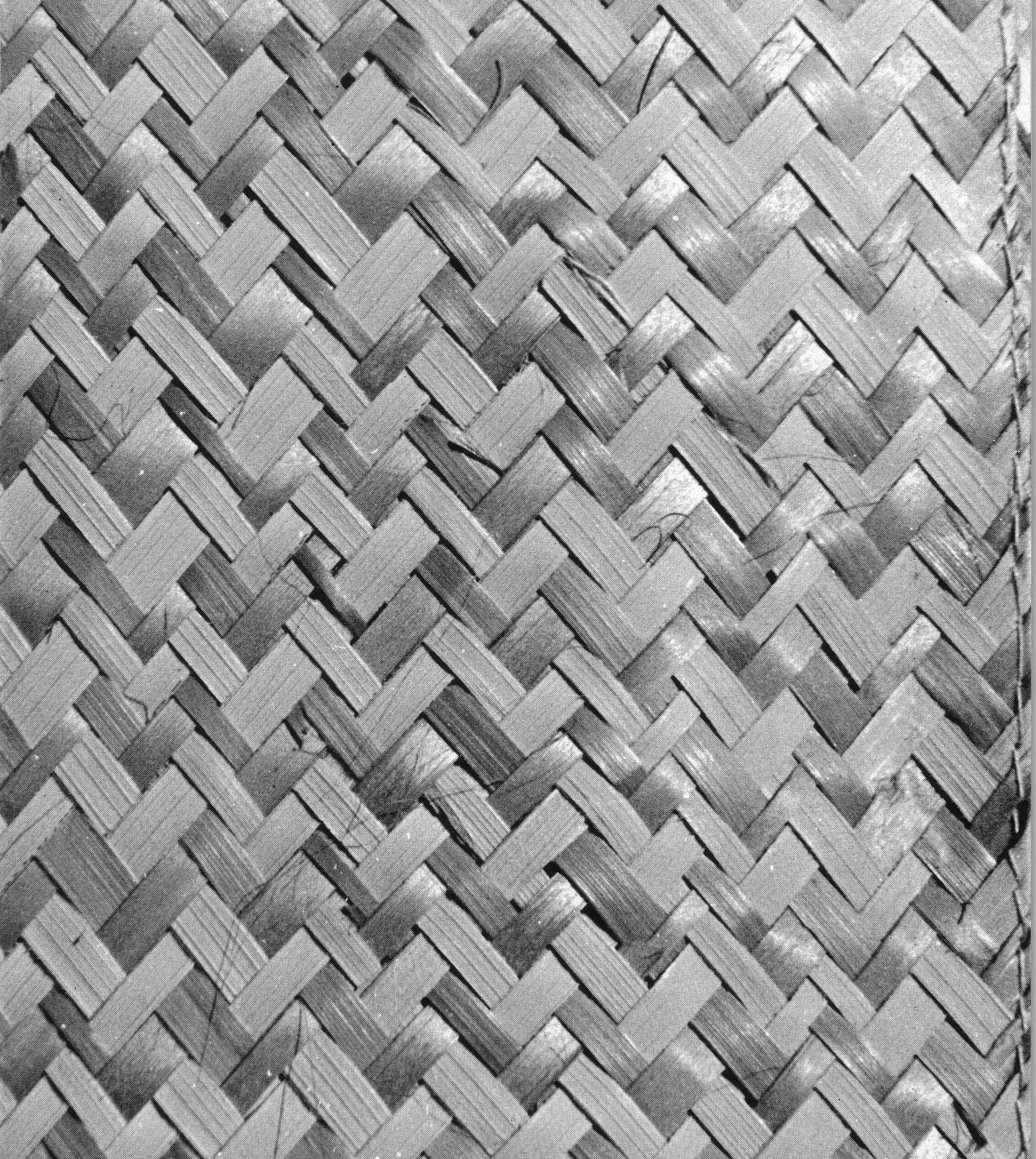

PRINCIPES

Journal of The Palm Society

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October, 1966

THE PALM SOCIETY

A non-profit corporation primarily engaged in the study of the palm family in all its aspects throughout the world. Membership is open to all persons interested in the family. Dues are $10.00 per annum payable in May. Requests for information about membership or for general information about the Society should be addressed to the Secretary.

PRINCIPES

JOURNAL OF THE PALM SOCIETY

An illustrated quarterly devoted to information about palms published in January, April, July and October, and sent free to members of The Palm Society.

Manuscript for PRINCIPES, including legends for figures and photographs, must be typed double-spaced on one side of 8½ x 11 bond paper and addressed to the Editor at Bailey Hortorium, Mann Library, Cornell University, Ithaca, New York, for receipt not later than 45 days before date of publication. Authors of one page or more of print will receive six copies of the issue in which their article appears. Additional copies or reprints can be furnished only at cost and by advance arrangement.

Contents for October

Cover Picture

The pattern produced by woven leaves of Jamaican silver thatch (*Coccothrinax jamaicensis* R. W. Read) used in the making of baskets.

Mailed at Miami, Florida
December 2, 1966

NEWS OF THE SOCIETY

Following the excitement of the Biennial Meeting, the Society's activities have been rather quiet. The greatest activity has been in the Seed Bank. Response to the form letter explaining the method of operating the Seed Bank has been good. To date, fifty-two members have sent back their lists, marking the species in which they are interested, and the list of desiderata for palms not on the main list is phenomenal. I despair of ever receiving seeds of some, such as *Pigafetta filaris,* but who knows? Other very rare species have been received and distributed, so we can continue to hope.

Offers of help in gathering and sending seeds have been numerous, and already members in various parts of the world have donated seeds to the Bank. Others will do so as the opportunity arises. This was a good growing and fruiting year in southern Florida, in spite of hurricanes, so many locally grown seeds have been sent out. Many thanks to the local members, Mrs. George F. Adams, Mr. Nat De Leon, Mrs. T. C. Buhler, Mr. John E. Turner, Mr. Wallace E. Manis and his three sons, Dr. and Mrs. John K. Robinson and the staffs at Fairchild Tropical Garden and the USDA Plant Introduction Station, who have helped with this chore. Out of town friends who have helped include Mr. R. W. Read, Kingston, Jamaica, Mr. Barry Osborne, Santa Barbara, Calif., Dr. U. A. Young, Tampa, Fla., Mr. R. G. Wilson, San Vito de Java, Costa Rica, Mr. R. H. Fackelman, Panama City, Fla., Mr. and Mrs. A. C. Langlois, Nassau, Bahamas, Mr. Robert E. Gauthier, Mountain View, Calif., Dr. H. E. Moore, Jr., Ithaca, N. Y., Dr. D. G. Huttleston, Kennett Square, Pa. and Mr. Ura Snidvongs, Bangkok, Thailand. I am listing here only those who have helped since the new "regime" went into effect this summer. In the past many others have been most generous with their time, efforts and seeds — to try and name them all would be impossible, since I have not kept records of donors until lately. It always makes me anxious when I list names of those who do so much for the Society, as I fear I shall leave out one or more important ones. If I do, please write and scold me.

Mr. William D. Manley, who has been so generous with seeds of hardy palms in the past, writes that this year there is a fairly good supply of *Rhapidophyllum hystrix* seeds, and he will try to help out those members who were disappointed last year. If you are still eager for seeds of this "most hardy palm in the world", according to Mr. Manley, write to him at his *new address*: RFD #1, Box 343, Stockbridge, Georgia (USA) 30281. He will accept orders of 20 seeds or more, at 10c per seed, or a minimum of $2.00, payment to be made direct to The Palm Society, 7229 S. W. 54th Ave., Miami, Fla. 33143. He does this as a contribution to the Society, never accepting payment for himself.

Mr. and Mrs. A. C. Langlois, of Nassau, Bahamas, spent several weeks in the South Pacific, with the object of seeing and photographing as many of the native palms of certain islands as possible. Boarding a cruise ship at Panama, they stopped at Sydney, Australia and the New Hebrides (where they found the *Veitchia* species of great interest), before debarking at New Caledonia, where they stayed seventeen days. Through the courtesy of M. Lucien Lavoix of Noumea, they were taken to the often difficult-to-reach locations of eight out of fourteen genera of palms native to New Caledonia, (sometimes being driven as much as 120 miles). M. Lavoix gave them pictures of five others, so that they obtained almost one hundred percent of their objective. (M. Lavoix has been very helpful to other palm-oriented visitors, such as Dr. H. E. Moore, Jr., and now plans to collect the native species into a planting on his mountainside property, where they can be protected and more accessible for study).

Flying on to Fiji, the Langlois spent twenty-two days and, with the kind advice and assistance of Mr. J. W. Parham, of the Department of Agriculture, they obtained photographs of five of the six genera listed for Fiji, four taken by themselves and one contributed by Mr. Parham. In Samoa, their score was two out of four. Of their list of twenty-five genera they now have photographs of twenty-one, which is truly remarkable.

Mr. and Mrs. T. R. Baumgartner, of Miami, went in the other direction, visiting their son and his family in Alaska. They saw few palms, except those in California, but they report that it was an exciting trip nevertheless.

Dr. R. O. Albert, of Alice, Texas, had an unusual experience on his trip around the world — he was jailed as an "imperialist spy" for thirteen days in Brazzaville, Congo! His trip began as a cactus collecting expedition to the Galapagos Islands. Dr. Albert has a marvelous sense of humor, and I had written him asking him to come to our Biennial Meeting and give a talk. He replied from abroad ship on his way from the Galapagos to South America, saying he would be unable to attend, but promising me two articles on the palms of the Galapagos Islands. He enclosed the first article, entitled: "The Native Palms of the Galapagos Islands." I quote the entire article: "There are no native palms on the Galapagos." I am still awaiting the second article. Meanwhile Dr. Albert had decided to use the 'round-the-world ticket he had bought, with the purpose of collecting insects for some entomologist friends. He interrupted the collecting for ten days at Lambarene, site of the famous Albert Schweitzer Hospital. While there he performed several operations.

Due to a mix-up in reservations, he had to over-stay his 48-hour stop-over in Brazzaville, and because of this he was arrested as an American spy. It was thirteen days before he could be rescued by the West German Embassy (the American Embassy has been closed for several months).

Our editor, Dr. H. E. Moore, Jr., flew to Japan to deliver an address at the Pacific Science Congress, then proceeded to Okinawa, Ryuku Islands, to try to untangle the riddle of *Gulubia liukiuensis* He sent a postcard with color photograph of this handsome palm, and later reported that he had great success in collecting material to bring back for study. He will publish his findings in PRINCIPES later on. Our member in Okinawa, Mr. Yamakawa, sent the Society seeds of this palm which were distributed to Seed Bank members last May. Hopefully, they are happily germinating in many a pot or flat. Dr. Moore reported that Mr. Yamakawa was most helpful to him during his visit to the islands.

* * *

Mr. Kyle E. Brown writes: Greetings from one of the rovingest members of our Society, and probably the only one on active duty with the U. S. Air Force. Uncle Sam has moved me and my family again. In this past year we have left Michigan, gone home to Florida, spent three months in Biloxi, Miss., where I photographed an amazing number of species of palms, and thence to Colorado. During the summer, 1965, we happened through Eufaula, Alabama, and were amazed at the enormous, plentiful and apparently native plantings of needle palm (*Rhapidophyllum* *hystrix*). I had never heard of this palm being reported so far north and west. Also wish to report successful growth of *Butia capitata* as far north as Montgomery, Alabama and in the Longview, Texas, area.

"Here in Colorado Springs I am having very good luck with *Erythea armata* and *E. edulis* as patio specimens. The two plants are three feet tall overall but growing vigorously at 6100 feet elevation. The dry air here seems to their liking. I will of course have to keep them indoors during the winters. These palms cause a lot of conversation as palms are very rare here.

"The palms photographed growing outdoors in Biloxi were: *Arecastrum Romanzoffianum, Washingtonia filifera, W. robusta, Phoenix canariensis, Sabal texana, S. Palmetto, Livistona chinensis, Butia capitata and Acoelorrhaphe (Paurotis) Wrightii.*"

* * *

P.S. to the Seed Bank report above: If by chance you did not receive one of the form letters, enclosing the list of species available, please let me know so I can send one.

Also, fresh seeds of *Chrysalidocarpus Cabadae* will be coming along at intervals. If yours do not germinate, or you want more, kindly advise.

* * *

Invitations: Mr. H. M. Spencer-Lewin, of "Soncy", Point Shares, Bermuda, writes: "Please tell anyone who may be interested that my garden is open to any member who may be in Bermuda." And Mr. Ura Snidvongs, of Bangkok, Thailand, writes: If any member of our Society will come to Thailand, please let me know; I will be pleased to bring him to my home and give any information he wants."

LUCITA H. WAIT

Translocation of Water and Nutrients In Palms

MARTIN H. ZIMMERMANN

The never-ending struggle of plants to reach a place in the sun led to the development of tall plants. A forest demonstrates this competition for light very clearly. Tall trees whose crowns are part of the general canopy — the forester calls them dominant trees — live under distinctly advantageous conditions when compared with shorter, so-called suppressed trees of the same species. It is not surprising then that the latter often succumb from lack of sufficient light. If we plant the same kind of tree in an open field, let us say in a meadow, in which it is artificially protected from competion because the meadow is regularly mowed and thus the growth of any other tall plant prevented, it does not grow as tall as its cousin in the forest, but more bushy which is, under these conditions, a more effective way of capturing the maximum amount of light.

As a tree grows in height the distance over which water and nutrients must be transported internally increases. Two types of long-distance transport are involved. First, leaves have to be supplied with water and mineral nutrients from the soil. This is movement up the tree. The leaves are the places where organic foodstuffs (carbohydrates) are manufactured by photosynthesis. Other parts of the plant which are unable to carry out photosynthesis, or sufficient photosynthesis, like roots, stems, buds, flowers or fruits, have to be supplied with carbohydrates which are produced in excess in the leaves. This second type of movement may be up or down the tree. It is clear, of course, that the longer the distances are the more energy has to be provided to maintain this transport. Under severe environmental conditions, for example in dry areas, less energy is available; plants cannot grow tall.

Channels of transport are very distinct in some trees and were recognized three hundred years ago by simple experiments. If a ring of bark is removed from a tree trunk (an operation called "girdling"), water still reaches the leaves (they do not wilt), but photosynthetic foodstuffs are prevented from passing the girdle and the roots are starved. This basic experiment as well as many more elaborate ones have taught us that water and minerals ascend from roots to leaves in the wood (the xylem) and photosynthetic nutrients are exported from leaves to places of need via the innermost layer of the bark (the phloem). This grand circulation system enables a land plant to distribute nutrients throughout its body in an effective manner.

Whoever has observed the growth of a tree has noticed that its stem grows in thickness as long as it lives. A growing layer between wood and bark, called the vascular cambium, produces regular layers of xylem toward the inside (the growth rings of the wood) and phloem to the outside. Thus, the vascular tissue is constantly renewed, and it is a well-known fact to botanists that all translocation takes place through relatively young tissue, in many cases less than one year old.

Let us now turn our attention to palms. The situation here is in many respects quite similar, but in other ways distinctly different [see also the article of Tomlinson (1961b) in this journal]. Palms do not increase the diameter of their stem once it is established; they just grow in height. In a population of palms of one species, the tallest individuals are usually the oldest. A young palm looks disproportionally stubby and an old, tall one disproportionally slender. Vascular tissues, once established in the stem, do not change but remain functional as translocation channels throughout the whole life of the palm. The functional permanence of these channels in a palm is therefore in sharp contrast to a tree like an oak or a pine where vascular tissues are regularly renewed. The arrangement of xylem and phloem in the stems of palms is also very different from that in a tree. Small strands of xylem and phloem are joined into units called vascular bundles which are distributed throughout the whole stem. Individual vascular bundles rarely exceed one millimeter (1/25 of an inch) in diameter and are usually much thinner. A great number of them run along the stem; in a small palm like *Rhapis* or *Chamaedorea* perhaps 1000 can be counted on a single transverse section, and in a large palm we may find as many as 50,000. Distribution and course of vascular bundles (the "plumbing system" of the palm) has been described in an earlier paper in this journal (Zimmermann & Tomlinson, 1965b) and in more technical detail elsewhere (Zimmermann & Tomlinson, 1965a).

Looking under microscopic magnification at a vascular bundle and the cellular matrix in which it is embedded, we can see four different types of tissues which are associated with the four major functions of the palm stem (Fig. 1 & 2; see also Figs. 70-72 in Zimmermann & Tomlinson, 1965b):

(1) The fibrous bundle sheath which gives the stem its mechanical strength (F, Fig. 1). Vascular bun-

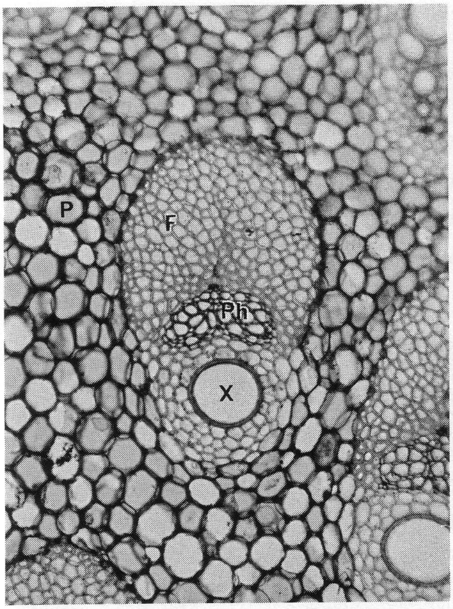


Fig. 1. A vascular bundle in the stem of *Rhapis excelsa* as seen in transverse section (100x). (F) the fibrous sheath of the bundle, giving the stem mechanical strength. (X) a xylem vessel, in which water ascends from roots to leaves. (Ph) the phloem; the larger cells are the sieve tubes where sugars move from leaves to other places. (P) the parenchyma, roundish cells of ground tissue in which surplus sugars are stored in the form of starch.

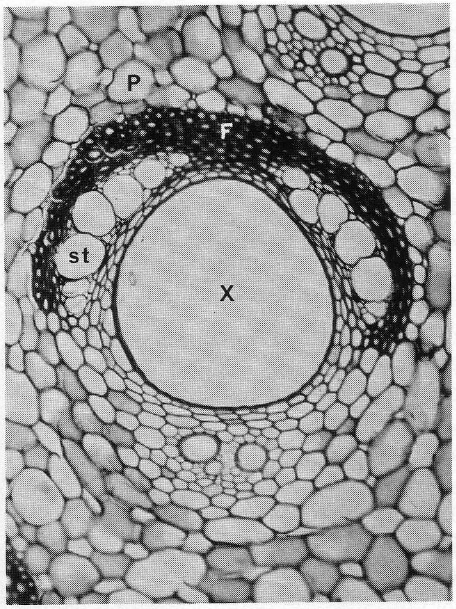


Fig. 2. A vascular bundle of a large-vessel palm (*Calamus*) at the same magnification (100x). Note that not only the xylem vessel (X) but also the sieve tubes (st) of the phloem are very large. The fibrous sheath (F) is not very strongly developed; the palm is a vine which does not support itself. (P) parenchyma.

dles with greatly developed fibrous sheaths are crowded near the stem periphery where they are — from the engineering point of view — most effective in giving the stem mechanical support.

(2) One or more xylem vessels which serve as channels for water conduction (x). Vessels are capillaries formed by long series of dead cells. These barrel- or tube-like cells are lined up end to end and form continuous capillaries because their end walls are more or less broken through (Fig. 4).

(3) The phloem (Ph, Fig. 1) with its cell-series, the so-called sieve tubes, which serve as conducting channels for photosynthetic products. Sieve tubes are not merely tubes like the vessels, they are living, highly specialized conducting cells (Figs. 5 and 6).

(4) The surrounding ground tissue (parenchyma, P) which represents the place where surplus carbohydrates are stored in the form of starch.

In plants with a vascular system like that of the palms where xylem and phloem are spatially very closely associated, translocation phenomena in the two different systems cannot be separated easily; the useful girdling experiments, for example, cannot be carried out. The few other experiments which have been made indicate that palms do not differ fundamentally from other plants. Let us review very briefly first the ascent of water and dissolved minerals in the xylem, then translocation of organic nutrients in the phloem of palms.

The ascent of water and solutes in the xylem

Water may be "pulled" or "pushed" through vessels. Transpiration of water from the leaves pulls water up through the xylem of the stem. At the same time the roots may be pumping water into the xylem and thus raise the pressure above +1 atm. (atmospheric pressure) in the lower parts of the trunk (Davis, 1961). This pumping is a process consuming metabolic energy and is closely associated with the uptake of inorganic ions from the soil (Brower, 1965). But this root pressure alone is seldom sufficient to raise the water to the top of the palm when the leaves transpire vigorously on a sunny day, and it is quite clear that transpiration and the resulting pull in the xylem does most of the work. If a leaf or a part of a leaf is cut and dipped into a dye solution, the dye rapidly spreads into other leaves thus indicating pressures below +1 atm. in the xylem. Pressures may even drop below zero and become negative. Indeed, the palm *Calamus*, the rattan vine, is a classical example of a plant in which tensions (negative pressures) have been demonstrated experimentally (Scholander *et al.*, 1961). Water movement *per se* through the xylem is a purely physical phenomenon, taking place along a pressure gradient. During times of minimal transpiration, during a rainy night for example, the pressure gradient must be 0.1 atm./meter (i.e., that of a standing water column); during the height of transpiration on a sunny day, it is probably of the order of 0.15-0.2 atm./meter as it has been calculated for trees (Zimmermann, 1963, 1964). All available evidence indicates that the same physical principles, known for trees, apply to palms.

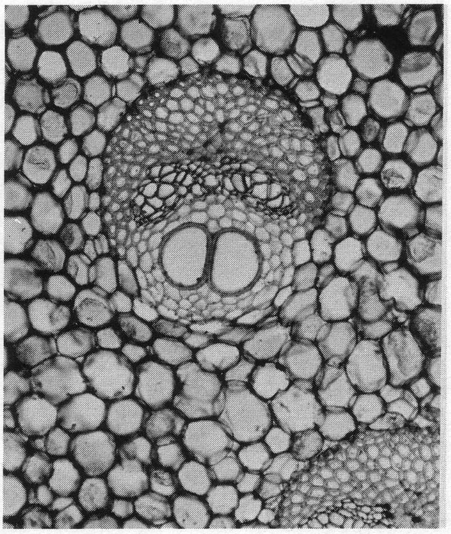


Fig. 3. A transverse section through a vascular bundle of *Rhapis excelsa* similar to that shown in Fig. 2 (100x). Two vessels overlap at this point. Water on its way up into the leaves has to move across the walls from one vessel to the other.

Protection against injury and breakage of water colums in vessels is of paramount importance for the survival of plants. A ruptured vessel cannot continue to function because air is pulled into it when pressures are below atmospheric pressure and, *vice versa*, when pressures are above atmospheric it will leak. Vessels are by no means of infinite length, they are very short compared to the height of the palm. In *Rhapis excelsa*, for example, lengths of 10 cm (4 inches) have been measured. However, adjacent vessels overlap for an appreciable distance so that water can pass from one into the next through the permeable cell wall. Two such overlapping vessels are illustrated in Figure 3. When a vascular bundle is severed, the damage remains confined to the injured vessel because air cannot penetrate the tiny pores of a wet wall from one vessel to the next.

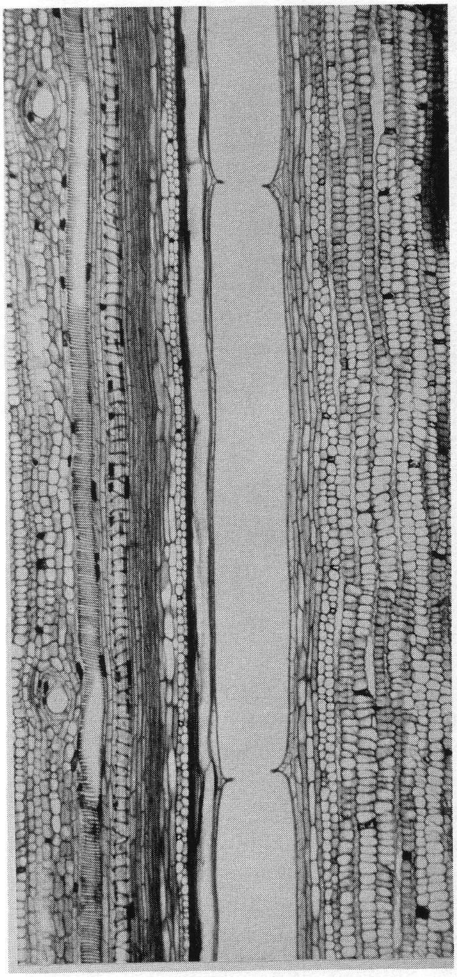


Fig. 4. A longitudinal section through a conducting bundle of *Calamus*, showing how vessels are made up of series of vessel elements, each the dead "shell" of an individual cell. The bottom and top walls are dissolved so that the cell series forms a capillary (i.e., the vessel). One whole vessel element can be seen in the center of the picture as well as part of the next above and the next below. Magnification 31½x.

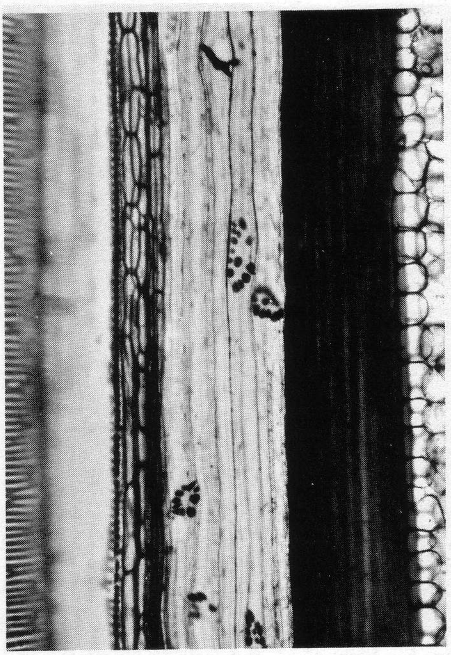


Fig. 5. Longitudinal section through a vascular bundle of the petiole of *Corypha umbraculifera* showing sieve tubes (the five series of long, light cells occupying about ¼ of the space in the center of the picture). The dark spots mark the end walls (sieve plates) between subsequent elements. The sieve plates are closed here by callose plugs, translocation could not take place. Magnification 88x. Photomicrograph by M. V. Parthasarathy.

Most palms have relatively small-diameter vessels; however, palms of the vine-type, such as the already mentioned *Calamus*, have very large-diameter (Tomlinson, 1961a), and also very long vessels (Scholander *et al.*, 1961) (Fig. 2). Their water transport is much more efficient because of lower flow resistance, but it is obvious that such a system involves much greater risks in the event of injury. There are trees in temperate regions, the so-called ring-porous trees (most oaks for example), which have vessels of a similar size. These trees depend on an annual renewal of xylem for their survival (Huber, 1935; Zimmermann, 1963, 1964). There is no renewal of xylem in the palm stem, and we do not know how these highly specialized palms cope with the problem.

Transport of photosynthetic products in the phloem

Phloem transport is fundamentally different from xylem transport. Whereas the solute concentration in the xylem

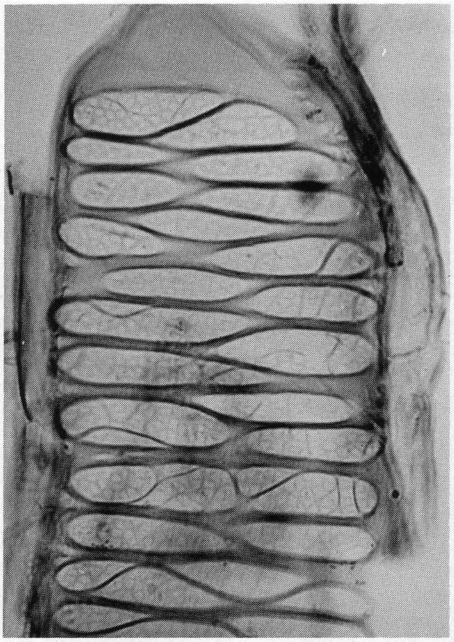
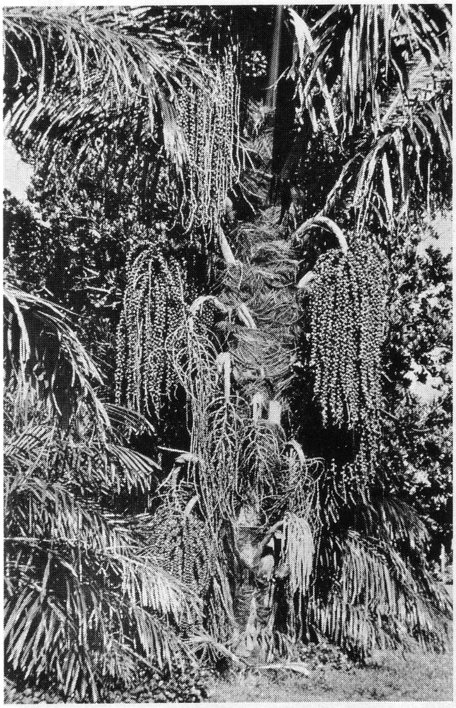


Fig. 6. View of an end wall (sieve plate) of a sieve element, a so-called sieve plate (*Borassus flabellifer*, root) The cell wall is perforated sieve-like, this is how the terms "sieve plate" and "sieve tube" originated. Magnification 490x. Photomicrograph by M. V. Parthasarathy.

is almost invariably extremely low (less than 0.5%), the concentration in the sieve tubes of the phloem is quite high (of the order of 10%, mostly sugars). Whereas water movement is largely a physical process, going along passively at low pressures through rigid, dead vessels, phloem transport depends intimately on the metabolic activity of living cells, proceeds through living sieve tubes, at high concentration and high positive pressures (Zimmermann, 1963, 1964). The mechanism of phloem transport is still vigorously debated by plant physiologists, but this is not the place to enter the argument. Let us relate, instead, some well-known phenomena in palms to our better knowledge of phloem transport in other plants. We can then see if our assumptions are reasonable.

The center of production of carbohydrates in palms is, of course, the crown of mature leaves. These export the bulk of their product (i.e., what they do not consume for their own respiration). Carbohydrates are needed in great quantities in the apex for the growth of young leaves which are not yet themselves photosynthesizing and for the further growth of the stem. Carbohydrates are also needed for the growth of inflorescences, and later for the developing fruits. All this requires fairly local transport at the very top of the palm. However, there is also considerable need for long-distance transport. The palm produces new roots continuously at the base of the stem so long as carbohydrates from leaves are available. Transport, therefore, must take place from leaves to roots. We know also that most palms store considerable amounts of starch in the ground tissue of their stems. It must be brought there via phloem. This storage material is of crucial importance in those palms which flower only during a short period at the end of their life span. Examples are *Corypha*, which produces a single terminal inflorescence (Fig. 9), and the *Caryotoideae*, which flower basipetally after completing their vegetative period of growth (Fig. 7). These palms translocate carbohydrates from mature leaves to the stem for storage as starch during their vegetative growth period. Then, during the reproductive phase, starch is mobilized and translocated into the inflorescence(s) within a relatively very short period of time.

In many parts of the tropics inflorescences of various species of palms are tapped and large quantities of sugary juice are obtained (Miller, 1964; see also the literature cited there). The juice is used locally as a source of sugar and for the manufacture of an alcoholic beverage, toddy. For *Arenga*,



7. Sugar palm, *Arenga pinnata*, at Fairchild Tropical Garden.

8. Tapping the male inflorescence of *Arenga pinnata*. Note the short bamboo collecting tube. Photograph by Robert H. Miller. Reprinted from *Principes* 8:131. 1964.

quantities up to 10 liters (over 2 gallons) per day are reported. A number of botanists have been interested in this phenomenon, but we owe most of our knowledge to a Dutchman, P. H. L. Tammes, who performed some very interesting experiments with exuding inflorescences (Tammes, 1933, 1952, 1958). The exudate contains about 15% solids, most of which is sugar (sucrose). Composition of the sap as well as all circumstantial evidence indicate that we are here dealing with an exudate from the phloem. Inflorescences which are cut from the stem continue to bleed for some time when put into water. It is also known that large quantities of starch are mobilized in the stem and translocated toward the inflorescence during the time of exudation because the starch content of the stem is depleted when the palm is tapped or when it flowers and sets fruit (Tammes, 1933).

This is exactly how the phloem behaves is most dicotyledonous trees. Cut ends of the sieve tubes are rapidly plugged and, when tapped, sugar in the sieve tubes is replenished from local reserve material. In dicotyledonous trees such an isolated sieve-tube system can be tapped with the mouth parts of an aphid (Weatherley *et. al.*, 1959). In the palm, flow is made possible by previous beating of the inflorescence, treatment which seems to slow down the clogging effect drastically. Even so, the cut end has to be sliced off at regular intervals to maintain the flow. It is not known precisely how the beating prevents clogging of the phloem.

In a further series of experiments, Tammes (1933) removed tapped inflorescences from the stem and put them with their cut end into solutions of various chemicals. He found that acid fuchsin (a red dye) was carried with the transpiration stream through the xylem to the (transpiring) flowers; the fuchsin could be detected in the xylem but neither in the phloem nor in the exudate. Ferrocyanide, however, was taken up into the phloem tissue; it was detected there as well as in the exudate

9. The appearance of the great flower cluster marks the gradual collapse of leaves on the stem of *Corypha umbraculifera.* Photograph by W. H. Hodge. Reprinted from *Principes* 5: 126. 1961.

by means of a simple histo-chemical reaction, the precipitation of Prussian blue with ferric chloride. This is perhaps the most elegant piece of evidence that sugar transport into the inflorescence takes place via phloem.

In conclusion we must admit that there are still many gaps in our understanding of translocation in palms. Palms have received far less attention from plant physiologists than they deserve, a neglect they share with many

10. At maturity, thousands of cherry-sized white fruits replace the cream-colored flowers of *Corpyha umbraculifera.* Photograph by W. H. Hodge. Reprinted from *Principes* 5: 127. 1961.

other tropical plants. We know that enormous quantities of water are daily lifted up to the leaves and considerable quantities of sugar are moved about the stem. This is an accomplishment few people realize when they look at the quiet beauty of a palm.

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Palm Hunting Around the World

Harold E. Moore, Jr.*

VI. New Caledonia and Fiji

On Sunday, April 5th, after a morning of collecting and photographing *Metroxylon Warburgii* on the island of Efate, I finally boarded the plane for Noumea where M. Lucien Lavoix, a dedicated member of The Palm Society, met me. As we drove from the airport, M. Lavoix pointed out some of the vegetation types that were later to become familiar, and I noted that a *Veitchia* similar to that just collected on Efate was planted occasionally by houses along the road, as it is also in Noumea. After dinner and an introduction to M. Lavoix's wife and children, I unpacked my bags in the quarters of the South Pacific Commission near the herbarium of the Institut Francais d'Oceanie where most of the plant drying was to be done. Thus began a whirlwind palm tour of New Caledonia.

April 6th was occupied partly with the inevitable processing of accumulated materials, partly with an afternoon trip to Mount Koghi where M. Lavoix has a home and garden set in the rain forset. Here we looked at two kinds of *Basselinia,* a most perplexing genus which cannot, I think, be understood without considerable field work on the island. The one which we collected is one of the handsomest with solitary (though perhaps not always so) stems up to approximately 12 feet high, the trunk dark green or nearly black on new growth. The leaf sheath is also nearly black outside but when removed is glossy orange-yellow inside. Pinkish bracts of the inflorescence turn red-brown at anthesis splitting to expose the dark red-brown inflorescence crowded with tiny dark flowers. We were to see this palm and others very similar to it elsewhere. Other palms grow about M. Lavoix's home but these we left for another day in order to prepare for a journey to the north and east of the island.

Next morning a party consisting of M. Lavoix, M. Luc Chevalier of the Musée Calédonien, M. Robert Barets of the Forestry Department, myself, and Jacob Boulango as driver, set off in a well-loaded truck for the town of Koumac as the night's destination. At lunch-

*From field work supported by National Science Foundation Grant GB-1354.

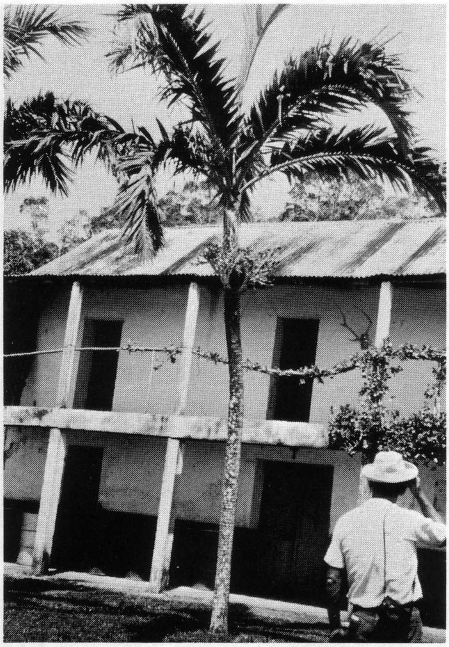
1. *Burretiokentia Vieillardii* grows with tree ferns on the property of M. Lavoix on Mt. Koghi

time we were in Bourail where a palm by a house opposite the restaurant caught our eye. Eventually a leaf and inflorescence were obtained with permission of the owners who told us the plant had grown from a seed removed from the crop of a pigeon 35-40 years ago. Today it is a healthy example of *Chambeyronia.* The inflorescences are borne below the dark green thick crownshaft and stiff green leaves, and in bud are white with yellowish-green male

2. Inflorescences with flowers and fruit of *Burretiokentia Vieillardii.*

buds. Because no fruit was available, the species is as yet uncertain. After this interruption the party continued on to Koumac for the night.

New Caledonia, like Madagascar has a most interesting flora with a very high percentage of plants known only from the island. Most of its palms belong to genera not known elsewhere, *Veitchia* excepted, and even here the species *V. arecina* is restricted to New Caledonia. Thus on the 8th, as we climbed over the central mountains through the Col d'Amos, the spying of wild palms in gallery forest beside a stream in the *Melaleuca* savannah caused real excitement. Along the banks of the stream were several individuals and with the aid of Max Shick's climbing rope and the fortune of finding a fallen live tree, we were able to gather a complete collection of *Cyphophoenix elegans.* This species reaches a height of about 20 feet, a diameter of about four inches. The solitary green trunk terminates in a somewhat inflated olive-green crownshaft covered with grey hairs and slightly arcuate pinnate leaves. The inflorescence bracts are red-purple in bud, covering a stiffly-branched green inflorescence set with red-brown buds and flowers. Though the fruits collected were not completely ripe, they did contain developed seeds to help in identification.



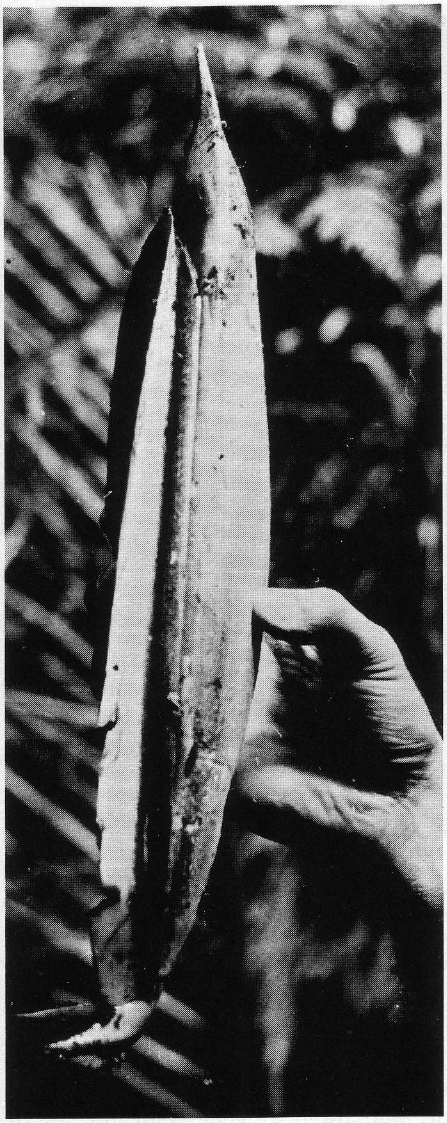
3. *Veitchia arecina* at Balade.

4. Male flowers of *Veitchia arecina* have a deep green interior, but otherwise resemble those of other species.

Our next stop of the day was at the Mission in Balade where we stopped to admire *Veitchia arecina* in cultivation before taking a trail into the hills, the Route de Parari, where in other gallery forests we came across two intriguing palms. One is a handsome very large *Basselinia* related to *B. tomentosa* with dark green trunks to 30 feet high, 7 inches in diameter. Most interesting were the brown densely woolly inflorescence branches with buds sunken in the wool. Although we found only defective fruits on old inflorescences, these clearly seemed compatible with *Basselinia* despite their larger size. But the second palm can only be guessed at for it was in very young bud and with immature fruit. Again, a solitary tree twenty feet high, this one could be distinguished by the grey-brown strongly-ringed trunk, the mass of exposed roots, and the stiffly branched inflorescence. Thus far the specimens remain marked ? *Campecarpus sp.*, though one day it may be possible to obtain the requisite material for complete identification.

We stayed that night and the two next at the home of M. Emile Limousin at Oubatche where preparation of specimens by lamplight each evening kept Jacob and myself more than busy, for the truck filled daily at an alarming rate.

The 9th saw us off for the slopes of Mt. Ignambi, attended by two guides — Chanel Daop and Etienne Yandaré from the village of Tchambouenne. In the mossy low forest beside a stream at about 2,100 feet elevation, we found a species of *Burretiokentia* (once known as *Rhynchocarpa*) which even today remains puzzling despite good material. The solitary trees have bright green trunks and red-hairy, somewhat inflated leaf sheaths below which hang the stiffish inflorescences. It was here that I first began to notice a feature characteristic of some genera of the Tribe Clinostigmateae, the tribe to which most of the New Caledonian palms belong — to wit the unusual lower bract which does not completely encircle the base of the inflorescence. Not far below the *Burretiokentia* we found a *Basselinia* very much like that of Mount Koghi but



5. The lower bract on the inflorescence of *Burretiokentia* does not completely enclose the upper.

6. *Basselinia Pancheri* with M. Barets for scale.

7. Leaves of *Basselinia Pancheri* are sometimes divided into a few broad pinnae.

here with stems clustered, and still lower in drier woods a *Basselinia* with very slender clustered stems, small leaves, and green inflorescences.

Our third day in this region started with collecting *Veitchia arecina* in coconut plantations at Tchambouenne where a few individual trees had been left. Aided again by the climbing rope, I managed to obtain a good fruit cluster and leaf and later, some miles away, we obtained an inflorescence covered with male flowers, these green outside with the petals very dark green inside. The fruits when ripe are bright crimson and nearly two inches long. After this conquest we drove down the coast, hoping to get part way up Mount Colnett but finding no one to guide us were content to climb lower slopes and to collect near the river another *Basselinia* and a small solitary palm with red leaf sheaths and very immature flowers which later proved to be the genus *Cyphosperma*. On the way to Colnett we picknicked by a beautiful stream in view of a waterfall with young *Chambeyronia* plants in the foreground and swam briefly in the clear pools just about the outlet to the sea. A similar stream further on had to be forded — without difficulty in the afternoon, when the tide was low, but with some excitement when we returned at dusk. In the interim, the tide had risen and backed water up so that we suddenly found ourselves in midstream with a stalled motor. With all our efforts we were unable to get the truck back to dry ground, so we had occasion again to swim and to watch the moon rise clear, bright and full, while the tide in

8. Plants of *Actinokentia divaricata* in the forest at Riviere Bleue.

its own time ebbed enough to let us dry out the motor which eventually coughed us through to dry ground and the road home. On the 11th we bid our host and family goodbye and returned to Noumea.

April 12th was a festive day with the Lavoix family at their home on Mount Koghi where, despite wet weather, we had time to really see the fine stands of *Basselinia*, *Burretiokentia*, and *Chambeyronia* that add so much to the property. The *Chambeyronia* is especially handsome because the new leaves are a beautiful red when they first emerge. In the forest, *Chambeyronia macrocarpa* reaches a height of 40 feet above an expanded base and a mass of exposed roots. The mature fruit is dark crimson in a red-brown cup of floral parts,

9. *Campecarpus fulcitus* with several inflorescences and its prominently ringed trunk.

borne on stiff zigzag branches of the infloresence. Altogether this is a most ornamental palm which, fortunately, is now being grown here and there in the United States.

Without letup, we continued our palm travels on the 13th with a trip to the Foret les Electriques on the Plaine de Lacs southeast of Noumea, stopping enroute at a sawmill to collect *Basselinia*

Pancheri with its odd irregular fruits. Threatening weather and finally heavy rain failed to dampen our spirits as we found palm after palm. The forest is at about 800 feet altitude in an area of streams and lakes where moisture is abundant. *Campecarpus fulcitus,* with its thick exposed roots, green trunk with very prominent nodes, and stiff inflorescences was an exciting discovery for me and close by it grew *Basselinia Pancheri* more robust than that seen at the sawmill and sometimes with the leaves scarcely divided into pinnae.

Somewhat further on, at Riviere Bleue, we found still another *Basselinia* like that of Mount Koghi, more *Campecarpus* and three other genera, all of more than usual interest to me. The first was *Actinokentia divaricata,* an odd small palm with usually four leaves borne in as many directions. The relationship of this palm is still in doubt so it was most rewarding to find all stages of flower and fruit which will help in our technical studies. The second find was *Cyphokentia macrostachys* in bud only but fairly abundant. The male buds are dull rose on purplish branches, somewhat reminiscent of *Archontophoenix Cunninghamiana,* and these, combined with the solitary habit, moderate height and attractive foliage, should make the species a good one for trial in cultivation. Perhaps the most exciting palm, however, was *Brongniartikentia vaginata,* not one to excite the horticulturist but botanically of special interest because of the odd flowers and the long inflorescences borne among the leaves. *Brongniartikentia* parallels in several respects an allied palm, *Taveunia,* which I later saw in Fiji.

Our last collecting had been done in drenching rain and since we seemed to have exhausted the available palm genera we returned to Noumea, the truck bulging with specimens which required all the next day to prepare and leave drying for shipment later to Ithaca. Unhappily, time had run out, as it seems always to do before everything is done, and the last leg of the palm journey from Noumea to Nadi in Fiji was scheduled for the 15th.

10. The crown and an unopened inflorescence of *Campecarpus.*

Fiji

Dominiko Koroiveibau, my assistant for three weeks (courtesy of Mr. John Parham, botanist in the Department of Agriculture in Suva), greeted me as my plane landed on Viti Levu late in the afternoon of April 16th. There being no rest for the botanist, this was the beginning of still another period of uninterrupted palm activity. After purchase of minor items and hurried packing and shipping of accumulated materials, Dominiko and I boarded the little plane that flies from Suva to Savu Savu on Vanua Levu late the next morning.

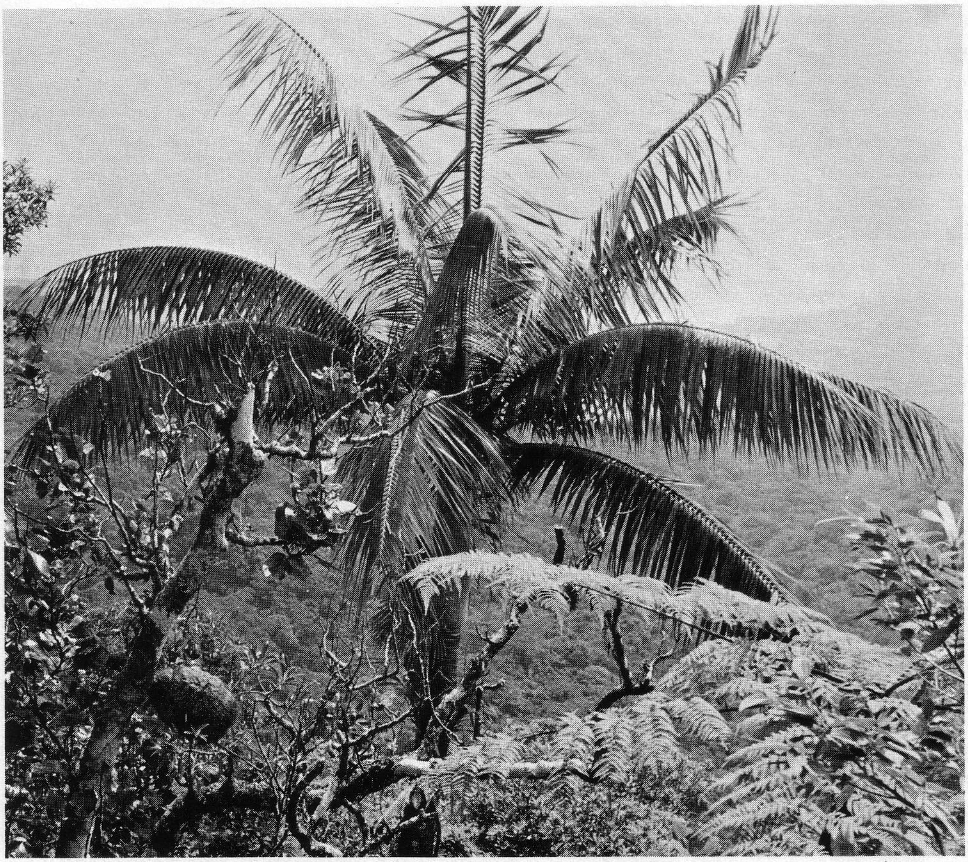
11. M. Luc Chevalier holds the top of *Brongniartikentia vaginata* in the rain.

After lunch at the small and very pleasant hotel in Savu Savu, we climbed aboard a landrover with our guide Suwani Ulaiasi and his nephew of the same name, for a drive to the head of Natewa Bay. There we transferred gear to a boat to cross to the other side where, after an hour's walk, we arrived at the village of Bucalevu as the sun was setting. A house had been vacated for our use where, after bathing in a nearby stream and paying our respects to the aged Chief, we sat down to the evening meal. I, as guest of the house, sat on a chair at a wooden table while the family, Dominiko, and the two Suwanis sat about a mat on the floor. How often the proprieties of life make one miss the real pleasures of sharing life in another land, for I should have enjoyed testing my ability to sit through a meal cross-legged!

However, it was not long before I had my chance. There remains in Fiji more formality than I had encountered elsewhere. On arrival we had paid our respects to the Chief and presented him with a gift of kava, the root of *Piper methysticum,* which is the base for the beverage about which formalities center. Now it was the turn of the village men to welcome us and in they came to sit in a circle while kava, fresh from the garden, was blessed, crushed, and strained through a linen cloth in a quantity of water, to make the whitish, slightly tart drink nearly filling a large wooden kava bowl. Dominiko cued me so that when the first bowl, served in half a polished coconut shell, was presented I was not too awkward in the drinking of a response. David Fairchild had once described the older and less pleasant method of kava preparation (The World Was My Garden 96, 97) and his distaste for it, but I found the drink increasingly palatable as time went on in Fiji.

After appropriate exchanges of remarks, I pleaded real fatigue and stretched out to doze (between the feasts of mosquitoes) only to find myself shaken awake about 11:00 by Dominiko. Then I saw that the further end of the house was filled with seated women from Bucalevu and two nearby villages dressed in their best and decked with flowers, many of them the intensely fragrant *Hedychium* blossoms. They turned as one, when I took my place on the floor facing them, and began to sing and dance, each village in turn with its chorus and usually four dancers who remained seated, using only their upper body. For over two hours this enchanting group filled the house with sound that still haunts me, until at last, just before 2:00 the exhaustion of seven months in the field overcame my ability to stay conscious and we bade each other good night. I drifted off to sleep to the strains of Isalei, the beautiful farewell song which can never be forgotten.

Our start the next morning, needless to say, was not an early one, but eventually we made our way up the steep trail leading to the summit of Mount Mariko where I hoped to collect full series of palms taken earlier by Dr. A. C. Smith, and only a year before my visit by my colleague, Dr. David Bierhorst. One of these had puzzled me for years, owing to the lack of mature seeds. The immature fruit and inflorescence suggested the genus *Heterospathe* which had not been reported from Fiji and now I hoped for an answer to my question. The answer was not long in coming, though it was a week before I realized it. Our first collection was from a small palm lacking stilt roots, but with long-stalked inflorescences, some with flowers, some with green fruits, yet with seeds formed, seeds of a most irregular shape and certainly not those of *Heterospathe.* Beyond, we found excellent material of another small palm with stilt roots, which I hoped would prove to be *Goniosperma,* and on the high ridges a large stilt-rooted palm with crowns



12. The crowns of *Clinostigma exorrhiza* reach above the low forest canopy on ridges.

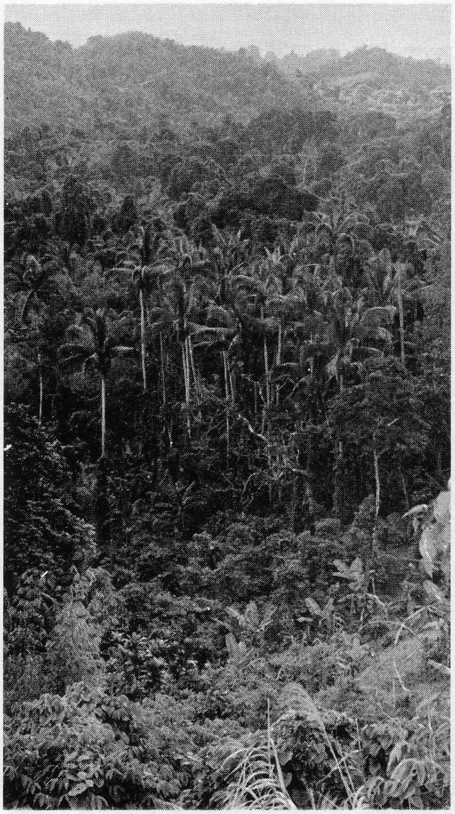
above the forest canopy. Adding to the excitement of finding these was the heavy rain which began to fall just as we had felled an example of the largest palm. We managed to gather all of the material and slipped down the slope without serious mishap, and as we prepared specimens, I tried to put each in its place without real success. It was only on the next island of Taveuni that all the species sorted themselves out in my mind. Meanwhile we returned to Savu Savu, spent a day collecting *Veitchia sessilifolia,* one of the smaller species of the genus, and tried to get a series of *Veitchia Joannis* without complete success, since those we had cut seemed to lodge each time in the surrounding forest. Trying to collect these more-than-70-foot-high monsters can sometimes be exceptionally frustrating and we ended this day in disaster as one of our helpers from the Agriculture Department gashed his leg very badly when he slipped against a sharp rock while tugging to pull down a trunk. Thus we ended palm hunting on Vanua Levu at the local hospital.

From Savu Savu we flew to Taveuni where, lodged in the comfortable Government Guest House, we had a good base for exploration. On Taveuni, my principal goal was to find the genus *Taveunia* which Dr. Burret had described from incomplete material. On the 22nd of April we went by landrover to slopes

13. The effects of drenching rain fail to obscure all the details of *Taveunia trichospadix* with its regularly pinnate leaves.

along a creek in lowland forest in the Salialevu Estate where a lone *Veitchia* rewarded our efforts. At first I assumed this to be *V. simulans* which I had described from Dr. A. C. Smith's collection on Taveuni, but since our material was in flower, his in fruit, the identity was only one of assumption. Returning, we did succeed in getting specimens of *Veitchia Joannis* at last, these growing on the sides of a steep but low hill at Kubelu, Vuna on the south end of the island. On the tree selected for felling, we counted eight inflorescences in all stages from bud to mature dark red fruit more than two inches long. Truly, *V. Joannis* deserves to be much more common than it currently is in cultivation.

The most rewarding day on Taveuni



14. A grove of vuleito, *Neoveitchia Storckii*, in the Rewa Valley.

was spent in the climb to the lake in the crater of an old volcano at the center of the island, starting from the village of Somo Somo. It was here, over a century ago, that Berthold Seemann collected the palm described by Hermann Wendland as *Kentia exorrhiza*, today known as *Clinostigma exorrhiza*. As we climbed, we saw the slender stems and dark, blunt-tipped leaves of *Balaka Seemannii*, two adult trees of *Veitchia simulans* in young fruit and rather clearly distinct from the *Veitchia* referred to earlier (which is probably an undescribed species), and finally the same three palms we had seen on Mount Mariko. Collecting these in various stages of flower and fruit made it possible to correlate our earlier collections and published descriptions. The *Heterospathe*-like palm could be identified as *Taveunia trichospadix*, the smaller stilt palm as *Goniosperma Thurstonii*, named after a former Governor of Fiji, and the largest clearly as *Clinostigma exorrhiza*. Once understood, these palms were easily distinguished, the *Taveunia* by its lack of stilt roots even when the long inflorescence was not developed, the other two by size, type of inflorescence and above all by their fruit, red and scarcely the size of a pea in *Clinostigma*, purplish-black and large as a hickory-nut in *Goniosperma*, which, on detailed study, proves to be the same as the genus *Physokentia* described by Beccari from the New Hebrides. We also saw a sterile and probably new *Calamus*, not the same as *Calamus vitiensis*, the only species reported for Fiji, which we collected later at Likuvausomo on the Ura Estate by the road to the southern end of the island.

Taveunia, *Physokentia* (*Goniosperma*), and *Clinostigma* having been found, it remained to search for the genus *Goniocladus* on Viti Levu where it grows in the forest of the interior. After flying back to Suva, shipping materials, and arranging for drying of specimens, we spent a day with Mr. Parham seeing *Veitchia vitiensis* var. *Parhamiorum* and *Balaka microcarpa*, both elegant relatives of *Ptychosperma*, in woods about the water catchment area on Savura creek at Tamavua, near Suva. On April 30th, with departure for the U. S. imminent, Dominiko and I with a driver, set out for the forestry area at Nadarivatu where a palm thought to be *Goniocladus* had been collected and where Dr. Otto Degener had collected an unknown palm in 1941.

Enroute we went along the Rewa River Valley, searching for *Neoveitchia Storckii*, a most unusual palm thus far known only from that area. Mr. Par-

15. Crowns of two *Neoveitchia Storckii.*

ham had been kind enough to provide me with study materials some years ago, but there is a satisfaction in seeing so rare a palm for one's self. A handsome grove of *vuleito,* as the *Neoveitchia* is called locally, was found in a forested area near Naqali Village where, by good fortune, we found flowering and fruiting trees near the road. *Vuleito* is a solitary palm, rather stoutish in trunk, with a crown of large arching and twisted leaves which make for a

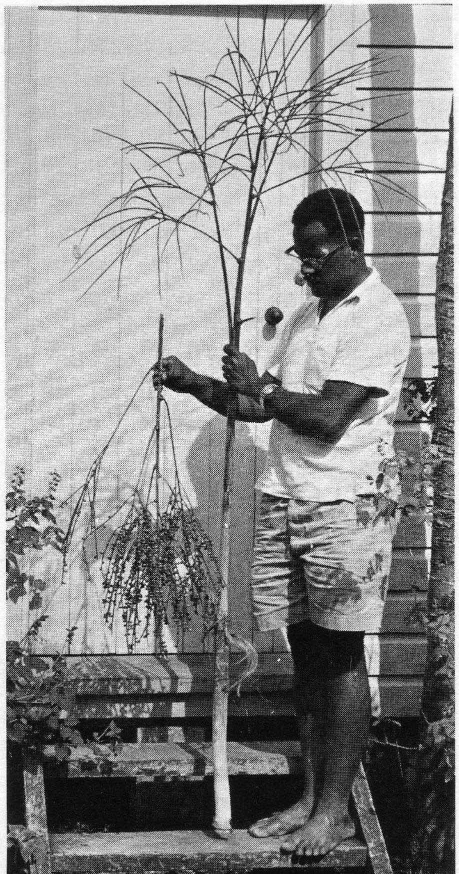
16. A young inflorescence of Neoveitchia shows the exserted horn-like upper bract.

17. In fruit, *Neoveitchia* much resembles true *Veitchia Joannis.*

handsome effect when trees are seen in mass. The bracts of this palm are rather unusual as is the development of the inflorescence which appears in bud in the leaf axils but does not expand until the subtending leaf has fallen.

Leaving the Rewa Valley with a load of foliage and inflorescences, we drove on to arrive at Nadarivatu in the mountains in time to prepare dinner in the Forestry Rest House and to view one of our goals, the mountain Lomalangi, rising above us. Lomalangi being accessible at short notice, we chose rather to spend our first day in a search for Degener's odd palm, beginning at the village of Dromodromo and climbing the slopes and ridges of Vuni Marasa where we found still another small *Veitchia* and *Balaka leprosa* but nothing else. On our return, therefore, we made further inquiry for the palm called *taqa* (pronounced tanga) and having located a possible guide made plans to return after a trip up Lomalangi. Success in part met our struggle up the mountain for although we did not find the *Goniocladus,* we did find the palm thought to be of this genus but which proves to be a new species of *Physokentia, P. rosea* (Principes 10:90. 1966) growing in the mossy cloud forests generally on east ridges beyond the second peak. This *Physokentia,* with its stilt roots, has rose-red male buds and red male flowers but such seed as we obtained was apparently not ripe enough

18. Dominiko Koroiveibau stands beside the leaf of *Taveunia Tanga.*



19. The inflorescence of *Taveunia Tanga* is taller than a man.

to germinate nor is it likely that the species could be successfully cultivated in the United States.

A severe *Staphylococcus* infection of the legs served to put me out of commission in the next two days so Sunday I prepared specimens and wrote while Dominiko made definite arrangements for a guide to the locality where *taqa* grew for our last day, May 4th. Here again I only saw the pair off and greeted them on return, when they proudly appeared sheltered by the great leaves of this palm. Inflorescences, flowers and immature fruits had been obtained from which it was clear that we had in hand a new species in *Taveunia* since described as *Taveunia Tanga* (Candollea 20: 98, 1965), thus adding a new genus and an undescribed species to the flora of Viti Levu.

By now only *Goniocladus* had eluded us. It was clear that with passage for the U. S. booked that evening from Nadi, this genus would have to await a return trip when time would permit the several days required to reach the locality where it had been collected originally. It's always well to have a focus for a return to exciting palm areas, thus I left Nadi that night ready to rest after more than seven months on the go but already thinking about returning to Fiji, to New Caledonia, to New Guinea and its neighbor islands and to Madagascar.

It would not be fitting to close this account without reiterating my thanks to all those who made it by far the most rewarding experience since I first began field work in 1940. Travel was made possible by National Science Foundation Grant GB-1354 as part of a broader program of palm study and though I should like to single out everyone who aided me, I shall have to be content with those already noted who made so many arrangements in Madagascar, and Mr. Don Jayaweera in Ceylon, Mr. Humphrey Burkhill in Malaya, Mr. B. Smythies, Dr. J. A. R. Anderson, Dr. Peter Ashton, Dr. W. Meijer in Borneo, Mr. John Hauser, Mr. Reginald Spence, Mr. Selwyn Everist in Australia, Mr. John Womersley and Mrs. Andrée Millar in New Guinea, Dr. T. Whitmore, Mr. G. Dennis and Mr. K. Treneman in the Solomon Islands, M. Lavoix in New Caledonia and Mr. John Parham in Fiji. To them I shall ever be grateful.

Salt Tolerance in Young Palms

A Personal Experience With the Effects of a Hurricane Tide on Several Hundred Small Palms in a Nursery

JACK KOEBERNIK

There is little to be found in the literature about the effect of ocean water on seedling palms — at least it has been difficult for me to find much published on this subject. Therefore, I thought that it might be of some interest to members of The Palm Society to know what happened to several hundred young palms after being submerged in salt water of varying depths and for varying lengths of time.

On September 7th, 1965, hurricane "Betsy," the second hurricane of the 1965 season (the U. S. weather bureau names the storms alphabetically), bore down on Key West, Florida, with winds to 90 miles an hour and very high tides. My small nursery is situated on Stock Island, on rather low ground, and the hurricane tide inundated it quite thoroughly. In the subsequent weeks I have noted carefully what effects the salt water had on a number of genera and species, and have compiled the following chart showing the results. Some of them surprised me not a little.

Palm	Size, How Planted	Approx. Depth Water and Time Submerged	Effect
Acoelorrhaphe Wrightii (*Paurotis Wrightii*)	3 ft., container grown	6 in., 3 hrs.	Unaffected
Aiphanes acanthophylla	Seedling in flats	6 in., 3 hrs.	Slight burn
Arecastrum Romanzoffianum	Gal. cans, 18 in. tall	6 in., 3 hrs.	Unaffected
Arenga Engleri	Large plants, 5 ft. tall	12 in., 6 hrs.	Unaffected
A. pinnata	Gallon cans	6 in., 3 hrs.	Unaffected

Arenga species	Gallon containers	6 in., 3 hrs.	Unaffected
Arikuryroba schizophylla	Large plants, 3 ft.	12 in., 6 hrs.	Unaffected
Arikuryroba schizophylla	Seedlings, 4-inch pots	12 in., 6 hrs.	Unaffected
Bactris species	Gallon containers	6 in., 3 hrs.	Unaffected
Basselinia eriostachys	Gallon containers	6 in., 3 hrs.	Unaffected
Calyptronoma dulcis	Gallon containers	6 in., 3 hrs.	Unaffected
Caryota mitis	12-ft., container grown	30 in., many hrs.	Much burn right away. Fungus set in. All but one plant had to be destroyed.
Chamaedorea elatior	Seedlings in flats	6 in., 3 hrs.	A little burn
Chamaedorea erumpens	7-ft., container grown	30 in., many hrs.	Unaffected
Chamaedorea erumpens	Seedlings in 4-in. pots	24+ in., m. hrs.	Unaffected
Chamaedorea erumpens	Seedlings in flats	6 in., 3 hrs.	Unaffected
Chamaedorea Seifrizii	4-ft., container grown	30 in., many hrs.	Unaffected
Chamaedorea Seifrizii	Seedlings in 3-in. pots	24+ in., m. hrs.	Unaffected
Chamaedorea Seifrizii	Seedlings in flats	6 in., 3 hrs.	Unaffected
Chamaedorea Tepejilote	Seedlings in flats	6 in., 3 hrs.	A little burn
Chamaerops humilis	4-inch pots	24+ in., m. hrs.	Little tip burn
Chrysalidocarpus lucubensis	2½ ft., container grown	6 in., 3 hrs.	Unaffected
C. lutescens	4-ft., container grown	30 in., many hrs.	Much burn right away. All died.
Dictyosperma album	4-ft., container grown	6 in., 3 hrs.	Unaffected
Dictyosperma album var. rubrum	10-ft., container grown	30 in., many hrs.	(seemed to thrive)
Dictyosperma aureum	Seedlings in flats	6 in., 3 hrs.	Unaffected
Drymophloeus Beguinii	Gallon containers	6 in., 3 hrs.	Unaffected
Elaeis guineensis	5-ft., container grown	12 in., 3 hrs.	Unaffected
Euterpe globosa see *Prestoea montana*			
Geonoma membranacea	Seedlings in flats	6 in., 3 hrs.	Little tip burn
Heterospathe elata	Seedlings in flats	6 in., 3 hrs.	Unaffected
Jubaea chilensis	4-inch pots	6 in., 3 hrs.	Unaffected
Latania Loddigesii	3-ft., container grown	6 in., 3 hrs.	Unaffected
Licuala spinosa	Gallon containers	6 in., 3 hrs.	Unaffected
Livistona chinensis	4-inch pots	6 in., 3 hrs.	Much burn right away. All died in short while
Livistona chinensis	Seedlings in flats	6 in., 3 hrs.	Unaffected
Mascarena Verschaffeltii	Seedlings in flats	6 in., 3 hrs.	Unaffected
Neodypsis Decaryi	Gallon containers	6 in., 3 hrs.	Unaffected
Oncosperma tigillarium	Gallon containers	6 in., 3 hrs.	Unaffected

Opsiandra Maya	Seedlings in flats	6 in., 3 hrs.	Unaffected
Orbignya Guacuyule	Gallon containers	6 in., 3 hrs.	Unaffected
Paurotis Wrightii see *Acoelorraphe Wrightii*			
Phoenix canariensis	Seedlings in 3-in. pots	6 in., 3 hrs.	Unaffected
Phoenix species	Seedlings in 4-in. pots	6 in., 3 hrs.	Some tip burn, fungus later
Phoenix species	Gallon containers	6 in., 3 hrs.	Unaffected
Phoenix Roebelenii	1-quart cans	12 in., 3 hrs.	Unaffected
Pinanga patula	Gallon containers	6 in., 3 hrs.	Unaffected
Prestoea montana (*Euterpe globosa*)	Gallon containers	6 in., 3 hrs.	Unaffected
Pritchardia species	Seedlings in a flat	6 in., 3 hrs.	Unaffected
Pseudophoenix Sargentii	Gallon containers	6 in., 3 hrs.	Unaffected
Ptychosperma elegans	12-ft., in containers	6 in., 3 hrs.	Some burn
Ptychosperma Macarthurii	9-ft., in containers	12 in., 3 hrs.	Unaffected
Ptychosperma Macarthurii	In 3-inch pots	6 in., 3 hrs.	Much burn, nearly all died
Rhapis species	3-ft., container grown	6 in., 3 hrs.	Unaffected
Roystonea species	10-ft., container grown	6 in., 3 hrs.	Some burn
Scheelea amylacea	Gallon containers	30 in., many hrs.	Unaffected
Syagrus sancona	Seedlings in a flat	6 in., 3 hrs.	Unaffected
Synechanthus fibrosus	Gallon containers	6 in., 3 hrs.	Unaffected
Tessmanniodoxa Chuco	2½-ft., container grown	6 in., 3 hrs.	Unaffected
Veitchia Merrillii	6-ft., container grown	30 in., many hrs.	Unaffected and seemed to thrive
Veitchia Merrillii	4-ft., 3-gallon cans	30 in., many hrs.	Much burn
Veitchia Merrillii	2-ft., 1-gallon cans	30 in. many hrs.	Much burn
Veitchia Merrillii	Seedlings in a flat	12 in., 6 hrs.	Unaffected
Washingtonia, species	3-ft., container grown	30 in., many hrs.	Unaffected and seemed to thrive

All the palms were thoroughly watered before the tide came in and as soon as posible after it drained away. The foliage was well washed off.

It is notable that plants grown in muck with no sand added showed no burn or other injury. Plants grown in muck and sand mixture showed some burn to much burn. For example, *Livistona chinensis* seedlings in 4-inch pots were in muck and sand mixture and all were lost. *Livistona chinensis* seedlings in flats were grown in muck with no sand and all survived undamaged.

An *Arenga Engleri* planted in the ground and about eight feet tall, growing about twenty miles from Key West was completely covered with salt water and was unaffected. Several *Veitchia Merrillii* and *Washingtonia* species in the same area were standing in several feet of salt water during the storm and showed no effects whatsoever from it. Several years ago some washingtonias were planted in Key West. One plant grew much more rapidly than the rest. Its roots were found to be in salt water. Later, the salt water was cut off from it and the rate of growth was much affected for over a year.

Coccothrinax jamaicensis The Jamaican Silver Thatch

ROBERT W. READ*

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In 1939, Dr. Liberty Hyde Bailey published the results of his studies of the genus *Coccothrinax* in the southern Greater Antilles (*Gent. Herb.* 4: 247-259). In this study, he considered six species of Hispaniola, and one each from Puerto Rico and Jamaica. During the same year, Brother León of Cuba also published his finding concerning the genus in Cuba (*Mem. Soc. Cub. Hist. Nat.* 13(3): 107-156) in which, out of a total of 21 species indigenous to Cuba, he described 13 new species and a number of new varieties. With so many species of *Coccothrinax* known in Cuba and Hispaniola, it is curious that only a single species occurs in Jamaica.

When Dr. Bailey first collected the silver thatch in Jamaica it had been known as *Coccothrinax argentata*, but the Jamaica plant differs from that species in having the flowers and fruits on very long pedicels. Because of inadequate sampling and the rather variable character of the Jamaican silver thatch, and possibly biased by the strongly fragrant flowers, Dr. Bailey chose to associate the palm with *Coccothrinax fragrans* Burret, a species of very limited distribution in Cuba "known by its yellow very fragrant flowers, . . ." The Jamaican plants do not have yellow flowers and the additional characters given are not adequate to combine the two as a single taxon. In the original description of *C. fragrans* by Burret, the indumentum on the abaxial surface of the leaf is described as ". . . *pallidiores, . . . mox plus minus caduco . . . demum fere glabris . . .*;" and this is the key to the problem, for the plants of Jamaica have brilliantly silvery undersurfaces on the leaves and the indumentum is strongly persistent, the leaves never being glabrescent. Further differences between the two species are tabulated below with characters for *C. fragrans* as given by Burret and León, and from León's specimens numbered 16388, 15926 (GH).

COCCOTHRINAX JAMAICENSIS R.W. Read, *sp. nov.*

Thrinax argentea sensu Griseb. pro parte, Fl. Br. W. Ind. 515. 1964 not Lodd. ex Schult. & Schult., Syst. Veg. 7: 1300. 1830.

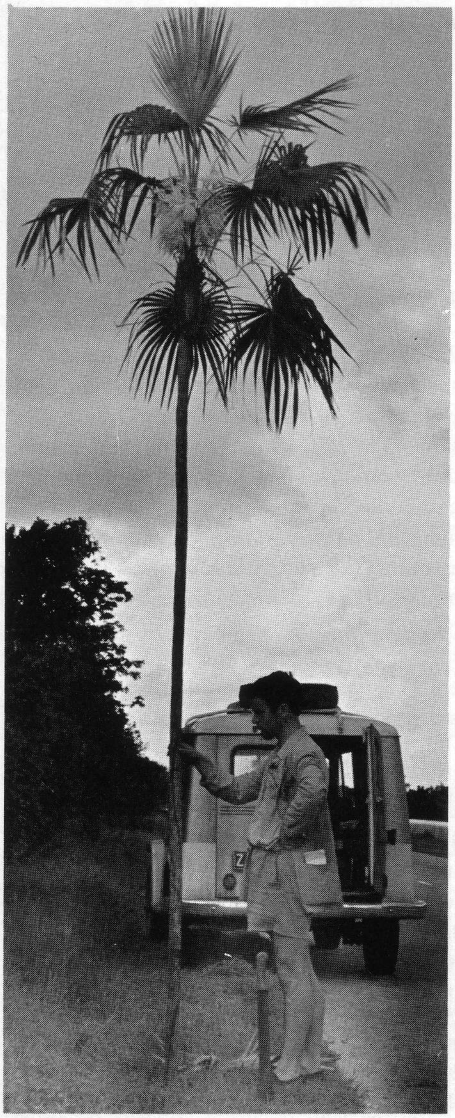
*I wish to express my appreciation to Dr. W. Dress of the L. H. Bailey Hortorium, Cornell University, for assistance with the Latin diagnosis and to Dr. C. D. Adams of the University of the West Indies for critically reviewing the manuscript.

	C. fragrans	*C. jamaicensis*
Palman length	13-16 cm.	(15-) 19-36 cm.
Abaxial surface of leaf blade	whitish	bright silvery
Indumentum of abaxial surface	inconspicuous, caducous, glabrescent	conspicuous, persistent, tomentose
Number of primary inflorescence branches	4-5	(4-) 5-7
Flower color	yellow	whitish
Hastula length (free portion)	(1.9-) 2-2.5 cm.	0.41-1.50 (-1.8) cm.

1. *Coccothrinax jamaicensis.* Close-up of flowers of plant from which the type specimen was made.

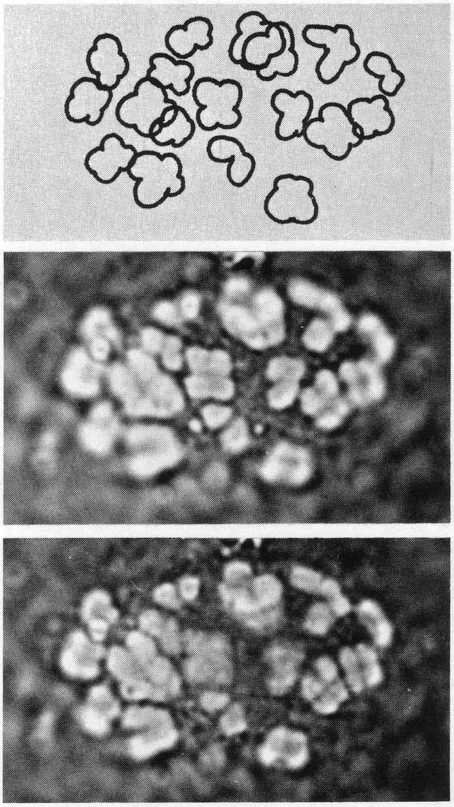
Coccothrinax argentea of authors not Sargent, Bot. Gaz. 27: 89. 1899. *C. fragrans* sensu Bailey, Gent. Herb. 4: 256. 1939 not Burret, Kungl. Svensk. Vet. Akad. Handl. 6(7): 15-16. 1929.

Palmae solitariae caulibus gracilibus; folii pagina abaxialis argentea, inconspicue punctulata, dense lepidota squamulis persistentibus hyalinis, palmine 18-36 cm. longo, hastula minus quam 1.8 cm. longa, segmentis 35-58, eis centralibus plus quam 2.5 cm. latis, vagina ex reti fibroso subtili constanti; inflorescentia brevis (4-) 5-6 (-7)-partita, floribus eburneis, staminibus (7-) 9-14 (-15), antheribus (2.0) 2.1-3.0 (-3.2) mm. longis; inflorescentia fructificans arcuata, pedicellis (2-) 3-6 (-6.2) mm. longis.

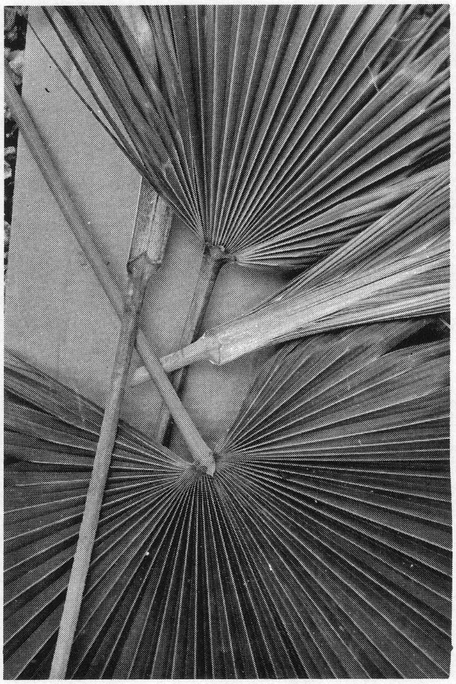


2. Brian Morley of Kew, England, holds the plant of *C. jamaicensis* cut in woods along the Queen's Highway from which the type specimen was made.

Trunk 6-8 m. high, (5-) 6.4-20 cm. in diam., gray, smooth, the plant commencing to flower when ca. 2 m. tall and producing flowers several times a year (Nov., May, July). Leaf blade palmate,

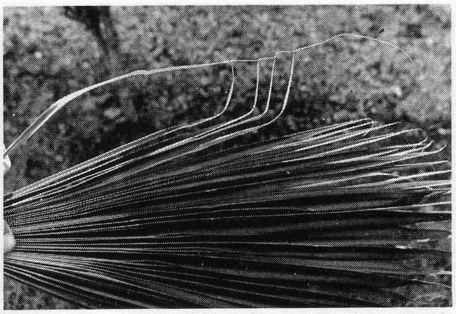


3. Chromosomes of *C. jamaicensis*: above, camera lucida drawing magnified about 2,700 times; below, photographs of chromosomes at two levels of focus from Kodachrome transparency. n = 18.



4. Hastulas from a single plant of *C. jamaicensis.*

circular in outline, 80-140 cm. in diam., with 35-38 linear-triangular lax segments connate in a palman (15-) 19-36 cm. long, central free lobes 31-66 cm. long, 2.5-4.8 cm. wide at widest point and tapering gradually to a very slightly bifid apex 0.6-2.2 cm. deep; adaxial surface glossy dark green with ridges yellowish, principal nerves of partially expanded blade with caducous scales; abaxial surface silvery, covered with a dense indumentum of persistent irregularly shaped fimbriate interlocked hyaline scales, the central portion of which is conspicuous as a smooth punctate dot; fully developed but yet unexpanded blades with a rein (lora of Eames) connecting all apices of the leaf segments (as the blade expands the rein breaks apart easily but is often found as an elongate whip-like attenuation of the lowermost segments); hastula various in outline (depending partially on extent to which the blade is expanded), at first covered with a dense indumentum of adpressed caducous gray scales, free adaxial extension 0.4-1.5 (-1.8) cm. long; petiole ancipitous (48-) 50-59 cm. long, ca. 1.3-2 cm. wide, very gradually increasing in width toward the union with sheath where ca. 2.5 cm. wide and flattened adaxially, abaxial surface densely covered with white scales which are soon lost along the central convex portion; sheath tubular, very slightly liguliform for ca. 2-4 cm., woven of fine fibers 0.5 mm. thick, at first covered with silky white hairs and scales (expansion of the bud region causing the sheath fibers to become



5. Partially expanded leaf blade showing the rein along the margin.

6. *Coccothrinax jamaicensis* in the type locality along the Queen's Highway.

separated forming a net). Inflorescence axillary, interfoliar, 70-90 cm. long, erect at anthesis to arcuate in fruit, composed of (4-) 5-7 primary branches, the lowermost branch ca. 11-23 cm. long to apex of terminal rachilla, the terminal primary branch often not fully exposed; peduncle with 2-3 empty bracts, the lowest one ancipitous and inserted about 1-2 cm. above the base of the peduncle within the leaf sheath, the others tubular with an oblique apical opening, each primary branch subtended by an elongate tubular bract with an oblique apical opening, the free portion frequently rigid and extended above the inflorescence, all bracts covered with white floccose hairs, each remaining bract enclosing the flattened stalk of the primary branch which it subtends and the lower portion of the next tubular bract; the stalk of each branch with a strongly bifid, ancipitous, partially tubular bract inserted about 2-3 cm. above its base; each primary branch once compounded with 14-40 rachillae, these 8-16 cm. long, with 35-50 or more pedicellate flowers. Flowers fragrant, white at anthesis, soon becoming creamy white, never yellow; perianth scarious, in a single series, with 5-6 unequal subulate lobes ca. 5 mm. long; stamens (7-) 9-14 (-15), about equalling pistil, filaments about equalling or shorter than the anthers, dilated and connate in a ring at the base, slender above; anthers attached at base of connective, (1.5-) 2.0-3.0 (-3.2) mm. long, sagittate at base, retuse to bifid for (0.2) 0.3-0.6 mm. at the apex, the pollen sacs rounded to pointed apically and frequently unequal in length, connective very narrow; pistil pyriform, style normally straight, stigma infundibuliform. Mature fruit with persistent perianth, (6.9-) 7.5-9.5 mm. in diam., purple-black, juicy-fleshed; seed cerebriform, 6.2-7.1 mm. in diam. when fresh, 5.6-7.1 mm. in diam. when dry; fruiting pedicels (1-) 2-6.2 mm. long; primary branches in fruit 15-33 cm. long. Chromosome complement: n = 18.*

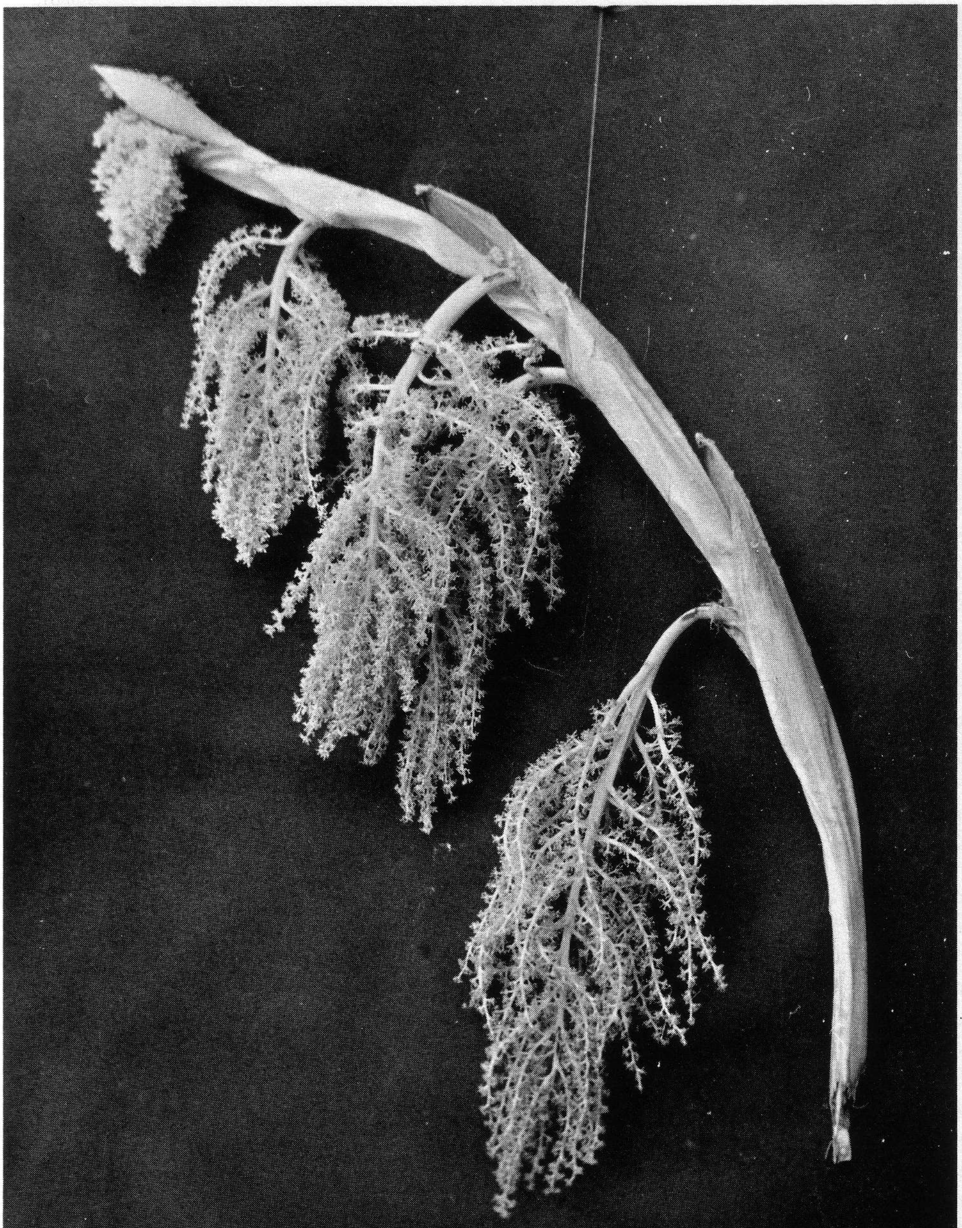
7. The silver thatch near May Pen on the south coast of Jamaica.

8. Close-up of the crown or bud region of silver thatch showing the fruiting inflorescence and sheathing material. Notice the white scales on the youngest unexpanded leaf.

*Chromosome studies were supported, as part of a larger palm study, by National Science Foundation Grant GB-2486.

Vernacular name: silver thatch.

Uses: leaves are used in the making of



9. A single inflorescence from the type specimen at anthesis.

hats, baskets, bags, and various articles sold in the native crafts markets.

SPECIMENS EXAMINED (in personal collection when not otherwise designated :

JAMAICA. St. Ann Parish: Queen's Highway, ca. 2 mi. east of Rio Bueno, *Proctor 11070* & *11250* (IJ) ; *Read 1563* (holotype, BH; isotypes, UCWI, S, GH) ; *Read 1606* (BH, UCWI, S, GH) ; *Read 1607, 1608*. St. Thomas Parish:

10. Leaves of *C. jamaicensis* woven into a useful and attractive basket.

near Grant's Pen, *Read 1679*. St. Andrew Parish: base of Long Mt. near August Town, *Read 1564*. Clarendon Parish: Curatoe Hill, *Read 1665;* intersection May Pen and Lionel Town Rds., *Read 1677*. Manchester Parish: 49 mi. marker near Gut River, *Read 1687*. St. Elizabeth Parish: Bideford District, S. W. of Malvern in the Santa Cruz Mts., *Webster & Proctor 5312* (IJ); between Font Hill and Scott's Cove, *Proctor & Mullings 21975* (IJ). Westmoreland Parish: 22 mi. marker near Negril Beach, *Proctor 11113* (IJ); *Read 1571, 1613, 1674, 1683.*

DISTRIBUTION: endemic.

Coccothrinax jamaicensis is a highly variable species widely distributed along the coastal regions of the island from sea level to an altitude of nearly 1,500 feet and on a variety of substrates. The silver thatch is never found far inland nor in areas of heavy rainfall and good soil. Rather, it occurs on steep mountain slopes or cliffs of limestone, deeply eroded "dog-tooth" limestone and sand just behind the beach.

On the north coast of Jamaica, between Discovery Bay (Dry Harbour) and Rio Bueno in the parish of St. Ann, the Queen's Highway runs through an area of sharply eroded "dog-tooth" limestone at the base of high limestone cliffs. This area, exposed to northeast breezes, has a fair amount of rainfall but because of the nature of the porous rock and lack of soil or humus is rather xerophytic. The silver thatch growing here (Fig. 6) on apparently bare rock among *Agave*, cacti, and other xerophytic plants, is tall and very slender with the trunk only 5-8 cm. in diameter and usually with a crown of small leaves with the brightest silvery undersurfaces.

Along the drier, often highly xerophytic south coast of Jamaica, the silver thatch is found in scattered populations in small ravines, on exposed mountain cliffs and on gently sloping regions of thorn scrub associated with broken or eroded limestone. In the parish of St. Thomas near Grant's Pen, *Coccothrinax jamaicensis* is found in light woods along the protected slopes of a ravine in a very dry area. The plants growing on limestone outcrops in light shade with heavy soil close about the roots have heavy trunks 10-15 cm. in diameter and produce large, nearly flat leaves forming a rather large crown. A short distance up the ravine, where it opens into a small dry valley of scanty soil and an abundance of eroded limestone, the vegetation is sparse and thorny and the scattered silver thatch palms exposed to full sun and wind are tall and slender (trunk diameter 5-8 cm.) with a small crown of glistening leaves. The silvery undersurface of the leaves of plants growing in the protected areas is not as pronounced as it is on plants growing in the exposed situations.

To the west, in the parish of St. Andrew, on the seaward-facing slopes of the Port Royal Mountains above the Cane River, the silver thatch is abundant on dry limestone and marl cliffs exposed to strong southeast winds. The plants here are tall and slender, and the leaves are so silvery as to be seen from far away. A short distance westward, on the lower slopes of Dallas and Long Mountains along the Hope River, the silver thatch is found both on limestone outcrops closely associated with soil (as at Grant's Pen) and on steep scree slopes of broken rock and soil. Rainfall is sparse and seasonal, and the runoff is rapid. Plants growing here in the light woods protected from strong drying winds are short (2- 3 m. tall), have heavier trunks (10-20, cm. in diameter) and the leaves and crown are larger with the silver less pronounced.

Further west, near Curatoe Hill south of May Pen in the parish of Clarendon, the silver thatch is found as scattered individuals on limestone outcrops and well drained soils. The region is exceedingly dry during the winter months and although it may rain heavily during the summer showers, the area has a very arid character throughout most of the year. The palms here are uniformly heavy-stemmed (15-20 cm. in diameter), usually tall (3-5 m.) and with large dense crowns of large leaves which are brilliantly silvery beneath (Fig. 7). South of this region, on dry, lightly wooded hills overlooking the sea, are some exceptionally tall (to 7 or 8 m.) slender-stemmed individuals with bright silvery foliage exposed to the strong sea breezes.

Westward on the lower slopes of the Carpenter Mountains in the parish of Manchester, the silver thatch is found on rocky cliffs and hills exposed to strong sea breezes, while near the western border of the parish of St. Elizabeth, it is found in light woods and thorn scrub. In both of these areas, the plants growing on exposed limestone are usually very tall with slender stems and have a smaller crown of leaves than those in protected situations or on rocky soils.

A peculiar situation exists in the region of Negril Beach at the westernmost end of the island in the parish of Westmoreland (near mile marker 22 miles from Lucea). In a small area of not more than 30 acres, a population of *Coccothrinax* is growing at sea level on sandy substrate (similar to beach sand) with a very high water table. In fact, there is frequently standing water all around the area with only a foot or two of difference in elevation between the standing water and the palms. In this region of almost no strong sea breezes and no long dry periods it is most interesting to find *C. jamaicensis* growing under conditions so contrary to its usual habitat.

INDEX

Figures in *Italic* indicate pages with photographs or other illustrations

Errata for volume 10:

page 63, col. 2, line 45 *for* who do not recognize *read* who do recognize

page 91, fig. 3 reversed

page 64, col. 1, line 27, col. 2, line 1 *delete* at his own expense.