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PRINCIPES

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Cover Picture

Marojejya darianii, a new palm from mountain swamps in northeast Madgascar with Dominic Halleux. Photo by Dr. M. E. Darian. See pp. 151–154.

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A Magnificent New Palm from Madagascar

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Dr. Mardy E. Darian, tireless and enthusiastic palm collector, has visited Madagascar several times in recent years seeking rare and unusual palms to introduce into his unparalleled collection at Vista, California. Collecting palms in Madagascar is fraught with difficulties, yet the palm flora is exceptionally exciting. After several false leads, in 1982 Mardy struggled to mountain swamps northwest of Maroansetra with the encouragement of Palm Society member Alfred Razafindratsira and the help of Dominic Halleux and found a truly magnificent, entire-leaved palm (see Cover). He returned with tales of this spectacular palm and tantalizing photographs. A second trip provided seeds and leaf fragments and a third trip pieces of old inflorescences.

Initially it appeared that the palm represented a new genus but as fragments accumulated, the affinities of the palm with *Marojejya insignis*, described by Humbert (1955) from the nearby Marojejy Massif, became more and more evident. Finally, in July 1984 we were able to compare the fragments collected by Mardy with the superb complete material of *Marojejya insignis* collected by Dr. H. E. Moore, Jr. in 1971. There seems no doubt that Mardy's palm is a new species of *Marojejya*. The palm is locally called *Ravimbe*—'Big Leaf.' We hereby honor with the specific epithet Dr. Darian's tireless efforts to discover and introduce this wonderful palm.

Marojejya darianii *J. Dransf. & N. Uhl* **sp. nov.** Palma egregie insignis, foliis indivisis maximis; a *M. insigni* petiolo carenti, vaginis auriculas maximas ferentibus, rachillis staminatis foveas profundiores ferentibus, rachillis pistillatis numerosioribus, seminibus subreniformibus, profunde-sulcatis, bene distincta. Typus: Madagascar, Maroansetra, *Darian s.n.*

Robust, solitary, monoecious, pleonanthic palm. Stem erect to 8 m tall, ca. 15–20 cm diam., when young covered in leaf bases and then appearing ca. 30 cm diam.; internodes short, bearing scattered, short, spinelike adventitious roots. Leaves massive, ca. 20–30 in the crown, held more or less stiffly erect, entire, bifid, pinnately ribbed, becoming torn by the wind; sheath with 2 conspicuous, large rounded auricles, ca. 10–12 cm wide; petiole absent; rachis ca. 15 cm wide near the base, very spongy in texture; blade ca. 7–9 m long, bifid in the apical 20–50 cm, basally the margins long decurrent to the sheath, gradually widening distally, ca. 1–1.2 m wide at the widest point, ca. ⅔ the blade length from the base; margins finely serrate; adaxial surfaces of the ribs and blade glabrous, abaxial surface of ribs bearing abundant pale, floccose scales, the blade abaxially with scattered, minute, dotlike scales. Inflorescences ?unisexual. Staminate inflorescence unknown except for rachilla fragments; rachillae more or less catkinlike, length unknown, ca. 7–8 mm diam., apparently bearing flowers to the tip; rachilla bracts, 2 × 1.75 mm, spirally arranged, congested, horizontally inserted, joined laterally and forming pits ca. 2 mm diam., the free tips apiculate, distally pointing, the exposed part densely tomentose except at the tip, the tip

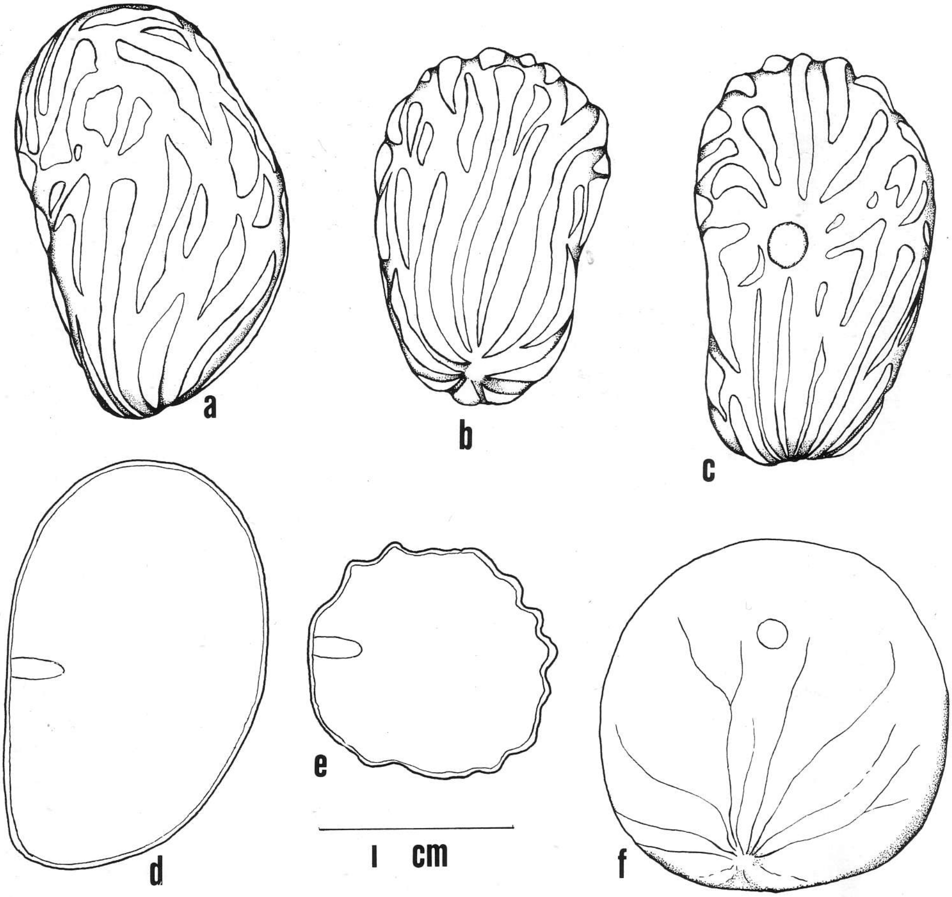
1. Dr. Darian points to the conspicuous auricle on the leaf of *Marojejya darianii*; note the absence of a petiole.

2. An old pistillate inflorescence of *Marojejya darianii.*

extending between the staminate flowers; floral bracteoles minute, only 1 seen. Staminate flowers borne in pairs, more or less symmetrical, ca. 3.5 × 2.0 mm; sepals 3, free, widely separated, tonguelike, ca. 2.25 × 1 mm, apically pointed, slightly keeled, the margins very finely serrate, 1 sepal usually slightly wider than the others; petals 3, free, valvate, more or less boat-shaped, 2.5 × 1.5 mm; stamens 6, filaments awlshaped, long and slender, ca. 2.0–2.5 mm long, united at the base with the pistillode, the antesepalous inserted lower than the antepetalous; anthers medifixed, ca. 2.5 × 1 mm, latrorse, more or less exserted at anthesis; pistillodes 3, irregularly joined, ca. 0.75 mm long. Pistillate inflorescence (Fig. 2) apparently partially concealed among the leaf bases; peduncle at least 15 cm long, more or less circular in cross-section, ca. 2 cm diam.; prophyll and peduncular bracts not available; rachis ca. 6 cm long, bearing 48 closely crowded, catkinlike rachillae; rachillae more or less equal, ca. 10–11 × 1.3 cm, bearing spirally arranged bracts united laterally and basally to form pits; pits ca. 4.5 mm diam.; rachilla bracts triangular, apiculate, ca. 3 × 4 mm, at first apparently closing the pit, becoming reflexed; abortive staminate flowers 2, very small, concealed within the pit, lateral to the pistillate, floral bracteoles 2, broadly triangular, 2 × 2 mm. Pistillate flowers unknown. Mature fruit not available, said to be rounded, smooth. Seed subreniform, ca. 20 × 12 × 10 mm, the surface covered with deep, broad, mostly longitudinal, anastomosing grooves; endosperm homogeneous; embryo lateral to the hilum. Germination adjacent ligular; eophyll bifid, epetiolate, with long decurrent blade margins.

MADAGASCAR. Northeast: In mountain swamps west northwest of Maroansetra, ca. 500 m altitude, *M. Darian s.n.* 1983. (Holotype BH, isotype K.)

Notes: Marojejya darianii is immediately distinguishable from *M. insignis* by the absence of a petiole and by the extraordinary pointed auricles on the leaf sheath (see Fig. 1). The staminate rachillae have much more pronounced pits but the flowers are almost identical to those of *M. insignis.* In the pistillate inflorescence there appear to be many more rachillae in the new palm. Perhaps the most striking difference is in the seed (Fig. 3); that of *M. darianii* is subreniform and deeply grooved, whereas that of *M. insignis* is irregularly globular and only very faintly grooved. However, the two seeds are basically similar in form and in the position of the embryo in relation to the hilum. The seedlings are easily separated; that of *M. darianii* bears epetiolate leaves, whereas that of *M. insignis* has definite petioles. These differences establish that the two palms are clearly specifically distinct, but there are many similarities such as the form of the leaf, inflorescence structure, and staminate flowers indicating that the two taxa are congeneric.



3. *Marojejya darianii,* a–c, the seed in three views; d, seed in longitudinal section; e, in transverse section. *Marojejya insignis,* f, view of seed to show the position of the embryo, lateral to the hilum, similar to that of *M. insignis* in c. Drawn by Soejatmi Dransfield.

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Note: *M. darianii* grows at temperatures of 50–80 F under deep shade in humus of sandy swamps where rainfall is very high. Dr. M. E. Darian, 2615 So. Santa Fe Ave., Vista, CA 92083, has seedlings of both *M. darianii* and *M. insignis* for exchange with Botanic Gardens and other collectors.

Principes, 28(4), 1984, pp. 155–162

Notes on the Palms of Guinea-Bissau

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Remote and lesser-known countries hold a certain fascination for the visitor because there is a sense of discovery in observing how people live and make use of their natural environment. Guinea-Bissau, wedged between Senegal and Guinea in West Africa, is such a place. Formerly Portuguese Guinea, this small nation is about equal in area to the states of Massachusetts and Connecticut.

The literature on African vegetation commonly mentions the paucity of palm genera and species in this the largest tropical area of the world (see Tomlinson 1962). Although smaller in area, tropical Asia and tropical America each has more types of palms. The contrast is strikingly shown by the fact that Cuba has a greater diversity of palms than continental Africa (Corner 1966). But what may be lacking in diversity is, at least in West Africa, more than compensated for by the sheer numbers of palms. They represent a common element of the vegetation landscape. Most prevalent is the African oil palm (*Elaeis guineensis*), certainly as useful a plant in West Africa as the coconut is in Polynesia. This holds true for Guinea-Bissau. Of secondary importance is the African fan palm (*Borassus aethiopum*), found throughout the continent.

I had the good fortune of spending three

1. Subspontaneous oil palms amid and adjacent to rice fields near Saucunda.

2. Utensils used for simple manual extraction of palm oil on a farm near Bafatá.

months in Guinea-Bissau in 1982, working as a consultant on an agricultural development project in the central part of the country. I took the opportunity to collect some notes on palm products, particularly those from the two mentioned above.

African Oil Palm

This pinnate-leafed palm has a dual role in the Guinea-Bissau economy in that it provides a major export (kernels) and furnishes palm oil, palm wine and other products for local consumption. Oil palms are abundant in the littoral zone, on the offshore islands and in the river valleys. Because of the long association with human activities, it is impossible to determine the precise ecological niche of this palm anywhere in West Africa. For that reason it is most often described as being subspontaneous. When forests containing oil palms are cleared for agriculture, the palms are commonly left standing (Fig. 1). Over generations, and if allowed to regenerate naturally, the palms form nearly pure stands. The palm's resistance to fire, extensively used in land clearing and for weed control, also gives it an advantage over other woody species.

Oil palms in Guinea-Bissau are of the *dura* type, which have large kernels and low to medium mesocarp content. Estimates place the area under oil palm in the country at about 100,000 ha. This figure is for natural stands; formal plantations do not exist.

Apart from a single industrial palm oil processing plant in Bubaque, on one of the offshore islands, the extraction of palm oil is a simple cottage industry solely for the domestic market. Palm oil is derived from the mesocarp pulp of the fruit, has a reddish-orange color because it is rich in carotene and is locally known as *chebeu.* The kernel contains a clear oil designated in the trade as palm kernel oil. Figure 2 shows some of the utensils used in the manual extraction process. Fruit bunches are harvested and transported to a local processing site. The fruits are removed from the bunches, loaded into

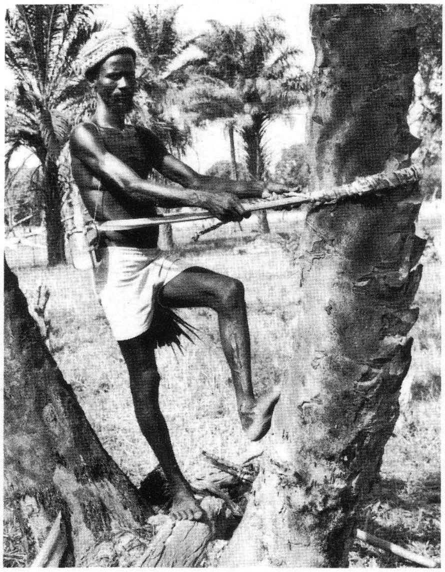
3. Oil palm kernels drying in the sun wreathed by empty fruit bunches on a farm near Bafatá.

large baskets such as the one in the foreground of the photograph, and dumped into used oil drums of boiling water. After being cooked for a few hours, the fruits are removed from the water, pounded to break up the pulp, and then returned to the boiling water. The oil separates from the pulp and floats to the top where it is skimmed off. The pans in the photograph are used to transport the pulp and the palm oil. The crude oil is filtered of impurities and sold in various-sized recycled glass bottles. This is the traditional cooking oil of the country and is also said to have cosmetic and medicinal applications.

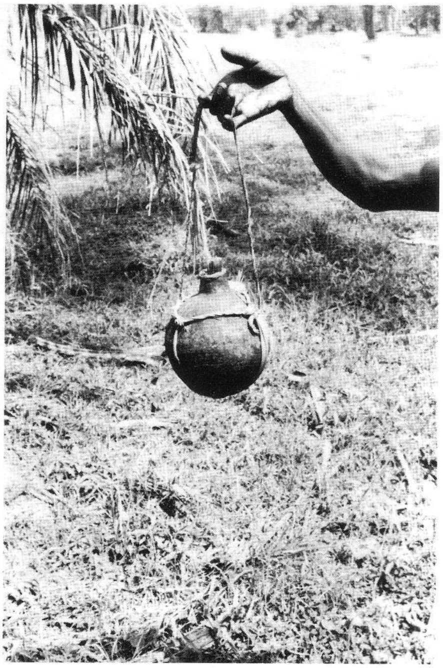
Most of the pulp having been removed during the extraction of palm oil, the remaining seeds are spread in the sun to dry and then more commonly cracked by hand to remove the kernels. Mechanized shelling by means of a small portable gasoline-powered machine is now being done to an undetermined degree in Guinea-Bissau. The extracted kernels are dried in the sun (Fig. 3) and exported. There is not the industrial capacity within the country to express the palm kernel oil. Production of palm kernels in 1982 was estimated to be 10,000 mt; that of palm oil 5,500 mt (FAO 1983).

The tapping of oil palms for palm wine is commonplace in Guinea-Bissau and throughout West Africa. Palm wine is the usual designation for the sap which ferments very quickly into a weak alcoholic beverage. This is equivalent to the palm toddy of Asia.

Oil palms selected for tapping must be cleared of dead leaves to permit easy access to the male inflorescences. A small incision is made in an unopened inflorescence and a receptacle positioned below it to collect the sap. A small funnel is made from a palm leaflet and placed in the neck of the bottle to direct the dripping sap. The man pictured in Figure 4 is ready to climb a palm with the aid of a beltlike device and empty the glass bottles of palm wine. The more traditional receptacle in Guinea-Bissau is a clay bottle (*moringo*) (Fig. 5). The bottle rests in a sling made of oil palm leaf fiber. The two loose ends



4. Tapper preparing to climb an oil palm near Saucunda.



5. Clay bottle suspended in its sling made of oil palm leaf fiber for palm wine collection near Bafatá.

6. Clay bottles attached to an oil palm for wine collection near Bafatá.

7. Oil palm trunks used for bridge construction near Jabicunda.

of the sling are fastened around the inflorescence to hold the bottle in place.

The beltlike device for climbing oil palms in Guinea-Bissau (Fig. 4) deserves further elaboration. Just as a paratrooper folds his own parachute, tradition has it that the palm wine tapper fashions his own belt, which is made from a fresh oil palm leaf. The midrib is stripped and bent to give it an elliptical shape. One end of the midrib is cut thin and flexible with a thick piece left at the extreme end to facilitate tying it to the opposite end where the midrib fibers have been separated and braided into a rope about 60 cm long. These ends are on the left side of the belt. Where the belt comes in contact with the trunk it often is wrapped with extra fiber to reduce wear. To climb a tree the tapper loops one end of the belt around the trunk and the other around his lower back, and secures the two ends. Grasping the sides of the belt, he leans forward and jumps the belt up the trunk a short distance. Then, leaning back against the belt, walks an equal distance up the rough trunk. The knot is secure enough that when he reaches the crown the tapper can have both hands free for work. Anyone who has seen an electrician ascend a wooden utility pole using a leather belt and spikes attached to his shoes can visualize the process of collecting palm wine. A belt made from an oil palm leaf midrib lasts about one month.

On one of my field trips I was able to borrow a belt and, to the great amusement of those assembled, made a shaky but successful ascent of an oil palm. Quite taken by the ingenuity of the belts, I later had one made. It, along with a clay bottle in a sling, occupies a prominent place on the wall of my office.

Palm wine yields vary considerably, but I was told that 10–15 liters per day per tree was about average. The oil palms are

8. African fan palms in the village of Nhacra.

tapped only during the dry season when the sap yield is sufficient to justify the labor. Inflorescence tapping decreases the tree's fruit yield, but apparently does not do any permanent damage. Palm wine has a milky appearance because of its high yeast content. The taste is pleasant. I sampled it on several occasions under different circumstances and found it best just after being collected (fermentation occurs within the receptacle on the tree) and at ambient temperature. Within a few hours palm wine becomes unpleasantly bitter. This beverage is popular among non-Moslems in the rural areas and is a good source of vitamin B complex. In 1982 a liter of palm wine cost the equivalent of 40 cents. It is not marketed in any organized fashion. Because of its high yeast content, palm wine is used in making leavened bread.

In Guinea-Bissau there is no current program to produce commercially and market palm wine, although the technology has been developed in Nigeria. There, the bottling and preservation of palm wine was investigated by Levi and Oruche (1957); a study of palm wine production was carried out by Tuley (1965); the Nigerian Institute for Oil Palm Research conducted experiments on tapping palms in the late 1960s and early 1970s; and the potential for improving traditional oil palm wine production was the subject of a recent article by Okereke (1982).

Other uses of the oil palm in Guinea-Bissau include weaving coarse baskets and mats from the leaves. These also are employed for thatching and to make fences. Small bridges are constructed with oil palm trunks (Fig. 7). The palm heart is eaten when trees are felled. Weaver-birds like the oil palm and use the leaflets to build their distinctive suspended nests. The oil palm is normally unbranched, but if some physical damage causes it to fork, such a tree in West Africa is thought to have taboo properties (Gledhill 1972).

African Fan Palm

In Guinea-Bissau, this attractive palm has the vernacular name *cibe*. Although it is not a source of oil, it furnishes other products similar to those from the oil palm. The classic savanna palm of Africa, it can be found growing in close proximity to the oil palm in Guinea-Bissau. The number of African fan palms within the country has been reduced significantly through a combination of land clearing, cutting the tree for its wood and insect pests which have become more severe as a result of upsetting the ecological balance by removal of the natural forest (Castel-Branco and Tordo 1956). A few relatively young palms are shown in Figure 8.

For purposes of weaving and thatching, African fan palm leaves are the preferred type. Quality hats, baskets and purses are woven from the leaves and command the highest prices on local markets. The entire leaf is employed in thatching, frequently as the supporting layer for the traditional grass roofs. I have seen individuals carrying freshly-cut leaves as rain umbrellas and the leaves spread over charcoal to keep it from getting wet.

The African fan palm bears green fruits which are about the size of an orange. When immature, the soft endosperm can be eaten raw and the mesocarp pulp sliced and cooked. The pulp of the ripe fruit is eaten fresh. When felled, the palm heart is extracted from the trunk and eaten. These palms also are tapped for palm wine in the same manner as described for the oil palm. Exploitation of this palm is not as widespread as it once was, due to their reduced numbers. I saw relatively few tall mature trees, possibly because it is they which furnish the best wood.

Other Palms

At least three other palm genera may be native to Guinea-Bissau. Raffia palms (*tara*) grow along the coast according to Mota (1954). Based upon the distribution of *Raphia* species provided by Russell (1964), *R. palma-pinus* and *R. sudanica* may be represented. I was unable to investigate utilization of raffia palms; however, in Nigeria, the palms are tapped for wine and, in the 19th century, oil was extracted from the fruit pulp on a small scale. Raffia oil is similar in quality to palm oil and has the same uses (Otedoh 1974).

The coastal forests of Guinea-Bissau also probably harbor climbing rattans, although I have no confirmation of this. The geographic range of *Laccosperma* (*Ancistrophyllum*) *secundiflorum* and *Calamus deeratus* reported by Irvine (1961) suggests that they may be found within the country.

Coconuts have been in West Africa since their 16th-century introduction by the Portuguese, and probably reached Guinea-Bissau as early as any place in the region. This palm is cultivated informally in the coastal region of the country. Husked coconuts are sold in local markets and copra made for export. Production of coconuts in 1982 was estimated to be 25,000 mt and copra production 5,000 mt (FAO 1983).

Acknowledgments

I wish to thank Mário Samba Embaló for helping arrange visits to areas of palm oil processing and palm wine collection, and Kit Macy for obtaining elusive documents about the oil palm.

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Principes, 28(4), 1984, p. 162

PALM LITERATURE

McCOY, R. E. (ed.) Lethal Yellowing of Palms. Bulletin 834, 100 pp. Institute of Food and Agricultural Sciences, University of Florida, Gainesville. 1983.

Several articles on lethal yellowing have appeared in *Principes* since an epidemic of the disease occurred in southern Florida in the early 1970s. A serious threat to plantations of tall varieties of coconut throughout the world, lethal yellowing also attacks more than two dozen other economic and ornamental palms.

This book draws together the results of a decade of research into the origin, cause and control of lethal yellowing. Ten scientists who worked on the problem in Florida are listed as coauthors. The book is divided into seven chapters and handsomely illustrated with 34 figures, including 21 color photographs. It contains an extensive bibliography of 176 references.

Strong evidence now supports the thesis that a planthopper (*Myndus crudus*) is the insect vector of the disease. Recommendations for control include eradication of diseased palms, antibiotic treatment of infected trees while resistant palms are established to replace them, and containment of the disease. The latter is not encouraging as lethal yellowing was identified in the Yucatan Peninsula of Mexico in 1982. However, any success in slowing the spread will permit more research to be completed and allow for substitution of resistant palms in threatened areas.

The authors are to be congratulated on this excellent study of such a serious palm disease.

DENNIS JOHNSON

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Halmoorea, A New Genus from Madagascar, with Notes on Sindroa and Orania

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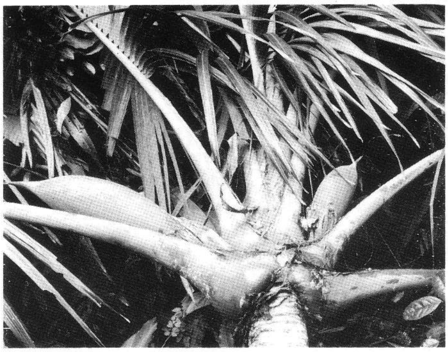
One of the major difficulties in the elucidation of the limits of palm genera from Madagascar lies in the great scarcity of good material from the island. The type specimens are frequently inadequate and the protologues do not even match the specimens they purport to describe. The monotypic genus *Sindroa* exemplifies these problems. Jumelle (1933) based *Sindroa* on a collection made by Perrier (*11937*) in the mountains of the Masoala Peninsula at Marambo. *S. longisquama* was described as being dioecious and bearing acute leaflets, yet the inflorescences of the type specimen show clear signs of bearing flowers of both sexes and the leaflets are clearly praemorse (attached to the type is a note in Perrier's hand to the effect that the leaflets are not acute because they had been eaten in the bud by rhinoceros beetle!). With this inauspicious beginning *Sindroa* remained almost unknown.

In April 1971, H. E. Moore searched for *Sindroa* on the Masoala Peninsula and collected (9921) a handsome distichous leaved palm, bearing some of the characters of *Sindroa* and furthermore called "sindroa" by the local people. Thus it seemed that *Sindroa* had been recollected. However some features of the distichous palm did not match the type of *S. longisquama*; in particular the leaflets of the distichous palm bore pale grey brown rather than dark reddish brown ramenta. Then in December 1972, Moore revisited the Masoala Peninsula and discovered and collected (10115) a palm with spirally arranged leaves which also seemed to be congeneric with *Sindroa*. The leaflets of the spirally arranged palm bore dark reddish brown ramenta as in the type of *S. longisquama*, and, although the type bears flowers and *Moore 10115* fruit, the two collections are clearly conspecific. Moore (in his field notebook) noted the great similarity between *Sindroa* and Asiatic *Orania* even in the rather unusual seedling; on the basis of these observations *Sindroa* was placed next to *Orania* in the "Major Groups of Palms and Their Distribution" (Moore 1973). In his field notes, it appears that Hal Moore was not certain whether the distichous palm was specifically distinct from *Sindroa longisquama*.

Bernardi recollected the distichous palm (*Bernardi 14450*) and described and illustrated it in a paper as *Sindroa longisquama* (Bernardi 1974). Unfortunately the copious fruiting material collected by Bernardi has not yet been distributed from Tananarive.

In reevaluating *Sindroa* for Genera Palmarum we have come to the conclusion that the only difference separating *S. longisquama* from the rest of the genus *Orania* (excluding *O. appendiculata*) is the presence of ramenta on the undersurface of the leaflet midribs. This vegetative character is too trivial for the separation of genera and thus we believe *Sindroa* to be congeneric with *Orania*. The rather wide geographical disjunction is paralleled by many angiosperms. *Sindroa* is thus



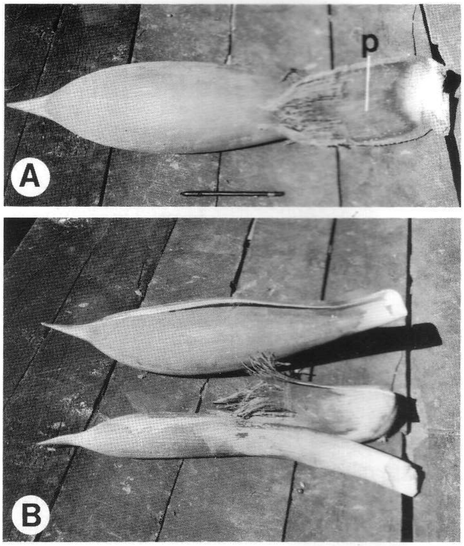
1. Crown of *Halmoorea trispatha, Moore 9921.*

formally reduced to synonymy in *Orania* and the combination *O. longisquama* published.

Orania longisquama (*Jumelle*) *J. Dransf. & N. Uhl,* **comb. nov.**

Sindroa longisquama Jumelle in Ann. Mus. Col. Marseille sér. 5.1 (1): 11. 1933; Jumelle & Perrier de la Bâthie, Fl. Madagascar 30: 160. 1945. Type: Madagascar, Masoala, *Perrier 11937* (P, holo.!).

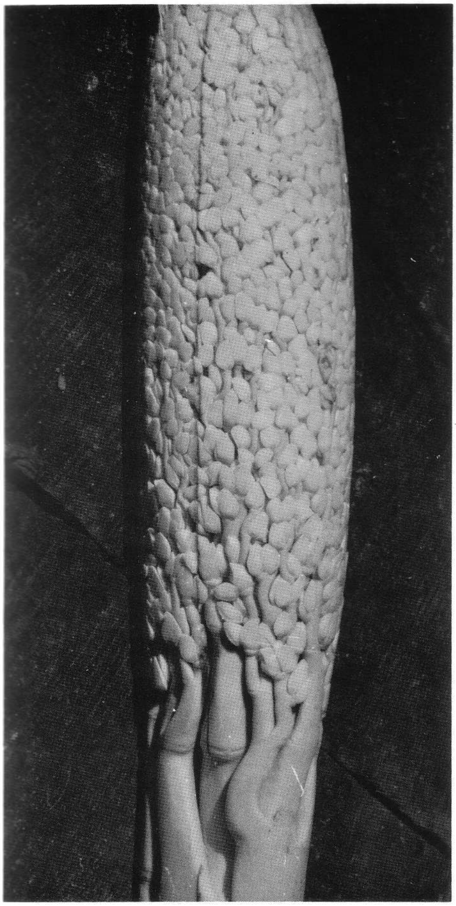
The distichous palm collected by Hal Moore as *Sindroa,* however, is clearly different from *Orania longisquama.* The inflorescence bears a prophyll and two large peduncular bracts rather than a prophyll and a single large peduncular bract as in *Orania.* The staminate flower has three large blunt or subacute, free, imbricate sepals (rarely two of them briefly connate), and bears 27–30 stamens, whereas in *O. longisquama* the sepals are united and acute and the stamens number 9–15. In the pistillate flower the staminodes number 12 whereas in *Orania* there are only 3–6. The distichous palm is thus abundantly distinct from *O. longisquama.* Furthermore the distichous palm does not fit within the variation found in *Orania.* We conclude that it represents a distinct genus albeit related to *Orania. Halmoorea* is an obvious choice of name for this extraordinary palm.



2. A. Inflorescence of *Halmoorea trispatha* in bud; p, prophyll. B. Inflorescence bud opened to show prophyll and two peduncular bracts.

Halmoorea *J. Dransf. & N. Uhl,* **gen. nov.** Palma solitaria, inermis, pleonantha, monoeca. Folium reduplicatum, pinnatum, pinnis praemorsis ramentas infra ferentibus. Inflorescentia interfoliacea trispatha, bracteis peduncularibus magnis, tubularibus, rostratis; rachillae basin triades versus apicem flores staminatos singulariter vel binatim ferentes. Flos staminatus sepalis 3, liberis, imbricatis (2 raro connatis), petalis 3, liberis, valvatis, staminibus 27–30, pistillodio carenti. Flos pistillatus sepalis 3 truncatis, basin connatis, petalis 3, liberis, valvatis, staminodiis 11–12, gynoecio triloculato triovulato. Fructus 1, 2, vel 3-lobatus. Genus egregium Madagascariense Oraniae affine sed inflorescentia bracteis 3 (vice 2), sepalis floris staminati fere liberis et numero staminum staminodiorumque differt.

Solitary, moderate, unarmed, pleonanthic, monoecious palm. Stem erect, bare, internodes short, irregular, nodes prominent. Leaf distichous, reduplicately pin-



3. Close-up of unopened flowers from inflorescence of Figure 2.

4. Photograph presumed to be of *Halmoorea* taken in Madagascar by Dr. M. E. Darian.

nate, neatly abscising; sheath splitting, short, thick, woody, densely covered with brown scales, fibrous along the margins; petiole elongate, stout, adaxially channeled, abaxially rounded, with pale indument abaxially; rachis much longer than the petiole, curved, abaxially rounded, adaxially angled except at the base where grooved, with indument as the petiole; leaflets single-fold, numerous, regularly arranged in one plane, rather stiff, linear-lanceolate, obliquely praemorse, green above with prominent midnerve, 2 marginal nerves, and numerous tertiary nerves, adaxially ± glabrous, abaxially with thin gray indumentum, small punctiform scales, and irregular large gray-brown ramenta along the main veins especially near the base, transverse veinlets obscure. Inflorescence interfoliar, about as long as the petiole, branching to 3 orders; peduncle stout, covered in caducous brown scales; prophyll ± ovate, 2 winged, persistent, margins irregular, irregularly splitting and becoming fibrous at the tip; peduncular bracts 2, tubular, inflated, beaked, both entirely enclosing the inflorescence, ± woody, deciduous at anthesis, densely covered with irregularly margined, brown scales; rachis longer than the peduncle, brown tomentose, bearing spirally arranged, low, glabrous, coriaceous, collar-like bracts subtending first order branches; first order branches bearing few, spirally arranged, similar bracts, each subtending a 2nd order branch; 2nd order branches with a basal bare portion and few small, spirally arranged bracts subtending rachillae, all axes finely roughened; rachillae moderate, irregular, bearing up to 10 spirally arranged triads basally, paired or solitary flowers distally; rachilla bracts and bracteoles low, rounded, inconspicuous.

Staminate flowers asymmetrical, fleshy, angled; sepals 3, free, imbricate or rarely 2 united, rounded, margins somewhat irregular; petals 3, free, valvate, ovate-triangular, blunt or subacute, thickened at the tip; stamens 27–30, filaments short, slender, erect, anthers linear-oblong, bifid at the base and apex, basifixed, latrorse, connective broad; pollen ± circular, monosulcate with finely rugulate, semitectate exine; pistillode absent. Pistillate flower only slightly larger than the staminate; sepals 3, rather large, free except basally where very briefly united, irregular, apically truncate, centrally thickened, laterally striate; petals 3, free, irregular, broadly triangular, valvate, abaxially smooth, adaxially irregularly roughened at the thickened tips; staminodes 11–12, free, threadlike, pointed; gynoecium trilocular, triovulate, irregularly obovoid, with 3 round bulges, one larger, stigmas 3, terete, ovule laterally arrached, pendulous, probably hemianatropous. Fruit developing from 1, 2, or 3, carpels, rounded, bi- or trilobed, relatively large, further details not known.

Type species *H. trispatha*

Halmoorea trispatha *J. Dransf. & N. Uhl* **sp. nov.** Palma elata, ad 20 m; folia disticha, vaginis ferruginoso–lepidotis, petiolis ad 1 m longis, rachidibus 2 m longis, pinnae untrinque ca. 62, infra ramentas pallidas ferentes. Sepala floris staminati 1.5 mm longa, petala 9 × 5 mm; sepala floris pistillati 5 × 5 mm, petala 10 × 8 mm; ovarium 5 × 8 mm, triovulatum; fructus 1, 2 vel 3-lobatus, ad ca. 6 cm latus. Typus: Madagascar, Prov. Diego Suarez, Masoala, *Moore 9921* (holotypus BH).

Moderate palm; trunk to 20 m tall, 20–35 cm dbh, swollen basally to 40 cm diam.; bark grey, weathered; internodes ca. 15 cm near the base, much shorter above, nodal scars prominent; crown with ca. 10 leaves held distichously in a fan; sheaths not forming a crownshaft, densely rusty brown scaly; petiole ca. 1 m long, ca. 4 cm diam., adaxially channeled, abaxially rounded, grey-green, covered in pale scales; rachis ca. 2 m long, abaxially rounded, adaxially angled, covered in pale indumentum; leaflets ca. 62 on each side, regularly arranged in one plane, abaxially green, adaxially grey-waxy and dotted with minute membranous brown scales, apex obliquely praemorse, midrib prominent adaxially, abaxially bearing abundant, large, laciniate ramenta, one pair of large veins prominent near the margin also bearing ramenta abaxially; transverse veinlets obscure; proximal pinnae ca. 65 × 1.5 cm, median pinnae ca. 75 × 3.5 cm, distal pinnae ca. 10 × 0.5 cm. Inflorescence spreading; prophyll woody, 2-keeled, green but densely rusty-scaly, to 30 × 10 cm; peduncular bracts 2, the first inserted 6–10 cm above the prophyll, terete, woody, inflated, beaked, brown, ca. 80 × 10 cm, 2nd peduncular bract inserted ca. 10 cm above the first, similar but not inflated; peduncle ca. 16–20 cm long; rachis ca. 30 cm long, bearing 10–12 branches, each subtended by an inconspicuous rachis bract; rachillae glabrous, ca. 10 cm long, probably becoming much longer at anthesis, somewhat flexuous, bearing about 10 triads basally and paired to solitary flowers distally; rachilla bracts very small, rounded; floral bracteoles very low, rounded. Staminate flowers asymmetrical, fleshy; sepals rounded, ca. 1.5 mm long; petals broadly triangular, ca. 9 × 5 mm; stamen filaments very short, anthers 6 × 1 mm. Pistillate flowers asymmetrical; sepals thick, ±keeled, striate laterally, ca. 5 × 5 mm; petals thick, ca. 10 × 8 mm; staminodes thread-like, ca. 2 mm; ovary 3-lobed, ca. 5 × 8 mm, stigmas papillose ca. 1.5 mm long. Fruit apparently 1, 2, or 3 seeded, green, the 3 seeded ca. 6 cm diam., stigmatic remains apparently basal.

Type: Madagascar, Prov. Diego Suarez, Masoala, across Onive River from Ambatobe and upriver from Ambohitralanana, 8 April 1971, *H. E. Moore 9921* (BH). Vernacular name "Sindroa."

Notes: The cabbage is said to be inedible. Dr. M. E. Darian informs us that there may be two species in this genus, based on differences in trunk and seed size. Unfortunately we have no other material definitely identifiable with Hal Moore's collection. Further collections are essential.

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Principes, 28(4), 1984, pp. 168–172

The Native Palms of Puerto Rico

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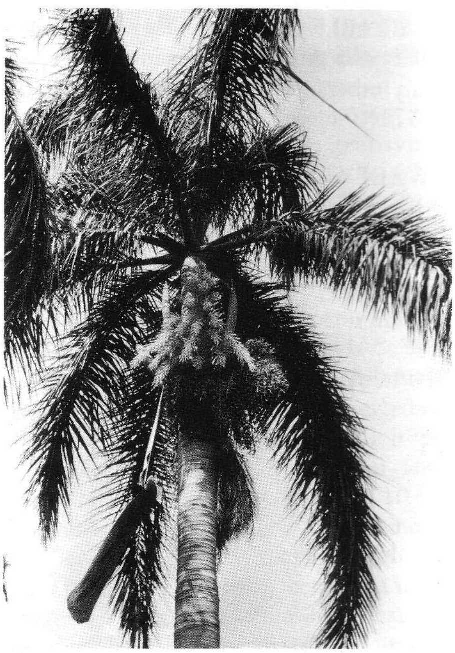
Puerto Rico is one of the Antilles, an island chain curving from Florida to Venezuela, dividing the Atlantic Ocean from the Caribbean Sea. It is the easternmost of the four Greater Antilles, the others being Cuba, Jamaica and Hispaniola. It is also the smallest, about 100 miles long and 40 miles wide. The flora is distinctly Caribbean, and while the palms are not so diverse as those of Cuba, they are no less interesting. Puerto Rico has ten native species in ten genera, and half of these are endemic (Little and Wadsworth 1964; Little, Woodbury, and Wadsworth 1974).

The most widespread and abundant species is *Roystonea borinquena*, the "palma real." This palm is endemic to Puerto Rico and three small neighboring islands. It is a large and imposing palm, easily recognized at a distance by its stout grey trunk and large head of pinnate leaves. It is seen throughout the island in lowland forests, fields and planted as ornamentals. The fruits are used by farmers to feed hogs. It is said that you can tell the number of hogs a farmer owns by the number of roystoneas he has on his land, usually four palms to a hog. Although farmers are thus inclined to conserve these palms, it seems that roystoneas actually benefit from forest clearance, and can extend their range in cleared areas. There are about eleven other species of *Roystonea*, with a circum-Caribbean distribution. However, their variability, and frequency with which they are planted, means that their taxonomy is in a state of some confusion. *Roystonea borinquena* has a distinctive bulge in the trunk, and so do some of the other species. The explanation of this is unknown, and it seems unlikely that it is entirely due to climatic changes.

The pattern of forest destruction in Puerto Rico is the same as that found in many areas throughout the Caribbean. During the last 100 years there has been extensive deforestation, leaving today only a small fraction of climax vegetation. Fortunately a well-developed conservation program has ensured that some of the most interesting vegetation types are preserved in national parks. These include subtropical dry forests, e.g., at Guanica, subtropical wet forest, e.g., at Maricao, and both



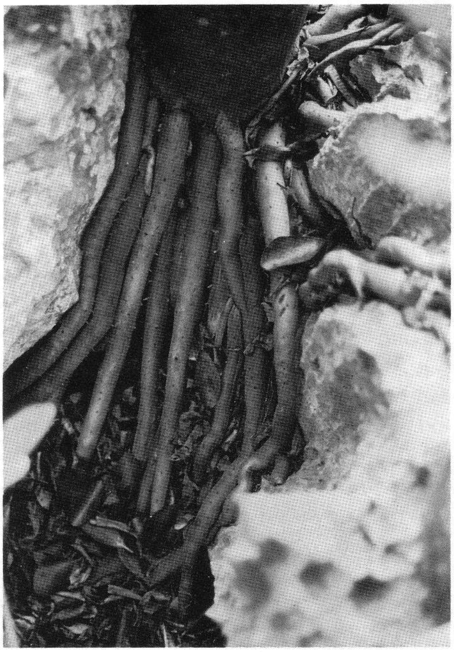
1. *Roystonea borinquena*, the most frequent palm in Puerto Rico.

2. *Thrinax morrisii*, growing in limestone rocks.

lower montane wet forest and lower montane rain forest, e.g., at Luquillo. Also secondary forests have increased in area in recent years as a result of the abandoning of marginal agricultural areas.

In the limestone hills of the island, *Thrinax morrisii* is common as an understory shrub. Typically it occurs in large populations of sterile stemless plants with a few fertile specimens with stems up to 2 m. The habitat of this species is similar to that of other related Caribbean palms, e.g., *Coccothrinax,* and consists of xeric limestone areas with a seasonal subtropical climate. The common name of *T. morrisii* is "palma de escoba," and this refers to the practice of making brooms from the leaves. This was a common industry many years ago, which then declined. Now, because of the economic recession, the practice has started up again, and brooms can be bought in local shops.

3. *Sabal causiarum*, the Puerto Rican hat plant.



4. *Gaussia attenuata*, the spine-like projections on the roots, anchored in limestone rocks.

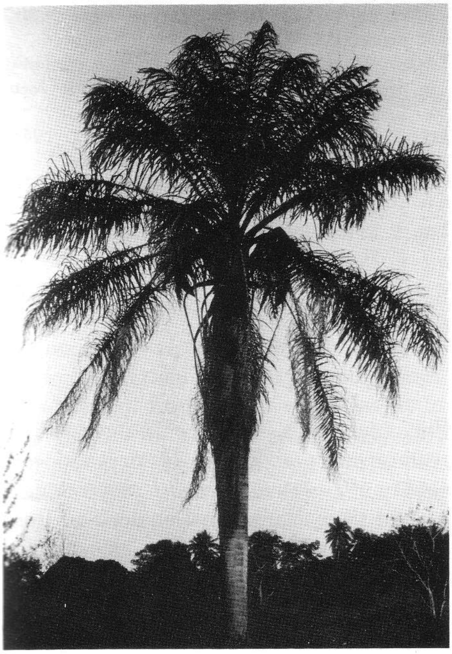
5. *Calyptronoma rivalis*, the rarest palm in Puerto Rico, growing beside a stream near San Sebastian.

Thrinax morrisii is very similar to another palmate-leaved palm, *Coccothrinax alta*, but the latter is more common in wetter limestone hills in the north of the island. The two genera can easily be separated because the bases of the petiole in *Thrinax* are split, while they are not in *Coccothrinax*.

The only other palmate-leaved palm in Puerto Rico is *Sabal causiarum*. This is another endemic species, and is found on coastal plains in the north and west of the island. Its stout grey trunks, up to 10 m, are a distinctive feature. It is known as the "palma de sombrero," although the practice of making hats from the leaves has declined over the years, with cheaper ones being made in other islands. *Sabal* is another Caribbean genus, but with wider inland extensions. Typically it inhabits lowland coastal regions, often on sandy soil. Again there is great diversity in this genus, leading to much confusion in naming.

There are two spiny pinnate-leaved palms in Puerto Rico, *Acrocomia media* and *Aiphanes acanthophylla*. The latter is rare in the forests of the subtropical moist zone, on the 'haystack hills' in the north of the island. It is easily distinguished, not only by its spines, but also by the truncated, jagged ends of the leaflets. The only other spiny palm, *Acrocomia media*, the "palma de corozo," is common at lower elevations in forests and fields. This species has deciduous spines on its trunk, and is found only in Puerto Rico and one of the Virgin Islands, St. Thomas.

In the hills between San Germán and Lajas, *Gaussia attenuata* is frequently seen. It grows on ridges and sticks out above the surrounding vegetation, the slender leaning trunk supporting a small head of pinnate leaves. Normally only isolated specimens are seen, and in contrast to palms like *Roystonea*, it disappears when its habitat is disturbed. This palm is



6. *Acrocomia media* is common in lower elevations in forests and fields.

endemic to Puerto Rico, and although not common it has two strongholds, not only in the San German hills but also in the northeast of the island near Manati. The roots of this species are interesting. They are visible above ground and are covered with spirally arranged spine-like projections. There is only one other species, *Gaussia princeps* from Cuba. Like *Thrinax* and *Coccothrinax*, *Gaussia* only grows on calcareous soils, although it is in no way related to these two coryphoid genera, being a member of the chamaedoreoid group of palms.

In the wet forests of the Sierra de Luquillo and the Cordillera Central *Prestoea montana* (syn. *Euterpe globosa*) is abundant, at altitudes of 300 to 1,000 m. There have been numerous ecological studies in these forests and much is known about the ecology of this palm, the "palma de sierra." It often occurs in dense strands, known as palm brakes, in very wet soil of steep slopes. Some ecologists believe that this palm is a secondary successional species, invading areas that have been disturbed naturally, either by landslides or hurricanes. Others think that *P. montana* is a typical climax species, and its dominance in steep wet areas is a result of its ability to anchor itself by means of numerous above-ground roots. Set against both these theories is the fact that this palm is very slow growing, only 20–30 cm per year, and despite its tremendous reproductive ability (5,000 seeds a year per mature tree) only one in a million seeds reaches maturity (Bannister 1970). There are also some interesting associations between this species and other animals and plants. The seeds are eaten by scolytid beetles (Janzen 1972) and the flowers are bee-pollinated. The trunks and leaves of the palms are often covered with epiphytes, from lichens, mosses and liverworts, to ferns and flowering plants, such as bromeliads and orchids.

Certainly the rarest Puerto Rican palm is the endemic *Calyptronoma rivalis.* It was discovered in 1901 by O. F. Cook, beside a small stream between Lares and San Sebastian. It is still there today, and has recently been found in a second locality nearby. The original site contains about 30 mature specimens, and since they are all on private land they are in a perilous position. Part of one colony has recently been destroyed, but it is to be hoped that the high level of interest by local botanists will ensure their survival. There are other closely related species of *Calyptronoma* in the Caribbean, and three closely related genera, *Calyptrogyne* in Central America and *Pholidostachys* and *Welfia* in both Central America and northern South America. They are all allied to the large genus *Geonoma.*

The tenth and last Puerto Rican palm has least claim to be included in the flora. One single specimen of *Pseudophoenix sargentii* has been recorded from Mona Island, 35 miles west of the main island. This represents the eastern limit of this species which is found from Hispaniola to Mexico.

Acknowledgments

My thanks to the many botanists in Puerto Rico who were so helpful to me on a recent visit to the island.

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LETTERS

Dear Editors and Contributing Writers,

This is a thank-you note to all the people who contribute their efforts toward making *Principes* the outstanding publication that it is. A prime example in point is the January 1984 issue. That issue has something for everyone.

Who could ask for anything more than to discover, or in this case, rediscover a palm like *Livistona exigua* in Borneo? How about the possibility of an indoor *Livistona* that looks like a *Licuala*? Thanks to P. R. Morgan and John Dransfield!

How about an article on the thirteen things that could possibly be wrong with your palm? You never knew whom to ask before, because no one had done the research. Now, thanks to T. K. Broschat and the University of Florida Agricultural Research and Education Center, we know who and where to ask. Thanks for making our palms green and healthy!

Next, we boarded our worldwide traveling armchair to Nepal. Here, Melvin and Phyllis Sneed guided us past Mt. Everest, then from Kathmandu, via elephant, landrover, and foot to see strange *Phoenix* palms, rare one-horned rhinos, and the Royal Botanical Gardens. Who wouldn't love to go along with the Sneeds? Thanks for sharing your adventures with us!

Perhaps the ultimate plant of all, the Coconut Palm, is discussed in the next article by Pablo Guzman-Rivas. The writer talks of other palms of Mexico and the Philippines also. Who could ever tire of reading more about the history and versatility of *Cocos nucifera*? Gracias amigo!

And then, Nancy G. Dengler and Ronald E. Dengler explore the microscopic formation of plications in two palm leaves. Everyone should have a scanning electron microscope. Thanks to these two people for taking us into the microscopic world where the folding begins to occur. Without the scientist and those who ask why, we would all still be in the Dark Ages.

And then there is the news. Of course, Florida and California have it all, but can you imagine Texas, the almost largest state with the smallest chapter, and that new chapter in Ohio, burrrrrrrrr!

And of course, our very own bookstore with the latest and greatest literature about palms. For $1.25 plus cost, you can build up your palm library.

In summary, we find that within this *Principes*, there is discovery, and/or, rediscovery of palms, how-to/or how not-to grow palms, a travelog, history and use of palms, and last but not least, the nitty-gritty of leaf formation. All of the above plus classified ads, Society news, a bookstore, and a Palmeter. What Dent Smith started and Harold E. Moore worked for (along with countless others) has turned into a marvelous Society with a truly remarkable publication, *Principes*. Thank you all!

Sincerely yours,
ERWIN M. RUHLAND

Principes, 28(4), 1984, pp. 173–178

Where's Joey?

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Once upon a time there was a palm, and for more than a century it was named *Teysmannia*. Early on, it was thought to be a genus with a single species; namely, *T. altifrons*. Time has proved it to be one of the world's most beautiful palms, with three other species described. But very few collectors have this palm in their gardens, nor can one find it in most of the world's renowned botanical gardens. Extremely "rare in cultivation" is the cachet attached to it.

The name was changed, perhaps with good reason, as explained by our late editor of *Principes*, Dr. Harold E. Moore, Jr. (see Vol. 5, No. 4, 1961, p. 116). So the palm subsequently has been known as *Johannesteijsmannia*, and the name change (which indeed is a "mouthful") also provided a cover for additional species which have been identified and described by Dr. John Dransfield.

During some of our travels, Phyllis Sneed and I went in quest of this palm, found it, and tried to collect it, but with little success. Seeds, especially viable ones, are extremely hard to find. Except for one of the species, which Dr. John Dransfield discovered up north in Malaysia west of Ipoh, the palm has no trunk. The large, entire, diamond-shaped leaves are stiff and leathery in texture, extending up from the ground on long leaf stalks. *J. altifrons* fruits at ground level, so collectors beware! When brushing away debris from the base of the plant to look for seeds, use a stick rather than hand to avoid contact with a viper. But do not be deterred. Your author never has seen a snake in the forests where this tree occurs, though no doubt some are there.

As one might surmise, the genus is indigenous largely to Malaysia (Peninsula Malaysia and Sarawak); it also occurs in Sumatra. If one crosses the causeway from Singapore to Malaysia, he will be in Johore; then a relatively short drive on up the East Coast to Mersing will deliver the "Joey" seeker into an area where they are abundant. However don't imagine that seeds will crawl into your open basket. Even here one should desert the highway and follow old loggers' roads back into

1. *Johannesteijsmannia* in the forest, Borneo.

2. Rain will not penetrate or leak through any shelter properly thatched with "Joey's" leaves.

what's left of the forest. That would be the best chance of finding colonies of "Joey," some of which might be in fruit.

Also one can find this palm dispersed in forests in north and central western Malaysia as well as the eastern Malaysian State of Sarawak, Borneo. (See Fig. 1 for a host of them under the forest canopy in Bako National Park, Sarawak.) We observed that "Joey's" leaf is one of the best possible thatches for native structures. One does not have to shred it, mat it, or weave it. Just pluck the magnificent leaf and attach it to whatever framework is to be covered, overlap the leaves slightly,

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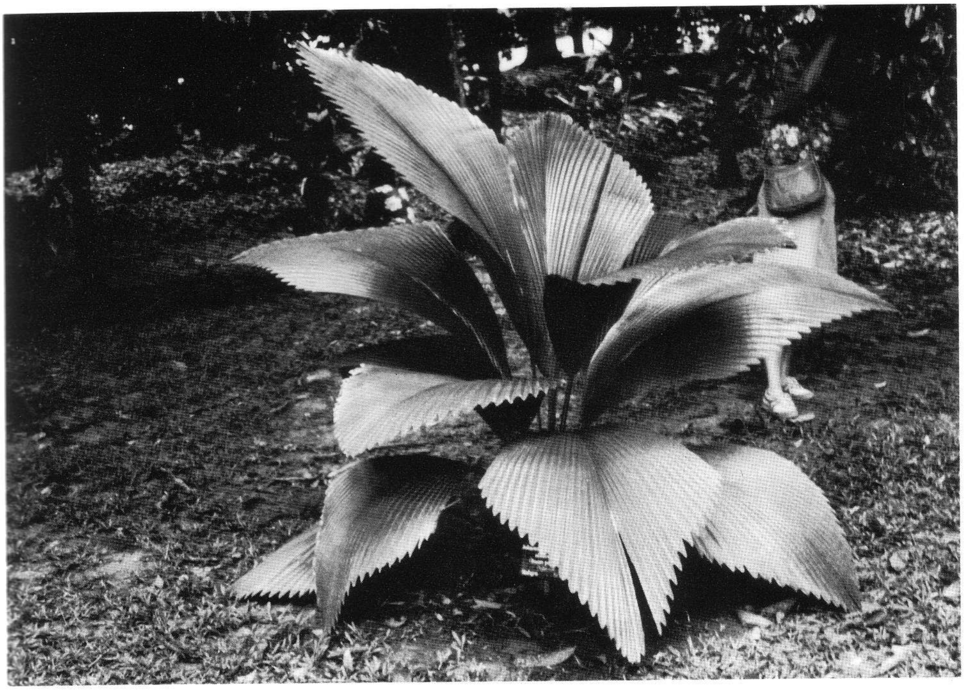
3. *Johannesteijsmannia* in the Botanic Garden, Singapore (Eric Taylor furnishes scale). This may be the first "Joey" palm cultivated in the Garden. At one time, Waterfall Gardens, in Penang, had one growing, but it was lost.



4. Recently, the Singapore Garden has cultivated and planted out in two open areas (small triangular plots) three "Joeys" in each.

and one has a waterproofed shelter (Fig. 2).

So we've seen the palm in its habitat. Where is "Joey" elsewhere? In 1978 we admired one specimen planted in the extensive gardens of Palm Society member, Mr. Paul Berli, in Bangkok, but it no longer survived in 1983 when we returned. To our knowledge, only the Singapore Botanical Garden now can boast of having it set out and growing.

Historically, some director got a "Joey" transplanted and established near his house at the far end of the Singapore Garden. Actually, this area was "out-of-bounds" for the multitudes visiting the garden, so hardly anyone saw the palm there. But the plant thrived, and on our second visit to the Garden we found and photographed it (Fig. 3). Since then the Singapore Garden, realizing that it has one of the world's rarest and most beautiful palms in its own backyard, has cultivated the palm and now has six new plants set out, which we discovered in April, 1984. Three are set out in a shade area adjacent to young *Verschaffeltia splendida,* easily visible from a walkway, and three others are in deepest shade across a walkway from the orchid houses (Figs. 4, 5).

So far we have been experiencing *Johannesteijsmannia altifrons.* But with thanks to John Dransfield's field work, there are other species of this unusual palm to be sought. As recently as April, 1984, we were looking for palms in the Cameron Highlands, some five hours leisurely drive north of Kuala Lumpur, capital of Malaysia. Once there we were not far from Ipoh, in the outstretches of which Dr. Dransfield found the single trunked "Joey."

We wanted to drive on to Ipoh, but our

5. Same as Fig. 4, with your author admiring a specimen.

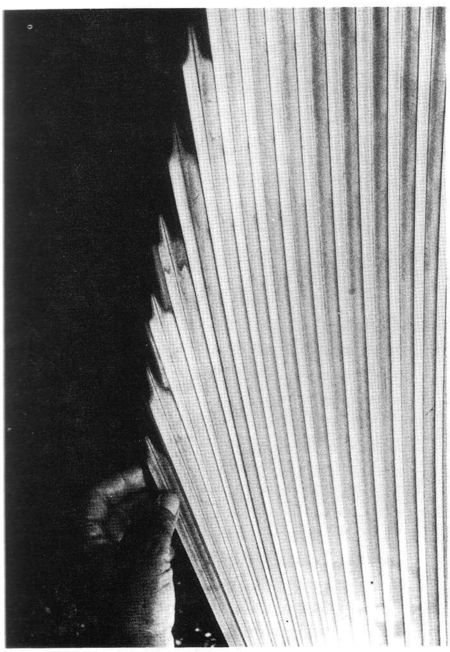
6. More palms, including *Iguanura*, on the hill (photographed by Eric Taylor).

companion, and long-time Palm Society member in Malaysia, Eric Taylor, said, "Mel, we can't get in and out of Ipoh. The Malaysian Government has some insurgents bottled up there, and we are not able to get into the area where the palm is without special permission from the Government." That squelched the Ipoh end of our trek, but we had fun looking in other directions.

For three days we explored the beauty of Cameron Highlands and collected seed for the Palm Society Seed Bank, most notably of *Livistona speciosa, Licuala spinosa* and *Orania sylvicola.* This area is loaded with many species of palms, though we saw no "Joeys." We found *Iguanura wallichiana* (Fig. 6) and collected a few seeds of questionable viability, and the area is rich in species of *Pinanga.*

Back to Kuala Lumpur, Eric drove us south to Seremban, passing plantations of *Metroxylon, Elaeis guineensis,* coconuts, mangoes, mangosteens and longsats. We

7. Eric Taylor, Azhari Ahmad and your author pose with leaves of *Licuala longipes* and *Johannesteijsmannia magnifica.*



8. Underside of leaf of *Johannesteijsmannia magnifica.*

saw some of the huge durian trees along the roadside as well as one fruiting *Actinorhytis calapparis.* We passed a cocoa factory where Cadbury chocolate is refined from nearby cocoa plantings. Turning back north and west to the Jelebu area, we arrived at Jeram Toi picnic area by a waterfall with cement steps leading about 200 feet along a tumbling stream, and steep hills above it. Up the hillside and atop were *Johannesteijsmannia magnifica, Licuala longipes* and *Pinanga* sp. (Fig. 7).

The front side of this "Joey" leaf was a deep green, pleated and stiff. The reverse side was even more beautiful, silver-tinted, glistening in the sun, with perfect configuration and displaying a natural etching that borders the entire leaf in a zig-zag design (See Fig. 8). This species is the "grey" Teysmannia" referred to by Dr. T. C. Whitmore in *Palms of Malaya,* p. 111, and only recently named by John Dransfield.

So, where do we go from here? Without doubt, *Johannesteijsmannia* being one of the world's most unusual and beautiful palms is endangered by logging and the shrinking forests of its habitat. In retrospect, the only way this rare palm ever will have a chance of being distributed is through the Palm Society Seed Bank. It behooves all of us (Palm Society members) to think a bit, and mount and support some effort to capture seeds of "Joey" to get it growing someplace outside of Malaysia. It will take a lot of "doing"!

In Malaysia, spring of 1984, we made an arrangement with Eric Taylor to correspond with Fairchild Garden, here in Miami, Florida, with a view to a plant exchange, including a seedling of "Joey." Eric had two of them started in his home nursery in Kuala Lumpur. We hope, eventually, that this deal will work out and Fairchild Garden will be a well-deserved beneficiary, with all thanks due to Eric Taylor.

Principes, 28(4), 1984, pp. 179–186

Vessel Elements in Roots of Young Palms

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ABSTRACT

Perforation plate type, end wall slope, and length to width ratio are described in wide vessel elements from roots of seedlings of 17 species of palms. Vessel elements with two different (i.e., "mixed") perforation plate types or end wall slopes occur in many of the specimens. The data contain correlations between the end wall characters and the length to width ratio of vessel elements. There is little resemblance between the sequence of the species according to Moore's (1973) systematic classification of palms, and the sequence according to the length to width ratio of vessel elements. The wide vessel elements from roots of young palms are usually more variable than those from roots of adult palms of the same species.

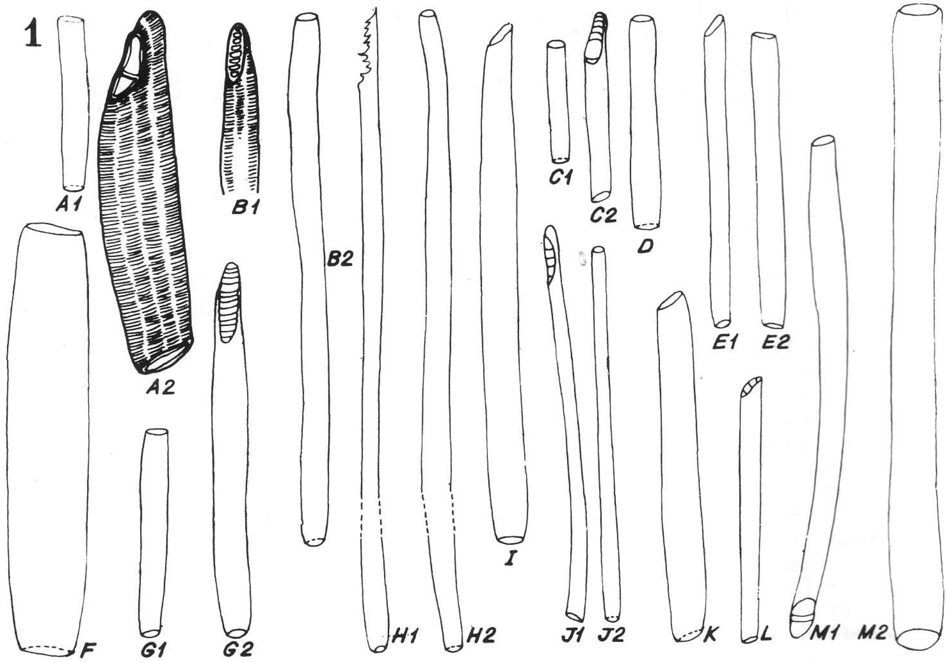
Data have been published on tracheary elements in the organs of adult palms (Bierhorst and Zamora 1965; Cheadle 1942, 1943*a*, 1943*b*; Klotz 1978*a*, 1978*b*, 1978*c*; Parthasarathy and Klotz 1976; Tomlinson 1961; Tomlinson and Zimmermann 1967). In seedling palms, no comparable work appears to have been done so far. The present study describes perforation plates, end wall slopes, lengths, widths, and length-width ratios of vessel elements in roots of seedling palms. The objectives are (1) to compare the data from young palms with those presented by Tomlinson (1961) and Klotz (1977) from adult palms, (2) to determine the degree to which end wall characteristics are correlated with length to width ratios, and (3) to observe whether the arrangement of species according to length to width ratios of vessel members resembles the systematic sequence of taxa in Moore's (1973) classification of palms.

The form of tracheary elements and the correlations among their features have supplied evidence for hypothetical evolutionary pathways (Carlquist 1975; Dickison 1975). Recently, Aldridge (1978) used a method of statistical correlation between features of tracheary elements in studying evolution within the genus *Sonchus*. The present analysis is based on her hypothesis about the evolution of tracheary elements. She used the length to width ratio of vessel elements as a tool to determine the phylogenetic relationship among species. A higher ratio indicates primitiveness while a lower ratio is more advanced (Aldridge 1978). According to Cheadle (1943*a*), primitive vessel elements have long, extremely oblique or very oblique end walls in which the perforation plates have many bars that are closely spaced while advanced vessel elements have slightly oblique to transverse end walls on which the bars are few or absent.

Materials and Methods

Small pieces of mature roots of average diameter were studied in seedlings of 17 species of palms (Table 1). Most of the seedlings were raised at the Crop Garden of the Indian Statistical Institute, Calcutta, from seeds collected from the Indian Botanic Garden, Howrah. The seeds of *Veitchia* and *Phoenix rupicola* were collected in Australia. Seeds were sown at different times according to their availability. The ages of the seedlings ranged from 8 to 30 months.

One piece of a root was sampled for each species. The roots were cut into small pieces and fixed in formalin-acetic acid-alcohol (FAA) for 48 hours or more. They were then boiled in 10% potassium



1. Camera lucida drawings of wide vessel elements of roots. Lateral-wall pits are represented as short, horizontal lines in A_2 and B_1. Magnification is 107 × in A_2 and B_1, 43 × in all the others. A_1, A_2. *Areca catechu.* A_1. Simple perforation plates, transverse end walls. A_2. Mixed perforation plates and end wall slopes. B_1, B_2. *Chrysalidocarpus lutescens.* B_1. Details of scalariform perforation plate. B_2. Simple perforation plates, transverse end walls. C_1, C_2. *Livistona rotundifolia.* C_1. Simple perforation plates, transverse end walls. C_2. Mixed end wall characters. D. *Arenge pinnata.* Simple perforation plates, transverse end walls. E_1, E_2. *Borassus flabellifer.* E_1. Simple perforation plates, end wall slopes mixed. E_2. Simple perforation plates, transverse end walls. F. *Cocos nucifera.* Simple perforation plates, transverse end walls. G_1, G_2. *Areca triandra.* G_1. Simple perforation plates, transverse end walls. G_2. Mixed end wall characters. H_1, H_2. *Veitchia merrillii.* H_1. Mixed end wall characters. H_2. Simple perforation plates, transverse end walls. I. *Phoenix rupicola.* Simple perforation plates, mixed end wall slopes. J_1, J_2. *P. reclinata.* J_1. Mixed end wall characters. J_2. Simple perforation plates, transverse end walls. K. *Salacca zalacca*, mixed end wall slopes, simple perforation plates. L. *Elaeis guineensis*, mixed end wall characters. M_1, M_2. *Hyphaene dichotoma.* M_1. Mixed end wall characters. M_2. Simple perforation plates and transverse end walls.

hydroxide (10 minutes), washed in water, soaked in 25% chromic acid (15 minutes), and washed again. The macerated material was teased apart and mounted on slides in phenol-glycerine. Some specimens fixed in FAA were sectioned transversely with a microtome and stained with safranin and fast-green. Camera lucida drawings and photomicrographs were made.

An ocular micrometer in a compound microscope was used to measure the length and width of 10 intact wide (or sometimes semi-wide) vessel elements in each species (Fig. 3). Slopes of end walls and types of perforation plates were also recorded. The mean and standard error of the measurements were computed. Spearman's rank correlation coefficient was employed to demonstrate the correlation between the end wall characteristics and length to width ratios.

Categories of Perforation Plates and End Wall Slopes

The terminology for perforation plates (except "mixed") is taken from Esau (1958), and the vessel elements are cat-

Table 1. *Perforation plate types, end wall slopes, and dimensions of wide metaxylem vessel elements in roots of young palms.*[1]

Major groups and species	% of vessel elements with perforation plates: Both scalariform	Mixed	Both simple	% of vessel elements with end walls: Both oblique	Both slightly oblique	Mixed	Both transverse	Dimension of vessel elements: Length (mm) Mean ± std. error	Width (mm) Mean ± std. error	Length : width rate Mean ± std. error
Coryphoid										
Livistona rotundifolia (Lam.) Mart. (10)	—	20	80	—	—	30	70	0.62 ± 0.04	0.062 ± 0.006	11.9 ± 2.1
Phoenicoid										
Phoenix reclinata Jacq. (8)	10	20	70	10	10	50	30	1.12 ± 0.07	0.042 ± 0.005	28.5 ± 3.8
P. rupicola Anders. (10)	10	10	80	10	40	—	50	2.05 ± 0.13	0.090 ± 0.004	23.5 ± 2.0
P. sylvestris (L.) Roxb. (16)	—	—	100	—	—	—	100	1.84 ± 0.10	0.091 ± 0.002	20.5 ± 1.1
P. pusilla Gaertn. (16)	—	20	80	10	40	10	40	1.07 ± 0.08	0.079 ± 0.010	14.9 ± 1.7
Borassoid										
Borassus flabellifer L. (8)	—	10	90	20	10	30	40	1.40 ± 0.15	0.064 ± 0.002	22.6 ± 3.0
Hyphaene dichotoma (White) Furtado (15)	10	10	80	10	—	20	70	2.16 ± 0.16	0.104 ± 0.009	23.3 ± 4.0
Lepidocaryoid										
Salacca zalacca (Gaertn.) Yoss (12)	—	20	80	—	—	20	80	1.52 ± 0.11	0.090 ± 0.005	18.8 ± 3.6
Caryotoid										
Arenga pinnata (Wurmb.) Merr. (30)	—	—	100	—	—	—	100	1.02 ± 0.06	0.091 ± 0.009	11.3 ± 0.9
Caryota urens L. (12)	—	—	100	—	—	—	100	2.39 ± 0.24	0.189 ± 0.023	15.0 ± 3.4
Arecoid										
Areca catechu L. (24)	10	10	80	—	10	10	80	0.88 ± 0.10	0.077 ± 0.005	12.3 ± 2.1
A. triandra Roxb. (19)	—	40	60	—	—	40	60	1.02 ± 0.12	0.068 ± 0.004	16.8 ± 3.9
Chrysalidocarpus lutescens H. A. Wendl. (16)	—	10	90	10	—	—	90	1.90 ± 0.16	0.084 ± 0.003	22.9 ± 2.2
Roystonea regia (H.B.K.) Cook. (11)	—	—	100	10	—	—	90	1.18 ± 0.09	0.111 ± 0.004	10.7 ± 0.9
Veitchia merrillii (Becc.) Moore (10)	—	20	80	—	—	40	60	2.15 ± 0.14	0.064 ± 0.003	33.7 ± 2.2
Cocosoid										
Cocos nucifera L. (12)	—	—	100	—	—	—	100	1.86 ± 0.18	0.200 ± 0.017	10.4 ± 1.8
Elaeis guineensis Jacq. (12)[2]	30	40	30	15	40	30	15	1.03 ± 0.07	0.043 ± 0.003	24.7 ± 1.8
Total of species	5	12	17	8	6	10	17	— —	— —	— —

[1] The classification is that of Moore (1973). The age of the plant in months is given in parentheses after the binomial.

[2] Only 7 vessel elements were examined in *Elaeis guineensis*.

egorized as follows: both perforation plates scalariform; "mixed" perforation plates, i.e., one plate simple and the other scalariform or reticulate (Fig. 1A_2, C_2, G_2, H_1, J_1, L, M_1); both perforation plates simple (Fig. 1A_1, B_2, C_1, D, etc.). Similarly, Cheadle's (1943*a*) classification of end wall slopes is employed, and the vessel elements are categorized as follows: both end walls oblique; both end walls slightly oblique; "mixed" end wall slope, i.e., one end wall transverse, and the other either oblique or slightly oblique (Fig. 1A_2, C_2, E_1, G_2, H_1, I, L, etc.); both end walls transverse (Fig. 1A_1, B_2, C_1, D, E_2, F, G_1, etc.).

Observations

Simple perforation plates and transverse slopes are the most frequent end wall characters in the vessel elements examined in this survey. Mixed perforation plates and mixed end wall slopes are the next most frequent. Table 1 shows that 17 species have vessel elements with two simple perforation plates; 12 species, mixed perforation plates; and five species, two scalariform perforation plates. *Elaeis* shows the highest percentage (30%) of scalariform perforation plates. The highest percentages of vessel elements with mixed perforation plates occur in *Elaeis* (40%) and *Areca triandra* (40%). The percentage of vessel elements with two simple perforation plates is highest in all of the species except *Elaeis*.

Vessel elements with both end walls oblique occur in eight species, both slightly oblique in six species, and both transverse in all the species. Vessel elements with mixed slopes occur in 10 species. The highest frequencies of vessel elements with both end walls slightly oblique occur in *Elaeis*, *Phoenix rupicola* and *P. pusilla*. *Areca triandra* (40%), *Phoenix reclinata* (50%), and *Veitchia* (40%) show the highest percentages of vessel elements with mixed slopes. The percentage of vessel elements with two transverse end walls is highest in all of the species except *Elaeis* and *Phoenix reclinata*. The highest numbers of vessel elements with both perforation plates simple and both end walls transverse occur in *Arenga*, *Caryota*, *Cocos*, *Phoenix sylvestris* and *Roystonea*.

The dimensions and length to width ratios of the vessel elements are also given in Table 1. The longest is found in *Caryota*, the shortest in *Livistona*. On the other hand, the widest is in *Cocos* and the narrowest are in *Elaeis* and *Phoenix reclinata*. The highest mean ratio occurs in *Veitchia* and the lowest in *Cocos*.

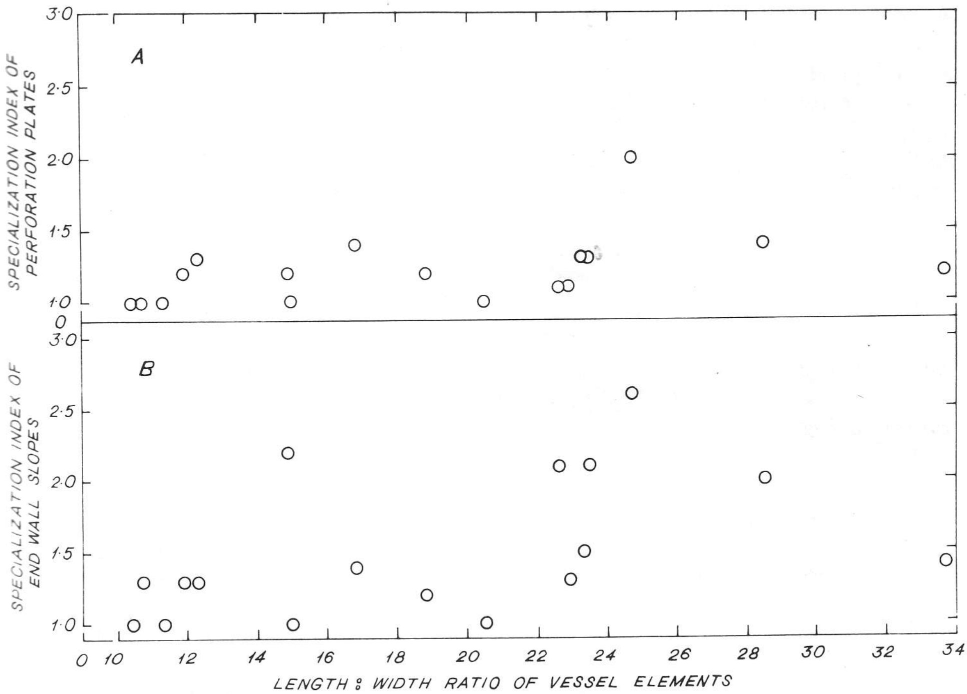
Spearman's coefficient of rank correlation (Steel and Torrie 1960) was employed to demonstrate correlations between the length to width ratio and the end wall characters. The data for these calculations are displayed graphically in Figure 2. The 17 species were ranked in increasing order of the average length to width ratio, and in a specialization index (adapted from Klotz 1978) based on end wall slopes (Fig. 2B):

> Specialization index of end wall slopes × 100 = 1 (% of both end walls transverse) + 2 (% of mixed end walls) + 3 (% of both end walls slightly oblique) + 4 (% of both end walls oblique).

The Spearman's coefficient of rank correlation between these two features is 0.650, which is significant at the 1% level. Similarly, the following specialization index was assigned for perforation plates (Fig. 2A):

> Specialization index of perforation plates × 100 = 1 (% of both plates simple) + 2 (% of mixed plates) + 3 (% of both plates scalariform).

The Spearman's coefficient of rank correlation (with length to width ratio) is 0.525, which is significant at the 5% level. In summary, the species with the lower length to width ratios tend to possess the



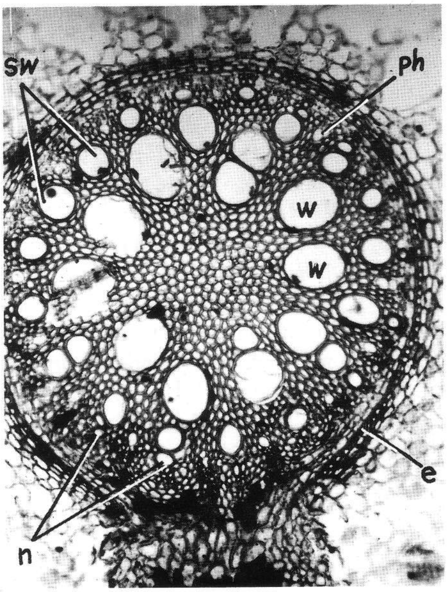
2. Correlation of length to width ratios with end wall features. A. Specialization indices of perforation plates plotted against length to width ratios. B. Specialization indices of end wall slopes plotted against length to width ratios.

higher percentages of simple perforation plates and transverse end walls. In contrast, the higher length to width ratios tend to occur in the species with the higher percentages of mixed end wall characters. A few species are exceptions to these trends (e.g., *Livistona*, *Phoenix sylvestris*, and *P. pusilla*).

Table 2 shows the differences in wide vessel element dimensions and end wall characteristics between young and adult palms. The young plants possess various types of perforation plates, the simple type predominating, whereas adult plants possess only the simple type. Again, various types of end wall slopes occur in young plants, but only transverse or sometimes slightly oblique occur in adults. The range of lengths of vessel elements is generally larger in the young plants than in the adults. The upper limit of length of vessel elements in young plants exceeds that in adult plants except in *Elaeis* and *Phoenix*. In contrast, the widths of the vessel elements are mostly greater in the adult plants.

Discussion

The data in the present study differ from the comparable observations by Tomlinson (1961) and Klotz (1977) in adult palms of the same species. The comparisons between young and adult palms reveal a general trend of shortening and widening of the wide vessel elements in the roots. Also, the end wall characters of these vessel elements are more variable in the young palms than in the adult palms. Thus, the pattern of differentiation of these cells apparently undergoes a transformation during the development of an individ-



3. Transverse section of root of *Phoenix pusilla.* ×100. e, endodermis; n, narrow tracheary elements; ph, phloem; sw, semi-wide vessels of metaxylem; w, wide vessels of metaxylem.

ual palm from the seedling stage to the adult. In the above features, the wide vessel elements from seedling roots resemble the narrow, early-maturing vessel elements from roots of adult palms (described by Cheadle 1942; Klotz 1977, 1978*a*; Parthasarathy and Klotz 1976).

Tomlinson (1961), Cheadle (1942, 1943*a*, 1973*b*) and Klotz (1978*a*) did not mention any mixed end wall characters in vessel elements from the species of adult palms that they studied. Apparently, such vessel elements either are absent in adult palms or have not been reported by the previous authors. However, Tomlinson and Zimmermann (1976) depicted mixed end wall characters in vessel elements from the lower part of the stem of *Sabal palmetto*; and Klotz (pers. comm.) observed but did not describe such vessel elements in the vegetative organs of various palms.

Klotz (1977, 1978*a*) observed reticulate and/or scalariform-reticulate perforation plates in wide vessel elements from

Table 2. Comparison of wide vessel elements from roots of young and adult palms.

Species	Author's data (young plants)		Tomlinson's (1961) data (adult plants)		Klotz's (1977) data (adult plants)	
	Dimensions (μm)	End wall*	Dimensions (μm)	End wall*	Dimensions (μm)	End wall*
Phoenix reclinata	900–1,500 × 30–60	sc, si/o, s, t	—	—	1,000–1,900 × 140–260	si/t
Salacca zalacca (*S. edulis*)	1,000–2,200 × 40–100	sc, si/s, t	1,000–1,400 × 180–260	si/t	—	—
Areca catechu	600–1,600 × 60–100	sc, si/s, t	840–1,210 × 115–190	si/t	—	—
Chrysalidocarpus lutescens	1,400–2,800 × 60–90	sc, si/o, t	1,400–1,800 × 95–210	si/t	—	—
Cocos nucifera	900–3,100 × 130–270	si/t	1,740–2,740 × 200–315	si/t	1,100–2,500 × 200–230	si/s, t
Elaeis guineensis	700–1,300 × 30–50	sc, si/o, s, t	1,210–1,500 × 270–340	si/t	—	—

* End wall characters: sc = scalariform perforation plates; si = simple perforation plates; o = oblique end walls; s = slightly oblique end walls; t = transverse end wall slopes.

roots of some species of adult palms. Such perforation plates were not observed in the present study.

Vessel elements from roots of young palms exhibit positive correlations between the length to width ratio of the cell and the degree of primitiveness of the perforation plates. This finding supports the conclusions of Aldridge (1978) and Cheadle (1943*a*) that were summarized in the introduction of this paper.

The sequence of mean length to width ratios in Table 1 can be compared with the sequence of species according to Moore's (1973) classification of palms. The lowest ratios occur in species of cocosoid, arecoid, and lepidocaryoid groups, while the highest ratios occur in species of arecoid and coryphoid groups. There is little resemblance between Moore's (1973) systematic sequence of the evolutionary lines and major groups and the sequence of species based on length to width ratio of vessel elements. For example, *Livistona* and *Phoenix pusilla* show advanced ratios although they belong to primitive coryphoid and phoenicoid groups, respectively. Similarly, *Veitchia* and *Chrysalidocarpus* of the advanced arecoid group and *Elaeis* of the advanced cocosoid group show a high ratio, which is a primitive character.

There is considerable variation among the species of individual major groups in characters of the vessel elements. For example, within the cocosoid major group, *Cocos nucifera* shows relatively advanced characters and *Elaeis guineensis*, more primitive characters. Similarly, within the arecoid major group, more advanced xylem occurs in *Roystonea regia* and more primitive in *Veitchia merrillii*. In phoenicoid major group, more advanced xylem occurs in *Phoenix pusilla* and more primitive in *P. reclinata*. Such differences among the members of individual major groups may be explained by Klotz's (1978*a*) conclusion that "evolution in the xylem appears to have progressed independently in the various taxonomic groups of palms."

Acknowledgments

I am grateful to Professor T. A. Davis, former Head, Crop Science Unit, Indian Statistical Institute, for his guidance during the course of this investigation; to Professor B. M. Johri, Delhi University, for his valuable comments on the article; and to Dr. Larry H. Klotz, Shippensburg University, Shippensburg, Pennsylvania, for his comments and scrutiny for improvement of this article.

I thank Mr. S. K. De, Artist and Dr. A. Dasgupta, Senior Research Fellow, Indian Statistical Institue, for drawings and statistical calculations, respectively.

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PALM LITERATURE

A BIBLIOGRAPHY OF GRADUATE THESES ON PALMS, PART II

An initial compilation of 101 titles appeared in a previous issue of this journal (Vol. 27(2), 1983, pp. 85–88). The results of continued research into this primary source of information on palms, following the same criteria, now justifies a second installment.

This listing consists of 57 additional doctoral and master's theses. More than one-half of the total were completed in three countries: United States (14), The Philippines (12) and France (10). As before, the major economic palms dominate the subject matter: coconut (23), oil palm (11) and date palm (8). Although most of the studies were completed within the past 15 years, a few older titles were found, such as the dissertation by Gatin dated 1906. Once again I must acknowledge the assistance of numerous individuals who provided me with thesis titles.

Doctoral Theses

AMMAR, S. 1978. La Culture de tissus de plantes issues de graines appliquée à la multiplication végétative du palmier dattier (*Phoenix dactylifera* L.). University of Tunis, Tunisia.

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DENNIS JOHNSON

A TOUR AND A COLLECTING TRIP

ROYAL HORTICULTURE SOCIETY TOUR TO THE SEYCHELLES, 12–17 April 1985, led by John Dransfield. For further details contact: ABERCROMBIE AND KENT TRAVEL, 42 Sloan St., London SWIX 9LU, England.

COLLECTING TRIP TO PANAMA. I am planning a trip to Panama, February 1985 to collect PALMS and ORCHIDS. Anyone interested contact JOHN O. WILD, 1123 15th Ave. S.E., Minneapolis, Minn. 51414. (606) 331-7221. Limited to five people.

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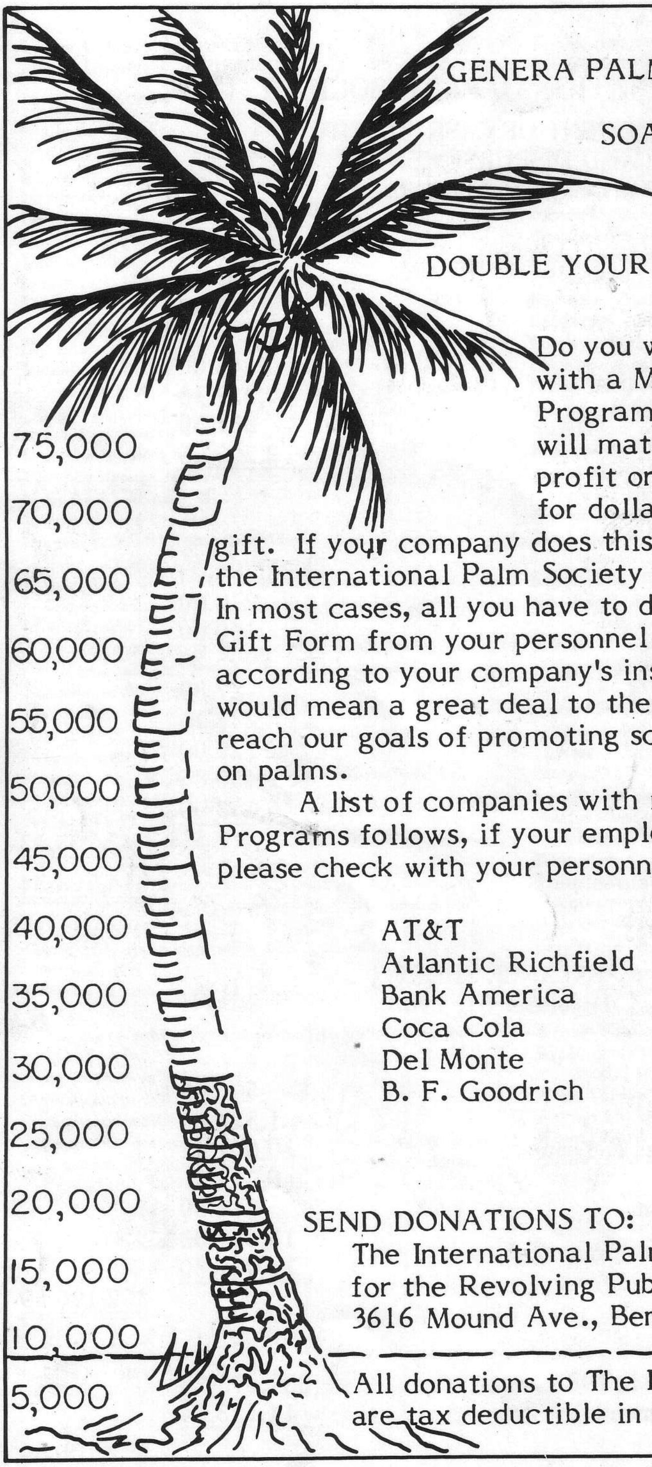
THE INTERNATIONAL PALM SOCIETY, INC.

STATEMENT OF CASH RECEIPTS AND DISBURSEMENTS
December 31, 1983

Income		
Membership	$39,765.13	
Interest	2,568.89	
Subscribers	1,569.30	
Seed Bank	3,144.00	
Publications	7,327.10	
Postage	851.50	
Miscellaneous	2,200.55	
Total Income		$57,426.47
Disbursements		
Printing of Catalog	$32,784.03	
Postage	270.00	
Accounting	150.00	
Travel	995.20	
Bank Charges	27.89	
Rent & Supplies	243.15	
Dues & Subscriptions	129.00	
Miscellaneous	1,450.86	
Grants	6,653.00	
Total Expenses		42,703.13
Excess Receipts over Disbursements		$14,723.34

BALANCE SHEET
December 31, 1983

Assets		
Petty Cash	$ 500.00	
"Super Now"	1,524.60	
Coral Gables Federal Savings & Loan	10,061.41	
"IMF"	8,717.36	
First National Bank of Miami	814.59	
Douglas County Bank	15,631.33	
World Savings & Loan	14,947.30	
Total Assets		$52,196.59
Fund Balance		
Fund Balance—December 31, 1983	$37,473.25	
Net Receipts over Disbursements	14,723.34	
Balance		$52,196.59



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