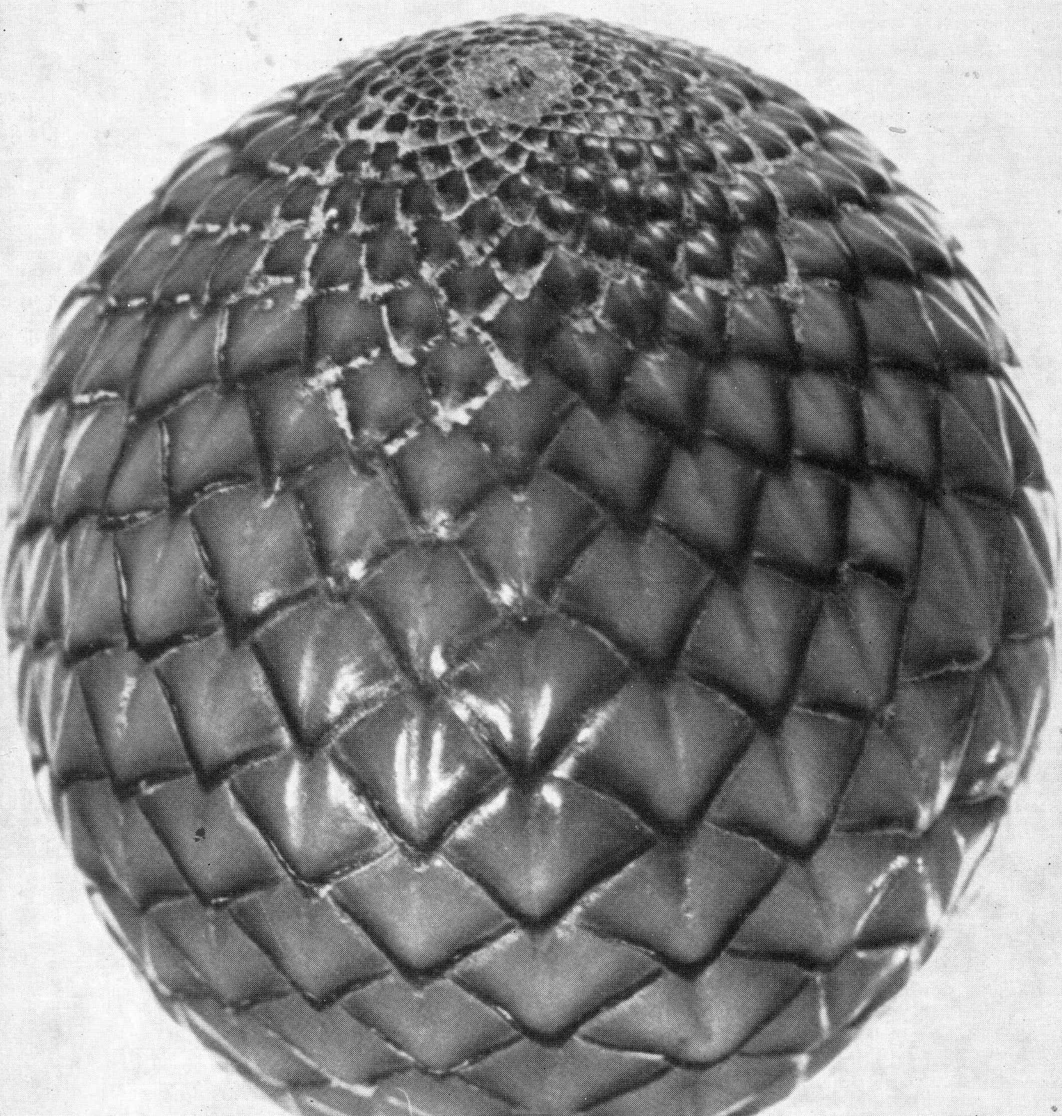

PRINCIPES

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July, 1977
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PRINCIPES

JOURNAL OF THE PALM SOCIETY

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Contents for July

Cover Picture

A fruit of *Metroxylon vitiense* collected in the Fiji Islands by P. B. Tomlinson. Photograph by Howard H. Lyon.

PRINCIPES

JOURNAL OF THE PALM SOCIETY

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Edible Palm Fruits of the Brazilian Amazon*

Paulo B. Cavalcante
Museu Goeldi, Belém, Pará, Brasil

Translated from the Portuguese by
Dennis Johnson
University of Houston, Houston, Texas 77004

PALMAE

Acrocomia sclerocarpa Mart.

[**Acrocomia** sp.]** MUCAJÁ
bacaiúva, coco-baboso, coco-de-catarro, macaíba, macaúba.

This species is common to nearly all of Brazil; however, it does not appear to reach the State of Amazonas. It is one of the most common palms in the vicinity of the city of Belém, and is found growing singly and spontaneously in open sites or in areas of low second growth.

Mature palms reach a height of 15–20 m, and bear some spines on the trunk. Leaves form a rounded, fairly regular-shaped crown and dead leaves remain attached to the trunk for some time. When the leaves do abscise, the leaf sheaths remain attached and commonly cover the upper half of the trunk. This habit constitutes one of the distinctive characteristics of the species.

The palm generally produces 10–12 fruit clusters which remain partially hidden among the lower, dead leaves. The fruit is a drupe, spherical, single-seeded, and about 4 cm in diameter. The epicarp is coriaceous, rigid, and light-green in color; the mesocarp (the edible pulp) is whitish in color, fibrous, and mucilaginous; the endocarp is of a rock-like consistency, enclosing a small, white kernel or seed, which contains a clear edible oil recommended for the manufacture of soap. The palm fruits from July to November, and into December.

Astrocaryum tucuma Mart.

TUCUMÃ
tucum, tucumã-açu

This palm is found in the states of Pará and Amazonas, but with greater frequency in the latter. It occurs in open sites, or in the midst of low second growth. The single, straight trunk reaches 8–14 m in height, and is adorned with long, black spines, arranged in rings, that are denser in the upper half of the trunk. Leaves have sturdy, enlarged sheaths and are densely aculeate. Fruit clusters are long and cylindrical, measuring about 1.5 m in length. The fruit is a drupe, ellipsoidal or rounded, yellow-green or orange in color, 5–6 cm in length, and weighs 70–75 g. The pulp is yellow in color, oily,

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* This translation represents the section on palms in the author's longer work entitled *Frutas Comestíveis da Amazônia II*, Museu Goeldi, Belém, Pará, Brasil, 1974.

** Editor's note. Some of the names used differ from those usually accepted today. Owing to a nomenclatural technicality, the name *Acrocomia sclerocarpa* is synonymous with *A. aculeata* (Jacq.) Lodd. ex Mart., a West Indian species, and the correct name for the Brazilian species is not yet clear. The preferred name is included in brackets when different from that given by the author.

7–8 mm in thickness, and with a flavor similar to that of an apricot (*Prunus armeniaca*). The tree is in fruit from February to May.

Astrocaryum vulgare Mart.

TUCUMÃ

This is the most common of the palms that are popularly called *tucumã* in Pará, and its range also extends to the Northeast Region of Brazil. The fruits of this palm are commonly confused with those of *A. tucuma*, but there are perceptible differences between the two species. *Astrocaryum tucuma* is a solitary palm with an erect trunk and large fruit: *A. vulgare* is a cluster palm and forms clumps of several thin trunks that are somewhat curved in their lower portions. The lower trunk does not have black spines, and the fruits are much smaller than in the other species. Leaves are up to 7 m in length and always erect. The spadix is up to 1.7 m in length. The fruit of this species is commonly found in the open-air markets of Belém in appreciable quantities from January to July. The fruits are eaten fresh, or used to make juice.

The rachis of the leaf furnishes a strong fiber that can be utilized in numerous ways. In addition, the palm yields an excellent heart of palm, although its extraction is made difficult by the quantity of spines on the upper trunk.

The largest consumers of *tucumã* are people of the lower class who, without realizing it, are getting an excellent supply of Vitamin A and other vitamins. The nutritive value of the pulp was demonstrated by the chemical analysis made by Chaves and Pechnik (1947: 17); the first item of their conclusions is quoted as follows:

1. The edible fruit of the *tucumã* reveals itself to be a food of estimable nutritive value for the following reasons:

a. Its Vitamin A value is 52,000 international units per 100 g, a value equalled only by the pulp of the *buriti* palm (*Mauritia vinifera*). It has 90 times more Vitamin A than the pulp of the avocado, and three times that of the carrot, a vegetable that until recently was considered to be the best source of the vitamin.

b. Its Vitamin B^1 (thiamine) value is important, and its Vitamin C (ascorbic acid) content rivals that of citrus fruit.

c. The food value of the edible pulp is significantly higher than fresh fruits in general, 247 calories per 100 g, due to the presence of 19.1% glycosides, 16.6% lipoids, and 3.5% proteides.

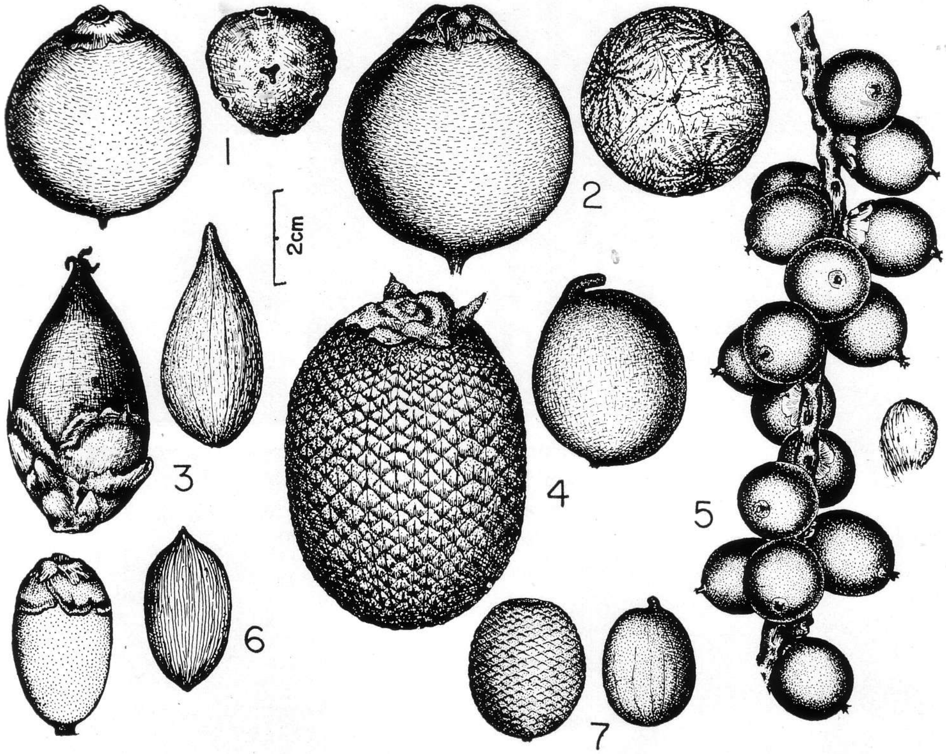
Elaeis melanococca Gaert.

[**Elaeis oleifera** (HBK) Cortés]
(*Corozo oleifera* (HBK) Bail.)

CAIAUÉ
dendê-do-pará

Although this palm does not yield an edible fruit, in its natural state, it is included in this listing because of its importance as one of the typically Amazonian oil palms. The height of the tree, at its maximum, is no taller than a man. While growing, the oldest part of the thick trunk assumes a procumbent position and produces adventitious roots. The oldest part of the trunk dies and decomposes, resulting in an almost imperceptible shift of the plant away from the place where it was originally planted. For that reason, individuals who know the *caiaué* in its habitat, often say that the plant "walks."

The low stature of the *dendê-do-pará* facilitates the collection of fruits. That characteristic has been experimented



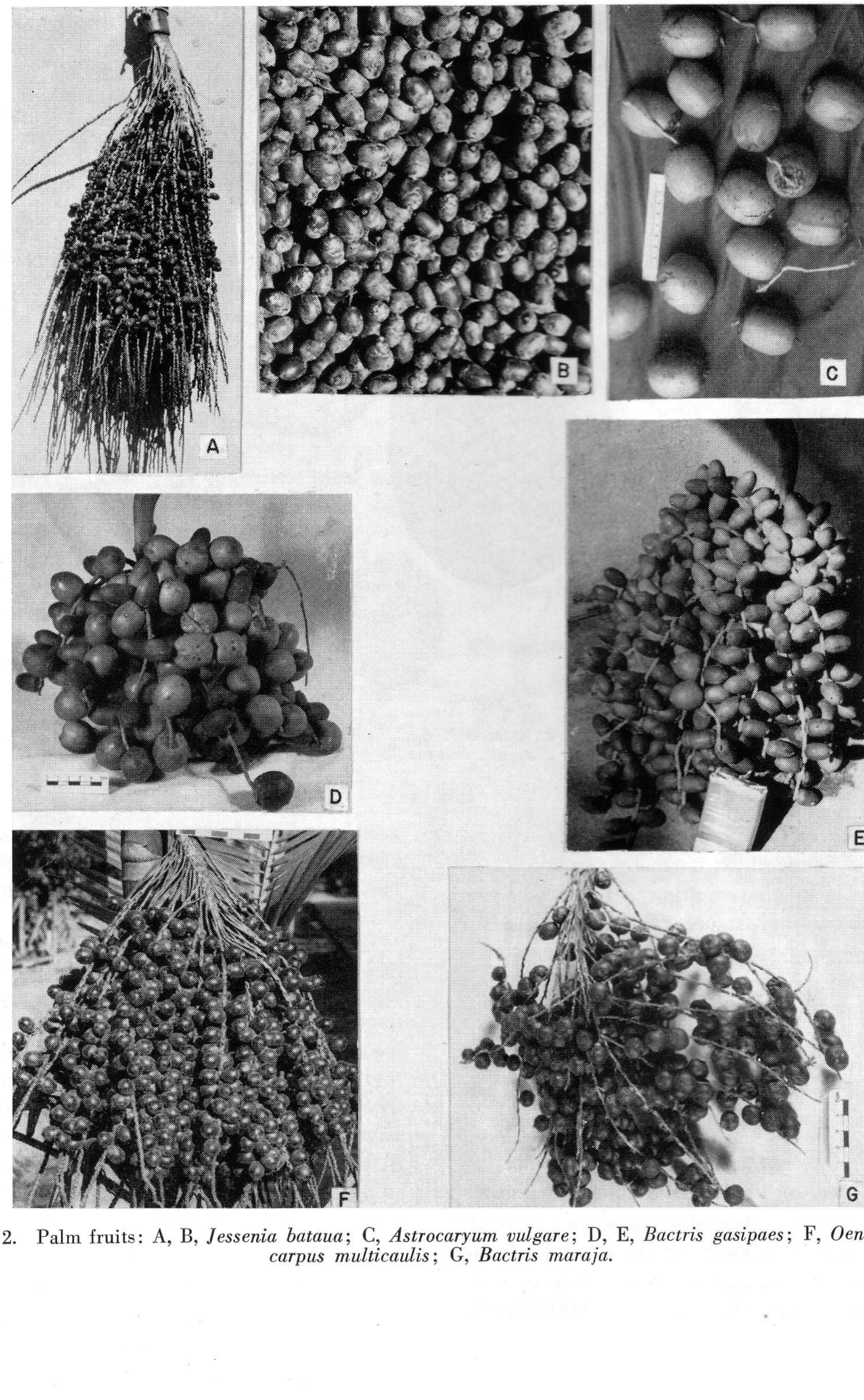
1. Palm fruits: 1, *Acrocomia* sp.; 2, *Astrocaryum tucuma*; 3, *Maximiliana martiana*; 4, *Mauritia flexuosa*; 5, *Oenocarpus distichus*; 6, *Jessenia bataua*; 7, *Mauritia martiana.*

with in cross-breeding with the African oil palm, which normally reaches 15–20 m in height, resulting in hybrids of low or medium stature. The fruit yields two types of oil: the pulp produces a reddish, edible oil, and the kernel contains a white oil that, when refined, can be utilized for the making of margarine.

Euterpe oleracea Mart. AÇAÍ
açaí-do-pará, açaí-do-baixo amazonas

Açaí is one of the most characteristic palms of Pará, found in nearly the entire state. Its major occurrence is in the Amazon estuary, on lands of the floodplains (*várzeas*), the backswamps (*igapós*) and on the uplands (*terras firmes*). At times the palms are found in almost pure stands, representing, along with *buriti*, the most prominent feature of the vegetation landscape.

One of the characteristics of the species is its growth in clumps, which is the result of basal suckering. The number of individual stems per clump varies according to environmental conditions, and may reach 25, including the suckers. The palm has a thin trunk, sometimes slightly curved, which reaches, on the average, 15–20 m in height. The crown of pinnate leaves with pendulous segments gives the palm its delicate and elegant bearing. For that reason it is not infrequently found in plazas and in private gardens as an ornamental plant.



2. Palm fruits: A, B, *Jessenia bataua*; C, *Astrocaryum vulgare*; D, E, *Bactris gasipaes*; F, *Oenocarpus multicaulis*; G, *Bactris maraja*.

The number of fruit clusters per plant varies up to eight, with three or four being most common. Each cluster is always at a different stage of development, from inflorescences still enclosed in the spathe to clusters with ripe fruit. The fruit is a rounded berry, black-violet in color when ripe, and from 12–15 mm in diameter. Fruiting occurs throughout the year, with the dry season, July to December, being the period of greatest abundance. Fruits from the dry season are said to produce the best-tasting juice. Harvesting the fruit clusters is an arduous and dangerous task, done by individuals accustomed to climbing the *acaí* palms. When someone is atop a palm to harvest the fruit clusters, it is possible to move from one stem to another without descending; in that way all the ripe fruit clusters from a clump can be harvested.

Juice is prepared from the *açaí* fruit, by either manual or mechanical processes, and consumed in the following ways:

a. With manioc meal or with tapioca and sugar (the most generalized use).

b. With manioc meal and grilled fish or dried shrimp.

c. As a porridge (*mingau*), cooked with manioc meal.

d. As an ice cream or popsickle flavoring.

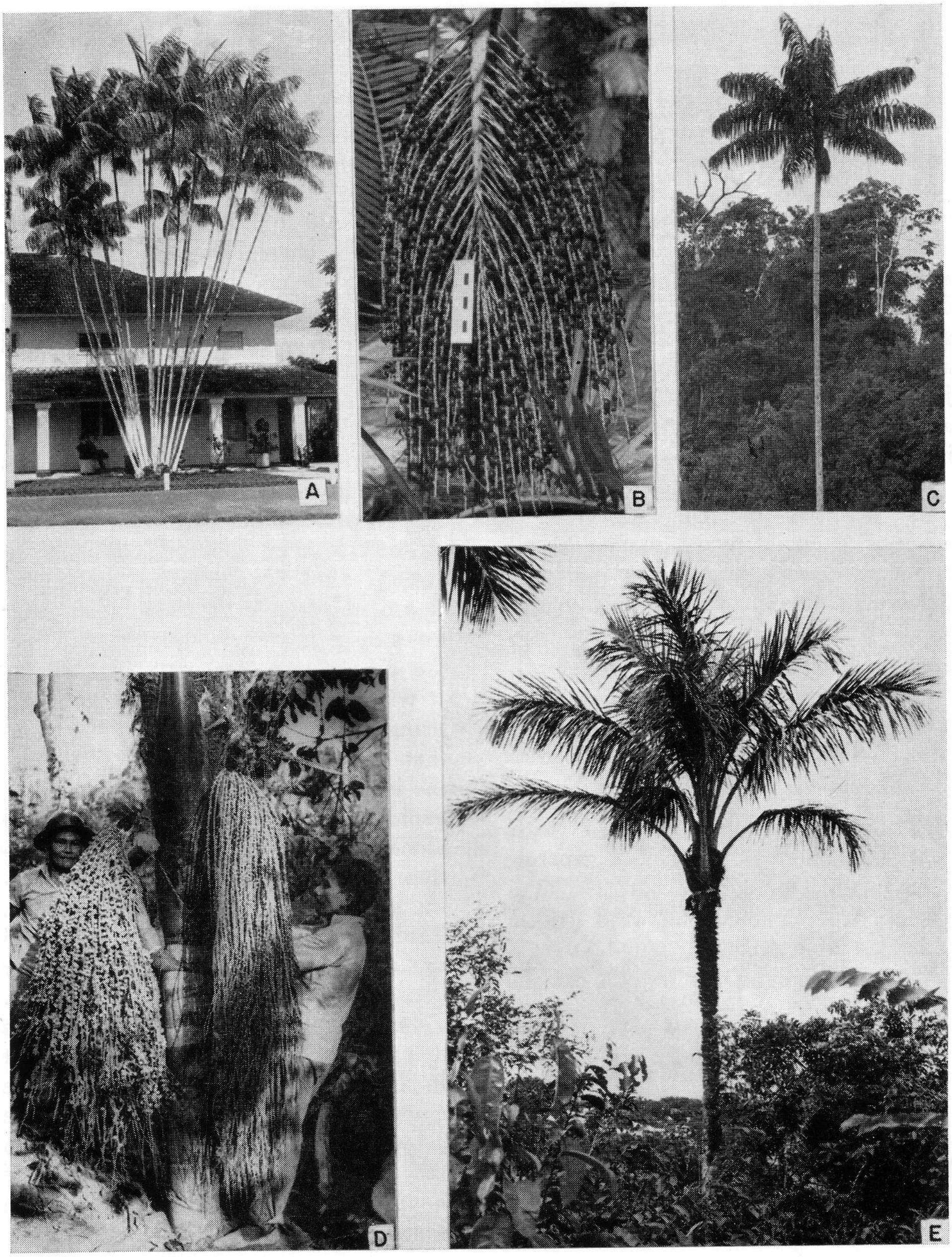
The juice, called simply *açaí*, is a basic complement to the diet of the lower classes and, in most cases, ceases to be merely a complement, but constitutes the principal food, above all in first form listed above.

Chaves and Pechnik (1945: 6), in discussing the nutritive value of *açaí*, said: "The interpretation of analytic data permits us to ascertain it to be an essentially energetic food, with a caloric value higher than that of milk and with a content of lipoids twice as high. It is not very rich in proteides, and the percentage of glycosides is not very high. Nevertheless, *açaí*, as it commonly consumed, with sugar and starch, may be considered a rich food of high caloric value. The content of minerals, calcium, phosphorous, and iron reveals benefit."

Dante Costa (1959: 51) conducted biological experiments with rats, and showed the presence of Vitamin A in *açaí*.

A comprehensive study carried out by Calzavara (1972) addresses all aspects of *açaí* in the Amazon region, notably its economic importance, ecology, agricultural aspects, and methods of cultivation. As far as the chemical composition of the fruit is concerned, Calzavara gives the results arrived at by more than ten different researchers.

Without any doubt, the *açaí* palm brings together exceptional qualities that places it in a primary position as the ideal, highly profitable palm for the exploitation of hearts of palm. One seed alone, after a period of time, can produce a clump of up to 25 palms, counting mature, young, and suckering plants. The mature palms, when they reach old age and die, are gradually replaced by younger plants in a natural sequence. Felling of individual adult palms for the extraction of the heart of palm does not imply, therefore, the destruction of the clump; to the contrary, it stimulates the growth of other plants in the group. On the other hand, the spontaneous and abundant proliferation resulting from fallen seed is another valuable characteristic of the *açaí* palm that encourages its exploitation for the extraction of hearts of palm, without the risk of probable extinction of the *açaí* stands, naturally assuming that rational methods of exploitation are not ignored.



3. Palms and their fruits: A, B, *Euterpe oleracea*; C, D, *Oenocarpus bacaba*; E, *Astrocaryum tucuma.*

Guilielma gasipaes (HBK) Bailey
[**Bactris gasipaes** HBK]
(*G. speciosa* Mart., *Bactris speciosa* (Mart.) Karst.)

PUPUNHA

The most common names in Central and South America are: *cachipay*, *chonta*, *chontaduro*, *gachipaes*, *mecanilla*, and *pejibaye*.

A palm which is native to the Americas, and has been widely cultivated for centuries by native peoples. According to historians, the natives festively celebrated the harvest season of the fruit. The country of origin of the palm continues to be a matter of conjecture, presumed to be Peru, Bolivia, or certain areas of Panama, Colombia, and Ecuador. To Huber (1904: 476), the *pupunha*, known only in its cultivated state, could only be a cross between two distinct species: *G. microcarpa* and *G. insignis*. The variation in size, color, and consistency of the pericarp, as well as the reduction or complete disappearance of spines on the entire plant, would be the supporting elements of Huber's hypothesis. Currently it is rare to find a house in Belém or in the interior that does not have a small planting of one or more clumps of this palm.

Beginning with a single palm, the *pupunha* forms a clump of several individual stems and, when mature, it is common to find three to five palms fruiting at the same time. The individual cylindrical trunk grows to a height of 20 m, and has internodes covered with fine, penetrating spines (except in the unarmed varieties). The *pupunha* is a monoecious palm with masculine and feminine flowers on the same spadix, which is enclosed in a persistent, woody spathe that splits longitudinally to release the spadix. The number of inflorescences per plant varies, and may reach as many as ten.

The fruit is in the form of a drupe, and variable in color and size. When ripe the epicarp may be red, yellow, or other intermediary colors, or even completely green. As to its shape, it is ovoid, conical-globose, or rounded, generally having a flattened base. The mesocarp, the edible part, is generally yellow-orange in color, dense, starchy-succulent, with a fat content higher in some varieties and almost absent in others. Fruits are eaten, after being cooked in salted water, and they are widely consumed by people of the lower class. Besides their popular taste, the fruits constitute a food high in Vitamin A. The cooked fruits can be eaten with coffee, with honey, or in the form of sweets, juice, etc. After harvest, and under normal conditions, the fruits will keep for up to ten days before spoiling.

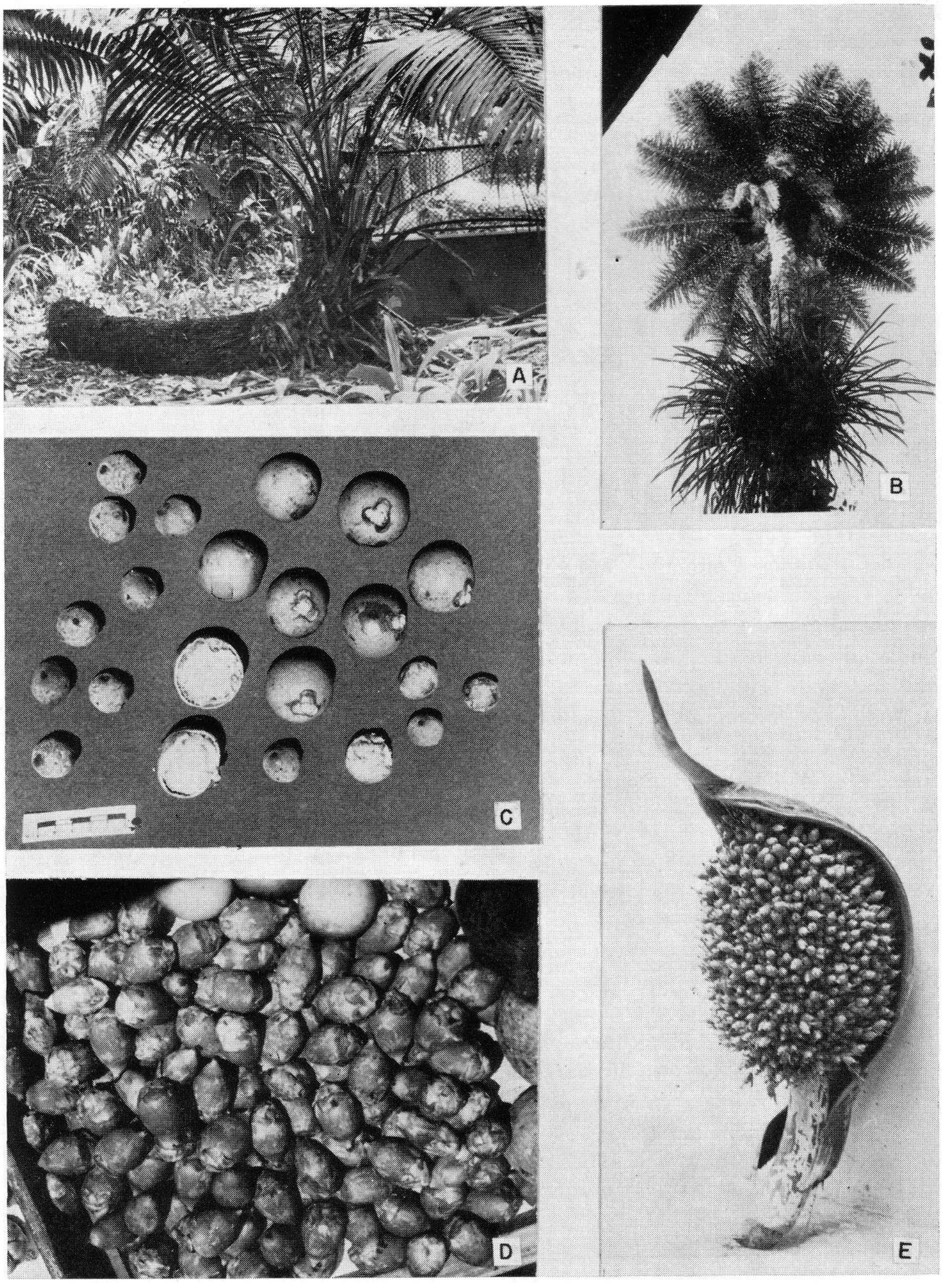
Propagation of the *pupunha* may be accomplished as easily with seed as with basal suckers. Seed propagation has the disadvantage that, many times because of segregation, the desired characteristics are not reproduced and, furthermore, requires a longer period to begin producing fruit. With vegetative propagation using basal suckers, the desired qualities selected for are guaranteed and there is a reduction in the amount of time necessary before fruiting begins. The *pupunha*, furthermore, furnishes an excellent heart of palm, and individual trees can be exploited for it after three to four years.

Appearance of the fruits in the open-air markets begins fairly regularly in November, and continues until June. The peak of the harvest is between March and May.

Jessenia bataua (Mart.) Burret
(*Oenocarpus bataua* Mart.)

PATAUÁ

batawa (Caribbean), *sacumana* (Peru), *palma seje* (Venezuela)



4. Palms and their fruits: A, *Elaeis oleifera*; B, C, *Acrocomia* sp.; D, E, *Maximiliana martiana*.

A palm of medium height, common in the entire Amazon region. Its area of major occurrence is in the less-flooded lands of the central-west portion of the Island of Marajó (Aramá and Anajás).

The fruit is an oblong berry, 25–33 mm long, with the epicarp a purple-violet color, covered by a light bloom. Juice is prepared from the pulp, using the same process followed for *açaí*; this drink, mixed with manioc meal, should be used sparingly because of its high oil content.

The importance of this palm rests, above all, in the oil extracted from the fruit pulp. Fruits are boiled in water to extract the oil, which can be used as a good substitute for olive oil in cooking. As a result of chemical analyses obtained by various authors cited in Pesce (1941: 29), the following statement is made: "By its chemical constants, by its taste and odor when refined, it closely approximates olive oil; . . . In conclusion, *patauá* oil can be considered an excellent edible oil."

Notwithstanding such significant characteristics, *patauá* oil has practically disappeared as a commercial product in Belém, naturally for a simple reason. The palm only exists in a wild state, which results in irregular harvests, and the collection of the fruits is difficult and onerous, a condition which does not exist with the cultivated crops furnishing raw material for the extraction of other oils, such as peanut, soybean, coconut, corn, etc.

The fruits are regularly found in the open-air markets, from October through March, but only in small quantities.

Mauritia flexuosa L. f. MIRITI

buriti, buriti-do-brejo; *moriche* (Venezuela); *palmier bâche* (French Guiana); *aguaje, achual* (Peru)

A majestic palm found throughout equatorial America, occurring in the backswamps (*igapós*), riverbanks, and along narrow channels (*igarapés*), almost always in stands forming the characteristic *miriti* groves. It is indisputably the most beautiful palm of the Amazon.

The trunk is straight, cylindrical, 30–60 cm in diameter, with a slight thickening about halfway up, and commonly reaches 25 m in height, rarely more. The palm has a crown of large, fan-shaped leaves, with pendulous ends of leaf segments. The palm is dioecious or polygamous-dioecious, that is, there are individual plants with masculine flowers and others with feminine and hermaphrodite flowers. Inflorescences are large, 2.5–3 m in length, and protected by a spathe of the same length. The number of inflorescences or fruit clusters varies from five to eight per tree. A *miriti* cultivated in the garden of the Museu Goeldi was observed to produce eight fruit clusters at the same time. One of the clusters was cut and a total of 724 fruits was counted, which gives a figure of about 5,700 fruits on that particular tree.

The fruits are globose or oblong, flattened, with an epicarp consisting of shiny, leathery, red-brown, rhomboidal scales. The mesocarp (the edible part) is a thin layer of oily, orange-colored pulp surrounding the more or less spongy endocarp. The large globose seed has a horny endosperm similar to the vegetable ivory palm (*Phytelephas macrocarpa*) but not quite as hard.

Miriti juice is made from fruits, but they must first be soaked for some time in warm water to facilitate removal of the epicarp and to soften the pulp. Another method is to wrap the fruits in leaves for three to four days which, according to some individuals, gives better results. This "softening" is nothing more than a means of accelerating the ripening of the fruits, inasmuch as they fall from the tree before they are completely ripe. The drink is consumed in the same way as *açaí* juice, that is, with sugar and manioc meal. *Buriti* sweet (*doce de buriti*), as it is best known, is also prepared from the pulp and marketed in other states of Brazil. Finally, it is also possible to obtain a reddish, transparent, edible oil from the pulp.

The *miriti* palm produces several other useful products: the new leaves yield a resistant fiber used to make rope, and are also used to wrap the traditional "ropes" of tobacco. The petiole furnishes a light material used to make corks for large bottles and other receptacles containing sugarcane brandy for shipment outside the region; the light material also has considerable use in making handmade toys seen principally during the festival of the Patron Saint of Pará. From the pith of the trunk an edible starch can be obtained, which is identical to sago starch. In addition, the trunk can be tapped for its potable sap.

Fruits appear in the open-air markets, from January to July, sometimes beginning in October, and other times in November or December.

In Belém, it is common to use the terms *miriti* and *buriti* for this palm, even though the names correspond to two distinct botanical species. The first term is Amazonian and refers to the palm *Mauritia flexuosa.* The term *buriti* is attributed to the species *M. vinifera,* found in the States of Bahia, Minas Gerais, Goiás, Ceará, and Mato Grosso. Although the two species are quite similar, they differ in their individual habitats and the morphological characteristics of their inflorescences and fruits, in conformity with the following:

Buriti (*M. vinifera* Mart.)—grows at altitudes above 500 m, in topographic depressions which have acid soils (Bondar, 1964: 42); male inflorescence is small, fruits ellipsoidal.

Miriti (*M. flexuosa* L. f.)—grows at low altitudes, characteristically in the backswamps (*igapós*) or very wet areas; male inflorescence is larger, fruits generally globose but flattened, with smaller scales.

In many cases, these differences are little noticed by the layman and therein lies the confusion.

Mauritia martiana Spruce CARANÁ
caraná-í, buritirana, burutizinho

This palm is common in the Amazon estuary, generally found in open swampy areas, quite characteristically in the backswamps (*igapós*). It is cespitose, has a thin trunk covered with strong spines over its entire length, and reaches up to 10 m in height. Leaves are circular, consisting of 30–50 linear-lanceolate segments, with the margins adorned with small aculei. Fruits are ellipsoidal, about 3 cm in length, with an epicarp made up of small, rhomboidal scales, arranged in spirals, similar to *M. flexuosa.* A juice is prepared from the pulp of the fruit which has, to some people, a better flavor than that of *miriti.* The process of "softening" the fruit, as well as the way it is consumed, is the same as for *miriti.* Fruiting is from January to June, but the fruits are not always found in the open-air markets.

Maximiliana regia Mart. INAJÁ
[**Maximiliana martiana** Karst.]

This robust palm reaches 10–18 m in height and occupies dry, sandy sites of the uplands (*terras firmes*). It is most common in the Amazon estuary, and extends to the neighboring state of Maranhão, and to Bolivia, Venezuela and Guyana. It has a thick trunk with swellings toward the top, and sometimes in the middle or at the base. Leaves are pinnate, up to 10 m in length and erect, with leaf segments in groups of three, four, or five, standing out in different directions, making the leaves characteristically crispate in appearance. When the leaves die and dry out, they break at the apex of the petiole and thus, for some time, the upper part of the trunk remains enclosed in the persistant leaf bases.

Inflorescences are large and compact, protected by a large, woody, cymbiform spathe which ends in a sharp point. The fruit is an ovoid drupe, 5–6 cm in length, with the tip pointed and the base protected by induviae. The epicarp is leathery, fibrous, covering a viscous, oily pulp which is slightly acid in taste, but agreeable. The endocarp is stony, with 1–3 seeds. These seeds, or kernels, contain about 60 percent oil, which is similar to *babaçu* palm oil (*Orbignya speciosa*), and has many of the same uses. New leaves are widely used to cover the roof and walls of dwellings, and are also used to make various woven objects. In the rubber-gathering areas, the fruits are burned to smoke latex. The woody spathe, when dried, becomes strongly curved and is used as a seat by the Amerindians. Excellent heart of palm can also be obtained from this tree.

Between January and June the fruits are regularly found in the open-air markets, but occasionally also appear from October to December.

Oenocarpus bacaba[1] Mart. BACABA
bacaba-açu, bacaba-verdadeira

This palm is found in the states of Amazonas and Pará (lower Amazon and Jarí rivers) and cultivated in the garden of the Museu Goeldi. It has a solitary, erect trunk, reaching up to 20 m in height. The leaves are crispate and 5–6 m in length. The fruit clusters are robust, about 1.5 m in length, with rounded fruits 1.5 cm in diameter, and an epicarp black-purple in color. Fruiting is in the rainy season of the year, from October to June.

1. All of the *bacaba* palm fruits can be used to make juice, which is prepared and consumed in the same way as *açaí* juice.

Oenocarpus distichus Mart.
BACABA
bacaba-de-leque, bacaba-de-azeite, bacaba-do-pará

This palm is of elegant stature, and one of the most characteristic of the Amazon estuary. It is common in the forest and in areas of second growth of the uplands (*terras firmes*), and its range extends to Maranhão, and to the borders of the states of Goiás and Mato Grosso. The palm grows as an isolated individual plant, up to 10–12 m in height, has a smooth trunk, dilated at the base, and with spaced rings. Leaves are crispate with the sheathing part of the leaf bases elongate and equitant, arranged distichously, that is, in the same plane, in the form of a fan; that characteristic is principal to its easy identification.

The inflorescence is protected by two long, somewhat woody spathes, originating under the lower leaf sheaths. Fruits are rounded or ellipsoidal, 1.5–2 cm in diameter, with a purple-violet epicarp, and yellow-white pulp. The pulp contains 25 percent of a clear, yellow oil that can substitute perfectly for olive oil in its usual cooking usages (Pesce 1941: 34). *Bacaba* juice is a drink of a creamy or milky color, and with a sufficiently good taste (although it has a high oil content).

Fruits are found in the open-air markets beginning in October, and become abundant in the rainy season (January to May), exactly in the period when the *açaí* are scarce, therefore compensating for their lack.

Oenocarpus multicaulis Spruce
BACABA
bacabinha, bacaba-i

This palm occurs in the upper Amazon and in Peru. It has been planted in the garden of the Museu Goeldi where it satisfactorily fruits the year-round. It grows in clumps of 5–10 plants, excluding basal suckers. Trunks are thin, sometimes inclined, 7–10 m in height, with distinctive rings. Leaf sheaths are dark green or chestnut brown. The wood is very hard and is streaked with dark and light fibers, reminding one of the wood of the *acapu* (*Vouacapoua americana*). The fruit is almost round, 2.5 cm in diameter, with a black-purple epicarp and a milky-white pulp. Juice made from the fruits and the fruiting season are the same as in *O. distichus*.

Oenocarpus minor Mart.
BACABINHA
bacaba-mirim, bacabí

This palm is found in the states of Pará and Amazonas, although it is not very common. It is characterized by its small size, as the common name *bacabinha*, which means small *bacaba*, indicates. The palm grows as an isolated individual plant to a height of 5–7 m, a diameter of 4–6 cm, and has small fruit clusters. The fruits are a shiny black color, some 1.5 cm in diameter, have a white pulp, and produce an excellent juice. Its fruiting season is from November to April.

Pyrenoglyphis maraja (Mart.) Burr.
[**Bactris maraja** Mart.] MARAJÁ

This small palm with a thin trunk and the rachis of the leaves aculeate, is common in the swampy areas, riverbanks, and narrow channels (*igarapés*) of the Amazon. The wood of the trunk is extremely hard and for that reason is widely used by the Amerindians in making weapons—arrowheads, lances, blowguns, etc. Fruits are globose drupes, purple-black in color, containing a thin mucilaginous pulp which has a bittersweet flavor, and is generally appreciated as a snack. The fruits appear in the open-air markets from March to June. Various other species of this genus, whether they have edible fruit or not, are also referred to by the name *marajá*.

LITERATURE CITED

BONDAR, G. 1964. Palmeiras do Brasil. Bol. Inst. Bot. São Paulo, No. 2.

CALZAVARA, B. B. G. 1972. As possibilidades do açaizeiro no estuário Amazônico. Bol. Fac. Ciên. Agr. Pará, No. 5.

CHAVES, J. M. AND PECHNIK, E. 1945. O assaí, um dos alimentos básicos da Amazônia. Amapá (mimeograph).

——— AND ———. 1947. Tucumã. Rev. Quim. Ind. 16(184): 1–20.

COSTA, DANTE. 1959. Presença da vitamina "A" no açaí. Bol. Insp. Agr. Pará 9: 53–63.

HUBER, J. 1904. Notas sobre a pátria e distribuição geográfica das árvores frutíferas do Pará. Bol. Mus. Goeldi Hist. Nat. Ethnogr. 4: 375–406.

PESCE, CELESTINO. 1941. Oleaginosas da Amazônia. Belém.

Notes on Embryo Culture of Palms

Don Hodel
Ho'olau, Box 29, Kealakekua, HI. 96750

Embryo culture involves excising an embryo aseptically from the seed and removing it to a sterile nutrient medium for germination. An excellent review of all aspects of general plant embryo culture is covered by Narayanaswami and Norstog (1964). Embryo culture has proved useful for several reasons. Firstly, embryos that would abort if left to develop naturally in the fruit, or embryos resulting from interspecific hybridization where defective endosperms are common, may sometimes be excised at an early stage of development and cultured successfully (Hartman and Kester, 1968). Secondly, embryo culture may be used to circumvent lengthy germination due to physical and/or chemical inhibitors in the fruit and/or seed. Excised embryos are usually freed from these inhibitors and begin immediate growth. Thirdly, green pod culture of orchids is done exclusively by embryo culture (Hartmann and Kester, 1968).

Although much work has been done on embryo culture of other plants, little work has been done on the embryo culture of palms. Rabechault (1962) studied the effects of indoleacetic acid on *in vitro* cultures of *Elaeis guineensis* embryos, while Abraham and Thomas (1962) and Cutter and Wilson (1954) cultured *Cocos nucifera* embryos. Guzman and Rosario (1964) cultured embryos of the 'Makapuno' cultivar of coconut and Balaga and Guzman (1970) and Guzman, Rosario, and Eusebio (1970) investigated root and shoot development of the 'Makapuno' cultivar in response to varying compositions of rooting media. Embryo culture may prove valuable to palm enthusiasts for several reasons. Embryos resulting from interspecific or intergeneric hybridization in palms (as currently being undertaken by Merrill Wilcox at Gainesville, Florida) may be improperly nourished due to a defective endosperm. Perhaps this problem can be overcome using embryo culture. Some palms, such as *Arenga engleri*, *Orbignya* spp., and *Attalea* spp., are notorious for slow germination due to physical inhibitors in the fruit, e.g., a thick endocarp, or chemical inhibitors in the seed. Perhaps if the embryos were excised and removed from these inhibitors they would germinate readily. Also, collectors of palm seed, especially of rare species, may find embryo culture of benefit. Often collectors are stymied by lack of ripe fruit but perhaps it may be worthwhile to collect unripe fruit. Although difficult, it may be possible to culture immature embryos, as these have been cultured successfully in other plants (Maheshwari 1962, 1963; Narayanaswami and Norstog 1964).

The impetus for my own study comes from a desire to devise a method for rapid multiplication of common palms. Embryo culture might lead to rapid multiplication if multiple adventitious shoots or embryos could be stimulated to form from one embryo. Formation of multiple adventitious shoots is common in green pod culture of orchids and has been observed in other plants by Maheshwari (1962, 1963) and Narayanaswami and Norstog (1964). Other workers have attempted to devise methods for rapid multiplication of palms by vegetative means. Davis (1969) suggested that coconuts be propagated by artificially splitting the growing point, by inducing the inflorescences to revert to vegetative shoots, or by inducing formation of bulbil-shoots on inflorescences. Success by such methods is rare and unpredictable.

Methods

Embryos of *Pritchardia kaalae* Rock and *Veitchia joannis* H. Wendl. were utilized. Embryos were aseptically excised and placed on a sterile, modified Vacin and Went medium for orchids (see Table 1). For one who lacks access to a laboratory, any of the commercial formulae available from orchid firms will suffice. The following procedures were then followed:

1. Fruit and instruments were cleansed in 95% ethyl alcohol.
2. Mesocarp and endocarp were removed using ordinary horticultural clippers.
3. Endosperm with embedded embryo was immersed for 2 seconds in 95% ethyl alcohol.
4. Embryo was excised (using a scalpel dipped in 95% ethyl alcohol and flamed) into a 5% Clorox solution for 5 minutes and then to a 1% Clorox solution for 1 minute.
5. Embryo was placed in culture tubes on a sterile medium and placed under a 40-watt Gro-Lux lamp at 85°F. Contamination will show after 48 hours.

If one has mastered aseptic excision, the Clorox baths may be eliminated. Working under a hood and filtered-air-flow apparatus is desirable but not essential, for I have excised embryos while simply sitting at a desk in a draft-free room.

Nutrient requirements for sterile media are similar to requirements of other plants. However, as more work is done on nutrient composition, species-specific media will be developed. I did not include coconut water in my modified Vacin and Went formula, for I wanted to eliminate as many unknowns as possible and to arrive at a relatively simple medium. Coconut water did not prove to be essential for growth of fully developed embryos.

Embryo age is important when considering nutrient requirements. The developing embryo becomes more and more able to germinate and its cultural requirements become less complex as it develops. Embryo culture at early stages of embryonic development is difficult. Ironically, these stages hold the most

Table 1. Components of a modified Vacin and Went medium.

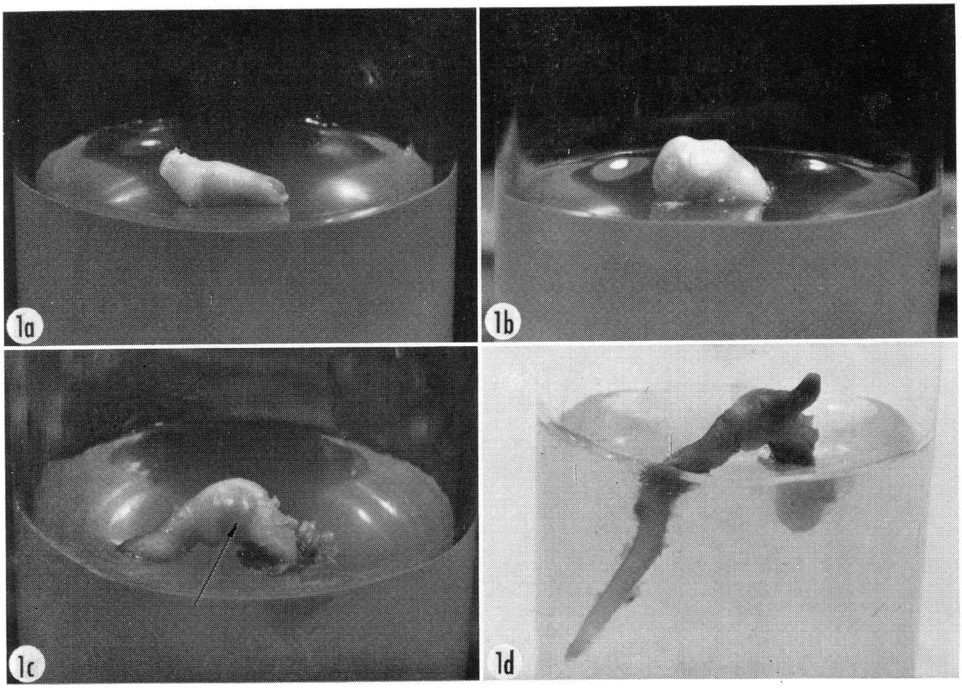
Components	Amount	
Tricalcium phosphate $Ca_3(PO_4)_2$	0.20	grams
Potassium nitrate KNO_3	0.525	grams
Monopotassium acid phosphate KH_2PO_4	0.25	grams
Magnesium sulfate $MgSO_4 \cdot 7H_2O$	0.25	grams
Ammonium sulfate $(NH_4)_2SO_4$	0.50	grams
Manganese sulfate $MnSO_4 \cdot H_2O$	0.0057	grams
Sucrose	20.00	grams
Agar	8.00	grams
EDTA (chelated iron)	5	ml/1
Water	850	ml
Coconut water (optional)	150	ml
Adjust pH to 5.8–6.0		

promise for formation of adventitious shoots. Attaining the correct nutrient balance of inorganic elements, sugars, vitamins, and organic complexes found in coconut water for culture of young embryos is difficult and may be species-specific. On the other hand, fully developed embryos need only inorganic elements and sugar, and as they grow, even the sugar may be eliminated.

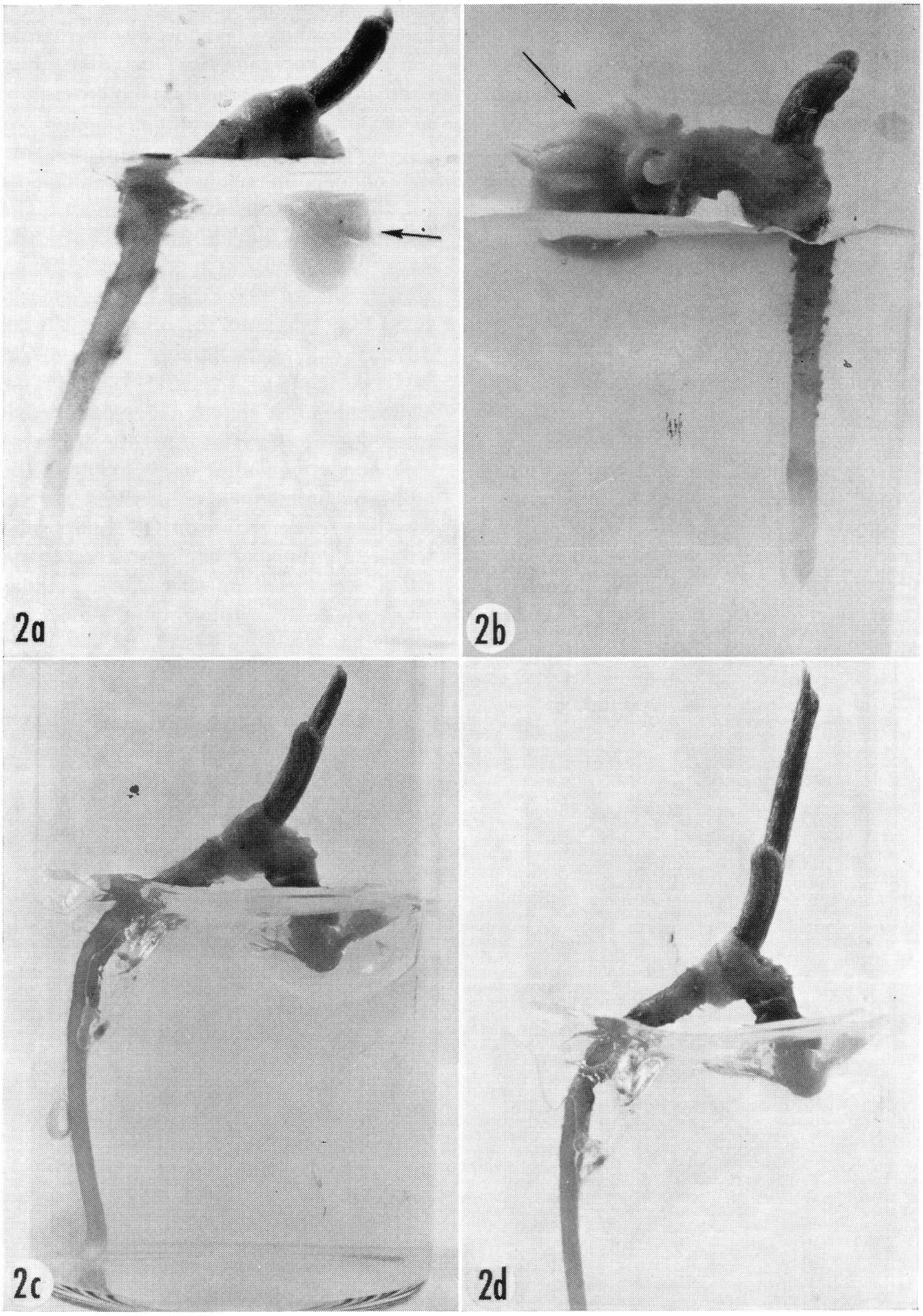
Observations

Figure 1a shows the embryo of *Pritchardia kaalae* after excision. Within 48 hours of excision, the embryo began to swell (Fig. 1b). This initial swelling is to exert the shoot and root primordium beyond the seed, enabling them to grow unhindered (Tomlinson 1961). Ten days after excision a well-developed root is visible as well as a green, domelike structure covering the shoot (arrow, Fig. 1c). Seventeen days after, the first green, sheathlike leaf has emerged from the domelike structure (Fig. 1d). Figures 2a and 2b (arrows) show development of the modified cotyledon or haustorium. This structure grows into the endosperm to assimilate nutrients for the developing root and shoot. The second sheathlike leaf appeared after 35 days (Fig. 2c). Fifty days after excision the third sheathlike leaf is emerging (Fig. 2d) and the seedling is well on the way to producing its first flat leaf.

Embryos of *Veitchia joannis* developed in the same manner as those of *Pritchardia kaalae*. Figure 3a shows the embryo immediately after excision. Swelling occurred after 48 hours and within 14 days of excision a root and shoot were evident (Fig. 3b). Figure 3c shows an emerging root and root cap.

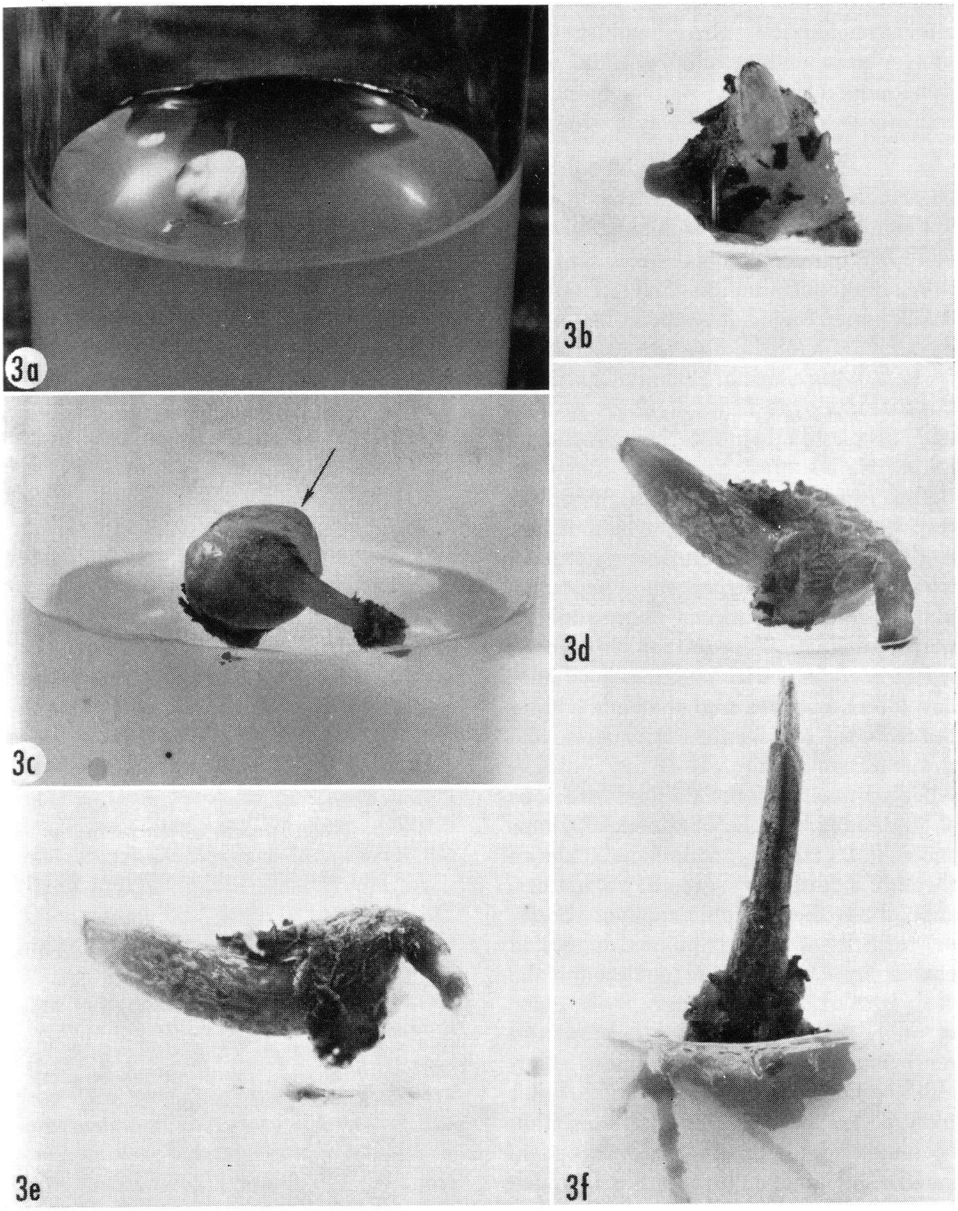


1. *Pritchardia kaalae.* a, embryo after excision; b, embryo 48 hours after excision; c, embryo 10 days after excision, showing root and area of future shoot (arrow); d, embryo 17 days after excision. Photos by Kheng Tuan Cheah.



2. *Pritchardia kaalae.* a,b, embryo showing haustorium (arrow); c, embryo 35 days after excision; d, embryo 50 days after excision. Photos by Kheng Tuan Cheah.

Notice the swelling on the upper right portion of the embryo (arrow). This is an area of future shoot growth. Figure 3d shows development 28 days after excision. Thirty-five days after excision the second sheathlike leaf has appeared (Fig. 3e). At this point I positioned the embryo so it was situated with its shoot in a vertical rather than horizontal position. At the same time I embedded



3. *Veitchia joannis*. a, embryo after excision; b, embryo 14 days after excision; c, embryo showing root, root cap, and area of future shoot (arrow); d, embryo 28 days after excision; e, embryo 35 days after excision; f, embryo 50 days after excision. Photos by Kheng Tuan Cheah.

the base of the embryo in the medium where before it was simply lying on the medium. This produced a marked increase in growth due to more root contact with the medium and subsequently more absorption of nutrients. Fifty days after excision the third sheathlike leaf was evident and secondary roots were developing (Fig. 3f). At this point the seedling was well on the way to the production of its first bifid leaf.

Conclusions

From preliminary results, I feel that embryo culture holds promise for shortening germination time. *In vitro* development of shoots took 14 to 21 days for *Pritchardia kaalae* and *Veitchia joannis*, while normal germination times are 30–45 days. More work is needed with species known for their slow germination.

It was found that cultures should be transflasked to fresh, sterile nutrient media every month until they attain true leaves. Then they may be transplanted into conventional potting mixes.

Other results showed that coconut water is not essential for growth of fully developed embryos and that embedding the embryo in the medium increased the growth rate.

Development of multiple adventitious shoots remains to be obtained. Perhaps successful results will be achieved through addition of growth regulators, subculture of embryonic roots or shoots, or refinement of techniques suggested earlier by Davis (1969). Perhaps the real breakthrough, though, will come through the use of tissue culture and meristem cloning as is common in orchids, chrysanthemums, and other plants. Staritsky (1970) showed that coconut and oil palms could be propagated by tissue culture but that much work is still needed.

Embryo culture can be interesting work for the palm enthusiast. It opens to view a phenomenon rarely seen, the actual development of a palm from embryo to seedling.

Literature Cited

Abraham, A. and K. J. Thomas. 1962. A note on the *in vitro* culture of excised coconut embryos. Indian Coconut J. 15: 84–88.

Balaga, H. Y. and E. V. de Guzman. 1970. The growth and development of coconut "Makapuno" embryos *in vitro*. II. Increased root incidence and growth in response to media composition and to sequential culture from liquid to solid medium. Philipp. Agric. 53: 551–565.

Cutter, V. and K. Wilson. 1954. Effect of coconut endosperm and other growth stimulants upon the development *in vitro* of embryos of *Cocos nucifera*. Bot. Gaz. 115: 234–240.

Davis, T. A. 1969. Clonal propagation of the coconut. World Crops 21: 253–255.

Guzman, E. V. de and D. A. del Rosario. 1964. The growth and development of *Cocos nucifera* L. (Makapuno) embryos *in vitro*. Philipp. Agric. 48: 82–94.

Guzman, E. V. de, A. G. del Rosario, and E. C. Eusebio. 1970. The growth and development of coconut "Makapuno" embryo *in vitro*. III. Resumption of root growth in high sugar media. Philipp. Agric. 53: 566–579.

Hartman, H. and D. Kester. 1968. Plant propagation principles and practices. Prentice Hall, Inc. Englewood Cliffs, N.J.

Maheshwari, P. 1962. Plant embryology: a symposium. Council of Scientific and Industrial Research. Delhi, India.

———. 1963. Recent advances in the embryology of angiosperms. Int. Society of Plant Morphologists. University of Delhi, India.

Narayanaswami, S. and K. Norstog. 1964. Plant embryo culture. Bot. Rev. (Lancaster) 30: 587–628.

Rabéchault, H. 1962. Recherches sur la culture "in vitro" des embryons de palmier à huile (*Elaeis guineensis* Jacq.) 1. Effets de l'acide β indolyl-acetique. Oléagineux 17: 757–764.

Staritsky, G. 1970. Tissue culture of the oil palm (*Elaeis guineensis* Jacq.) as a tool for its vegetative propagation. Euphytica 19: 288–292.

Tomlinson, P. B. 1961. Anatomy of the monocotyledons II. Palmae. Oxford University Press, London.

Unique Setting of Roystonea in the Bahamas

William T. Gillis
Biology Department, Hope College, Holland, MI 49423

Earlier, Gillis, Proctor, and Avery (1975) reported *Roystonea* for the first time in the Bahama Islands. At that time the royal palms had been seen by the writers only from the air. A trek back through the bush to the royal palm site by Mr. Donald Buden had netted some fruits from the trees and had confirmed their identity.

Under the auspices of an expedition from the Carnegie Museum of Natural History, the author has had the opportunity to visit the royal palms and examine their habitat on Little Inagua Island. The purpose of this paper is to describe their setting, which appears to be unique in the Bahamas.

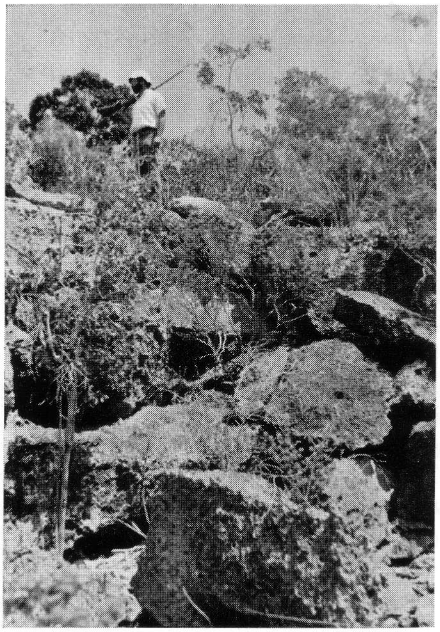
During a visit to Little Inagua by boat in mid-March 1976, Mr. Harry Clench, Mr. Arthur Bianculli, and I hiked back from the coast to visit the royal palms. We were fortunate in finding the trail through the bush which Mr. Buden had cut fourteen months previously, enabling us to make the trip in four hours, whereas it had taken Buden seven half-days to cut the trail initially.

The royals are found in five or six giant sinkholes, all in the northwest quadrant of the island, all about 2.5–3.0 miles south of the north coast and about the same distance from the west shore. There is no anchorage on the north or east coasts, hence, any assault on the island has to be made from the southwest or west shore. The path which we followed enters from the west. It meanders somewhat, following burro trails for the most part, and covers an estimated five miles.

From the coast one climbs a low foredune. Immediately behind the dune is a rocky swale, dominated by thatch palms (*Coccothrinax inaguensis* and *Thrinax morrisii*), manchineel (*Hippomane mancinella*), various cacti (*Melocactus intortus*, *Opuntia nashii*, etc.), and typical scrub of the dry, southeast Bahamas. (It is estimated that less than 25 inches of rain falls on Little Inagua per year, but there are no rain gauges for accurate measurement.) There is no soil development in this swale, all plants growing in solid coral limestone.

Behind the swale is a curious ridge of coral boulders that forms the face of an undulating plateau that comprises the bulk of the interior of Little Inagua (Fig. 1). Whether the boulders have eroded in place on the face of the plateau (the most logical explanation) or were piled there by fierce storms in the past (the explanation which best fits their appearance) is unknown. This ridge, however, is more or less continuous along the entire west side of the island and to a large extent, the south and north coasts as well. We have not been able to visit the east shore.

Mounting the ridge, which is six to ten meters in height, one emerges onto the central plateau. The vegetation is all mixed scrub over head height with an occasional mahogany (*Swietenia mahagoni*) or poison wood (*Metopium



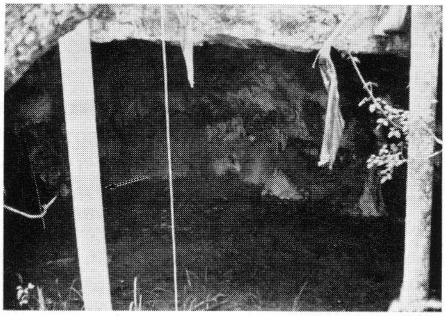
1. View of 10-meter boulder facing of plateau, Little Inagua. Mr. Arthur Bianculli, 1.75 meters tall, is the scale.

2. Royal palms shown towering above sinkhole and surrounding vegetation.

toxiferum) projecting above the rest. It was by climbing to the top of an occasional emergent that we could see the royal palms, even from the edge of the plateau. The royals tower as much as 12–13 meters above the surrounding terrain, so it is no small wonder that they can be seen from such a distance (Fig. 2).

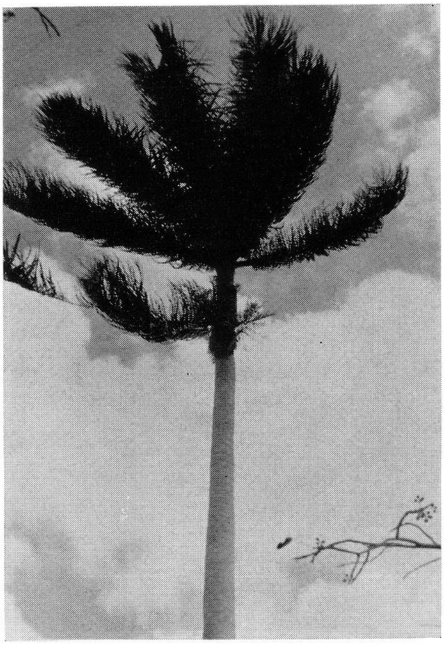
The scrub is dense, dominated by poison wood, boxwood (*Buxus bahamensis*), grandfather cactus or dildo cactus (*Cereus bahamensis*), pigeon plum (*Coccoloba diversifolia*), *Caesalpinia bahamensis, Vernonia arbuscula, Bursera inaguensis, Lantana involucrata,* and *Amyris elemifera.* The final half-mile was the roughest. The scrub became more dense, the dogtooth limestone sharper and more uneven, and the prickly vine (*Oplonia spinosa*) increased markedly. It was almost as if nature had intended to protect the royal palms from intrusion by the infidel, man. At last we reached the amazing sinkholes in which the royals live.

The sinkhole which we visited is about 25 meters long and 10 meters wide. It is also about 8–10 meters deep (Figs. 3 and 4). The royals are rooted in the bottom and yet, still



3. Interior of sinkhole showing organic soil and standing water. Arrow indicates royal palm trunk. To the right of the trunk is an aerial root of *Ficus.*

4. *Roystonea hispaniolana* as seen from edge of sinkhole. Note juvenile royal palm at bottom of hole.



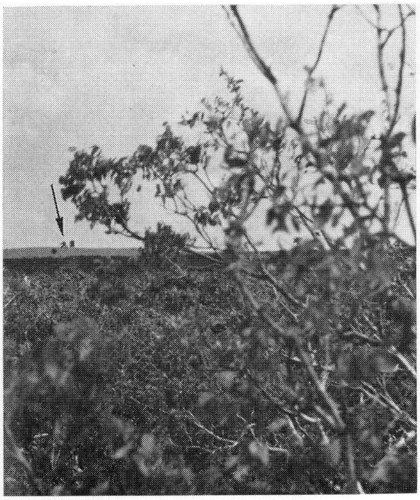
5. *Roystonea hispaniolana* growing from sinkhole on Little Inagua.

tower 12–13 meters out of the holes. The hole we examined had six mature royals in it and one juvenile (about 5 meters tall), plus several mahoganies. The bottom was covered with a layer of organic matter and some mineral soil, a unique feature for the island. Generally moist, the soil supports a stand of sawgrass (*Cladium jamaicense*) and wild coffee (*Psychotria ligustrifolia*) in addition to the tree species. There is also potable standing water beneath the overhanging walls and roof of the sinkhole, another unique feature for the island. Other than a few blue holes seen on aerial photographs, we know of no fresh standing water on this dry island.

The margins of the sinkholes are undercut with shallow caves. On the top edges of the holes are a number of short-leaved figs (*Ficus citrifolia*) whose aerial roots hang down into the hole, often becoming rooted in the moist medium for growth at the bottom. As a consequence the figs are healthier and more robust than the surrounding vegetation which has not tapped into the abundant water supply in the sinkhole. We judge this water to be entirely from rainfall and not from any springs.

How did the palms reach Little Inagua? They appear to be royals of a Hispaniolan affinity, *Roystonea hispaniolana* L. H. Bailey (see Fig. 5), rather than of a Cuban affinity as suggested earlier (Gillis *et al.*, 1975). In either case their disseminules must have been transported to Little Inagua by birds. Such birds—long-distance fliers —may have visited these sinkholes specifically to obtain water. Failing that, the seeds, probably after passing through the gut of the birds, may have been broadcast over the landscape

6. Royal palm seen from 200 meters distant through the scrub vegetation.



7. Vista across Little Inagua landscape as seen from top of mahogany tree. Royal palms indicated by arrow in distance.

of eastern Inagua and Little Inagua through the centuries, finding suitable site for growth only in the bottom of the sinkholes. As would be expected, some of the royal palm sinkholes also have *Sabal* palms in them; the sabals probably arrived in the same manner as the royals. The oldest of the royals appears to be more than a century old. It is possible that a single successful introduction may account for all the royals present today; of course, repeated introductions may have taken place.

One might enquire if the source of the palms might have been man's introduction. There is no evidence of man's prior subsistence on Little Inagua, although men from former nearby settlements on adjacent Inagua were known to have introduced the burros which we heard and saw droppings of (but never saw in the flesh). They also introduced boars which have naturalized on the island, and they may have introduced goats. Unless primitive man had stumbled on the royal palm sinkholes or others like them, he would have had no source of fresh water. There is no evidence of habitation near the holes. Local lore in Matthew Town, the only extant settlement on Great Inagua, about 60 air miles southwest of Little Inagua, suggests that there are royal palms in similar habitats on Great Inagua. We have flown the length of Great Inagua several times searching for such phenomena, but have not seen them. Perhaps the local folk have stands of buccaneer palm (*Pseudophoenix sargentii* subsp. *saonae*) in mind. But then, the eastern half of Inagua is as much a mystery as most of Little Inagua, there having been no naturalist into the middle of the island, save for along one seven-mile stretch of recently constructed road east of the lake (called Lake Windsor on old maps and Lake Rosa on contemporary ones) that is the home of many thousand flamingoes.

We mused earlier (Gillis *et al.*, 1975) as to the reason why these palms had not been discovered earlier. It is now obvious. Despite their imposing, towering height, the surrounding vegetation (over head height) effectively blocks the view of the royals until one is but 200 meters or so from them (Fig. 6). From the shore, the ridge and vegetation block the view. Only by climbing a tree on the plateau, and then only within six miles or so from the palms, would it be likely that they could be picked out against the background. From the west they are silhouetted not against the sky, but against a hill in the background where the palm fronds are seen against a background of green scrub (Fig. 7). Had Nash and Taylor, or Percy Wilson, the earlier botanist visitors to Little Inagua, been looking specifically for the royals, they could have seen them from a tree top. Had they been lulled into the belief that the plateau was uniform in its vegetation mixture, they would never have thought to look for this palm treasure against the sky, not having found it on any other island.

So intriguing is this feature and, indeed, the entire island, that we shall propose preservation of it to the Bahamas National Trust. Despite the fact fact that we saw no butterflies for lepidopterist Harry Clench once we left the coastal region, he felt the trek to the royals was the highlight of our five-week trip through the Bahamas. Seeing the spectacular royals rising majestically out of their subterranean home was indeed worth the arduous hike through the bush and thorny vines.

Acknowledgments

Photographs contained herein were processed by Mr. John Lupo of the Biological Laboratories of Harvard University from colored slides taken by the author. I am indebted to Dr. Mary Clench, scientific leader of the expedition to the Bahamas from the Carnegie Museum, for including Little Inagua on the itinerary. Sponsors of the expedition include the World Wildlife Fund and the M. Graham Netting Fund of the Carnegie Museum. Determination of the species as *R. hispaniolana* was made by Dr. Robert W. Read, whose assistance in this matter is greatly appreciated.

Literature Cited

Gillis, William T., George R. Proctor, and George N. Avery. 1975. Indigenous royal palms in the Bahamas. Principes 19: 104–105.

Nash, George V. 1905. Botanical exploration of the Inaguas, Bahamas. Journal of the New York Botanical Garden 6: 1–19.

Germination of Jubaeopsis caffra Seeds

B. L. ROBERTSON AND J. G. C. SMALL
Department of Botany, University of Port Elizabeth, P.O. Box 1600, Port Elizabeth 6000, Republic of South Africa

Abstract

Preliminary work indicated that fresh, viable seeds of *Jubaeopsis caffra* failed to germinate promptly under normal incubation conditions. Subsequent studies showed that none of the covering structures (including the thick, hard endocarp) are impermeable to oxygen and water, but that an increased oxygen tension markedly improved germination. The addition of endosperm to the nutrient medium of excised embryos in culture inhibited the growth of these embryos. It is considered possible that a factor inhibiting germination, and which can be overcome by a high oxygen tension, might be present in the endosperm. Maximum germination was achieved by sowing seeds in coarse sand with a 14 percent (oven-dry basis) moisture content at 25°C in pure oxygen.

According to Good (1964), more than 90 percent of all palm species enjoy very limited distribution and occur naturally only in small areas. *Jubaeopsis caffra* Becc. is no exception. It is perhaps one of the palm species with the most restricted distribution in that it is confined to the northern banks of the Mtentu and Msikaba estuaries in Pondoland on the east coast of South Africa (Robertson and Visagie, 1975). These authors ascribe the rarity of *J. caffra* largely to the lack of viable seeds or, at least, to the apparently very specific requirements of the seeds for successful germination.

A preliminary study of the germination pattern indicated that under normal conditions seeds fail to germinate, and further research was conducted, firstly, to try and establish the possible cause of this failure, and secondly, to ascertain the optimum requirements for successful germination.

Procedure

The detailed procedure for each experiment will be given together with the results to avoid confusion. However, a few general procedures were used throughout and are presented here.

All germination experiments were conducted in Controlled Environments model E 7H growth cabinets. Temperatures were maintained within 0.5°C of the programmed conditions and incubation was conducted in total darkness.

For the culturing of excised embryos, a modified White's nutrient solution for plant tissues (White, 1963) was used as culture medium. Each liter of the culture medium contained the following compounds:

Sucrose	20.0 g
$Ca(NO_3)_2 \cdot H_2O$	0.3 g
KNO_3	0.08 g
KCl	0.065 g
$MgSO_4 \cdot 7H_2O$	0.75 g
Na_2SO_4	0.2 g
$NaH_2PO_4 \cdot H_2O$	19.0 mg
$Fe(SO_4)3$	2.5 mg
$MnSO_4 \cdot 4H_2O$	5.0 mg
$ZnSO_4 \cdot 7H_2O$	3.0 mg
H_3BO_3	1.5 mg
KI	0.75 mg
$CuSO_4 \cdot 5H_2O$	0.01 mg
MoO_4	0.001 mg

The fruit of *J. caffra* is a drupe with a thick, hard endocarp covered by a fibrous mesocarp. In all the experiments, the mesocarp was removed prior to use, while the endocarp was left intact.

Results

(a) *Preliminary experiments*

Preliminary experiments were conducted to establish whether seeds would germinate under normal conditions and to ascertain whether the fresh seeds were in fact viable. In the first of these experiments, dehusked seeds were half-buried in coarse sand, watered daily, and incubated in the dark at 25°C.

Concurrently, excised embryos from the same batch of seeds were cultured in White's medium. Thirty milliliters of White's medium were placed in 100 ml conical flasks, stoppered with nonabsorbent cotton wool and sterilized by autoclaving for 30 minutes at a pressure of 1 kg/cm^2. Seeds were surface-sterilized by immersing them in 0.2 percent $HgCl_2$ for five minutes and subsequently washing them very thoroughly with autoclaved water. The endocarp was then cracked in a vise and the embryo excised aseptically. One excised embryo was placed into each flask and incubated on a Kotterman orbital shaker in an E 7H growth cabinet at 25°C.

None of the sown seeds had germinated at the end of a three-month incubation period. However, the excised embryos showed immediate signs of growth and increased their mean length from 5.16 mm to 29.0 mm in 32 days (see also Fig. 2). From these results it is clear that fresh seeds were viable but remained dormant under the experimental conditions.

Because *J. caffra* seeds are enclosed within a hard, thick endocarp (Robertson, 1977), moisture and oxygen uptake of the seeds was subsequently investigated. Following these experiments, the possible presence of a germination inhibitor in the endosperm was investigated.

(b) *Moisture absorption by the nut, kernel and endocarp*

This experiment involved the establishment of the rate of water absorption by the seed with and without the endocarp and by the endocarp itself. (The term "nut" used in this section refers to a seed enclosed within an intact endocarp.)

The seeds used had been air-dried at ambient temperature (approximately 20°C) for 25 days after harvesting. At this stage they were 14.58 percent lighter than fresh material. This loss of mass constitutes 79.4 percent of the moisture that can be lost by *J. caffra* seeds through air-drying and consequently the seeds used in the experiment were considered to be dry. Five intact nuts (i.e., kernels with unbroken endocarp), five kernels (endosperm plus embryo with endocarp removed), and the endocarp shells of five fruits were weighed. The three groups of material were then soaked in water at 25°C. The water was changed daily and the mass of each category was recorded at various times in the 16 days during which the experiment was conducted. The mass increase of each category is expressed as a percentage of the air-dried mass of that category. The results are shown in Figure 1A, B.

From these figures it can be seen that the absorption rate of the intact nut was fairly high during the first six days of imbibition. Absorption of water continued after this time, but at a very much reduced rate. Sixteen days after commencement of the experiment, the mass of the seeds had increased by 22.5 percent. This represented an absorption of 2.4 g of water per nut (Fig. 1B).

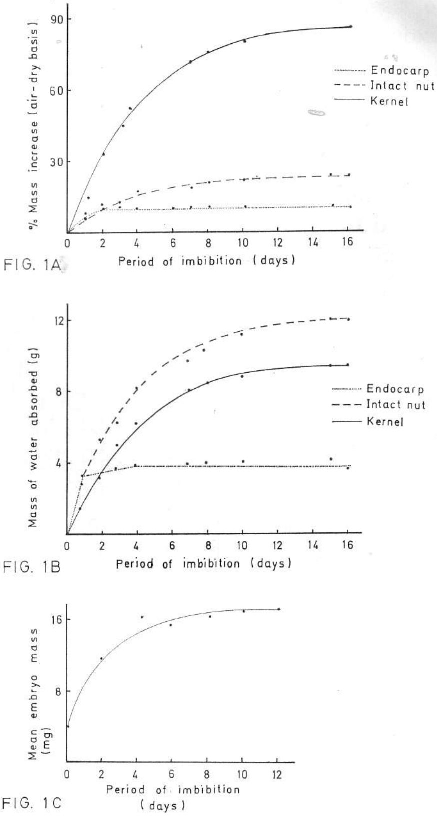
The endocarp fragments or shells absorbed water extremely rapidly and were fully saturated within two days. At this stage the percentage increase in mass was 10.5 percent. The endocarp of a single nut absorbed only 0.75 g of water. Relative to the other two categories, the absorption of the kernel was very high and after imbibing for ten days, the mass of these kernels increased by 79 percent. After sixteen days the increase in mass rose to 85 percent. This however, represented an absorption of only 1.92 g water per kernel.

Although the endocarp absorbed water very rapidly during the first two days of imbibition, it became just as rapidly saturated and it was incapable of absorbing more than 10.5 percent of its own mass in moisture (Fig. 1A). The intact seed however, absorbed moisture at a rate only slightly slower than that of the endocarp, but over a much longer period and as is shown in Figure 1A, the mass of the nut was still increasing after 16 days imbibition. The amount of water absorbed by the seed was therefore somewhat larger than that absorbed by the endocarp alone, viz. 12.2 g for five seeds as opposed to 4.0 g for the endocarp of five nuts (Fig. 1B).

The difference in the mass of water absorbed by the intact nut and that absorbed by the endocarp alone must be attributed to absorption by the kernel. This is confirmed by the data presented in Figures 1A, B. The great absorptive power of the endosperm is demonstrated not only by the fact that the mass of the kernel increases by 85 percent during 16 days of imbibition (Fig. 1A) but also that between 66 and 75 percent of the total moisture absorbed by the intact nut is absorbed by the kernel (Fig. 1B).

It is interesting to note too that during the first day of imbibition, the rate of absorption of the endocarp is precisely the same as that of the intact nut (Fig. 1B). This suggests that during this initial period, all the moisture absorbed by the nut is retained by the endocarp and that the kernel receives moisture only from the second day onwards, as the endocarp nears saturation point. It is evident from this experiment that the endocarp is permeable to water.

To establish whether absorbed moisture was reaching the embryo, a further experiment on 35 air-dried kernels was conducted. Five of these were dissected and the excised embryos weighed while the other 30 kernels were soaked in



1. The absorption of moisture (A); the amount of water absorbed by five air-dried nuts, kernels, and endocarp of *J. caffra* (B); and absorption of moisture by the embryo while still in the endosperm kernel (C).

water, which was changed daily. After every two days of soaking, five kernels were removed and their embryos excised and weighed. This pattern was continued for a total of 12 days. In this way the absorption rate of the actual embryo was ascertained. These results are reflected in Figure 1C. It is evident that the embryo within the intact seed increased in mass. This is evidently due to moisture uptake.

An experiment in which embryos were soaked in water and weighed at the same intervals as above, showed that the initial rate of water uptake was greater than in the case of embryos in intact seeds. The excised embryos were fully imbibed within two days. However, the final mass was approximately the same as that of embryos in intact seeds.

From the above results it is concluded that the seeds are permeable to water.

(c) *Effect of oxygen on respiration of the seed*

The aim of this experiment was to determine whether an increased oxygen tension would affect oxygen uptake by the seed. Although indirect, this procedure would give some indication of the permeability of the covering structures to oxygen.

Fresh nuts were immersed in water for eight days, with a daily change of water. Thereafter the nuts were air-dried in the laboratory for one day and their respiration determined on a Gilson Differential Respirometer at a constant temperature of 25°C. Owing to the large size of *J. caffra* seeds, standard respirometer flasks could not be used and special large flasks, which could each hold three seeds, were constructed.

Oxygen uptake in air and in pure oxygen did not differ significantly (Table 1) indicating that the covering structures are sufficiently permeable to permit oxygen uptake from the air.

Table 1. Oxygen uptake of J. caffra *seeds in air and pure oxygen*

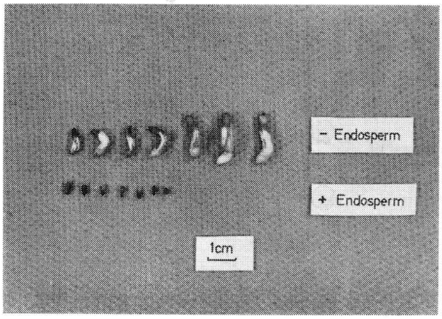
Treatment	O_2 uptake (μl/hr/g (oven-dry basis)).
Air	9.69
Pure O_2	10.96

(d) *Inhibitory effect of endosperm on growth of excised embryos*

Wareing (1969), Egley (1972) and van de Venter (1974) all state that, in certain cases, germination inhibitors which induce and maintain dormancy are present in the tissues of the seed surrounding the embryo. In view of the fact that excised *J. caffra* embryos grew satisfactorily in culture and the covering structures apparently did not inhibit the uptake of moisture and oxygen, an experiment was performed to test the effect of endosperm on the growth of excised embryos.

Twenty embryos were excised from five-week-old seeds, sterilized as described previously, and placed in White's modified medium in conical flasks. Whole kernels were sterilized by immersing them in 0.2 percent $HgCl_2$ for five minutes and subsequently washing them very thoroughly with autoclaved water. The kernels were then cut in half, their embryos discarded, and half a kernel added to each of ten flasks while the remaining ten flasks served as controls for the experiment. Incubation took place in the dark at 25°C and the trial was terminated after 17 days.

During the course of the experiment, 30 percent of the control embryos and 10 percent of the embryos in the endo-



2. Excised embryos of *J. caffra* cultured for 17 days in a liquid nutrient medium with and without endosperm.

sperm treatment became infected with microorganisms and were discarded.

At the end of the experiment the mean embryo mass of the control embryos was 118.17 mg while that of the embryos cultured with endosperm was only 6.1 mg. Mean embryo lengths were 1.43 cm and 0.36 cm respectively (Fig. 2).

These results indicate that the endosperm might contain a factor which inhibits the growth of excised embryos. Whether this factor functions to induce dormancy in intact seeds requires further study.

(e) *Experiments to establish optimum conditions for seed germination*

In oil palm seeds, oxygen tension, temperature, and moisture content were shown by Hussey (1958) to be of prime importance for germination. By manipulation of these three factors, germination of *Elaeis guineensis* seeds could be increased from five percent in eight weeks to over 80 percent during the same period. Since both *J. caffra* and *E. guineensis* are members of the subfamily Cocosoideae, and are the only two cocosoid palms that occur naturally on the African mainland, it was decided to base this investigation largely on Hussey's (1958) work.

Three experiments were conducted, and because the only seed available at that stage was already two months old, the experiments were conducted concurrently.

In the first of these, the effect of oxygen and temperature on germination was investigated. The other two experiments were aimed at establishing the optimum moisture level for maximum seed germination. In one of the experiments the optimum moisture content of the seed itself was studied, while in the other, an attempt was made to ascertain the optimum moisture content of the sand in which the seeds were sown.

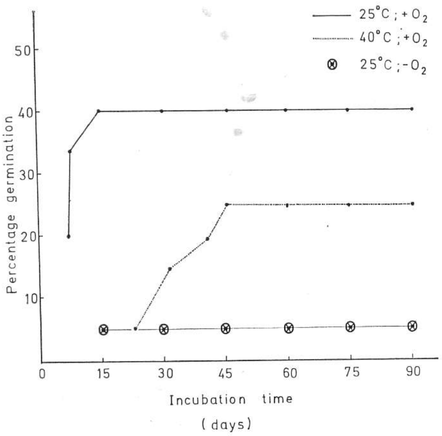
(i) *Effect of temperature and oxygen tension on germination*

The procedure followed in this study was similar to that described by Rees (1963). In this method the seeds are presoaked in water, thereafter air-dried for a day and then placed in a beaker or flask without a medium. The moisture content of the seed is subsequently kept constant by weighing the flask daily and supplementing any loss in mass with water.

Seeds were soaked in water which was changed daily. After eight days they were removed from the water and air-dried in the laboratory until their moisture content was equal to two-thirds of that amount which is required to saturate air-dried nuts. This particular level was found by Hussey (1958) to be optimal for *Elaeis* seeds.

The seeds were then sterilized in 0.1 percent $HgCl_2$ in 10 percent ethyl alcohol for one minute and thereafter washed very thoroughly three times with autoclaved water.

Twenty seeds were placed into each of four one-liter Erlenmeyer flasks which had been previously autoclaved. Two of these flasks were stoppered with non-absorbent cotton-wool while the other



3. The effect of oxygen on the germination of *J. caffra* seeds at 25° and 40°C.

two were sealed with vaccine caps. The latter two flasks were flushed daily for five minutes with pure oxygen. The two flasks with cotton-wool tops served as the control treatment.

Hussey (1958) found that a response to the increased oxygen level was only evident at 40°C. Consequently two temperatures were used in this experiment and incubation took place at 25°C and 40°C. A control flask and one oxygenated flask were incubated at each of these temperatures. The mass of each flask was recorded at the start of the experiment and maintained throughout by the addition of water when necessary. Germinated seeds were removed regularly and the change in mass taken into account. The experiment was continued for four and a half months.

The results of this experiment are shown in Figure 3. At both temperatures, germination was stimulated by the increased oxygen tension, while virtually no germination occurred in the control flasks. Germination also proved to be better at 25°C than at 40°C, not only in terms of actual number of seeds germinated, but also with respect to the rate at which germination occurred. While the oxygen treatment at 25°C resulted in 40 percent germination within 15 days, pure oxygen at 40°C produced 25 percent in 45 days, the first seed germinating only after 23 days (Fig. 3).

(ii) *Effect of moisture on seed germination*

Although Hussey (1958) gives very precise figures with respect to optimum moisture content of both seeds and germination medium (sand) for the oil palm, Rees (1963), in describing his method of germination for palm seeds in general, states rather vaguely that the seed's moisture content must be maintained "as wet as possible with no superficial moisture." An attempt was therefore made to try and establish the optimum moisture level for *J. caffra.*

Two experiments were conducted. In the first one the seeds were germinated in a beaker without a medium and the effect of the moisture content on germination of the seeds themselves was studied. The second experiment, in which the seeds were germinated in sand, was conducted to ascertain the effect of the moisture content of the medium on seed germination.

In the first trial, air-dried seeds, which had previously been weighed, were soaked in water for eight days with daily changes of water. Thereafter the seeds were again weighed and divided into three groups comprising 20 seeds each. The first group of seeds was air-dried to a moisture content of seven percent (based on the mass of air-dried seeds); the second group was air-dried to 14 percent, while the third group was not dried at all. The seeds in this latter group were very nearly saturated and contained 21 percent moisture.

After sterilizing all the seeds as in the previous experiment, the three categories of seeds were placed into separate beakers and covered with a thin sheet of polythene held in place by an elastic band. (This cover minimized evaporation of moisture from the seeds but permitted the free exchange of gases.)

The mass of each beaker was recorded and maintained at this level by briefly immersing the seeds in water every third or fourth day, depending on the rate of loss of moisture. Germinated seeds were removed when observed and the differences in mass taken into account. The three beakers were placed in a large desiccator (without desiccant) which was flushed daily with oxygen for five minutes. The desiccator was in turn placed in a growth cabinet and the seeds incubated at 40°C for 150 days.

In the second experiment, three 15 cm petri dishes were filled with coarse sand and varying amounts of water added so that three different moisture contents could be obtained. In the first one, 21 g of water was added, resulting in a moisture content of seven percent (on oven-dried basis); the second dish received 42 g of water and contained 14 percent moisture, while the sand in the third dish was saturated (21 percent) by adding 63 g of water. (It is purely coincidental that these three levels were numerically similar to the ones in the previous experiment.)

Six seeds were then half-buried in the sand in each dish and the mass of each dish recorded and maintained by the addition of water to the sand when necessary. The petri dishes were placed, without lids, into a desiccator, flushed daily with oxygen for five minutes and the seeds incubated at 40°C for 150 days. Germinated seeds were removed and the change in mass taken into account.

It was not known at this stage that 25°C was more conducive to germination of *J. caffra* seeds than 40°C. The

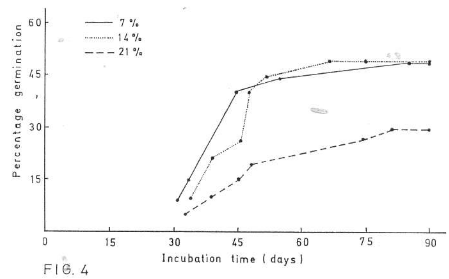


FIG. 4

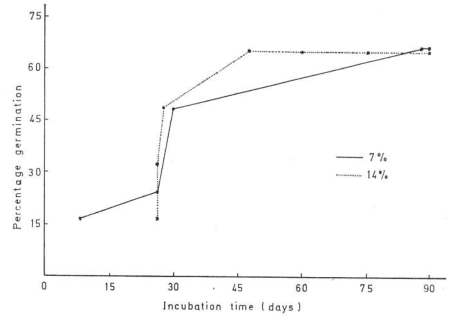


FIG. 5

4. Effect of moisture contents of the nuts of *J. caffra* on germination at 40°C in oxygen.
5. Germination of *J. caffra* seeds (nuts) in oxygen at 40°C half-buried in sand at two levels.

latter temperature, as well as the increased oxygen tension were used in both these experiments purely because of their effect on the germination of *Elaeis* seeds as described by Hussey (1958). The results of the experiments are presented in Figures 4 and 5. The overall germination percentages obtained in these two experiments were very good, especially in the second experiment, where 66.6 percent of the seeds germinated. In this same experiment, however, the seeds in water-saturated sand failed to germinate. So too, the germination of the water-saturated seeds in the first experiment was poorer than the other two treatments.

The results of these two experiments indicate that *J. caffra* seeds tend to germinate better in sand than without a medium, provided that the moisture content of the sand does not exceed 14 percent, i.e., a moisture level that is equivalent to two-thirds of the moisture content at saturation point.

When no medium was used the best results were obtained when the moisture content of the seed was 14 percent because, although the percentage germination (50 percent) did not exceed that of the seven percent treatment, germination occurred sooner in the former case (Fig. 4). The saturated seeds germinated relatively poorly. Similarly, where seeds were sown in saturated sand, no germination occurred.

When seeds are sown in the conventional manner, i.e., in sand, it would appear that 14 percent moisture is optimal because, although the seven percent treatment also resulted in 66.6 percent germination (Fig. 5), this figure was attained within 48 days by the 14 percent treatment, and only after 89 days in the seven percent treatment (Fig. 5).

Discussion

In view of the thick and hard nature of the endocarp it was expected that this structure might prevent the absorption of sufficient moisture for germination. However, the results indicate that neither the endocarp nor any of the other covering structures are impermeable to water.

In the event of an oxygen deficiency, germination is very much reduced. This would explain the complete inhibition of germination during the preliminary trials in which the seeds were totally saturated as the result of overwatering. Further confirmation of this is to be found in the later experiments in which the interaction of moisture, temperature, and oxygen were studied. From these results it is clear that irrespective of the temperature and oxygen level, germination is severely inhibited when the moisture level is too high.

Under normal moisture conditions, i.e., not total saturation, the covering structures of the seed are apparently sufficiently permeable to oxygen. This is substantiated by the results of the respiration experiment in which the uptake of oxygen was studied. No significant increase in oxygen uptake occurs when the seeds are placed in pure oxygen.

Clearly, though, an increased oxygen tension stimulates germination of *J. caffra* seeds, but there is also an interaction between oxygen and moisture and temperature. As the moisture content of the covering structures increases, so the uptake of oxygen will naturally decrease. Further, according to Hussey (1958), the diffusion of oxygen into compact tissues may be considerably restricted at high temperatures.

While the optimum moisture level in the seeds of *J. caffra* seems to be the same as that for *Elaeis guineensis*, viz. two-thirds of the moisture required to saturate the seed (14 percent in *J. caffra*), the optimum temperature for germination of *E. guineensis*, viz. 40°C, proved to be too high for *J. caffra* and inhibited the germination of this species' seeds. This difference in response of these species to temperature might have an ecological explanation in that while *Elaeis* is essentially a tropical palm, occurring mainly in the warmer latitudes, *Jubaeopsis* is one of the most southerly occurring palm species and is probably adapted to lower temperatures.

To obtain the maximum percentage germination in the shortest possible time, an optimum combination of temperature, moisture, and oxygen is necessary. From the results obtained in this study, it appears that this optimum combination would be the incubation of seeds in sand with a 14 percent moisture content at 25°C in pure oxygen.

Concerning the positive effects of an increased oxygen tension on the germination of *J. caffra* seeds, and the negative effects of endosperm on the growth of excised embryos, the following might be relevant.

In a number of species, slow seed germination has been associated with a lack of oxygen (Crocker, 1948 cited by Hussey, 1958). Originally it was thought that the covering structures of certain seeds restrict the uptake of oxygen and consequently also respiration, which in turn inhibits germination.

It was demonstrated in the respiration experiments, though, that the oxygen uptake did not increase when *J. caffra* seeds were placed in pure oxygen. Consequently, it would seem that a higher oxygen tension affects not the respiration of *J. caffra* seeds, but rather some other physiological process.

Roberts (1969) states that endogenous germination inhibitors increase the oxygen requirements of some seeds, while in others, it appears as if the function of the oxygen is to oxidize the inhibitor into an inactive form. Whether or not an inhibitor of this nature is present in the seed of *J. caffra*, is at this stage still not clear. However, in view of the fact that the addition of endosperm to the nutrient medium of excised embryos severely inhibits the growth of those embryos, it seems possible that an endogenous inhibitor might be present in the endosperm. It is tentatively suggested that the stimulation of germination of *J. caffra* seeds by oxygen may be due to the effect of oxygen on the inhibiting factor itself. This would be in accordance with the hypothesis proposed by Roberts (1969) for other plant species.

Acknowledgements

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Literature Cited

Egley, G. H. 1972. Influence of the seed envelope and growth regulators upon seed germination in witchweed (*Striga lutea* Lour.) Ann. Bot. (London) ser. 2, 36: 755–770.

Good, R. 1964. The geography of flowering plants. Longmans, London.

Hussey, G. 1958. An analysis of the factors controlling the germination of the seed of the oil palm *Elaeis guineensis* (Jacq.) Ann. Bot. (London) ser. 2, 22: 259–284.

Rees, A. R. 1963. Germination of palm seeds using a method developed for the oil palm. Principes 7: 27–30.

Roberts, E. H. 1969. Seed dormancy and oxidation processes. *In* H. W. Woolhouse (ed.). Dormancy and survival. Symp. Soc. Exp. Biol. 23: 161–192.

Robertson, B. L. 1977. Morphology and development of the fruit and seed of *Jubaeopsis caffra*. Principes 21: 23–32.

——— and G. P. Visagie. 1975. *Jubaeopsis caffra* Becc.—an Eastern Cape rarity. The Eastern Cape Naturalist 55: 15–19.

Van de Venter, H. A. 1974. Distribution, leaf morphology, embryology and germination of the acaulescent species of *Strelitzia* Ait. Ph.D. thesis, University of Port Elizabeth, South Africa.

Wareing, P. F. 1969. Germination and dormancy. *In* M. B. Wilkins (ed.). The physiology of plant growth and development, ed. 1, Chapter 17. McGraw-Hill Book Company.

White, P. R. 1963. The cultivation of animal and plant cells. 2nd ed. The Ronald Press Company, New York.

Palm-Collecting Adventures in Asia

MELVIN W. SNEED

8107 S.W. 72nd Avenue, 113E, Miami, Florida 33143

II. Indonesia

On 11 September 1975, we left Kuala Lumpur for Medan in northern Sumatra. An early flight got us there with ample time to establish ourselves in the modern Danau Toba International, make arrangements for a guide and transportation, and resume our palm quest shortly after noon. The main objective of this leg of our adventure was Sibolangit Garden, one of five branches established by the Bogor Botanic Gardens. Specifically we wanted to see the mature *Pigafetta filaris* and this garden, only 25 miles from Medan, has a beautiful stand of them within a short walking distance of the entrance. Dr. John Dransfield invited attention to Sibolangit in *Principes* 17: 105–107 which includes photographs of *Pigafetta* there. We photographed them also but through a regrettable misadventure with the camera lost the pictures.

No question that these towering, stately trees with sheer glistening trunks, rate among the most beautiful of palms. Although we had received seeds supplied by John Dransfield to the Seed Bank from these very same trees, we looked for more without success. And despite ample warning, one in quest of Sibolangit seeds must hazard contact with a nettlelike, stinging shrub to which Phyllis will attest.

Seeds of *Pinanga* and several unidentified palms were found, and we literally "struck pay dirt" in a ditch along the main road extending from each side of the garden's entrance. The trench was the receptacle for an accumulation of fallen fruits from a line of magnificent *Actinorhytis calapparia.* Buried in the soggy humus of the ditch, many of the seeds were germinating and we promptly gathered and cleaned several dozen of these egg-sized gems for the Seed Bank. Subsequent packaging and posting was as complicated as the collecting had been easy; we toted a parcel for two weeks before affixing the postage.

Along the road back to Medan *Arenga pinnata*, often in fruit, was conspicuous and we were introduced to that famed, protein-rich dietary item of Southeast Asia—the durian. Our reaction to the fruit, which tastes good but smells bad, was mixed. Phyllis didn't like it, the author tolerated it, and our driver ate most of it!

With appreciation for the very able assistance rendered by Mr. Soripada Lubis, who had arranged the transportation and accompanied us as interpreter in Medan, we flew on to Jakarta next day, following the forested volcanic ranges that span the 1,000 mile stretch of Sumatra. We were met at the domestic flight terminal there by Eric Taylor, accompanied by Mr. Richard W. Sulingan, a Jakarta proprietor and friend, who were to drive us on to Bogor, some 30 miles south of Jakarta. Coupled with the language barrier, transportation can be a vexing problem for the uninitiated palm traveler in Indonesia, and we were relieved that Eric had been able to precede us to Jakarta and arrange it.

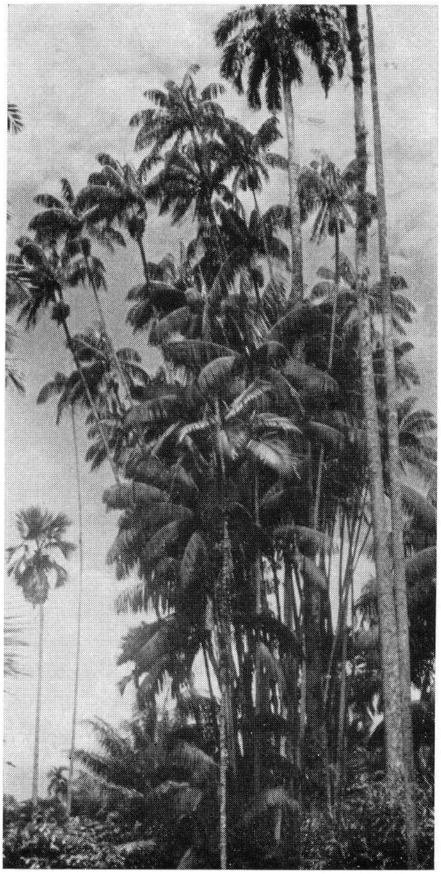
The two-lane curving road to Bogor was heavily trafficked and tedious, but

1. Richard Sulingan, Eric Taylor, the author and Dr. John Dransfield at Bogor, Indonesia.

Richard Sulingan made it a delight, stopping at a favored place to treat us to *kelapa puan*, a soothing coconut milk drink derived from the so-called dodal coconut, said to be found occasionally only in Java. With it came a unique durian candy, packaged in long, sausagelike rolls, tasting somewhat like soft caramel and otherwise not resembling the durian fruit.

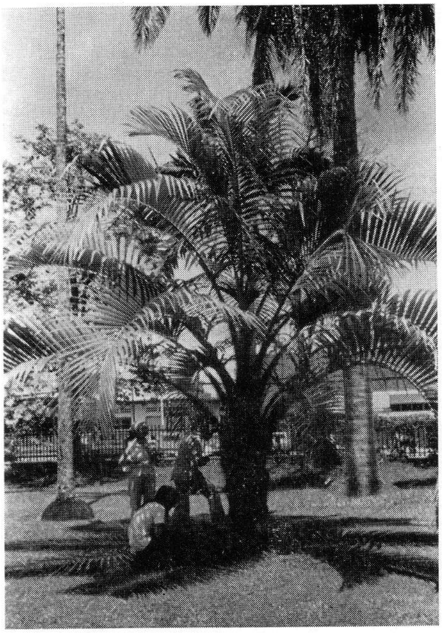
Upon arrival at the Salak Hotel, the only conveniently located hostelry in Bogor, albeit not at all geared to modern hotel standards, we were near the gates of Bogor Botanic Gardens with the allure of its famed palm collection. Also, we looked forward to meeting John Dransfield at Bogor, to which he had returned for a short working vacation a few days before our arrival. He joined us while Phyllis photographed the group (Fig. 1).

We saw John at the herbarium the morning of the 13th when he graciously got us started on our first excursion through the gardens. We obtained a late (1973) catalog of plants, got permission to collect, and followed him into the nursery, which featured palms. A small, potted *Synechanthus warscewiczianus* in fruit was particularly interesting—the seed had been furnished by DeArmand Hull, who collaborates with Lucita Wait in The Palm Society Seed Bank. We surmised that in his tenure at Bogor during recent years John Dransfield had been much involved with revival and reemphasis in operation of the Bogor nursery.



2. Some of the palms in Bogor.

Although the gardens' palms have been much photographed, they command attention and we captured some limited views of different parts of the collection (Fig. 2). We admired a young specimen of *Pigafetta filaris*, which embodies reestablishment of this palm in Bogor. Earlier the gardens had two mature specimens, but they were lost. The tree in Fig. 3 grew from a batch of seedlings brought to Bogor



3. John Dransfield inspecting *Pigafetta filaris,* recently reestablished in Bogor.

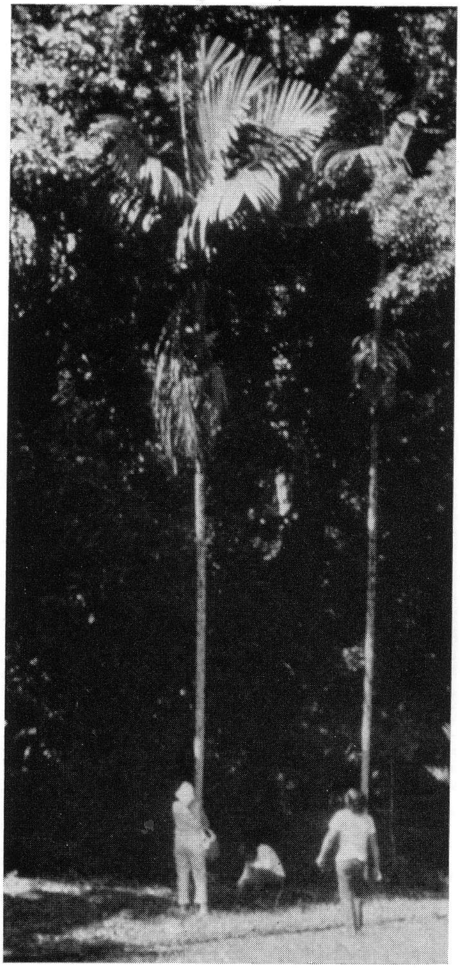
4. *Phoenicophorum borsigianum* gets attention in Bogor.

from Sibolangit by John Dransfield. Also an avenue of *Pigafetta* has been planted near the laboratories, but these were not as advanced as the one pictured. Near the *Pigafetta* was a handsome specimen of *Phoenicophorium borsigianum* which invited scrutiny (Fig. 4) and, of course, we gleaned seeds here and there as we went along. Interestingly enough we were delighted to find viable seeds of *Oenocarpus panamanus* and *Roystonea oleracea,* which are seldom seen in Jamaica, though both are indigenous to the Caribbean area.

We returned to our lodging in late afternoon just steps ahead of Bogor's heavy daily rain shower. Thanks to John Dransfield's command of the language, we had arranged for transportation next day to the Tjibodas Mountain Garden, another branch of the Bogor gardens. Tjibodas is on the slopes of Mt. Gedeh at an elevation of 4,200 feet, some 40 miles southwest of Bogor, with 200 acres of park and 3,000 acres of forest reserve.

To get there one drives past rice fields, ascending on up through tea cultivations and the picturesque Puntjak pass, a mountain resort area, hence off the main highway on an interesting narrow road to the garden. Tjibodas does not have an extensive palm collection but there we found *Pinanga javana,* which we had not been able to collect previously.

We arrived at the headquarters armed with a note penned by John Dransfield in Indonesian, requesting the attendants' assistance in helping us find and collect the palm. They were very cordial



5. *Pinanga javana* at Tjibodas, near Bogor. Seedlings are being collected.

and pointed out many interesting plantings as they guided us to the upper parts of the garden, bordering the forest, where mature specimens of the palm were growing. This tall, slender *Pinanga* is a fine ornamental (Fig. 5) and will take full sun as a juvenile at Tjibodas. Fruits on the trees seen were not ripe but the ground yielded a few seeds as well as a crop of seedlings. These were wrapped in wet moss growing nearby and most of them subsequently survived the long return journey. More of these palms have been planted out in Tjibodas without forest cover.

Tjibodas has splendid *Araucaria* and *Eucalyptus* collections and fine specimens of *Dracaena draco*, among others, and its rolling lawns, vistas, and crisp clear air are superb. With the cherished *Pinanga* in hand and appropriate gestures to our patiently waiting driver we headed back to Bogor, stopping for refreshments and to make inquiries for future reference regarding hotel facilities on the road some 20 miles from Bogor.

Next day we returned to the Bogor gardens starting with a visit to the office of Dr. Juan V. Pancho, a Palm Society member from the Philippines, who was on a corporate research assignment in the Bogor laboratories. After a good chat, he joined us for a while in the gardens. Perhaps the most exciting palm in Bogor during the time of our visit was the rare *Arenga borneensis.* It had started fruiting, and it seemed that every knowledgeable person around the gardens was anxious about progress of the fruits—rather like expectant fathers in the waiting room! John Dransfield had pointed it out to us earlier, and Juan Pancho steered us back to it again. Though we didn't collect it, we did enjoy seeing this rare palm, along with Juan whom many Palm Society members met when he attended the 1974 biennial meeting in Florida.

The day passed quickly as we further explored the reaches of these magnificent gardens. As our time there drew to an end we had the feeling that we had seen the gardens but certainly hadn't studied them in much detail. While we coursed the gardens, John Dransfield was on a short field trip nearby but returned in time to join us

6. Rice paddies and palms dominate the countryside of Bali.

for dinner that evening. We said au revoir, with heartfelt appreciation, and John gave us some seeds gleaned from his field trip, namely, *Pinanga pumila* and *Ceratolobus glaucescens*, an endangered species. He was to return to his base in Kew Gardens and we were going on in Indonesia.

Next morning, 16 September, Eric Taylor drove from Jakarta and took us back to the international airport where we left for Jogjakarta in central Java. We also said au revoir to Eric and could only hope that he knew how much we had appreciated his help and companionship.

Jogjakarta is more renowned as the Javanese cultural center and the city of bicycles than it is for palm hunting. First off we luxuriated in the modern Ambarrukmo Palace Hotel, indulging in the first running water shower bath we had had for some time, then exploring the trim, well-landscaped surroundings. Dinner and an exotic Javanese ballet performance were accompanied by the unfamiliar sounds of gamelan music.

Transportation was easily arranged here, and we proceeded next day to Borobudur and Mendut Temples, then to the Prambanan temple complex. Some palm species were seen from the roads but none adorned the temple bases. Flowering ornamentals were in outer landscaped areas, and in lieu of palms we collected a few of these. After visiting silverware and batik workshops, we readied to continue east to Bali.

We arrived in Denpasar 18 September, and after settling in the recently opened Hotel Sanur Beach we were ready to resume our adventures in a uniquely different setting. Bali's 2,269 square miles class it as a small island, but its charm and beauty and

7. Profusion of plantings visible from Balinese kampong entrance.

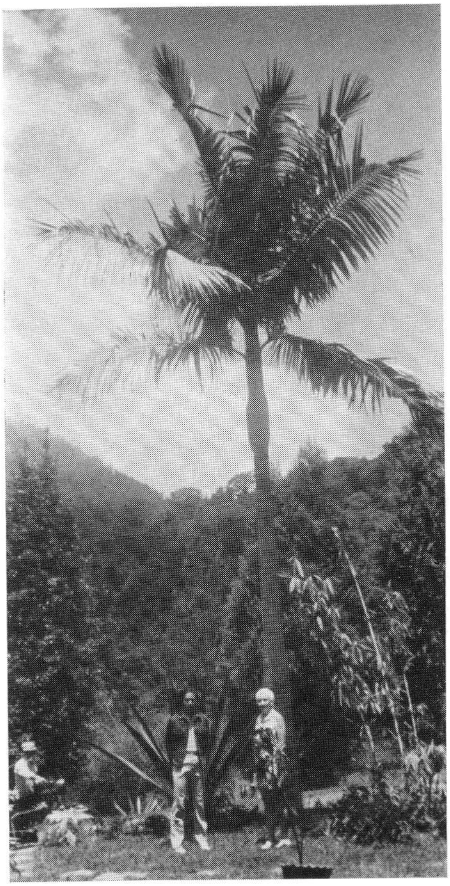
its friendly people unfold to the visitor who is willing to desert the beaches and take to the interior mountains and byroads. With an interpreter and transportation lined up, we began several days' exploration.

Palms are seen all over the island, with cultivations of *Areca catechu* and coconut species outlining the many steeply tiered rice paddies (Fig. 6). Though most of Bali's dense population resides in family or village kampongs, walled in, end-to-end along and back from the main roads, occasional palm-thatched structures are seen apart in picturesque surroundings.

The kampongs not only are the hallmark of family living and the Bali-Hinduism culture of the island, with its many colorful ceremonial processions and celebrations, but they also harbor palm and other exotic plantings that, if one could somehow catalog them all, might well eclipse collections in many botanic gardens. The Balinese adore plants and make artistic use of flowers and leaves of all sorts in their ceremonies. We visited some kampongs at random, as we went along, always with a friendly reception even though we couldn't handle the language. Perhaps typical of them is a scene in Figure 7, where a few of the plantings are visible.

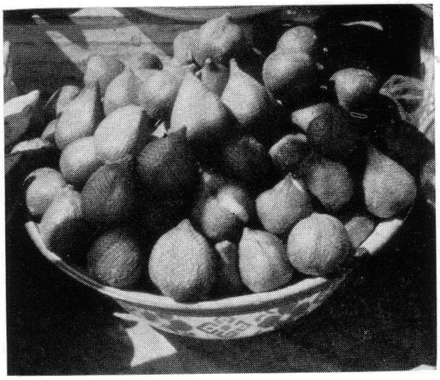
On one occasion, driving through a remote rural area, we sighted an isolated palm which at first glance seemed insect-ridden, if not diseased. We were puzzled. Thanks to a cheerful, elderly lady who soon appeared out of a small cultivation near the road, and to our interpreter, we learned that the palm's missing leaflets had been plucked for ceremonial rites.

All the while, we had been anticipat-



8. Gede Kanten and Phyllis furnish scale for the largest of the pinangas, Bedugul Forest Reserve, Bali.

ing arrival at the Bedugal Forest Reserve, the Bali branch of Bogor Gardens. Before leaving Bogor, John Dransfield had written another note for us in Indonesian introducing us to Mr. Gede Kanten, in charge of Bedugul. Our prime objective there was a *Pinanga* sp., the largest of the pinangas. Mr. Kanten very obligingly took the time to show us a beautiful mature specimen of it growing not far from the headquarters. We were somewhat astonished to see a *Pinanga* that seemed almost as large as some of our roy-



9. Pear-shaped fruits of *Salacca edulis* prominently displayed by roadside fruit vendor.

stoneas back in Jamaica. It is indeed a handsome tree (Fig. 8). But it wasn't fruiting and no seedlings were under it. Though this was disappointing, Gede Kanten promised to collect seeds later, and we received them after returning to Jamaica. The palm flourishes on the mountain slopes of the reserve. As we prepared to leave Bedugul, it seemed that everyone connected with the reserve had assembled to see us off.

We explored Bali rather thoroughly, visiting the sacred springs where, before admittance into the precincts, the custodians had difficulty furnishing the author with a requisite ceremonial sash of sufficient girth, and attending a morning performance of the Barong and Kris dancers. We admired the superb craftsmanship of the Balinese woodcarvers and enjoyed outrigger adventures off shore, all interspersed with palm hunting. *Salacca edulis* is cultivated over much of the island, and we stopped frequently to admire stands of this spiny, clustering, usually trunkless palm which we found growing on hillsides as well as in lowlands. Its fruits are tasty and a feature of roadside stands around the island (Fig. 9).

But sojourns for palm enthusiasts, even in "paradise," end quickly, and as the moon silhouetted the tall coconut trees along the beach at our hotel cottage we readied for another departure, another destination. We recall with gratitude Mr. Stanley Allison, our hotel manager who had helped with travel arrangements and made our stay in Bali so worthwhile, Mr. Philippus Hartono, our erudite guide and interpreter, who accompanied us over the island, and the many friendly people we met along the way.

We departed 23 September for Singapore, buoyant with expectations of the journey ahead which was to include not only Singapore Island but an excursion into Johore in quest of *Johannesteijsmannia*, meeting more Palm Society members, and discovering the relatively unpublicized palm collections in Taiwan. This will be the final chapter of our account.

PALM QUESTIONS AND ANSWERS

Q. Recently I heard that more palm species have been added to the list of palms susceptible to the lethal yellowing disease. Can you give me an updated list of the susceptible species?

A. As of April 1, 1977, there are 22 palms *officially* appearing on the list of palms susceptible to the lethal yellowing disease. The palm species with their common names, their subfamily and their origin are listed below.

	Scientific Name	Common Name	Palm Group	Origin
1.	*Arenga engleri*	Sugar palm	Caryotoid	Formosa
2.	*Arikuryroba schizophylla*	Arikury palm	Cocosoid	Brazil
3.	*Borassus flabellifer*	Palmyra palm	Borassoid	India, Ceylon, Burma
4.	*Caryota mitis*	Cluster fishtail palm	Caryotoid	Southeast Asia
5.	*Chrysalidocarpus cabadae*	Cabada palm	Arecoid	?
6.	*Cocos nucifera*	Coconut palm	Cocosoid	Old World tropics
7.	*Corypha elata*	Buri palm	Coryphoid	Andaman Is. to Philippines
8.	*Dictyosperma album*	Hurricane palm	Arecoid	Mascarene Is.
9.	*Gaussia attenuata*	Puerto Rican gaussia palm	Chamaedoreoid	Puerto Rico
10.	*Hyophorbe verschaffeltii*	Spindle palm	Chamaedoreoid	Mascarene Is.
11.	*Latania* sp.	Latan palm	Borassoid	Mascarene Is.
12.	*Livistona chinensis*	Chinese fan palm	Coryphoid	Japan to Bonin Is.
13.	*Nannorrhops ritchiana*	Mazari palm	Coryphoid	Afghanistan, Iran
14.	*Phoenix canariensis*	Canary Island date palm	Phoenicoid	Canary Is.
15.	*Phoenix dactylifera*	True date palm	Phoenicoid	W. Asia, N. Africa

16. *Phoenix reclinata*	Senegal date palm	Phoenicoid	Tropical Africa
17. *Phoenix sylvestris*	Wild date palm	Phoenicoid	India
18. *Pritchardia affinis*	Kona palm	Coryphoid	Hawaii
19. *Pritchardia pacifica*	Fiji Island fan palm	Coryphoid	Fiji Islands? Tonga
20. *Pritchardia thurstonii*	Thurston fan palm	Coryphoid	Fiji Islands
21. *Trachycarpus fortunei*	Windmill palm	Coryphoid	Cent., E. China
22. *Veitchia merrillii*	Christmas palm	Arecoid	Philippine Is.

This list was provided by Dr. Henry Donselman, Assistant Professor, Extension Ornamental Horticulturalist, from the Agricultural Research Center at Fort Lauderdale. Dr. D. L. Thomas, Assistant Professor, Plant Pathology, states that they are suspicious of two other palm species, although they have not been officially added to the list and therefore not confirmed. The two species are *Aiphanes lindeniana* and *Nypa fruticans*.

According to Dr. John Popenoe, the Director of Fairchild Tropical Garden, several other species of palms at the garden have died with symptoms similar to those of the the list susceptible to lethal yellowing. Among these he has included *Nypa fruticans* and a couple of *Copernicia* species (Fairchild Tropical Garden Bulletin, April 1977).

The symptoms of lethal yellowing vary in the different species of palms. The pritchardias tend to lose their center bud leaf along with the lower leaves turning yellow. The veitchias, phoenix, caryotas and dictyospermas tend to turn completely brown overnight almost as if they had been scorched with a blowtorch. *Cocos nucifera*, the coconut, of course, drops its fruit and the leaves turn yellow as the disease progresses.

Palm Society members in the South Florida area should report any new species of palms that appear susceptible to the disease. As an Agricultural Agent in Palm Beach County, I can be contacted by phone in West Palm Beach at 305/683-1777. Also, susceptible palm species can be reported to Dr. Henry Donselman at 305/584-6990.

DEARMAND HULL
Extension Agent—Ornamentals
Palm Beach County
531 North Military Trail
West Palm Beach, Florida 33406

NEWS OF THE SOCIETY

Often the mail brings amusing notes from many places. Here is something written by a lady from South Carolina who inquired about joining—I think she'd make a good member, don't you?

"We had two lovely California fan palms approximately 5′ tall and one sabal 3′. We protected them by making a boxlike structure with bales of hay on sides and top. Early frost and . . . you know the rest. Palms not sheltered and frozen. Not one to be completely put down I sprayed palm fronds green. No one guessed unless inspected closely. Kept painting for three years until fronds fell. It was fun."

News from California

Warren Dolby, Chairman of the Northern California Chapter of The

Palm Society, Inc. has sent the following report about the meeting held in October. The meeting took place in the newly palm-landscaped garden of Richard Douglas and Walter Haught at Walnut Creek. Members were asked to come early to have plenty of time to see the lovely garden and to go carefully through the greenhouse full of choice, beautifully grown palms. Members from as far as 100 miles away came to buy over $350 worth of the many palms for sale, and to browse through the books offered for sale at a table presided over by Gary Wood. Then Paul Drummond, who was on his return from a trip to the Far East, told about his trip, spoke about the Biennial Meeting that had been held in Florida in June, and also gave a quick resumé of the status of lethal yellowing.

The Northern California Chapter has been invited to become a member of the San Francisco Flower Show, Inc., which puts on the San Francisco County Fair. The chapter felt honored to become a part of this organization and at the show last August some 60 beautiful palms from the collection of Richard Douglas were placed in strategic areas at the show, with a large number complementing the orchid exhibit. They were well received, being noted both in the newspapers and the TV coverage. This year the chapter has been awarded $200 by the state as prize money. The chapter has submitted the names of its judges and has had the categories of awards accepted. Things are really happening in San Francisco! Congratulations to those active members.

Both the Southern and the Northern California Chapters put out interesting bulletins. They not only keep their members informed of the activities of the group, but offer hints about growing, or, in the case of the northern group, give suggestions how to cope with the terrible drought being experienced in that area. At the time of this writing some rain had fallen and it had snowed at least a small amount at the higher elevations which will not eliminate the drought, but will at least keep it from getting worse. We wish them much more rain and snow before too long.

Pauleen Sullivan has submitted the following report about the Southern California Chapter: "Our second annual banquet was a huge success with 135 members and guests attending, an increase over last year. Everyone enjoyed the delicious buffet dinner served in a beautifully decorated Polynesian room at Sam's Seafood Restaurant in Huntington Beach. Free palm seedlings of *Pritchardia* sp., *Rhapis humilis*, *Livistona saribus*, *Phoenix roebelenii*, and *Caryota mitis* donated by Ralph Velez and your chapter money, and *Trithrinax acanthocoma* and *Butia eriospatha*, donated by California Jungle Gardens were available at the door. Ralph Velez, Chairman for the past two and a half years, was presented with a plaque in appreciation of an outstanding job.

"New officers were introduced: Chairman, Jim Wright; Vice Chairman, Al Bredeson; Secretary, Lois Rossten; and Treasurer, Mark Foster, as well as Myron Kimnach, President of The Palm Society, Inc. Pauleen Sullivan will continue to be in charge of addressing the newsletter, of the local seed bank, and of the book store. Highlight of the evening was a slide presentation by Mardy Darian of the botanical gardens he visited in Venezuela, Brazil, the Seychelles Islands, Ceylon, Singapore, and Indonesia during his recent trip around the world."

Florida

The South Florida area members gathered in the Corbin Educational Building at Fairchild Tropical Garden on April 8 for a buffet supper. The food was paid for out of the money earned at the palm sale last October and about 50 members and guests showed up to enjoy it. Afterwards, Ken Foster, visiting from California, delighted his audience with pictures and tales of his recent trip to New Caledonia and Fiji. But it was sad to hear again how the beautiful island of New Caledonia has been denuded of its once lush forests by primitive burning practices, which the government is now, very belatedly, trying to prevent in order to save the last remnants of the original vegetation. Ken and Don Hodel were able to find and bring back some of the now scarce seeds, both from New Caledonia and from Fiji as well, and to make arrangements for some that were not yet ripe to be shipped to them later on.

The Palm Beach County Chapter of The Palm Society will be having its annual sale on Saturday, October 1, from 10 A.M. to 3 P.M. at the Mounts Agricultural Center, 531 North Military Trail, West Palm Beach. Hundreds of rare and common palms will be available to Palm Society members.

Texas

The Houston Area Chapter met January 29, 1977 at the Memorial Park Arboretum. James Cain led a discussion on the freeze and cold damage suffered by members' palms during the freeze and showed slides of various South American palms. Afterwards, everyone moved to the classroom to look at and discuss the several unusual palms brought by members. There were 14 in attendance including guests. Bimonthly meetings will be held from now on.

TEDDIE BUHLER

Seed Bank Notes

A palm from Lifou in the Loyalty Islands near New Caledonia, seed of which was distributed in 1974 as a new species of *Cyphophoenix*, has been given the name *Cyphophoenix nucele* H. E. Moore. The epithet comes from the local name *nucele*, derived from *nu* (coconut) and *cele* (sling), the fruits having formerly been used as projectiles in hunting birds. On Lifou, *C. nucele* grows on raised coral near sea level and it should thus be adapted to southern Florida.

New Botanical Garden Wants Seeds

The Central Mindanao University, Musuan, Bukidnon 8213, Philippine Islands is starting a botanical garden and would appreciate seed of all kinds of palms but especially those of economic importance. The garden is on clay loam of volcanic origin at an altitude of 1500 feet. Rainfall is about 100 inches a year but there is a drier period in April and May in some years. The climate is warm except for November to March, when it is quite temperate. Because of the altitude, nights are always cool.

Cycad Society Formed

Members who have an interest in cycads and have been inquiring how to get information about them will be happy to know that an international cycad society was formed April 23, 1977. Persons interested should contact Dr. Walter J. Harman, Department of Zoology, Lousiana State University, Baton Rouge, La. 70803, U.S.A.

Bring Back the Chamber Pot?

At a recent meeting of the Strybing Arboretum winter lecture series, the speaker suggested that we may be overlooking a very important bit of garden fertilizer that could also help us with the drought. She was speaking of using urine in the garden instead of flushing it down the drain with the six or seven gallons of water it takes to empty the bowl.

Diluted with five times its volume in water it makes an excellent fertilizer. In fact, one adult can provide enough nitrogen in this way to fertilize seven acres of corn a year!

The idea may take some bit of emotional adjustment to be acceptable to everyone, but the pathogens that cause disease are found in solid waste, which must not be used. Urine is pure. It seems that in a time when we are short of so many resources, including water and fertilizer, that this may be worthy of some consideration.

1978 Biennial Meeting

Plans are forming for the 1978 Biennial Meeting of The Palm Society in Southern California. The main meeting will be in San Diego, followed by tours of the Los Angeles and Santa Barbara areas. Nine or more talks by palm authorities are planned, as well as a post-convention trip to Costa Rica. A tentative schedule follows:

- July 9: board and business meetings, principal talks, banquet
- July 10: tour of public collections in San Diego
- July 11: free day or tour of private collections, San Diego
- July 12: tour of private gardens in Los Angeles
- July 13: tour of Huntington Botanical Gardens and of private gardens in Los Angeles
- July 14: tour of gardens in Ventura and Santa Barbara
- July 15: departure for Costa Rica (optional)

Further details will be available later in the year and registration forms will be mailed to all members early in 1978. Start planning now to attend!

PALM BRIEFS

A New Palm Arboretum

For thousands and thousands of years there have been natural palm canyons in what we now call San Diego County, in California. Today, these palm canyons still thrive in their beautiful wild mode, populated with the indigenous palm which we call *Washingtonia filifera*. But *Washingtonia filifera* doesn't like the moist air which prevails close to the Pacific Ocean, for which reason all the native palm canyons of southern California are inland, beside springs and creeks along the eastern slopes of the Coastal Range, bordering on the desert. As a result, in the past, San Diegans have had to travel maybe 100 miles to see a really spectacular palm canyon.

But no more! Very soon, San Diego will have its own palm canyon, right in town! San Diego's palm canyon will be even more spectacular than the natural ones way out there in the hot desert. And what is more, it will not have just one species of palm; rather it will boast a great variety of palm species and palm genera, collected from all over the world.

The site of the new palm arboretum is near the geographic center of Balboa Park, immediately west of the Organ Pavilion, in the canyon. The "first phase" of the project just now is being completed; this phase includes preliminary plantings, paved walkways, an irrigation and drainage system, benches, an overhead walkway, and a massive rustic staircase.

But first, let's go back to the beginning of it all. Bob Nelson, general park supervisor for the city of San Diego, and himself a palm enthusiast, indicates that it all began way back in 1913. That is when San Diego was preparing Balboa Park as the site for the 1915–1916 Panama-Pacific Exposition, which celebrated the opening of the Panama Canal. At that time a large number of *Washingtonia robusta* palms were planted in the canyon. Many of them, now more than 65 years old, still are alive and growing, and they are taller than any of the *Washingtonia filiferas* which grow in any of the palm canyons of the desert area. The tops of these palms now reach well above the level of the mesas which border the canyon; they "soar"; they really are the foundation and the basis for the present "palm arboretum" project.

A couple of decades after those original palms were planted, Balboa Park was the setting for an even greater event: The California Pacific International Exposition of 1935–1936. That fair celebrated an attraction even more sensational than the opening of the Panama Canal; that attraction was Sally Rand, the fan dancer, in person! Sally, with her fans and bubbles, danced on a ramp which was centered in a shallow "lake" which was located slightly north of the Organ Pavilion. To beautify the surroundings for her act, many palms, including *Butia capitata*, *Phoenix canariensis*, and *Trachycarpus fortunei* were planted in the area. Some of those palms, now over 45 year old, remain immediately to the northeast of the 1913 plantings.

In 1970 the Parks Department of the City of San Diego decided, as recommended in the Bartholomew Master Plan for Balboa Park, to develop a "palm arboretum," using the old exposition palms as a base. Since then, well over $100,000 has been expended in basic physical development of the site, including the walkways, the staircase, the bridgework, and the benches mentioned previously. Separately and additionally, the Parks Department since then has been deliberately and systematically acquiring—by purchases from exotic nurseries and by donations from members of The Palm Society—seeds and seedlings of many many palm species. Utilizing hothouse procedures, it has grown these seeds and seedlings into nursery stock of size such that it is ready to be planted out this summer (1977) in the now-prepared site. An inventory of the potted plants on hand indicates that 25 different palm genera are included, with the number of species and of individual specimens proportionately greater. Container sizes range all the way from gallons to huge tubs. Also waiting to be planted out as companion plants to the palms are, most notably, semitropical members of the genera *Acalypha* and *Brassia*.

1. These seven beautiful *Washingtonia robusta* palms are among the many which still survive from the 1915–16 Panama-Pacific Exposition. These 65-year-old palms will be the top tier of San Diego's new palm arboretum.

This new palm arboretum in San

Diego will be just one of the many interesting gardens which will be "on tour" for the next Biennial Meeting of The Palm Society. That meeting is scheduled to convene in San Diego on July 9, 1978, and to terminate in Santa Barbara 5 days later, with an optional post-meeting trip to Costa Rica. Put those dates on your calendar now, and make your plans now to attend.

BILL GUNTHER

2. This rustic staircase, and the elevated walkway which traverses the background, are new components of the "palm arboretum" which is now being developed in San Diego's Balboa Park. Large palms, the heritage from two different World's Fairs, are scattered through the entire area. During the summer of this year, many hundreds of young palms of many species will have been added to this landscape. As a consequence, by the time this garden is viewed by those who attend the 1978 Biennial Meeting of The Palm Society, the presently stark character of the vista will be greatly softened. In another decade the staircase and the walkway will be out of sight, submerged in a palm jungle.

PALM LITERATURE

DIVAKARAN PILLAI, M., E. V. V. BHASKARA RAO, AND C. P. MAMOO KOYA. 1976. Annotated bibliography of coconut in India (1936–1976). Central Plantation Crops Research Institute, Kasaragod 670-124, Kerala, India. 270 pp. $2.00 outside India.

This bibliography, compiled for the Diamond Jubilee of coconut research in India, covers contributions made by scientists in India during the past 40 years and supplements *A Bibliography of the Literature on Coconut Palm, Cocos nucifera* L. by W. V. D. Pieris (1935). Entries are grouped under the following categories—agronomy, botany and breeding, chemistry and physiology, diseases, pests, statistics, economics and marketing, technology, general, and books—followed by an author index. Each entry is accompanied by a brief summary of content.

GLASSMAN, S. F. 1977. Preliminary taxonomic studies in the palm genus *Attalea* H. B. K. Fieldiana: Botany 38(5): 31–61.

A description of *Attalea*, a key to related genera, a key to species, and a listing of species by alphabet are provided in this preliminary study.

HARBORNE, J. B., C. A. WILLIAMS, J. GREENHAM, AND P. MOYNA. 1974. Distribution of charged flavones and caffeylshikimic acid in Palmae. Phytochemistry 13: 1557–1559.

The presence of an unusual acid is demonstrated in flowers of nine palms.

MANOKARAN, N. 1976. Germination and early growth rates of the bertam palm—*Eugeissona tristis* Griff. Malaysian Forester 39(2): 83–90.

Germination in the bertam palm, considered a forest weed in Malaya, is described and illustrated. Average germination time was 9½ months and the rate of establishment was found to be very slow—the second leaf matured about 13 months after germination.

MOORE, HAROLD E., JR. 1976. New species of *Brongniartikentia* and *Cyphophoenix* (Palmae). Gentes Herbarum 11: 151–167.

Second species—*Brongniartikentia lanuginosa* and *Cyphophoenix nucele*—were described in two previously monotypic New Caledonian genera. *Cyphophoenix nucele* has been introduced into cultivation (see Seed Bank Notes).

MOORE, HAROLD E., JR. AND ANTHONY B. ANDERSON. 1976. *Ceroxylon alpinum* and *Ceroxylon quindiuense* (Palmae). Gentes Herbarum 11: 168–185.

These two species have long been confused. Recent collections show that *C. alpinum* grows at generally lower elevations than *C. quindiuense* (see *Principes* 20: 127–135. 1976) and is distinguished by number and shape of stamens, by fruit coat, and differences in leaf and inflorescence.

SAAKOV, S. G. 1971. Vetvvlenie u pal'm (ramification of palm trees). Bot. Zurn. S.S.S.R. 56: 1491–1496.

Professor Saakov, who earlier wrote on palms of the Soviet Union in *Principes* 7: 88–99, 1963, has provided in the reference above an illustrated account of branching in *Roystonea regia*, *Chrysalidocarpus lucubensis*, *Cocos nucifera*, *Sabal parviflora*, and *Coccothrinax miraguama* as seen during a visit to Cuba in 1966.

UHL, N. W. 1976. Developmental studies in *Ptychosperma* (Palmae). I. The inflorescence and the flower cluster. II. The staminate and pistillate flowers. American Journal of Botany 63: 82–109.

Details of the development and morphology and anatomy of inflorescence and flowers in *Ptychosperma* are described and illustrated by Dr. Uhl. Of particular interest is the basically trimerous nature of the androecium which ultimately becomes multistaminate.

WILBERT, JOHANNES. 1976. *Manicaria saccifera* and its cultural significance among the Warao Indians of Venezuela. Botanical Museum Leaflets, Harvard University 24(10): 275–335; plate LXVI–XCVIII.

Dr. Wilbert has prepared an exhaustive and handsomely illustrated ethnobotanical study of the *temiche* palm in Venezuela, pointing out that it is a source of sago previously unrecorded. A multiplicity of other uses makes *Manicaria* an important resource for the Warao.

LETTERS

G.P.O. Box 1151
Suva, Fiji
29th November, 1976

Mr. Rawe, in his letter published in July, 1976 asks "How in the devil is one supposed to know how to grow these plants [palms] if one cannot read up on it?"

My answer to this is that one can do a lot. I am a complete amateur with no background of biology or horticulture but a keen interest in growing plants and a growing ability to keep my eyes open to see what *is* happening, not what I *think* is happening. My only reference books on palms are *Palms of the World* by McCurrach, *In Gardens of Hawaii* by Marie Neal, and *Exotica 3* by Graf and, in Fiji, I am a long way from people to talk to about palms. But there is still a lot I can do to improve my ability to grow them.

The things I can do are: 1. Check what reference books are available to see where the palm comes from; 2. Check with atlases and other books to try to ascertain the climate in that area; 3. Experiment with a number of plants by putting them in different places around the garden—when growing from seed you usually have a reasonable number of plants to play around with and while they are still small and in pots, experimenting with varying degrees of shade, water, humidity, wind, and fertilizers can teach you a lot; 4. Try to build up correspondence around the world and keep writing and asking questions—I have found that there are many people happy to write and tell you of their own experiences. However, you have to keep in mind that what works in Florida may not work in California, or in Fiji. In other words, using the experience of others as a guide (and only as a guide) you must learn to grow palms *under your own conditions.*

I agree that it would be wonderful if there were a publication that gave a lot more detail on the growing of all the different types of palms but until someone produces this book the only thing we can do is use our heads and experiment—and keep our eyes open.

If I could give an example. It took me quite a long time to realize that all fan palms (or at least those in Fiji) when grown from seed first send out a cotyledonary stalk (sinker) which later divides into the ligule and radicle (see *Principes* 20: 108, July 1976), while most pinnate palms do not. I believe that this is the reason why you find few seedlings under fan palms but many under pinnate palms. Any damage to this cotyledonary stalk normally means the death of that seed—the primary roots of pinnate palms seem to be able to stand a lot more damage before they are killed. This might be pretty elementary stuff to trained botanists but it was quite important to me as it made the growing of fan palm seed much easier.

Of course, I have to admit that import of new palm varieties—both plants and seed—into Fiji is banned and I have only the native palms plus what was brought in before the ban to deal with. However, there is quite a bit of difference between growing conditions on the northwestern side of our islands (wet summers with 65 inches of rain and dry winters with 15 inches) and the southeastern side (wet summers with 80 inches and dry [?] winters with 40 inches). There is also some difference between the humid areas at sea level where pritchardias and most of the introduced species thrive and the very wet (over 200 inches), cooler, heavily forested highlands (3,500′) where you find the physokentias, clinostigmas, and taveunias.

Finally, may I recommend one fertilizer worth trying? While we are happy to use animal wastes—cow and horse manure, etc.—we are unwilling to use any human wastes. Urine, diluted about 10 to 1 is an excellent fertilizer and normally readily available and cheap! It has worked wonders on a potted *Phoenix roebelenii,* which had made no progress with other fertilizers, and many people here use it for citrus, bougainvilleas, and all sorts of plants, both potted and in the open garden. Several people spray it, diluted as above, onto orchids—vandas, arachnis, cattleyas, dendrobiums, etc.—(usually early in the morning so that it dries before the sun gets too hot) and the results are excellent. I presume it would be better still if you were taking vitamin pills!

/s/ DICK PHILLIPS
R. H. PHILLIPS

WHAT'S IN A NAME?

Aïphanes (ay eýe fan eez) was not explained by Willdenow. Dr. W. J. Dress suggests that it may come from the Greek word *aeiphanes,* which means "ever-shining" or "ever-appearing."

Bentinckia (ben tínk ee a) commemorates Lord William Henry Cavendish-Bentinck (1774–1839), who was Governor-General of India from 1828 to 1835. The original species, *B. condapanna* Berry, is native in the south of India.

Bentinckiopsis (ben tínk ee óp sis) employs the Greek suffix *-opsis* (having the appearance of, like) to suggest a resemblance to *Bentinckia,* although today *Bentinckiopsis* is considered a synonym of *Clinostigma.*

Clinostigma (clý no stíg ma), according to Wendland, comes from the Greek *klinein* (to bend) and *stigma* (mark, spot, brand, but in botanical terminology that portion of the gynoecium in the female flower that receives pollen). Presumably the name was proposed because the stigmas, though terminal in flower, become lateral in fruit through differential growth of the ovary.

Clinostigmopsis (clý no stig móp sis) was formed by adding the suffix *-opsis* (having the appearance of, like) to *Clinostigma* because of its resemblance to that genus. Today *Clinostigmopsis* is considered a synonym of *Clinostigma.*

Cyphosperma (sý fo spér ma) is a name coined by Wendland and taken up by Sir Joseph Hooker in *Genera Plantarum* without explanation. It is derived from the Greek *kyphos* (bent, humped, hunch-backed) and *sperma* (seed), probably because the seed has irregular ridges and protuberances.

Exorrhiza (éx o rýe za) combines the Greek prefix *exo-* (out of) and the Greek word for root, *rhiza,* and was used by Wendland as a specific epithet for *Kentia exorrhiza* (now *Clinostigma exorrhizum*) because that species has very prominent prop roots. Beccari later used the epithet in a generic sense, as *Exorrhiza wendlandiana,* for the same species. Today *Exorrhiza* is considered a synonym of *Clinostigma.*

Goniocladus (gó nee o cláy dus) combines the Greek *gonia* (angle) with *cladus* (branch). The type species, *G. petiolatus,* was described as having longitudinally angled inflorescence branches, hence the name.

Goniosperma (gó nee o spér ma), now a synonym of *Physokentia,* was thought to differ because it has seeds with acute longitudinal edges, according to Burret. The name is taken from the Greek *gonia* (angle) and *sperma* (seed).

Neoveitchia (née o vée chee a) is derived from the Greek prefix *neo-* (new) and the generic name *Veitchia.* Fruits of *Neoveitchia storckii*, the only species, and those of *Veitchia joannis* are very similar, and both were originally described as species of *Veitchia.* Beccari thus coined *Neoveitchia* when he removed *Veitchia storckii* to a different genus.

Roscheria (raw shér ee a) commemorates Dr. Albrecht Roscher, a young man from Hamburg, Germany, who followed close on Burton, Speke, and Grant in exploring East Africa. Among Germans, he preceded Baron Carl Claus von der Decken, for whom *Deckenia* is named (*Principes* 20: 80). Roscher arrived in Zanzibar in September, 1859, and travelled in Africa until March 19, 1860, when he was murdered (like Decken) by natives at Kisunguni on the return from a four-month stay at Lake Nyasa. An account of his journeys is to be found in the first volume of *Baron Carl Claus von der Decken's Reisen in Ost-Afrika* (1869) compiled by Otto Kersten, a member of Decken's expedition. Roscher collected algae in Zanzibar and the algal genus *Roschera* was named after him by W. Sonder in 1879, two years after the publication in 1877 of the palm genus.

Taveunia (táv ay óo nee a) is simply a modification of Taveuni, the name of one of the Fiji Islands, where the palm was first collected.

Verschaffeltia (vér shaff él tee a) was chosen by Hermann Wendland to honor Ambroise Colette Alexandre Verschaffelt (1825–1886) for his introduction and reintroduction of numerous and magnificent species of palms. Verschaffelt early in life became director of a nursery established by his father, Alexandre, in Ghent. In 1854, he founded the horticultural journal *L'Illustration Horticole*, which he published until 1870, when both nursery and journal became the property of J. Linden. Other palms named after Verschaffelt are *Hyophorbe verschaffeltii* and *Latania verschaffeltii.*

Notice

I am interested in contacting any member of The Palm Society who knows of *Jessenia bataua* (Mart.) Burret (*Oenocarpus bataua* Mart.) or other closely allied species in cultivation in the United States or elsewhere. This is for a portion of a doctoral dissertation involving the biology and taxonomy of these palms, which have promising economic value.

MICHAEL BALICK
Botanical Museum of Harvard University
Oxford St.
Cambridge, Mass. 02138

Twenty-year Index to Principes

A 68-page index to the first 20 volumes of PRINCIPES for the years 1956–1976 is available from the Executive Secretary at a cost of $3.00. Orders, with payment, should be sent to Mrs. T. C. Buhler, 1320 S. Venetian Way, Miami, Florida 33139. The entries are inclusive of authors, names, and subjects in a single alphabetical sequence.

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