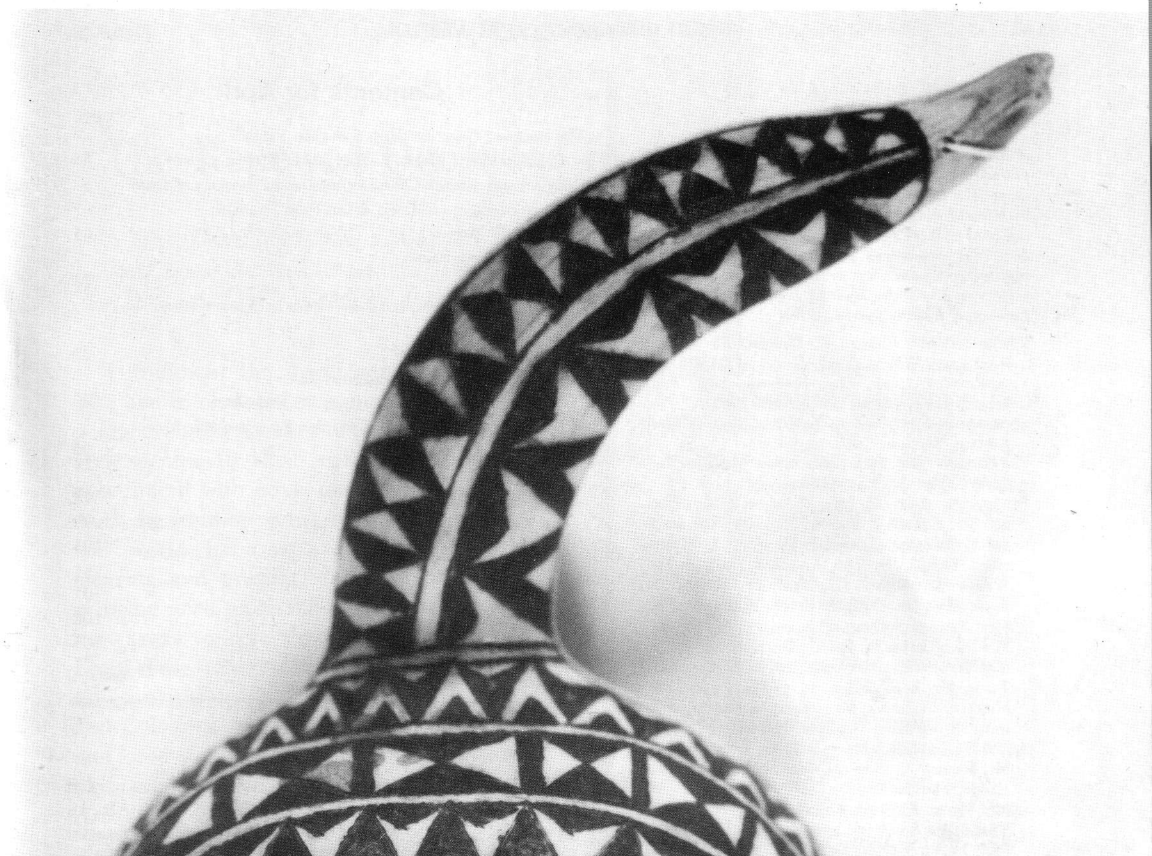

PRINCIPES

Journal of The International Palm Society

April 1984
Vol. 28, No. 2

Jack B. Fisher

THE INTERNATIONAL PALM SOCIETY

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PRINCIPES

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Contents for April

Cover Picture

A bottle gourd, probably *Lagenaria vulgaris*, with a burned design that depicts palm wine or sap from the native African oil palm, *Elaeis guineensis*, being carried in the traditional manner. From Guinea-Bissau, West Africa. Dennis Johnson.

PRINCIPES

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The Renewed Quest for High Elevation Palms

DALE MOTISKA, J. GARRIN FULLINGTON, AND CYNTHIA ANDERSON
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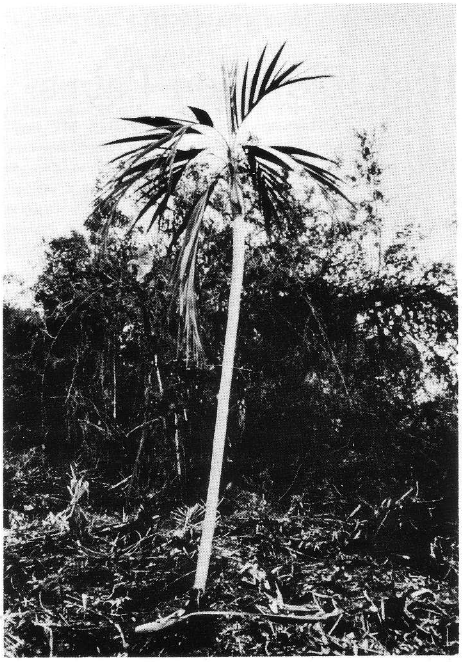
Throughout the world palm collectors who live in climates marginal for growing palms are always eager to add new genera and species to their collections and to experiment with novel plants in their gardens. In addition many areas of the tropical world habitats are threatened by clearing and grazing, and there exists a pressing need to establish many species in new areas to save them from extinction. From these considerations arose our interest in traveling to the Andes of Ecuador and Colombia, where the days are bright and mild and the nights cool and moist like our home in the San Francisco Bay Area.

The three of us met at San Francisco International Airport to begin our exciting adventure. Upon departure our minds and conversation were filled with anticipation of finding and collecting seed of all the palms of which we had read and dreamed of there in the misty highlands. We hoped to locate as many species of *Ceroxylon* as possible, as well as of *Euterpe, Geonoma, Dictyocaryum, Parajubaea, Wettinia, Aiphanes*, and *Catoblastus*. Our first destination was Quito, Ecuador, where *Parajubaea cocoides* abounds. And so it did! Everywhere were avenues of them, parks full of them, and garden plantings, loaded with clusters of mature seed to our delight. But nowhere was a seed to be seen on the ground! We soon found out that the children and the poor people find the endosperm rather tasty and a plentiful source of food. So our collecting had to take place in churchyards, a military base, hotel gardens, and private properties where the friendly Ecuadoreans happily welcomed us and provided whatever assistance they could. We were even given food at one home where we asked to collect some seeds. In two days we collected several hundred seeds. Even with a sharp knife the leathery fruit is difficult to clean from the seed unless it is well rotted, as our sleepy eyes and sore fingers attested.

Our accommodation at the Inca Imperial Hotel was comfortable and inexpensive. Rain showers came each afternoon, but the temperature was a comfortable 9–18°C at the 9,500 foot elevation. After *Parajubaea*, the most common palm we found in Quito was *Trachycarpus fortunei*, which in that moist climate had almost completely shed the fibrous cover to produce a clean trunk. We occasionally also saw *Phoenix canariensis* (rather common), *Ceroxylon quindiuense, C. alpinum, C. utile*, a few *Jubaea chilensis*, and *Washingtonia robusta* in the city. After two days of collecting, shopping, and sightseeing in Quito we arranged for a taxi to take us to the Colombian border. Although the distance is not far and the highway is excellent, the trip took a whole day because of delays. The first major delay was at Quito airport in the Air Freight office. Not every day does someone come in with 40 kg of *Parajubaea cocoides* seeds to send to the U.S. The oval fruits are rather large and heavy, each weighing about 36 g, and measuring about 4.5 × 3.5 cm. The enclosed seed weighs about 18 g, and is about 4 × 2.5 cm in size. There were great amounts of paper work to be completed first, as well



1. *Geonoma* sp. at 3,500 m on the road from Pasto to Sibundoy.

as an Ecuadorean agricultural inspection. Cindy charmed the young man at the desk into helping us cut through the red tape, and in only two hours the packages were out of our hands.

Along the Pan American highway going north from Quito there are no wild palms to be seen. Plantings of *Parajubaea* and *Phoenix canariensis* are common in the towns and farms. The next delay came in crossing into Colombia. Although we were told by numerous authorities in California that no visa would be required to enter Colombia, the border officials had another opinion. A trip back to Tulcan, a town near the border, brought us to a Colombian consulate which was closed for siesta. But after a couple of hours we were again headed to the border and allowed to cross. Our Ecuadorean taxi driver accompanied us in a Colombian taxi the few miles into the town of Ipiales.

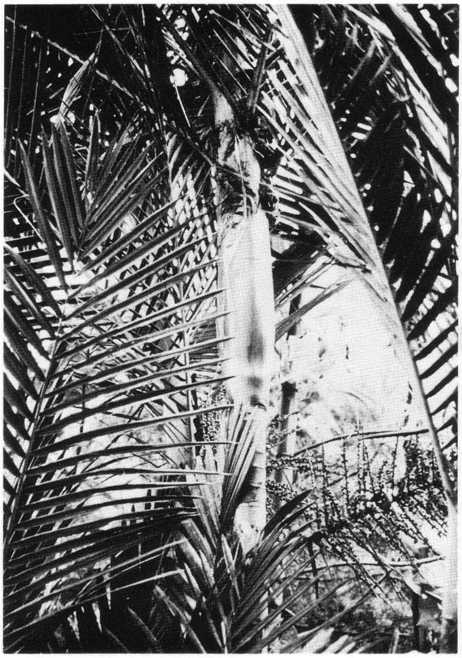
The next morning at 7:00 we were in the town square arranging for a four-wheel-drive jeep to make the trip to Chiles, supposedly the home of *Ceroxylon utile*. Along the rugged and rutted road we spotted thousands of utility poles made from the trunks of *C. utile*, but by the time we reached Chiles we had not seen a single live tree. No one in the town even knew of such a palm. Finally from an old man we learned that 40 years ago they were all cut down to provide the power line poles we were seeing. A two day hike to the other side of the mountain, we were told, would take us to a few remaining trees. We found one remaining tree in the town of Chiles behind a farm house. The occupants had moved it as a small plant a few feet from their home site to the garden in 1923. Now in 1983 it is only 30 feet tall, but very healthy and beautiful—a perfect size palm for our small gardens. We paid our thanks and bounced back along the road to Ipiales and later on in the day to Pasto.

For $40 in Pasto we arranged for a taxi to take us the next morning into the mountains east of Pasto as far as the Sibundoy Valley. After crossing the first ridge where the pavement ended, we began seeing an occasional palm back in the thick vegetation. An exciting feature was to see *Eucalyptus globulus* and *Cupressus macrocarpa*, common trees in northern California, planted by the farmers on the cleared land. We decided we would gladly take back their *Ceroxylon utile* to complete the trade. We soon came into an abundance of a striking species of *Geonoma* growing out above the low vegetation in very wet soil at an altitude above 3,500 m (Fig. 1). Here we found the soil temperature to be only 9° C (48° F)! The air temperature near mid-day was chilly. The species of *Geonoma* here is a very attractive small palm of no more than 3 m in height, with a creamy white trunk having a diameter of about 8 cm. Garrin found one mature seed but the other many seeds

2. *Euterpe* sp. Sibundoy, Colombia.

on the trees were very immature at this time in late April. We continued on in the taxi until we saw the object of our hopes—*Ceroxylon utile* growing in abundance in a cow pasture. There were plants of all ages except small seedlings, with a few large male trees dominating the scene. But not one female plant was to be seen. We travelled along the narrow gravel road through the thick growth of stunted cloud forest around us. Tree ferns abounded, with gunnera, bamboo, mosses, aroids, and bromeliads in such profusion that travel through the brush was next to impossible even at these high elevations. The local people slash and burn trails to make elbow room and passage possible. We saw an occasional *Ceroxylon hexandrum* poking out above the forest as we began our descent into the Sibundoy Valley. More cleared farm land appeared giving us great views of the vast valley below us.

The elevation of the Sibundoy area is about 2,500 m. As we passed through a small town we noticed more tropical types of vegetation (taro, ensete bananas, mountain papayas, etc., and some exciting new palms). Ahead came into view an abandoned farm house overgrown with highland tropical fruits and several beautiful clumping *Euterpe* palms (Figs. 2, 3), laden with thousands of ripe seeds waiting for our collection. We ate mountain papayas, passion fruits, sweet tree tomatoes, citrus fruits, naranjillas, and some fruits for which we know no name, we made soil pH and temperature measurements, and continued on into the town of Sibundoy for lunch. It began pouring a cold rain, a marked change from the 82° F sunshine a short time before. The hillsides around the town were scattered with *Ceroxylon* palms. We found out that the clumping *Euterpe* sp. has been brought down from the moun-



3. *Euterpe* sp. at 2,500 m, Sibundoy, Colombia.

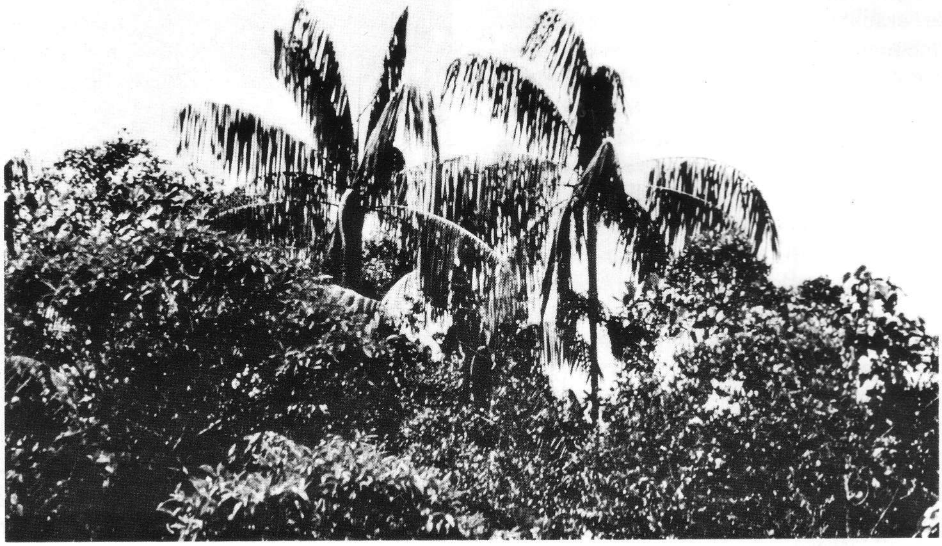
tains as well as trees of *Ceroxylon hexandrum* adorning the local gardens. We purchased a few plants of *C. hexandrum* from a friendly farmer and his family and returned to Pasto while bartering with our driver for a return trip the next day with a machete to attempt to hack our way to a possibly fruiting *Ceroxylon utile* which had caught our eyes. This later turned out to be a muddy, exhausting, impossible task.

The next morning we returned to the pasture where the *C. utile* trees abounded. The local inhabitants told us that the seed ripen in December. The family who owned the pasture thought the palm to be very beautiful, and realized that the palm was becoming more scarce. So they had selected and cleared the land specifically to grow the young palms up without competition from other trees. They were even giving them fertilizer. And these were people who had probably never heard the word conservation! They called this palm "palmo ramo," presumably referring to Domingo de Ramo (Palm Sunday), and the *Geonoma* sp. growing in the area they referred to as "palmicha." Soon all the neighbors were following us with great curiosity and helping us look for seeds. They gave us a few plants of *Ceroxylon utile* and we gave them a few gifts and some payment in return. One of the men came running after us as we were leaving to tell us he knew of a palm full of red, ripe fruits. We followed him 10 km down the road to a farm house. The family came out full of curiosity, and the son and our guide took us down hills, over streams, across cow pastures into a steep valley lush with subtropical vegetation where at about 3,000 m elevation by a rushing stream stood a magnificent *Ceroxylon hexandrum* full of ripe orange-red fruit. It was an instant "Easter-egg hunt" searching out the colorful fallen fruits in the grass. Already out of breath the boy made his way up the slippery trunk to shake down more fruits. Winded like ourselves from the hike and elevation he soon came down and Dale went up the 15 m trunk. Having knocked down another bunch of seeds and extremely winded from exertion he came back down also (fireman-style for the last third of the way). Meanwhile our guide had chopped up two-foot sections of tree branches and did a thorough job of removing the remaining fruits with this throwing arm. We gathered several bags of seed and took a break feasting on wild blueberries, courtesy of our skillful guide. We gave them payment for their services and hiked back up the hills with pounding heads and happy faces. We thanked the family, took pictures, and said our good-byes.

Back to Pasto for the night, then we were off by jet the next morning for what we thought was going to be Medellin. The airline agent in Pasto had informed us that we would make two stops before reaching Medellin. As we approached the third landing we marvelled at the green countryside below, lush with coffee plantations and villas with swimming pools. We were too enthralled with the beauty of what we thought was the Medellin area to notice the crackling Spanish on the intercom announcing the landing at Pereira. Upon disembarking the jet we thought it peculiar that no one was there for baggage unloading. When nothing had been unloaded after 15 minutes, we ran out and had our bags pulled out of the airplane just as it was closing up to leave. The jet took off down the runway as we remarked how good it was to have reached Medellin. Moments later we were to find out in a flurry of Spanish astonishments that: 1. We were not in Medellin. 2. The plane taking off was the last one of the day. 3. We were an 8 hour drive by taxi from our destination. We were by then in need of a break from our fast pace, and so decided to go with the flow, South American style. We lodged at an elegant old hotel, toured the city and its beautiful small zoo. We saw many interesting palms growing in Pereira, at 1,000 m elevation. The streets were lined with 10 m tall clumps of *Chrysalidocarpus lutescens* and an occasional grove of *Cocos nucifera.* There were large *Roystonea* and *Syagrus sancona, Aiphanes caryotifolia,* and *Bactris gasaipes.* In the charming zoo were *Elaeis guineensis, Archontophoenix* sp., and more of the palms listed above. Surprisingly also were small plants of a species of *Ceroxylon,* all well protected by the locally common framework of braced poles tied with barbed wire. We collected photos of the palms in Pereira but no seeds and were off to Medellin the next afternoon.

Our arrival there was exciting, as we were met at the gate by Colombian Palm Society member Gloria Galeano-Garces, co-author of the recent *Principes* article

4. *Wettinia fascicularis* at 2,000 m. Note seed clumps at base of crownshaft. Antioquia, Guatape, Santa Rita, Columbia.

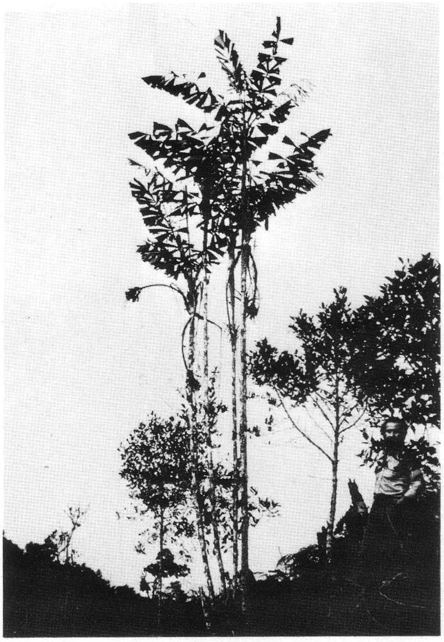


5. *Euterpe* aff. *microcarpa* at 2,000 m near Medellin.

defining *Ceroxylon mooreanum* and *C. flexuosum*, and Gabriel Bolivar, who has collected *Ceroxylon* seed in the past for The Palm Society. Together with these gracious young hosts we made our plans for the next few days and shared our treasures from the Pasto area. We rented a small Renault and squeezed shoulder to shoulder as we honked our way up the highway into the mountains to the northeast of the city. After climbing a steady grade for an hour and a half, we reached about the 2,500–3,000 m level and were amazed again at the similarity of the vegetation to that of northern California. We were reminded of being in Colombia only by an occasional *Ceroxylon quindiuense*. In San Jose de la Montana, at 2,600 m we turned down a gravel road, and more *Ceroxylon* palms began to appear until soon we were among large stands in the cattle lands on the hillsides. We spotted several trees with ripe fruit and soon were dancing down the hillsides to find seed everywhere. Ripe seeds fell from the trees around us and on us while we stood there marvelling at the serene beauty of the scene. Birds twittered and enjoyed their *Ceroxylon* fruit meals. We began to gather fallen seed, some from caches the mice had collected beneath the bark of fence posts, and also a few seedling plants while Gabriel began a three hour ascent up one of the slippery, wax-coated trunks using a rope sling. He cut down thousands of seeds more. Also present here were several trees of *Ceroxylon flexuosum*. We found a few seeds beneath to which Gloria later added several hundred she had collected two weeks before.

Cows eat the young *Ceroxylon* plants in these remaining stands, and pigs delight in munching the seeds. We saw one waist-high plant struggling to live that must have

6. Collecting seeds of *Euterpe microcarpa.* Left to right: Gloria Galeano-Garces, Cynthia Anderson, Dale Motiska, Gabriel Bolivar. 7. *Dictyocaryum platysepalum* against the sky at 2,000 m.



8. *Aiphanes pachyclada* at 2,000 m with Gabriel Bolivar.

been chewed back thirty times over the years. Beneath the few broad-leaved trees along stream banks were perhaps hundreds of palm seedlings. The soil tested to a pH near 7 and was 54–56° F in early afternoon. Groves of white-trunked majesty on the emerald green hillsides together with distant blue mountains and white-washed farmhouses created the most serene and peaceful setting imaginable. Cumulonimbus clouds built and the smell of coming rain swept over us as a golden orange sunset displayed itself. The rain poured on us all the way back to Medellin. Throughout the night we cleaned seeds.

The next morning we were up into the mountains again on the other side of the valley. At 3,000 m elevation, the vegetation here was more lush and less disturbed. We were here to have our most successful day of collecting yet. We encountered the small stilt-root palm *Wettinia fasicularis* (Fig. 4) in full ripe fruit. We collected small plants of *Geonoma pulcherrima* (syn. *G. euterpoidea*). *Euterpe microcarpa* was nearby with its graceful, drooping leaflets, and also full of ripe fruit (Fig. 5). We collected thousands of seeds and also young plants (Fig. 6). Beautiful *Dictyocaryum platysepalum* trees devoid of fruit kept us going down the road in search of one in seed (Fig. 7). In a grove of them on a cleared hillside Gloria spotted one with a recently dried infructesence. Sure enough, there were a few hundred seeds beneath the tree, many already sprouting. Gloria pointed out *Aiphanes pachyclada* growing nearby, a small clumping palm covered with vicious needles even under the fish-tail leaflets (Fig. 8). We collected a few hundred ripe seeds. Once again the afternoon clouds were building and we felt a few drops of rain, so we took a last look at the *Dictyocaryum* palms with their plume-like leaves mounted on long blue-green crownshafts. The soil had temperatures of 58–61° F in the early afternoon and was acid (about pH 5). We again returned to Medellin to clean and package seeds most of the night. The next morning we sadly said goodbye to our gracious hosts with hopes of return again soon.

We flew on to Bogota, our last stop in South America. The first evening we met with the other author of the *Principes* article on *Ceroxylon mooreanum*, Rodrigo Bernal-Gonzalez, who was in Bogota for a few days of study. Because he had to return to Medellin the next morning we made the most of our time together and at 2 AM we were still out in the park in Bogota counting stamens on the fallen flowers of a magnificent *Ceroxylon quindiuense*. This was of very suspicious interest to the local police. The weather was very much like that of San Francisco. We returned to the park again after sunrise and were lucky to find a few seeds of the *Ceroxylon* there. We met our other Colombian Palm Society member, Sr. Eduardo Puyana, who introduced us to

9. Young *Ceroxylon* palms in the Bogota Botanical Garden. Left to right: J. Garrin Fullington, Sr. Eduardo Payana, Cynthia Anderson, Dr. Francisco Sanchez.

Dr. Francisco Sanchez, the director of the fairly new Bogota Botanic Garden (Fig. 9). We spent the afternoon in the garden seeing hundreds of young *Ceroxylon* set in groves among the tall trees. An effort is being made to preserve all the species of *Ceroxylon* there. We saw at least a hundred palm species on the lawns and in the conservatory. For an age of only seven years the garden is extremely impressive. After a last minute shopping spree we packed and prepared for our return to the U.S.

Thanks to our good cleaning work, mostly Dale's and Cindy's, the agricultural inspection in Miami was routine, and both the seeds and the plants were allowed entry. Enjoyable visits were made in Miami to Fairchild Tropical Garden and to the wonderful garden of member Paul Drummond.

From the U.S. our seeds have gone to collectors throughout the world and to our seed bank. After 60 days the *Euterpe* seeds began breaking the ground, a few *Ceroxylon* and *Parajubaea* seeds began to grow, the *Dictyocaryum* seeds were sprouting, and the plants of *Ceroxylon* had recovered and begun to grow again. We hope they are now doing so around the globe.

Principes, 28(2), 1984, pp. 64–72

Growth Form, Growth Characteristics, and Phenology of Raphia taedigera in Costa Rican Palm Swamps

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Raphia taedigera, one of the several palms that form large, nearly monospecific swamp forests, extends through the Caribbean lowlands of Colombia, Panama, Costa Rica, and Nicaragua. Disjunct populations occur in the Golfo Dulce region of Pacific coast Costa Rica and in the delta of the Amazon River. Palms forming vast monodominant stands are largely unstudied. Presented here are data on the phenology and growth of *Raphia taedigera* studied in the swamp forests near Tortuguero in the northeast corner of Costa Rica (Fig. 1).

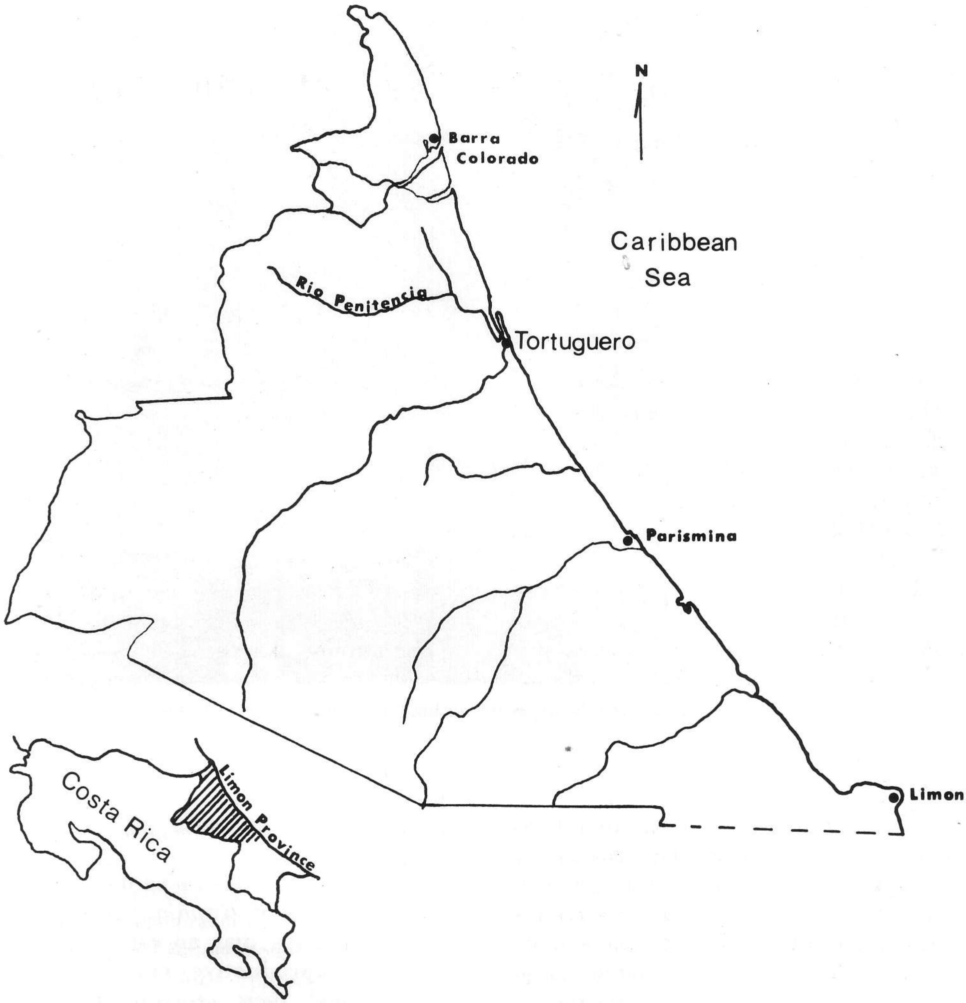
The physiography of the Caribbean lowlands of Costa Rica consists of a broad alluvial plain known as the Llanuras de Tortuguero. The plain is bordered on the east by the Caribbean Sea, and on the west by a gradual undulating incline that ultimately abutts the steep eastern slopes of the Cordillera Central. As the coast is approached the undulations become less pronounced until there is a flat coastal wetland interrupted only by several isolated volcanic hills that range from 100 to 300 m. The vegetation on the plain consists of several types of palm swamps dominated by either *Raphia taedigera* or *Manicaria saccifera* (Fig. 2).

The climate in the Tortugero area is aseasonal, but heavy rainfall and extensive flooding routinely occur in July–August and November–December. Drier months are less predictable, but January through April and the month of September usually experience the least rainfall. Annual rainfall varies between 4,000 and 7,000 mm.

Vegetative Characteristics

Woodson and Schery (1944), in their *Flora of Panama,* describe *Raphia taedigera* as a thick-trunked soboliferous palm forming clumps of stems with massive ascending and arching leaves (Fig. 3). The leaves average 12–14 m, but lengths up to 20 m have been recorded (Allen 1965), making them among the largest leaves in the plant kingdom. Hallé (1977) mentioned leaves even longer in *R. regalis.* The trunks in the multi-stemmed clumps are stout (approx. 30 cm in diameter) and erect (8–9 m tall), arising as if from a platform. They are never leaning or curved. The stems are always sheathed by both live and persistent dead petioles, which are not entirely sloughed off until after the stem dies. Vegetative offshoots are numerous around the bases of the stems.

Aerial negatively geotropic roots or pneumatophores cover the swamp soil. They develop from horizontal subterranean roots and protrude 10–40 cm above the soil. They are denser and taller near the base of the clump, and they may branch profusely, forming a dense mat. Cardon (1978) described the morphology and anatomy of these roots in several African species of the genus. Never men-



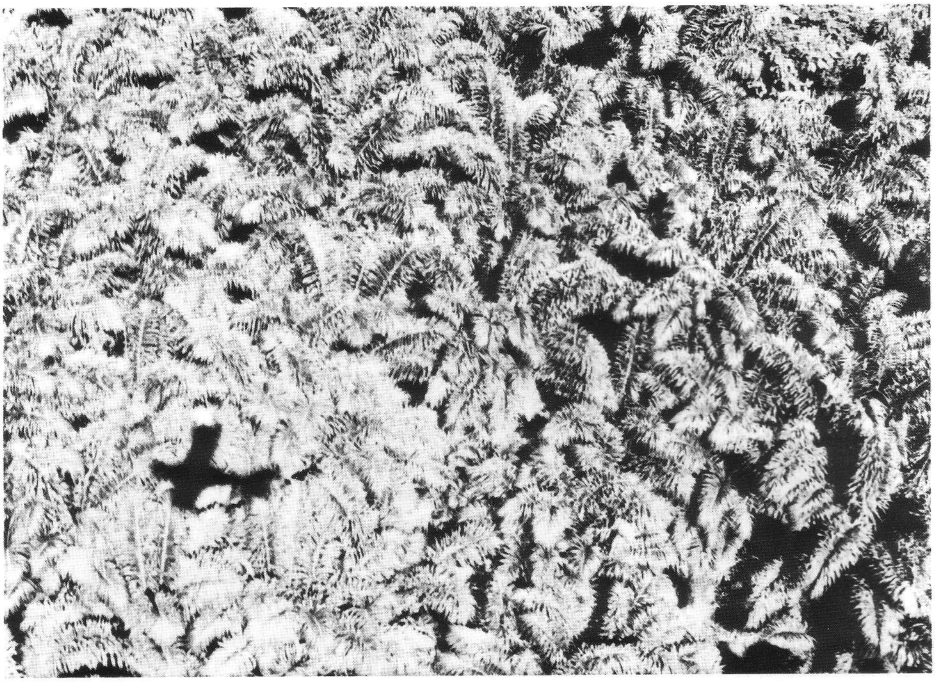
1. Map of the northeast corner of Costa Rica showing the location of Tortuguero and Rio Penitencia.

tioned in the literature are the negatively geotropic roots that arise from the stem and grow up the stem under the dead petioles. They may be found originating up to 3 m above the ground.

The leaves are pinnate. The pinnae or leaflets are subopposite, reduplicate (i.e., roof-shaped in cross-section on the rachis), 1–1.5 m long, and 4–5 cm wide. The margins bear widely spaced, minute, sharp spinules that go unnoticed until the leaves are handled. The petiole is 15–20 cm thick near the base, and its upper surface is deeply concave, forming a trough.

Reproductive Characteristics

Raphia taedigera is monoecious. The inflorescences arise in the axils of the distalmost, often reduced leaves; each stem is hapaxanthic, dying after fruit fall. It is not a true monocarpic species because



2. Monospecific *Raphia taedigera* swamp in the Caribbean lowlands of Costa Rica.

there are usually several other large stems and numerous sprouts. Occasionally a reproductive individual is found without other stems or sprouts. It is not known if this is genetic or the result of competition.

The pendant spadices are immense, at times over 2 m long. The flowers occur in clusters on distichous hand-like rachillae. At fruiting time the persistent staminiferous "fingers" protrude beyond the fruit. The fruit is oblong, 5–7 cm long, 3–4 cm thick, and completely covered with shiny, brown imbricate scales giving it the general appearance of an unopened pine cone, hence the English common name of *pine-cone palm*. Inside the outer shell is a dense, fleshy orange-brown integument that encases an oblong, extremely hard seed, 3–5 cm long. The surface of the dark seed is coarsely grooved; the endosperm is deeply ruminate.

Methods

Phenology. To determine the periodicity of flowering of *Raphia*, two hundred *Raphia* clumps that appeared to have reached reproductive maturity were marked and their reproductive status noted. To facilitate observation, all of the individuals selected occupied a fringe along the Penitencia Lagoon and River near Tortuguero. These trees appeared larger and more vigorous than those inside the swamp, so their reproductive behavior may have been different from that of the more crowded individuals in the swamp.

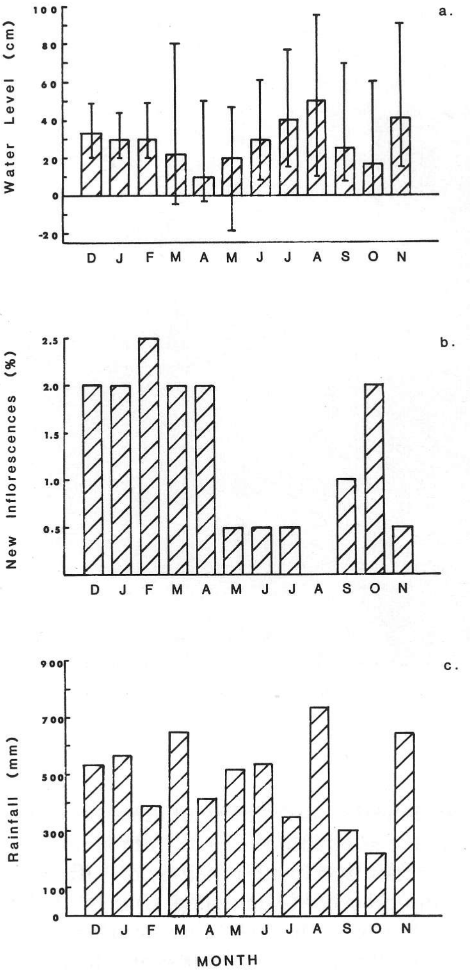
Once a month for 12 months observations were made on the flowering status of each clump. Eight categories were used to describe the flowering/fruiting status of each stem within each clump. They were: 1) no inflorescence, 2) new unexpanded inflorescence, 3) expanded yellowish-green

3. *Raphia taedigera* along Rio Penitencia.

inflorescence indicating that the individual flowers had not yet opened, 4) brown inflorescence indicating mature flowers, 5) immature fruit present, 6) mature fruit present, 7) old inflorescence, i.e. all fruit fallen, and 8) dead reproductive stem. Easily accessible individuals were observed more frequently to determine time of pollen release and duration of fruit development and fruit fall.

Dead stems were not initially recorded but were noted if they died during the observation period. Changes from new to yellowish-green to brown inflorescences were quite abrupt and easily ascertained. It was more difficult to determine the changes from brown inflorescence to immature fruit to mature fruit. Most likely the length of the "mature fruit" period was overestimated. A reproductive stem was classed as "mature" when fruit fall was in process. At times this was difficult to ascertain as fruit fell into the water and disappeared into the mud. Although deterioration and death of leaves on a fruiting stem proceeded while some fruit remained on the tree, the "old" category was designated when no fruit remained on the tree. The "dead" category was used when all leaves were brown. At the beginning of the observation period it was impossible to determine cases where monkeys had destroyed a fruit crop or where fruit set had failed to occur, even though both situations are not uncommon.

Growth and Biomass. Raphia growth was measured by selecting 14 stems as they were encountered along a line transect on the lower slope of the natural levee along Rio Penitencia and running parallel to the river. Six clumps were involved. One had four large stems, another had one stem, another three stems, and the rest two stems. The youngest leaf of each



4. a). Mean monthly water level and ranges in the Rio Penitencia swamp during the study period. b). Monthly percentages of *Raphia* genets producing new inflorescences (sample size 200). c). Monthly rainfall during the study period.

stem was marked with paint at its lowest point, the number of leaves was counted and after a year the number of new leaves was determined. All leaf material produced during the year was then harvested, and the petioles and rachi separated from the leaflets. The two categories were then weighed to within ±200 g using a Salter suspended weigher. Subsamples were taken, oven dried at 105° C until there was no further weight loss, and weighed to 0.1 g. In the case of marked leaves, only the portion that expanded below the orange paint was harvested. This underestimated the total biomass produced by those leaves because at the time of marking the leaflets above the mark were not fully developed and expanded.

To determine the amount of stem produced per leaf, ten dead stems with prominent leaf scars were measured and the mean amount of stem produced per leaf calculated. An equivalent sized live sample was cut, weighed, and subsampled for dry weight determination.

Four mature inflorescences were harvested, the fruits removed and counted and both the inflorescences and fruit weighed and subsampled. Using forest structure data for the Rio Penitencia swamp (Myers 1981), the number of clumps and stems per hectare was calculated. The expected number of inflorescences per hectare per year, an estimate of the number of reproductive stems per ha, and the number of stems that die per year were obtained from the phenological data. From these, *Raphia* growth, leaf turnover, and biomass were estimated. Pneumatophore biomass and growth were not measured.

Results

Phenology. At the onset of the study 53 percent of the clumps had no stems flowering or fruiting. Initially 2 percent had new inflorescences, 2.5 percent had expanded inflorescences, 11.5 percent had open flowers (many of these may have had small unnoticed fruit), 9.5 percent had immature fruit, and 19.5 percent had mature fruit. Seven percent had old inflorescences and during the course of the year 4.0 percent died. Many others were in advanced stages of senescence. At the end of one year 44.5 percent of the orig-

Table 1. Summary of Raphia *leaf and stem data*

	Mean	Sample Size	Standard Deviation
Leaves			
Length of leaves (m)	11.9	56	1.45
Total No. of leaves per stem	5.4	14	1.15
No. of new leaves per stem	0.9	14	0.47
No. of expanded leaves per stem	4.0	14	1.24
No. of senescent leaves per stem	0.4	14	0.51
No. of leaves per clump	12.5	6	
No. of new leaves produced per stem per year	2.1		0.63
No. of new leaves produced per ha per year	954.3		
Stems			
No. of stems per clump	3.3	50	1.47
No. of clumps per ha	163.3		1.53
No. of stems per ha	537.3		
No. of stems per ha producing new leaves	452.3		
No. of stems per ha with inflorescences	85.0		
Stem turnover per ha per year	25.3		

inal non-reproductive clumps still had not reproduced.

The monthly appearance of new inflorescences, rainfall, and waterlevels are shown in Figure 4. New inflorescences developed during every month except August, and even in August they were observed on individuals not included in the study. The monthly average of clumps producing reproductive stems was 1.3 percent, and the maximum was only 2.5 percent. In total, 31 clumps or 15.5 percent of the individuals had a stem produce a new inflorescence during the year. Twenty-two clumps (11%) had three stems in different stages of flowering/fruiting. At no time was a clump observed that had two or more inflorescences in the same stage of development.

Growth and Biomass. Table 1 summarizes *Raphia* leaf and stem data. Table 2 gives estimates of above-ground standing crop and organic matter production of *Raphia*. In calculating the values several assumptions were made that may not be valid. I assumed that a new leaf is produced as an old one is sloughed off. In general, this is the case with palms (Tomlinson 1963), and the number of leaves on each stem at the end of the study was approximately equal to the number at the beginning. Additional leaf loss occurs through the death of reproductive stems. I assumed that this is balanced by the leaves of sprouts that move into the "mature" category.

The amount of stem produced per leaf (large stems only) was calculated to be 2.53 kg dry weight. It was easy to estimate stem production because palms possess little or no stem diameter growth after a leaf has matured, stem diameter in

Table 2. Estimates of above-ground biomass and organic matter production of Raphia

	Biomass ($kg\ ha^{-1}$)	Production ($kg\ ha^{-1}\ yr^{-1}$)
Leaves	11,789	5,516
Stems	29,904	2,414
Inflorescences	1,840	548
Fruit	749	749
Sprouts	—	2,036
Totals	44,283	11,263

Raphia is fairly uniform, and prominent leaf scars on dead stems mark the amount of stem produced per leaf. These are only true after the internodes have started to greatly elongate, i.e., after establishment growth. Biomass accumulation per stem was calculated to be 5.3 kg per yr. Since only non-reproductive stems accrue stem biomass, total stem production was 2,414 kg per ha per yr. Sprout production was estimated by considering it equal to the loss of reproductive stems and their leaves. Overestimation of some biomass components was quite likely. For example, stem biomass was calculated assuming all large stems were the same diameter and height. Because sprouts are continually moving up to the "mature stem" category, all stems are not the same size.

There were approximately 85 inflorescences in some stage of development per ha. The mean dry weight of a mature inflorescence was 21.7 kg. Assuming that an expanded inflorescence weighs the same regardless of its stage of development, they account for 1,840 kg per ha. Since 15.5 percent of the clumps (or 25.3 stems per ha) produce new inflorescences during the year, inflorescence production was 548 kg per ha per yr.

The mean dry weight of a single seed with fruit was 0.046 kg. The mean number of seeds per inflorescence was 643, but was highly variable (Standard Deviation = 333). Because the appearance of new inflorescences was fairly uniform throughout the year, I assumed that the same number of stems that have mature fruits equals those that were producing new inflorescences. Based on this assumption the fruit-seed production was 749 kg per ha per yr.

Discussion

Phenology. The one year duration of the study gave a clear indication of inflorescence development from the "new" to the "open flower" stage. These stages were quite abrupt and easily determined. Other stages were more difficult to distinguish. Closer observation on selected individuals suggested the following time periods for each stage: 1) appearance of new inflorescence to expanded inflorescence: one month, 2) expanded inflorescence to open flowers: less than one month, 3) mature flowers to immature fruit: less than one month, 4) immature fruit to initial fruit fall: greater than one year, 5) initial fruit fall to last: minimum of six months. The entire process may exceed two years.

The small, but consistent number of individuals that produced new inflorescences each month suggest that reproductive events of *Raphia* are nonperiodic and occur independently of seasonal cues. In the aseasonal environment of Tortuguero there are few predictable periods that a species like *Raphia* can use to facilitate pollination, seed dispersal, or seed germination. Favorable periods for any of these processes are very short and can occur at any time during the year. Heavy rainfall and flooding can occur during every month. Even the relatively predictable dry periods in March, April, and September rarely expose the soil in the habitats where *Raphia* is found. Unpredictable rainfall can interfere with pollination. Lack of flooding may expose seed to predation. The only option is to have some individuals in each stage of reproduction throughout the year. The long period of fruit fall for an individual increases the probability that at least some seeds will escape post-dispersal predation or find suitable conditions for germination.

No detailed studies of pollination were undertaken, but observations on a few individuals showed that when the inflorescences change from yellow to brown, pollen is released. I do not know if female flowers on the same inflorescence are mature when pollen is released. Indications are that both wind and insect pollination occur. *Raphia* produces a large number of small, inconspicuous, unscented (at least to humans) flowers characteristic of anemophilous species. Bumping a mature inflorescence releases a powdery pollen. Its habit of growing in nearly pure stands may facilitate anemophily, but the small number of receptive flowering stalks in a given area at any one time, coupled with the frequent rainfall, may limit outcrossing by anemophily. *Raphia* does occur in more seasonal environments on the Pacific coast of Costa Rica and in the Amazon River delta in Brazil where anemophily may play a far more important role. Within the palm family anemophily was originally considered to be the primary mode of pollination (Tomlinson 1979). More recently the importance of entomophily has been recognized (Schmid 1970; Uhl and Moore 1977).

Entomophily appears to occur in *Raphia.* At maturity a number of insects are found on the inflorescences. I observed two species of euglossine bees visiting the flowers during this time. Insect activity as a whole seems to vary little during the year.

Inflorescences that did not develop fruit were fairly common. It may be that the stems were merely acting as males. Janzen (1978) pointed out that the lack of fruit set does not mean a reproductive event has not taken place, but only that the flowers on that individual may have acted as males. Another explanation for the observed lack of fruit on some inflorescences was predation of the immature fruits by two species of monkeys (*Cebus capucinus, Ateles geoffroyi*). They were observed to strip immature fruits off the inflorescences. They would bite off the end of the fruit, suck out the gelatinous immature endosperm then discard the fruit. Evidence of their activity could always be found at the base of the clumps.

The long period from fruit set to fruit maturity exposes the seed to these and other predispersal losses. Apparently the advantages of producing large heavy seeds that mature at different times on the same inflorescence outweigh any disadvantages associated with extended fruit exposure on the tree, or for some reason the cost of rapid fruit maturation cannot be borne by the plant.

Growth and Biomass. The most notable feature of *Raphia* growth is the large amount of energy that goes into reproduction. Each year 2,036 kg per ha in reproductive stems and their leaves die. A total of 1,297 kg per ha per yr goes into inflorescences and fruit. The loss of a reproductive stem opens a small gap that must be filled by a sprout if the clump is to continue to occupy the site. The long period of senescence of one stem may allow sufficient time for a sprout to move into the canopy position of the dying stem.

The above-ground biomass of 44,283 hg per ha (that does not include *Raphia* sprouts, understory vegetation, and infrequent hardwoods) is considerably less than that reported by other researchers for forests in the humid tropical lowlands. A mean of 25 biomass values reported by Brown and Lugo (1980) was 290,000 kg per ha. In Colombia, Golley *et al.* (1976) measured three types of marsh vegetation in a life zone equivalent to that of Tortuguero and reported values of 41,500 kg per ha in a *Paspalum repens* marsh, 34,400 kg per ha in a *Montrichardia arborescens* stand, and 38,500 kg per ha in a *Heliconia latispatha* marsh. It appears that monospecific *Raphia* swamps do not support nearly as much biomass as more diverse tropical forests and are more comparable to some of the herbaceous marshes.

New growth totaled 11,133 kg per ha per yr. This was offset by a loss of 8,843 kg per ha per yr through leaf senescence, death of reproductive stems, leaves, inflorescences, and through fruit dispersal. The difference, if the forest is in steady state, may be balanced by the occasional death of non-reproductive stems, sprout leaf turnover, and death of sprouts. The range of 9 tp 11 mt per ha per yr is similar to that reported for most forests in the humid tropics (Brown 1980). If these values are valid it appears that *Raphia* swamps are as productive as other, more diverse forests in the tropics.

Acknowledgments

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More Venezuelan Palms

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These pages include the descriptions of 20 species of Venezuelan palms which I have collected, cultivated, and propagated successfully in the Botanical Garden in Caracas. It is my purpose not only to write about the general appearance of each of them, but also of my adventures in the mountains of Venezuela, my general observations, and of the propagation of the plants in our nursery.

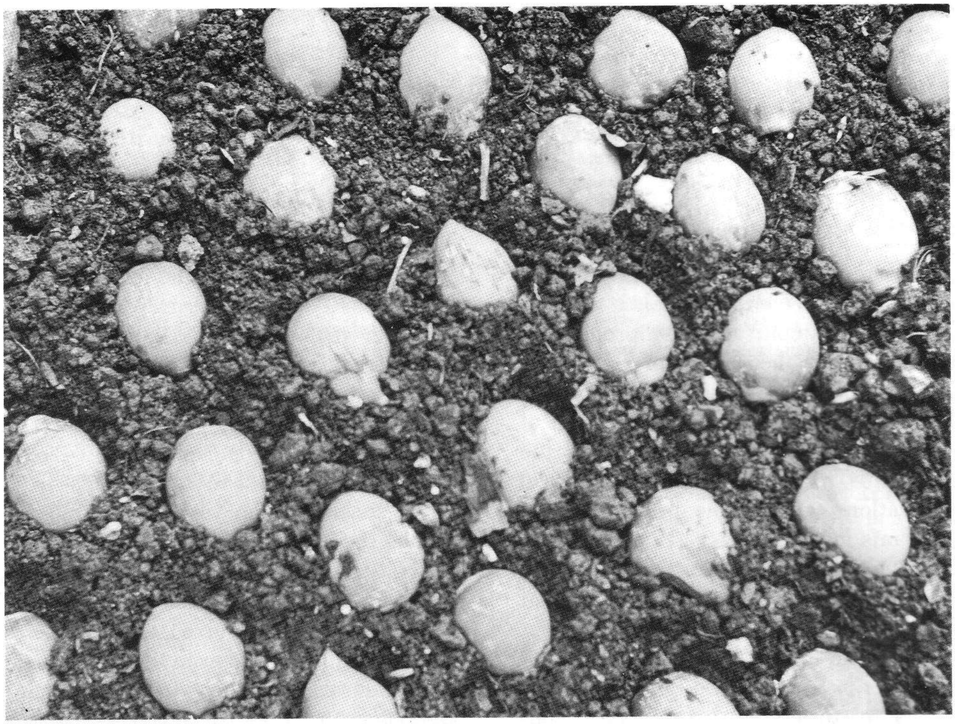
To go to the mountains, to the Amazonian forests, or to the cloud forests of the Cordillera de la Costa of Venezuela, means to me in the first place, to be with the palms in their natural habitat so as to be able to study them better and to consider their potential for ornamental use.

I have spent a long time in those regions of Venezuela where palms can be found and I never tire of looking at them. I have visited them in all the seasons of the year taking with me my camera, my notebook and collecting equipment.

In the field I have verified the flowering rhythm both in the highlands and in the hotter lowlands. I noticed, for example, that most of the palms of the lowlands have a fixed rhythm, so we know that the time when the palms bear seeds coincides with the months of June–August, even though some plants bear seeds in the months before and after these. The rhythm in the cool regions of the mountains is very different. There, according to my observations, the palms flower and fruit in different months of the year. *Ceroxylon klopstockia*, for example, has a flowering cycle of three years during which it flowers in a different month each year. The cycle starts in February and flowering the next year is in June and the following year in October–November. Each plant requires a whole year to develop and mature its seeds. After the three year period, the plant starts to flower again in February. *Catoblastus praemorsus* and *Euterpe acuminata* have similar cycles. In consequence, the collection of seeds from these species is done in different months in different years.

The trips and excursions in Venezuela have always been interesting and sometimes adventurous, mixed with problems and difficulties where even the climate can be a frustrating and delaying factor. Inundations in the wet season have caused me on various occasions to collect seeds while walking in dirty water, forcing me to walk in it in the "Morichales." The changes in temperature in the mountains also often produced high fevers and other disagreeable symptoms. To loose your way in the forest can be something terrible. I'm going to tell you one of the adventures that I had at 2,000 m of altitude in the cloud forest of the Cordillera de la Costa. The fog was so dense that I couldn't find my way and after hours of difficult walking over rocks, deep clefts and other obstacles I had to spend the night in the cold mountains without food or water.

On one of my trips to the Territorio Amazonas, my traveling companions fell gravely ill with paludism so that the trip had to be postponed for some days. One day after that I had the pleasure of collecting ripe seeds of *Astrocaryum munbaca*, which I had been trying to get for years. I was feeling very happy because of this collection when the next day I dis-



1. Propagation of nuts from *Scheelea.*

covered that the majority of the seeds were half-eaten by an insect and empty inside, really lamentable! In 1979 I found that all the seeds of *Catoblastus praemorsus* had been eaten by squirrels two months before ripening in a radius of about 3 km so that not a seed was left to be collected.

In the propagation of palms we also found surprises. For example, for many years I had been trying to germinate the seeds of *Bactris granatensis.* After putting the seeds in a concrete box with a natural bottom, covered with plastic to let the light in, with an inside humidity of a constant 100%, and having watered them only once in five months, I uncovered them to find that the majority had germinated.

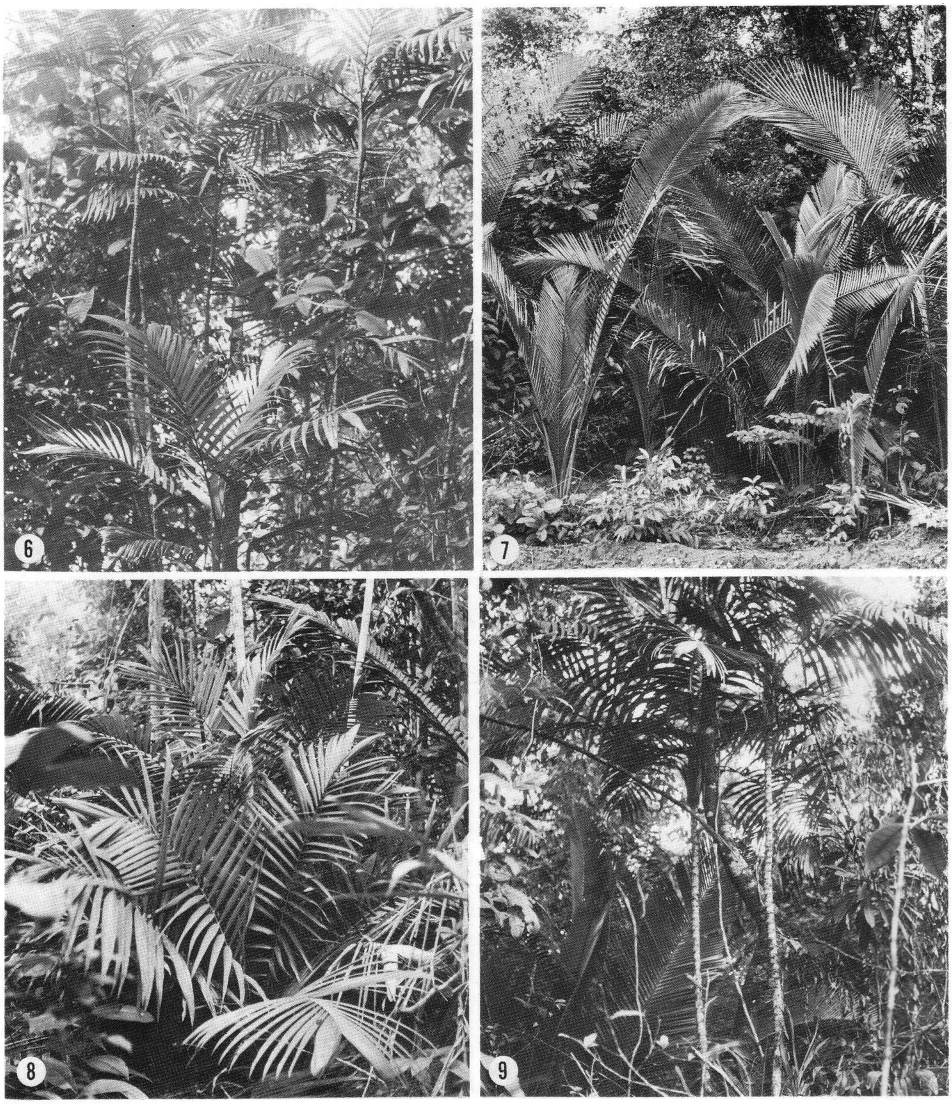
Before each sowing we use different methods to take off the fleshy pericarp. We never cover the seeds with soil but depending on the species and the quantity, we cover them partially or completely with moss or wood cuttings (Figs. 1, 2). The seeds have to have moderate humidity for if they receive too much water they drown. The transplanting must not be done before the plantlets have developed their third leaf (Fig. 3). On many occasions I collected small plantlets in the forests but the results were never satisfactory. For this reason I prefer to propagate palms by seeds instead of taking young plants from the forests.

The young plants of some palms are very attractive and very much desired by the public. I am referring particularly to *Catoblastus praemorsus.* The plantlets one or two years old are so attractive and graceful that the visitors to our Botanical Garden always want to take one of them home (Fig. 4). There are really few species of palms that have such a beautiful seed-

2. Seeds are planted in pots and covered with moss. 3. Seedlings of *Geonoma* transplanted into pots. 4. *Catoblastus praemorsus*, one-year-old. 5. *Hyospathe pittieri*, one-year-old; this palm needs dense shade.

ling leaf which is oblong-rounded and of a light bright-green color. To grow this palm one has to add a good amount of granular sand to the soil and arrange for good drainage because the palm is very sensitive to too much water. *Hyospathe pittieri*, also from the cloud forest, was first cultivated in our nursery and grew well (Figs. 5, 6). It is a palm that grows in very shady forests; perhaps it could be adapted to poorly lighted apartments.

On my last trip to the Orinoco river I had the great fortune to find the beautiful *Attalea racemosa*, which is a dwarf palm



6. *Hyospathe pittieri* grows only in the darkest part of the forest at 1,100 m in the Venezuelan coastal range. 7. *Attalaea racemosa* along the upper Orinoco. 8. Young plants of *Astrocaryum munbaca*. 9. Mature *Astrocaryum munbaca* has slender trunks.

only two meters in height and with pinnate leaves very similar to a *Cycas* (Fig. 7). Among hundreds of specimens only one plant had seeds, which was very surprising.

Yes, dear reader and palm friend, the seed collector has to have good luck in his trips as knowledge provides only a basic help. One with no patience, perseverance, and luck is really lost in this activity.

Descriptions of some Venezuelan palms follow:

Aiphanes elegans Wendland

Plant 3–4 m tall. Trunk solitary, ca. 12 cm in diameter, densely covered with black spines up to 9 cm long. Leaves 9 to 14 in number, arched, 1.5–1.7 m long with 20–25 pairs of leaflets in groups of 3–4; leaf sheath and petiole covered with black spines of different sizes. Leaflets quadrangular, denticulate apically, approximately 46 cm long and 7 cm wide at the tip. Flowers yellow, fruit rounded, 1.6 cm in diameter, orange-red when ripe.

This is a palm from the dry regions of the Estados Apure and Sucre.

Cultivation: The seeds require about two months to germinate. The plants do best when planted in places where they receive sunlight in the morning and shade in the afternoon.

Astrocaryum munbaca Martius (Figs. 8, 9)

Trunk up to 5 m tall and 6 cm in diameter, light colored and armed with flat black spines of different sizes. Leaves 8 in number, gray below and green above. Rachis of the infrutescence near 10 cm long with numerous small branches. Fruits rounded, 1.2 cm in diameter, red-orange when ripe. Collected in the gallery forests of the "Galipero" river, 30 km north of Puerto Ayacucho, Territorio Federal Amazonas of Venezuela. Of 100 seeds collected, only 20 were viable, the rest were eaten by insects.

This armed palm grows in groups inside shaded forests of the Territorio Amazonas of Venezuela.

Attalea racemosa Spruce (Fig. 7)

Acaulescent palm approximately 2 m tall with 8–14 leaves light green in color; leaf sheath about 40 cm long; rachis 1.5–2 m in length with 70–130 pairs of rigid leaflets, all in the same plane. Fruit ovoid 7 cm × 4 cm; perianth cupule clear with staminodial cup, endocarp thick, fibrous.

Grows in big colonies in the Alto Orinoco in the Territorio Federal Amazonas in periodically flooded forests but also in open savannas. This beautiful palm is sometimes cultivated in Puerto Ayacucho.

Bactris granatensis (Karsten) H. A. Wendland (Fig. 10)

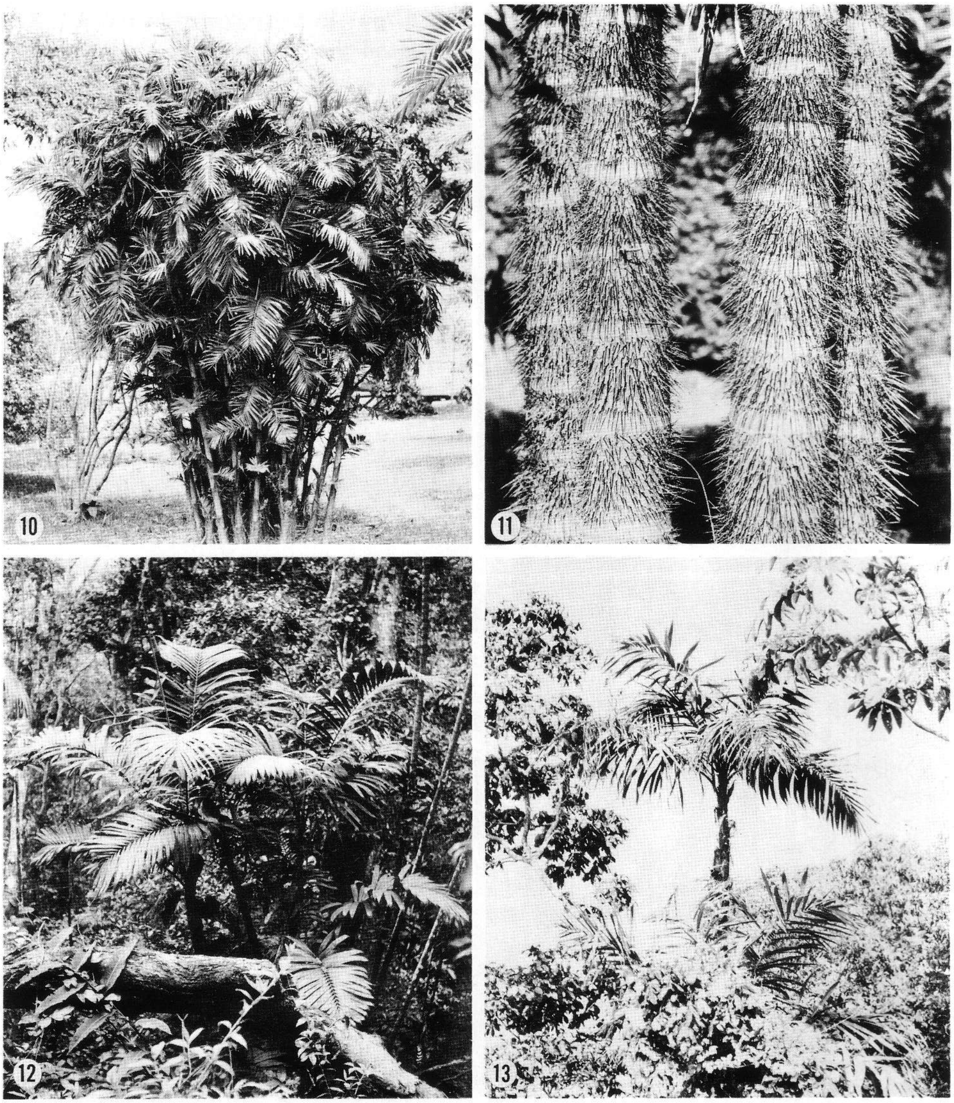
Multicaulescent palm, armed, 10–12 m tall. Trunks grayish in color, about 8 cm in diameter with spines of different sizes up to 8 cm in length. Leaf sheath about 60 cm long, covered with dark spines up to 7 cm long; petiole 32 cm in length with clustered spines up to 5 cm in length; rachis 1.6 m long, approximately 63 pairs of leaflets in groups of 3, 4 or 7; the central ones 58 cm long and 3 cm wide, at different angles. Inflorescences with approximately 70 small branches up to 20 cm in length. Flowers cream, with strong smell. Fruit globose, depressed, 2 cm in diameter, black when ripe.

A very valuable ornamental species for parks and gardens in hot climates. Grows in the northern part of Venezuela where it is frequent, for example, in the Parque Nacional Guatopo at approximately 600 m above sea level.

Cultivation: the seeds require 5–6 months to germinate. Requires half shade to direct sunlight, fertile soil and abundant water.

Bactris macana (Martius) Pittier (Fig. 11)

Multicaulescent palm, armed, 5–10 m tall, with 8–17 leaves softly arched. Trunk approximately 16 cm in diameter, covered with black spines of different lengths, up to 6 cm in length. Leaf sheath 80 cm long, armed with spines; petiole near 20 cm in length, also with black spines; rachis 1.8 m long, armed in its lower part, with 90 pairs of leaflets in groups of 4, 5 or 7, at different angles, 50 cm in length and 3 cm wide, dark green in color. Inflorescence axillary with ca. 40 small branches.



10. *Bactris guineensis* in the Caracas Botanic Garden. 11. The spiny trunks of *Bactris macana.* 12. Young plants of *Bactris setulosa* in the cloud forest. 13. *Bactris setulosa* at 1,650 m.

Flowers cream-colored. Fruit subglobose, 12–16 mm in diameter, bright orange in color; seed globose-depressed.

Grows at the foot of the Cordillera Andina of Venezuela, up to approximately 600 m above sea level.

Cultivation: Propagation by seeds which germinate after 4–5 months. Requires half shade and heat, abundant water and fertilizer.

Bactris piritu H. A. Wendland (Fig. 10)

Multicaulescent palm, armed, 3–5 m tall. Trunks several and very near each other, approximately 3 cm in diameter, covered by the old leaf sheaths. Petiole and leaf sheath armed with acicular, yellow-brown spines, up to 6 cm long. Leaf rachis 30–40 cm in length with 20–40 pairs of linear leaflets, 20–30 cm in length, dark green in color. Inflorescences axillary, rachis 5–10 cm in length with 20–30 small branches. Fruit globose-depressed, 1–2 cm in diameter, black-purple in color when ripe.

A palm typical of the semidry regions of the llanos of Venezuela.

Cultivation: Propagation by seeds which germinate after 4–5 months. Requires complete or partial exposure to the sun. Needs a very hot climate.

Bactris setulosa Karsten (Fig. 12, 13)

Multicaulescent palm, 5–7 m tall. Bearing up to 10 trunks, 7–10 cm in diameter, armed with dark spines of different sizes. Leaves dark green; rachis 2–3 m long with 40–50 pairs of leaflets, in groups of 3–8, 9 cm in length. Rachis of the inflorescence 15–20 cm long with about 60 small branches. Flowers yellow-cream colored. Fruit globose-depressed, about 2 cm in diameter, red to dark red when ripe.

This species grows spontaneously in the shaded parts of the wet forests of the Cordillera Costanera de Venezuela between 1,650 and 5,000 m above sea level.

Cultivation: Propagated by seed which take 9–10 months to germinate. Requires partially shaded places, fertile soils, and frequent watering.

Bactris simplicifrons Martius (Fig. 14)

A dwarf palm, up to 2 m tall, armed and multicaulescent. Trunks 3–6 in number, about 5 mm in diameter, covered with black spines up to 10 cm in length. Leaves pinnate, up to 5 in each trunk. In young plants the rachis usually has only one pair of wide united leaflets. In adult plants the rachis is 1 m long with 30–35 pairs of lanceolate leaflets, in groups of 3–6, measuring almost 43 cm in length and 4 cm in width. Inflorescences auxillary, white-tomentose, up to 10 cm long, the first simple, later ones forked or rarely with 3–4 small branches. Fruit subglobose, approximately 7 mm diameter.

Grows in half-shaded places in Venezuela under 1,200 m above sea level.

Cultivation: Propagated by seeds which germinate after 3–4 months. Requires half shade and warm soil.

Ceroxylon interruptum (Karsten) H. A. Wendland (Fig. 15)

Solitary palm 10–20 m tall. Trunk grayish about 35 cm in diameter, almost always covered with lichens. Leaves 12–18, grayish; rachis about 2 m long with approximately 100 pairs of leaflets arranged in series of 3–9, apically almost regular. Inflorescences axillary, 1–4 in number with 40–50 small, much branched lateral branches. Fruits rounded, about 2 cm in diameter, bright red ripe, very verrucose.

Ceroxylon interruptum is very similar to *C. klopstockia*, it differs at first sight because it is less dense than the latter; moreover the leaves appear regularly ripped by the wind and are reddish in color.

Very slender palm characteristic of the cloud forest between 1,500 and 2,800 m above sea level of the Cordillera de la Costa and the Cordillera de Los Andes of Venezuela and Colombia.

Cultivation: Adequate for parks and gardens with temperatures of 15° C. The seeds usually germinate after 6–13 months, but may take up to 2 years.

Coccothrinax barbadensis (Lodd.) Becc. (Fig. 13)

A solitary palm, not armed, up to 8 m tall. Trunk 10–15 cm in diameter, wrapped for a long time in a fine brown-colored net, eventually bare. Leaves 15–20, palmate, green above and silver below. Leaf sheath covered with fibers that sur-

14. *Bactris simplicifrons* in the forest. 15. *Ceroxylon interruptum* in the Junquito cloud forest at 2,200 m. 16. *Coccothrinax barbadensis*. 17. *Euterpe acuminata* in the Junquito cloud forest at 1,950 m.

round the trunk. Flowers bisexual. Inflorescences axillary, shorter than the leaves, branched at different levels. Fruit black, rounded or slightly flattened, approximately 7 mm in diameter. Seed with deep furrows.

A palm of a great ornamental value for parks and gardens. In Margarita, hats and handbags are made with the fibers of the young leaves. In Venezuela this species has been found only in the Isla de Margarita where it grows in open ground on the slopes of dry hills.

Cultivation: The seeds germinate after 4 months or longer. Not demanding as to soil type.


18. A four-year-old *Geonoma simplicifrons* in the Caracas Botanic Garden. 19. A five-year-old *Geonoma spinescens* also in the garden.

Euterpe acuminata (Willdenow) H. A. Wendland (Fig. 17)

Multicaulescent palm about 14 m tall. Trunk more or less 8 cm in diameter. Leaves 5–6 in number, arched, dark green. Leaf sheath up to 1 m long, purple colored; petiole 30–60 cm long; rachis 1.5–3 m long with 35 pairs of leaflets, the central ones 48 cm in length. Rachis of the inflorescence 60–80 cm long, with 60–80 small pendulous branches. Flowers lilac-colored. Fruit globose, 1 cm in diameter, dark blue when ripe.

Grows in the very humid forests of the Cordillera de la Costa of Venezuela between 1,500 and 2,000 m above sea level.

Cultivation: The seeds germinate very easily after 40–50 days. A palm for cool places of approximately 10–20° C. Requires high humidity and shade.

Euterpe precatoria Martius

Solitary palm, stem 18–28 m tall with approximately 13–17 leaves; leaf sheath about 1.5 m long glaucous-green; petiole 35 cm long; rachis 3.5 m long with approximately 75–90 pairs of leaflets, pendulous, glaucous above and green-grayish below, up to 1.2 m long and 2.5 cm wide. Inflorescence with peduncle measuring 15–20 cm in length; rachis with 80–130 small branches, 80–90 cm long, white-tomentose.

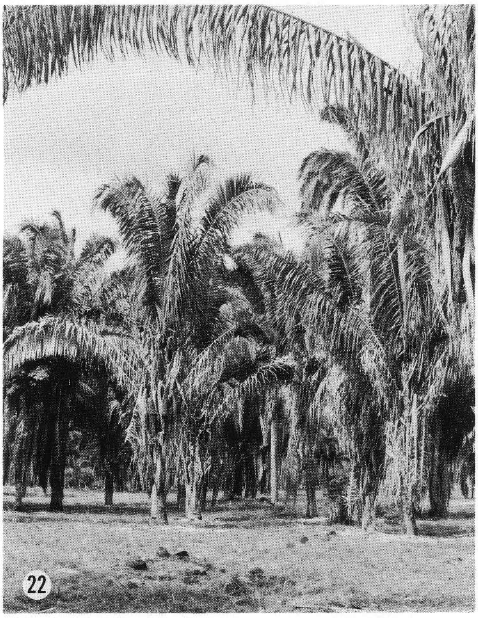
The most abundant plant in the Territorio Amazonas of Venezuela where it grows at low altitudes.

Geonoma simplicifrons Willdenow (Fig. 18)

A solitary palm, unarmed, 1–2 m tall. Trunk more or less 1 cm in diameter. Leaves pinnate, 7–10 in number, segments 15–30 cm in length, rarely simple or only in the first years. Inflorescences axillary; peduncle of the inflorescence 20–30 cm long, branches 15–30 cm long and 3 mm wide. Fruit globose, ca. 5 mm long, blackish when ripe.

Another dwarf palm from the cloud forests of the Cordillera de la Costa of Venezuela, between 400 and 1,400 m above sea level.

Cultivation: The seeds germinate after 4 months. The plants always require shade. Adequate plants for apartments but requiring daily care.



20. *Genoma undata* in the Venezuelan cloud forest at 1,950 m. 21. *Geonoma undata,* about five years old. 22. *Scheelea butyracea,* Barinas State. 23. Infructescence of *Scheelea butyracea.*

Geonoma spinescens H. A. Wendland ex. Burret (Fig. 19)

An almost acaulescent palm, 0.5–1 m tall. Trunk some 3 cm in diameter with foliar scars very near each other. Leaves 8–12, usually simple, but sometimes irregularly pinnate. Leaf blade 40–50 cm long and the sheath up to 26 cm wide, multi-nerved. Inflorescences axillary; main axis up to 30 cm long; rachis 8–10 cm long with 10–12 branches, 8 cm in length and 1 mm wide, reddish in color as are the axis and the rachis. Fruits rounded, approximately 7 mm in diameter, shiny black when ripe.

This beautiful dwarf palm grows spontaneously in the Venezuelan Cordillera de la Costa, between 1,100 and 1,650 m above sea level.

Cultivation: Propagation by seeds which germinate after 4 months. Requires half-shade to shade and high humidity. An excellent palm for apartments with temperatures between 15–23° C.

Geonoma undata Klotzsch (Fig. 20, 21)

Solitary palm; stem 5–10 m tall and 10 cm in diameter. Leaf blade 15–25 cm long and irregularly pinnate. Inflorescences axillary and twice branched; small branches 25–45 cm in length and 3–6 mm wide, cream-colored.

A species native to the coastal forests and into the Andes at an altitude of 1,400–2,400 m.

Cultivation: The seeds need 4–6 months to germinate. A palm for shady places with temperatures between 10 and 19° C.

Hyospathe pittieri Burret (Fig. 5, 6)

A multicaulescent palm, not armed, 5–6 m tall. Trunk 3–4 cm in diameter. Leaves 10–12 in number; rachis 1 m long with 19–27 pairs of leaflets up to 60 cm long. Inflorescences growing from under the leaves; rachis of the inflorescence 15–25 cm long; flowers cream-colored during anthesis and reddish after opening. Fruit elliptical, 1.5 cm long, blackish when ripe.

There is no other Venezuelan species that grows in such a shaded region as this one. It is common in very humid forests of the Cordillera de la Costa of Venezuela, between 800 and 1,100 m above sea level.

Cultivation: To this day cultivated only in the Jardin Botanico de Caracas. The seeds require approximately 4 months to germinate. The plants need sufficient shade, only 12–20° C and high humidity.

Prestoa longipetiolata (Orested) H. E. Moore

Palm usually solitary, 1–2 m tall. Trunk not armed, ringed, about 10 cm in diameter. Leaf sheath about 60 cm in length with approximately 34 pairs of rigid leaflets. Inflorescence 30–50 cm long, with 20–40 small branches up to 20 cm long. Fruit globose, 9–10 mm in diameter, almost black in color.

This beautiful dwarf palm is quite rare in Venezuela. To this day it has been reported only from the humid forests north of Nirgua (Edo. Yaracuy) between 1,200 and 1,300 m above sea level.

Cultivation: Propagation by seeds which germinate easily after a 40 day period. Requires half-shade and temperature of 15–20° C. A palm that would do well in apartments.

Scheelea butyracea (Mutis ex Linnaeus f.) Karsten ex H. A. Wendland in Kerchove (Fig. 22, 23)

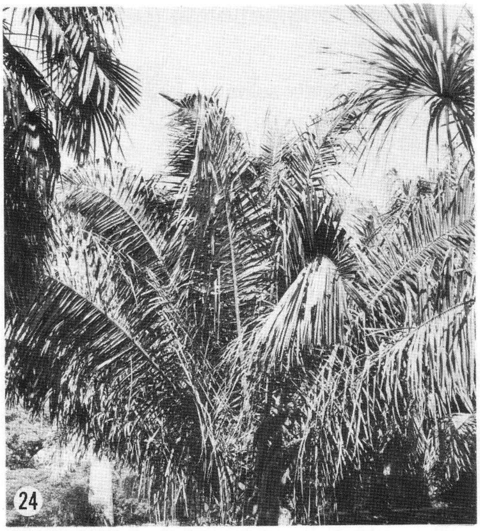
Columnar trunk, 20–25 m tall in mature plants and 30–40 cm in diameter. Leaves 15–20; sheath 1.5 m long and fibrous; petiole almost absent; rachis 6–9 m long with about 200-230 pairs of leaflets, irregularly arranged. Inflorescences about 3 m long; rachis 1 m long with approximately 200 short branches. Flowers cream colored. Fruit oblong, 2.5–5 cm long and 3 cm in diameter.

Very impressive palm from the llanos of Barinas and Apure and in the Territorio Amazonas of Venezuela and Colombia.

A very spectacular palm, appropriate for parks and large gardens. The seeds germinated in Caracas after 17 months.

Scheelea macrolepis Burret (Fig. 24)

Solitary palm with columnar trunk, up to 6 m tall and nearly 30 cm in diameter. Leaves 15–20 in number, green-blue-grayish in color, more or less arched. Leaf sheath fibrous along the margins; petiole



24. *Scheelea macrolepis* in the Caracas Botanic Garden. 25. *Syragrus sancona*, Barinas State.

very small; rachis with approximately 180 pairs of leaflets in mature plants, 70–80 cm long. Axillary inflorescences 1–2 m long. Fruits irregular, ovoid, ca. 5 cm long and 3.5 cm wide.

The "Coroba" palm, as it is commonly called, grows along the northern part of the Orinoco river, mainly in the savannas of the Cuchivero and Caicara del Orinoco (Edo. Bolivar).

Cultivation: Propagation by seeds which germinate after 2–4 months or longer. Requires fertile soil, heat and abundant water. Very appreciated in the country for its oily fruits. The leaves are used to roof rural buildings and the trunk as firewood.

Syagrus sancona Karsten (Fig. 25)

Solitary palm, 10–18 m tall. Trunk 20–25 cm in diameter. Leaves about 14, varying from light to dark green. Leaf sheath laterally fibrous. Rachis 2.5–3 m long with 120–150 pairs of leaflets grouped at different angles, 60–80 cm long and 3–4 cm wide. Rachis of the inflorescence 0.5–1 m long, with numerous small branches. Flowers cream-colored. Fruit approximately 3.5 cm long and 2.5 cm in diameter, orange when ripe.

Native to the Andes region and the lowlands of Venezuela and Colombia.

Cultivation: Propagation by seeds which germinate after 3–4 months or longer. Hot climate palm. Very suitable for parks and gardens, requires fertile soil and abundant water.

Know Your Palms

A. *Actinorhytis calapparia* (with *Areca catechu* on right). B. *Carpentaria acuminata.* C. *Bismarckia nobilis.* D. *Heterospathe elata.*

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The Ecology of Oncosperma horridum on Siberut Island, Indonesia

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Oncosperma horridum (Griff.) Scheff. is one of five species in the genus *Oncosperma*, which ranges from Ceylon to the Philippines and belongs to the large and diverse subfamily Arecoideae. The genus appears not to have a center of radiation, although the perhumid zones of Malesia possibly support a greater number of species than have been described. Two species, *O. horridum* and *O. tigillarium* (Jack) Ridl., occur in Malesia, with *O. fasciculatum* Thw. recorded from Ceylon and *O. gracilipes* Becc. and *O. platyphyllum* Becc. from the Philippines.

Members of the genus *Oncosperma* are usually tall, clustering, spiny palms with distinct crown shafts and pinnately divided leaves. *O. horridum* may reach 20 m or more in height and clusters may have up to 15 major stems. It is a widespread species, being the single representative of the genus in inland lowland and sub-montane rainforests of the Malay Peninsula, Sumatra, Borneo and the Philippines. It is not found in Java or the Lesser Sunda Islands. Usually *O. horridum* is confined to forests below 450 m, but occasionally may be seen at 900 m (Whitmore 1973).

This study was undertaken on the island of Siberut, the largest of the Mentawai chain which lie 140 km off the west coast of Sumatra. *O. horridum* (local name *ari ribuk*) is one of the most conspicuous forest components of many parts of the island, and fulfills many basic needs of the indigenous people (House 1983). The species thrives at low elevations and in the relatively aseasonal climate of Siberut. *O. tigillarium* replaces *O. horridum* near the coast on sandy beach-derived deposits and along the tidal stretches of large rivers.

This paper presents preliminary observations on apparently edaphically determined micro-habitat preferences of *O. horridum* on Siberut.

The Study Site

The study site is located in more or less undisturbed lowland tropical rainforest (sensu Whitmore 1975) in central Siberut, in the upper reaches of the Saibi River. Climatic conditions are truly tropical, with more than 4,000 mm of rain a year (>100 mm in every month) and mean monthly maximum daily temperature of 30° C. The forest at the study site contains four floristically and structurally distinct sub-types; *O. horridum* was common in three, namely Mixed forest (no dominant tree family), Dipterocarp forest (Dipterocarpaceae dominant) and Myrtaceous forest (Myrtaceae dominant). *O. horridum* was very infrequent in permanently inundated inland swamp forests. Mixed forest is found on flat ground and low hills and has a high species diversity. Individual tree species are locally common but this represents patchy, contagious tree species distribution rather than seral or climax dominance. Myristicaceae, Euphorbiaceae, Dipterocarpaceae, Lauraceae and Ebenaceae are the commonest tree families. Dipterocarp forest, occurring on higher hills and clay ridges away from centers of habitation is somewhat poorer in tree species, with a distinct dominance of species of Dipterocarpaceae, notably of *Dipterocarpus* and *Shorea*. Flacourtiaceae, Myristicaceae and Sapotaceae may be locally co-dominant. Myrtaceous forest is found on steep sided sandstone ridges and is dominated by *Tristania whiteana* Griff. Other species from both Mixed and Dipterocarp forests are present but in low numbers. Myrtaceous forest has the lowest species diversity of the three sub-types.

Parent rock materials throughout the study site are sedimentary series of Tertiary or pre-Tertiary origin, being micaceous sandstones and shales. Derived soils are deeply weathered and form two types: heavy, sticky clays and porous sandy loams. The high rainfall and erodibility of the soils have resulted in a rugged, dissected landscape with steep sided gullies and little flat ground. Soil slip and small landslides are common in wet weather. Inundation of low-lying areas is frequent during the two equinoctial wet seasons of April–May and September–January.

Procedure

The data presented here have been taken from 8 study plots, five located in Mixed forest, two in Dipterocarp forest, and one in Myrtaceous forest. Plot sizes ranged from 0.16 to 0.24 ha (mean plot size 0.21 ha). Discrete clumps of *O. horridum* were counted and the size of each clump in terms of the number of stems with conspicuous leaf scars and developed crown shafts were noted. The number of single, juvenile stems not associated with large clumps was also counted. Juvenile stems close to a clump (i.e. at distances equal to or less than that of the radius of the clump) were counted as being of that clump and likely to be suckers rather than seedlings.

Soils were sampled from each plot, the site of each pit chosen randomly. Samples taken from two or three depths (range 2–75 cm) were analyzed separately to give surface and mean profile values. Chemical and physical analyses were performed on air-dried samples. Exchangeable bases were extracted with neutral normal NH_4OAc, and cation exchange capacity determined by replacing exchanged ammonium salts with normal KCl at pH 2.5. pH was measured on a 1:5 soil water mix. Total N was determined by the Kjeldahl method, and loss on ignition measured by weight loss after ignition at 475° C for 8 h. The physical structure of the soils was determined by removal of clay using ultrasonics and sedimentation, and sand content measured by sieving and washing.

Other environmental plot characteristics recorded were the mean relative crown density of trees, assessed subjectively on two 3-point scales to accommodate size and compactness/openness of individual tree crowns, the density of trees >50 cm gbh, and the total basal area of trees >50 cm gbh.

Results

The densities of mature clumps and single juveniles, and the mean clump size and range of clump sizes are shown in Table 1. Table 2 shows the results of the chemical and physical soil analyses, and the tree density, crown density and basal area of plot trees are shown in Table 3. The effects of the measured edaphic and environmental parameters on the density and size of *O. horridum* have been assessed using simple correlation statistics (Table 4). The sample from which the correlations have been calculated is small (n = 7), and so the strict statistical significance of the values of r are limited. However, the results in Table 4 do show definite responses by *O. horridum* to small variations in habitat conditions.

Several interrelated soil factors, combined, appear to be responsible for determining palm densities; *O. horridum* shows a preference for coarse textured, well drained soils of low fertility (plots M2, M5, D2 and MY), behavior which parallels that

Table 1. Densities and sizes of O. horridum in study plots.

	M1 Flat	M2 Gentle	M4 Flat	M5 Steep	D1 Gentle	D2 Gentle	MY Steep
No. clumps ha^{-1}	13	16	6	19	10	22	15
Mean no. stems $clump^{-1}$	3.8	4.4	4.8	4.3	3.9	2.3	2.1
Range stems $clump^{-1}$	1–9	1–10	1–8	1–10	1–10	1–5	1–5
No. juveniles ha^{-1}	—	21.5	—	—	8.2	6.2	9.2

M = Mixed forest; D = Dipterocarp forest; MY = Myrtaceous forest.

of *O. tigillarium* near the coast, and avoids poorly drained clayey substrates with subsurface mineral flushing and possible occasional flooding (plots M1, M4). The influence of slope on soil texture and water holding capacity determines, in part, the levels of available mineral nutrients: soils on slopes tend to be coarser and better drained than those on flat ground where run-off has created accumulations of small soil particles. The mean palm density on flat ground is 9.5 clumps ha^{-1}; that on slopes is 16.4 clumps ha^{-1}.

Of the three major soil minerals measured, Mg^{++} appears to be most influential, high surface levels of which correspond to low densities. Similarly, overall soil fertility is negatively correlated with palm density. Surface mineral levels appear to be more influential than the general nutrient status of the whole soil profile; most *O. horridum* feeding roots are probably close to the soil surface, in common with many rainforest plants.

Trends in the size of individual plants are less significantly correlated with edaphic parameters, and because of a weak negative correlation between palm density and size ($r = -0.53$), most of the trends are opposite to those for palm density. High soil mineral status thus allows for fewer but larger plants.

Table 2. Results of chemical and physical analyses of study plot soils.

Plot		pH	% Moist	Bulk Density g ml^{-1}	% l.o.i.	Meq 100 g^{-1} Exch Ca^{++}	Exch Mg^{++}	Exch K^{+}	TEB	CEC	% N	% Fine Sand	% Silt	% Clay
M1	surface	4.7	4.6	0.87	5.7	0.7	1.1	0.3	2.1	21.6	0.2	22	32	46
	mean	5.0	6.6	0.96	4.9	0.6	1.3	0.4	2.3	27.4	0.1			
M2	surface	4.2	4.5	0.67	22.5	0.1	0.7	0.5	1.3	35.3	0.7	58	21	19
	mean	4.5	3.6	0.75	14.8	0.1	0.3	0.3	0.7	22.3	0.5			
M4	surface	4.8	10.0	0.86	4.8	5.6	2.7	0.4	8.7	41.8	0.2	9	31	60
	mean	4.9	10.5	0.90	4.3	4.8	2.7	0.5	8.0	42.2	0.2			
M5	surface	4.4	3.4	0.73	16.7	0.5	0.7	0.5	1.7	23.7	0.6	52	27	18
	mean	4.6	2.2	0.88	6.9	0.2	0.3	0.2	0.7	11.4	0.3			
D1	surface	4.8	7.3	0.66	23.5	4.4	2.5	0.7	7.6	39.8	0.9	16	35	48
	mean	4.8	7.6	0.83	10.5	1.5	1.5	0.4	3.4	37.3	0.4			
D2	surface	4.9	5.3	0.70	18.9	0.1	0.4	0.4	0.9	16.7	0.5	8	21	71
	mean	4.8	4.7	0.80	11.7	0.1	0.4	0.3	0.8	13.6	0.3			
MY	surface	4.5	2.9	0.82	12.2	0.3	0.7	0.4	1.4	20.2	0.4	63	19	15
	mean	4.8	2.1	0.94	7.6	0.1	0.4	0.2	0.7	11.9	0.2			

N.B. Na^{+} levels were too low to be of significance.

Table 3. Environmental parameters of the study plots.

Plot	Tree Density (Trees ha^{-1})	Mean Crown Density	Basal Area (m^2 ha^{-1})
M1	208	0.75	31.22
M2	363	1.40	41.03
M4	156	0.63	21.25
M5	276	1.03	30.52
D1	156	0.65	26.97
D2	333	1.33	48.43
MY	467	2.09	36.19

The independent variables of tree density, crown density and tree basal area do not exert significant influences on palm density or size. At high tree densities and crown densities (these are closely correlated: $r = 0.99$), where competition for light may be assumed to be intense, palm densities do not drop, suggesting some degree of shade tolerance by young palms. Both tree density and basal area are negatively correlated with soil fertility (vs. total exchangeable bases: $r = -0.77$ and -0.80 respectively).

Discussion

The preference that *O. horridum* exhibits for soils of low fertility contrasts with the behavior of the bertam palm (*Eugeissona tristis* Griff.) in Malayan rainforests (Fong 1977). The densities of this palm increase with cation exchange capacity; it is an opportunistic species of relatively short life span that rapidly colonizes canopy gaps, whereas *O. horridum* is a long lived species reproducing beneath a closed canopy. A greater limiting factor to *O. horridum* may be soil drainage quality; the palm cannot tolerate soils that may be saturated for long periods each wet season, hence its scarcity in permanent swamp forests. It does not develop aerial adventitious breathing roots as do many palms of wet soil habitats. *O. horridum*, in common with other large clustering palms, may overcome apparent low nutrient levels by self-mulching; copious leaf litter from several palm crowns falls either within the clump or at its base, providing the surface feeding roots with newly released nutrients, preventing excessive surface mineral leaching, and reducing competition from juveniles of other plants.

Table 4. Values of correlation coefficient r.

		Clumps ha^{-1}	Stems $Clump^{-1}$
1. *Edaphic*			
Bulk density	surface	−0.14	0.18
	mean	−0.37	−0.13
pH	surface	−0.09	−0.13
	mean	−0.48	−0.21
% moisture	surface	−0.75	0.43
	mean	−0.80	0.47
% fine sand[a]	surface	0.34	−0.07
% silt[b]	surface	−0.75	0.50
% clay[c]	surface	−0.18	−0.06
Exch. Ca^{++}	surface	−0.86*	0.51
	mean	−0.83*	0.53
Exch. Mg^{++}	surface	−0.91***	0.54
	mean	−0.89**	0.50
Exch. K^+	surface	−0.14	0.25
	mean	−0.86*	0.50
T.E.B.	surface	−0.87*	0.61
	mean	−0.87*	0.54
C.E.C.	surface	−0.78	0.74
	mean	−0.90**	0.61
Loss on ign.	surface	0.45	−0.11
	mean	0.47	−0.17
% N	surface	0.23	0.05
	mean	0.25	0.05
C:N	surface	0.84*	−0.67
2. *Environmental*			
Tree density		0.62	−0.67
Crown density		0.52	−0.71
Basal area		0.85*	−0.64

* $p < 0.02$; ** $p < 0.01$; *** $p < 0.005$.
[a] 20–250 μ; [b] 2–20 μ; [c] <2 μ.

The abundance of *O. horridum* in parts of Siberut suggests that conditions for its establishment and growth are extremely favorable. Much higher clump densities than given in Table 1 were observed within the study site: an estimated 61 clumps ha^{-1} were found in a Mixed forest plot close to plot M2. Wherever *O. horridum* is present as tall, mature plants the crowns form an important component of the main rainforest canopy layer. It is sometimes seen as an emergent where the surrounding canopy has been disturbed. As with many much rarer rainforest plants, *O. horridum* shows some degree of site specificity, although this appears as changes in density and size rather than presence or absence. There are no data in the literature with which to compare these high densities; certainly Ashton (1964) found *O. horridum* to be rare and scattered in the mixed Dipterocarp forests of Brunei, and the species is not conspicuously common in either lowland Central Malayan or West Sumatran rainforests (pers. obs.).

A number of factors may account for the abundance of *O. horridum* on Siberut. There is a high tree fall incidence caused by high rainfall, unstable soils on steep slopes, occasional earth tremors, and wind storms (but not cyclones) coincident with the equinoctial wet seasons. Canopy conditions are therefore relatively unstable, and although *O. horridum* is not a true gap exploiter, it does appear to be able to take advantage of disturbance to the canopy. Seeds are not seen to germinate in open, sunny conditions, and young plants show yellowing on sudden exposure to full sun after a tree fall. However, this shade requirement for establishment and early growth seems to be gradually lost as the palm grows into the main tree canopy, and some exposure is necessary for flowering and successful fruit set. Seedlings were not found beneath mature clump canopies; whether an allelopathic mechanism operates is not known, but *O. horridum* crowns do exert a significant effect over general rainforest regeneration. The continuously shed and heavy litter and dense array of palm crowns casting heavy shade creates a poor environment for seed germination and seedling establishment; those seedlings that do germinate are likely to be damaged or smothered by further fall of palm leaves. Seeds of *O. horridum* itself are probably widely dispersed by long-distance travellers such as fruit pigeons, hornbills, macaques and gibbons.

Oncosperma horridum is an extremely important palm to the indigenous Mentawaian people (House 1983). The present level of use may assist the maintenance of palm populations. The felling of one or two mature stems from a clump of six or seven does not adversely affect the clump if basal buds are not damaged, and may release these from inhibition and thus prolong the life of the clump.

Acknowledgements

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Root Regeneration in Transplanted Palms[1]

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Palms play important roles in landscapes of warmer regions of the world. Palms differ from most broadleaf trees in that large specimens can be transplanted fairly easily. The size of root ball taken with palms transplanted by nurserymen varies from almost nothing to nearly 2 m in diameter. Little is known about the effect of root ball size on subsequent regrowth of roots and success of transplanting in palms. Tomlinson (1961) states that if a palm root apex is destroyed, it will usually be replaced by one or more branch roots arising immediately behind the dead apex. On the other hand, it is common practice among people who transplant large palms commercially to cut the roots fairly short (<45 cm) when digging due to a general belief that cut roots will die back to the trunk anyway and will be replaced by new roots originating from the trunk. Perhaps this branching response in palm roots is a function of the distance from the trunk that the cut is made and varies among palm species. An experiment was conducted to help answer these questions with the hope that formulation of scientifically sound recommendations regarding optimum root ball size for transplanted palms will be possible.

Materials and Methods

Five 5–8 m tall field-grown palms each of royal palm (*Roystonea regia*), coconut palm (*Cocos nucifera*), queen palm (*Arecastrum romanzoffianum*), and sabal palm (*Sabal palmetto*) were used in the experiment. A trench 1.5 m long, 30 cm wide, and 60 cm deep was dug with a mechanical trencher through the root system of each palm, tangent to the trunk of the palm. This exposed cut roots varying in length from 5–100 cm. The trench was then refilled with moist perlite and was covered with a porous polypropylene fabric. Palms were irrigated periodically to keep the perlite zone moist. Eighteen to 30 weeks after trenching, depending on the species, the perlite was removed, the roots rewashed, and root growth response recorded for 4 different length classes (0–15 cm, 15–30 cm, 30–60 cm, and 60–90 cm) of root stubs.

Results and Discussion

The severed queen palm roots were re-exposed after 18 weeks of regrowth. Among 88 roots cut to a length of less than 15 cm, only 3% branched and continued growth (Table 1). Percentage of cut roots branching increased to 41% for roots 15–30 cm long and continued increasing with increasing root length to 57% for roots 60–90 cm long. Thus 15–30 cm appears to be the minimum threshold length for branching of cut queen palm roots. Since relatively few new roots initiated from the trunk during the 18 week regrowth period, emphasis should be on taking as large a root ball as possible to increase the percentage of roots branching and continuing growth.

After 20 weeks the root pruned royal palms were re-excavated. As with queen palms, the percentage of branched cut roots increased as root length increased. Less than 1% of roots cut to 15 cm or

[1] Florida Agricultural Experiment Stations Journal Series No. 4694.

Table 1. Average percentage of cut roots branching in 4 different length classes. Total number of cut roots examined in each size class is shown in parentheses

Species	Root length				Avg. No. New Roots
	<15 cm	15–30 cm	30–60 cm	60–90 cm	
Queen palm	3 (88)	41 (31)	49 (43)	57 (14)	13
Royal palm	1 (432)	6 (163)	24 (86)	36 (42)	97
Coconut palm	47 (100)	61 (46)	50 (10)	50 (4)	20
Sabal palm	1 (1,780)	1 (600)	3 (215)	1 (75)	196

less branched whereas 24% of the 30–60 cm long roots and 36% of the 60–90 cm long roots branched. Large numbers of new roots emerged from all royal palm trunks following root pruning. This suggests that if roots must be cut to a length of less than 30 cm where branching is minimal, root pruning should be performed 2–3 months prior to actual moving of the palm. In this way active new roots will already have emerged by the time the palm is moved and transplanting shock should be minimized. If handling large root balls with royal palms can be accomplished, then root pruning prior to digging such that 60–90 cm long roots remain, should result in considerable branching of old roots as well as extensive production of new roots and would be the preferred method of handling these large palms.

Coconut palms were redug 23 weeks after root pruning. Cut root length had no effect on branching in this species and roots of all lengths branched about 50% of the time. Relatively few new roots were produced, but that may have been due to the rather young age (ca. 5 yr vs. 7–12 yr for the other species) of the coconut palms used in this experiment. Root ball size in coconut palms thus appears to be less important for root branching than in queen or royal palms.

Root regrowth in sabal palms was much slower and more irregular than in the other 3 species. The severed roots were reexamined 30 weeks after trenching and even then branching of cut roots averaged only 1% for all root lengths. New root production was extensive (191–393 new roots/palm) on 3 of the 5 palms, but in 2 plants few (5–26) new roots were produced. Since sabal palm roots generally do not branch at any length, root pruning prior to digging for stimulation of new root production is important for successful transplanting of this species.

In summary, cut root branching response varies among species of palms. Percentage of branched roots increases with increasing root length in queen and royal palms so that larger root balls are desirable for branching and continued growth of old roots. Root length had no observable effect on branching in coconut and sabal palms with half of all cut roots branching in coconuts and virtually none branching in sabal palms. Root pruning 2–3 months prior to moving the palms is important for species such as royal and sabal palms in which root branching may be minimal and new root production extensive, but is also helpful for coconut and queen palms which produce some new roots following root pruning.

Acknowledgment

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Principes, 28(2), 1984, pp. 92–98

Palms in the Microclimates of the San Francisco Bay Area

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When one considers that the San Francisco Bay Area lies in approximately the same latitude as Wichita, Kansas; Evansville, Indiana and Washington, D.C., it is remarkable that any palms grow in the area. It is even more remarkable to find not only hardy palms such as *Phoenix*, *Trachycarpus* and *Washingtonia* but also tall *Arecastrum*, *Archontrophoenix* in flower, and *Howeia* heavy with ripening fruit. All of these palms will not necessarily be found together, however, for this is a very complex region with more microclimates for its size than any other part of North America.

The U.S. Department of Agriculture's hardiness-zone map places the San Francisco Bay Area in zone 10. This is the same classification as is given the southern half of Florida, the southernmost tip of Texas, and coastal southern California. There is a gap of more than 200 miles between the zone 10 area of southern California and the appearance of zone 10 again around San Francisco Bay. There is also a small area of zone 10 on the north side of Monterey Bay about sixty miles south of San Francisco. As will be noted below, these pockets of tropic and subtropical climates have influenced the attitude toward palms in the San Francisco are area.

The placement of San Francisco in zone 10 is misleading, however, because the climate is not very similar to southern Florida and Texas. What the regions have in common is a lack of frost. There are many places in the hills overlooking San Francisco Bay that never see a white frost. The lowest temperatures ever recorded in San Francisco have been in the high 20's (F) in a freeze during the 1930's. This part of zone 10 differs from other parts in the lack of heat. It is a mostly cool area that may be likened to tropical highlands. Nights are generally in the 50's (F) and daytime temperatures rarely reach above the 70's (F). In the city of San Francisco the average high for the warmest month—September—is 68° F, while the average low for the coldest month—January—is 45° F.[1] Summers in San Francisco are cooler than in any other major city in the USA. In some years February has had more days over 70° F than has June. Mark Twain is supposed to have observed that "The coldest winter I ever spent was one summer in San Francisco." And attributed to actor W. C. Fields is the assertion that "San Francisco is the only place where you can freeze to death while sitting under a palm tree smelling your roses." Anyone visiting San Francisco during the summer and anticipating summer heat is likely to be disappointed; warm weather comes in September and October and sometimes surprisingly in January or February.[2]

San Francisco's climate is classified as

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[1] January average low temperature for Los Angeles is also 45°.

[2] At this writing in January 1984 there have been two weeks with daytime temperatures in the high 60's and 70's in San Francisco and temperatures reaching over 80° in outlying areas.

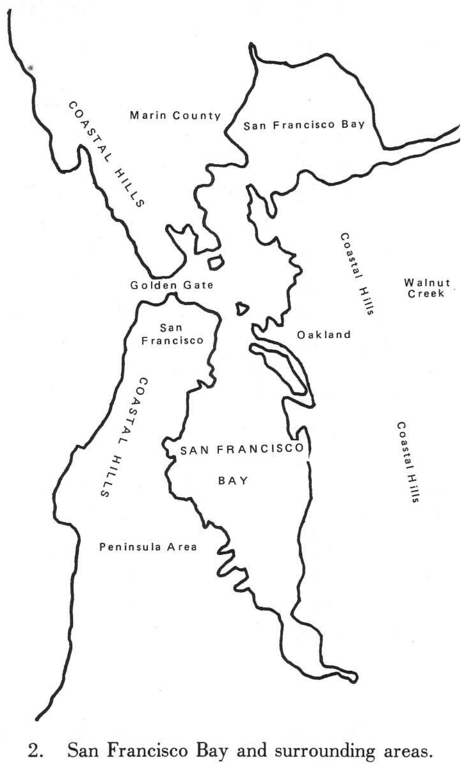
1. California's coastline bulges westward.

Mediterranean or Dry Summer Subtropical. It has a dry summer alternating with a moist winter, receiving about 21 inches of rain mainly between October and April. On the Koppen system of climate classification San Francisco is ranked as Csb, or cool summer Mediterranean. Several geographic factors operate in the San Francisco Bay Area to orchestrate its truly unusual climate. These are (1) its position on the west coast of North America, (2) the adjacent ocean current, (3) the prevailing winds, (4) the complex system of hills, and (5) the great bay.

The coastline of California does not run north and south, but bulges westward and then continues in a decidedly southeastward direction. This places San Francisco in a position more than 200 miles farther west than Los Angeles, and thrusts its shoreline into the cool California current which flows northward from Japan, across the Gulf of Alaska, and then southward along the coast of North America to finally reach California. The temperature of this current is always in the 50's (F), being somewhat warmer in the winter than during the summer. The cooler summer temperature are due to an upwelling of colder waters to the surface.

The prevailing winds along the California coast are from the west, and thus must pass over the cool currents before striking the land. In the summer, air blowing across the Pacific is warm and moisture laden until it strikes the cool offshore waters. There it is chilled and fog forms. All during the summer months a wide bank of fog lies along the coast. Almost daily it invades the San Francisco Bay Area pouring in like cotton through the Golden Gate and other gaps in the hills. It is not experienced as a ground fog, but as a high fog cutting out the sun, cooling the area, and appearing as a low cloud mass.

The coastline of California is characterized by ranges of parallel hills. In most places the hills rise directly from the ocean



2. San Francisco Bay and surrounding areas.

as cliffs, alternating with valleys, and extending inland as a mass up to sixty miles wide. Some of these coastal valleys are famous for their agricultural development, as the Salinas and Santa Clara Valleys to the south and the grape growing Napa and Sonoma Valleys to the north. In the San Francisco Bay Area these hills manifest themselves as three distinct parallel ranges forming a corrugated barrier about forty miles wide. The first range cuts through the San Francisco peninsula and Marin County to the north; Mt. Tamalpais at 2,606′ is the highest peak. The second range inland and east of San Francisco Bay forms the background for such cities as Berkeley and Oakland. The mountains are higher in the south and culminate in the highest peak in the Bay Area, 4,206′ Mt. Hamilton, east of San Jose. The third range lies still farther inland and is dominated by Mt. Diablo at 3,849′.

Beyond Mt. Diablo lies the great Central Valley of California—over 400 miles long and walled in on the east by the Sierra Nevadas, the highest mountains in the forty-eight adjacent states. This mighty mountain range, along with the Cascades to the north, diverts polar air masses from rolling down into California and producing the periodic deep freezes so frequently experienced in the eastern half of the continent.[3] The coast ranges and the Sierra Nevada create a benign Mediterranean climate for the Central Valley. For example, oranges are grown commercially as much as 200 miles north of San Francisco, and Redding at the north end of the valley—at exactly the same latitude as Philadelphia—delights the traveler from the north with his first sight of California palms—streets lined with *Washingtonia*.

A major gap in the coastal hills—the Golden Gate—allows the ocean to flow inland and fill up the "valley" between the first two ranges of hills to form San Francisco Bay. This is a large shallow body of water over sixty miles long and in some places ten miles wide. The bay acts as a great thermostat, warming the winters and cooling the summers of the lands adjacent to it, giving the area some of the most equable temperatures anywhere. It is through the Golden Gate that the winds and fogs rush in during the summer time; other smaller gaps in the hills also act like doors left open for more winds and fog to blow through. The hills and the flow of fog through the gaps produce many microclimates. One area may be covered with fog while a few blocks away the sun is shining—temperature differences may be as much as 20 degrees. Real estate agents speak of property as being in pneumonia gulches or in banana belts. As one moves farther inland in summer, and farther from the effects of the cool ocean and the fog, the weather becomes warmer. The land over each range of hills takes on a different mood. It is impossible in July to experience temperature changes of one degree per mile. One can get on the BART commuter train in Daly City near the ocean where temperatures may be in the fifties and get off the train less than an hour later at Concord near Mt. Diablo and find the temperature at 95 or 100 degrees. In fact in the San Francisco area one can pick almost any summer temperature one desires from the cool coast to the hot interior and all the variations in between. In the winter, however, similar but reverse conditions prevail. Around the bay there may be no sign of a frost, but in the inland valleys night-time temperatures may drop into the low twenties.

All these climate variations give rise to a broad and at times confusing array of horticultural potentials. There are basically four major horticultural climates in the San Francisco area. There is first the area along the coast not protected by a range of hills. Golden Gate Park is in this area. Here it is too cool for tomatoes to

[3] In spite of the Sierras the area does get an occasional deep freeze as in 1972, 1949, 1937.

ripen, oleanders will not flower, but fuchsias grow into small trees, calla lillies are naturalized, tree ferns from New Zealand and Australia grow to great size and the Metrosideros trees that line the streets, send out aerial roots and produce masses of red bloom in the summer.

A second zone is found in areas farther inland and protected from the fogs that pour in through the Golden Gate and Alemany Gap. An example is the Mission District of San Francisco. This is where geraniums grow into shrubs, where one finds datura and jasmine, bougainvillea, lemons and the flame-colored *Eucalyptus ficifolia.* And here too are palms, mainly common hardy varieties, but there is a street lined with *Brahea* and one finds too the occasional *Howeia.* The area is generally too cool for *Washingtonia* to grow well; however, *Phoenix canariensis* seems to thrive.

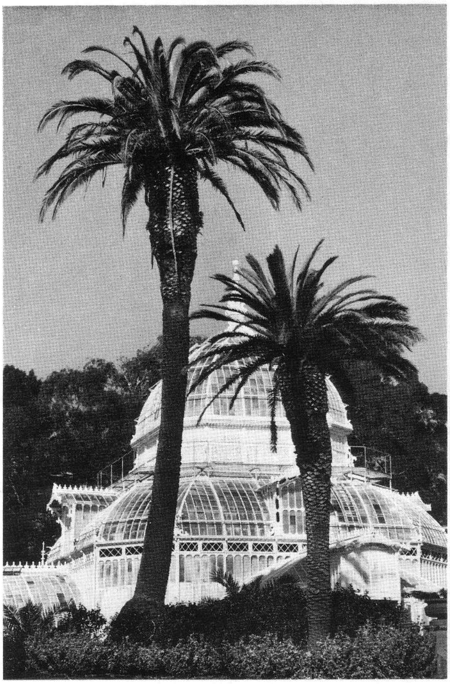
Across the bay, and north in parts of Marin, and south into the bay side of the San Mateo peninsula is the third recognizable horticultural zone. This is a warmer area—farther removed from the influence of the ocean and the fog, and because of the moderating influence of San Francisco Bay, receives little frost in the winter. Gardens here may include strelizias, hibiscus, bananas, tibouchina, eucalyptus and jacaranda. In warmer spots one can raise avocados and limes and, in the same garden, apples and pears. Winter brings blooms of acacias and camellias. The palm grower has a wide choice in this area. Heat loving palms grow slowly but he can grow fine specimens of *Archontophoenix, Arecastrum, Chamaedorea, Phoenix roebelinii,* and even *Caryota. Parajubea* fruits in this area and palms from the tropical highlands have enticing potential.

Over the hills in Contra Costa Country and to the north in Solano and Sonoma Countries is the hot summer area. Winters may be too cold for hibiscus, jacaranda and flaming eucalyptus, but one finds the summer heat just right for the

3. *Howeia forsteriana* producing inflorescences and fruit in San Francisco. Photo by E. Charles Cornell.

oleanders that line the freeways; crape myrtle blooms and oranges ripen. Hardier palms grow luxuriantly. Heat-loving palms which may languish near the bay rejoice in this climate. Here are found magnificent *Brahea, Sabal, Trithrinax, Jubaea, Butia* and such rarities as *Nannorrhops.* Palms are used more freely here and in the Central Valley and one encounters great lines of *Washingtonia* and *Phoenix canariensis.*

In spite of the fact that so many species of palms can be grown in the San Francisco Bay Area, palms are not widely planted. One can travel considerable distances without seeing the silhouette of a palm on the horizon. There are several noteworthy plantings, however. Most tourists are impressed by the great *Phoenix canariensis* growing in Union Square in downtown San Francisco. The new Nie-

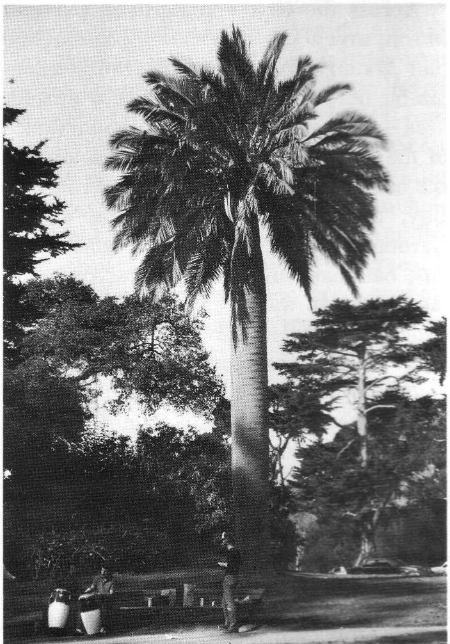


4. *Phoenix canariensis* is the most frequently seen palm in the San Francisco area. These are near the conservatory in Golden Gate Park. Photo by E. Charles Cornell.

man-Marcus store has even incorporated these trees into its logo. Dolores Street on which San Francisco's old Mission Dolores (1776) is located is lined with *Brahea*, *Washingtonia* and *Phoenix* species. The Presidio military base has some fine old palms and there are a few in Golden Gate Park at the conservatory and at the museum science-academy complex. Again most are *Phoenix* species with several newly planted *Butia* originally given by the Palm Society for another site. One splendid palm in Golden Gate Park is the grand old *Jubaea* staged on a lawn across from the conservatory against a background of evergreen eucalyptus trees. It is worth a detour just to admire this splendid tree.

South of San Francisco one notes more palms on the horizon, again mostly *Washingtonia* and *Phoenix*. None are used in highway landscaping, most are in private gardens or around a hotel or restaurant striving for a tropical panache. The great planting south of San Francisco is at Stanford University where palms were used lavishly in the original landscaping nearly a century ago.

In the area across the bay from San Francisco around Berkeley and Oakland there were more palms in the past than there are now. Berkeley at one time had entire streets lined with palms. Remaining in Oakland is a magnificent quadrangle of tall, old *Washingtonia* that can be seen for several miles. After Francis M. (Borax) Smith made his fortune with the Twenty Mule Team Borax Company in Death Valley, he moved to Oakland and built his



5. *Jubea chilensis* is infrequently planted but is well adapted to the area as shown by this well-grown specimen in Golden Gate Park. Photo by E. Charles Cornell.

estate on a low-lying hill with a commanding view of the bay. He lined the perimeter with palms. The house is long gone, but most of the palms remain and they have now been designated by the city as an historical treasure.

South of Oakland there is a wonderful old planting around Mission San Jose. Here are mature and well-grown *Phoenix rupicola*, *Brahea* and several long avenues of *Washingtonia*.

The outstanding palm planting in the entire San Francisco area is the palm garden developed by the Northern California Chapter of The Palm Society in Lakeside Park in Oakland. This is the largest project ever undertaken by a chapter of The Palm Society. Located adjacent to a lake as part of a larger garden center, the garden has an even more benign climate than other parts of the East Bay. The Palm Society chapter engaged Alan Fernandez of Miami, Florida to design the garden. After approval by the city of Oakland, The Palm Society was given free hand to develop and maintain its palm garden. Over sixty-seven species have been planted and the chapter has twice been cited by the mayor for its achievement. The garden will be formally dedicated at the Biennial Meeting of The Palm Society in August 1984.

A discussion of palms in the San Francisco Bay Area would not be complete without considering the attitude toward palms that seems to pervade the horticultural thinking of the area. A palm enthusiast will wonder why more palms are not used in public landscaping. Palms were more popular in an earlier era, but then slipped into disfavor. In the fourth quarter of the last century and up to the great earthquake of 1906 when San Francisco was the great metropolis of the West and the gateway to exotic Asia, Los Angeles was still a country town, and Florida was undeveloped and the southern U.S. was in the shambles of the post-Civil War era. At that time for many Americans San

6. Although rarely used as street trees, *Washingtonia* grow tall in warmer areas inland from the ocean. Photo by E. Charles Cornell.

Francisco was the great sub-tropical city, the place without snow. San Francisco celebrated its climate in the Midwinter Fair of 1894 and it planted palms. The rich with their grand houses and noble estates used palms as a symbol of their wealth and elegance. Real estate developers to lure the easterner weary of cold winters lined their developments with geraniums and palms.

By the 1920's, however, palms were losing favor. Perhaps it was due to the overplanting of huge palms like the *Phoenix canariensis*. Some observers feel it was a result of the rivalry that developed between San Francisco and Los Angeles as the southland developed and Hollywood was symbolized by palms. Even today one often hears the disparaging remark about the palm planting to the effect that "it looks too much like L.A."

It is interesting to note that some of southern California's notable palm plantings got their start in the San Francisco area. Huntington Botanical Gardens got some of its first palms from San Francisco. Mr. Huntington had a grand house on Nob Hill surrounded by palms. After the 1906 earthquake he decided to move from San Francisco. Owning a major interest in the railroad, he was able to have his palms dug up and transported by flatcar to his new home in San Marino where the palms were the beginning of the present outstanding botanical garden. When William Randolph Hearst was building his castle near San Luis Obispo, he needed palms and found that Berkeley (disillusioned with palms) was willing to let him remove tall *Washingtonia* from a tree-lined street and ship them south to his landscaping project.

No community in the Bay Area uses palms as one of the approved street trees. Palms are most frequently used to create a special effect, not as an element in the general landscape. Zoos will plant palms around the monkey cages; restaurants and hotels will use palms to create a south seas ambience if this be their theme. In 1939 San Francisco had a world's fair built on a man-made island in the bay. The theme called for palms and from all over the Bay Area people offered mature palms from their gardens. Contemporary observers recall the strange sight of barges of palms being hauled across the bay to Treasure Island. Today several fine alleys of these palms remain, and it is a particular thrill to a palm lover to stand beneath these palms and view the tall buildings of the city, Alcatraz, and the Golden Gate.

Another factor that may account for the lack of enthusiasm for palms in the Bay Area is the discontinuity between this area and other parts of zone 10. There is no gradual edging outward of plants from the tropics. It is difficult to feel a continuity and as a result there is a widespread feeling that palms are not appropriate for the area. This feeling has validity, perhaps, as long as palms are associated mainly with the tropics.

Members of The Palm Society in northern California are gradually bringing a new awareness of palms into the San Francisco Bay Area, however. The tastefully designed garden at Lakeside Park will introduce many gardeners to small manageable palms. Palm Society members have given talks to horticultural groups, several work on park staffs, some are engaged in commerical landscaping. The Director of the Botanical Garden at the University of California at Berkeley was president of the local chapter of The Palm Society. Little by little Bay Area gardeners and landscapers are coming to take a second look at palms.

For the palm enthusiast the future is exciting. This seems to be a prime area for the introduction of palms from the tropical highlands. *Parajubaea* is found to grow more vigorously here than perhaps anywhere else in North America. *Ceroxylon* and the many other yet-to-be-introduced palms from the Andes fire the imagination of those who garden in the Bay Area. The day may come when the skyline is punctuated by the silhouettes of new palms that have found their particular home in some microclimate of the San Francisco Bay Area.

NEWS OF THE SOCIETY

Itinerary for The International Palm Society Post-Biennial Australia Tour

August 9, Thursday: Depart San Francisco on Qantas #4 at 9:00 PM.

August 10, Friday: Lost to International Date Line.

August 11, Saturday: Arrive Sydney at 6:25 AM. Welcome by local Palm Society members, and transfer to Park Plaza Hotel. The hotel is a five minute walk from the botanic garden, so after resting from the long flight you will be free to wander at will there to see the magnificent palm collection or any other local attractions. A welcoming cocktail party will be held in the evening and possibly a program arranged by local members.

August 12, Sunday: A full day trip along the beaches to the north of Sydney as far as Palm Beach to visit private palm gardens and inspect some *Livistona australis* groves in their natural state. From there we will travel inland to Pymble and the home of local President Nicholas Heath. A barbecue lunch will be enjoyed at the beautiful home and garden of Director Bob Paisley, then on to the home of former Director, Ian Daly, at Hunters Hill.

August 13, Monday: A full day travelling south of Sydney to see private palm gardens at Stanwell Park, the rain forest at Minnamurra Falls, and a visit to the coastal resort area of Kiama and the outlook at the top of Bulli Pass for the panorama of the Australian coast.

August 14, Tuesday: Some free time in the morning, then a 12:00 noon flight to Townsville, gateway to North Queensland. Arrive at 3:30 PM, make a short sightseeing tour, and check into the Townsville Travelodge.

August 15, Wednesday: Transfer by bus and chartered helicopter to Dunk Island, a tropical rainforest wilderness area with wonderful, well-maintained hiking trails, and a plush resort on a coconut-shaded sandy beach. The luscious, all-you-can-eat buffet meals are all included here.

August 16, Thursday: Free for hiking, relaxing, snorkeling, or whatever on Dunk Island.

August 17, Friday: Transfer back to the mainland by helicopter, and bus north into tropical Cairns, where we will check into the Tuna Towers Hotel. The local members here have set up an unforgettable itinerary for us. We will meet them at a welcoming cocktail party.

August 18, Saturday: Full day trip to Cape Tribulation by 4-wheel drive vehicles. Cape Tribulation has some of the most lush rain forest (comparable to the Amazon!) in Australia. We will study *Linospadix minor*, *Hydriastele wendlandiana*, *Normanbya normanbyi*, and *Archontophoenix* and *Calamus* species in habitat.

August 19, Sunday: Scenic rail trip up the mountains to Kuranda and the Kuranda markets—a day of entertainment.

August 20, Monday: A field trip to the Herberton Mountain Range by 4-wheel drive vehicles, then to Atherton via the Gillies Highway. We will see stands of *Cycas media*, *Laccospadix australasica*, upland *Archontophoenix*, and "*Orania appendiculata*," (a new genus), also taking in Lake Barrine, Wright Creek, and Lake Eacham. Return to Cairns via Tinaroo Dam, Mt. Haig, and Tinaroo Creek Road.

August 21, Tuesday: A day trip to Green Island to experience the wonders of Australia's Great Barrier Reef. All facilities available. Also we will see *Arenga australasica*, *Ptychosperma elegans*, and *Pandanus tectorius*.

August 22, Wednesday: Visit to Cairns Botanical Garden and Cairns palm nuseries. Meeting and dinner (cost included) with local Palm Society members and friends at our hotel, followed by slides and a talk on palms by Anthony Irvine.

August 23, Thursday: All day trip to Mt. Lewis by 4-wheel drive vehicles to study *Archontophoenix* sp. Mt. Lewis, single trunk *Laccospadix australasica*, *Linospadix microcarya*, *Linospadix minor*, and an unnamed *Linospadix* species.

August 24, Friday: Bus trip to Mission Beach and Kurrimine Beach. Here we will see *Hydriastele*, *Livistona drudei*, *Calamus* sp., *Licuala ramsayi*, and *Arenga australis*. Return via Bellenden Ker Landing.

August 25, Saturday: Free day or tour of Hambledon Sugar Mill Complex. Transfer to airport for Qantas flight #25 leaving at 8:45 PM. Transfer to Qantas #3 at Honolulu at 9:15 AM arriving in San Francisco at 6:20 PM (2 hr 25 min *before* our departure by the calendar, because of the Date Line). $20.00 departure tax must be paid by each member at Cairns airport.

Total cost of the above trip and activities will be $2,180.00 per person. A deposit of $100.00 (payable to Bonway Travel) should already have been sent to Garrin Fullington before April 30 if you plan to go, with final payment of the balance due before June 20. Space is limited—if you failed to respond to the notice in the last *Principes* about the trip, contact Garrin Fullington at once in case space might still be available. You must have a passport with 6 months valid time remaining at the time of departure in order to obtain a visa for this trip. Visas will be available from the consulate in San Francisco during the week of biennial.

GARRIN FULLINGTON
3017 May Road
Richmond, CA 94803

Arrangements for the Co-Publication of Genera Palmarum Completed

The International Palm Society is happy to announce that the Liberty Hyde Bailey Hortorium of Cornell University will join us as co-publisher of "Genera Palmarum." Since the early days of The Palm Society (see Principes 26: 1, 1982) there has been a close association between The Society and The Bailey Hortorium in the production of *Principes* and other palm projects. It is very fitting that the two institutions collaborate in the publication of this major work. Recent discussions by the President, Dr. David A. Young, Director of the Hortorium, and Dr. Natalie W. Uhl have established that the resources of both organizations are needed to bring this important venture to completion. Returns from the sale of the book will be distributed in proportion to the amounts contributed by each partner.

RICHARD DOUGLAS
PRESIDENT

Coming Events in California

(Proceeds to be donated to The Revolving Publications Fund—First Venture Co-Publication of "Genera Palmarum")

UNIQUE SLIDE PRESENTATION of new and magnificent palms, ferns, pachypodiums, and villages of remote, inaccessible areas of MADAGASCAR, by palm enthusiast and explorer, Dr. M. W. Darian.

Date: Saturday, 23 June 1984, 7:30 PM.
Place: L. A. Arboretum, Arcadia, CA
Admission: $6.00 per person

PALM AND EXOTIC PLANT SALE. All members are invited to participate. Start preparing now by potting up your palms.

Date: Saturday, 26 April 1985; Sunday 27 April 1985
Place: L. A. Arboretum, Arcadia, CA
Pricing: 50% grower, 50% donation
For more information contact Lois Rossten, Frank Ketchum, or Pauleen Sullivan.

FOR SALE. Seeds of *Jubaeopsis caffra*—$2.50 each. Limited number. Order quantity wanted but don't send money until contacted. PAULEEN SULLIVAN, 3616 Mound Ave., Ventura, CA 93003.

Palm Conferences

The coconut and the African oil palm will be the focus of two international conferences scheduled in 1984. The first is the International Conference on Cocoa and Coconuts Progress and Outlook, October 15–17; the second the World Conference on Processing of Palm, Palm Kernel and Coconut Oils, November 12–17. Information about the conferences, or publication of the proceedings, can be obtained from, respectively, The Incorporated Society of Planters, P.O. Box 262, Kuala Lumpur 01-02, Malaysia and the Palm Oil Research Institute of Malaysia, P.O. Box 620, Kuala Lumpur 04-06, Malaysia.

DENNIS JOHNSON

BOOKSTORE

A MANUAL OF THE RATTANS OF THE MALAY PENINSULA (J. Dransfield 1979, 270 pp.) $25.00

COCONUT PALM FROND WEAVING (Wm. H. Goodloe 1972, 132 pp.) 3.95

CULTIVATED PALMS OF VENEZUELA (A. Braun 1970, 94 pp. and 95 photographs.) 4.50

FLORA OF PANAMA (Palms) (R. E. Woodson, Jr., R. W. Schery 1943, 122 pp.) 17.00

FLORA OF PERU (Palms) (J. F. MacBride 1960, 97 pp.) 8.00

FLORIDA PALMS, Handbook of (B. McGeachy 1955, 62 pp.) 1.95

HARVEST OF THE PALM (J. J. Fox 1977, 244 pp.) 16.50

INDEX TO PRINCIPES (Vols. 1–20, 1956–1976, H. E. Moore, Jr., 68 pp.) 3.00

MAJOR TRENDS OF EVOLUTION IN PALMS (H. E. Moore, Jr., N. W. Uhl 1982, 69 pp.) 6.00

PALEM INDONESIA (in Indonesian) (Sastraprdja, Mogea, Sangat, Afriastini 1978, 52 illustrations beautifully done, 120 pp.) 5.50

PALMS (A. Blombery & T. Rodd 1982, 192 pp., 212 colored photographs) 25.00

PALMS FOR THE HOME AND GARDEN (L. Stewart 1981, 72 pp., some color) 10.95

PALMS OF BRITISH INDIA & CEYLON (Blatter 1926, reprinted in India 1978, 600 pp.) 75.00

PALMS OF THE LESSER ANTILLES (R. W. Read 1979, 48 pp.)	8.00
PALMS OF MALAYA (T. C. Whitmore 1973, 132 pp.)	16.95
PALMS OF SOUTH FLORIDA (G. B. Stevenson 1974, 251 pp.)	7.95
PALMS OF THE WORLD (J. C. McCurrach 1960, 290 pp.)	19.00
PALM SAGO (K. Ruddle, D. Johnson, P. K. Townsend, J. D. Rees 1978, 190 pp.)	7.50
SECRET OF THE ORIENT DWARF *Rhapis excelsa* (L. McKamey 1983, 51 pp.)	3.95
SUPPLEMENT TO PALMS OF THE WORLD (A. C. Langlois 1976, 252 pp.)	25.00
THE GENUS PTYCHOSPERMA LABILL. (F. B. Essig 1978, 61 pp.)	5.50
THE INDIGENOUS PALMS OF SURINAME (J. G. W. Boer 1965, Part of Flora, 172 pp.)	42.00
THE MAJOR GROUPS OF PALMS AND THEIR DISTRIBUTION (H. E. Moore, Jr., 1973, 115 pp.)	4.50
THE MINIATURE PALMS OF JAPAN (U. Okita, J. L. Hollenberg 1981, 135 pp.)	19.95
THE PALM FLORA OF NEW GUINEA (F. B. Essig, 1977, 46 pp.)	6.50

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.)	2.00
RARE PALMS IN ARGENTINA (reprint from *Principes*, E. J. Pingitore 1982, 9 pp., 5 beautiful drawings)	2.75
THE HARDIEST PALMS (J. Popenoe 1973, 4 pp.)	1.25

The palm books listed above may be ordered at the prices indicated plus $1.25 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. Send check payable to The International Palm Society to Pauline Sullivan, 3616 Mound Avenue, Ventura, CA 93003, U.S.A. ALL SALES FINAL.

Principes, 28(2), 1984, pp. 102–103

PALM LITERATURE

BLOMBERY, ALEC AND TONY RODD. 1982. Palms: an informative practical guide to palms of the world: their cultivation, care, and landscape use (with illustrations by Betty Maloney). Pp. 1–199, numerous color plates. Angus & Robertson Publishers, Australia. ISBN 0 207 14848 1. Price US$24.95

This beautiful book arrived somewhat unexpectedly for me to review. It is a slim, large-format (11 × 8″) book of about 200 pages, filled with color photographs, in which the authors describe briefly the ecology, economic importance and general morphology of palms, their cultivation and uses in horticulture, and then provide a selection of palms from the world over. In three appendices, palm classification is summarized, major palm collections of the world indicated, and selections of palms for different climates provided. There is a glossary and a selected bibliography. The dust jacket is very compelling and few palm enthusiasts will be able to resist the temptation to buy the book. A book so obviously attractive, so free of printer's errors and so well produced demands a careful look to see what it really provides and how it compares with its competitors.

Intended as an introduction to the cultivation of palms, the book perhaps offers more than is necessary. Descriptions are very detailed (without being too tedious), the introduction to palm morphology is generally very good, and the notes on cultivation are generally very helpful, but the selection of genera and species is eclectic; for example, there is no mention of *Bismarckia*, *Cryosophila*, *Heterospathe*, *Neodypsis*, *Rhopaloblaste*, or *Zombia* to give just a few commonly cultivated palm genera. The authors clearly state that the selection of species has depended on the photographs available rather than the other way round, but perhaps the title of the book is misleading—it is not really a guide to the palms of the world.

The nomenclature is excellent, with a very few exceptions—*Copernicia cerifera* (which should be *C. prunifera*), *Rhopalostylis baueri* var. *kermadecensis* (which should be *R. baueri* var. *cheesemanii*) *Salacca edulis* (which should be *S. zalacca*) and *Crytostachys lakka* (which should be *C. renda*). There are a few taxonomic misinterpretations. *Licuala flabellum* as illustrated is correctly known as *L. gracilis* (see my note in Kew Bulletin 37:111. 1982); even though the synonymy of *L. flabellum* with *L. gracilis* is not quite assured, the palm illustrated was collected as seed by me in West Java and so must be *L. gracilis*. The names of the two species of *Hyphaene* need correction. Furtado showed that *H. coriacea* is a palm with a small fruit shaped like a cottage loaf, equating modern specimens from coastal Kenya with Gaertner's type. This species is a small palm with, generally, decumbent stems. In fact *H. natalensis* is merely a southern form of *H. coriacea* and so, in my interpretation (to be published shortly in the Flora of Tropical East Africa), *H. natalensis* is a synonym of *H. coriacea*. The large, erect, dichotomising palm illustrated seems to me to be *H. compressa*, if I assume the photograph was taken in East Africa—one can only be certain if fruit is available.

There are some minor errors. Raffia fiber for horticultural purposes is not obtained from the leaf stalks but is the epidermis and hypodermis of the leaflets of the unexpanded sword leaf. The fleshy layer of most lepidocaryoid fruit is not an aril (which would be an outgrowth of the funicle) but is a fleshy seed coat—a sarcotesta; its development from the outer integument of the ovule is easily demonstrable. The indication of the orders of branching in the inflorescence is at variance with the usual method. An inflorescence may be unbranched (or in other words spicate); if it is branched then the axis of the inflorescence bears branches of the first order, not of the second order as described in the book.

I regret that there are no locality details accompanying the photographs, though I did gain entertainment from guessing.

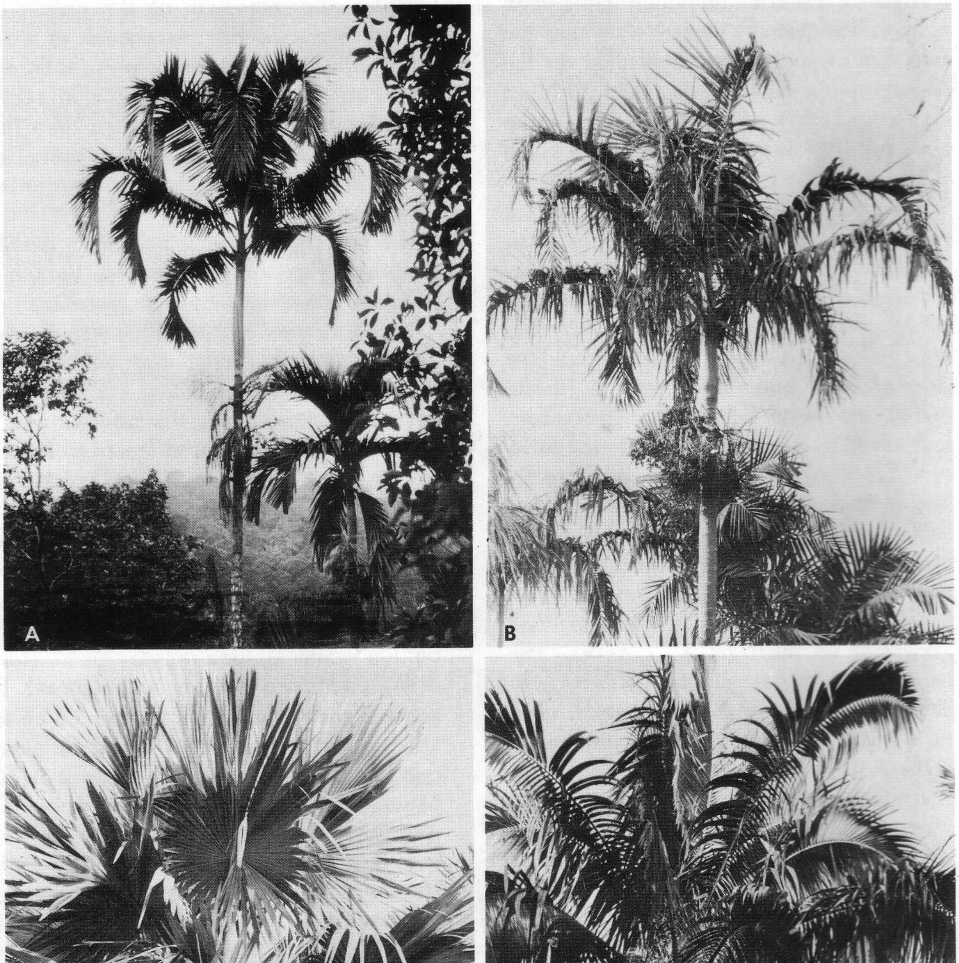
One statement surprized me very much. *Arenga porphyrocarpa* is said to be native in Java but no longer known in the wild. I wonder whence this information; I have seen this palm in at least ten localities in West Java and in several places in Sumatra.

The detailed descriptions of individual species and genera would be appropriate in a work of a more definitive nature and are perhaps unnecessarily detailed (though not too technical) for a popular guide. How does it compare with its competitors? It gains highest marks for its use of color and for the simple introduction to palm morphology. As a guide to cultivation of palms the habitat details are very helpful. As a guide to genera and species the selection is too arbitrary to be really useful. However, it really is so attractive and so well produced that every palm enthusiast will wish to purchase it and I recommend them to do so. Do not expect this to be a guide to the world's palms because that it is not. The palm enthusiast already provided with the range of palm literature available from The Palm Society Book Store will find this book a really useful new synthesis and, I think, would be foolish not to buy it—it is such a beautiful book.

JOHN DRANSFIELD

Principes, 28(2), 1984, p. 104

KNOW YOUR PALMS



Can you name these palms? See p. 84 for answers.