly to the endocarp, which is extremely thin and connected with the testa of the seed all over the surface of this, except at the base, in proximity to the hilum, where it forms a kind of papyraceous, straw-colored, non-adherent, suborbicular, thin shield, 5-6 mm. in diameter.

The *seed* is globular, 11 mm. in diameter, has a dull hazel brown surface, upon which there usually remain adherent and slightly impressed some of the inner, soft, whitish, very thin fibres of the mesocarp; the vascular branching of the raphe forms a complete network all around, but this is very superficial and not very apparent; the hilum is linear and extends over to about the fifth part of the circumference of seed; the albumen is deeply irregularly radiately ruminate, and has an irregular fissure in its center; the embryo is exactly basilar, and penetrates the third part of the mass of the seed; its position is recognizable externally by a small depression, which is covered by the shield-like portion of the endocarp. The fruiting perianth is rather shallowly cupular, 7 mm. in diameter; the sepals and petals are rigid, dry in texture, reddish brown; the sepals are reniform, callous and gibbous at their bases; the petals are twice as long as the sepals, broader than high, very obtusely apiculate, nitent inside, finely striately veined externally. (Figure 144.)

E. globosa is a fine tree with a smooth cylindrical trunk, attaining the height of 10-15 m., perhaps more, from 12-15 cm. in diameter, and distinctly ringed by the leaf-scars. The leaves are large and very regularly pinnate. It seems a rather variable plant with regard to some of its vegetative features, having the leaves of a more or less rigid texture, and varying, also, exceedingly as to the development of the branches of the spadix, these being sometimes short and rigid, at other times elongate, flaccid and sinuous. I have, however, found the most perfect identity of the flowers and fruits in all the numerous specimens I have examined, which come from almost every island of the Antilles, from Cuba to Grenada, the most southern of the Lesser Antilles. It is true that the specimens coming from this last island, to which properly the

name of *E. montana* is due, have stout spadices with short thickish rigid branchlets; but this same aspect of spadices is shown in specimens from Martinique (Hahn n. 805); while other specimens from this same island (Hahn n. 580) have spadices in no way distinguishable from those of the plants from Porto Rico, Cuba, etc. The more or less stoutness and rigidity of the spadix and of the leaves is no doubt a phenomenon depending upon the different conditions of ambient, in which the plants lived, from which the specimens were gathered.

Figure 144. Euterpe globosa. a, portion of a branchlet with two fruiting perianths; b, fruit, front view; c, seed covered by the sac formed by the inner layer of fibres of the mesocarp; d, seed covered by the partial shield-like endocarp; e, same seed after it had had its surface polished to show the branching of the raphe, as seen from the side of the hilum; f, the same seed cut longitudinally through the embryo; g, longitudinal section of an entire fruit after it had recovered its fresh appearance by boiling; this last figure from fruits collected in Porto Rico; all the other figures from Wright No. 1468.

Of *E. oleracea* I have seen specimens from the following localities: Cuba—*Wright* n. 1468 (Herb. de Cand.). S. Domingo—*Pater Miguel Fuertes* n. 562; *Eggers* n. 1601, 1848 "Sierra de Palo Quemada"; *H. Von Tuerckheim*, prope Barahona (Herb. Berol.). Porto Rico—*Sintenis* n. 483, 2118, 1525, 1468 (Herb. Berol.); *Bertero* (Herb. de Cand. et Berol.); *Eggers* n. 1165, 1170. Saba (Dan. Ant.)—*Suringar*, 23, IV, 1885 (Herb. Berol.). Tobago (Dan. Ant.)—*Eggers* n. 5740. Martinique—*Hahn* n. 580 and n. 805 (Herb. de Cand.); *Pere Duss* (Herb. Berol.). Guadeloupe—*Duchassaing* (Herb. Berol.); *Pere Duss* n. 3800. St. Vincent—*Eggers* n. 6756 (Herb. Berol.). St. Kitts (St. Christopher)—*Britton* and *Cowell* n. 306 (Herb. Berol.). Grenada—*Eggers* n. 6173 (Herb. Berol.); *R. V. Herring*, 15, V, 1891 (Herb. Berol.); *W. E. Broadway* n. 1460 (Herb. Berol.).

I have seen no specimens from Jamaica.

Gardiner in Proceed. Ac. Phil. (1890) p. 359 (non vidi) mentions a *Euterpe oleracea* from the Bahamas, which also should probably be reduced to *E. globosa*.

CALYPTROGYNE H. Wendl.

H. Wendl. in Bot. Zeit. 1859, 72; Benth. et Hook. Gen. plant III, 914; **Calyptronoma** Griseb. Fl. Brit. W. Ind. 518; **Geonoma** Auct. plur.

Calyptrogyne swartzii Becc. **C. dulcis** G. Maza in Dicc. Botan. (1889), 72, and Nociones de Bot. (1893), 50. **C. occidentalis** G. Maza, Noc. l. c. **C. intermedia** G. Maza, Noc. l. c. **Calyptronoma swartzii** Griseb. Fl. Brit. W. Ind., 518. **Geonoma (Calyptronoma) swartzii** Gris., Wright n. 1466; Gris. Cat. pl. Cub., 222. **Geonoma (Calyptronoma) dulcis** Wr., in Gris. Cat. pl. Cub., 220. **Geonoma swartzii** Gris. et Wendl. (Wr. 1466); Sauvalle, Fl. Cub., 153. **G. intermedia** Gris. et Wendl. (Wr. 3972); Sauv. l. c. **G. dulcis** Wr., Sauv l. c. **G. plumeriana** Mart. Palm. Orb. 34, et Hist. nat. Palm. III, 316. **Elaeis? occidentalis** Sw. Fl. Ind. occ. I, 619.

In the photograph reproduced in Fig. 145, *Calyptrogyne swartzii* appears as a palm of medium size, but with relatively stout stem, 20-25 cm. in diameter, somewhat crooked, and rendered rough by very prominent ring-like leaf-scars. According to Grisebach the trunk is 5-8 m. high, and is only slightly enlarged at its base (trunco 15′-25′ alto basi subæquali—Gris.)

Leaves 5-6 m. long (Gris.), very regularly pinnate; leaf-sheaths short, with a thick broad base, which gradually narrows into a short robust petiole; rachis glabrous, or minutely dotted with inconspicuous scales. The leaflets are numerous, closely and very regularly set in one plane, narrow and long, or ensiform, very gradually acuminate from below the middle to a long, slightly falcate, and slender point; are strongly reduplicate at the base, and with the margins almost involute, firmly papyraceous or thinly coriaceous and distinctly 5-8-costulate; the side costæ appearing considerably prominent underneath, and slightly above; the lower surface moreover has the mid-costa furnished with linear, brown, chaffy scales, and has the tertiary nerves covered with extremely minute punctiform scales; otherwise it is of about the same

Figure 145. Calyptrogyne swartzii.

color as the upper; margins sharp; transverse veinlets quite obliterate. The middle leaflets of larger leaves are 60-80 cm. long and 3-4.5 cm. broad, but at times they are considerably smaller, shorter and narrower; the upper and lower leaflets are always shorter and narrower than those of the middle.

The *spadices* are glabrous in every part, interfrondal, and several, of different degrees of development, are present at the same time on the same tree; they are strongly recurved and make their way from among the bases of the leaves; they form a dense, oblong, pendulous, twice-branched panicle, 40-50 cm. long, borne on a rather robust peduncular part, about as long. The spathes are double, the outer sheathes the peduncular part of the spadix and the base of the inner spathe; this is about 50 cm. long, 8-9 cm. broad, thinly but firmly coriaceous, concave-cymbiform, lanceolate in outline, tapering above to a dorsally keeled acuminate apex; it is mahogany red, striate and almost glossy inside, dull, reddish brown, when dry, and very thinly and sparingly furfuraceous externally; the main branches are thick and short, spirally arranged all around the axis and approximate one to the other; each primary branch is suffulted by a broadly triangular acuminate bract, and very soon divided into 2-4 flower-bearing branchlets; these are 15-25 cm. long, subterete, thick, of the uniform diameter of 5-8 mm. and only taper a little above to an acute tip; they are deeply, very regularly and closely scrobiculate or alveolate along 5-7 longitudinal series; the alveoles are polished inside and have the form of an ogival niche, 8-12 mm. apart in each series, and have, at the base, a very conspicuously rounded lip suffulting the glomerules of the flowers; the branchlets in the herbarium specimen with their seriate alveoles and lower projecting lip resemble a coarse rasp.

The *flowers* are ternate in the alveoles from the base to the apex of the branchlets; but the two males of each glomerule open a long time before the female; only one of the males is furnished with a triangular, erect, acute, dorsally keeled, bract; the female flower (of each glomerule) has two bracts, larger than that of the male, and all, like the flowers, are tinged with mahogany red.

The *male flowers* of each group are collateral and open in succession; the fully developed buds have their bases inserted in their respective alveoles, are 6 mm. long, 2 mm. broad, narrowly oblong, bluntish, and tapering towards the base. They are somewhat angular and irregular from mutual pressure; *sepals* entirely free, slightly imbricate at the base, linear-spathulate membranous-scarious with hyaline margins, cucullate, and rounded at the apex, very acutely keeled on the back. Corolla, somewhat less than twice as long as the calyx, divided from about the middle upwards into three narrowly spathulate segments, which are concave, slightly thickened, valvate, bluntish or roundish at the apex and of the same texture as the sepals; the corolla in its lower, undivided half is tubular-cyathiform and tapers to a narrow base. The stamens form a rather long column, divided above into six short and relatively thick filaments, radiating at about a level with, or a little above, the corolla at the time of the anthesis. Anthers basifixed and erect in the bud, introrse, con-

spicuously biauricled, or cordate-sagittate, acute with the cells slightly divaricate, united by a broad black connective; the rudiment of the ovary is represented by a small trilobed tubercle, placed on the summit of the staminal column, in the center, between the radiating filaments.

The *female flowers,* when the males open, are very little evolute and are pressed between and behind these; I have not seen them at the time of flowering, but judging from the perianths at the base of the fruits they appear to be 4 mm. long and with the sepals scarious, imbricate, lanceolate and very

Figure 146. Calyptrogyne swartzii, a, portion of flowering branchlet, one male flower is open, the others are still closed; b, entire male flower during the anthesis; c, male flower from which a portion of the corolla has been removed; d, very young female flower; e, urceolum enveloping the ovary, formed by the staminodes from the above female flower; f, fruit with its perianth; g, fruit with its perianth removed to show the remains of the abortive carpels at its base; h, the putamen. The flowers from Wright No. 1466; the fruit from Van Hermann No. 875.

sharply keeled; the petals are also scarious, somewhat longer than the petals, imbricate at the base and with valvate apices. From what can be judged by the very young female flowers, the staminodes form a thin, membranous, conical tube, entirely enveloping the ovary and crowned by six narrow teeth. The ovary is trigonous and narrows abruptly into the style, which is divided into three linear stigmas.

Fruit (when dry) broadly ovoid, about 1 cm. long, 8 mm. broad, with a smooth surface and rounded at both ends; it bears the remains of the sterile loges, and of the style, at its base in the form of an inconspicuous tubercle

hidden by the perianth; the pericarp is somewhat wrinkled in the mature dry fruit; epicarp thin, membranous; mesocarp apparently somewhat fleshy with an internal fibrous layer; this last, combined with the endocarp, forms a shell or putamen to the seed, easily detachable from the pulpy tissue; the putamen is obovate, rounded above, acute at base, slightly flattened, keeled at each side, 9 mm. long, 6 mm. broad, 5 mm. thick; the outer covering of the putamen is rendered coarsely reticulate by a few relatively large, looping, fibrous strands adhering to the very thin cartilaginous endocarp. The *seed* is suborbicular, broader at the base than above, slightly flattened or sublenticular, 6 mm. long, 5 mm. broad, 4.5 mm. thick; it has a smooth blackish surface; the hilum is linear and is continued all round the edge of the seed in a narrow whitish line (the raphe?); albumen homogeneous, finely radiate and also faintly ringed by numerous minute concentric layers; embryo exactly basilar. (Fig. 146.)

I have reduced to only one species the *Calyptrogynes* growing in Cuba, Jamaica and S. Domingo, which have been considered as belonging to two or three distinct species. The oldest name for this palm is *Elaeis? occidentalis* Swartz, of which Grisebach made his *Geonoma* or *Calyptronoma swartzii;* it is this specific name which I propose to adopt, and which I consider as embracing all the other (supposed) species.

Of *Geonoma plumeriana* Mart. I have seen in the Berlin Herbarium a copy of Plumier's plate, upon which the species was founded, and in which it is easy to recognize *Calyptrogyne swartzii* by its characteristic cylindrical, elongate, flowering branchlets. The fruits are represented as globular, 14-15 mm. in diameter and, possibly, when the fruits are thoroughly mature they do assume this form. In one of the plates the general appearance of the plant is shown, from which it appears no larger than the plant of Cuba, but with gregarious stems.

Specimens from S. Domingo collected at S. Lorenzo, Samana Bay (Taylor n. 97, Herb. Berol.) exactly agree with the Cuban specimens with large leaflets.

From Jamaica I have examined Harris n. 9842 (Herb. Berol.), Farm Morass near Black River. In these specimens some of the flowering branchlets are larger than usual, as much as 30 cm. in length, and 1 cm. in diam.; but other branchlets are of the usual size. In the flowers I have not discovered the slightest difference from those of the Cuban specimens. The very immature fruits are obovate-oblong, 12-14 mm. in length.

On number 3972 of Wright has been established *G. intermedia,* and under this same name have been distributed Curtiss n. 485 from the Isla de Pinos. Of number 3972 I have seen no specimens, and those of Curtiss are in no way distinguishable from those of Wright's n. 1466; the leaflets are 70 cm. long, 3.7 cm. broad, and have 7-8 nerves, only the branchlets are somewhat shorter than usual (12-15 cm. long). Furthermore I have not been able to discover diagnostic characters of any value to render a specific differentiation possible amongst the numerous specimens of *Calyptrogyne* gathered in different parts of Cuba. I have found that the size of the leaflets and the number of their nerves is very variable in specimens collected in the same region. I may

mention those gathered by Baker and Dinmock (n. 4882) between Paso Real y Herradura, from the same place where was taken the photograph reproduced in Fig. 145, which have the intermediate leaflets with 7-8 nerves, or as many as in Wright's n. 1466, considered as *C. swartzii* by Grisebach himself; whereas another specimen gathered in about the same region with the preceding, at Herradura, by van Hermann (n. 875), but probably obtained from a plant growing in less favorable conditions of ambient, has the intermediate leaflets 35-40 cm. long, 15-17 mm. broad and with 4-5 nerves only; these specimens, therefore, would be considered as of *C. dulcis.* In the spadices I have found only slight differences in the dimensions, and these chiefly in the length of the branchlets, between the specimens of the two localities.

The Cuban specimens of *Calyptrogyne* I have examined are: Herb. *Baker* n. 4882 as quoted above (Herb. Berol. et Becc.); the, also, already mentioned *van Hermann* n. 875, Herradura (Herb. Becc. and Berol.); from these last specimens I have described and figured the fruit; *Baker* n. 3050 (in Herb. Becc.) at Baracoa, Prov. Santiago de Cuba; *Wright* n. 1466 (in Herb. de Cand.) from the east of the island, distributed under the name of *Geonoma* (*Calyptronoma*) *swartzii* Gr. et Wendl; this I used for the description of the flowers and their analyses; *van Hermann* n. 745 (Herb. Berol.), Provincia Pinar del Rio; *Curtiss* n. 485 (in Herb. de Cand. and Berlin), Isla de Pinos. Of Wright's n. 3972, referred by Sauvalle, Fl. Cub. n. 2387, to *Geonoma intermedia* Gris. et Wendl., I have seen no specimens.

ACROCOMIA Mart.

Mart. Hist. nat. Palm. II, 66, and III, 285; Drude in Mart. Fl. Bras., III, II, 388; Benth. et Hook. Gen. plant, III, 943. **Gastrococos** Morales in Repert. fisico-natural de la Isla de Cuba, I (1865), p. 57-64 (ex sched. Urbanianis).

A very rigorous examination of the numerous specimens of *Acrocomia,* derived from almost every island of the Greater and Lesser Antilles has led me to the conclusion that in these islands only two distinct species of *Acrocomia* grow wild. One of these, *A. crispa,* is apparently endemic in Cuba; the other is widely dispersed in the islands to the east, and espeially in the Lesser Antilles. I believe, therefore, that all the specific names attributed to the *Acrocomia* existing in the Antilles (except in Cuba) are to be reduced to only one, i. e. to the oldest, which is, I think, *Cocos aculeata* (*trunco foliisque aculeatis*) Jacq. Amer. (1763), p. 278, t. 169 (non vidi); edit. pict., p. 135, t. 254 (ex Mart.); Willd. sp. pl. IV, p. 401. I consider the *Cocos fusiformis* Swartz, Fl. Ind. occ. I, p. 616 (1797), as exactly the same plant as that of Jacquin (mentioned above) against the opinion of Swartz himself, who, at first, (novas Gen. et sp. plant. seu Prodr., 1788, p. 151) had reduced to *C. aculeata* the plant which, afterwards, he named *C. fusiformis,* as he could not believe it possible that Jacquin had overlooked the character of the fusiform trunk, possessed by the *Acrocomia* of Jamaica and Hispaniola, to which Swartz, just for that reason, had applied the name of *C. fusiformis.* But the trunk of *Acrocomia* (*Cocos*) *aculeata* is very variable as to its forms, and in the same

Island of Porto Rico, while it is frequently, more or less, fusiform, it is also at times, quite cylindrical. An unpublished picture by Krug in the Herbarium at Berlin shows it thus.

I do not think the name of *A. fusiformis* at all applicable to the plant of Cuba, which has the trunk almost smooth, the spines being detachable and deciduous; while the spinescence described by Swartz for his *C. fusiformis* is exactly the same as that which covers the trunk of *C. aculeata.*

The fruit described by Swartz as that of his *A. fusiformis* (drupa . . . . oblonga) is certainly that of a quite different plant, and is, very probably, as supposed by Martius, the fruit of *Syagrus* (*Rhyticocos*) *amara.*

To be enabled to decide on the right names to be assigned to each of the two species of *Acrocomia* of the Antilles I have passed in review all the known species referable to that genus, and I have been able to recognize that, although all the *Acrocomia* are very similar in general aspect, they nevertheless offer good diagnostic characters in their flowers, both male and female, by which the species may be easily distinguished.

Conspectus of the Species of Acrocomia

1. *Acrocomia aculeata* Lodd. ex Mart. Hist. nat. Palm. 286.
   (*A. fusiformis* Sweet).....The Antilles except Cuba
2. *Acrocomia crispa* (H. B. et K.) C. F. Baker in exicc.
   (*A. cubensis* Lodd.—nomen; *A. lasiospatha* Auct. plur.).....Cuba
3. *Acrocomia glaucophylla* Drude in Mart. Fl. Bras. v. III, II, 392.....
   .....Brazil (tropical and subæquat.)
4. *Acrocomia intumescens* Drude in Mart. l. c. 391.....
   .....Brazil (Prov. Rio de Janeiro)
5. *Acrocomia lasiospatha* Mart. in Palm. Orbign. 81.....Cayenne
6. *Acrocomia mexicana* Karw. ex Mart. Hist. nat. Palm. III, 285, t. 138
   (*A. zapotecis* Karw.).....Mexico
7. *Acrocomia sclerocarpa* Mart. Hist. nat. Palm. II, 66, t. 56, 57, 100 f. 5.
   (*A. sphaerocarpa* Desf. ex Ind. Kew.).....Brazil (Rio de Janeiro)
8. *Acrocomia wallaceana* Becc.
   (*A. sclerocarpa* var. *wallaceana* Drude; *A. lasiospatha* (non Mart.) Wallace Palm trees t. XXXVIII).....Brazil (Para)
9. *Acrocomia totai* Mart. in Palm. Orbign., 78, t. 9 f. 1.....Bolivia
10. *Acrocomia vinifera* Oerst. in Kjoeb. Vidensk. Meddel. (1858) 47.....
    .....Nicaragua
11. *Acrocomia mokayayba* Barb.-Rodr. in Pl. nov. Rio, v. II.....
    .....Brazil (Prov. Matto grosso)
12. *Acrocomia odorata* Barb.-Rodr. Palmæ Mattogr, 48.....
    .....Brazil (Prov. Matto grosso)
13. *Acrocomia microcarpa* Barb.-Rodr. in Vellosia, 1885-88, ed. 2, I (1891), 107 .....Brazil (Amazonas)
14. *Acrocomia erioacantha* Barb.-Rodr. Contr. Jard. bot. Rio, I, 85.....
    .....Brazil (Amazonas)
15. *Acrocomia antioquiensis* Posada-Arango in Bull. Soc. bot. de France, v. 25 (1878), 183.....Antioquia in Colombia

Figure 147. Acrocomia crispa.

Acrocomia gujanensis Lodd. (nomen).....Guiana=*A. lasiospatha* Mart.?
Acrocomia minor Lodd. ex Don in Lond. Hort. Brit, 382.....Quid?
Acrocomia horrida Lodd. (nomen).....Trinidad=*A. aculeata* Lodd.?
Acrocomia globosa Lodd. (nomen).....St. Vincent=*A. aculeata* Lodd.?
Acrocomia tenuifrons Lodd. (nomen)....St. Domingo=*A. aculeata* Lodd.?

Acrocomia crispa C. F. Baker exicc., n. 4566. **Cocos? crispa** Humb. Bonpl. et Kunth, nova Gen., I, (1815), 302; Mart. Hist. nat. Palm, III, 324; Kunth, Enum. pl. III, 287. **A. cubensis** Lodd. ex H. Wendl. Ind. Palm. I, (nomen). **A. lasiospatha** (non-Mart.) Gris. Cat. pl. cub. 222 (Wr. n. 3223—non quoad Fl. Br. W. Ind. 521); Sauvalle, Fl. cub. p. 153, n. 2389. **Astrocaryon** sp. n. sec. Wendl. et **Cocos armentalis** Morales ex Sauvalle Fl. Cub., p. 153, n. 2393. **Astrocaryon crispum** G. Maza in nociones de Bot. (1893), 50. **Gastrococos armentalis** Morales l. c.

The Cuban *Acrocomia* is a most remarkable palm, being one of those in which the bulging of the trunk in its upper aerial part is pre-eminently great (Fig. 147). As far as I can judge from the picture, the trunk is about 10 metres in height, and 25-30 cm. in diameter at its base; thence it gradually swells to nearly three times the thickness of its basal diameter; the greatest diameter (about 70 cm.) being attained at 6-7 m. above the ground, thence the trunk tapers again gradually, but in a much lesser degree than below; its general aspect therefore cannot truly be termed fusiform, but is rather that of an enormous club; in its lower and older part the surface looks rough and corky; above it is obscurely and closely ringed by the leaf-scars, otherwise it is smooth; it must, however, have been more or less permanently covered by spines, but these seem easily detachable, and only a few remain visible in the photograph. The crown of leaves is dense, but in proportion to the volume of the stem it is relatively small. The lowest leaves drop off at every emission of new spadices, and leave the trunk clean, with the spadices hanging below the crown, when loaded with fruit.

The *leaves* on the whole seem to be about 3 m. long, have their bases much and suddenly enlarged, very thick, short and broad, and widening in their lower parts so as to embrace the trunk; petiole very short or almost obsolete; rachis glabrous, apparently not much armed, being quite spineless in the small portions seen by me. Leaflets very numerous, arranged, more or less distinctly, into approximate pairs on each side of the rachis; each pair is obliquely inserted in contrary ways on the rachis, and the blades extend in two different planes. The leaflets are firmly papyraceous, ensiform, and quite straight, and gradually narrow from a rather considerable distance below the middle, to a very long-acuminate, very briefly bifid apex; they taper also, but slightly, towards the base, are green, and almost glossy in the upper surface; the lower surface is paler or slightly glaucescent, and especially in the newly expanded leaves, which, when seen under a strong lens, show themselves covered on all the numerous tertiary nerves with extremely minute hair-like corpuscles, not always easily discernible; the mid-costa is strong, prominent above and frequently furnished with a bristle-like spinule at its base, superficial and smooth

below; on each side of the mid-costa are 3-4 slender secondary nerves; the tertiary nerves are numerous, especially distinct underneath; the middle leaflets are 70-75 cm. long and 25-30 mm. broad; the margins are not, or only very slightly thickened; the transverse veinlets are very much interrupted, and usually too much immersed in the parenchyma to be visible.

I have not seen the spathes. The *spadices* on the whole are about 1 m. long, of which about 30 cm. are occupied by a robust peduncular part, and when in fruit form enormous, elongate, pendulous, grape-like bunches, about 70 cm. in length, and about 25 cm. in diameter at their bases, being somewhat less in their apical parts. The flowering branchlets are 20-30 cm. long, very densely and spirally arranged round the main axis, have a distinct callus at their axilla, and are suffulted by a very small bract; they are sinuous, glabrous, subterete, 3-5 mm. in diameter in their basal part, where they carry 4-5 female flowers only; are angular but about of the same diameter in their upper two-thirds, where they are deeply scrobiculate and densely covered with the male flowers. The scrobiculi are arranged in six longitudinal series, and are not contiguous, those of each series being 2-3 mm. apart from one another, they have their lower margin bracteiform, concave like a swallow's nest, rounded, and projecting horizontally about 1 mm.

The *male flowers* appear to be geminate in each scrobicule, from the scars left by their fall, but none remained on the specimen seen by me.

The *female flowers* in bud are broadly conical, 8 mm. high (judging from the perianth of the growing ovaries); the calyx is almost flat, suborbicular, slightly three-lobed, about 7 mm. in diameter; the corolla is parted nearly down to its base into three very broadly subcordate lobes, which are slightly imbricate at the base, have the margins entire, and triangular, rather acute apexes. The staminodes form a complete cup about as long as the corolla, irregularly and not very deeply three-lobed, the lobes are broadly triangular and occasionally terminated by a rudimentary anther; three of the lobes are very conspicuous between the divisions of the corolla. The pulvinuli of the female flowers are flat, orbicular, 3-5 mm. in diameter and surrounded by the bracts which form a narrow ring, and bear above them the very short pedicels which suffult the two male side flowers. The ovary is covered by silvery appressed hairs, is broadly ovoid with a conical apex terminated by three circinate stigmas.

The *fruit* is spherical, 3 cm. in diameter, very slightly depressed on the apex, where it bears the remains of the stigmas, a very small three-lobed papilla. The outer coating or epicarp of the ripe fruit is thinly crustaceous, brittle, of a yellowish ochraceous color (when dry), almost polished and only rendered very obscurely uneven by minute granules resting under its tissue; the mesocarp is slightly parenchymatous with its inner layer traversed by very minute slenderly filiform, sinuous, much branched fibres, especially numerous near the base. The putamen is somewhat irregularly globose, or else obsoletely trilobed and slightly depressed, 20-22 mm. broad, 18 mm. high; its surface is of a plumbeous color, uneven, coarsely and slightly pitted; the

foramina are at regular distances in the middle of the periphery; the cavity is irregularly three-lobed, 16 mm. in width in its broadest part; the wall of the shell is 3-4 mm. thick; the cavity of the only fruit I had at my disposal had a general subcordate outline, but was empty.

The *fruiting perianth* is not accrescent, and is quite explanate under the fruit. (Fig. 148.)

A. crispa grows wild in Cuba as isolated individuals. The photograph reproduced in Fig. 147 was taken at Santiago de las Vegas near Havana, whence Prof. Baker's sterile specimens bearing n. 4566 are derived. My description, however, is based on Wright's specimens of the "Plantæ cubenses" bearing the n. 3223 (in Herb. de Candolle) distributed under the name of *A. lasiospatha* Mart. ex Gris. Cat. cub. 222. The native name of this palm in Cuba is "Palma Corojo" (Baker).

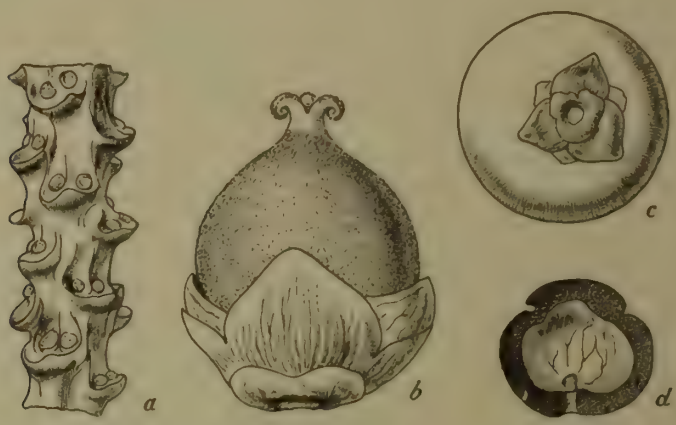

Figure 148. Acrocomia crispa. a, portion of an empty male flower-bearing branchlet; b, a growing ovary; c, fruit as seen from its base; d, transverse section of a seed. From Wright No. 3223. Fig. a, b, enlarged; c, d, natural size.

The *Acrocomia* endemic in Cuba is rendered very distinct from all the other species belonging to this genus, at least from those known to me, by its male flowers being in pairs in each alveole, and by the alveoles not being in contact with one another; in all the other species the alveoles form by their ensemble a kind of honey-comb, with a single male flower in each cell and with the margins of the cells more or less produced into bracteiform wings.

From the other *Acrocomia* growing in the Antilles, *A. aculeata* (Jacq.), *A. crispa* differs not only in the characters just now mentioned, but also in its very conspicuously inflated stem and in the fact that the stem is only temporarily covered with spines; also by the leaves being far less spinous in every part; by the female flowers having their petals cordate-triangular and entire; by the staminal urceolum with six broad triangular lobes which, on the whole, look like a second corolla; and finally by the ovary being covered by a silvery indument which is formed by very appressed scale-like branched trichomes.

Furthermore the fruit of the Cuban *Acrocomia* is smaller than that of *A. aculeata,* and the fruiting perianth has the pieces of the corolla triangular, rather acute, and entire, not lobed and crenulate as are those of *A. aculeata.*

Generally the *Acrocomia* of Cuba has been known under the name of *A. lasiospatha,* a name which was originally applied by Martius to a species growing at Cayenne; but to it he also appended the synonym of *Palma cocifera caudice tumido et aculeato* of Plumier, reproducing also the description left by that author; in this description, however, it is easy to recognize the *Acrocomia* growing in the island to the east of Cuba, provided we take into account his description of the fruits, of which it is said that they are "pila lusoria paullo minores", that is to say, of about the size of a small billiard ball; these dimensions are never attained by the fruit of *A. crispa,* while they really are approached by those of *A. aculeata.* The localities given by Plumier for his *Palma cocifera* (Martinique, San Domingo and S. Vincent) are also an argument in favor of its identification with *A. aculeata.*

As I consider that not the slightest doubt can now remain as to the identity of *Cocos? crispa* H. B. et K. with the Cuban *Acrocomia,* I think that the name of *A. crispa* may be considered as the most appropriate one.

Acrocomia aculeata Lodd. ex. Mart. Hist. nat. Palm. III, 286 (excl. syn. **A. sclerocarpae**). **A. fusiformis** Sweet. Hort. Brit. ed. I, 432 (ex. Ind. Kew.) **A. fusiformis** Maycock, Fl. Barb. (1830), 355 (excl. descript. fol.). **A. funiformis** Baill. Hist. des plant, 304, e Jamaica (psalmate pro **A. fusiformis?**). **A. lasiospatha** Mart. Palm. Orb., 81, et Hist. nat. Palm. III, 286 (tantum quoad citatum Plumierii: **Palma cocifera caudice tumido et aculeato**); Griseb. Fl. Brit. W. Ind., 521 (partim?). **A. sclerocarpa** (non Mart.) Griseb. l. c.; Bello, Apunt., II (1833), 114, n. 771 (ex Urban, Symb. Ant.) **A. media** O. F. Cook in Bull. Torrey Bot. Club, XXVIII (1901), 566; Urban, Symbolae Ant., IV, 130; Cook et Coll. Econ. pl. Port, 67. **Cocos aculeata** Jacq. Select. Amer. (1763), 278 (non vidi), et in Willd. sp. pl. IV (1805), 401; Swartz Nova Gen. seu Prodr. (1788), 151 (una cum syn.) **C. fusiformis** Swartz Fl. Ind. occid. I (1797), 616, (una cum syn. sed excluso fructu).

Stem 10 to 15 m. high, and 20-30 cm. in diameter, more or less fusiform in its middle part, but at times almost cylindrical throughout, armed with close rings of robust, black, very sharp spines.

The *leaves* have the leaflets polished above, dull and more or less whitish beneath, rather brittle, and easily splitting longitudinally; those of the intermediate part of the rachis 70-75 cm. long, 3 cm. broad; the rachis is very powerfully armed with black, very unequal spines, some of them being as much as 10 cm. in length, flattened, covered with a rusty woolliness in their basal part, otherwise polished.

The inner *spathe* is densely covered with very fine, soft, brown hairs, mixed occasionally with a few spines.

The *spadix,* on the whole, is 1 to 1.5 m. long; the peduncular part is armed with spines 5-12 mm. long which are covered with rusty woolliness in their lower part, their points being of a shiny black. The branches of the spadix are

very numerous, 25-30 cm. long, somewhat swollen at the base, otherwise subterete, or slightly flattened, 4-6 mm. thick, and slightly sinuous in their lower third, or fourth, part, where they carry 2-5 female flowers; the part bearing the male flowers is 16-20 cm. long, and about 15 mm. in diameter, when bearing the flowers; its axial part alone is 7 mm. broad, very closely, regularly, and deeply hollowed by rhomboidal alveoli; each contains one flower only, has narrowly winged margins, and the lower lip protrudes 1-1.5 mm.

The *male flowers* are each furnished with a very small triangular bracteole; their fully developed buds are 7 mm. in length, are oblong, rounded above, and slightly narrowing towards the base; the calyx is small, the sepals are slightly imbricate at the base, 1.5 mm. long, are membranous with hyaline margins, deltoid, acute, entire or faintly ciliate-denticulate. The corolla is divided down to a little past the middle into three ovate, concave, more or less acute, rather thickly coriaceous segments, each having a callous thickening at its base internally. Stamens six, inserted just at the mouth of the corolla where the segments separate one from the other; the rudimentary ovary is formed by three small elongate bodies placed between the bases of the stamens; below the insertions of the stamens the body of the corolla is solid and fleshy; the filaments are terete, subulate, about as long as the segments of the corolla, and with the apex briefly inflected when in the bud; anthers elongate-rectangular, equally rounded at both ends; during the anthesis the loges remain open and applied one against the other by their backs. (The loges must open when the flowers are still very young, as I have found them in that condition even when the corolla was not yet open.)

The *female flowers* have very broad bases and are almost globular, being about 1 cm. high and about as broad; the calyx, on the whole, forms a very narrow ring, and is formed by three sepals, very narrow, semi-circular, with hyaline margins. Petals large, imbricate, suborbicular, three-toothed at the apex, the middle point being rigid, very acute, and almost pungent, the side points are, like the margins, hyaline and irregularly ciliate-toothed; the staminal urceolum is very short and truncate; ovary globose-ovoid, narrowing above, densely hairy-hispid from the base to the stigmas; these are circinate.

Fruit globose, slightly depressed, about 4 cm. in diameter, but apparently, judging from some of the kernels, at times larger; it is 3 cm. high and has a small papilliform apical mucro; it has a polished surface, and when dry is of a dirty-yellow color. The epicarp is brittle, two-thirds of a millimeter thick; the mesocarp in the dry condition is rather soft, adherent to the putamen, almost corky in texture, and without rigid fibres. The putamen is depressedly globose, 25-28 mm. broad, 20-21 mm. high; the pores are about in the middle of the periphery; the surface is uneven, venose-impressed, marked below by three very faint and shallow grooves which radiate from three very small holes placed in the center of the base; of the upper surface the center is slightly raised and obsoletely apiculate. The wall of the shell is 3-4 mm. thick. *Seed* usually solitary, but at times two collateral seeds are to be found within the same shell, separated by a woody dissepiment. When the seed is

solitary, the cavity is very obsoletely three-lobed in transverse section, and 18 mm. in breadth. The seed (when solitary) is obsoletely subcordate-three-lobed, slightly flattened, with a brown venose-impressed surface. Albumen oily, equable, with a small central cavity, perfectly white; it is rather hard, but it may be cut with a knife.

Fruiting perianth explanate, with the petals crenate-lobed on the thinned margins, slightly callous and gibbous at the base. (Fig. 149.)

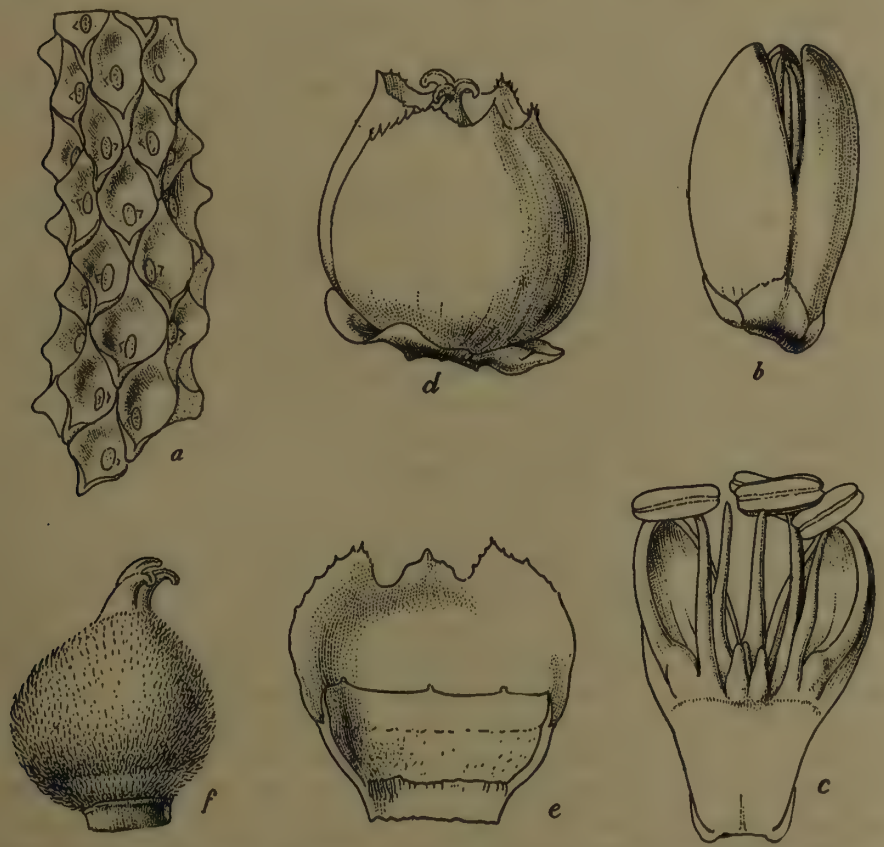

Figure 149. Acrocomia aculeata, a, portion of an empty male flower-bearing branchlet; b, male flower; c, male flower from which a portion has been removed to show the insertion of the stamens and of the sterile ovary; d, female flower; e, section of the corolla to show its inner side, and the cup formed by the staminodes; f, detached ovary during the anthesis. From a specimen collected by Sintenis in Porto Rico.

Acrocomia aculeata has been often considered as not differentiating from *A. sclerocarpa* Mart., and on this subject Martius (Palm. Orbign. 81) writes that a branchlet with male flowers coming from Porto Rico and named *Cocos aculeata,* hardly presents any character by which it may be distinguished from *A. sclerocarpa.* But *A. aculeata* differs from *A. sclerocarpa* by the fruit of the first being larger, and having the perianth almost explanate, the bases of the

petals being only slightly swollen. In *A. sclerocarpa* the petals of the fruiting perianth are strongly swollen, or conspicuously callous. In *A. aculeata* the lower lip of the scrobicules is not much produced, while in *A. sclerocarpa* it is bracteiform or liguliform, and 4-5 mm. in length. The ovary in *A. aculeata* is hairy from its base to the origin of the stigmas; in *A. sclerocarpa* it is densely hairy in its lower part only and glabrous above. The ring formed by the staminodes in *A. aculeata* is perfectly truncate, while it is distinctly six-toothed in *A. sclerocarpa.*

I have especially described the palm growing in Porto Rico known by the vernacular name "Palma de Corozo", and of which Mr. O. F. Cook has made his *A. media.* I have, however, examined also numerous other specimens collected in various of the Greater and Lesser Antilles, which all seem to me referable to *A. aculeata.*

From Porto Rico I have seen: *Sintenis* n. 3972, 4935, 6483 (Herb. Berol.) *Bertero* also collected this palm in Porto Rico and fragmentary specimens of it are preserved in the Herbaria de Candolle and of Berlin. In the latter, one specimen bears the n. 286, and comes from the Herbarium Sprengel; another comes from the Herbarium Kunth; all are labelled *Cocos aculeata.*

Jamaica: *Harris* n. 9943 (Herb. Berol.) near Malvern, 730 m. alt.; the flowering branchlets are exactly as in the plant of Porto Rico.

Haiti: In the plain near St. Michel leg. *W. Buch* 1907 (n. 3 in Herb Krug et Urban). Habitus *Oreodoxæ regiæ* Fructus flavi, edules. The fruits are 37-40 mm. in diameter. The seed is 26 mm. broad, 23 mm. high. The fruiting perianth is exactly as in the plant of Porto Rico.

Tobago: *Eggers* n. 5739 (Herb. Berol.) "Grougrou" incol. Common on the River Bacolet. The fruit is said to be 38 mm. in diameter, and to be edible; the specimen has only a portion of a leaf, corresponding to those of the plant of Porto Rico.

Guadeloupe: *Pere Duss* n. 3805 (Herb. Berol.) Plains and marshes of the Lamentin, Vulgo "Dinde". The flowers and fruits, 4 cm. in diameter, are exactly like those of the plant of Porto Rico. In a note Pere Duss describes the leaves as 3-4.5 m. long with segments on two series; the entire plant 10-17 m. high with a straight trunk; this is swollen at the base in young individuals, but in the middle in those older, and in the very old ones near the summit; the trunk is marked by annular rings, and furnished with spines. The spadices are at first erect, then recurved, 1 to 1.30 m. in length, and bear 80-100 flowering branchlets. The flowers are yellow and exhale a bad smell. An entire spathe is 1.20 m. long, very densely velutine, quite devoid of any kind of spines.

Dominica: *Eggers,* March 1882, "Grou-Grou" inc. (H. Berol.), only leaves of young plants which do not show differences from analogous leaves of the same age from Porto Rico. Also *Eggers,* Goodwill Valley, 23, 2, 1880, as above.

Martinique: *Pere Duss,* Riviere Salée, Ducos, Lamentin, vulgo "Glouglou" (Herb. Berol.) Leaves as in the plant of Porto Rico. The spathe

is velutinous, but is sprinkled with a few elongate black spines. The male and female flowers exactly as in the plant from Guadeloupe. Ovary hispid in the usual way. Fruits 40-42 mm. in diameter. Fruiting perianth with crenulate petals.

Grenada: *Eggers* n. 6302 in Herb. Berol. From near sea level to about 180 m. elevation between Goyave and Grand Pauvre. "Grou-Grou" inc. The specimens consist of flowering branchlets, portion of the leaves and detached spines of the trunk; everything as in the plants of Porto Rico.

BACTRIS Mart.

Bactris plumeriana Mart. Palm. Orbign. 64, and Hist. nat. Palm. III, 280; Griseb. Pl. Wright, 531, and Cat. plant Cub., 222; Sauv. Fl. Cub., 153, n. 2390.

A small tree apparently forming small thickets, with stem 8-10 cm. in diameter and 4-6 m. high, densely covered with very rigid, slender, unequal spines, 10-15 cm. long or less.

Leaves conspicuously interruptedly pinnate. Petiole rather elongate, armed densely with very irregular needle-like black spiculæ; leaflets numerous, approximate in groups of three to nine, about 1 cm. apart in each group, with rather long vacant spaces between the groups; they are firmly papyraceous of about the same color on both surfaces, inserted at an angle of about 45°, and all in one plane; the intermediate leaflets are 55-60 cm. long, 20-23 mm. broad, linear-ensiform, quite straight, somewhat narrowing to a rather acute base; here their margins are strongly reduplicate, but otherwise they have the blade flat, very gradually acuminate above to an unsymmetrical apex, the upper margin being prolonged 2-5 cm. beyond the lower one; the apex appears therefore two-toothed, but with one of the teeth linear, 2-3 cm. long, and the other very short and obtuse; on the upper surface the mid-costa is prominent, acute, and irregularly armed with a few distant black, stiff, subspiny bristles (5-8 mm. long); on the under surface the mid-costa is slender, and minutely hairy throughout, sometimes, however, inconspicuously; the secondary nerves are in number 3-4 on each side of the mid-costa; the tertiary nerves are numerous and sharp and render both surfaces, but especially the lower one, conspicuously longitudinally striate; in addition on these under surface nerves are aligned innumerable, extremely minute, hair-like squamules, frequently of a rusty color; the margins are acute, rendered irregularly and remotely ciliate by subspiny bristles, similar to those of the mid-costa. The rachis is rusty-furfuraceous, and rather densely armed all round with unequal, black, and very slender, spiculæ of which the largest are 3-4 cm. long.

The *spadices* are 25-40 cm. long, arched, and have two persistent coriaceous spathes, of which the outer is short, 8-12 cm. long, oblong, strongly flattened, hairy-hispid externally, broadly and acutely two-edged, or with a wing-like expansion at each side; the inner spathe is 3-5 times as long as the outer, and it broadens from a narrow sheathing base into a spathulate-cymbiform limb, 4-5 cm. broad, and ending in an acuminate tip; this spathe is thinly coriaceous but of a rather brittle texture, glossy and cinnamon-brown inside, externally it

is thinly tomentose, and densely covered with stiff, very fine, black spiculæ, mostly deflexed. The panicle is 10-15 cm. long, formed by several simple flowering branchlets, and borne on a curved peduncular part, as long or longer; this is 8-10 mm. thick, densely hispid, or covered by spiculiform bristles; is furnished above, immediately below the panicle, with a loosely sheathing cyathiform bract, of which the irregularly truncate mouth is produced into 2-3 irregular, broad-based, subulate teeth. The flowering branchlets are all almost of the same length, 8-12 mm. long; at first fastigiate; later, when they are loaded with fruits, spreading; they are filiform, 1.5-2 mm. in diameter at the base, thickening to 3 mm. when bearing fruit, subulate at the apex, slightly sinuous, terete, covered at first by a dense, rusty-furfuraceous, pulverulent indumentum, formed by small papillæ which become partially deciduous by age. During the flowering time the axial part of the branchlets is entirely hidden by the flowers, which are very closely packed together.

The *male flowers* are more numerous than the female, have very inconspicuously hyaline bracts at their bases, are superficially inserted on the branchlets, and solitary on each pulvinule; they are rendered very unsymmetrically three-gonous by mutual pressure, 4 mm. long and about as large; the calyx is small, membranous, and has three narrow acute teeth; the corolla is much longer than the calyx, fleshy, divided almost to the base into three valvate, deltoid, acute, flat segments; stamens six, filaments short, anthers linear, obtuse at both ends; rudiment of an ovary inconspicuous, punctiform.

Female flowers scattered among the male flowers; apparently each female flower is accompanied by two male flowers, but the glomerules are not regular; at the time that the male flowers are about to open, the female flowers are 2.5-3 mm. long, and apparently are ready to be fertilized; they are cylindraceous, probably thinly fleshy when fresh, membranous and of a lighter color than the males in the dry herbarium specimens; the corolla is about three times as long as the calyx, and thicker than this, tubular, slightly campanulate, obsoletely striately-veined (when dry), three-toothed, the teeth broadly triangular, acute, and connivent; ovary clavate-oblong, rounded above, and surmounted by a conspicuous, quite sessile, convex suborbicular papillose stigma; the corolla is accrescent after the fertilization of the ovary, and becomes broadly campanulate, 3 mm. high, 5 mm. broad, truncate and very obsoletely three-denticulate at the mouth, but in time becomes explanate under the mature fruit; it is then 7 mm. in diameter, more or less split into three strongly striately-veined lobes.

Fruit, globose, slightly depressed, 11-12 mm. in diameter, and about 2 mm. less in height, with the papilliform remains of the stigma in the center of the slightly depressed apex; in the dry condition it is yellowish and more or less sharply, longitudinally striate; the pericarp on the whole is very thin; the epicarp very thinly pellicular and adherent to the mesocarp; the mesocarp is very scanty, possibly slightly fleshy when fresh, it has only a layer of unequal fine fibres, which give a finely striate appearance to the dry fruit. The putamen has a smooth black surface and three pores placed a little above the

middle; its wall is very thin, 0.5-1 mm. thick; it contains only one seed, which is globular, slightly flattened, very superficially lobed, 10 mm. in diameter, 7.5 mm. thick. Albumen not very hard, white, slightly oily; embryo basal.

I have based my description chiefly on the specimens of the "Plantæ Cubenses Wrightianæ", n. 1465 in Herb. de Candolle. In the Berlin Herbarium I have also seen a fruiting specimen collected by Gundlach in Oriental Cuba, one from the New York botanical Garden collected by Shafer (n. 3555) on Sierra Nipe near Woodfred, Oriente, Pinelands, 500-650 metres altitude, and another (Shafer n. 1750) from the Pinales, S. E. of Paso Estancia, Oriente. Very slightly differing from the above is one I have received from Prof. Baker (n. 3051) collected by W. T. Horne at Baracoa, Prov. Santiago de Cuba. In this specimen the fruiting perianth is slightly smaller than in Wright's type specimens (6 mm. in diameter) and is not split into three parts, or is at most, only superficially three-lobed; the leaflets bear only a few bristles here and there near the upper end, and on the mid-costa the spiculæ are present only near the base, and a few scattered near the apex; the upper leaflets shorten gradually and have the apex briefly and almost equally obtusely two-toothed. A very young plant collected by Eggers in Cuba (n. 5239) at La Prenda (800 m.) has primordial leaves which are deeply bilobed, acutely cuneate at the base, with the lobes acuminate, and 6-7-costulate; the petiole and the rachis are powerfully armed with unequal needle-like, black, nitent spiculæ, of which the largest are 2-3 cm. long; all the other nerves are smooth; the margins are irregularly spinulous. This palm is known in Cuba under the name of "Coco-Macaco".

I have not seen specimens of this palm from any other of the Antilles. I think that Grisebach had correctly identified the *Bactris* growing in Cuba with the *B. plumeriana* of Martius, who applied this name to the *Palma dactylifera aculeata minima* represented in Plumier's unpublished plates XLIII, XLIV, XLV. Of these plates I have seen a copy in the Berlin Herbarium and about them I have to observe that the spadix represented in plate XLIV bears fruits 10-11 mm. in diameter, or slightly smaller than those of the plant from Cuba.

Other species of *Bactris* are mentioned as proper to the Antilles, but I have not as yet made a special study of them.

SABAL Adans.

Adans. Fam. nat., II, 495; Becc. in Webbia di U. Martelli, II (1907), 10. **Sabal** and **Inodes** O. F. Cook in Bull. Torrey Bot. Club, 1901, 529.

A. All the primary divisions or segments of the leaves unicostulate and deeply bifid.

Divisions of the segments having a very acuminate, but rigid apex. Flowers oblong-ovoid, very small, 3 mm. long, 1.8 mm. thick. Fruit spherical, rounded at its base, 1 cm. in diameter. *S. parviflora*

Divisions of the segments having a very elongate filiform flaccid apex. Full-grown flower-buds narrow and elongate, 5 mm. long, 2 mm. thick. Fruit. . . . . *S. florida*

Figure 150. Sabal parviflora.

B. Leaves with the blade unequally divided, with several of the primary divisions three-costulate, and divided again into unicostulate bifid segments.

Full-grown flower-buds relatively large, obovoid with a rounded top, 4 mm. long, 2 mm. broad. Fruit globular, 9-10 mm. in diameter, narrowing a little towards a slightly bent base. *S. Yapa*

Sabal parviflora Becc. in Webbia di U. Martelli, II, 43. **S. mexicana** (non Mart.) Sauvalle, Fl. Cub. 152.

From the Fig. 150 the adult plant appears to be a fine palm with a rather robust, high and almost regularly cylindrical columnar trunk surmounted by a fine and dense crown of large leaves. The trunk is evidently thicker than

Figure 151. Sabal parviflora. a, full-grown unopened flower; b, c, flowers during the anthesis; d, longitudinal section of a flower; e, fruit; f, fruit as seen from the hilum side; g, h, seeds, median section through the embryo. Fig. a, b, c, d, e, g, from Curtiss No. 484; fig. f, h, from Wright No. 3970.

that of *Sabal palmetto*. From what I can judge by the photograph, the old leaves do not remain long hanging down from the lower part of the crown, but drop off, as soon as their physiological function is fulfilled, leaving the naked stem slightly but closely ringed by the leaf-scars. (Fig. 151.)

One photograph which I have seen shows the crown invaded by an epiphytic *Cereus* which having first rooted itself in the rubbish accumulated at the base of the leaves which also readily catch and retain the rain water in their axils, has grown into a large and very dense mass of long dependent tail-like stems. I have observed a very similar occurrence in a photograph of a *Sabal*, communicated to me by Prof. Trelease, which I have doubtfully referred to *C. rosei* (see Webbia l. c., p. 85) ; in the mass among other epiphytes there appear to be also a *cactaceous* plant. In the back-ground of the same picture may be seen several individuals of apparently the same *Sabal*, having their long trunks terminated by only a tuft of the central and youngest leaves,

the others having evidently been cut away, to be employed in thatching houses, etc., or perhaps in the manufacture of hats.

Prof. Baker's photographs were taken in the savannahs of the western part of the island, where this *Sabal* seems to be a common plant (n. 857 of the dry specimens). Baker's n. 2308 from Batabano, Prov. of the Habana, and Wright's n. 3970 belong to this species.

S. parviflora grows also at Nueva Gerona in the Isla de Pinos, near the southwest coast of Cuba, according to Curtiss n. 484.

Figure 152. Sabal florida. a, portion of a flowering branchlet; b, flower during the anthesis; c, longitudinal section of a flower. From Combs No. 292.

Sabal florida Becc. in Webbia di U. Martelli, II, 46; **S. umbraculiferum** (non Mart.) Combs in Trans. Ac. Sc. St. Louis, VII (1897), 471.

It has been said by Mr. N. L. Britton in the review of my paper on the "Palme Americane" (Torreya, VIII (1908), 238) that *S. florida* differs but slightly from *S. palmetto;* but from this latter it is at once distinguishable by its terete (not angular) flower-bearing branchlets, and longer and narrower flowers. The specimens upon which the species was established were collected by Rob. Combs (n. 292) at Cieneguita, Prov. of Santa Clara, district of Cienfuegos, were common in poor soil, have a portion of the spadix in flower, the fruit is wanting, and nothing is known of the aspect and general dimensions of the plant. (Fig. 152.)

Sabal yapa Wright, Pl. Cubenses n. 3971 (nomen nudum); Sauvalle Fl. Cubana 152; G. Maza, Nociones, etc. (1903), 51; Becc. in Webbia di U. Mart., II, 64. **S. mexicana** (non Mart.) Gaum. Pl. Yucat. exic., n. 317. **Corypha maritima** Humb. et Bonpl. Nov. Gen. et Spec. pl. I, 298?

It is easily distinguishable from the other two Cuban species by its leaves, which are unequally and twice divided, several primary divisions being three-costulate and divided again into two unicostulate acuminate segments having

deeply bifid apices. It is also characterized by the relatively large, obovoid flowers, having a round top when in bud, and by the fruit being somewhat bent or slightly resupinate at its base.

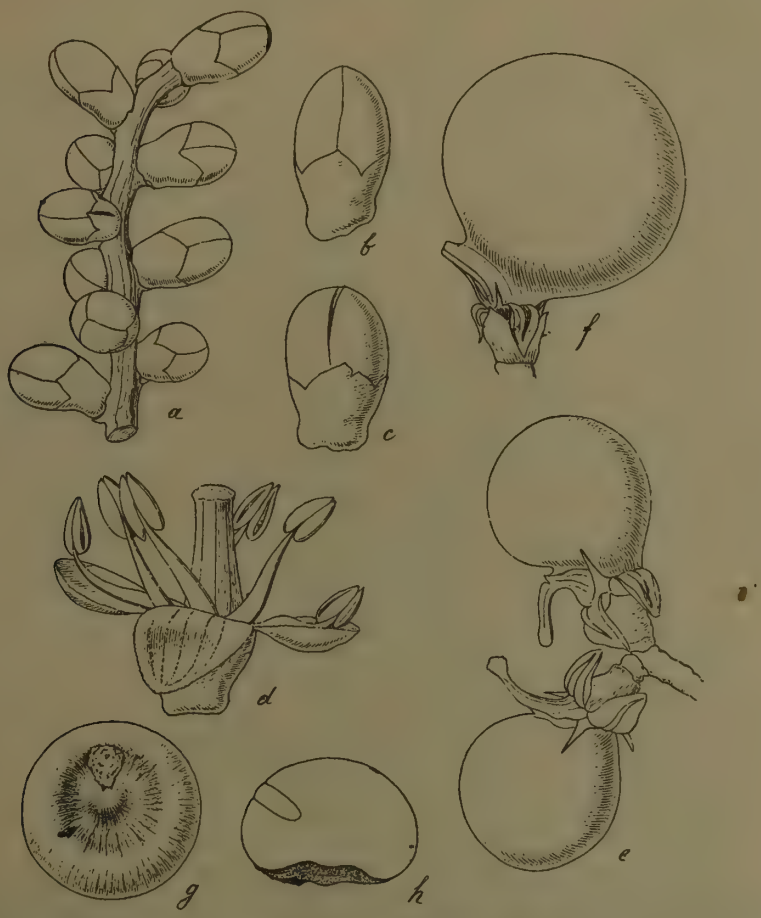

Figure 153. Sabal yapa. a, summit of a flowering branchlet; b, c, full grown unopened flowers; d, flower during the anthesis; e, young fruits; f, mature fruit; g, seed as seen from the raphal side; h, seed longitudinally cut through the embryo. Fig. e from a specimen collected in Cuba by Ramon de la Sagra; all the other figures from Wright No. 3971.

It was collected in Cuba by Ramon de la Sagra in 1829 (n. 222), and it has been found again there more recently by Wright (n. 3971, precise locality not stated) and by Jose Torralbas at Batabano (n. 179) near the sea, in the southwest part of the island. It grows also in Yucatan, as I have identified it with *S. yapa* Gaumer's n. 317 of the "Plantæ Yucatanæ".

Torralbas gives it the vernacular names of "Palma de Guano," "Cana" and also "Miraguano", Sauvalle those of "Guano cana de monte", and "Chagareta".

Roselle (*Hibiscus sabdariffa* L.)

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Many plants were brought to the warmer parts of the United States more than a hundred years ago by the Catholic padres, and the colonists who followed in the wake of the cross have, in most cases, been slow to continue the spread of the cultivation of those plants. Some which were perennial, have withstood the changes of the years and are now horticultural landmarks, and it has remained for the present generation to realize the economic value of those plants and to extend their culture. Within very recent years has the olive been put on a paying basis in California; it is within the last four years that the avocado or ahuacate has been planted as an orchard fruit; the white sapote has not even yet been put out in acreage. Plants introduced even more recently are still in many cases, specimen plants; for example, the mango, which, to be sure, is out in acreage in southern Florida, the cherimoya, the Queensland nut, the Feijoa, the black sapote, and others still less common. These are all trees or somewhat tree-like.

Several years ago there was introduced into the United States the roselle, known botanically as *Hibiscus sabdariffa* L., of the family Malvaceæ, and a close relative of *Hibiscus esculentus* L. (okra), *Hibiscus sinensis* Hort. (the Chinese Hibiscus), *Gossypium* L. (cotton), *Althea* L., *Abutilon* Tourn. (the flowering maple), *Malva* L., and others. The plant was probably first introduced into the United States from Mexico or the West Indies although it is probably a native of the eastern continent where its cultivation is of long standing. It was probably first introduced into California from Australia. It does well in warm, rather dry climates. It is an annual and on account of its fruiting in a single season, it is a valuable plant in newly settled countries. The seed is usually planted in February and March, and in a single season the bushy plant may attain a height about equaling that of a man. The leaves vary from entire leaves on young plants to five-parted leaves on older and larger plants and to three-parted leaves, in the axils of which the flowers are borne. The flowers are large and yellow with red centers. They last for only one day. Within three weeks after flowering the calyxes usually enlarge to a length of from one and a fourth inches to two inches and a width of three-fourths of an inch to one and a fourth inches. By this time the calyx is a bright, clear, red, pointed structure enveloping a round, hard, green seed pod and subtended by bright, clear, red bracts. This usually occurs in October and November.

While roselle has long been cultivated in parts of the far east as a fiber crop, the young stems, also, are used in making jelly, but the most common use of the plant is made of the reddened calyxes and bracts, from which a tart sauce is manufactured. By cutting off the basal end of the bracteate calyx far enough up to cut into the cavity of the calyx, one may very readily squeeze

out the green pod or fruit which is not edible, and may then have left only the edible calyx and its bracts. A very delicious jelly is frequently made from the calyxes and bracts and in so using them, it is not necessary to remove the green fruits from the calyxes prior to cooking, as they may be eliminated at the time the boiled material is strained to separate the juice from the pulp. The juice

*Figure 154. Plant of roselle (*Hibiscus sabdariffa* L.) much reduced.

is often combined with other juices in the manufacture of jelly. Quince juice is frequently combined with it.

Roselle sauce and roselle jelly have been likened to similar cranberry products and are sometimes substituted for them, but an admirer of the

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Figure 155. Calyxes of roselle—the Victor variety—natural size, showing, also, the red bracts.

cranberry sees little like it in roselle. True, both are tart and both are bright, clear, red, but both, also, have distinctive flavors.

The National Standard Dispensatory (Hare, Caspari, and Rusby, 1905) says that roselle "is sour from the presence of tartaric and malic (or oxalic?) acids" on which account it is used in hospitals in Mexico as a refrigerant as well as for its mucilage. The root is said to contain saponin.

The commercial use of roselle in southern California is still very limited, most of the product being raised in private gardens for private use. It is usually to be found in a few of the fruit stores in small quantities in its season. One firm in Los Angeles used a small quantity of it a few years ago in certain bakery products, as a jelly filling, but has been unable to buy it in sufficient quantities since. The Luzon Pineapple Plantation Company of Cabanatuan, Nueva Ecija, P. I., is planning to plant about twenty acres to roselle next year and expects to market it as sauce.

Roselle is of the easiest culture. It likes a hot, dry climate best but needs occasional irrigating. A long growing season is essential in order to bring the calyxes to proper size. Irrigation, if too frequent, delays maturity, but an abundance of water is said to heighten the red color of the calyxes. A loose deep soil is probably best for it. P. J. Wester, of the U. S. Department of Agriculture, in Farmers' Bulletin 307, advocates the use of commercial fertilizers rather than stable manures for roselle.

The plant has not received the popularity it deserves and when the people once become acquainted with it, surely it will increase in favor and possibly supplant some of the cheap imitation jelly products now on the markets.

The Small City Park as a Great Asset

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In the growth of cities, the past tendency has generally been to develop the commercial, the industrial and the residential districts. During this growth no effort has been made in behalf of the common people to beautify the streets uniformly, to provide for parks or to acquire and hold municipal squares or tracts of land for landscape improvement at such a time as the growth and wealth of the city would warrant the initial expenditure and subsequent upkeep. Blind practicality is apt to come first in the mind of the American of today, and the future welfare of the community and the betterment of humanity are overlooked in the attempt to excel commercially, industrially, or in population.

The task of properly providing breathing space and places of retreat from the noise and dirt and confusion of a large city is a vital problem. The provision of public parks for public use becomes a live question. Green grass and trees, flowers, fresh air, and sunshine are all absolutely essential for the health and happiness of the human race. It has truthfully been said that wretchedness and squalor breed crime; that beauty and cleanliness of surroundings inspire worthy thoughts and deeds and tend toward the elimination of things evil. The matter of city parks thus becomes an all important city problem and should be carefully weighed and considered in all city planning. Too much attention cannot be given this subject, and its importance is so often borne in upon the city relatively late in its growth, when it becomes necessary to condemn, or acquire by private purchase at high figure, lands for such public use. California has ever been inclined to profit from the experience of others, but she is still embryonic in her development and can realize with difficulty, if at all, the enormity of her future growth and progress.

This one small phase of city growth and welfare applies less to the smaller towns and its importance is proportional to the size of the village; but it is to the suburban towns, to the valley and foothill municipalities that the writer wishes to call especial attention. Here, the mere smallness of the incorporate limits tends to discourage even the thought of such municipal thrift, and to conceal its true significance. The lack of funds prevents investment in an enterprise of unquestionable but often underestimated value for the future good of the community. The small number of residents argues that there is enough of the country with its health-giving freshness and purity and that it is wasted effort to attempt civic park improvement.

But it is their decided lack of size that argues most strongly, from the standpoint of future welfare, in favor of present consideration of, and action upon the question at hand. In this early stage of development, land can be acquired readily and cheaply, in the most desired locations, relative to the future growth of the city, and reserved for park development till such a time

Plate 156. Here, the appearance of spaciousness and distance is given by mass plantings with well proportioned vistas of open lawn. This view was taken in one small corner of a park comprising in all a single city block.

Plate 157. It is here difficult to imagine the truth, that this vista shows but one corner of a single city square. The effect is accomplished by proper balance in planting and grouping.

as conditions may warrant. Planting need not be done immediately, although such action would be ideal; but there should be an aim in all city planning to provide ample and sufficient park lands in all sections of growth, to serve for future beautification and uplift of those districts.

For many of the smaller towns a single city block affords ample provision for the immediate and near future needs of the people. This, if planted and cared for, will be a source of investment to the city to be considered as capital stock of interest bearing value, because of its influence in attracting outsiders to the community and because of the civic pride and enthusiasm which it instills into the hearts of those who have created and are supporting it. It will pay its own way from the start, if only as an advertisement.

Central Park, in Los Angeles, is an example of such a city block given over to park purposes in the infantile stage of growth of the city, when there seemed no great, pressing need of such a step. Because of the city's magnitude, the value of Central Park to the civic health and welfare cannot now be estimated. Were the park many times its present size and still of such easy access from the business district, it would have many times its present value. It probably has more pedestrian visitors per square foot of its area than any other two or three of the city's abundant park reservations, excepting the Plaza. Its greatest good comes from the fact that it is restful to the tired eye of the passing worker, from the fact that it is of easy access to those who need its cheering influence, and from the mere fact that it affords a change from the glare and noise of the bustling city.

The larger parks, located in the outskirts of the city, are inaccessible and therefore of least value to those who would derive the greatest benefit from their use, as it is the person who lives on the pavement and has nothing to draw him out, or who has not the means to take an occasional outside holiday, who is in the greatest need of that influence created only by nature's green out-of-doors. The above cites one instance in which a relatively small town reserved a city block near the center of its business district, for park purposes and the future welfare of the community.

The Plaza in Los Angeles is another instance of a small city square doing a great good, and is situated in a district where it can be most enjoyed by those in the greatest need. The fact that Central Park and the Plaza are the most populous parks in Los Angeles, speaks well for their location and for the public service which they render.

Again citing the instance of the small town—we have proceeded to so advanced a stage that it is a small town indeed, that does not have ordinances controlling the play of children in the streets. Even though there be no such ordinances, streets are manifestly unfit for playgrounds. Every child should have access to spacious grounds for play, and every ideal city should provide such privileges. Where a municipality has only one or two small parks, they should not be given over entirely to this one phase of recreation, but they might have sections where young America could run and play, could enjoy the shade of real trees and become acquainted with flowers. Play under such conditions is natural, as nature intended, and is to be highly encouraged.

Plate 158. So restful and refreshing a retreat as this might readily be made a feature in the smallest of city parks.

Plate 159. An artistic and harmonious grouping of palms which affords a tropical effect for one corner of the public square.

In most instances where playgrounds have been established in California, and these instances are many, the grounds and apparatus are situated in the glaring sunlight with never a tree nor a leaf to freshen the view and break the monotony. It would be decidedly practical and very desirable to locate these playgrounds among trees and surround them by plantings of shrubbery and flowers; making of them not only a group of mechanical devices for the physical growth of the child, but also a garden for aid in its mental growth. The twofold utility of play and beauty might be furnished the child, as the plantings would afford secluded place for play and would have a pleasing influence both upon the children within and the passersby without.

A city square may be handled in either of two ways, as regards its planting plan. It may be treated in a decidedly formal manner, or it may be planted as simply and naturally as possible. Such a public square is the inevitable spot for the location of statues and fountains, and quite properly so, but it may also be planted with masses of shrubbery and trees arranged in rather an informal style. Wherever possible, the more natural methods of grouping and planting are to be preferred to the strictly formal style.

On the other hand, the public square may be laid out with a view to the pleasure which it will give to those passing by, without; or it may be arranged with the idea of affording pleasure to him who may pass through on his way to or from work, or who may tarry for a moment of relaxation. A combination of the two above schemes is undoubtedly that which should be most sought for in planning the park.

When designed as a park to be viewed from without, the planting is massed and executed with the sole idea of producing a pleasing picture when seen as a whole, with little attention given to the impression of pleasure or comfort from within the square. On the other hand, when the block is to be given over to public use, the methods of procedure, with reference to planting, are much modified. The designer then attempts to combine utility as a park, with attractiveness as a picture. Trees are planted in groups, to form dense shade under which seats and benches may be placed, or they are planted in rows along the walks and paths, for a similar reason. Shrubs and low growing plants are used to soften outlines, to blend and harmonize larger group plantings, and to create a more easy and natural effect in arrangement.

The paths and walks should be given easy and graceful curves but should form quite direct means of crossing the square. Aimless, winding walks lose their charm because of the attending bewilderment to one traversing them, and are a source of disgust to him who wishes to cross the grounds on his way to or from work.

Simplicity in landscaping should always be observed. It is doubtless unneedful to speak of the beauty of lawns and of the added attraction that well kept stretches of lawn always afford. Equally needless should it be to discourage the use of the already fast disappearing flower bed as an ornament in the center of a lawn, where it is highly out of place and detracts rather than adds to the pleasurable effect.

Plate 160. The shaded walk here invites rest and repose and is a welcome relief from the glare of the city streets.

Plate 161. The sunlit open, with the cool shade beyond, beckons, and invites the weary to restful relaxation.

The whole purpose of the designer should be to afford the greatest pleasure and benefit to the public, by giving ample shade, copious seating facilities, direct paths, and at the same time to afford pleasing vistas in miniature, with harmonious grouping and blending of shrubs as a means to the end of effective planting. The matter of creating a sky line and of exclusion, from the outside, of the city sights and noises, is not to be considered greatly because of the small area of parking space and the close proximity of outside influences.

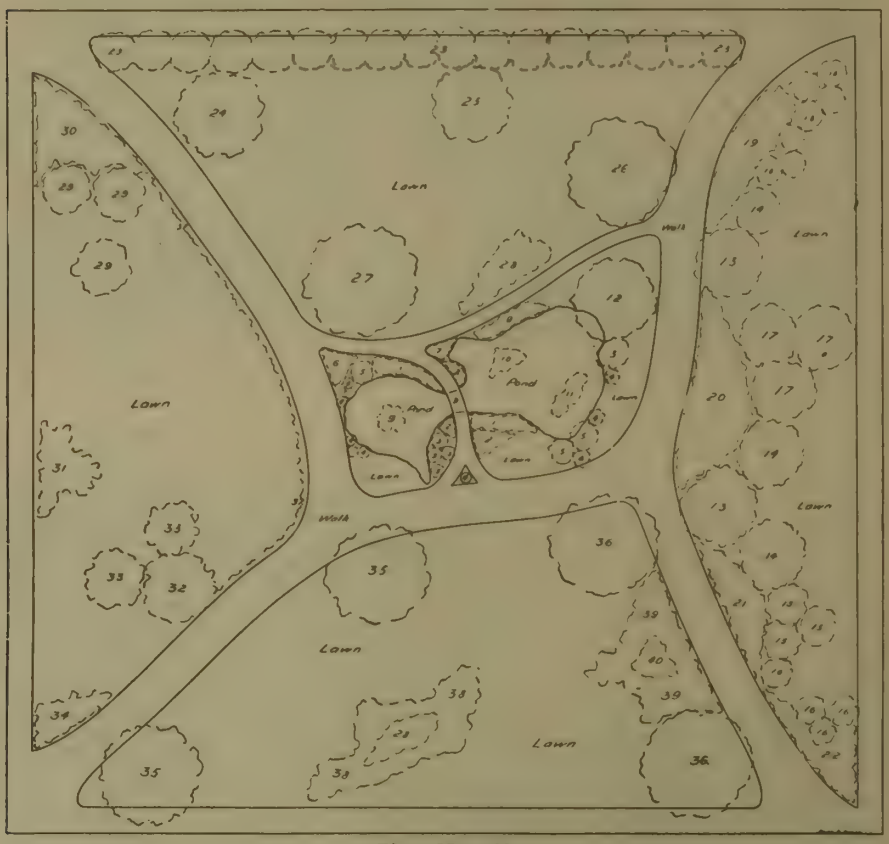

Plate No. 162

PLANTING LIST FOR PLATE No. 162. (The Plan showing the Lake)

A, Drinking fountain; B, foot bridge; 1, *Arundinaria falcata*; 2, *Andropogon citratus;* 3, *Betula alba;* 4, *Gynerium jubatum;* 5, *Maytenus boaria;* 6, *Colocasia antiquorum;* 7, *Bambusa aurea;* 8, *Dendrocalamus latiflorus;* 9, *Cyperus papyrus;* 10, *Nymphaea odorata;* 11, *Nelumbo nucifera;* 12, *Salix babylonica;* 13, *Phoenix canariensis;* 14, *Phoenix reclinata;* 15, *Erythea edulis;* 16, *Erythea armata;* 17, *Cocos plumosa;* 18, *Cocos eriospatha;* 19, Cacti (in variety); 20, Cycads (in variety); 21, Aloes (in variety); 22, Agaves (in variety); 23, *Cupressus macrocarpa;* 24, *Pinus canariensis;* 25, *Libocedrus decurrens;* 26, *Araucaria bidwilli;* 27, *Cedrus deodara;* 28, *Hakea suaveolens;* 29, *Olea europea;* 30, *Feijoa sellowiana;* 31, *Choisya ternata;* 32, *Acacia baileyana;* 33, *Acacia pendula;* 34, *Acacia verticillata;* 35, *Eucalyptus amygdalina;* 36, *Eucalyptus viminalis;* 37, *Heliotropium peruvianum;* 38, *Grevillea thelemanniana;* 39, *Melaleuca hypericifolia;* 40, *Hakea laurina.*

In the accompanying line cuts, Plate 162 is an original sketch showing one possible treatment for a city park of one block. The upper side of the plan represents the west exposure of the park; the Monterey Cypress thus is used to form a break from the prevailing winds while the grouping of palms on the right will give protection from the occasional north winds of our winter seasons. The treatment here is that which will give a pleasing effect from without, while still maintaining something of the spaciousness and seclusion that gives to a park its greatest charm. With the exception of the two sides above mentioned, no attempt has been made to shut the park away from outside sights and influences. Water, whether natural or artificial, is always an added

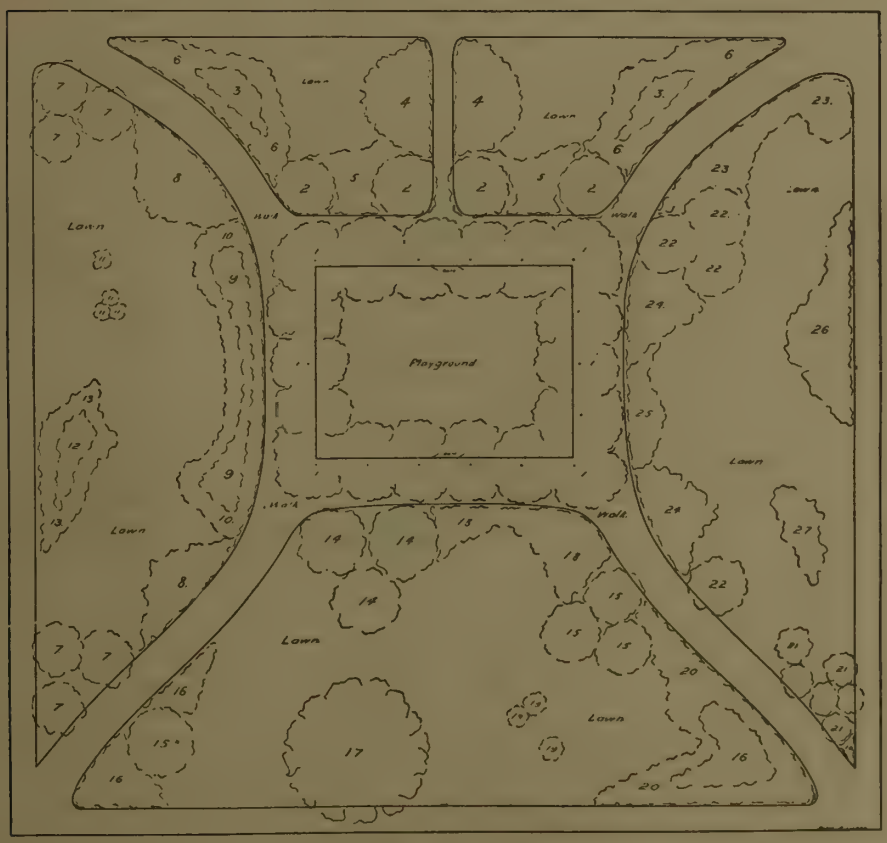

Plate No. 163

PLANTING LIST FOR PLATE No. 163. (Plan with Playground)

1, *Eucalyptus viminalis;* 2, *Acacia latifolia;* 3, *Spartium junceum;* 4, *Tecoma stans;* 5, *Hypericum floribunda;* 6, *Genista florida;* 7, *Ceratonia siliqua;* 8, *Pittosporum eugenioides;* 9, *Euonymous japonica;* 10, *Coprosma baueri;* 11, *Raphiolepis ovata;* 12, *Carissa grandiflora;* 13, *Carissa arduina;* 14, *Sterculia acerifolia;* 15, *Eucalyptus ficifolia;* 16, *Melaleuca hypericifolia;* 17, *Ficus macrophylla;* 18, *Grevillea thelemanniana;* 19, *Eugenia myrtifolia;* 20, *Erica carnea;* 21, *Prunus integrifolia;* 22, *Cinnamomum camphora;* 23, *Romneya coulteri;* 24, *Eleagnus reflexa;* 25, *Choisya ternata;* 26, *Hakea elliptica;* 27, *Diosma ericoides.*

attraction to a planting, and can be very readily and tastefully worked into the smallest of parks with slight expenditure.

Plate 163 represents a type of treatment in which the dominant idea is that of affording shade and greenery for the playground, with shaded and attractive approaches leading to it; and at the same time of affording a pleasing view from the streets without. This treatment is rather more formal than that of the preceding plan, but is unavoidably so because of the necessary shape and size of the playground and because of its location in the center of the park. Were this reservation made in one corner of the block, it would allow greater, unbroken park space and make possible a less formal scheme of planting. Sufficient shade is here available for copious seating arrangements so that the park as a whole might be made into a decidedly utilitarian project.

Each of the accompanying line cuts represents a type of treatment that might well be carried out in the park of minimum dimensions. Specific cases, where distinctive problems arise and where special difficulties need to be overcome, require individual treatment that will meet the requirements of the locality and should be handled in a way to acquire the best results from the material at hand and to take best advantage of any natural assets such as contour, water facilities, and established trees.

Every small town should be able to boast of its public square, tastefully planted to trees and shrubs. Every undeveloped city should establish and maintain park spaces for the future, and thus avoid crime and squalor and sometimes, possibly even death that comes as a result of overcrowding in which insufficient opportunity is afforded to the laboring classes for indulgence in and enjoyment of fresh air, verdure and sunshine. If we make of our towns models, while young, they will continue to be models, when old, and will be free from much of the wretchedness and disease and crime of the overgrown metropolis. Let small city parks do their part in accomplishing this end.

Pomona College

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