



PRINCIPES

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THE INTERNATIONAL PALM SOCIETY

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Cover Picture

Corypha umbraculifera, shortly after anthesis, in Fairchild Tropical Garden, Miami, FL, August 1984. This was the first plant of the species recorded to flower in the continental United States. Photo by W. Farnsworth. See pp. 68-77.

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Growing Chamaedoreas: Six Simple Leaved Ones

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This discussion on chamaedoreas will concern those that I have grown over the years in Miami, San Francisco, and Walnut Creek. Also I will touch on those I'm familiar with in southern California. It seems that in each of these climate zones some grow better than others, while other species excel in all zones. This will be the first of a series of articles about the various aspects of *Chamaedorea* culture.

I will refer to "Palms in Australia" by David Jones because it has nice color photographs and for the most part gives adequate descriptions.

Jones states there are 133 species of *Chamaedorea*. Dr. Hal Moore thought about 100, but there may be more. I have seen photographs taken by Dr. Bob Read and others of plants from South and Central America that look like *Chamaedorea*, but the palms had never been seen before, and are still not collected or identified. These unidentified exotics are mostly cloud forest palms that require exacting temperatures, humidity, and soil pH, and are not well suited for home or garden culture in the U.S.A. The cloud forest chamaedoreas seem to tolerate only a narrow temperature range somewhere in the 60's and 70's, with constant humidity, and just the right amount of subdued light. They don't like chemical fertilizers and are fussy about their growing medium—not ideal plants for the home environment. I have given up trying to grow the cloud forest chamaedoreas. They are often small and quite beautiful, but are so difficult to grow, they may bring disappointment.

There are some chamaedoreas that come from higher elevations that do well in coastal California, primarily in southern California. The temperatures in northern California are a little extreme for these palms to look their best, although they do grow here. Many of these are large clustering plants, and some are hybrids. Several years ago, a grower in southern California let me test some of his hybrids in Walnut Creek, where the climate is more extreme than in other areas of the San Francisco Bay area. These plants are too big for the house and must be protected in the winter. As an experiment, I left one out last winter under the protection of an oak and it was defoliated. I moved it back in the greenhouse before the winter was over, and it has recovered nicely. I will discuss the large species and hybrids in a later article.

Now for the ones that have survived my care! If you think the automobile companies put their wares to the test, think of what my chamaedoreas have gone through—drought, heat, dust, neglect, and sometimes too much attention.

If one had the room, the time, and the climate, just chamaedoreas alone could occupy all of a palm enthusiast's time. They did mine for many years, until I got stung by the *Rhapis* bug. Unfortunately, *Rhapis* don't lend themselves to fast growth, or hybridizing. The chamaedoreas are relatively fast growing, inexpensive, and with a little persistence, easy to acquire.

Rather than put them together botanically, which I am not qualified to do, I am

going to put them first in order of appearance, and discuss some later that seem to be closely related.

The Simple Leaved Ones

The simple or entire fronded ones: *C. metallica*, *C. ernesti-augusti*, *C. geonomiformis*, *C. fragrans*, *C. stolonifera* and *C. brachypoda* are six, easy-to-grow palms. They all require shade, and are frost tender. They will take temperatures right down to freezing, and maybe a little below, if frost is not allowed to form on the foliage, but they are all essentially tropical palms, so anything below freezing could be the end. *Chamaedorea fragrans* seems to be the most tropical of the group; it doesn't like cool nights. *C. metallica* and *C. geonomiformis* are the next in tenderness. Three of the six, *C. fragrans*, *C. stolonifera* and *C. brachypoda*, are clustering and are usually propagated by division. Their opposite sex often isn't around, and except for *C. fragrans*, they are easy to propagate vegetatively.

I'll start with *C. fragrans* (Fig. 1), a rare species, difficult to divide, and found only in botanical and a few private collections. Most of the original plants in this country came from David Barry. It was once considered endangered, but I think there are both sexes in south Florida now. *C. fragrans* is from Peru, where Allen Fernandez from Miami visited its habitat several years ago. He could find no seeds, but he has several plants which he brought back, presumably including both sexes. He said the *C. fragrans* were growing in a sandy, rather poor soil with about 2" of mulch over it. Growing on the trees above them were *Platycerium andinum*, the only staghorn fern native to the Americas. *C. fragrans* is slow to grow from seed, and is probably best propagated by division. The base of each stem has a bulb-like swelling which will put out several pups if given time. This species won't tolerate much light and does better in my house than in the greenhouse, where it seems to

tolerate low humidity. It thrives on neglect, and doesn't mind getting quite dry.

Secondly, *Chamaedorea stolonifera* is in my opinion, the best of all; this is a clustering palm with small stems less than 1/4" in diameter and was another David Barry introduction which, he told me, he found in France. It was lost to cultivation in the U.S.A. for many years until Barry found it. Hal Moore told me that it was probably extinct in the wild. It comes from that area in Mexico in Chiapas where the volcano blew up a few years ago. There couldn't have been much left after that, but from what I know, that is the area that *C. stolonifera* came from.

C. stolonifera is easy to grow and propagate. It throws out rather weird stolons above the soil surface, and after they are several inches or up to a few feet long, they anchor themselves on the soil and begin to grow a new plant. After the stolon grows to a certain length, it makes a swollen area along its stem. This can be easily "mossed," and within two or three months after roots have formed can be cut off to make a new plant. It is best to let three fronds form above the mossed area before it is severed from the mother plant. From that, you have a mature plant in two or three years.

Teddie Buhler has a clone of *C. stolonifera* that seems different from mine. I believe hers came from a botanical garden in Germany, but it has a slightly different appearance. She gave some to Fairchild Tropical Garden several years ago, and they have a large clump growing in the ground near the sink hole. Both clones are female.

Chamaedorea stolonifera and *C. brachypoda* are often confused, but *C. brachypoda* has been in cultivation for some time and is not so rare. It probably has the smallest trunk diameter of all the palms. *C. brachypoda* does not like strong chemical fertilizers, as they make the fronds develop brown tips. Fish emulsion seems to be the best substitute. *C. brachypoda* produces rhizomes below ground, while *C.*



1. *Chamaedorea fragrans*, photograph of a drawing by Phil Elia.

stolonifera "stolonates" above ground. The description of *C. brachypoda* in "Palms in Australia" is accurate; it should be noted that *C. brachypoda* has a thin papery texture and a lighter color than *C. stolonifera*. Of the six palms, *C. brachypoda* is the most difficult to grow to perfection as it often seems to become chlorotic and it is sensitive to low humidity, but it is well

worth the effort. It should be in every enthusiast's collection.

C. stolonifera has a heavy textured, shiny frond and produces about five fronds a year per stem. It is somewhat resistant to red spider, but may get it sometimes, as the others do. An occasional spray under the foliage seems to keep the spider in check. *C. stolonifera* and *C. brachypoda*

can be bonsaied, but after about three or four years must be moved into a regular container.

The three remaining single trunked species must be grown from seeds. *C. geonomiformis* takes only about three years to start flowering after germination, *C. metallica* about three to four years, and *C. ernesti-augusti* about five to six years. To confuse the issue, I should mention that *C. metallica*, *C. ernesti-augusti*, *C. stolonifera*, and *C. sartori* (to be included later) are in the Eleutheropetalum group and were once classified in a different genus. I won't dwell on pollination or what will cross with what, since that will be in another article and will be lengthy and complicated.

I don't know why *C. ernesti-augusti* and *C. geonomiformis* are confused with each other. *C. ernesti-augusti* is about ten times as large, has entirely different flowers, and a lighter green foliage. *C. ernesti-augusti* has been in the trade for years, while *C. geonomiformis* has only been around for about the last fifteen, and I was the one who originally got *C. geonomiformis* out of the closet!

For many years, the only plants of *C. geonomiformis* known in cultivation were growing in the *Chamaedorea* collection at Fairchild Gardens and Paul Drummond had a few plants growing in his garden in Miami. When Paul's plants started producing seeds, he let me have all of them for the first few years. I grew them up and distributed the plants to palm society members in California and took plants back to Florida to members there. I gave Fairchild some young plants as their plants were getting old and leggy. Soon seeds were being produced from the plants that I distributed.

Finally, the Seed Bank received a lot of seeds and they were distributed far and wide. After propagating the plant for about ten years, I sort of lost interest in it and allowed my seeding plants to dwindle. Just last year, Jim Mintken gave me some seeds from plants that I had given him several

years ago. How about that for a full circle? We plant collectors are fickle people.

Besides being a neat little plant and easy to grow in a home, I discovered something about *C. geonomiformis* that even Hal Moore didn't know.

Most of the *chamaedoreas* flower in the spring, grow their fruit in the summer, and mature in fall or the winter months. Every time I visited Paul Drummond, it seemed his female *C. geonomiformis* had a few ripe and green fruit on them. This puzzled me.

It was only after I observed my newly seeding plants that it occurred to me what was happening. I had hand pollinated my females the year before and had plenty of fresh pollen, so I was sure that every single flower had been pollinated. Only about $\frac{1}{3}$ of the female flowers were producing seed the first year, but the flowers on the female spike that didn't seem to be pollinated didn't fall off, but remained firmly embedded on the inflorescence. (All the other *Chamaedorea* species abort their female flowers within two days to several weeks after anthesis if they aren't pollinated, the "eleutheropetalum" species usually within two days.)

One spring when both sexes of *C. geonomiformis* were blooming, something very strange was happening. I was pollinating the flowers on the newly emerged inflorescence, but I noticed that those old flowers on the year-old inflorescence were beginning to grow seed.

I thought to myself, "I've never heard of this before." After careful observation, I realized that this process had been going on for some time, but I hadn't been clever enough to realize it.

In addition to the ripe fruit, about $\frac{1}{3}$ spaced at random along the inflorescence, and the young green fruit, there were a few others in varying stages of development. This was a great discovery for me, and I couldn't believe it. Sometime that same year or the next, Dr. Moore visited me, and I showed it to him. At first he couldn't believe it either, but as I related

my observations, and showed him the plants, he scratched his chin, shook his head, and said, "Amazing, this isn't recorded anywhere." Then he flew into me and "growers" in general for not recording these things. "You people," just don't know how important these things are, etc., etc. I'm sure I was always a "grower" to Hal, but it gave me a great deal of satisfaction to point out something that he didn't know.

I talked to Hal about how this phenomenon should be described, but he didn't have a ready answer. Fortunately, "National Geographic" had an article about kangaroos the same year, and they discussed "embryonic diapause," a situation where if the primary "joey" gets killed, there is another little thing there waiting to take its place. Embryonic diapause means arrested growth of the embryo. What happens in *C. geonomiformis* is a sort of parallel.

By producing seed over an extended period, *C. geonomiformis* has ripe seeds throughout the year, and when climatic conditions are right, they germinate to form new plants. When the female plants bloom in the spring, apparently hormones or enzymes are produced in the plants which stimulate the dormant, but pollinated embryos into producing fruit. As I said, approximately $\frac{1}{3}$ of the dormant flowers produced fruit, and then the remaining flowers would produce sporadic fruit for the following year or two.

The peduncle of *C. geonomiformis* is quite small in diameter and grows to about eight inches long. At first they are vertical, but finally the weight of the fruit bends the peduncle down. The peduncle is covered with bracts which become papery in texture when they dry. After the bracts dry, I peel them away to expose the wiry peduncle which turns bright orange when exposed to light for a few weeks, as does the spike bearing the fruit at its tip.

C. geonomiformis gets very pale if given too much light. Grown in a subdued corner of the greenhouse or a home situation, it seems to be quite happy. It is a small palm

about $\frac{1}{4}$ the size of *C. metallica* and will grow to maturity in a 1 gal. pot. Given subdued light and ample fertilizer, the shiny foliage turns dark green. The female plants are quite attractive when holding their green unripe fruit and ripe black fruit on the orange flower spikes. With its irregular maturation, there is always some fruit on the female, if they have been pollinated.

(I'm going to interrupt my dissertation on *C. geonomiformis* for a moment, because writing about it brings something very important to mind if one grows seeds of these plants.) What I am about to tell you is true, not only on the six simple fronded chamaedoreas, but on the others that I will discuss later on—in another article!

When chamaedoreas bloom, the inflorescence pushes out from the base of the leaf. This is that portion that surrounds the trunk of the plant. It could almost be called the crownshaft, such as is found on the royal palm. Because chamaedoreas are so small, this tubular leaf-base doesn't quite qualify as a crownshaft, but it is the same thing.

I like my palms to be tidy, so as the lower fronds fall away or are cut off, the old leaf-base will remain and turn brown or tan. I carefully remove these to expose the pretty green trunks. Nature put these things there for several reasons, and one is to give support to the peduncle and the weight of the fruit. When we hand pollinate, sometimes every single flower will set a seed. This seems more than nature planned and the structure of the plant may not support the weight of the fruit.

If the supporting leaf-base has been removed and the peduncle is growing from the exposed trunk, I tie green stretch tape around the trunk and the base of the peduncle. If the fruit is particularly heavy, I support the peduncle at about the middle of its length with more tape to the trunk.

This may sound a little extreme, but I can tell you there is nothing more heart-breaking than to have gone to the trouble of hand pollinating a *Chamaedorea*, and

watched the fruit grow for months, or with some of the hybrids two or three years, and then suddenly one day have the whole thing break away when you brush against it or because of the added weight of water when it is sprinkled.

I once had a *C. ernesti-augusti* female that I had crossed with *C. sartori*. It had two inflorescences loaded with almost mature fruit. They were still green; the seed aren't ripe until the fruit turns black. Paul Drummond came out to visit and blasted my greenhouse with the water hose. The added weight of the water on the seeds caused both peduncles to break away from the trunk. I could have killed him, but anyway I learned an important lesson.

What brought all this to mind is the fact that *C. geomiformis* holds seeds for several years, and often the peduncles will be below the foliage on a bare trunk. *C. geomiformis*, in particular, needs a little help if the fruit is to remain intact.

Does all the above make sense? The process wouldn't be necessary if one weren't so impatient to remove the old leaf-bases, or if there was not so much weight from the additional fruit caused by hand pollination.

Before I leave *C. geomiformis* behind, it is worth referring to the pictures of it and *C. metallica* in *Principes*, Vol. 10, No. 2 with descriptions. Also, *C. metallica* used to be, and sometimes still is, mistakenly called *C. tenella*. *C. tenella* somewhat resembles *C. geomiformis* but is more diminutive. Hal Moore told me that *C. tenella* might just be another form of *C. geomiformis*. I didn't mention *C. tenella* in the easy to grow ones, because it is quite rare, and not very pretty. It is quite small and gets leggy later on.

Chamaedorea ernesti-augusti (Fig. 2) is quite an attractive plant, probably the most spectacular of the group, but I have stopped growing it because it takes up so much room. A mature plant is three to three and one half feet across. It is easy to grow and produces about five fronds a

year. A healthy plant will hold about 10 fronds. Unless one lives in an area without frost, this plant just requires too much space and attention. I once had several of these, and they did well outside in the warm months. When I had to move them in, they took up half of my greenhouse, and the others in the house were always getting in my way. *C. ernesti-augusti* is somewhat susceptible to red spider, and unless it is perfectly grown can look untidy. If one of those big entire fronds get damaged, it detracts from the whole plant. I had perfect plants for many years, but with the addition of *Rhapis* and the attention of other things, I just had to let them go. I have finally and sadly replaced *C. ernesti-augusti* with *C. metallica*.

C. metallica (Fig. 3) is my current favorite. It doesn't take much room; it's about $\frac{1}{3}$ the size of *C. ernesti-augusti*, and it is easy to grow. *C. metallica* has so many good things going for it that I'm surprised it's not more common. I don't know of any other palm that has such a heavy texture to the foliage and such a deep green color. It's tough too. The plants can be dropped, knocked over, walked into, and they just don't get damaged. (I've done all of the above!)

C. metallica tolerates the home environment better than any other palm I know of, even *Rhapis*! When a *Rhapis* dries out totally, it is usually dead. *C. metallica* starts to drop the lower fronds which is a clear warning, but recovers rapidly with a little water and tender loving care. *C. metallica* looks good grown as a single or several together in a larger pot. Because of the imposing foliage of *C. ernesti-augusti*, it should always be grown as a single.

C. metallica comes in several forms, the one most common is entirely fronded. I have developed the split-leaved one, and like it even better, because it has easy growth requirements, and if one of the leaflets gets damaged, it can be cut off and not detract from the entire plant.



2. *Chamaedorea ernesti-augusti*, photograph of a drawing by Phil Elia.



3. *Chamaedorea metallica*, photograph of a drawing by Phil Elia.

Every year when the first "warm rains" come I take the plants outside to be washed off. There is something about rain that is very beneficial. It dissolves all the dust and salts on the foliage and helps to dissolve the mineral deposits from the soil. I use rain water all winter, but bring it inside in buckets to warm to room temperature before watering. Perhaps it's the pH, but plants sure respond to rain water.

The entire fronds are easy to clean, and to groom the plants for shows, I wash them off with a fine spray from a garden hose and then let them dry in the shade. I then make a mixture of 2 qts. warm water, 1 cup white vinegar, and 2 tbl. spoons of Half & Half or whole milk. I wipe the foliage with a soft sponge using the above mixture. The vinegar dissolves water spots, and the oil from the milk leaves a soft natural-looking gloss.

Almost any kind of well draining potting soil seems to suit the chamaedoreas, although to the prepared soils that I use, I add Perlite for drainage and oxygen circulation to the roots and some coarse builders sand to add weight and substance.

I use Peters 20-20-20 for fertilizer, and

always make sure that the plants have been watered the day before so there is no danger of burning the roots. Occasionally I alternate with fish emulsion which seems to supply the necessary micronutrients to the plants and also seems to condition the potting soil and make it more water retentive.

As a final note, and perhaps the most important of all, as the seasons change, I am careful to observe the amount of sunlight that falls on the plants. In the summer when the sun is most intense, the plants are moved to the most protected, shady locations. One should be particularly careful during the winter and spring when the sun angle is low on the horizon. The warm spring sun, at its lower angle, can burn plants sitting too close to a window or under an overhang. Scorched fronds are unsightly and it will take a year or more to replace the damaged fronds with new healthy foliage. A little precaution will prevent this most unfortunate occurrence, and then you will have some of the most beautiful small palms in the plant kingdom to admire and enjoy!

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An Unconventional Alcohol Fuel Crop

F. W. FONG

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Anticipated scarcities of petroleum-based fuels and increasing energy consumption in most developing countries explain the need to examine alternative indigenous sources of energy such as fuel alcohol. Raw materials for alcohol (ethanol) production are usually sugarcane, cereal grains (principally maize, barley, and rice), grapes, and some rootcrops (cassava, sugar beet, and potato). Potentially, any source of hexose sugar can be used as a basis for fuel alcohol production. However, current realities regarding diminished energy sources appear to require somewhat more unconventional approaches towards fuel production specifically aimed at low input technologies. One such approach is the identification and cultivation on a large scale of alternative plant sources that could be used for their sugar content, such as high-yielding varieties of palms.

Nipa palm (*Nypa fruticans* Wurmb) has been the subject of much recent research because of its potential as a renewable source of fuel alcohol (Amio et al. 1979, Melana 1980, Newcombe et al. 1980, Halos 1981, Lorica and Fortes 1982, Fortes and Lorica 1982, Nyawin 1983, Pavoike 1984, 1985). It is a dominant and characteristic element of mangrove forests of Asia and Oceania (Saenger et al. 1983), and to a lesser extent in West Africa where it was introduced (Zeven 1973). It is well known that the palm traditionally provides medicines, thatching and construction materials for village dwellings, fiber for weaving of coarse baskets and sleeping mats, leaf peels for cigarette wrappers, sweetmeats and vegetable ivory; while in fishing, the petioles are used as floats for fish nets, the main axes for fish

poles, and the midribs of leaflets soaked and twisted as ropes (Gonzales 1979). The sap tapped from the stalk of the inflorescence or infructescence (Fig. 2) provides sugar and alcohol, or vinegar if acetic fermentation takes place. Historically, nipa as a fuel crop has gained little headway in the world largely for economic reasons. Some attention was given to establishing nipa plantations in Southeast Asia, particularly in British North Borneo (now Sabah), Malaya (now Peninsular Malaysia) and the Philippines during the early 1920's to 1930's. In Kuala Selangor, Malaya, the processing plant, "Nipah Distilleries of Malaya Limited," with distilling capability of ca. 9,092,180 liters per annum, was disbanded before actual production began (Hinchy 1938). Competitive prices in the world sugar market and high taxes on malt and distilled beverages led to a slump in the industry at that time.

Nipa grows in natural stands sufficiently large for commercial exploitation. If planted it grows indefinitely by nature of its spreading subterranean rhizome (Fig. 1), and can be cultivated on lands, such as swamps, otherwise of marginal value for conventional agriculture. Revolutionary efforts to develop a new kind of agriculture based on seawater irrigation currently in the United States and Israel augur well for serious consideration of "petroleum plantations." In the not too distant future huge areas of hitherto "unproductive" land may become amenable to cultivation with naturally salt-tolerant plants gathered from coastal swamps around the world. Establishing and maintaining a nipa crop on marginal lands in the brackish hinterland of mangroves are not without problems.



1. Nipa palms growing in clumps. Note the 'stemless' habit with the erect leaves and inflorescences arising from a branched subterranean stem rhizome.

Harvesting nipa on soft soils presents special difficulties. Conventional heavy transport machines and sophisticated harvesting equipment would not be practical in such areas. The sap collection technique tends to be slow and labor intensive. Sap is collected once or twice a day and each stalk needs to be shaved and manipulated at each collection. Furthermore, pretreatment or *goncang* of the stalks by bending and kicking is regarded as a prerequisite for sap extraction—without pretreatment there is no sap flow. This has to be carried out two to four times a week and the pretreatment period varies from a few days to three months. Sap yields on an annual basis depend on the pretreatment period, the length of the inflorescence/infructescence stalk, and the number of tapping days in the year, the last factor being influenced by spring tides which flood the swamps. If the palm is to be successfully exploited for sugar and fuel alcohol output, development of cost effective sap collection

methods is vital. One encouraging factor is that since tapping can be carried out on different stages of development of the inflorescence/infructescence stalk, production of sap can be continuous throughout the year despite the fact that flowering may be seasonal in some localities.

Another problem in maintaining a nipa crop is the control of pests and diseases. Grapsid crabs are known to cut or girdle the young seedlings (Dammerman 1929), while monkeys and wild pigs can cause serious damage to the fruit bunches (Roxas 1929). The agricultural literature of the colonial era in the Southeast Asian region includes numerous finds of insect pests on nipa palm trial plantations. In particular, at Kuala Selangor, Corbett (1931) first reported the presence of an anthomyiid fly, *Phaonia corbetti* (Mall.) that arrested the development of the female inflorescences. The lepidopteran, *Tirathaba leucotephras* (Meyr.), was later found to contribute some damage to the inflorescences



2. The mature globose fruit head of nipa.

as well (Corbett 1935); because of the close proximity of coconut the insect also utilized nipa as an alternative food plant. Nipa apparently shows very few serious insect pests; there are very few problems relating to heavy or widespread infestation on the palms. Natural enemies are present and serve to check population numbers of the pests (*viz.*, Corbett and Miller 1933, Lever 1932, 1934). Evidence for the occurrence of pathogens or diseases attacking nipa is meagre. Tomlinson (1979) reports that cultivated nipa away from its natural habitat in Florida can succumb easily to lethal yellowing disease.

Processing Methods

New processing methods would have to be devised for some aspects of the exploitation of nipa for alcohol. The conversion process of the sap to alcohol is fairly straightforward. The powerful fermenting

microflora, established in bamboo collecting receptacles through the practice of not washing them by sap collectors, ensures a rapid fermentation of the sap sugar to alcohol. The productivity, however, is limited by the tolerance of the natural yeast flora to heat and to the concentrations of sugar and alcohol produced. In the distillation process, there are limitations that must be faced before ethanol can be considered as a potential large fuel source. For every 4.55 liters of ethanol produced there are 45.46–68.19 liters of residue to be disposed of (Coombs 1980, Huff 1981). The residue has a high biological oxygen demand (B.O.D.), and can be seriously polluting if discharged into rivers without treatment. Furthermore, large amounts of cooling water are required, both for the fermentation and the distillation processes in the distilleries.

Nipa like all other renewable sources of liquid fuels, will ultimately have an economic and energy advantage over the limited supply of fossil fuels. Nevertheless, the key to overall economic improvement of the nipa swamps is the availability of capital and management, both of which are in desperately short supply in most developing countries. Currently, the strongest awareness in the region of the potential of nipa agriculture is shown in Papua New Guinea where nipa, surprisingly, according to Newcombe et al. (1980) had little significance in the subsistence activities of local people until quite recently. Management procedures associated with the constraints outlined above will need to be given serious attention by researchers concerned with developing natural resources. What is urgently needed in research is to determine the agricultural requirements and optimal conditions for the crop, to conduct a breeding program for the development of better yielding strains, since variability in stalk lengths, flowering period and sap yields are known to occur (Pavoike 1985), and to develop processing technology to optimize extrac-

tion of alcohol from the sap, thereby increasing the productivity per hectare.

The purpose of the present paper is to describe exploitation of marginal, mangrove land based on nipa palms, point out its potential value, explore possibilities and promote investigation of its feasibility, particularly in Southeast Asia and the Western Pacific. To serve as a basis for future research on *Nypa fruticans*, a bibliography of *Nypa* has been prepared. This bibliography is relatively comprehensive but additions and corrections will be welcomed. References have been arranged according to specific aspects such as botanical studies and utilization, the latter further catalogued according to type of use. It is to be hoped that this format will facilitate a more rapid inventory of relevant publications. A copy of the bibliography may be obtained by writing to the author or to Dr. Natalie W. Uhl.

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The Flowering and Fruiting of *Corypha umbraculifera* in Miami, Florida

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A sign of a maturing botanical garden is often the age of its plantings. One of the most striking symbols of maturity in Fairchild Tropical Garden, though it is barely fifty years old, was the flowering of the talipot palm, *Corypha umbraculifera* L., during May 1984 (cover photo). Few palms exhibit flowering in such a spectacular way as the talipot.

This event drew international publicity. The staff of Fairchild Tropical Garden, as proud parents, were excited about the flowering talipot, the first documented flowering of this species in the continental United States. Another species, *Corypha utan* Lam., had been reported (as *C. elata* Roxb., see Kew Bull. 37(1): 109) and studied in 1972 at the Subtropical Horticultural Research Station (U.S. Department of Agriculture) which is also in Miami (Tomlinson and Soderholm 1975). Locally, the talipot was described as the "Giant palm due to deliver" (South Dade Newsletter, 21 March 1984), or as the "Blooming miracle" (The Miami Herald, 11 June 1984). Across the country, other feature writers were even more anthropomorphic in their appreciation: "fatal reproductive frenzy" (A. Lacey in The Wall Street Journal, 14 May 1984), "palm bearing seeds . . . ends its own life" and "palm stages spectacular death dance" (D. Kollars in Knight-Ridder, Boston Globe, and Arizona Republic, 17 June 1984). As a result of the publicity from these articles, the flowering talipot attracted thousands of people from all over the world. During anthesis, May-June 1984, attendance at

Fairchild Tropical Garden was double that in previous years.

Although commonly found cultivated in S.E. Asia, the talipot is rarely encountered in natural stands. It is an example of one of the wonders of nature because of its ultimate, fantastic size and its unusual life history. Generally talipot palms develop trunks 9-25 m tall and 0.6-0.9 m wide. The fan-shaped leaves, each of which can shelter a dozen people from the rain, have blades ca. 5 m in diameter with spiny petioles ca. 3 m or more long. Each inflorescence branch can extend 3-6 m from the main axis. Millions of tiny flowers orderly arranged on branches compose the inflorescence. Reputedly, a ton of fruit may be produced.

Phenology

In October 1937, seeds of the talipot palm were received from Hope Botanical Garden in Jamaica. A young plant from this accession (P-1909) was included in the permanent collection (plot 80) of Fairchild Tropical Garden in May 1943. For most of its life, the talipot generated palmate leaves ca. 3 m in diameter arranged in a crown at the top of a stately grey trunk that was eventually 13 m tall and ca. 0.6 m wide. After 47 years of vegetative growth, there was an abrupt change from this stage to the reproductive stages (Figs. 1,2; Table 1). The only subtle suggestion of this switch was the diminishing size of the gigantic palmate leaves at the end of 1983. In January 1984, the first

evidence of the flowering spike was a huge pyramidal spear emerging from the leafy crown (Fig. 1a). Rapid development occurred from this initial inflorescence "bud" to complete expansion four and a half months later at anthesis (Figs. 1b-d, 2a-c). Garden visitors came to see a palm that grows only trunk and leaves for 20 to 80 years of its existence. Then, because of some unknown internal biological signal, an inflorescence is initiated. The inflorescence towered 6.15 m above the trunk. Millions of creamy white flowers were borne on the branched panicle.

To document this flowering, one of us (RWS), assisted by Dade County employees, rode a bucket lift to a height of ca. 14 m and cut a first-order branch axis and leaves from the crown for herbarium vouchers (*Sanders & Watson 1664*, FTG) and morphological studies (Fig. 3a). Another of us (NE) took close range photographs of the crown from the bucket lift. At this height one could examine the reduced leaves which wrapped around the main axis (Fig. 2c) as well as have a panoramic view of the palmetum. When the branch was brought to ground level, staff members snapped many photographs and commented on the fragrance of the flowers. Opinions varied widely. One suggested the flowers smelled like the ungulates' stall at the Bronx Zoo. Another suggested the fragrance was spicy-floral.

Relative to the total age of the plant, the reproductive stages were brief. Anthesis lasted six weeks, development of the fruit took 12 to 15 months. Fruits began developing in August 1984, continued through the winter of 1985 (Fig. 2d), and began maturing in June 1985. The yield of fruit collected in June through September was only 5.4 kg instead of the anticipated ton.

Inflorescence Structure

The shoot of *Corypha* is hapaxanthic, that is there is a defined period of vege-

tative growth in which the shoot bud produces new leaves and stem, followed by a defined period of reproductive growth in which the inflorescence and flowers are produced. The act of flowering terminates the growth of the stem. In a single-stemmed palm like *Corypha*, flowering and fruiting end the life of the individual plant. During its vegetative phase of 50 or so years from the time of seed germination, only stem and leaves are produced by the growing point or apical meristem. No lateral buds are formed until the reproductive phase begins. At this time a series of modified leaves develop in which the petiole and blade regions become smaller in successive leaves until only the sheath portion is developed (Fig. 2c). These reduced leaves which are termed bracts enclose the main inflorescence axis, itself a direct continuation of the trunk. Lateral buds in the axils of these bracts grow out as the main or first-order branches (Fig. 3a) of the massive terminal inflorescence. Using the terminology proposed by Tomlinson and Soderholm (1975), we can describe the mature reproductive structures of our specimen as follows:

The central vertical axis (ax_0) decreases in diameter towards the tip (Figs. 1,2). Bracts enclose this axis and subtend 27 lateral, horizontal, first-order branches (ax_1) which push out through the split bases of most bracts (Fig. 2c). These first-order branches in turn produce bracts. In a representative first-order branch cut from the lower half of the inflorescence (Fig. 3a) there is a thick, two-keeled bract or prophyll at the base, followed by two empty (=branchless) tubular bracts, and then 25 bracts subtending second-order branches (ax_2). Each second-order branch (Fig. 3b) lacks a prophyll and has very reduced, non-tubular bracts, often represented only by a tissue ridge, below the third-order branches (ax_3). Further branching occurs up to fifth-order branches (ax_5) in the basal region of the first-order branch. Bracts do not subtend third and higher orders of



1. Inflorescence development in *Corypha umbraculifera*. a. Early appearance of inflorescence spear, Feb. 1, 1984 (Photo: S. Kantor). b. Early growth of first-order branches, Feb. 23, 1984. c. Elongation of first-order branches, March 1, 1984. d. Appearance of second- and higher-order branches, March 25, 1984.



2. Inflorescence development, continued. a. Development of rachillae, April 11, 1984. b. Anthesis, photographed from lift at level of the inflorescence, May 9, 1984 (composite of 2 frames). c. Close view of proximal portion of main axis (ax_0) after the sampled first-order axis (ax_1) was cut off, May 9, 1984. Note reduction series of bracts, white arrows point to reduced blades. d. Developing fruit, Feb. 1985.

branching. The distal second-order branch (number 25 in our sample) is an extension of the first-order axis beyond the last tubular bract and had a total of four branching orders. We interpret this region as having a main axis (=ax₂) and ending with a maximum fifth-order axis (=ax₅). Although the main axis appears to be a linear extension of the first-order axis, the tubular bract is interpreted as subtending a theoretically axillary branch system which only appears to be terminal. Further study of early stages of development is necessary to clarify this speculative interpretation.

A similar question of interpreting branch position arose in dealing with the distal-most first-order branch of the whole inflorescence. Is the distal-most branch a direct continuation of the central trunk, or is it a lateral branch which only appears to be terminal? In all cases the terminal branch units bearing the flowers are called rachillae and can be third- to fifth-order branches depending upon their positions within the whole inflorescence.

Flower and Fruit Structure

Flowers occur in clusters which are interpreted as cincinni or highly reduced, adnate sympodial branching systems (Fig. 4). The flower clusters are arranged more or less in a spiral on the rachillae (Fig. 4a). Each flower (Fig. 4b) in a cluster is subtended by a tiny bracteole, and the whole cluster is subtended by a tiny bract which is often barely recognizable in the mature rachilla (Fig. 4c). The number of flowers varies from seven or eight in large clusters near the base of a rachilla to about three near the tip of a rachilla. Single flowers are found at the very tips of many rachillae.

Each flower is perfect (bisexual) and elevated on a thickened, rugose pedicel (Fig. 4b). Terminating the pedicel are three small, lobelike sepals, three cream-colored petals, six stamens, and three carpels, which are fused to form a three-lobed ovary. Usually only one carpel develops into a single fruit per flower. The flowers are abscised below the pedicel if none of the ovules are fertilized or if fruit development ceases; the pedicel scars remain (Fig. 4c).

We have no information on the self compatibility of flowers or the need for cross pollination for fruit set. The tree at Fairchild Tropical Garden clearly had reduced fruit set as compared with reports of other trees of this species (Douglas and Bimontoro 1956) and with *C. utan* (= *C. elata*, Tomlinson and Soderholm 1975). The mature fruit (Fig. 3c) was ca. 4.5 × 4.5 cm at maturity and contained a single seed (Fig. 3d) with more or less homogeneous endosperm and a straight embryo (Fig. 3e).

The entire inflorescence produced approximately 24 million flowers. We estimated the number produced by the tree by extrapolating measurements made on the first-order branch sample. The details of calculations are given in the Appendix.

Conclusions

The inflorescence of *Corypha umbraculifera* is the largest known among palms, as well as all other flowering plants. This immensity, in part, is a consequence of having the apex of the entire plant converted into an inflorescence structure. However, in making direct comparisons, the concept of inflorescence becomes a problem. The whole inflorescence in other palms is equivalent (possibly homologous)

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3. *Corypha umbraculifera*. a. First-order branch, collected May 9, 1984. b. Second-order branch, note that the most proximal third-order branching occurs within the bracts subtending the second-order branch. c. Fruits (left, whole; right, exocarp and mesocarp removed), collected summer, 1985. d. Seed cut longitudinally; arrow points to embryo cavity (embryo removed). Note thin testa-like endocarp. e. Embryo removed from seed, slightly injured on right by forceps during dissection.

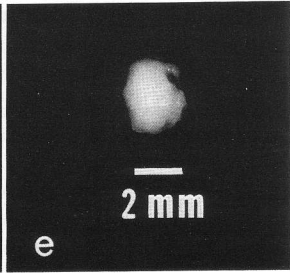
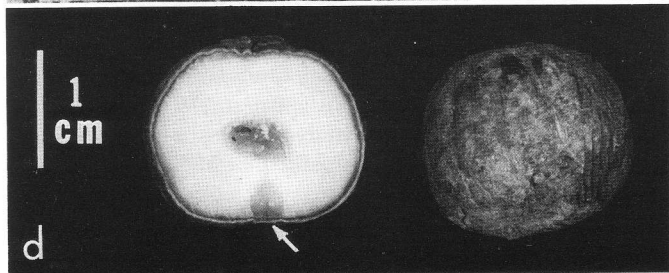
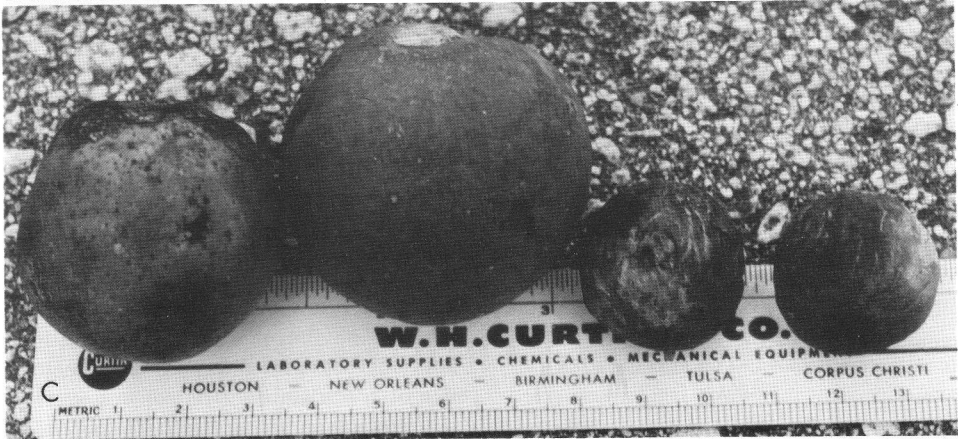
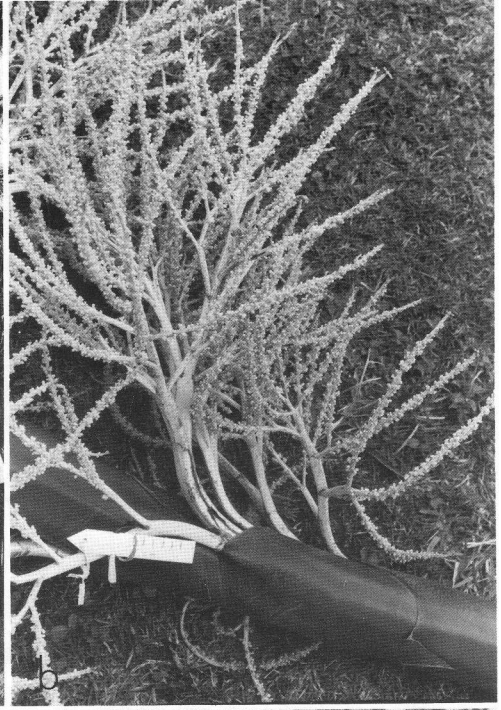


Table 1. Chronology of flowering and fruiting in *Corypha*.

Date	Observations
Late Dec 83	Reduced new leaves first noted
24 Jan 84	Inflorescence bud first noted
10 Feb 84	Inflor. 4.05 m tall; longest first-order branch with 4 visible bracts (Fig. 1a)
17 Feb 84	Inflor. 4.95 m tall
24 Feb 84	Inflor. 5.31 m tall; longest first-order branch approx. 2 m (Fig. 1b)
2 Mar 84	Inflor. 5.61 m tall (Fig. 1c)
9 Mar 84	Inflor. 5.76 m tall
16 Mar 84	Inflor. 6.06 m tall; second- and higher-order branches emerge and rapidly elongate over 1-2 days
20 Mar 84	Inflor. at maximum height, 6.15 m; rachillae immature; all 6-8 foliage leaves greenish-brown and bent down (Fig. 1d)
Mid-April 84	Rachillae reach mature size; floral buds begin expansion (Fig. 2a)
4 May 84	Flowers first noted falling on ground
9 May 84	Flowering observed within the crown; representative first-order branch collected (Fig. 2b,c)
August 84	Anthesis completed, young fruits beginning to develop (cover photo)
Nov 84-May 85	Immature (abortive) green fruit falling on ground (Fig. 2d)
Jun-Sept 85	Fruit mature and dropping to ground
August 86	Tree standing with dead leaves and inflorescence intact

Final dimensions:

Trunk height from ground to base of inflorescence = 13.05 m.

Trunk diameter (without leaf bases) at breast height = 61 cm.

Inflorescence length from base to top = 6.15 m.

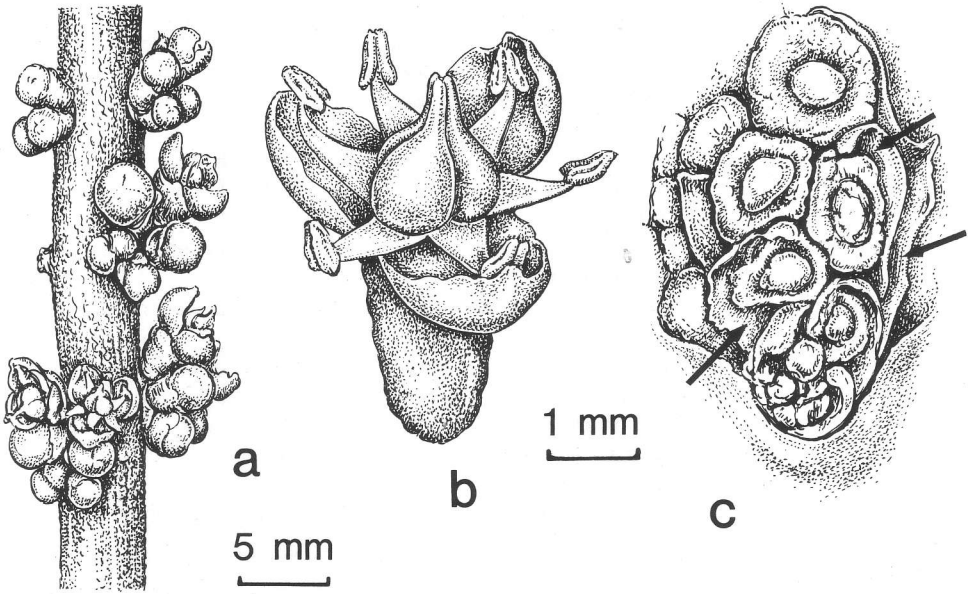
Inflorescence width (longest first-order branch) = ca. 3.5 m.

to a single first-order branch (ax_1) of *Corypha*. Thus, many pleonanthic palms, e.g., *Sabal*, *Borassus*, eventually produce as many (or more) ax_1 's as does *Corypha*, and these are often as long as those in *Corypha*. However, the ax_1 's of these other genera are not as massive as and probably bear fewer flowers than those of *Corypha*.

Our estimate of the total number of functional flowers is about 24 million. The accuracy of this figure depends in part on the representativeness of the first-order branch collected and on our interpretation of the shape of the whole inflorescence. This figure is probably near the upper limit of possible flowers. Tomlinson and Soderholm (1975) estimated 10 million (3-15 million) flowers for *C. utan* (which they called *C. elata*). Their specimen had almost twice as many first-order branches as our specimen of *C. umbraculifera*; the first-order branches were about the same length in both. However, in *C. utan*, they found only 13 second-order branches per first-order branch, 33 rachillae per second-order branch, and 375 flowers per rachilla compared, respectively, to 25, 86, and 440 in *C. umbraculifera*. Thus, our estimate appears to be proportionately similar to theirs for *C. utan*.

Fruits collected from our specimen of *C. umbraculifera* were markedly larger (4.0-4.8 cm diameter) than those collected by Tomlinson and Soderholm from *C. utan* (1.5 cm). In producing larger fruits, our tree may have compensated for a very low fruit set, and thus, the difference in size of fruits may not reflect any genetic difference (specific or individual) between the two trees. The disappointingly small crop from our tree prevents a direct comparison to their study of reproductive biomass in *C. utan*.

In that study, Tomlinson and Soderholm (1975) estimated that 15% of the biomass produced by the *C. utan* specimen went into reproductive effort. This is high for a woody plant and is comparable to the reproductive effort of annual weeds. They



4. *Corypha umbraculifera*. a. Part of rachilla with open flowers and flower buds in each cluster. b. Single flower at anthesis. c. Flower cluster after individual flowers have fallen or were removed; six clear flower (i.e., pedicel) scars and possibly one or two more are visible, arrows point to bracteoles. (Drawn by P. Fawcett)

concluded that "... despite its massive size, *Corypha* has to function essentially as an annual weed in order to survive." The reproductive biology of *Corypha* and other single-stemmed, monocarpic trees (those which die after fruiting once) are discussed in more detail by Hallé, Oldeman, and Tomlinson (1978). Such trees, similar to annual weeds, have a periodically high reproductive rate but are not as short-lived as weeds. They are so called "*r*-strategists" and usually live in unstable habitats. In fact, the natural habitat of *Corypha* appears to be disturbed forests (J. Dransfield, pers. comm.). The opposite extreme in reproductive behavior is found in plants with long-lived, slowly reproducing individuals in a stable population. These so called "*K*-strategists" continue to reproduce for a long time and often in stable habitats. Royal palms (*Roystonea* spp.) are pleoanthic and good examples in which each tree continues to grow while it flowers and fruits throughout its adult life span.

Certain tropical woody plants are distinctly periodic in seed production. Some are monocarpic like *Corypha*. Others are polycarpic and set fruit many times during their lives but only once every several years. Janzen (1978) reviewed this mode of reproduction and recognized two major categories.

1. Unsynchronized periodic fruiting: exemplified by *Cassia grandis* (polycarpic) and *Tachigalia versicolor* (monocarpic; Foster 1977), both legumes.

2. Synchronized periodic (or mast) fruiting: exemplified by polycarpic species, e.g., *Ateleia herbert-smithii* (Leguminosae), *Andira inermis* (Leguminosae), and most species of Dipterocarpaceae in the Malaysian rainforests, and by monocarpic species, such as some bamboos and *Strobilanthes* spp. (Acanthaceae).

Janzen (1978) believed that the biological or adaptive significance is the escape from seed predators by producing such enormous numbers of seed that only a portion can be eaten. In his terminology,

this behavior is predator satiation. The synchronized or mast fruiting allows this escape, not only by excessive individual and regional crops, but also by not supporting the seed predators for several successive years between fruiting events.

The time of fruiting for most polycarpic mast fruiting species apparently is set by external weather cues; whereas, Janzen (1976, 1978) suggested that the monocarpic bamboos and *Stobilanthes* have their timing set by an internal physiological calendar.

Data are not available to classify unambiguously *Corypha* as a plant with monocarpic unsynchronized fruiting (e.g., *Tachigalia*) or as one with monocarpic mast fruiting (as some bamboos). Whitmore (1977) cites the flowering of a 40-year-old tree of *C. utan* (= *C. elata*) at the Singapore Botanic Gardens in 1935 after a drought. Douglas and Bimantoro (1956) noted an abnormal dry period of four months before their three mature specimens of *Corypha* (*C. utan*, age 39 years; *C. umbraculifera*, ages 30–35 years and 65 years) all came into flower over a thirteen-month period. They related this to the observation of Griffith (1850) that in Bengal the *Corypha* species bloom in March and April which is about six months after the beginning of the long dry season (mid-September to mid-June). However, the first physiological change to flowering must have occurred many months before any external change could be seen. Reitz (1974: fig. 1) published a striking photograph of a row of ten trees of *C. umbraculifera* grown in the Peradeniya Botanical Garden (Sri Lanka) that bloomed simultaneously in 1969.

Thus, we suggest that *Corypha* spp. are synchronized or mast fruiting. However, unlike some bamboos, the cue for the one-time flowering may be external. Whether the adaptive advantage to the species of *Corypha* is strictly the avoidance of seed predators is unknown. We believe that

other possible advantages include: 1) reducing the distance traveled between flowering trees by pollinators, 2) providing a light gap for the seedlings to become established after the parent tree dies, and 3) maintaining carbohydrate reserves during the long period of uninterrupted vegetative growth.

Unfortunately, much of our discussion of the reproductive biology of *Corypha* is speculative because our observations were made on a cultivated specimen. Studies of the species in their natural environments are needed to sort out the possible causes and biological advantages of this unusual perennial behavior.

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Appendix

Details of estimating the number of branches and flowers in the inflorescence of *Corypha*. Data taken from one representative first-order branch collected on 9 May 1984 (Fig. 3a).

Number first-order branches = 27
 First-order branch (about ninth from base)
 Total length of first-order branch = 345 cm
 Number of second-order branches (including terminal portion) on this first-order branch = 25
 Maximum length of second-order branch = 64 cm
 Rachillae per second-order branch
 Proximal second-order branches (1-15) = 110
 Middle second-order branches (16-20) = 70
 Distal second-order branches (21-25) = 37
 Length of each rachilla: \bar{x} = 165 mm, s = 191, range = 47-253 mm
 Rachilla sum for one entire first-order branch = 2,185

Flower number

Per cluster (range = 2-8)
 Distal $\frac{1}{4}$ of rachilla: \bar{x} = 3.8
 Proximal $\frac{3}{4}$ of rachilla: \bar{x} = 5.6
 Per rachilla: \bar{x} = 441, s = 126, range = 80-755
 Per first-order branch = $(441)(2,185)$ = 963,585
 Total for inflorescence before shape factor = $(27)(963,585)$ = approx. 26×10^6

Shape factor as follows: ca. 75% of first-order branches as long as representative branch; ca. 20% of first-order branches were estimated as 77% of the representative branch; and 5% of first-order branches were estimated as 31% of the representative branch.

$$\begin{aligned}
 (.75)(26 \times 10^6) &= 19.5 \times 10^6 \\
 (.20)(.77)(26 \times 10^6) &= 4.0 \times 10^6 \\
 (.05)(.31)(26 \times 10^6) &= 0.4 \times 10^6
 \end{aligned}$$

Estimated total number of flowers in the inflorescence after using the shape factor = 23.9×10^6 .

Palm Research

I am working on an account of the cultivated chamaedoreas to be published by the International Palm Society. I would appreciate members sending me information about chamaedoreas in their collections. Information needed includes but is not limited to name of the plant, source of the plant and name, locality if collected in the wild, parents if a hybrid, general description, germination times, cultural information, photo of leaf and inflorescence/fruit, or any other information that may be useful or of interest to other Palm Society members. Send to DONALD R. HODEL, Environmental Horticulturist, University of California, 2615 S. Grand Ave., Suite 400, Los Angeles, CA 90007, USA.

Flowering Behavior in the Sugar Palm, *Arenga pinnata*

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ABSTRACT

When the sugar palm starts to flower, one of the axillary buds close beneath the apical meristem of the shoot grows into an inflorescence and is followed by the development of other buds in basipetal succession. Meanwhile, the apical meristem ceases functioning and becomes transformed into undifferentiated parenchyma. The inflorescence apex forms 8-9 new bracts in addition to the 6-7 bracts already present in the bud, and flower-bearing branches or rachillae are initiated in the axils of small bracts at its distal end. The uppermost 3-7 inflorescences are pistillate, the rest staminate. On the rachillae, flowers are originally formed in clusters of three. The developmental pattern in both types of inflorescences is similar. At the time of exposure of the rachillae from their ensheathing bracts, triads consisting of two lateral staminate buds and one central, pistillate flower bud are seen. In pistillate inflorescences, the three flower buds grow to a similar size, then the two lateral buds fall off, leaving the central pistillate buds to mature. In staminate inflorescences only the two lateral, staminate flower buds develop and mature. Organogenesis in a pistillate inflorescence shows that the first and second flowers to develop in a cluster are staminate and are initiated in rapid sequence. There is a delay in the initiation and early development of the third flower, the central one which is pistillate.

Flowering types in palms comprise pleoanthxy where the stem produces lateral inflorescences throughout its adult life, and hapaxanthxy where the stem flowers once only and then dies. Although the pleoanthxy method of flowering is much more widespread than the hapaxanthxy, the latter method has attracted great attention because of the often spectacular form (Dransfield 1978). In the hapaxanthxy tree palm *Corypha*, for instance, the huge terminal inflorescence is a compound structure made up of many lateral inflorescences (Dransfield and Mogeia 1984). In

another example, the acaulescent *Daeconomorops calicarpa*, the flowering axis consists of crowded internodes with short leaves which become smaller and smaller towards the top, the inflorescences in their axils likewise showing a reduction acropetally (Dransfield 1976).

A special type of hapaxanthxy is found in the tribe Caryoteae (Arecoideae) where the production of inflorescences is basipetal rather than acropetal (Dransfield 1978). *Arenga pinnata*, which belongs to this tribe, has been known to produce inflorescences basipetally (Heyne 1950). The production of inflorescences starts distally on the stem and development of lateral flowering axes occurs in basipetal sequence from successively older, dormant buds. It has been reported that the vegetative apex of the sugar palm is modified into the first inflorescence at the time of flowering (Sudasrip 1980). Others suspect that inhibition imposed by the vegetative apex upon the growth of the axillary buds into inflorescences is released basipetally when the reproductive phase begins (Moore and Uhl 1982). The present work attempts to fill some gaps in information concerning the flowering behaviour in *Arenga pinnata* by studying the morphological development of the inflorescence.

Material and Methods

Observations were made on sugar palm trees in the neighborhood of the city of Bandung, West Java, situated 800 meters above sea level. Trees approximately 16-20 meters tall and 8-12 years old were examined for one year in 1982 and mate-

rial obtained from these trees. To identify the nature of the apical meristem and to obtain young pistillate inflorescence buds at the distal end of the tree, a tree was selected which had just commenced flowering. The tree was felled and the apical meristem, the last formed leaf, the young inflorescences, and axillary buds were collected. Older stages of the pistillate inflorescences and growth stages of the staminate inflorescence were obtained from nearby trees. To follow the early development of the individual flowers, various stages of axillary buds and flowers were fixed in FAA (formalin, acetic acid, and alcohol) and processed with the paraffin method (Sass 1958). Serial sections 8–10 μm in thickness were stained with Delafield's haematoxylin and safranin.

Morphology of the Inflorescence and Flower

The sugar palm is a massive solitary palm which grows in the tropical rain forest as well as in semi-cultivation. The tree reaches a height of 20 meters and a diameter of 50 cm. The crown consists of dark green, steeply ascending plumelike leaves usually 3 meters long and 2 meters wide (Fig. 1). All leaves except the last formed subtend an axillary bud. The bud is widened tangentially with respect to the trunk and reaches a width of 8–15 cm and a height of 10–15 cm. At sexual maturity one of the most distal and healthy axillary buds develops into an inflorescence, followed by others in a basipetal sequence. As a rule the distalmost 3–7 inflorescences are pistillate and the rest are staminate. Both types of inflorescence are panicles consisting of a peduncle with flower-bearing branches called rachillae at the end. Using the terminology introduced by Tomlinson and Moore (1968) where the trunk is named ax_0 , the inflorescence axis would be ax_1 and the rachillae are ax_2 . Staminate and pistillate flowers occur singly on their respective rachillae and pistillate

flowers may be found between the two staminate flowers, but as a rule the sexes remain on separate inflorescences.

When young inflorescences are developing at the distal end of the trunk it was found that the apical meristem of the stem is a small, flattened, blunt organ consisting of parenchymatic tissue while the last formed leaf is incomplete with a rudimentary sheath, petiole and blade (Fig. 5). Although the basipetal sequence of inflorescence development is the rule, some buds seem to be inhibited or abort and are bypassed. Later, a healthy, bypassed bud may grow into an inflorescence resulting in the occurrence of a younger staminate inflorescence above older ones. This usually occurs halfway down the trunk (Fig. 2). Another irregularity observed was the development of an inflorescence close to the bottom of the tree bearing one rachilla with sterile pistillate flowers and other undifferentiated and smaller rachillae (Fig. 3). On the same tree development of new staminate inflorescences higher up the trunk still occurred.

A mature pistillate inflorescence may reach a length of two meters, the peduncle becoming 80 cm long. There are 35–40 rachillae in one inflorescence each of which may produce 130 individual flowers so that a total of 5,200 flowers may be produced by a single inflorescence. There is a reduction in size of the inflorescences down the trunk; the staminate inflorescences are even smaller. In the pistillate inflorescence the solitary flowers are arranged in a spiral around the axis. A mature pistillate flower consists of three yellowish green colored sepals, three thick valvate petals which are greenish purple on the outside but light green colored on the inside, while the green gynoecium is tricarpellate, trilocular, and triovulate with a sessile tripartite stigma which is somewhat recurved at the end and becomes brownish black at a later stage. A pistillate flower is 14–16 mm high with a diameter of 20–22 mm. During anthesis the pistillate flower emanates a

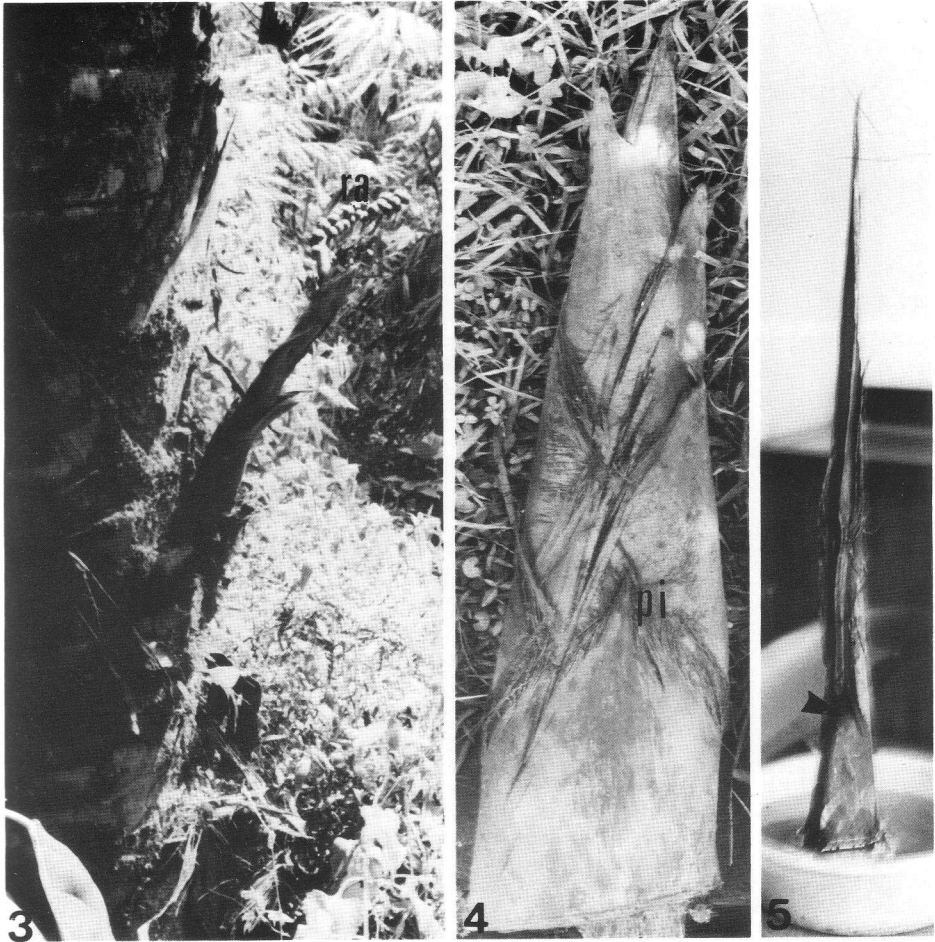


1,2. *Arenga pinnata*, inflorescences. 1. Tree with two pistillate inflorescences in fruit. The trunk is somewhat hidden by bamboo branches in foreground. 2. Disruption of basipetal development of inflorescences on another tree. A young, pale-colored staminate inflorescence (arrow), 4 days after emergence from its sheaths, is located above older inflorescences, two at the left and one on the right side of the trunk.

soft, fragrant scent and its stigma appears coated with a shiny substance.

A staminate inflorescence located close to the region where pistillate inflorescences are produced may be 150 cm long with a peduncle 50 cm long. There are 40–45 rachillae, each of which may bear 166–244 flowers so that a maximum of 10,980 individual flowers can be found on a single inflorescence. Later formed inflorescences are smaller in size and may be only 70 cm

long, including a 30 cm peduncle with 24 rachillae, each approximately 25 cm long. On staminate rachillae, flowers are found in pairs which are also arranged in a spiral around the axis. A mature staminate flower has three yellowish-green imbricate sepals, three leathery, maroonish purple, valvate petals and a large number of yellow stamens. Yellow-colored pollen is produced copiously, feels rather sticky, and tends to clump. A staminate flower in late bud is



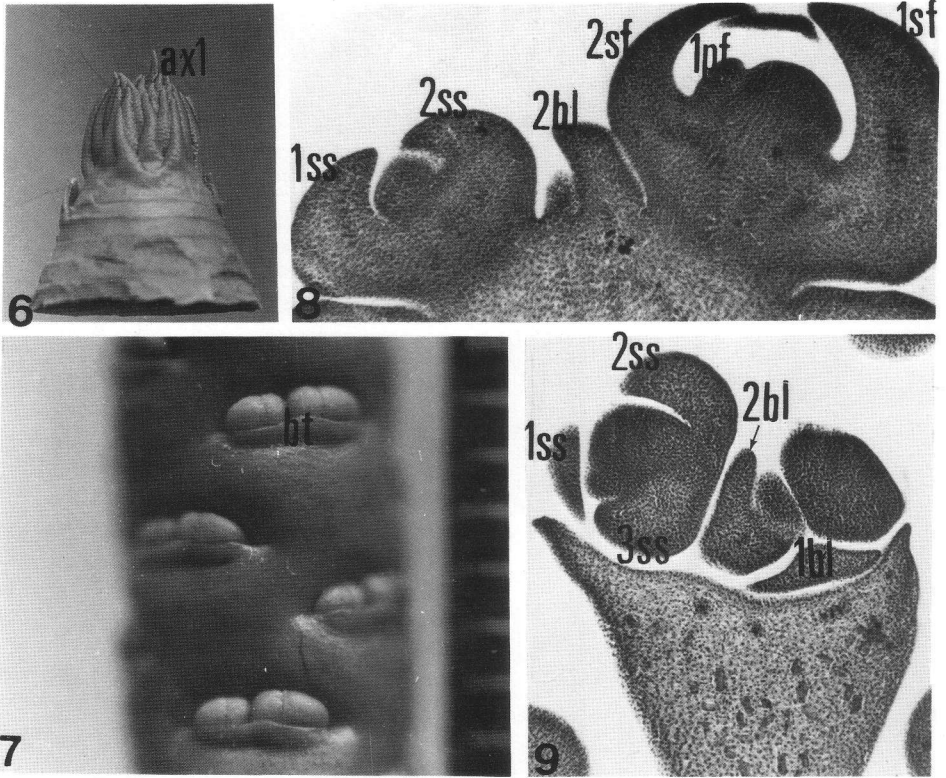
3-5. *Arenga pinnata*, organs. 3. Pistillate inflorescence with only one, 20 cm long rachilla (ra) bearing solitary, sterile flowers is located close to the base of the trunk. 4. A growing, axillary bud 50 cm long showing peduncular bracts each consisting of a short fibrous sheath and a rudimentary petiole (pi). 5. Parenchymatic shoot apex of tree which has started flowering, with the last formed rudimentary leaf. $\times \frac{1}{8}$.

18-20 cm high with a diameter of 8 mm. Larger flowers are found on vigorous trees and may be 3 cm high with a diameter of 1 cm. At anthesis staminate flowers also produce a scent similar to that of the pistillate flower.

Development of the Inflorescence

An axillary bud consists of a very low domelike apical meristem surrounded by 6-7 bracts, the bases of which are similar

in height and together form the base of the bud. The first bract or prophyll is inserted in an adaxial position, is two-keeled, and encloses the bud completely. Subsequent bracts also cover the bud entirely. During inflorescence formation the now active apical meristem produces 8-9 additional bracts, some of the first of these cover the rest of the inflorescence entirely but others reduced in size, do not constitute a complete covering. A bract



6-9. Organogenesis in the flower cluster. 6. Young inflorescence without its bracts showing 1 cm long rachillae (axl). $\times 6$. 7. Part of a 12 cm long rachilla showing bract (bt) subtending flower cluster and the two first flowers with the younger, smaller flower primordium at the left. $\times 9$. 8. Longisection through a flower pair of Figure 7. Sepal primordia of both flowers have been formed and the first petal primordium of the first flower can be recognized. The third flower is not yet initiated. $\times 45$. 9. Transection through the more distal portion of a 12 cm long rachilla showing a flower cluster somewhat younger than in Figure 8. The bracteole of the first flower is situated parallel to the bract subtending the flower cluster. Bract itself is not shown being situated at some distance above this section. $\times 45$. Details: axl, inflorescence axis; bt, bract; 1sf, first sepal of first flower; 2sf, second sepal of first flower; 3sf, third sepal of first flower; 1ss, first sepal of second flower; 2ss, second sepal of second flower; 1pf, first petal of first flower; 1bl, bracteole of first flower; 2bl, bracteole of second flower.

can be looked upon as a modified foliage leaf which consists of a blade, a petiole, and a leaf sheath possessing a large tubular ligule narrowing at the distal end (Hidajat and Utomo 1976). The succession of bracts along the peduncle shows a gradual reduction from a bract consisting of a short sheath with a remnant of the ligule and a short petiole (Fig. 4) to a small, scalelike, light green bract distally where rachillae production starts. In total 14-16 bracts including the prophyll are found on the

peduncle in a $2/5$ phyllotaxy. Bracts do not abscise but dry and remain on the peduncle.

The inflorescence apex forms rachillae acropetally, accompanied by a reduction of the axis diameter which ultimately becomes the last rachilla. Each rachilla except the last is subtended by a small, inconspicuous bract. The full number of rachillae is already formed in a 25 cm long inflorescence bud in which the length of a rachilla is 0.3 cm. Rachillae are oriented

vertically and are almost similar in length except the most distal which is the transformed distal end of the axis (Fig. 6). This difference disappears later.

Development of Rachillae and Flowers

The development of the rachillae and flowers is best understood by following the organogenesis of a pistillate inflorescence. Each rachilla develops bracts in acropetal succession. In the axil of each bract, three flowers are formed consecutively and each flower bud is subtended by a bracteole. When the bracteole of the first flower is formed in the axil of the lowermost bracts, additional bracts are still being formed at the growing rachilla apex. The various growth stages along the length of each rachilla are markedly similar to those of other rachillae of the same inflorescence.

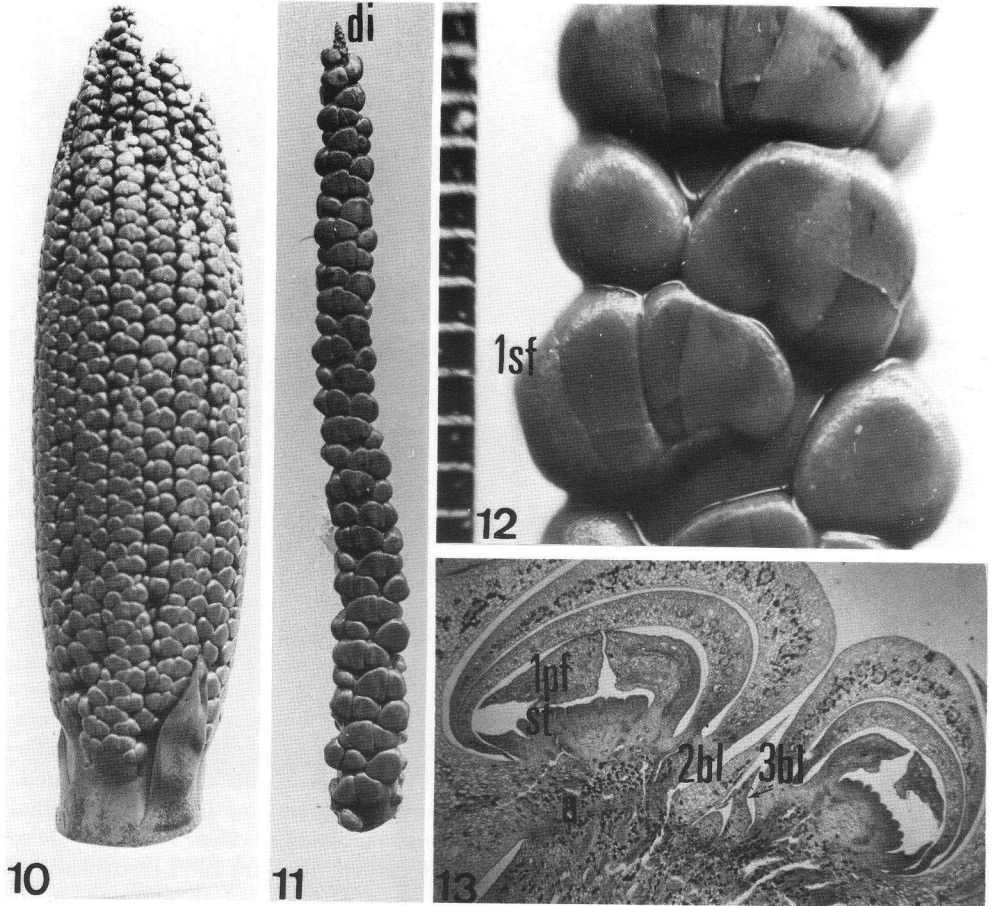
The first two flowers in a flower cluster are initiated in rapid succession producing two flower primordia which do not differ much in size. This size relationship persists during further growth stages (Figs. 7,12). The first bracteole is borne by the first flower and is oriented parallel to the bract subtending the flower cluster. The second bracteole, borne by the second flower, is situated in between the two flower primordia and is oriented perpendicular to the first bracteole.

The shallow side of the second bracteole is facing its flower primordium and indicates whether the primordium is at the right or left side of the first and therefore whether the cluster is right- or left-handed.

Figure 8 shows a longitudinal section through a flower cluster of a 12 cm long rachilla and Figure 9 shows the arrangement of flower parts in a cross section through a somewhat younger cluster of the same rachilla. At this particular stage the three sepals of the first flower are formed and the formation of the first petal in the first flower is visible. The second flower starts to form its first sepal while the third

flower is not yet initiated. The place where the third flower will be developed, however, can be detected since its bracteole will face the bracteole of the second flower (Figs. 9,13). It will be noted that the position of the third flower, although it is in between the two lateral flowers is also closer to the proximal side of the flower cluster (Fig. 14).

Table 1 shows some of the events during organogenesis of the flowers in a cluster in relation to the length of the respective rachilla. In comparison to the 12 cm stage, at the 18 cm stage sepals and petals of the first and second flower have increased in size. Since the rachilla axis length has not much increased, it seems to be covered by pairs of flower primordia (Fig. 10). At this stage also, the lack of further development of primordia at the distal end of each rachilla is notable (Fig. 11). The bracteole of the third flower has formed (Fig. 13). When the rachilla is 49 cm long, sepals and petals of both the first and second flowers have increased in size and are respectively 2 mm and 1.5 mm in diameter and stamen primordia are being initiated. The third flower, now 1 mm in diameter, has at this stage developed sepals, petals, and carpels, and initiation of ovules has occurred. Further growth before the inflorescence sheath opens involves an increase in the diameter of the flowers along with lengthening of the rachilla axis. Although further development of flower primordia at the distal end of a rachilla seems to be inhibited, this inhibition apparently does not apply to the elongation of the internodes on that portion. At the time of exposure of rachillae from their confining sheaths, the two rounded lateral flower buds are approximately 4 mm in diameter and 2 mm high while in between them the central flower bud is 2 mm in diameter and 1 mm high. Upon exposure its pale yellow color will change first to light green and then to dark green along with further growth of the three flower buds and elongation of the rachilla axis. At the time of

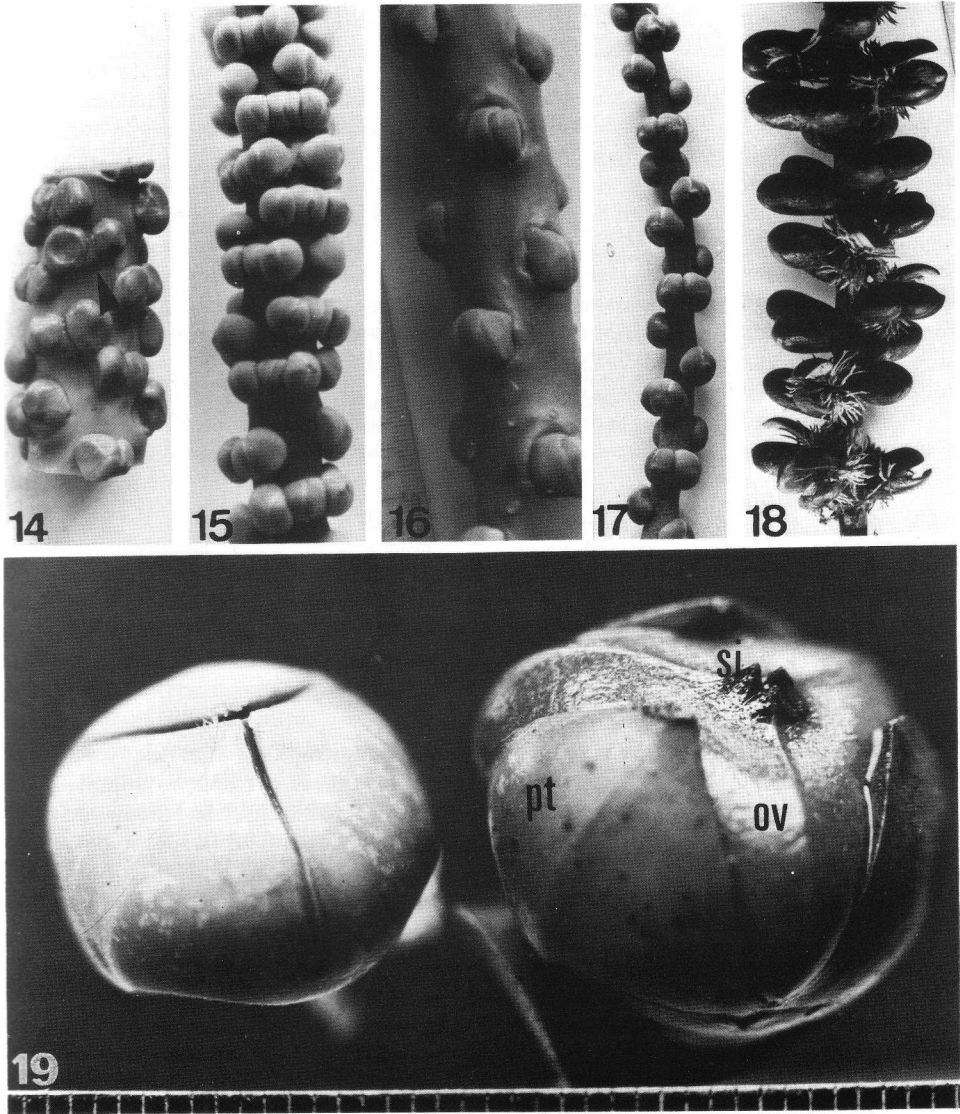


10-13. Flower clusters in a rachilla 18 cm long. 10. Pistillate inflorescence without its bracts where flower primordia have enlarged and cover the rachilla axis. The rachilla is 18 cm long. $\times \frac{1}{2}$. 11. Somewhat enlarged picture of part of a rachilla from the inflorescence in Figure 10, to show the very distal tip (di) where further growth of flower primordia has ceased. 12. A smaller portion of the rachilla showing the two first formed flowers. $\times 6$. 13. Longisection through the flower cluster showing sepals, petals and stamen primordia (st). Only the bracteole and apex of the third flower are present. $\times 20$. Details as for Figures 6-9 and the following: a, abscission layer; di, distal tip of rachilla; 1ps, first petal of the second flower; 3bl, bracteole of the third flower; st, stamen primordia.

exposure the rachilla is approximately 60 cm long.

The three flower buds are of similar height and diameter when the rachilla is 90 cm long, forming easily detected triads (Fig. 15). Afterwards, when rachilla length is 100 cm, the two lateral flower buds fall off leaving the central, pistillate flower bud to mature (Fig. 16). Apparently, the

abscission layer formed very early in the staminate flower bud (Fig. 13) functions at this moment. Anthesis of the pistillate flowers occurs when the rachilla is 135 cm long. Figure 19 shows a pistillate flower near anthesis and another one some time after anthesis when the stigma has turned dark brown. At the distal end of the pistillate rachilla the development of the pis-



14-19. Further development of the flowers. 14. Part of a 50 cm long rachilla. Early growth of the third flower (arrow) which is located in between, but more to the proximal side of the first (left) and second (right) flower. Natural size. 15. The central flower bud has grown to a similar size as the two laterals. $\times \frac{3}{8}$. 16. After the two lateral flowers have fallen. $\times \frac{1}{2}$. 17. Part of a staminate rachilla showing pairs of staminate flower buds. $\times \frac{1}{2}$. 18. Staminate flowers at anthesis. $\times \frac{1}{2}$. 19. Left, pistillate flower shortly before anthesis; right, early fruit formation. $\times 2$. Details: ov, ovary; pt, petal of the pistillate flower; si, stigma.

tillate flowers remains inhibited. The later staminate flowers do not increase in size as much as elsewhere on the rachilla and fall off together with the others, leaving a

portion bare of flowers. Since elongation of the rachilla axis does not seem to be inhibited, the distal bare end may comprise $\frac{1}{3}$ th of the rachilla length at maturity.

Table 1. Organogenic events in a pistillate rachilla in relation to its length.

Length of Rachilla (cm)	Events in			
	Rachilla Axis	1st Flower (Staminate)	2nd Flower (Staminate)	3rd Flower (Pistillate)
0.3	bracts formed acropetally	—	—	—
0.5	bracteole of the first flower formed in flower bracts	bracteole of first flower formed	—	—
2.3	all bracts with flower primordia	sepals formed	bracteole 2, initiation of first sepal	—
12	—	first petal initiated	sepals formed	—
18	—	sepals increase in size, all petals formed and stamens initiated	sepals increase in size, all petals formed and stamens are initiated	bracteole 3 formed
49	—	diameter 2 mm	diameter 1.5 mm	sepals, petals, carpels formed, ovules initiated, diameter 1 mm
55	—	diameter 3 mm	diameter 2 mm	diameter 1.5 mm
60*	—	diameter 4 mm	diameter 4 mm	diameter 2 mm
90	—	diameter 7 mm	diameter 7 mm	diameter 7 mm
100	—	falls off	falls off	diameter 8 mm
135	—	—	—	diameter 20 mm, anthesis

* Exposure of rachillae from the sheath.

The staminate rachilla shows a similar mode of development as the pistillate except that the central flower of the triad does not develop at all (Fig. 17). At the time of exposure, the staminate flowers are at the stage of stamen initiation which is similar to that of the staminate flowers in a pistillate inflorescence. The two lateral staminate flowers continue to develop to maturity (Fig. 18). A distal end, bare of flowers, also occurs but is much shorter than in the pistillate rachilla.

Discussion

In the sugar palm the stem apex does not change into an inflorescence as reported by Sudasrip (1980) but remains parenchymatous. Axillary buds are apparently formed in acropetal succession along with their subtending leaves. The last formed leaf, however, does not subtend an axillary bud. This may be due to lack of necessary growth substances usually provided by the

apical meristem so that the young leaf primordium is not able to stimulate the initiation of its axillary bud (Snow and Snow 1942, in Cutter 1980). All the buds show a similar structure consisting of an apical meristem surrounded by several bracts indicating that potentially they all may form inflorescences. The stimulus for their further development could be the diminishing amount of certain growth substances due to the absence of young leaf primordia at the apical meristem. Therefore, the inhibition of development of the buds is released basipetally as suggested by Moore and Uhl (1982).

Disruption of the basipetal succession has been reported previously (Dransfield and Mogeia 1984). The occurrence of a pistillate rachilla at the trunk's proximal end is another irregularity and others may yet be found. Proximal pistillate flowers, however, are sterile. The fact that fertile pistillate flowers are found only on the distal inflorescences accompanied by the drop

of staminate flower buds seems to indicate regulation by balanced amounts of internal substances which are coordinated spatially as well as temporally, and result in the separation of sexes on the respective inflorescences.

Both inflorescences show that at the time of exposure from the ensheathing bracts, staminate flowers have reached the stage of early stamen formation, whereas ovules are in their primordial stage. Protection of ovules, and pollen which are formed later is therefore provided by the perianth as in *Ptychosperma* (Uhl 1976).

The pattern of development in both types of inflorescence is similar. Periods of organ initiation and development are generally uniform for all rachillae within an inflorescence. Flower clusters within a rachilla are usually all right- or all left-handed. Occasionally, however, some of the proximal clusters may show a different direction from the rest as shown in Figures 8 and 9 which were taken from the same rachilla but at different sites. The significance of the delay in the initiation of the third flower in the cluster is not known. Its slow increase in size before exposure may cause misinterpretation during field observation where at first only the two lateral staminate flower buds are easily visible.

The ontogeny of the three flowers in the cluster supports the finding that it is a short axis formed sympodially as was found in *Ptychosperma* (Uhl 1976). Although at later stages of development, the pistillate flower is seen in between the staminate and together form a straight series perpendicular to the rachilla axis, it may be noted that in early ontogeny the central flower is situated close to the abaxial side of the two laterals. In podococcoid palms the pistillate flower is located abaxial to the two staminate (Moore and Uhl 1982). The pattern of flower development involving falling of staminate flower buds before anthesis of the pistillate shows a similarity to that in *Caryota* where staminate flowers

open and fall before the anthesis of the pistillate flower (Dransfield and Mogege 1984).

The sugar palm is presumed to be wind pollinated (Miller 1964) but the bright yellow colored stamens, the large amount of yellow, sticky pollen, and the fragrant scent produced by both types of flowers seem to indicate insect rather than wind pollination. Field observations are needed to determine the mode of pollination. Knowledge of histological features could be used to reach a more definite conclusion (Uhl and Moore 1977) about their correlation with either manner of pollination.

Acknowledgments

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- THE GENUS PTYCHOSPERMA LABILL. (F. B. Essig 1978, 61 pp.) 6.50
- THE INDIGENOUS PALMS OF NEW CALEDONIA (H. E. Moore, Jr., N. W. Uhl 1984, 88 pp.) 12.00
- TROPICA (A. Graf, 7000 color photos, 1138 pp.) 125.00
- PALM PAPERS (Postage Included)
- FURTHER INFORMATION ON HARDY PALMS (J. Popenoe 1973, 4 pp.) 1.25
- NOTES ON PRITCHARDIA IN HAWAII (D. Hodel 1980, 16 pp.) 2.50
- RARE PALMS IN ARGENTINA (reprint from *Principes*, E. J. Pingitore 1982, 9 pp., 5 beautiful drawings) 2.75
- PALMS—ANCESTRY AND RELATIONS (B. Ciesla 1979, a chart) 6.00
- PALMS FOR TEXAS LANDSCAPES (R. Dewers & T. Keeter 1972, 3 pp.) 1.25
- THE HARDIEST PALMS (J. Popenoe 1973, 4 pp.) 1.25

The palm books listed above may be ordered at the prices indicated plus \$1.50 extra per book to cover packaging and postage. (California residents please add 6% sales tax.) Foreign checks must be in US dollars and payable on a USA bank. In some countries it is possible to send International Money Orders through the Post Office. Please include your International Palm Society membership number. Send check payable to The International Palm Society to Pauline Sullivan, 3616 Mound Avenue, Ventura, CA 93003, U.S.A. ALL SALES FINAL.

A New Occurrence of *Phoenix theophrasti* in Kumluca-Karaöz, Turkey

MELIH BOYDAK

*Associate Professor of Silviculture, Faculty of Forestry,
University of Istanbul, Büyükdere-Istanbul, Turkey*

ABSTRACT

Until recently *Phoenix theophrasti* was known from only five coastal localities in Crete, Greece. Recently this species has been recorded in a rather large area in the Datça Peninsula of Turkey. Last year (1985) a new occurrence was also recorded in Kumluca-Karaöz, Turkey. These natural stands in Anatolia represent the first recorded occurrence in Asia, too. In this article the new occurrence in Kumluca-Karaöz (at the side of Fınike Bay) is described.

Phoenix theophrasti Greuter was known from only five coastal localities in Crete, Greece (Barclay 1974, Anon. 1983) and accepted as a species endemic to Crete (Strasburger 1978, Anon. 1983), until the recent record was made in the Datça Peninsula of Turkey (Boydak 1983, Boydak and Yaka 1983, Boydak 1985). In Crete the main occurrence is at Vai. There are some occasional specimens elsewhere on the island, too (Snogerup 1985). In addition to these occurrences, native stands of *Phoenix theophrasti* were recorded in Kumluca-Karaöz (at the side of the Fınike Bay), Turkey in 1985.

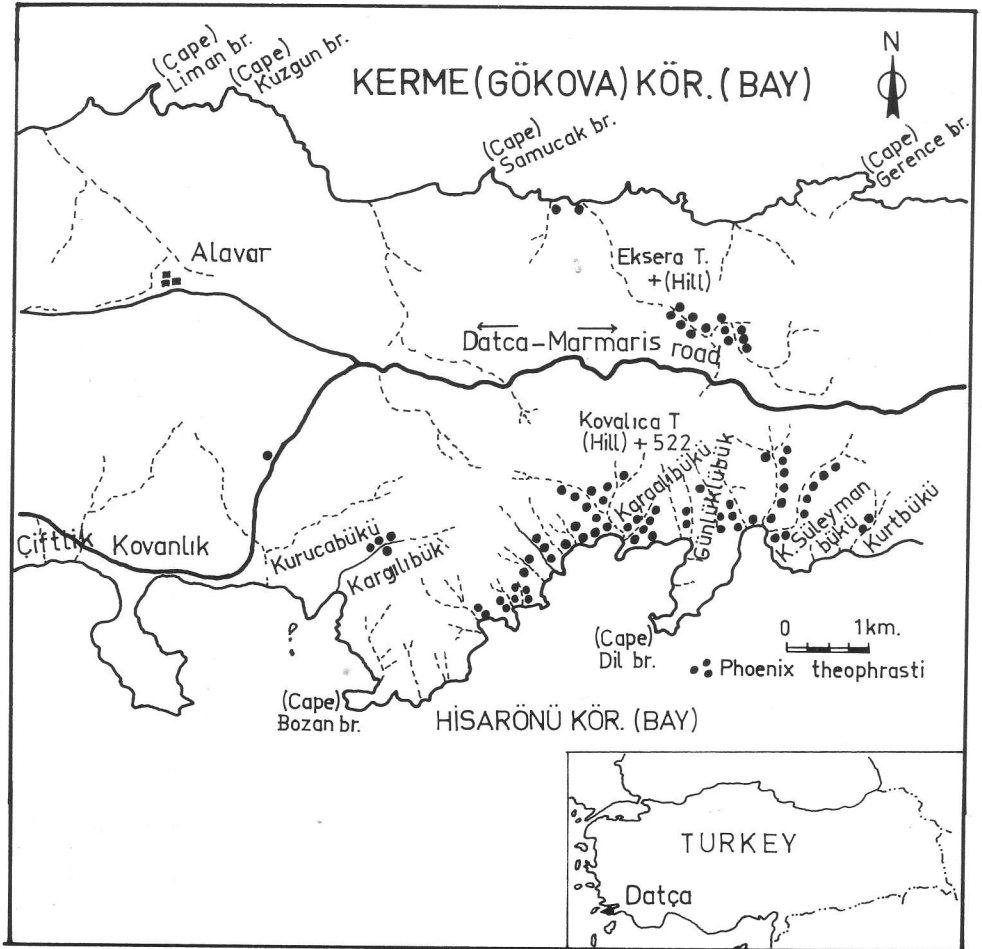
Although some species of the genus *Phoenix* and also other representatives of family Palmae are cultivated in Turkey (Oraman 1945, Baytop 1977, Kayacik 1982), the family was not known to occur naturally in Turkey until the first occurrence of *Phoenix theophrasti* was recorded in the Datça Peninsula. The occurrence of this species in Turkey has considerable scientific importance. According to our present knowledge, these

represent the only natural stands of *Phoenix theophrasti* in Asia.

Considering the scarcely accessible areas, rarely visited in Turkey, together with other evidences, I reached the opinion that some other groves of *Phoenix theophrasti* might occur in Turkey, and explained this idea in the above mentioned literature. It is very satisfying that the new record of *Phoenix theophrasti* in Kumluca-Karaöz supported my conjectures. There could be still more groves of this species waiting to be discovered in Turkey. Research on probable sites will be continued.

The occurrence, botanical characteristics, relationships, ecological and silvicultural features of *Phoenix theophrasti* have been described in previous literature (Greuter 1967, Zohary 1973, Barclay 1974, Strasburger 1978, Franco 1980, Anon. 1983, Boydak 1983, Boydak and Yaka 1983, Boydak 1985, Snogerup 1985), each writer considering one or more aspects.

Phoenix theophrasti was first discovered on the island of Crete (Greuter 1967). Greuter mentions that the "Cretan Date Palm" has been known since the beginnings of the science of botany, the first written information about it being given by Theophrastus. More records of this species were made by several former travellers, who have considered this tree to be an escape from formerly cultivated date groves (Zohary 1973). However, according to Greuter's investigation, it should be

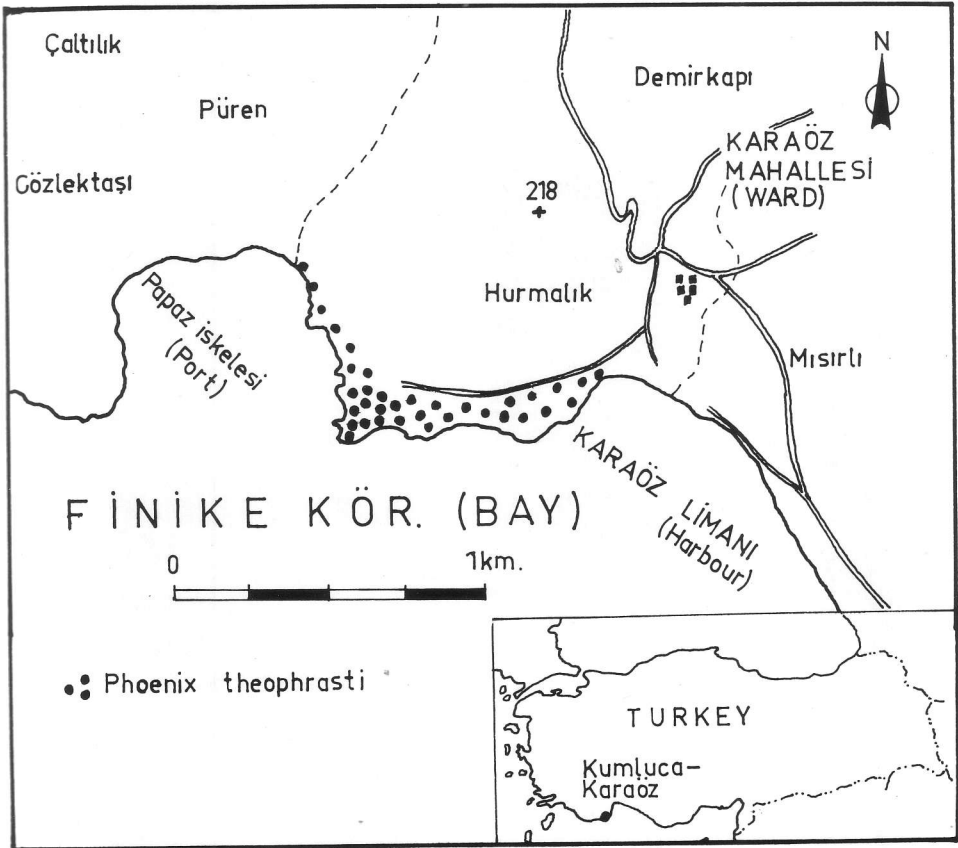


1. The occurrence of *Phoenix theophrasti* in the Datça Peninsula, Turkey (Boydak 1985).

regarded as a species distinct from the cultivated date palm as the differences are significant. Greuter (1967), quoting from Evreinoff (1956) writes that fossil investigations reveal that some representatives of the genus *Phoenix* were found in Miocene formations of central Europe. Around the Aegean coastal areas it also occurs in Pleistocene formations. The features of the fossil form *Phoenix dactylifera fossilis* Drude were found to be very similar to those of the date palm *Phoenix dactylifera* L. (Boydak 1985). Recent fossil investigations in Santorini (Greece) also

revealed some fossils resembling *Phoenix theophrasti* (Friedrich 1980).

The main differences from the cultivated date palm were described as the upright fruit clusters and small inedible fruits (Anon. 1983). On the other hand the taxon of *Phoenix* native to the coastal plains of southern Iran and Iraq at Sharqa, Bander Abbas and Basra is mentioned as a wild form of *Phoenix dactylifera* by Fischer (1881, in Greuter 1967). It is explained that further investigations are needed to understand whether the present information agrees with *Phoenix theo-*



2. The occurrence of *Phoenix theophrasti* in Kumluca-Karaöz (at the side of the Finike Bay), Turkey.

phrasti (Zohary 1973). In addition, Theophrastus (Greuter 1967) described two *Phoenix* species native to Cyprus, and considered that there could be relationships between *Phoenix theophrasti* and one of these two species.

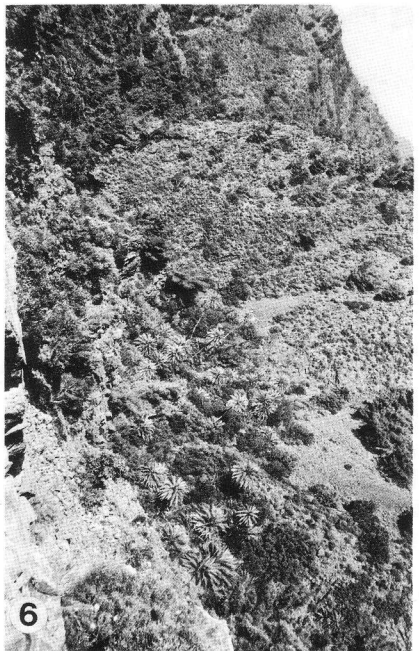
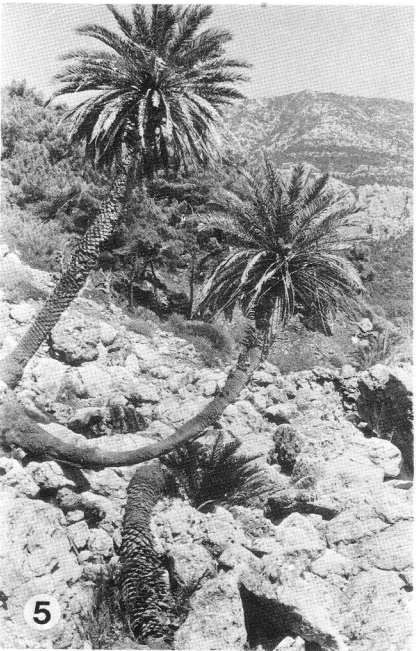
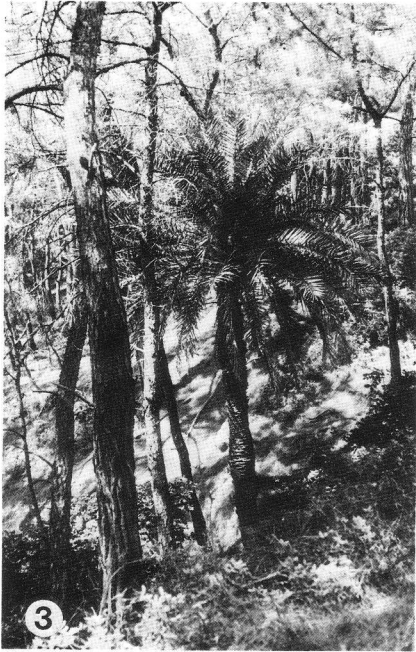
Greuter (1967) and Zohary (1973) accept that *Phoenix dactylifera* originated in the mid-eastern hot deserts. Zohary explains that these assumptions are in accordance with Fischer and Beccari (1890, in Zohary 1973). He also explains that this assumption of the Irano-Arabian origin of the date palm agrees very well with the fact that the earliest evidence on date cultivation comes to us from the Sumerians. He accepts, however, that this does not rule out the existence of an

ancestral relationship between the cultivated date palm and *Phoenix theophrasti* (Boydak 1985).

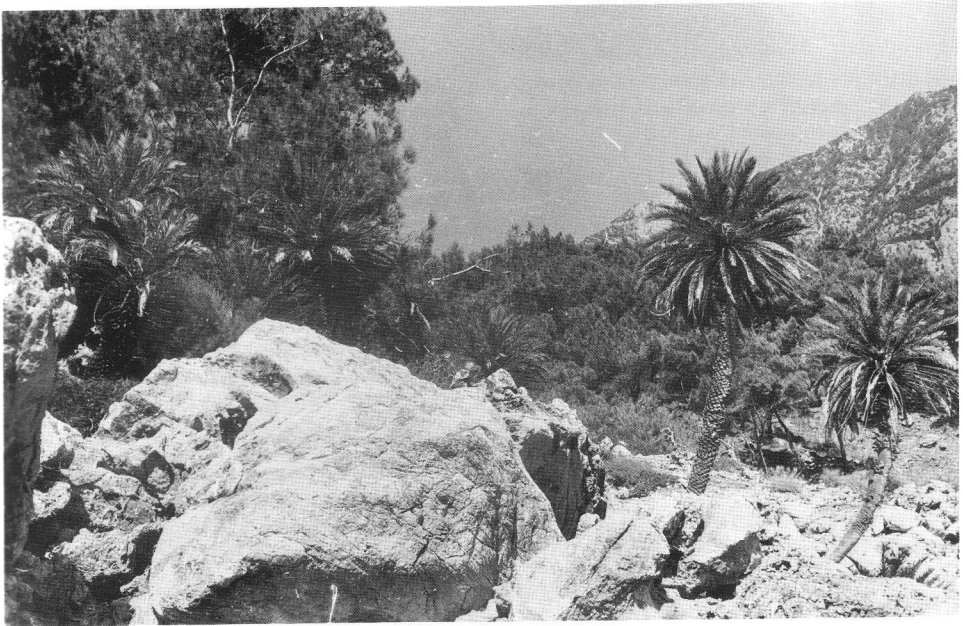
Natural Distribution in Kumluca-Karaöz

According to our present knowledge, there are two main natural areas of *Phoenix theophrasti* in Turkey: Datça Peninsula and Kumluca-Karaöz (Figs. 1, 2). The occurrence in the Datça Peninsula has been explained elsewhere (Boydak 1983, Boydak and Yaka 1983, Boydak 1985). Only the new occurrence recorded in 1985 in Kumluca-Karaöz (at the side of the Finike Bay) will be considered here.

The natural stand of *Phoenix theo-*



3. *Phoenix theophrasti* with *Pinus brutia* (left) and with the other mediterranean flora (above) in Kumluca-Karaöz. 4. *Phoenix theophrasti* at the seaside in Kumluca-Karaöz where *Phoenix theophrasti* occurs. 5. The severe conditions in Kumluca-Karaöz where *Phoenix theophrasti* occurs. 6. *Phoenix theophrasti* on soils derived from serpentine and serpentine-peridotite in the Datça Peninsula.



7. *Phoenix theophrasti* individuals growing on conglomerate and limestone (left), and on karst-limestone (above) in Kumluca-Karaöz.

phrasti in the Kumluca-Karaöz locality is very far from Datça Peninsula, but the trees are under similar climatic influences in the Mediterranean region. Here the occurrence is limited to between Karaöz Limani (Karaöz Harbor) and Papaz Iskelesi (Papaz Port). The grove consists of hundreds of young and old individuals of *Phoenix theophrasti*. It is associated with *Pinus brutia* and other typical mediterranean plants (Fig. 3). The occurrence is between sea level and about 50 m altitude (Fig. 4). The grove seems to be struggling to survive (Fig. 5). However many seedlings, young and old trees among the rocks show the biological vigor of the grove and explain its survival to the present day (Fig. 7). Here many trees are about 10 m height. The highest tree we observed was about 15 m.

The bays at the side of the Peninsula, Karaöz Limani and Papaz Iskelesi, are fantastically beautiful. As a matter of fact, this *Phoenix theophrasti* grove is inside

the Beydağları (Olimpos) National Park near Antalya which is also very famous from the historical and tourism point of view. There are many other marvelous bays far from inhabited areas, and other beauty spots in the Beydağları (Olimpos) National Park, too.

In the Datça Peninsula *Phoenix theophrasti* grows on soil derived from serpentine and serpentine-peridotite (Fig. 6), while it grows on soils derived from limestone in Kumluca-Karaöz (see Fig. 7). In the Kumluca-Karaöz occurrence we also observed conglomerate, siltstone and sandstone. Here the grove is generally on a shallow soil or rocky site which contains several deep crevices. These crevices are full of soil which permits the root development and provides conditions suitable for the tree growth; such rocky substrates are general features of the extensive karst lands of the Taurus Mountain Ranges in the Mediterranean region of Turkey.

Some investigations were made on the

literature of water relations of *Phoenix theophrasti*. Although writers have similar ideas in general, there are some differences among the details of their opinions. Ecological features of water relationships and moisture requirements of *Phoenix theophrasti*, taking into consideration the root system and air humidity should be investigated. In the Kumluca-Karaöz occurrence, this species has better water supply conditions, as its distribution is between the sea level and about 50 m altitude. However, we should not forget the complexity of water relations in karst areas, and also the long and hot drought period prevailing in the Mediterranean region.

It is worth comparing the natural distribution of *Phoenix theophrasti* with that of the endemic *Liquidambar orientalis* Mill. (Hamamelidaceae) in Anatolia. As far as is known, the natural distribution of *Liquidambar orientalis* is mostly concentrated around Muğla Province which also includes the Datça Peninsula where *Phoenix theophrasti* occurs. In addition, there is a remnant of *Liquidambar orientalis* in Antalya region, in the valley of the River Aksu. Similarly, *Phoenix theophrasti* also has a remnant in Antalya region, Kumluca-Karaöz. On the other hand, some species of both families have been found as fossils in the European Tertiary. Moreover, at present, species of both families are mostly confined to the tropics and subtropics.

Necessary Conservation Measures

Phoenix theophrasti in Kumluca-Karaöz is vulnerable because of the possibility of forest fire when compared with its occurrence in the Datça Peninsula. In the Datça Peninsula the stands are hardly accessible, and consist of populations on rather steep slopes, far from inhabited areas. In contrast, a big summer village has been built in Kumluca-Karaöz. This increases the fire danger. In fact, in

1985 a dangerous forest fire happened quite near the grove. Therefore, as a first measure, the local Forest Service decided on fencing the grove. A fire break should be also considered. As mentioned above, the grove is inside the Beydağları (Olimpos) National Park. Therefore other conservation measures could be easily effected. Some trees which are growing near the seaside among rocks, widely separated from the other flora may survive forest fire. However, as the palm is so rare and very important and the grove rather small, it deserves special great attention and should be adequately protected. As indicated in previous literature, in order to conserve the groves of *Phoenix theophrasti* in Crete some protection measures have been undertaken (Leon 1983), and similar measures are being applied in the Datça Peninsula (Boydak 1985). We also encourage the propagation and planting of this species in parks and gardens.

Acknowledgments

I am grateful to Prof. Dr. Faik Yaltirik for helpful suggestions in the identification and other related subjects from the beginning of the record of *Phoenix theophrasti* in Turkey. Miss Christine Leon and Dr. John Dransfield encouraged me to publish this article in *Principes*. Dr. J. Dransfield also edited this paper. They deserve sincere thanks. Mr. Ali Kemal Aydin contributed information on *Phoenix*. The Turkish Forest Service—Region Directorate of Antalya, especially Mr. Suphi Koparal, Mr. Mehmet Gültürk, Mr. Mustafa Kargül, Mr. Ersen Tipe contributed during the expedition. They also deserve my sincere thanks.

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***Corypha umbraculifera* Seeds Available**

From the Bahamas comes good news: The Talipot Palm (*Corypha umbraculifera*) at The Retreat is fruiting! The long-time home of Margaret and Arthur Langlois is now headquarters of the Bahamas National Trust, whose Retreat Committee is offering the much-sought *Corypha* seed for sale as a fund-raising activity. Proceeds will be used for the upkeep of the property and its palm collection. The South Florida Chapter of the International Palm Society has offered to package and distribute seeds to fill orders from the United States.

Seeds will be distributed over a period of several months in the order in which requests are received. However, in the interest of achieving optimum distribution, the Society reserves the right to fill large orders last.

Please submit your request, along with a check made payable to "S. Fl. Ch. of The Palm Society," to Leonard Goldstein, 8101 S.W. 72nd Ave., #313-W, Miami, FL 33143. The cost is as follows:

1-7 seeds	2/\$1 + \$.65	packaging/postage
8-14 seeds	2/\$1 + 1.25	packaging/postage
15-21 seeds	3/\$1 + 1.40	packaging/postage
22-29 seeds	3/\$1 + 1.75	packaging/postage
30-38 seeds	3/\$1 + 2.10	packaging/postage
29-49 seeds	3/\$1 + 2.40	packaging/postage
50-74 seeds	4/\$1 + 2.70	packaging/postage
75-99 seeds	4/\$1 + 3.00	packaging/postage
100+ seeds	5/\$1 +	(Packaging/postage cost to be billed)

Inquiries from outside the U.S. should be sent to Mrs. Sara Bardelmeier, P.O. Box N-7790, Nassau, Bahamas.

Conservation Status of Wild Palms in Latin America and the Caribbean

DENNIS JOHNSON

3311 Stanford Street, Hyattsville, MD 20783

The IUCN (International Union for the Conservation of Nature and Natural Resources), Species Survival Commission, Palm Specialist Group, recently completed a project entitled Economic Botany and Threatened Species of the Palm Family in Latin America and the Caribbean, supported by World Wildlife Fund—U.S. (WWF 3322). Collaborating on the research were Robert Read and Michael Balick, as well as Stephan Beck (Bolivia), Rodrigo Bernal (Colombia), Hermilo Quero (Mexico) and Thomas Zanoni (Dominican Republic).

One general objective of the project was to determine the current *in situ* (in the wild) status of threatened native palms. As far as we know, there are not yet any cases of total extinction of contemporary species within the region. However, a total of 53 palms are now classified as Endangered (Table 1). The official IUCN definition of "endangered" is "taxa in danger of extinction and whose survival is unlikely if the causal factors continue operating." Of the palms listed, two have been found to be on the verge of extinction in the wild: *Attalea crassispatha*, with only three adult plants located in Haiti in 1986; and *Schippia concolor*, last seen in nature in 1973. Fortunately, both species are reportedly under cultivation in botanical gardens in Florida. It has yet to be ascertained if these specimens are mature and producing viable seed.

Of great concern is the fact that 33 of the Endangered palms are not reported to be under cultivation anywhere. Private palm growers and botanical gardens are urged to give particular attention to the

cultivation of these species as insurance against their total extinction. Planned future activities of the Palm Specialist Group include monitoring the status of threatened palms and taking appropriate actions to assure that extinctions do not occur. I invite Society members to send me any information they may have concerning the palms in Table 1. With Palm Society membership building steadily toward the total estimated number of palm species in the world (2,600), we possess the interest and expertise to protect the plant family we all so enjoy.

Table 1. *Endangered palms of Latin America and the Caribbean.**

<i>Acanthococcus emensis</i> Toledo (<i>Acrocomia emensis</i> (Toledo) [Moore])—Brazil
<i>Attalea burretiana</i> Bondar—Brazil
<i>A. crassispatha</i> (Martius) Burret (<i>Orbignya crassispatha</i> (Martius) [Glassman])—Haiti
<i>A. septuagenata</i> Dugand—Colombia
<i>A. tessmannii</i> Burret—Peru
<i>A. victoriana</i> Dugand—Colombia
<i>Bactris militaris</i> Moore—Costa Rica
<i>Barbosa pseudococos</i> (Raddi) Beccari—Brazil
<i>Ceroxylon alpinum</i> Bonpland—Colombia
<i>C. crispum</i> Burret—Peru
<i>C. latisectum</i> Burret—Peru
<i>C. verruculosum</i> Burret—Peru
<i>C. weberbaueri</i> Burret—Peru
<i>Chamaedorea amabilis</i> Wendland ex Dammer—Costa Rica
<i>C. cataractarum</i> Martius—Mexico
<i>C. ferruginea</i> Moore—Mexico
<i>C. glaucifolia</i> Wendland—Mexico
<i>C. klotzschiana</i> Wendland—Mexico
<i>C. metallica</i> Cook ex Moore—Mexico
<i>C. montana</i> Liebmann ex Martius—Mexico
<i>C. oreophila</i> Martius—Mexico
<i>C. pulchra</i> Burret—Guatemala

- #*C. radicalis* Martius—Mexico
 #*C. seifrizii* Burret—Mexico
 #*C. stolonifera* Wendland ex Hooker—Mexico
 #*C. tenella*—Wendland—Mexico
Chelyocarpus dianeurus (Burret) Moore—Colombia
Coccothrinax borhidiana Muñiz—Cuba
 #*C. crinita* Beccari—Cuba
C. pauciramosa Burret—Cuba
C. victorini León—Cuba
 #*Copernicia ekmanii* Burret—Haiti
C. humicola León—Cuba
C. occidentalis León—Cuba
Cryosophila cookii Bartlett—Costa Rica
C. kalbreyeri (Dammer ex Burret) Dahlgren—Colombia
Geonoma hoffmanniana Wendland ex Spruce—Costa Rica
Hemithrinax ekmaniana Burret (*Thrinax ekmaniana* (Burret) [Moore])—Cuba
Itaya amicornum Moore—Brazil, Peru
 #*Lytocaryum insigne* (Drude) Burret & Potztal—Brazil
 #*L. weddelliana* (Wendland) Moore—Brazil
- #*Neonicholsonia watsonii* Dammer—Costa Rica, Panama
Oenocarpus circumtextus Martius—Brazil, Colombia
Parajubaea torallyi (Martius) Burret—Bolivia
Reinhardtia koschnyana Wendland & Dammer—Costa Rica, Nicaragua, Panama, Colombia
 #*Schippia concolor* Burret—Belize, Guatemala
Socratea hecatonandra Dugand—Colombia
Syagrus acaulis (Drude) Beccari—Brazil
S. campicola (Barbosa Rodrigues) Beccari—Paraguay
S. leptospatha Burret—Brazil
S. lilliputiana (Barbosa Rodrigues) Beccari—Paraguay
S. macrocarpa Barbosa Rodrigues—Brazil
Wettinia castanea Moore & Dransfield—Colombia

* This listing uses the current binomials in the Conservation Monitoring Centre database. In the case of *Acanthococcus emensis*, *Attalea crassispatha*, and *Hemithrinax ekmaniana* yet unpublished name changes are indicated.

Reported to be in cultivation.

Principes, 31(2), 1987, p. 97

LETTERS

Dear Professor Uhl:

Recently, during a stay on Nevis in the West Indies, I met Lewis Knudson, who is active in palm cultivation there and a member of the Society.

I told him about an early and interesting botanical collection of palms in the garden of the Marquise di Corsini in Italy. We visited him there last fall and were fascinated with the scope and rarity of the collection, dating from the early 19th century.

His address, should the Quarterly want to contact him, is Sr. Cino Corsini, Porto Ercole, Italy. He is also looking for botanists/students who can help identify some of his collection.

Sincerely,

WILLIAM HOWARD ADAMS
 Hazelfield
 Shenandoah Junction
 West Virginia 25442

Principes, 31(2), 1987, pp. 98-102

NEWS OF THE SOCIETY

Gulf Coast Chapter

The Fall 1986 meeting of the Gulf Coast Chapter was held at the home of Maxwell Stewart in Mobile and was an astounding success. Maxwell truly served a gourmet banquet at his poolside guest house. Our largest crowd ever heard Mr. Edward McGehee, President of I.P.S., speak on the history of the I.P.S., past and present.

After everyone had a chance to explore Maxwell's beautiful palm plantings, we concluded our meeting with a lively auction. Dozens of palms were sold including a special shipment of less common cold hardy palms from California and some very nice *Trachycarpus* palms donated by new member Mike Cheney of Baker, Florida.

The quarterly meeting dates and locations for 1987 are January 18 in Pensacola, April 26th in Atlanta, July 19th in Panama City, and October 18th in Mobile.

THOMAS G. MIGNEREY

Houston Area Chapter

The Chapter met on January 29th at the Houston Garden Center. Jim Cain, outgoing president, introduced the new officers: President, Horace Hobbs; Vice President, Erwin Ruhland; Secretary, Bonnie Ruhland; Treasurer, Bernard Green. Jim Cain showed slides of Singapore Botanical Garden and of gardens toured during the Biennial Meeting of the IPS at San Diego in June. Thirty-one members have paid dues for 1987 and an updated roster is available. Last minute arrangements for the sale and show at the Houston Arboretum will be the topic for the March meeting at the home of Bernard and Grace Green.

From the Editors

In this issue you'll find a new feature—a special column—**Seed Bank News**.

We are glad to report that we currently have many manuscripts and other copy on hand for *Principes*. The account of the 1986 Biennial Trip to Hawaii is held over until July.

SEED BANK NEWS

Seed Bank Visits Australia

When David Sylvia and I took over the Seed Bank we were aware of many pitfalls that we might run into, but nothing had prepared us for the fluctuation of currency against the dollar. One simply never considers this in the cost of an item. While our European members were crowing about how "cheap" the dollar had become, the Australians and New Zealanders were concerned about the opposite effect. In addition, their banks charged them a large sum for each check they drew on American currency. As payments failed to roll in, I realized we had to do something. First, of course, we set the computer to accept credit, so larger checks could be accepted and slowly used up, but this had to be explained. What better way to establish a personal relationship with those belonging to what has become the largest sector of Seed Bank members than to go and visit Australia?

In Brisbane we were received with enthusiasm and warmth. While Rolf Kyburz was our local host and showed us around the nearest palm growing areas, John Dowe and Greg Cuffe coordinated a meeting in one of the office skyscrapers. I showed some slides of "Palms around the world" from some of our collecting trips, but soon found that everybody else had much more experience than I will ever have. However, the meeting gave us the opportunity to talk to the members present of our combined problems: payment and availability of seed.

With plenty of addresses of members to visit in north Queensland, we set out with our camper along the beautiful coast-

line. After a short visit to the very impressive nursery of Stan Walkley, who gave us information on palm habitats and a large package of seed, we were on our way.

Rolf Kyburz had shown us *Archontophoenix cunninghamiana* and two different kinds of *Linospadi*x on Mt. Tamburin, but it was another day before we hit the habitat of those tall graceful palms again and this time they were right beside the road and intermixed with *Livistona decipiens*. It is thrilling to find the first palms in their natural habitats but it is also a reminder of how hard it is to collect seed from such tall trees. Even if the trees should be in fruit, who could shinny up those endless trunks? The grass-trees and cycads we saw on our trip were far more approachable.

Our first do-it-yourself seed collection venture began near Mission Bay only 100 km south of Cairns. We had left the main road and looked for a camping spot when we saw along the recently cleared dirt road a beautiful stand of *Licuala ramsayi*—and in full, ripe fruit. *Calamus radicalis* (no seed) scratched us up badly but my husband Hans found a *Licuala* overhanging a bit of dry ground. He hung on to that slender trunk and shook it mightily. The fruit came down over our heads but most of it vanished in the dense undergrowth. We had managed to find some of the fruits and now took photos of the incredible intertwined bush. We never could clearly distinguish another palm that was in the vicinity. Later, at Clump Point, we saw *Arenga australasica* and *Calamus caryotoides*.

At Cairns' Fletcher Botanical Garden we found friends who let us roam at will. This way we learned to distinguish the palms. After all, we had only known them as pampered pets in our gardens and pot cultures.

Then began the best part of our trip, the Atherton Table Land. This is not only a very scenic part of northern Queensland, but also is much cooler, and best of all, we met really good friends there. First there

was Tony Irvine, the botanist whom we wanted to visit only for an hour or so. He has a fantastic collection of native plants on his property and we spent all morning listening to him lecture on palms. From him came the seed that were distributed through the Seed Bank as "*Archontophoenix cunninghamiana*, Walsh River Heberton Range." This palm has a decidedly light-green trunk and much stiffer leaves than the usual *A. cunninghamiana*, but this may be only a variation.

That afternoon, Lou Gatti hosted us, showing proudly his fine collection of potted palms and other rarities.

The next day we came to Paradise and were invited by Maria Walford-Huggins. We had no idea what to expect and were simply overwhelmed. The driveway leading up to the house was bordered with magnificent specimens of *Syagrus roman-zoffiana* and *Roystonea*. In a rather remote area below Mt. Lewis, Maria has created what is to me the most natural setting and yet most artfully arranged garden I have seen to date. Each palm is a masterpiece of perfect growth and health, with rare species sheltering younger or miniature species—a *Chambeyronia*, with its red, juvenile leaf sticking out, sits in front of a *Licuala grandis* with huge leaves, an *Elaeis guineensis* sheltering *Linospadi*x and *Chamaedorea*. Maria is an avid collector and also a loyal donor to the Seed Bank and here I could see and feel how important this interchange really is. That evening we had a long conversation on the work involved in collecting seed and the cost of getting them to the Seed Bank.

During this day, Maria drove us in her 4-wheel drive Jeep up Mt. Lewis and showed us some fine plants we would never have seen without her. The road was a disaster. It rained and even the jeep had a hard time reaching the altitude where the plants could be found. An *Oraniopsis* was our first find, but alas without seed. That they do not set seed every year was the lesson for this day (this I had not

known); also the seed is scarce some years and more abundant in others.

Crashing through the heavy bush we found *Laccospadix australasica* with its bronze colored juvenile leaves; one was in seed—Hans got busy with his trusty plastic bag. Photography was another matter. In the dark rain forest, where it was raining, only a flash would do the trick. Imagine carrying all that equipment around when there is scarcely room enough to wind through all the undergrowth. A miserable business.

Several species of *Linospadix* were seen but who could name them? *Calamus* was everywhere; be it *Calamus radicalis* or *Calamus moti*, they all hang on to you and the untangling takes time and nerves. The star of the forest tour was *Archontophoenix cunninghamiana* "Mt. Lewis purple crownshaft." I had never imagined that this crownshaft was really purple. Now I had my proof—on color film.

Next day Maria drove us up to Cape Tribulation, again in her jeep. Here we saw for the first time the tall and graceful *Normanbya normanbyi* and, while thrashing around in the dense bush, Maria showed us a *Hydriastele* with fishtail leaflets. Shortly before reaching the turn-off to Geoff Fowler's residence, she also showed us the tallest cycad I had ever seen. The *Lepidozamia hopi*, right on the edge of the forest, was at least 20 feet tall. Geoff is still clearing the bush and building his house in this ideal spot but he already has a fine collection of large plants in pots ready to be planted out, again, each one a rarity, each one a winner in any contest.

Later we met in Cairns more of our faithful donors, such as Dusan Balint and Horst Goetze. In their small but superbly tended locations they not only grow rare plants for themselves but also distribute to a select few customers—many of the palms grown from seeds supplied by the Seed Bank.

It made me proud to be part of this in a small way through my affiliation with the

Seed Bank. For the first time it dawned on me how important our role really is. The seeds that those people had nurtured will some day be the source of seed for our other members—an endless chain of planting and growing palms around the world.

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Seed Bank Visits Caracas

South America is for the Seed Bank a tough nut to crack. I had been writing to everybody who had an address there but the result left a lot to be desired—mainly there were no seed shipments coming in. My customers got restless, the demands mounted, and I had no answer to the questions asked. That was the state of affairs in January when I decided to take a look at what was holding things up. My husband had no more vacation, so I was alone on that little venture.

Bright and early I stood in front of the Caracas Botanical Garden and wondered what a soldier with a gun wanted from me. Well, it was the National Guard and they do watch for vandals etc. (with a machine-gun??).

I was downright glad when August Braun came out of his little house right behind the gate and welcomed me. Then began one of the most marvelous days I have ever spent in any botanical garden. August Braun was not only very knowledgeable but also the instigator of all the palm splendor around me. He had started the Palm Garden with his own hands, had collected most of the specimens on display in their natural habitats, and knew how to show them off. Anyone who had seen his magnificent book must wonder about the photography—it was all done by August Braun himself. Ever so often he took me by the

arm to push me into a better vantage point for a picture. All the while a stream of names, explanations, and palm-lore kept me busy with my trusty tape-recorder. The fly in the ointment? There was not one little old seed to be had. With the palms came the squirrels and they made short shrift of all that might grow. In addition to this disaster the water table for the ever growing city of Caracas has become lower and the palms barely hold their own as far as growing is concerned. They produce fronds—but no flowers or seed. My very charming host pointed out also that he had only one gardener on the grounds who could help with watering and no money for the necessary fertilizing. August Braun is still very much the all-around man at the Caracas Botanical Garden and in spite of a foot-ailment which makes it hard for him to walk, does most of the work himself.

Of the native plants, the *Syagrus* species from the Orinoco absolutely charmed me, as did the many different *Copernicia* species. A showpiece was the *Roystonea venezuelana*, lining a walkway with their light green crownshafts and large crowns, and one particular group of *Euterpe* from Guiana. An experimental sowing of left-over seed in an area that has no access to artificial watering turned out surprisingly well. There is an untended section now that consists of a total palm forest of local varieties as well as some specimens from seeds obtained from Seed Bank members.

Later in the day a new Palm Society member, Mr. Monaldi, showed up and with his help we planned an outing for the next day. Mr. Monaldi brought his car and took August Braun and me into the mountains around Caracas. Caracas has one of the best climates in the world, I am sure, and the mountains that surround it must be a plant lovers paradise. At about 1,900 m the first palms seen were *Ceroxylon interruptum*, thousands of them. We climbed over a fence to get at some babies for a close-up shot of the undersides of the silvery leaves. Unfortunately, I began to see

what Mr. Braun had told me all along—there were no seeds, not one. In a small publication, "Palm Phaenology in Venezuela," August Braun has made painstaking notes over a period of two years (Sept. 1976 to November 1978) on the growing habits of *Catoblastus praemorsus*, *Euterpe acuminata*, and *Geonoma pinnatifrons* in the cloud forest on Avila peak. Another publication deals with the growing habit and influence of the climate on *Ceroxylon klopstockia*. He pointed out that the right conditions to bring these trees into flower and eventual seed may not occur for several years. It does not help that nowadays forests covering whole hillsides are cut down and the areas developed, changing the availability of water and overhead shelter even more.

Luckily for Mr. Monaldi and me, Mr. Braun knew of a small pocket of virgin forest near the Avila peak that was on private property. Here we could see and photograph most beautifully grown specimens of the multi-trunked *Euterpe acuminata* with its chocolate-brown crownshaft. We even found one in fruit—alas not ripe. I hope that Mr. Monaldi made note of the location for later collection. *Catoblastus praemorsus* had always piqued my interest as it could very well be grown in the San Francisco Bay area. Our Palmetum here rarely gets frost, yet in the summer it is not too hot either. A late lunch at Junquito, consisting of the native corn-pancakes with homemade cheese melted over them, rounded out our search and we called it a day.

My final day was spent with the ubiquitous City Tour—but all was not lost. Right at the Monument for the Heroes of Venezuela grew a wonderful *allé* of *Roystonea venezuelana* and I had the good luck to find some seed for my Seed Bank members. So who cared that I held up the tour? The same thing happened only an hour later at the Palace of Justice in the middle of Caracas. I spotted a *Syagrus* sp. "Sancona" growing in the courtyard

of the building and while everybody else learned all about the history of Venezuela, I found the gardener and the dumpster that contained the seed he had just swept up under "my" palm.

Light on history but heavy on seed I

left Caracas to wing it further south to Lima, Peru—the next leg on my "Seed Bank Visits" venture.

INGE HOFFMANN

**The L. H. Bailey Hortorium,
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For information contact: Cornell Conference Services, 221 Robert Purcell Union, Cornell University, Ithaca, NY 14853 USA. (607) 255-6290.

HUNTINGTON POSITION OPEN

Horticulturist for Palm and Jungle Gardens, Huntington Botanical Gardens.

Applicant should be knowledgeable about palms, cycads, and other tropical shade plants and have worked professionally as a gardener. He/she will supervise one helper and be expected to participate in landscaping, record-keeping, and general garden maintenance. This position is available August 1, 1987. For further information write: MYRON KIMNACH, Curator, Huntington Botanical Gardens, 1151 Oxford Rd., San Marino, CA 91108. Phone: (818) 405-2161.

Principes, 31(2), 1987, p. 103

PALM LITERATURE

PROCEEDINGS OF THE RATTAN SEMINAR, 2nd-4th October 1984. Edited by K. M. Wong and N. Manokaran. 247 pp. The Rattan Information Centre, Forest Research Institute, Kepong, Malaysia. 1985.

This volume of proceedings represents the most comprehensive overview ever published on the subject of rattans in Asia¹ and their development potential for either management of wild stands or through bringing certain of the more promising species into cultivation. The 23 papers presented at the seminar are divided into 5 major subject areas: Propagation and Nursery Practices; Ecology, Silviculture and Conservation; Properties, Pests, Diseases and Preservation; Processing, Utilization and Product Development; and Extension and Information Dissemination. Country Reports covering the current status of rattans in China, India, Indonesia, Malaysia, Philippines and Thailand are also included. The book concludes with a set of recommendations which focus on conservation of these climbing palms to assure germplasm resources for domestication programs, improvements in the rattan industry and trade. Carefully edited and handsomely printed, I highly recommend this book.

DENNIS JOHNSON

¹ An earlier workshop on rattan was held in Singapore in 1979. For a review of the proceedings see: *Principes* 25(4), 1981, p. 181.

Principes, 31(2), 1987, p. 104

PALM BRIEF

The Serpent Palm

The palm in Figure 1 is the same one that Dent Smith is observing on the cover of the January 1986 issue of *Principes*. The 'serpent palm' connotation in the explanation of the cover of the journal refers to the circular growth of this sabal. After growing to normal height of some 15 to 20 feet, it could have been blown over in a rain and wind storm and upon recovery began to grow horizontally and at the same time curving upwards towards a light source. Dense foliage and the weight of the leaves and bud also assisted in the circular growth. Dent probably traveled at least a half a mile through Florida swamp land to reach this palm and have his picture taken.

My current personal opinion of the area is that the owner of the land at one time was interested in trees in general. There are large full grown pecan trees, numerous citrus trees and an oak that is estimated to be over 400 years old. However, progress takes its toll. The bull dozers have destroyed untold numbers of different varieties of trees planted, not by a 'palm nut,' but I think by just a plain 'tree nut.' Today



1. *Sabal palmetto*, approximately 65' in length forms a complete circle around an oak tree, Port Orange, FL.

there is a housing development here and our sabal will be about 15 feet from the edge of the paved street.

I would have to think that this tree has grown 10 to 15 feet since Dent's picture and I have been assured that the developer will preserve the setting. The palm is over 65' in length now and seems to be in good health. The location is at the Country Walk subdivision in Port Orange, Fla.

CHARLES E. GRANT