SMITHSONIAN MISCELLANEOUS COLLECTIONS
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(With 26 Plates)

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(Publication 3532)

CITY OF WASHINGTON
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Cocos is a small, mountainous, forest-covered island less than 4 miles across, lying in the Pacific Ocean about 250 miles southwest of Panama, chiefly known as a resort of buccaneers and seekers of buried treasure. The mountains rise to nearly 3,000 feet, with surfaces too precipitous for cultivation or grazing, so that permanent settlements have not been made, and the native vegetation has not been exterminated. The new palm was collected by Dr. Waldo L. Schmitt, of the United States National Museum, during the 1938 cruise of President Roosevelt on the U.S.S. *Houston*. It is a tall, handsome palm, of a group that has received relatively little study. Though not related to the coconut palm, it is remarkably similar in size and general appearance, and apparently was responsible in part for the name of the island. Certainly it was included with the coconut by Lionel Wafer in the account of his visit to Cocos Island in 1685, in "A New Voyage and Description of the Isthmus of America," published in 1699.

A nearly complete series of specimens was obtained by Dr. Schmitt, including flowers preserved in formalin, and photographs showing the native conditions and habits of growth, with the result that detailed comparisons with related palms from the mainland of Central and South America are made possible in this paper. Entire inflorescences and sections of the trunk were brought back, which make it possible to determine and to present illustrations of several features usually disregarded in descriptions, though of biologic and taxonomic interest. Palms are poorly represented in collections, and many have been described from fragmentary material, with only a few of the distinctive characters represented.

The study of palms has remained backward compared with other branches of tropical botany, notwithstanding that popular interest in palms is perhaps greater than in any other plants. No other order of plant life contributes so much to the tropical landscape or finds so many uses among the tropical peoples. The reason why collectors of other plants usually neglect or avoid the palms is that specimens are

difficult to obtain and too bulky to be handled by herbarium methods. Collecting a single palm may take more time and trouble than a dozen or a score of herbaceous species, or of branching, small-leaved trees. The leaves, flowers, and fruits of the tall forest palms may be completely out of reach, since many of the larger kinds have the habit of not flowering or fruiting until they emerge from the forest, or at least are tall enough to reach the direct sunlight, at 30 or 40 feet, so that climbing or cutting is necessary before any detailed study can be made. Felling a tall palm in a tangled tropical forest often proves difficult, even after the trunk is severed, but Dr. Schmitt was able to enlist for such an adventure a party of men [1] from the cruiser.

Since few of the related palms have been illustrated, the photographs from Cocos Island are of special value. Several of the illustrations are from photographs obtained for Dr. Schmitt by R. B. Thompson, who took part in the palm excursion. The specimens were collected August 1, 1938, and are preserved in the United States National Herbarium.

Since the name *Rooseveltia* appears not to be preoccupied in botany, it is a pleasure to accede to the wish of Dr. Schmitt that the beautiful palm of Cocos Island, if it proved to be new, might bear the name *Rooseveltia frankliniana,* in honor of President Roosevelt.

HABITS OF ROOSEVELTIA AND RELATED PALMS

The new palm is related to the well-known "royal palms" of Florida and the West Indies (*Roystonea floridana, R. regia* and *R. oleracea*), and to the mountain palms of Puerto Rico and neighboring islands (*Acrista monticola*). Other related palms are known from different localities in the tropical forest regions of South America, and through Central America to Guatemala. About 40 species have been described under the generic name *Euterpe,* others under *Hyospathe, Prestoea, Oreodoxa, Acrista, Catis, Plectis, Oenocarpus,* and *Jessenia.*

The royal palms, the largest and best-known members of the group, are readily recognized by their massive symmetrical trunks, like columns of marble, but among the other kinds are even more beautiful forms. Some are known as mountain palms, from their habit of growing at the summits of tropical mountains, above the dense forests that cover the lower slopes; others live in swamps or among the undergrowth, in the permanent shade of the forest. Barren soils or rocky

[1] Lt. Comdr. R. M. Peacher; Lt. L. M. LeHardy; Ensigns J. P. M. Johnston, R. W. Meyers, and M. H. Buass; and J. L. Learson, M. S. Simon, R. B. Thompson, Jack Barron, T. M. O'Neil, Joe Balicki, and L. F. McPherson.

outcrops unfavorable for other vegetation sometimes give the palms exclusive possession of the mountain summits, with the elevated groves of palms standing out like islands in a sea of forest verdure.

All the mountain palms and their forest relatives are of slender habit, with smooth, clean trunks prolonged by a green column of closely wrapped leaf-sheaths, as in the royal palms, but with the foliage usually a lighter, fresher green, more regular and more open, so that the general effect is exceedingly graceful. The name *Oreodoxa,* meaning "mountain-glory," was very appropriately given to one of the high-altitude palms of Venezuela, discovered by Willdenow, but misapplied by Martius to the royal palms of the West Indies, which grow in the lowlands.

The new genus from Cocos Island finds its affinities with the mountain palms, though larger than other members of that series and different in many features from the mountain palms of the West Indies. The trunk is tall, rigid, and columnar, not attaining the thickness usual in the royal palms, but the crown of foliage having an equal spread and a form even more attractive. A trunk measured by Dr. Schmitt was more than 66 feet long; the leaf-blades attain 13 feet in length, and the segments or pinnae of the leaves are nearly 4 feet long. The open appearance of the leaf-crown is determined by the pinnae not being crowded together and set at different angles to the midrib, as in the royal palms, but regularly spaced and positioned, drooping and swaying in the graceful manner reckoned by many writers as the special charm of the coconut palm, a deceptive similarity that allowed the native Cocos Island palm to remain unrecognized, although every visitor must have seen it. The nature of the resemblance may be appreciated by referring to small photographs taken for Dr. Schmitt by Mr. Thompson and reproduced at the top of plate 13. On the left is a group of coconut palms growing at Wafer Bay, on the right a profile of one of the native palms, emerging above the forest.

COCOS ISLAND AS DESCRIBED BY LIONEL WAFER

The remarkable similarity of the foliage makes it easy to understand how the palms that Wafer and later visitors saw on the hills of Cocos Island would be identified with the coconut palms that grew along the shore, and how this error might complicate the history of the coconut palm, as well as conceal the existence of a different native type. Wafer's circumstantial account of wild coconut palms growing freely on the forest-covered hills of an uninhabited island doubtless has contributed greatly to the belief, still held by some, that the coco-

nut originated in the Pacific Islands. Opposed to this theory is the fact that none of the endemic palms of the islands or of the Asiatic continent is related to the coconut, whereas on the American continent, and especially in South America, are scores of closely related genera and hundreds of species, composing the coconut family.

Cocos Island was described by Wafer as "a very charming place," "so called from its coco-nuts, wherewith 'tis plentifully stored," the impression of abundance no doubt being drawn largely from the native palms growing on the hills in the interior of the island, readily seen from the ship but not easily visited ashore. The coconut palms no doubt were confined to the lower ground, near the landing place, which would seem to have been cleared and planted by previous inhabitants, in view of the many coconuts featured in Wafer's narrative. All coconut palms had disappeared when Cocos Island was visited by Henry Pittier, in 1898 and 1902, in the interest of the government of Costa Rica.

To quote further from Wafer[2]:

> Tis but a small island, yet a very pleasant one; for the middle of the island is a steep hill, surrounded all about with a plain, declining to the sea. The plain, and particularly the valley where you go ashore, is thick set with coconut trees, which flourish here very finely, it being a rich and fruitful soil. They grow also on the skirts of the hilly ground in the middle of the isle, and scattering in spots upon the sides of it, very pleasantly. But that which contributes most to the pleasures of the place is, that a great many springs of clear and sweet water rising to the top of the hill, are there gather'd as in a deep large bason or pond, the top subsiding inwards quite round; and the water having by this means no channel whereby to flow along, as in a brook or river, it overflows the verge of its bason in several places, and runs trickling down in many pretty streams . . .
>
> Nor did we spare the Coco-nuts, eating what we would, and drinking the milk, and carry several hundreds of them on board. Some or other of our men went ashore every day; and one day among the rest, being minded to make themselves merry, they went ashore and cut down a great many coco-trees; from which they gathered the fruit, and drew about 20 gallons of milk. Then they all sat down and drank healths to the King, queen, &c. They drank an excessive quantity: yet it did not end in drunkenness; but however, that sort of liquor had so chilled and benum'd their nerves, that they could neither go nor stand: Nor could they return on board the ship, without the help of those who had not been partakers in the frolick: nor did they recover it under 4 or 5 days time . . . (pp. 175, 176).

If this account be credited, the coconut palms of Wafer's time must have survived from an earlier settlement of people on the island,

[2] Wafer, Lionel, A new voyage and description of the Isthmus of America. Pp. 191-193. 1699.

of which other traces might be found if adequate search were made outside the range of the treasure-hunters. The coconut is strictly a sun palm, unable to develop under shade conditions, and hence unable to compete where forest vegetation is allowed to grow. Tall coconut palms in abandoned plantings may survive for many years before they are covered by the forest growth, but none of the seedlings develop and the old palms die out eventually.

Other parties of buccaneers may have cut more of the coconut palms at Wafer Bay and hastened their extermination, but all had disappeared by the end of the nineteenth century. The only coconut palms that Pittier found at Wafer Bay were a recent small planting of nuts brought by a treasure-seeker from the mainland of Costa Rica, at Puntarenas. At another locality, near the southwestern end of the island, not accessible to landing from the sea, Pittier encountered a few other coconut palms of a different variety, not recognized on the mainland, and possibly a remnant from the former period when the Island was at least temporarily populated before Wafer's time.

Pittier was the first to recognize that the palms on the hills were not coconuts, although no specimen was obtained. But his verbal communication was definite, and was noted in Contributions from the U. S. National Herbarium, volume 14, page 291, published in 1910. Also in "A List of the Plants of Cocos Island," by Alban Stewart, in the Proceedings of the California Academy of Sciences, January 1912, page 388, there is mention of "an undetermined species of palm occurring quite abundantly on the hillsides above both Chatham and Wafer Bays." Specimens with immature fruits were collected, but were not identified. Several other scientific expeditions reporting on the plants of Cocos Island seem to have overlooked the native palm.

OTHER CABBAGE PALMS

To the early explorers and the writers of the colonial period the royal palms and the related mountain palms were known as "cabbage palms," referring to their use as food. The "cabbage" was the tender edible bud of the palm, borne at the top of the trunk, wrapped in a green cylinder of sheathing leaf-bases. The cabbage of the coconut palm and of many others could be eaten in emergencies, but the royal and the mountain palms were held in greatest repute, and in some of the tropical colonies were destroyed in great numbers or even completely exterminated in districts that became populous. The palms of this group which still survive in the West Indies and in Central America are remote from settlements or occur in places so difficult of

access that at least a few are allowed to mature to the stage of producing seeds. These the birds scatter, so that rare individuals may be found.

Appreciation of the royals and similar palms for decorative planting, as in southern Florida and California, is a relatively recent development, mostly in the present century, though now attaining great proportions. The real-estate values of palms in Florida would be reckoned in many millions, single well-grown individuals often being bought at high prices, $500 or more.

Some of the related palms in South America, notably the *assai* palm of Brazil, are spared by the natives for the sake of their small oily fruits, like grapes or cherries, borne in huge clusters. A valuable food beverage is prepared, sometimes called "wine" on account of its rich purple color, though not fermented, and by others compared to chocolate. Alfred Russell Wallace and other scientific travelers have given very favorable accounts of the *assai* as tasty and wholesome, referring to its extensive use in the district of Para as "one of the greatest luxuries that the place affords." Similar uses are reported of the fruits of related palms in Brazil and Guiana.

That the Cocos Island palm has not been exterminated no doubt is explained by the failure to establish permanent settlements, and it may be hoped that protection will be given, should the island be occupied in the future. The palm probably can be cultivated in the Canal Zone, possibly also in Florida, in sheltered locations, and as a conservatory palm would be very striking. Fortunately Dr. Schmitt was able to obtain a quantity of seeds, which arrived in good condition and were planted at once, but with most of the palms germination requires several months, and the young seedlings grow very slowly. Of the several seedlings also brought from Cocos Island by Dr. Schmitt, two survived in the Washington greenhouses of the Department of Agriculture.

OTHER PALMS ON SMALL ISLANDS

Although it is not impossible that the palm of Cocos Island may also occur on the mainland, this is hardly to be expected in view of the localized distribution of many species and monotypic genera. It is much more probable that Cocos Island will share with several other small islands in remote parts of the world the distinction of producing a strictly endemic palm, found nowhere else, except as some of the island species are being cultivated in other countries. The most important commercial species, the so-called "Kentia" palm, *Denea*

forsteriana, familiar as a decorative plant, exists in the wild state only on Lord Howe Island, between Australia and New Zealand. The Canary date palm, *Phoenix canariensis,* hardier and more imposing than the commercial date palm, is restricted in nature to the single island Palma, northwest of Tenerife. The Bermuda palmetto, *Sabal blackburniana,* is a distinct species, all the other palmettoes being found on the American continent or in the West Indies. Navassa Island and Saona Island in the Caribbean Sea, have endemic species of *Pseudophoenix.*

One of the most beautiful fan-palms, *Erythea edulis,* with emerald-green foliage, a favorite ornamental along the coast of California, was introduced from Guadalupe Island, off Lower California, where the wild stock is nearly extinct. Other magnificient fan-palms are found in single islands of the Hawaiian archipelago, and elsewhere among the Pacific Islands. A remarkable new genus, *Pelagodoxa,* was discovered a few years ago in one of the Marquesas Islands. Also in southern latitudes, beyond the tropical belt, insular palms occur; *Juania australis* on Juan Fernandez, off the coast of Chile, and *Eora ultima,* a little-known palm on Chatham Island, southeast of New Zealand. Other species of *Eora* are found on Norfolk Island and Kermadec Island, and one on the main island of New Zealand.

The genera that now are confined to the small islands may be considered as remnants of richer floras existing formerly on the continents. Human agency, no doubt, has exterminated many palms in the regions that were populated in prehistoric times. But even before the human period other types of woody vegetation may have displaced many palms, with the development of continuous forests of branching small-leaved trees, which formed dense canopies of shade under which more primitive sun-palms were unable to grow.

Tolerance of shade has been acquired in different families of palms in several forest regions of the tropics, each region having its special flora of forest palms. The more primitive open-country palms are more widely distributed. Partial tolerance of shade, at least in the younger stages of development, is a positive requirement with all the forest palms, the extent of such tolerance often determining their ability to thrive in cultivation. The early stages of the forest palms may be more definitely specialized for shade conditions, as shown by longer petioles or more delicate foliage, than the later stages, which rise above the forest "roof" and so gain access to the full sunlight. To meet such requirements in the early stages of growth, locations with partial protection from sun and wind should be chosen for the

Cocos Island palm in southern Florida, Puerto Rico, or the Canal Zone, should the seedlings attain the transplanting stage. Permanent soil moisture is needed, of course, for any palms from humid tropical forests. All the hardy types of palms are adapted to open conditions, and do not thrive in the forest or under shade.

EUTERPE A TRADITIONAL NAME OF CABBAGE PALMS

The generic name *Euterpe,* used by Martius and subsequent writers for this group of palms, was borrowed without warrant from an East Indian genus not represented in America. The first specific name, *Euterpe globosa,* was proposed by Gaertner in 1792 for a palm described and figured in 1741 as *Pinanga sylvestris globosa* by Rumphius in the "Hortus Amboinensis," an important early work that served as the basis of many binomial names assigned by later writers. The failure of Gaertner to mention any specimen or locality leaves the name attached to the Amboina palm. The fruit is described and figured by Gaertner with an apical point, erect mesocarp fibers, and a lateral embryo, characters that do not appear in the American palms.

Martius recognized his mistake before the second volume of his "Historia Naturalis Palmarum" was completed, and directed in the index that the reference to Gaertner be suppressed. In his third volume he placed Gaertner's genus *Euterpe* as a synonym under the Malayan genus *Areca,* though continuing to use "*Euterpe* Mart." for the American palms. Also in the "Palmetum Orbignianum," published in 1847, Martius says "*Euterpe* Mart. non Gaertn." In the time of Martius it was customary for botanical authorities to modify definitions and change the applications of names in an arbitrary manner, instead of holding the names to their original applications, as is now considered necessary.

The transfer by Martius of the name *Euterpe* to South America occasioned the proposal by Blume in 1836 of a second name, *Calyptrocalyx spicatus,* for the same palm that Rumphius had described and Gaertner had called *Euterpe globosa.* Several other Oriental palms have simple inflorescences and globose seeds, and Gaertner may have seen some of these. A second species, *Euterpe pisifera,* established by Gaertner on a seed of unknown origin, also was identified by Martius with a Brazilian palm, but Gaertner's drawing of *Euterpe pisifera* has been identified by Herr Burret with *Heterospathe elata,* another East Indian palm, so that no occasion remains for further association of the name *Euterpe* with American palms.

Methods of classifying and naming plants have been profoundly altered since the work of Darwin gained credence for the idea of

gradual development of the organic world. From being concerned primarily with the fixing of names, classification has widened to a study of the courses of development, and is no longer limited to definitions or to logical analysis of the characters originally used in distinguishing groups, but calls for comparative study of any and all differences to the end of discovering and formulating new characters that mark the courses of development and the relationships of the groups to each other. The facts of development and adaptation determine the characters to be defined and the form of statements needed to present the differences clearly.

Floral characters are less specialized among the palms than in many other groups, but stages of specialization are marked as definitely by other features. The inflorescences and the floral envelopes, instead of being enlarged and expanded as in many of the groups that are pollinated by insects, have been greatly reduced and simplified in many of the palms, in order to be covered more effectively during the early stages of development. The usual protective functions of the floral envelopes in other groups of plants often are assumed among the palms by the spathes, or even by the leaf-sheaths, thus avoiding any exposure of the tender budding tissues to the sun or to the wind, or to insect injuries. Inflorescences have been simplified and floral envelopes have been reduced to rudimentary organs in many of the palms. That different courses of specialization have been followed in the various groups, though all in the direction of protecting the flowers, is evidence of the adaptive values of such specializations.

Characters framed for taxonomic use are no longer to be considered as permanent definitions, seeing that supposedly diagnostic differences may lose their significance and that changes in descriptions often become necessary when closer relatives are discovered and compared. For such purposes of gradual improvement of classifications and descriptions, it obviously is necessary that names be held to their original application instead of being borrowed or shifted from one group to another, as the custom was among the older writers.

In order that a generic name like *Euterpe* may always refer to the same group of plants, it should be attached inseparably to its original "type" species, instead of being allowed to drift away to other species that later may prove to belong to different genera, and so leave the original type to be renamed, as often has happened. The need of replacing these insecure methods began to be recognized several decades ago, but much of the confusion caused by casual or arbitrary transfers of names has still to be corrected. Darwin himself appreciated the basic

need of authentic names for scientific study, and left a legacy for establishing a universal list of all the genera and species that had been described, the well-known "Index Kewensis."

GENERA FROM SOUTH AMERICA AND THE WEST INDIES RELATED TO ROOSEVELTIA

The palms that have been referred to *Euterpe,* though having a general similarity in habits of growth, show numerous specialized differences, some of which will undoubtedly be formulated to serve as generic distinctions in place of the larger group which is still in part treated as a large composite genus. Four genera have already been recognized in this assemblage, *Acrista* in the West Indies, *Oreodoxa* in Venezuela, *Catis* in Brazil, and *Plectis* in Guatemala. Thirteen new species of *Euterpe,* mostly from Colombia, were described in a single paper published by Herr Burret in 1930, indicating that the group may be much larger than has been supposed.

The name *Acrista* was proposed in 1901 for the mountain palm of Puerto Rico, as distinct from the *assai* palm of Brazil, which Martius had described as *Euterpe oleracea.* This specific name was found to be invalid because in the same work Martius had placed under *Euterpe* a much older *Areca oleracea,* from the West Indies, originally described by Jacquin in 1763, and later recognized as the royal palm of Barbadoes, *Roystonea oleracea.* To resolve this confusion, the name *Catis martiana* was suggested in 1901 for the palm that Martius had described as *Euterpe oleracea.*

The genus *Catis* is similar to *Acrista* in its seeds with ruminate endosperm and its seedlings with simple, bilobed leaves, but distinct in its slender long-jointed trunk, longer leaves with more numerous (80-100) narrow drooping pinnae, the inflorescence branches adnate to the rachis above the insertion of the subtending bract; surface of axis and branches closely beset with stellate-tufted scales, including the surface of the bracts; scars of male flowers often separated 2 to 4 times their diameter from the female flower-scars; male flowers with a large calyx, more than half as long as the petals, and oblong anthers 3 to 4 times as long as broad, notably longer than the filaments, instead of short anthers and long filaments as in *Acrista;* female flower-scars enclosed by prominent triangular bracts, much overlapping below, but little above.

Catis is not a mountain palm like *Acrista,* but thrives in swamps and water-courses in the lower Amazon Valley, its fruits being used extensively, as already stated. *Acrista* in Puerto Rico is confined to

mountain summits, and apparently requires somewhat open conditions, like most of the palms with small fruits eaten by pigeons or other birds. Many of the tropical forest trees, including some of the palms, have very large seeds, allowing seedlings to grow taller in the deep shade. The light requirements of *Acrista* were indicated by great numbers of the seedlings, only a few inches high, growing in the leaf-mold of a dense forest of tabonuco (*Dacryodes hexandra*) near Ysolina, south of Arecibo, visited in 1901. The forest floor was carpeted with the small palms, but in the permanent twilight none of them grew beyond the seedling stage. A photograph of this unusual pure-stand forest appears in the "Economic Plants of Puerto Rico," by O. F. Cook and G. N. Collins, Contributions from the U. S. National Herbarium, volume 8, page 132, 1903.

The genus *Oreodoxa,* in its original application to *Oreodoxa acuminata* Willdenow, a mountain palm of Venezuela, apparently is much closer to *Acrista* than to *Catis,* in having straight, naked branches, widely spaced flower-clusters, the male flowers with large compressed divergent pedicels, and the collar bracts very short, enclosing only the lower part of the female flower-scar, not covering the pedicels of the male flowers. These distinctive features are shown in Beccari's drawings of specimens from Venezuela, published in "The Palms Indigenous to Cuba." Beccari held that the name *Oreodoxa* was available for transfer to the royal palms, because Willdenow's *Oreodoxa* belonged to *Euterpe.* In reality Martius did not transfer *acuminata* to *Euterpe,* but listed it under *Oreodoxa.* The change of application apparently occurred incidentally, through disregarding the original use of *Oreodoxa* by Willdenow and featuring the better-known royal palms as representing that genus, instead of providing the new name that was needed for the royal palms and later was supplied in *Roystonea.*

A CLOSELY RELATED PALM IN GUATEMALA[3]

The ample material obtained by Dr. Schmitt allows many more characters to be studied than are usually treated, descriptions of most of the species being drawn from herbarium specimens alone. Several features of the new palm have not been previously recognized, some of them doubtless existing among the related types, but not yet formulated. Statements of new characters can have little meaning unless they take account of contrasting features of related forms. The palms are so different from other plants that many of the

[3] See description on page 22.

customary descriptive terms and expressions are applicable only with special meanings, and may prove misleading unless the actual features can be illustrated, preferably by photographs.

The Cocos Island palm is related rather closely to *Plectis owcniana* Cook, discovered in mountain forests of eastern Guatemala in 1902 and briefly described in the Bulletin of the Torrey Botanical Club, June 1904. The specimens of *Plectis* preserved in the United States National Herbarium include entire inflorescences and spathes, with several photographs taken in the type locality, so it is possible to illustrate several features for comparison with the new genus. Two species described under *Euterpe,* by Oersted from Costa Rica in 1858, *E. macrospadix* and *E. longipetiolata,* are well represented in the Herbarium. They are small, slender palms, with ruminate seeds and simple-leaved seedlings, related to *Acrista* but not to *Plectis* or to *Rooseveltia.*

A COMPARISON OF ROOSEVELTIA AND PLECTIS

HABIT AND TRUNK CHARACTERS

Though sharing many of the characters of *Plectis,* the Cocos Island palm is of more robust habit, with a thicker trunk and shorter, broader internodes, much wider than long, whereas the trunk of *Plectis* is more slender, with internodes often much longer than wide, sometimes twice as long. The base of the trunk is rather abruptly thickened, instead of tapering gradually as in *Plectis,* the leaf-sheath bundle is thicker, the stalk or petiole of the leaf is much shorter, and the rachis or midrib notably longer. The trunk is supported on a mass of coarse roots, 2 cm. or more in diameter, usually not appearing above the surface, but the lower side of the root mass is sometimes exposed on steep slopes of tenacious clay soil, as shown in plate 4.

A rather young palm, 25 or 30 feet high, was measured by Dr. Schmitt, 45½ inches around the thickened base of the trunk, and 20½ at 2 feet above the base; but notably larger palms were seen, so that a diameter of 40 cm. or more is indicated, rapidly narrowing to about 20 cm. and then narrowing very gradually to 12 or 13 cm., as shown by sections from the top of the trunk, with inflorescences still in place. The trunk of *Plectis* tapers much more gradually from the base, and becomes much more slender at the top.

The gradual thickening of the trunk is a feature that most of the palms do not share, the function of secondary growth being recognized only in the exogenous, bark-bearing plants, that have a special layer of cambium tissue for forming new wood. Although the trunk

of *Rooseveltia* has a fibrous structure like other palms, the arrangement of the fibers makes it possible for growth to continue, a hard shell being formed by closely compacted stout fibers, but with finer fibers outside, under a surface crust. The layer of large indurated fibers is about 2 cm. thick, with the fibers about 2 mm. in diameter, as shown in natural size at the right of plate 5; the layer of finer surface fibers is about 4 mm. thick. The fibers of the interior of the trunk are only 1 mm. or less in diameter, separated by loose pith. Each of the pith fibers has a large tubular channel on its mesial face, notably larger than the channels of the thick fibers or those of the smaller fibers near the surface. The finest fibers, delicate and filiform, are embedded in a light brownish corky stratum underlying a brittle surface crust, less than 1 mm. thick. The exposed surface of the crust, though appearing nearly smooth, is marked with fine longitudinal grooves, rather irregular and indistinct, usually 2 to 4 mm. apart, as shown at the left of plate 5. Where the surface is protected by crustaceous lichens, or overlaid with fine roots of epiphytic plants, the "bark" becomes thicker and more deeply fissured, leaving no doubt of a gradual renewal taking place where the surface is exposed.

The leaf-scars are difficult to detect on sections from the lower part of the trunk, but internodes 5-6 cm. long are indicated; on the fruiting section the internodes are reduced to 2.5 cm., the leaf-scars longer than the intervening zones, often attaining 2 cm., the scars not impressed or constricted, the surface somewhat uneven with scattered granules or tubercles where the fibers are attached (see pls. 10 and 12). Much longer internodes are indicated by photographs of *Plectis,* probably attaining 12 to 15 cm. (see pls. 20 and 21). Two or three consecutive joints bear inflorescences, with an interval of 3 or 4 barren joints before the inflorescences of the next season are developed.

CHARACTERS OF THE LEAVES

The leaf-crown of *Rooseveltia,* as shown in the photographs, is more ample than that of *Plectis,* and has a different aspect on account of the longer rachis and the more numerous and longer pinnae, and because the pinnae of *Plectis* droop from the rachis in a gradual curve. The rachis is held more erect or ascending in palms that stand in the open, shown in plates 1 and 19, instead of spreading or drooping, as in the more protected forest locations, plates 2 and 3. Although the leaf-blade is notably longer than in *Plectis,* about 4 m. instead of 3 m., the petiole is much shorter, 10-15 cm. instead of 35-45 cm., and the lowest pinnae are much closer together, only 3-6 cm. apart to 12-14 cm.

in *Plectis*. The pinnae number 73 on a side and attain 115 cm. in length near the middle of the leaf, compared with 63 pinnae in *Plectis*, 90 cm. long. The upper pinnae are reduced to 60 cm. in *Rooseveltia*, in *Plectis* to 37 cm.

The leaf-sheath is indurated and somewhat bulged in the middle of the lower part, extremely hard when dry, the outer surface nearly smooth, finely and irregularly striate, with the lines broadly and regularly sinuate near the base, thus affording space for the development of the young inflorescence, which apparently reaches nearly full size before the leaf falls. The remarkable thickening of the lowest joint of the peduncle may have a function in rupturing the base of the leaf-sheath at the proper time, although the sheath splits on the opposite side. Inner surface of sheath a much darker brown, deeply and coarsely striate when dry, also showing sinuate lines marking the courses of the fibers, but more prominent on the side supporting the petiole, there with 6 or 7 rows of fibers, distinctly coarser than those of the thinner sections; thickness of the middle section in the dry state attaining 5 mm., elsewhere about 1 mm. thick. The thickening of the sheath in the middle extends to the base, including the leaf-scar; length of leaf-scar below the thickened section usually about 1.5 cm., sometimes nearly 2 cm., about 1 cm. on the other side. The upper part of the leaf-sheath, the back of the petiole, and the lower part of the rachis with a distinct pale vitta nearly 2 cm. wide, of harder tissue and somewhat more prominent than the neighboring surface.

Petiole 4 cm. wide, deeply grooved, very densely beset with coarse rusty-brown scales on the upper side, underneath with only minute scattered brownish scales, the surface with rather thin, minute appressed tomentum, appearing silvery or glaucous. Considering the petiole morphologically as a naked basal section of the rachis, the length would be reduced by the pinnae extending lower down, and this is indicated by the lower part of the rachis being grooved in *Rooseveltia*, but nearly flat in *Plectis*.

Rachis measuring 343 cm. in the only complete specimen, broadly grooved at the base, nearly 4 cm. wide, narrowed gradually and thickened in the middle, the ridge widening and the lateral margins sharpening, soon forming a distinct lateral groove where the pinnae are inserted, the groove gradually wider and deeper, with the median ridge gradually narrowed and the lateral projection above the groove gradually suppressed, till only a thin median flange remains, rising about 1 cm. above the insertions of the pinnae. On the terminal third of the rachis the median flange is suppressed gradually, and the rachis

narrowed to 2 mm. near the end. Upper surface of rachis beset with coarse brown scales, the lower surface nearly naked, the scales minute and widely scattered.

Lowest pinnae 3-6 cm. apart, very narrow, 66 cm. long, 5-6 cm. wide, often splitting into 2-3 slender shreds; fourth pinnae 60 cm. long, 12 mm. wide; middle pinnae 115 cm. long, 4.5 cm. wide, with a prominent vein on each side 1-1.3 cm. from the midrib, usually more remote from the upper margins than from the lower, as 7 mm. to 4 mm. Three or four of the intervening venules larger than the others, but not regularly spaced, the finer venules very close; no indication of cross-veins. Upper pinnae 2.5-3 cm. apart, measured from the midveins. Pinnae with coarse brown scales underneath along the midveins, like the scales of the upper side of the rachis. Terminal pinnae very slender, 60 cm. long, 3 mm. wide, tapering to a long filiform point. The base of the rachis is shown in natural size at the left in plate 7, the pinnae on the left side torn off, and also the third pinna of the right side, but the attachment is perceptible as a narrow oblique scar near the middle of the section. Thus the narrow basal pinnae are nearly as close together as the pinnae at the middle of the leaf, shown in plate 8, in marked contrast with the lowest pinnae of *Plectis,* shown in the right-hand figure of plate 7.

STRUCTURE OF THE INFLORESCENCE

The inflorescences are similar to those of *Plectis* but relatively much shorter and more compact, attaining about 65 cm. instead of exceeding 1 m. as in *Plectis,* the peduncle and axis more reduced, the branches set closer, the flowers notably more crowded, too close for contiguous fruits to develop without contact, notably congested in the proximal portions of the lower branches instead of being farther apart as in *Plectis;* also the naked basal sections of the branches much shorter and more compressed than in *Plectis,* with a smaller and more specialized pulvinus. Surface of branches with a dense tomentum of stellate scales, notably coarser and thicker than in *Plectis.*

Spathes somewhat unequally developed, the lower spathe scar relatively narrow and superficial, the triangular lateral expansion of the scar much narrower than in *Plectis* and the projecting angle smaller. Inner spathe attaining a length of 85 cm., including a slender unopened tip 7 cm. long, 1.5 cm. wide at the base; width 5-6 cm., somewhat thickened at the sides but not distinctly carinate, the surface smooth but not shining, costulate along the fibers, and minutely striate, like an appressed tomentum; in the middle or lower part with scattering light-colored lacerate-stellate scales, more of the rays directed upward.

The peduncle is relatively smaller and more compressed than in *Plectis,* except the basal joint, which is strongly swollen and indurated, 3.5 cm. long in the middle, 6 cm. wide at the notches below the spathe scar, and 12-14 cm. wide across the basal rim that embraces and nearly encircles the trunk, the ends only 5-6 cm. apart; the line of attachment, where the fibers from the inflorescence enter the trunk, very narrow, only 4 mm. wide; lower face of joint abruptly swollen immediately below the spathe scar, whereas the lower joint of *Plectis* is only slightly and gradually swollen on the lower side, though distinctly swollen in the middle of the upper side. Second and third joints more abruptly reduced than in *Plectis,* though relatively longer, because the first joint is shortened; second joint more than half as long as the basal joint and nearly twice as long as the third joint, whereas in *Plectis* the first joint may be two or three times as long as the second, and the third joint nearly equal to the second. The entire inflorescence in flowering and fruiting stages shown in plate 13, figures *c, d, e* and *f,* with the remarkable enlarged basal joint, this also in natural size, with the basal joints of the axis in plates 11 and 12.

Axis much longer than the peduncle, though relatively short, from lowest to highest branch 27-29 cm., instead of 38 cm. in *Plectis,* closely beset with about 80 branches, not including those suppressed near the base, 18 on the upper side and 6 on the lower, or about 100 branch positions in all; the lower branches and branch positions subtended by short transverse bracts, much broader than long; bract of third joint 1.5 cm. long, 2.3 cm. wide; bract of first branch 5 mm. long, 1.8 cm. wide, other bracts 2 mm. long, 1 cm. wide, gradually smaller, these reduced bracts notably contrasting with the large linguiform bracts or secondary spathes that subtend the lower branches of *Plectis,* shown in plate 22. End of axis appreciably thicker than the branches, attaining 6 mm., the branches 5 mm. or less, gradually tapering to 3 mm. Naked base of branches attaining 3 cm. Lower branches attaining 57 cm. long, upper branches 43-45 cm. The male flowers are mature on the lower and middle sections of the branches soon after the inflorescence is exposed, but near the ends of the branches are many undeveloped flowers with the corolla not emerging beyond the calyx. A branch at the stage of flowering is shown in plate 14 at the left, cut in three sections, with many full-sized male buds still in place, but the flowers fallen, leaving many female buds standing alone, natural size; also detached male flowers and upper sections of a less-developed branch with the male flower-buds still in place. Lower sections of two mature fruit-bearing branches are shown in plate 16.

FLOWERS AND FRUITS

Flowers in clusters of three, each cluster subtended by a broad lunate basal bract less developed than in *Plectis,* mostly covered with rather coarse tomentum of stellate scales like the surface of the branch, the margin of the bract usually naked, often sharply angled or apiculate in the middle; female flower enclosed by two large, broadly triangular longitudinal bracts, notably more prominent than the basal bract, slightly overlapping at the ends, forming a collar around the flower scar; one bract usually longer than the other, more distinctly angled at the apex and more carinate at the back, the margin often notched or fringed in the middle by the ends of parallel fibers like those of the sepals, outer surface of collar bracts with a rather sparse tomentum, shorter and finer than that of the basal bract; two male flowers above each female flower, the male flower scars usually circular, quadrate or oblong, usually separated from each other by less than their combined width, set close to the large collar bracts of the female flower but separated by a rim of dense tomentum doubtless representing a very short pedicel; one of the male flowers more distinctly pedicellate than the other, and the scar somewhat smaller; the small bracts that subtend the male flowers decurrent between the upper extremities of the basal bract, often sharply angled. The collar bracts are distinctly accrescent, growing much larger where fruits are developed, sometimes nearly 2 mm., or nearly half the length of the sepals, in section through the middle thicker than the sepals or the petals; of the same brownish or purplish color as the perianth and the neighboring tomentum, possibly stained from the ripe fruits. Scars of female flowers and ripe fruits are shown in great numbers in plates 16 and 17.

Male flowers 6 mm. long, the calyx triangular, the sepals broadly overlapping, 3 mm. long, thickened in the middle and often distinctly carinate, the prominence usually ending abruptly below the angular apex; margins on each side minutely fringed. Petals narrowly triangular, 5 mm. long, 2 mm. wide at base, rather irregularly costate-striate on the inside, with a rounded basal pulvinus nearly 2 mm. long, fused with the large staminal cushion filling the lower third of the flower.

Stamens 6, not exserted, the filaments rather robust, subconic, of firm, fleshy texture, 3.5 mm. long, broadened at base to nearly 1 mm. and somewhat united, forming a low ring on the staminal cushion; filaments incurved at base, above gradually recurved, especially those alternate with the petals; end of filament subtruncate, the attachment

at one side. Anthers introrse, oblong, slightly tapering, 2-2.5 mm. long, the narrow subversatile attachment a little above the middle, the dark connective exposed at the back, nearly as long as the pale closely contiguous anther-cells. Pistillodes nearly 3 mm. long, conic-cylindric, assimilated to the filaments in form, texture, and color, thickened and somewhat united at the base, not flattened or much united as in *Catis* or *Acrista*.

Female flowers with sepals and petals of the same texture and form, broadly obovate-triangular, the distal margin often transverse or retuse, but distinctly mucronate in the middle, the mucro thickened and the median area prominent, with numerous parallel longitudinal fibers, the marginal band very thin and transparent, often lacerate-fimbriate. Petals in the bud enclosed by the sepals, but strongly accrescent, at maturity about one-third longer than the sepals, covering the lower third of the fruit, the mature perianth brownish, tinged with dull crimson-purple along the margins. Staminodes obsolete, lacking even the thin rudiments sometimes found in *Plectis*.

Fruits somewhat larger than in *Plectis,* subglobose, nearly 1 cm. in diameter; style and stigma subapical, persistent, borne on a prominent indurated frustum, surface more coarsely granular than in *Plectis;* the outer crust thicker and harder, formed of large accretions of stone-cells; mesocarp fibers few, though stronger and more irregular than in *Plectis*. Not only the style and stigma are thicker and more persistent than in *Plectis* but the supporting frustum is more prominent and much more indurated, the difference in texture being indicated by a dull yellowish color, instead of purplish like the surface elsewhere. The frustum in *Plectis* is somewhat less prominent, and only the rim is indurated and of a lighter, yellowish color, along the upper margin; also the induration is less in *Plectis* and the disk nearly flat, the style not being thickened, and the base relatively narrow and abrupt.

SEEDS AND SEEDLINGS

Seeds globose-reniform, with uniform endosperm, basal embryo and subapical hilum, the upper surface somewhat flattened, a broad shallow groove between the hilum and the embryo; the upper margin of the groove around the hilum somewhat prominent or inflated, more than in *Plectis,* also the groove broader and more sloping on the sides, the raphe or downward extension of the hilum much narrower than the groove, with distinct margins tapering gradually to a point about halfway to the embryo; the groove mostly occupied by a strand of parallel fine fibers, radially diverging under the embryo; the outer

layer of fibers much more irregular than in *Plectis,* some rather broad and flat, the inner layer also somewhat less regular, the lining membrane very thin, closely adhering around the seed, with the finer fibers impressing the surface of the testa. In *Plectis* the raphe is broader and longer, extending to near the embryo, and the fibers are free from the testa, leaving the surface clean and only faintly impressed with fine parallel lines.

Seedlings like those of *Plectis,* but more slender and delicate; first expanded leaf with 6 separate segments, the rachis 1.2 cm. long, uniting the middle segments for 8 mm.; second leaf and at least three others with only 4 segments, 2 on each side; sometimes remaining adherent on one or both sides; the segments somewhat more slender and grasslike than those of *Plectis.* Segments of first leaf 6.5 cm. by 3.5 mm., widest below the middle, tapering gradually; midvein and submarginal veins distinct, with 3-4 venules between; margins distinctly thickened.

Seedling internodes very short, only 1 to 2 mm., with 2 or 3 roots emerging from each joint, either from the leaf-scars or from the intervening surface; roots 1-2 mm. in diameter, attaining 15-30 cm., tapering gradually, branching irregularly, often with fine ramifications near the base; roots very stiff and wiry, often injured at the sockets, so that transplanting may be difficult, as indicated by the survival of only two of those brought home by Dr. Schmitt. These individuals were among the smallest obtained.

Sheaths and petioles of seedling leaves very long, no doubt an advantage in reaching more light; second bladeless sheath 4 cm., sheath of first expanded leaf 5 cm., increasing to 15 cm. on the next 4 or 5 leaves, the filiform petioles as long as or longer than the sheaths, and the segments nearly as long, so that a height of half a meter is reached before the trunk is a centimeter long or a centimeter thick. Much longer petioles, probably a meter or more, are shown in the photograph of young palms or offshoots growing in the forest (pl. 3), in striking contrast with the very short petioles at the adult stage. Compared with the seedling leaves of *Plectis,* the sheaths are longer and the petioles relatively shorter, in agreement with the proportions of the adult palms. The rim of the sheath, opposite the insertion of the petiole, even on the lower leaves, is not transverse, but has an upward projection or antiligule 1-2 cm. long, indicating that this structure is a general feature of the palm.

The seeds began to germinate in a few weeks, and by the middle of April 1939, many of the seedlings had expanded the first 2 leaves,

showing a remarkable regularity in the 6 pinnae of the first leaf-blade, with fewer pinnae and the number less regular on the second leaf. The antiligule is a constant feature, even on the first leaf, triangular and sharp-pointed, 5 to 7 mm. long, of very thin texture and soon turning brown like the tips of the bladeless sheaths. The first sheath, about 1 cm. long, has little chlorophyll and soon dies, the second sheath, 4-5 cm. long, being more persistent. The surfaces of the seedling, including the bladeless sheaths, midribs, veins and margins of leaves, are moderately beset with reddish-brown scales, more abundant near the base and the tip of the leaf-segments than in the middle. The outer sheath rises from a shallow cup, about 2 mm. high, like that figured by Martius as the coleoptile of *Euterpe oleracea,* the Brazilian *assai* palm now called *Catis martiana.* This organ is an outgrowth of the cotyledon, not a part of the plumule, and lacks the longitudinal fibers that give the sheaths a ribbed appearance in drying. A single primary root usually is surmounted by a single secondary, close to the coleoptile, which splits on that side. The roots are very slender and wiry, with many contorted lateral rootlets and adherent patches of a dark-brown membrane, suggesting an early surface layer that exuviates.

CONTRASTING FEATURES

The outstanding differences are the columnar, short-jointed trunk, abruptly thickened at the base; the thicker, more indurated leaf-sheaths; the large fibrous antiligule; the short, densely squamous petiole; the long rachis with numerous close-set pendent pinnae; the more compact and shorter inflorescence, with the basal joint strongly crassate and expanded to encircle the trunk; the close-set branches, subtended by small bracts; the crustaceous exocarp with the style persistent, and mounted on a broad indurated frustum; the irregular mesocarp fibers; and the broadly grooved seed, with a narrow short raphe.

The relative absence of a petiole in the adult stage of *Rooseveltia,* the more compact and shorter inflorescences, and the harder shell of the fruits, in comparison with *Plectis,* may be taken to indicate less definite specialization as a forest palm, and better adaptation to open conditions than related palms that are natives of heavily forested regions on the continent. The island flora is very limited, of course, in comparison with that of the continent, including only a few kinds of trees, and these doubtless recruited gradually, so that in former times the palms may have had much more open conditions than in the recent period.

The branches of the inflorescence are set too close along the axis to afford space for thickened bulbous bases and swollen pulvini like those of *Plectis,* which stand much wider apart. There is only a short abrupt basal widening of the branches in *Rooseveltia,* and this notably flattened, with thin angular margins; the pulvinus also is more reduced, in the dry state appearing as a small corneous prominence, rather than broad, woody and persistent as in *Plectis.*

As a consequence of the flower-groups being set more closely along the branches the positions of the male flowers are somewhat different from those of *Plectis,* the male buds not lying so flat against the branches, as shown by the long impressions above the female flowers. With the male buds more perpendicular to the branches, the bud-scars are not so much sloped or tilted against the base of the female flower, and hence appear more distinct in the photographs than do those of *Plectis.* Also the more upright position of many of the male flower-buds is shown in the natural-size photograph of inflorescence branches at the early flowering stage (pl. 14).

ROOSEVELTIA FRANKLINIANA,[4] n. gen. and sp.

Plates 1-19

Diagnostic characters.—Agreement in many characters shows close affinities with *Plectis,* but the trunk more robust and columnar, abruptly thickened at the base, not forming aerial roots; internodes short, much broader than long; leaf-sheaths indurated at the base on the axial side; rim of leaf-sheath fibrous, produced in the middle, opposite the petiole, into a long fibrous antiligule; petiole very short, densely squamous; rachis very long, the pinnae more numerous, very long and pendent, the lower pinnae adjacent; inflorescence shorter and more compact, with more numerous close-set branches, the peduncle very short, the basal joint indurate, crassate and inflated; numerous lower branches suppressed on the upper side of the axis and several on the lower side; branches and branch positions subtended by short, transverse, rudimentary bracts; branches with a short, naked base slightly inflated at the insertion; surface of branches densely tomen-

[4] Rooseveltia genus novum, *Rooseveltia franklíniana* species typica, palma spectabilis formosa, insulae nuncupatae "Cocos" indigena, ad Plectina "halaute" Guatemalensium proxima, trunco valido columnari crebricincto, antiligula ampla fibrosa, petiolo perbrevi supra dense squamoso, pinnis permultis approximatis praelongis pendentibus, spadice compacta, floribus congestis, baccis grumosis, seminibus late impressis recedit. Typus, *Schmitt* 134 (U. S. Nat. Herb. 1,746,833—841).

tose; flower-clusters closely crowded on the branches, especially on the lower sections of the basal branches; basal bract of flower-clusters moderately developed, notably less prominent than the collar bracts; male flower-scars often oblong quadrate or rounded, margined or winged with tomentum especially on the mesial side, the pedicel reduced to a thin disk, but sometimes distinct; fruits with an indurated discoid frustum bearing the persistent indurated style and stigmas; pericarp granular-tuberculate on the surface, hard and crustaceous in texture, with irregular granules like stone-cells; mesocarp fibers flexuous and variable in size, forming a rather irregular network; seed distinctly flattened on the upper face, a broad gradually sloping groove between the hilum and the embryo, and a short, narrow raphe, extending about halfway to the embryo.

DESCRIPTION OF PLECTIS OWENIANA COOK[5]

Plates 4, 7, 20-26

Trunk smooth, ringed with leaf scars, attaining 25 m. in height, 68 cm. in circumference at base, 50 cm. at one meter above the base, 27.5 cm. at the top; trunk supported on a conical mass of thick tuberculate roots 7.5 cm. in circumference, with large fibrous root-caps; sometimes with aerial roots growing from higher internodes, to a meter above the surface, forming props around the trunk as in the stilt-palms, *Iriartea* and related genera. The special development of aerial roots may be an adaptive character for growing on massive limestone formations.

Leaf-sheath bundle 150 cm. long, 27.5 cm. in circumference near the top; margin of the sheath thin and friable, a projection or antiligule about 6 cm. long opposite the petiole, of fleshy or membranous texture, not fibrous, fragile when dry, about 6 cm. long, 5 cm. broad. Texture of leaf-sheaths thin, with a delicate lining that separates readily; petiole 37-47 cm. long, nearly 4 cm. wide near the base, 3 cm. below the first pinnae, broadly grooved in the lower part, nearly flat above, the upper surface with scattered minute fugacious scales.

Rachis 267 cm. to the insertion of last pinna, 27 cm. wide near the base, the upper surface nearly flat, gradually becoming ridged and triangular in cross-section, flat underneath, tapering from 8 mm. wide to only 2 mm. near the end, continued as a slender fiber as long as the last pinnae. Surface of rachis with scattered fine scales, larger and more abundant on a small oblique area below the insertion of the pinna

[5] Bulletin of the Torrey Botanical Club, vol. 31, p. 353, June 1904.

and also on the base of the pinna, the scales flat and rather regular in outline, often split or notched along the margins, but not rayed or fringed; lower part of rachis surface naked.

Pinnae 61-63 on each side, lower pinnae widely spaced, 12-14 cm. apart, the middle and upper pinnae closer and more regular, about 4 cm. apart; basal pinnae 67 cm. by 1.1 cm.; middle pinnae 81-93 cm. by 3.5 cm.; terminal pinnae 37 cm. by 1.2 cm. or less, often split into narrow shreds, 5 mm. or less in width. Upper pinnae with coarse brown scales on a short basal section of the midrib underneath, the scales possibly fugacious elsewhere. Secondary veins distinct, but less prominent than in *Rooseveltia*.

Outer spathe longer than the inner, attaining 130 cm., broadly auricled at base, 15 cm. broad across the auricles, 10 cm. broad above the auricles, gradually wider above, the lateral margins winged, the tip thin and flat, 4 cm. wide near the end. Auricles of the first spathe supported on the widened basal joint of the peduncle, the lateral expansion of the spathe-scar measuring 2.5 by 1.5 cm., but the scar only 2 mm. wide near the median line. Scar of second spathe 6 mm. wide on the sides, 3 mm. near the middle. The two spathes similar in size and texture, thin and friable when dry like the leaf sheaths, not woody and rigid as in some of the related genera that have unequal spathes, only the inner spathe complete, the outer much shorter. A similar specialization, two complete spathes of thin texture, and these retained in the leaf-sheaths till the time of flowering, appears in several East Indian palms, *Seaforthia, Loroma, Archontophoenix,* and *Linoma*.

Spadix, including the very long, slender subequal branches, exceeding 1 m.; peduncle to first branch 9-13 cm., basal joint 5-9 cm., second joint 2.2-2.5 cm., third joint slightly shorter than the second. Branching axis 37-39 cm., with 65-70 branches; tip of axis beyond branches 66 cm.; several branches (7-9) suppressed on the upper side of the lower part of the axis, none on the under side; the lower branches and locations of suppressed branches subtended by large rusty-brown spathelike bracts, attaining 22 cm. by 4 cm. Lower branches 60-70, long, the naked base or stalk attaining 6 cm., gradually shorter, 2-4 cm., on upper branches; distal sections of branches tapering, the terminal 5-6 cm. with only male flowers. Lower branches often with a rounded dark-colored pulvinus above the lowest flower-cluster or flower position, doubtless a carry-over from the pulvini in the axils of the branches.

Flower-clusters rather remote in the lower sections of the branches, then gradually closer, though not crowded as in *Rooseveltia,* the middle and upper sections becoming distinctly notched and flexuous on account of the deep depressions formed by the male flower-buds; male flower-scars usually transverse or triangular, surrounded by a narrow rim of compact tomentum, one of the pair often distinctly pedicellate at least on the lower part of the branches.

Female flowers with sepals 3 mm. by 4 mm.; petals subquadrate, 5 mm. long, subtended by two broadly triangular erect bracts, often distinctly carinate on the outside, often exceeding 1 mm. in height. Staminodes sometimes distinct, at least the outer 3, those alternating with the petals minute and membranous or somewhat indurated.

Fruits broadly conic-ovoid, with a prominent subapical stigma-scar or slender shriveled style, surrounded by a low flattened frustum: surface nearly smooth, the exocarp thin, firmly fleshy; mesocarp fibrous in two layers, an outer coat of brown interlaced and anastomosing fibers and an inner coat of much finer pale-yellowish fibers, subequal and parallel, imbedded in a rather firm fleshy membrane, the surface of the testa only faintly impressed.

Seeds reniform-globose, with uniform endosperm, basal embryo and subapical hilum, a broad abrupt groove between the hilum and the embryo, mostly occupied by the broad raphe decurrent from the hilum to near the embryo.

Seedlings with the first leaf compound, of 3 pinnae on each side followed by at least 3 leaves with only 2 pinnae on a side, sheaths of seedling leaves 6-7 cm. long, petioles to 19 cm.

The original specimens of *Plectis oweniana,* the type of the genus, were collected in Alta Vera Paz, Guatemala, northwest of Panzos, near the Finca Sepacuité, between Senahú and Cajabón, March 1902.

The very large bracts or supplementary spathes subtending the lower branches of the inflorescences and marking the locations of suppressed branches are a notable example of the retention of a primitive feature that in *Rooseveltia* and most of the other related forms are reduced to mere rudiments. The spathes undoubtedly are homologous with the bracts that subtend the branches, some of the primitive palms having compound inflorescences with spathes developed at each branch, and all the spathes nearly equal, instead of the basal spathes being largely developed and the others suppressed. The original protective function having passed entirely to the large basal spathes and the leaf-sheaths, it is difficult to imagine that the large bracts of *Plectis* are of any use, though of scientific interest as marking a stage

of gradual suppression. In retaining the large bracts, *Plectis* may be considered as less specialized, and also in having the two large basal spathes nearly equal, the first somewhat larger than the second, the usual relation being that the first or outer spathe is much shorter, with the inner spathe emerging at a relatively early stage of development, and becoming much firmer in texture than the outer spathe.

Each of the flower clusters is subtended by a bract, as though representing a shortened branch of a primitive compound inflorescence, and four other bracts are represented in each flower cluster, one on each side of the female flower, usually overlapping at the ends, forming an upright persistent collar around the base of the flower. Outside the collar bracts are two others, much smaller, each subtending a male flower, these male bracts decurrent between the collar bracts and the upward extensions of the basal bract, at the sides of the female flower. The basal bract is nearly as prominent as the collar bracts and often distinctly apiculate. The collar bracts are angled or broadly rounded, somewhat carinate at the back, and thickened with parallel fibrovascular ribs like the basal bract and the calyx, though less so than in *Roosevcltia*. Surface of basal bracts and also of collar bracts covered with short tomentum like that of the branches. This functional involucre in *Plectis* and related genera is in contrast with *Acrista* and *Oreodoxa,* which have the bracts minute and rudimentary, buried under the flowers in the depressions of the thickened branches.

Small off-shoots are formed on young palms, as shown in the photograph, though under forest conditions only one trunk is developed from a cluster of roots. On a cut or injured trunk another off-shoot may develop, as observed in several cases where roads or temporary clearings had been made through forest areas.

The fact that all the young palms are much more slender than the mature individuals leaves no doubt that a gradual thickening of the trunk takes place during development, although the surface is nearly smooth and evidences of enlargement were not obvious on the largest palms, that may have attained the full diameter. On palms of medium size, a more rapid thickening may take place, and longitudinal fissures of the outside layer were in evidence, although the surface is kept nearly even by the furrows filling with a new growth of brownish, barklike, corky material. Also it was noticed that a rather soft outer layer could be distinguished, with fibers much smaller than those of the harder "wood" underneath. By a gradual addition of fibers on the outside, fine at first and gradually thickened, a form of exogenous growth seems possible.

A large individual, about 25 m. tall, in the forest near Sepacuité, was cut in 1902 but remained upright, held by vines that bound it to an adjacent large tree, and was still alive in 1904, with the leaf-crown still fresh. That the moisture stored in the trunk had been sufficient to support the crown is difficult to believe, and raises the question of the leaf-crown absorbing water or of a few fibers near the center of the trunk remaining uncut and continuing to function for a time. It is known that trunks of other palms continue to exude sap at the upper end for several months after being felled, as in the "molasses palm" of Chile, *Jubaea chilensis* (Molina), and the humid forest conditions doubtless would lengthen the period of continuing to furnish moisture.

SHORE OF COCOS ISLAND AT CHATHAM BAY, WITH ROOSEVELTIA PALMS EMERGING ABOVE THE FOREST

1. A leaf-crown of a palm standing in the forest.

2. Leaf-crown of felled palm, stood up to show leaf-sheath, the very short petioles and the close-set lower pinnae.

FOLIAGE OF ROOSEVELTIA, GROWN UNDER FOREST CONDITIONS, WITH SPREADING LEAVES AND NUMEROUS DROOPING PINNAE

1. Foliage and habits of growth.

2. Base of mature palm-trunk overgrown with epiphytes of the Bromelia family. At right of trunk slender leaves of palm offshoots, with long petioles.

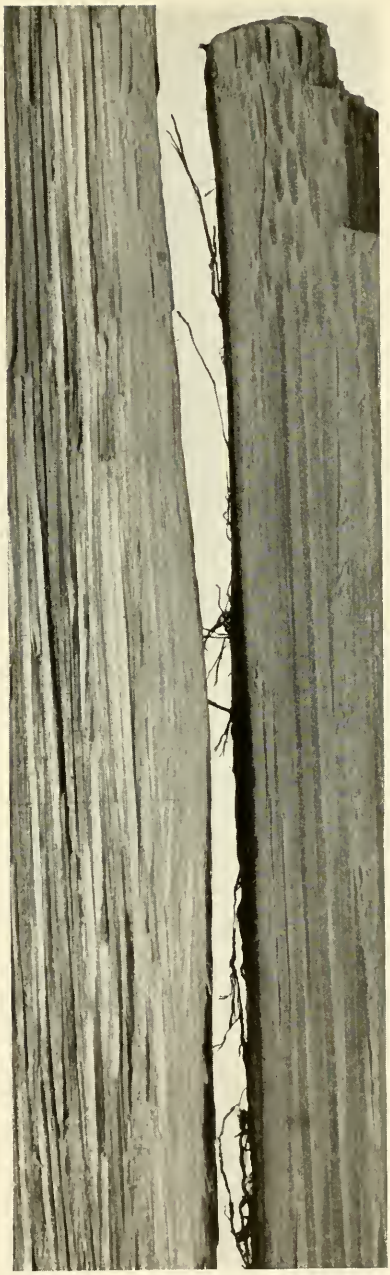
FOREST ON COCOS ISLAND, WITH NATIVE PALMS

1. Base of a *Rooseveltia* palm and large offshoot, growing on a steep slope, the roots exposed on the lower side.

2. Aerial roots of *Plectis oxeniana*, Alta Vera Paz, Guatemala.

ROOTS OF ROOSEVELTIA AND PLECTIS

1. Outer surface of mature trunk near the base, the thin surface layer with fine longitudinal grooves less distinct above than where the surface was protected by the crustaceous lichens, the "bark" broken in the lower part showing the smooth subsurface layer. (Natural size.)

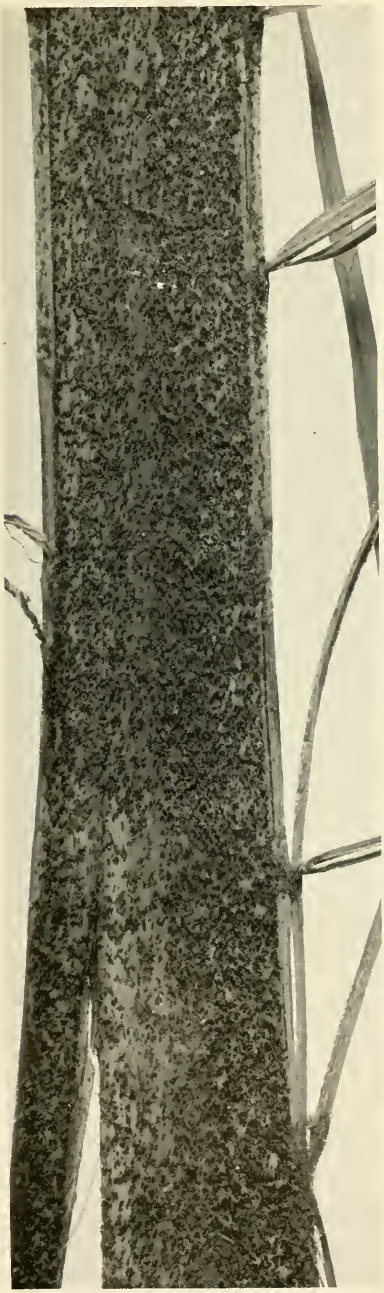


2. Longitudinal sections of the trunk, at the right a radial section showing fine fibers near the surface and coarse compact fibers underneath; left-hand section with finer fibers, farther up the trunk. (Natural size.)

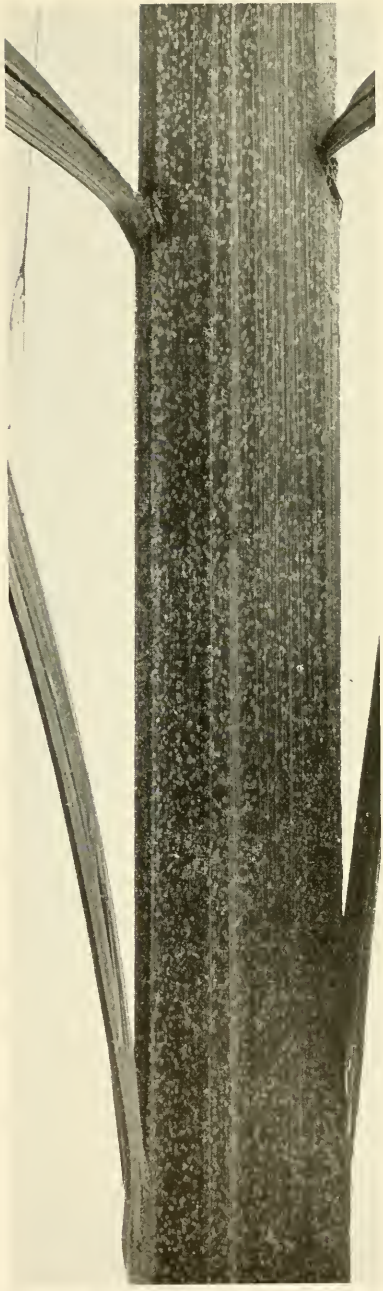
TRUNK OF ROOSEVELTIA PALM

Mouth of leaf-sheath and base of petiole, the leaf-sheath opened and flattened, showing the antiligule as a large fibrous expansion of the sheath beyond the attachment of the petiole. Also the light-colored vitta at the back of the petiole is distinctly shown. (Natural size.)

ANTILIGULE OF ROOSEVELTIA



1. *Rooseveltia*, basal section of the rachis showing insertions of 5 pinnae, the middle pinna lost, but the scar perceptible.



2. *Plectis*, lower section of rachis with only 2 pinnae on each side, widely separated. (Natural size.)

BASE OF RACHIS OF ROOSEVELTIA AND PLECTIS

1. Section near the middle of the leaf, showing the rachis with a high median flange above the insertion of the pinnae.

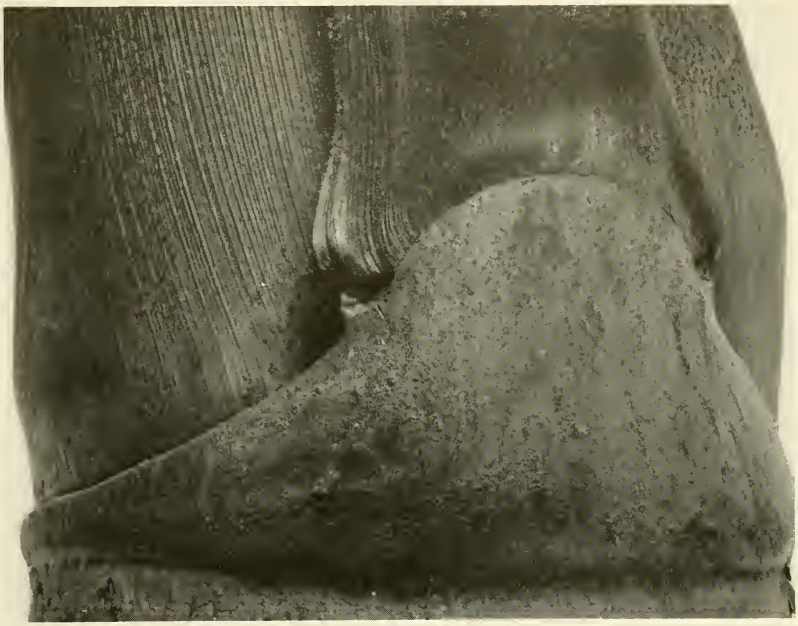
2. Terminal section of the rachis, to insertion of last pinnae, the upper surface of rachis beset with brown scales. (Natural size.)

RACHIS OF ROOSEVELTIA

LEAF OF ROOSEVELTIA, MIDDLE SECTION, SHOWING REGULAR INSERTION OF VERY LONG PENDENT PINNAE

YOUNG INFLORESCENCE OF ROOSEVELTIA

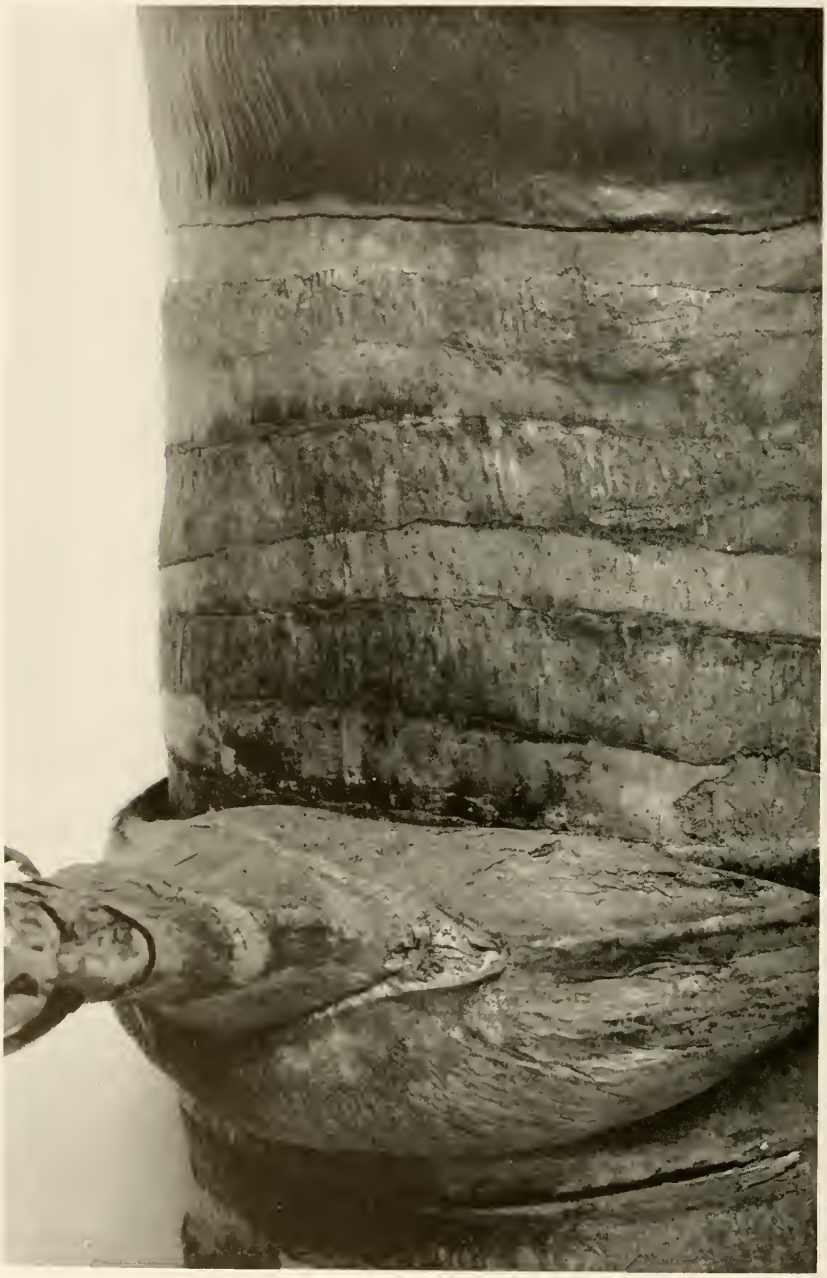
Section of the spathe and first joint of peduncle, seen from the side, showing the lateral expansion that nearly encircles the trunk. Also note striate surface of young leaf-sheath, unevenly beset with small brown scales.



1. Base of young inflorescence.

2. Base of mature inflorescence. (Nearly natural size.)

ROOSEVELTIA, BASAL JOINT OF PEDUNCLE



ROOSEVELTIA TRUNK AND INFLORESCENCE

Summit of trunk, base of mature, indurated leaf-sheath, short trunk-zones and longer leaf-scars, with basal joints of mature inflorescence. (Natural size.)

a

b

c

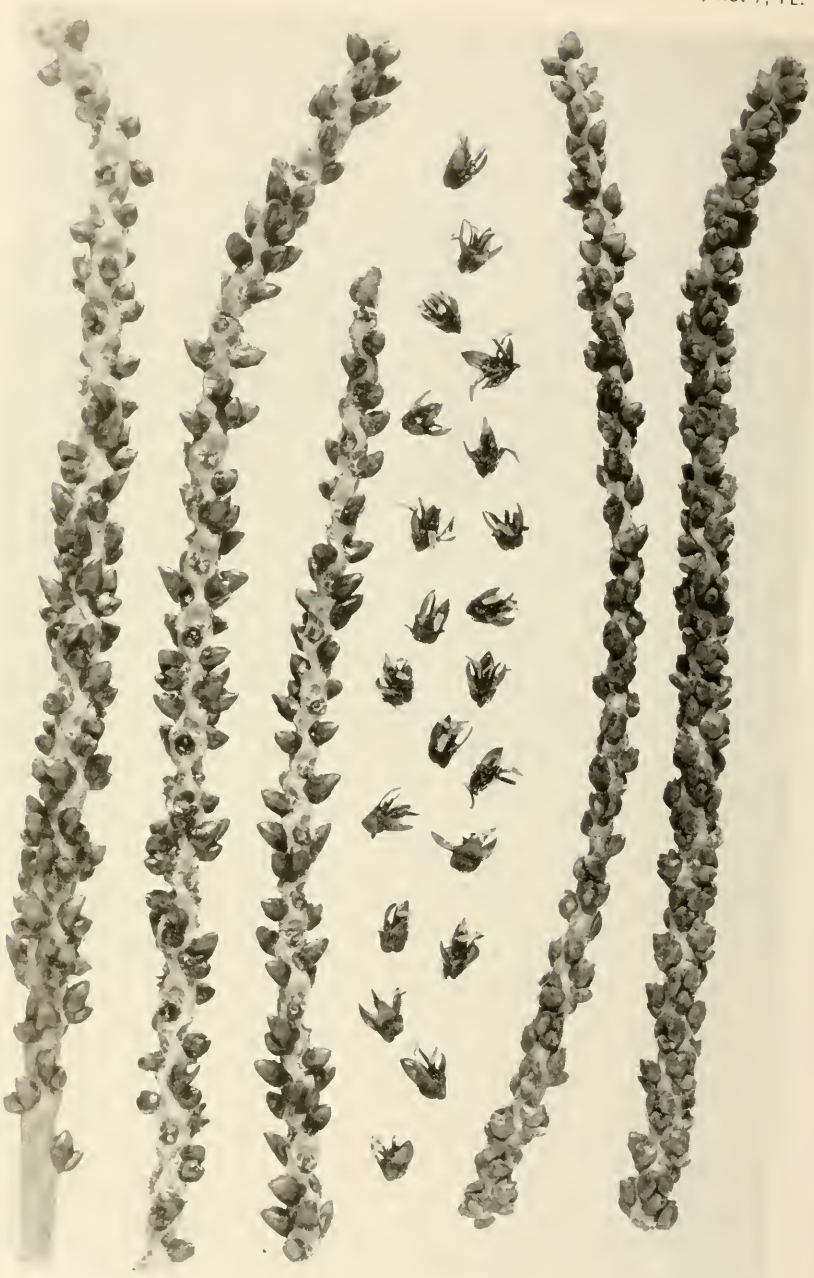
d

e

f

Coconut Palms and Rooseveltia

a, coconut palms at Wafer Bay, Cocos Island, to compare with *b*; *b*, leaf-crown of *Rooseveltia*, showing similar leaf-form and drooping pinnae; *c*, *d*, young inflorescence of *Rooseveltia* at the opening of the male flowers; *e*, *f*, mature inflorescence of *Rooseveltia*, viewed from the side and underneath, showing the greatly swollen basal joint of the peduncle and the ripe fruits.



ROOSEVELTIA BUDS AND FLOWERS

At the left a complete flower-branch cut in three sections, many large conical male buds still in place but the flowers detached. At the right terminal and basal sections of branch with younger buds, showing clusters of two males and one female flower still in place. (Natural size.)

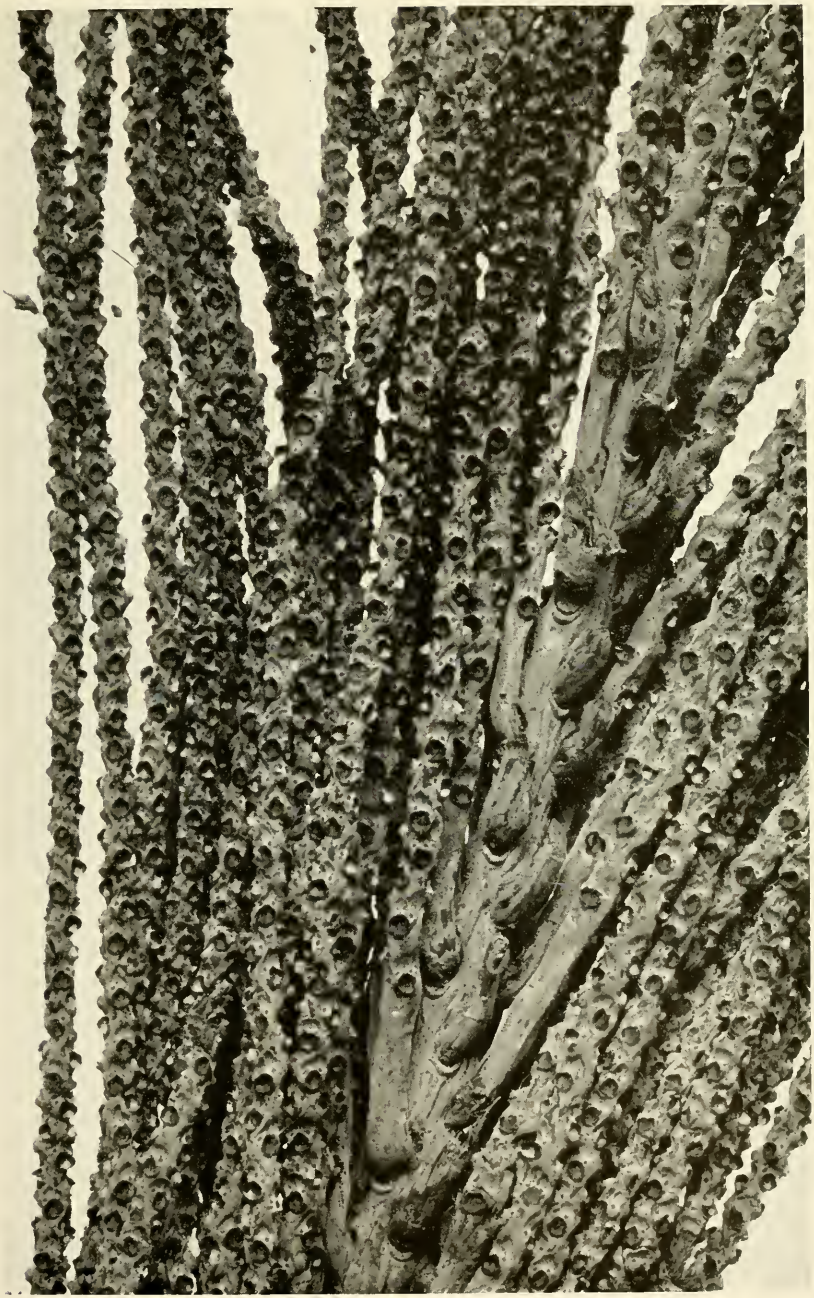
ROOSEVELTIA MALE FLOWERS

Showing short overlapping sepals, large valvate petals, fleshy recurved, truncate filaments, oblong-triangular anthers, and divaricate pistillodes. (Enlarged about 7 diameters.)

1. Basal sections of inflorescence branches with mature fruits. (Natural size.)

2. Basal section of mature inflorescence, showing insertion of branches along the axis and suppression of branches on upper face. (Natural size.)

FRUITING STAGE OF ROOSEVELTIA



BRANCHING OF ROOSEVELTIA INFLORESCENCE

Several branches removed to show close insertion of branches and end of branching axis somewhat thicker than the branches. (Natural size.)

SEEDLING STAGE OF ROOSEVELTIA

Seedling with first expanded leaf showing 6 radiating grasslike segments; base of older seedling right, showing long sheaths and petioles; leaf of still older seedling at left; to compare with seedlings of *Plectis*, plate 24. (Natural size.)

1. Palms in exposed location, the leaves held more upright than in the forest.

2. An entire leaf-blade of *Rooseveltia*, with veterans of the palm excursion.

ROOSEVELTIA AT COCOS ISLAND

PLECTIS PALMS EMERGING ABOVE THE FOREST, ON THE SUMMITS OF LIMESTONE MOUNTAINS IN THE DEPARTMENT OF ALTA VERA PAZ, IN EASTERN GUATEMALA

MATURE INFLORESCENCE OF PLECTIS

Upper joints of trunk and portion of leaf-sheath showing very long slender branches, to compare with more compact inflorescence of *Rooseveltia*, plate 13.

YOUNG INFLORESCENCE OF PLECTIS PALM

Upper part of peduncle and lower section of branching axis, showing large spathelike bracts subtending branches and locations where branches are suppressed. At the left a naked seed and a seed with fibrous covering, beginning to germinate. (Natural size.)

PEDUNCLE AND FRUITS OF PLECTIS PALM

With lower section of branching axis, showing long naked base of branches with pulvini at the insertions, also section of a branch with mature fruits. (Natural size.)

SEEDLINGS OF PLECTIS PALM

Seeds with fibrous covering, at different stages of germination, the first expanded leaf with 6 segments, the second leaf with 4 segments; 2 bladeless sheaths preceding the leaves. (Natural size.)

OFF-SHOOTS OF PLECTIS PALM

A large off-shoot giving rise to 4 much smaller off-shoots, with narrow grass-like leaf-segments like those of seedlings, but more numerous. (Natural size.)

FOLIAGE OF PLECTIS PALM

Upper section of trunk, leaf-sheath bundle, and part of leaf-crown, brought out of forest to photograph, at Finca Sepacuité, in the district of Panzos, showing long petioles and widely spaced sloping pinnae, in comparison with *Rooseveltia*, plate 2.