

PRINCIPES

Journal of The Palm Society

January, 1977
Vol. 21, No. 1

THE PALM SOCIETY

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JOURNAL OF THE PALM SOCIETY

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Neodypsis decaryi at the Fairchild Tropical Garden. Photograph by M. V. Parthasarathy.

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JOURNAL OF THE PALM SOCIETY

An illustrated quarterly devoted to information about palms and published in January, April, July and October by The Palm Society, Inc.

Subscription price is $7.00 per year to libraries and institutions. Membership dues of $12.50 per year include a subscription to the Journal. Single copies are $1.50 each. The business office is located at **1320 S. Venetian Way, Miami, Florida 33139.** Changes of address, undeliverable copies, orders for subscriptions, and membership dues are to be sent to the business office.

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Second class postage paid at Miami, Florida and at additional mailing offices.

Mailed at Lawrence, Kansas
February 25, 1977

Ptychosperma in Cultivation

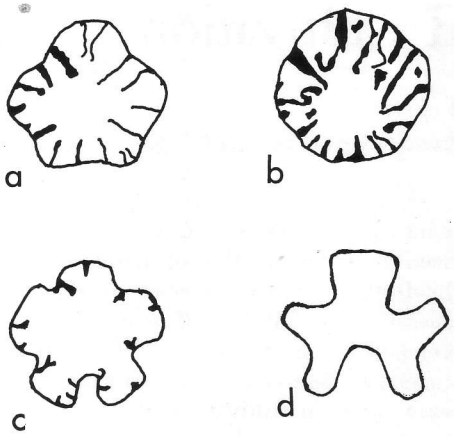
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The genus *Ptychosperma* is familiar to tropical gardeners around the world, as several species have been widely cultivated for more than a century. Other introductions over the years have brought the total in cultivation to about 12 of the approximately 28 species known to occur in the wild. Two of the species, *Ptychosperma elegans* and *P. macarthurii*, are widely used in landscaping, but the others have been limited largely to botanical gardens and specialized private collections. In recent years, a few other species have been introduced, but I will consider here primarily those 12 of which mature individuals might be encountered. Several of the species have probably died out completely, though they may be found in some of the older botanical gardens such as that at Bogor in Java. Others appear no longer to exist in cultivation as pure species but have contributed to the formation of hybrids with other species.

This article is intended to serve as a guide for those who would become familiar with the cultivated species of *Ptychosperma*, and who might occasionally encounter an unusual specimen or one that is difficult to identify. I have perhaps too frequently invoked hybridization in explaining such specimens, but this is often the only way to make sense out of a confusing combination of features. It appears that, as in some other palm genera such as *Phoenix*, fertility between the various species of *Ptychosperma* is the rule rather than the exception. This is an opinion based on over six years of experience with both wild and cultivated specimens. I have seen no documentation of deliberate hybridization between species of *Ptychosperma*; the mixing of genes in this genus is assumed to have occurred spontaneously between plants growing near each other in cultivation. For this reason, persons should propagate ptychospermas from seed with special care. Hand pollination and bagging of the inflorescences must be carried out religiously if particular species are to be preserved in their original form. Otherwise, there is a serious risk of merging many species into one super hybrid species. Distressing signs of this are already evident in specimens of *Phoenix* cultivated in Florida.

Ptychosperma is one of the advanced arecoid genera of palms that are characterized by well-developed crownshafts and infrafoliar inflorescences. *Ptychosperma* itself is further characterized by its apically praemorse or cleft pinnae and, most importantly, by its longitudinally 5-grooved seeds (Fig. 1). *Brassiophoenix* and *Ptychococcus* are genera closely related to *Ptychosperma* and have similar seeds, but the fruits are larger (3.5 cm or more long as opposed to less than 2 cm long for most species of *Ptychosperma*) and have thick, bony endocarps.

In my revision of the genus (Essig 1975b), I recognized three subgenera, one of which is again divided into two sections. The first subgenus, which consists of the former genus *Ponapea*, is characterized by its larger fruit (greater than 2.5 cm long, but without a bony endocarp), and is very rare in cultiva-



1. Seeds of several species of *Ptychosperma* cut in cross section. a, *Ptychosperma elegans*; b, *Ptychosperma salomonense*; c, *Ptychosperma schefferi*; d, *Ptychosperma macarthurii*.

tion. There are juvenile specimens of *Ptychosperma hosinoi* at Fairchild Tropical Garden and of *P. ledermannianum* at the Lyon Arboretum in Honolulu.

Subgenus *Ptychosperma*, characterized by the deeply ruminate endosperm of the seed, includes *Ptychosperma elegans*, *P. salomonense*, and a number of others not yet cultivated. The new *Ptychosperma mooreanum* (Essig 1975a) belongs here also.

The remaining subgenus, *Actinophloeus*, is characterized by seeds with homogeneous endosperm (or weakly ruminate in *Ptychosperma schefferi*). One section of this subgenus is characterized by black fruit and solitary stems (e.g. *Ptychosperma waitianum*), and the other section by red, orange, or black fruit and stems that usually (but not always) sucker at the base to form clumps (*P. macarthurii*, *P. sanderanum*).

A key to the species of *Ptychosperma* known to have been in cultivation at one time or another is presented below, followed by discussion of the species in order of their introduction into cultivation. The most recently introduced species will not be discussed. For complete descriptions of the wild species, and further background on the genus, I refer the reader to my recent revision (Essig 1975b). All herbarium specimens cited are at the L. H. Bailey Hortorium, Cornell University.

Key to the Cultivated Species of Ptychosperma

1. Stems suckering to form clumps
   2. Fruit black at maturity
      3. Endosperm of the seed ruminate (Fig. 1c) ..... 4. *P. schefferi*
      3. Endosperm of the seed not ruminate ..... 11. *P. lineare*
   2. Fruit orange to red at maturity
      4. Pinnae very narrow, at most 1.5 cm wide; flowers and fruit densely crowded on the rachillae ..... 6. *P. sanderanum*
      4. Pinnae more than 3.5 cm wide; flowers and fruit not densely crowded
         5. Pinnae regularly arranged along the rachis; inflorescence branches sparsely brown-scaly ..... 5. *P. macarthurii*
         5. Pinnae irregularly arranged along the rachis; inflorescence branches densely dark-scaly ..... 2. *P. propinquum*
1. Stems solitary
   6. Fruit red at maturity
      7. Endosperm of the seed ruminate
         8. Central pinnae very elongate, about 10 times as long as broad, with many pale, elongate, twisted scales on the prominent ribs of the lower surface; seed distinctly 5-angled or -grooved (Fig. 1a) ..... 1. *P. elegans*

8. Central pinnae at most 6–7 times as long as broad, elongate scales lacking on the ribs of the lower surface, or if present then the seed very weakly grooved (Fig. 1b) ..... 10. *P. salomonense*

7. Endosperm of the seed not ruminate
   9. Seed deeply grooved (Fig. 1d) ..... 5. *P. macarthurii*
   9. Seed shallowly grooved (as in Fig. 1a, but without the rumination)
      10. Pinnae at most 6 cm wide; inflorescence branches not scaly (mature individuals rare in cultivation) ..... *P. ledermannianum*
      10. Pinnae up to 18 cm wide; inflorescence branches scaly (mature individuals rare in cultivation) ..... *P. hosinoi*

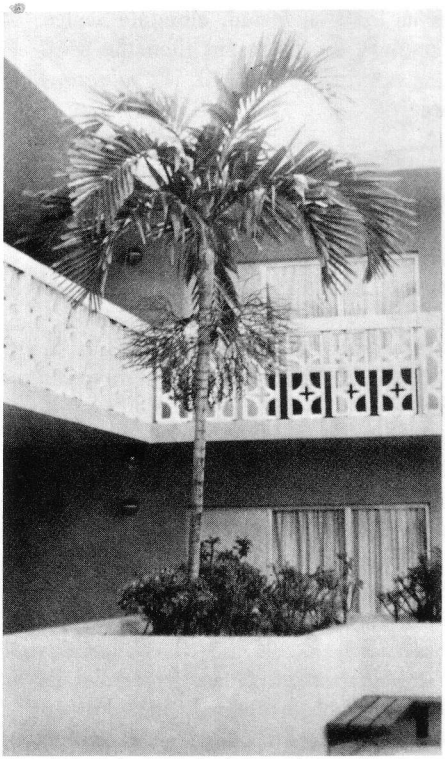
6. Fruit black at maturity
   11. Endosperm of the seed ruminate (no mature specimens in the U. S. at present) ..... *P. mooreanum*
   11. Endosperm of the seed not ruminate
      12. Pinnae broadly cuneate, regularly arranged along the rachis, with many dark, elongate, twisted scales on the ribs of the lower surface; flowers conspicuously dark-scaly ..... 12. *P. waitianum*
      12. Pinnae linear to narrowly cuneate, irregularly arranged along the rachis, elongate scales few or lacking on the lower surface of the pinnae, flowers not scaly
         13. Pinnae linear, elongate; inflorescence sparsely branched (not known in cultivation in the U. S.) ..... 3. *P. ambiguum*
         13. Pinnae narrowly cuneate or with margins nearly parallel in the upper part; inflorescence much branched (not known in cultivation in the U. S.) ..... 9. *P. cuneatum*

Note: Specimens that do not key precisely here may be hybrids. See the following discussions.

1. *Ptychosperma elegans* (R. Brown) Blume (solitaire palm).

Ptychosperma elegans was introduced into England early in the nineteenth century from its native Australia. Hooker illustrated it in 1857 in *Curtis's Botanical Magazine* (Vol. 83, *plate 4961*) from a specimen cultivated in England. The species is vigorous and prolific in cultivation and has been widely used in tropical landscaping (Fig. 2). The stem is always solitary, and the pinnae are very elongate, bearing elongate, pale, twisted scales along the ribs on the lower surface. The inflorescences are profusely branched and pale green in color, bearing finally globose to slightly elongate red fruit and seeds with deeply ruminate endosperm.

Ptychosperma elegans has apparently hybridized with several species, including *P. salomonense* and the enigmatic *P. kerstenianum* (for both of which see below). Perhaps most interesting are the many individuals that appear to be hybrids with *Ptychosperma macarthurii*. Characteristics of these plants vary, but they typically have seeds shaped like those of *Ptychosperma macarthurii* (i.e. with three deep grooves and two shallow ones) but with some rumination of the endosperm inherited from *P. elegans*. The inflorescences tend to be pale greenish in color and more robust than is usual for *Ptychosperma macarthurii*, but with the conspicuous bracts subtending the branches that are characteristic of that species. The presence of several to



2. *Ptychosperma elegans* growing in the courtyard of a Miami motel.

many long, twisted scales on the ribs of the underside of the pinnae serves as an indicator of *Ptychosperma elegans*, and is very useful when found in conjunction with features characteristic of other species. One example that can be seen in Fairchild Tropical Garden is no. P-637 in plot 117 (voucher: *H. E. Moore, Jr. 9584*).

2. *Ptychosperma propinquum* (Beccari) Beccari.

Ptychosperma propinquum and a form formerly recognized as *P. keiense* were collected from two different islands in eastern Indonesia in 1872. Plants were successfully established at the Bogor Botanic Garden (then called Buitenzorg) and were eventually distributed from there. Evaluation of specimens labeled as *Ptychosperma propinquum* is difficult because the type collections were rather meager and no other collections from the original areas have ever been made. The species appears to be closely related to *Ptychosperma macarthurii* and the essential characteristics are as follows: The pinnae are irregularly arranged along the rachis (see Fig. 3), the inflorescence is densely covered throughout with fine, blackish, wool-like scales, and the fruits are about 2 cm long. Few individuals that I have seen match these characteristics well. The best fit I've seen in the New World is a plant labeled *Ptychosperma nicolai* (which see) at Fairchild Tropical Garden. Most living specimens labeled as *Ptychosperma propinquum* (or *P. keiense*), and a number labeled *P. macarthurii*, are probably hybrids between the two species. Herbarium specimens at the Bailey Hortorium that represent hybrids include a series collected at Bogor by van Steenis in 1935 (grown at that garden under the numbers V-K-2, V-K-2a, X-D-83, X-D-83a, XII-E-33, XII-E-70, XII-E-70a) and a specimen from the former Atkins Garden of Harvard University in Cuba (*Moore 7048*).

3. *Ptychosperma ambiguum* (Beccari) Beccari in Martelli.

This poorly known species from West Irian (western New Guinea) was collected by Beccari in 1872 and plants were established at Bogor. It appears to have died out there before being propagated to other gardens and probably did not contribute to the hybrid gene pool. It is a diminutive palm with reddish inflorescences and black fruit, like its relative, *Ptychosperma waitianum*. It is distinctive, however, in its very narrow, linear pinnae, which are clustered along the rachis.



3. Leaf of a *Ptychosperma* hybrid growing at Fairchild Tropical Garden (no. 3988), labeled *P. nicolai*, but more closely resembling *P. propinquum*.

4. *Ptychosperma schefferi* Beccari in Martelli.

This black-fruited, caespitose palm from the north coast of New Guinea was collected by Teysmann in the early 1870's and planted at Bogor. The species is characterized by the combination of black fruit and seeds with weakly ruminate endosperm (Fig. 1c). From Bogor, seeds were distributed around the world, both as *Ptychosperma schefferi* and under the erroneous name of *Coleospadix oninensis*. Seeds that ultimately reached Florida, however, appear to have resulted from hybridization with *Ptychosperma macarthurii*. An example is the plant grown at the U. S. Plant Introduction Garden at Chapman Field, Florida under the number PI 97545-5480 (voucher *F. B. Essig 710122-1*). I have not seen living specimens in the United States that match the wild material.

5. *Ptychosperma macarthurii* (H. Wendland) Nicholson (Macarthur palm).

Ptychosperma macarthurii is the caespitose species most frequently encountered in cultivation, probably equalling in popularity the solitary *P. elegans*. The name had rather dubious beginnings, however, having been in use in the horticultural trade for decades before its valid publication under botanical standards. Even then, decades more passed before an adequate description of the species appeared in the literature and before a type specimen was designated (see Essig 1975b). The species is characterized by its robust, caespitose habit (Fig. 4), the regular arrangement of its pinnae, and its sparsely brown-scaly inflorescence with conspicuous bracts subtending the branches, bright red fruit, and seeds that tend to show three deep grooves and two shallow ones



4. A typical clump of *Ptychosperma macarthurii* at Fairchild Tropical Garden.

when cut through the middle (Fig. 1d). It is the most vigorous of the species in the genus, and appears to have hybridized with many of the others.

6. *Ptychosperma sanderanum* Ridley.

This species is very distinctive by virtue of its extremely narrow, elongate pinnae, and secondarily by the very crowded arrangement of the flowers and fruit on the rachillae. Genuine material of this species is very rare in cultivation. I have matched herbarium specimens from Bogor and Hawaii with the original description. In Fairchild Tropical Garden, the plant numbered FG 4155 (Plot 143), and illustrated here (Fig. 5) is the only living specimen I have seen that matches. Other material labeled *Ptychosperma sanderanum* (usually written incorrectly as '*sanderianum*') appears to represent hybrids with *Ptychosperma macarthurii* or more complex hybrids



5. *Ptychosperma sanderanum* at Fairchild Tropical Garden. Notice the extremely narrow pinnae.

involving also *P. propinquum*. Herbarium specimens of this sort of hybrid at the Bailey Hortorium are from Brazil (*L. H. Bailey & E. Z. Bailey 421*) and from Singapore (*L. H. Bailey s.n.*, 1925).

7. *Ptychosperma nicolai* (Hort. Sander) Burret.

This name is associated with some hybrid specimens. The species was described nearly 80 years ago from a juvenile plant in cultivation, and no herbarium specimens were ever made, nor were flowers or fruit ever described from



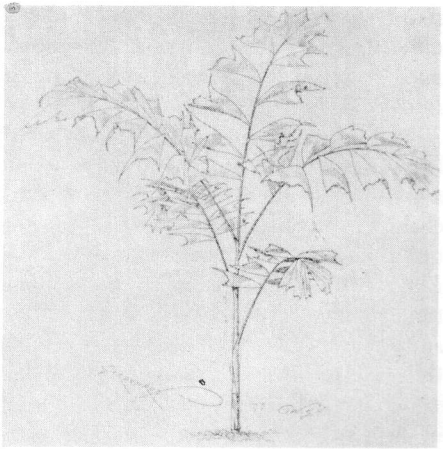
6. The original illustration of *Ptychosperma nicolai*, from *The Gardener's Chronicle*, ser. 3, vol. 33, p. 245. 1903.

authentic material. From the original illustration (Fig. 6) one can see a unique combination of characteristics. The plant appears to be caespitose, as there are several stems of varying age arising from the base of the plant. This suggests an affinity with *Ptychosperma macarthurii* and other caespitose species. The pinnae are rather broadly cuneate, however, which is unlike any of the known caespitose species. The pinnae are regularly arranged along the rachis, and according to the original description, the foliage is reddish when first emerging. It seems fairly likely, then, that *Ptychosperma nicolai* is, or was, a legitimate species. However, I have not seen any specimen, living or preserved, with this combination of characteristics, and the species may never be properly identified.

The few herbarium specimens I have seen bearing this name appear to represent hybrids with *Ptychosperma propinquum* as one parent. Several such specimens were collected in Cuba (*L. H. Bailey 328*, in Havana, and *H. E. Moore 7054*, at the former Atkins Garden of Harvard University, Cienfuegos), and a living specimen can be seen at Fairchild Tropical Garden (no. 3988, beside the Rare Plant House; voucher *F. B. Essig 710123-4*). Aside from the name tag, the only characteristic linking these specimens with *Ptychosperma nicolai* is the reddishness of the young foliage, which cannot always be seen in the plant at the Fairchild Garden. Otherwise these specimens are difficult to distinguish from *Ptychosperma propinquum*. The pinnae are narrow, not cuneate, and irregularly arranged (Fig. 2), and the inflorescence is densely dark scaly, as is characteristic of the latter species. For the present, at least, the name *Ptychosperma nicolai* should not be used for any cultivated plants.

8. *Ptychosperma kerstenianum* (Hort. Sander) Burret.

The circumstances surrounding this species are very similar to those surrounding *Ptychosperma nicolai*. The two were probably brought back together from New Guinea by Micholitz, for they were presented to the public within a year of one another by Sander in England. As in *Ptychosperma nicolai*, the species was described from a juvenile plant, without preservation of a type, and no description of flowers or fruit was ever made. Later efforts by botanists to fix the identity of this species are in conflict with one another as they were based on different herbarium specimens from cultivation, none of which could be reliably identified as authentic material (see Essig, 1975b). The illustration accompanying Sander's note (Fig. 7) is even less useful than that accompanying *Ptychosperma nicolai*. The plant figured was solitary and had



7. The original illustration of *Ptychosperma kerstenianum*, from *The Gardener's Chronicle*, ser. 3, vol. 24, p. 391. 1898.

broadly cuneate pinnae, but little else can be discerned. As such, the plant may be matched with several known species of *Ptychosperma* (such as *P. waitianum* or a number of others not yet in cultivation), or even with species of other genera such as *Balaka* or *Drymophloeus*. It does not match any recently cultivated specimens I have seen, however. Two herbarium specimens bearing the name *P. kerstenianum* appear to represent hybrids with *Ptychosperma elegans*. One specimen is from Rio de Janeiro (*Toledo 49483*) and the other from the Langlois estate in the Bahamas (*H. E. Moore, Jr. & M. Langlois 5861*). These two specimens resemble *Ptychosperma elegans*, but the pinnae are somewhat cuneate rather than tapered at the tip as in that species. The puzzle of what the true *Ptychosperma kerstenianum* was or is can probably never be solved and the name should be abandoned.

9. *Ptychosperma cuneatum* (Burret) Burret.

This black-fruited species from northern New Guinea was introduced to Bogor Botanic Garden in 1903, but apparently never spread from there. It is a close relative of *Ptychosperma waitianum*, but differs from that species in its more elongate, narrowly cuneate pinnae that are irregularly arranged along the rachis, and in its larger, more branched and more sparsely scaly inflorescence. The species has not been grown in the New World, but I collected herbarium specimens from the wild in New Guinea in 1971 and sent a small number of seeds to The Palm Society Seed Bank. They were distributed under the numbers *Essig LAE 55097* and *55098*.

10. *Ptychosperma salomonense* Burret (*Strongylocaryum* spp.).

Seven species of *Ptychosperma* have been described from the Solomon Islands, three of them under the generic name *Strongylocaryum*. After considerable study of herbarium specimens from nearly every major island in the chain, I came to the conclusion that they all represent forms of one highly variable species. I confess however to a lack of firsthand field knowledge of the Solomon Island ptychospermas, and someone more intimately familiar with them might have a different opinion. I am provisionally using the earliest published name for the entire complex, having failed to find meaningful or consistent differences between the supposed species.

The first ptychospermas from the Solomon Islands to be cultivated were sent by Dr. J. D. Campbell in 1940. The kind grown as *rakii* is very robust, resembling *Ptychosperma elegans*, while *takasi* is more diminutive with a delicate inflorescence that takes on an orange tinge as the fruit ripen. Plants introduced as *Strongylocaryum latius* are much like that grown as *takasi*.

Ptychosperma salomonense is characterized primarily by the extreme shallowness of the five longitudinal grooves of the seed. The seeds, in fact, often ap-

pear completely round in cross section. It was this characteristic that prompted Burret to erect the genus *Strongylocaryum*. However, seeds from Bougainville have very distinct grooves and there are others from throughout the range that show varying degrees of grooving. For this reason the genus *Strongylocaryum* was abandoned. Most of the plants in cultivation can be distinguished by this characteristic however. At least some of those that cannot be so distinguished appear to be hybrids. Hybridization between *Ptychosperma salomonense* and *P. elegans* is not obvious, since the two species are rather similar. Perhaps some of the specimens with weakly distinct grooves belong in this category. More distinctive is an apparent hybrid between *Ptychosperma salomonense* and *P. macarthurii* collected from the Jennings estate in Miami in 1959 (*H. E. Moore, Jr. 7729*). The seeds have three deep grooves and two shallow grooves, as is so common in cultivated *Ptychosperma macarthurii*, but the endosperm is somewhat ruminate. The inflorescence has the general appearance and scaliness of *Ptychosperma salomonense*, but prominent bracts subtend the branches as in *P. macarthurii*. These two species are in different subgenera, suggesting again that barriers to hybridization may be lacking throughout the genus.

11. *Ptychosperma lineare* (Burret) Burret.

This species is closely related to *Ptychosperma macarthurii* except that the fruits are black instead of red. As the name implies, the pinnae also tend to be somewhat narrower than in species, but occasional specimens of *Ptychosperma macarthurii* can be found with equally narrow pinnae. Unless they are in fruit, one can hardly distinguish between the two species. *Ptychosperma lineare* was sent to Florida by L. J. Brass in 1953 from southeastern Papua New Guinea where it is native. Some fine examples can be seen at Fairchild Tropical Garden in plot 149 (*FG 3174*, voucher: *F. B. Essig 710127-1*).

12. *Ptychosperma waitianum* Essig.

Ptychosperma waitianum, which has recently been described and illustrated (Essig 1972), is one of the newest and most distinctive members of the genus to be introduced into cultivation. It too was sent to Florida by L. H. Brass from southeastern Papua New Guinea, this time in 1956. It is a diminutive palm, with broadly cuneate pinnae that have many dark, twisted scales below, and a small, densely dark scaly inflorescence that has few branches. The flowers are reddish and the fruit is black. The name honors Lucita Wait for her service to The Palm Society. Plants can be seen at Fairchild Tropical Garden in plots 127 and 149 (*FG 57-22*, voucher *F. B. Essig 710121-1*).

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Vesicular-Arbuscular Mycorrhizae Affect the Growth of Bactris gasipaes

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Abstract

The effects of vesicular-arbuscular mycorrhizae on the growth and survival of *Bactris gasipaes* HBK were investigated by growing inoculated and uninoculated seedlings in sterilized soil. Uninoculated plants grew very little after seed reserves were exhausted, and most died within a year of planting. Seven of nine inoculated plants were surviving at the end of the experiment. They were significantly taller and had larger as well as more leaves than uninoculated plants. Uninoculated and inoculated plant roots examined had remained uninfected and developed vesicular-arbuscular mycorrhizae, respectively.

The importance of mycorrhizae to palms, and its implications for the palm grower are discussed.

Introduction

Over a decade ago David Barry, Jr. wrote an article for *Principes* entitled "The Possibility of Mycorrhizae in Palms" (Barry, 1962). He had germinated seeds of two palm species only to have all of the seedlings die after exhausting their seed endosperm. He suggested that these deaths resulted because the seedlings lacked mycorrhizal fungi associated with their roots. His hypothesis was not tested, however, and the importance of mycorrhizae (literally, "fungus-roots") to palms remained just a "possibility." This paper reports the effects of vesicular-arbuscular (V-A) mycorrhizae on the growth and survival of *Bactris gasipaes* HBK.

Bactris gasipaes, the *pejibaye* or peach palm (Fig. 1), has long been used in South and Central America for its wood and edible fruits. The latter are a commercial crop in Costa Rica (Kitzke and Johnson, 1975). Recently, interest in using this species for production of palm heart has arisen, although silvicultural information is needed (Balick, 1976).

Vesicular-arbuscular mycorrhizae occur on most plant species (Gerdemann, 1968). Redhead (1968) found that 86% of 51 species from lowland tropical rainforest in Nigeria had them. Palms are not likely an exception to this general occurrence. Specific mention of mycorrhizae on palms, however, is scarce. Janse (1896) reported V-A mycorrhizae in *Calamus* in Java, and Johnston (1949) noted them on *Cocos nucifera* L. in Trinidad.

This paper provides limited background information concerning V-A mycorrhizae. Further details may be found in Gerdemann (1968) and Mosse (1973).

Materials and Methods

This study was conducted at Finca La Selva, the Organization for Tropical Studies' field station and forest reserve in northeastern Costa Rica at a latitude of about 10°26′ N. The vegetation is tropical premontane wet forest in the Holdridge life zone classification system (Holdridge *et al.*, 1971). Mean annual precipitation is 3997 mm, and the mean annual temperature is 24.1°C (Hartshorn, 1972). The months of January through April are slightly cooler and drier than the rest of the year. This experiment was begun at the end of February, 1975, and continued until mid-March, 1976.



1. A young *Bactris gasipaes*, the *pejibaye* or peach palm, in the *pejibaye* plantation where this experiment was conducted.

Bactris gasipaes seeds collected in the vicinity of Finca La Selva were removed from fruits, cleaned, and surface-sterilized by soaking them for two minutes in aqueous sodium hypochlorite. Surface-sterilization reduces the growth of saprophytic fungi on the seeds during germination, which required two to three months in a closed plastic bag. V-A mycorrhizal fungi are not carried on seeds (Nicolson, 1960). Contrary to what Barry (1962) suggests, removal of seed coverings, or seed sterilization has nothing to do with the absence of these fungi unless such cleaning eliminates soil which contains them. Spores of V-A mycorrhizal fungi are often produced underground and are not forcibly discharged (Gerdemann and Trappe, 1974). Any agent moving a volume of soil such as wind, water, or dirty garden tools may transport spores in that soil, but the spores alone are not airborne. If seeds have adhering soil they may carry mycorrhizal associates, but seeds removed directly from fruits have not likely encountered the fungi.

Soil from an old alluvial terrace was used for the experiment. It is a typical humid tropical soil, very strongly acidic and low in available phosphorus and exchangeable cations (Table 1). Thirty-six large tin cans filled with soil were sterilized with methyl-bromide gas with 2% chloropicrin ("Dowfume") at a rate of 13,866 pounds per acre.

One group of 18 cans was inoculated by the addition, to each can, of approximately 15 g fresh-weight of chopped cacao roots in an even layer 2–3 cm below the soil surface. The cacao roots were observed to be mycorrhizal. Extremely broad host ranges of V-A mycorrhizal fungi permit the use of chopped

Table 1. Analysis of the soil used for the Bactris gasipaes *growth experiment. Mineral availability was unchanged by sterilization with methyl-bromide plus 2% chloropicrin gas. Analyses were performed by the Departamento de Agronomia of the Costa Rican Ministerio de Agricultura y Ganaderia with the exception of the range for % N which is taken from Bourgeois* et al. *(1972)*

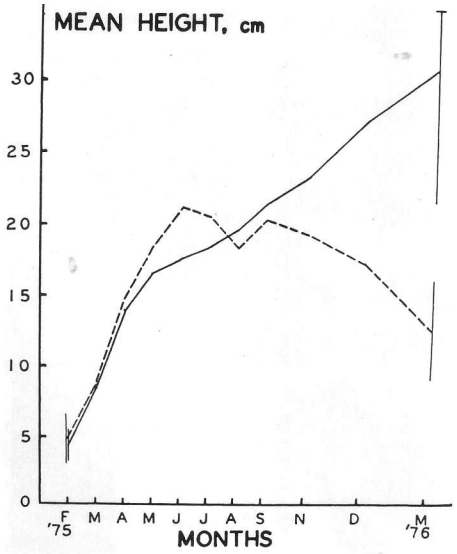
			Exchangeable		
pH	N %	Available (Truog) P ug/ml	K	Ca m.e./100 g	Mg
4.6	0.14–0.49	5	0.18	1.0	0.4

cacao roots as inoculum for other species (Janos, 1975a). A single fungus species can produce V-A mycorrhizae on maize, red clover, soybean, onion, and strawberry (Gerdemann, 1968). Therefore, at least some of the fungi that form V-A mycorrhizae on cacao may be expected to associate with *pejibaye* palms.

The remaining cans each received an equal weight of sterilized chopped cacao roots and 200 ml of a suspension made by soaking the unsterilized inoculum overnight in water, which was then filtered with a 74 micron soil sieve. This size sieve is sufficiently small to exclude V-A mycorrhizal fungi but not bacteria and other microorganisms. The sterilized roots and the microbial suspension were added to the control group to supply them with everything added to the inoculated group except the fungi.

Thirty-six similarly sized seedlings one to two weeks old were selected from the lot of germinated seeds. I removed the endocarp from one-half of these by cutting the suspensor with a razorblade. Each can received one seedling, with the endocarp-removed seedlings divided equally between the inoculated and uninoculated cans. All cans were randomized and placed on slat-tables under the light shade of a *pejibaye* plantation. They were spaced at least 15 cm apart to minimize the chance of rain splashing soil and possibly mycorrhizal fungi from inoculated to uninoculated cans. Watering was only by the rain.

Plants were measured biweekly for the first six months, then four more times at irregular intervals during the following six months. Height was measured from the soil surface to the tip of the largest leaf stretched upright. Length of the largest leaf from one of its tips to the base of the blade at the rachis, and the number of live leaves were also recorded. The experiment was discontinued after one year when the inoculated



2. Mean height of *Bactris gasipaes* seedlings which were inoculated with vesicular-arbuscular mycorrhizal fungi (solid line) and uninoculated (dashed line). Height was measured from the soil surface to the vertically extended tip of the largest leaf. Inoculation was at the time of planting in February 1975. Vertical lines indicate ± one standard deviation.

plants had shown a significant growth response to infection, and most of the uninoculated plants had died. At the close of the experiment the roots of one plant from each group were stained (see Phillips and Hayman, 1970) and examined to confirm their infection status.

Results

Almost all of the endocarp-removed seedlings died within three months of planting whether or not inoculated, and none of them lived longer than eight months. One uninoculated seedling, the largest of its group at the time of endocarp removal, did reach a height of almost 16 cm before dying.

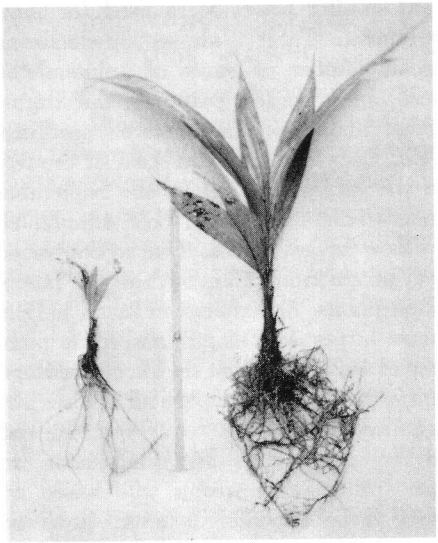
The results of the experiment for the seedlings from which the endocarps were not removed are summarized in Figure 2 and Tables 2 and 3. Most of these

Table 2. Number of surviving inoculated and uninoculated Bactris gasipaes *seedlings*

	Months after inoculation				
	0	3	6	10	12
Inoculated	9	8	7	7	7
Uninoculated	9	9	8	7	3

seedlings survived at least ten months (Table 2). After that time, however, several of the uninoculated seedlings died. A binomial distribution test applied to the numbers of seedlings surviving at the close of the experiment indicated that the difference in seedling survival would be expected due to chance alone only 5.8% of the time. Considering the relatively small number of seedlings employed in the experiment, this suggests that survival of plants inoculated with V-A mycorrhizal fungi is improved.

The evidence for improved survival of mycorrhiza-inoculated seedlings is strengthened by the fact that inoculated plants were larger (Fig. 2, 3), and had more leaves (Table 3) at the end of the experiment. I have omitted leaf length data from Figure 2 because it closely parallels the height data. Growth of both groups of seedlings was similar for the first nine months of the experiment (Fig. 2). From November through March 1976, however, there was a decline in the mean height of uninoculated plants. This decrease was a consequence of the death and loss of large leaves so



3. Comparison of the largest surviving uninoculated (left) and inoculated *Bactris gasipaes* seedlings at the close of the experiment, one year after planting and inoculation. Ruler is approximately 30 cm long.

Table 3. Mean number of leaves of inoculated and uninoculated Bactris gasipaes *seedlings. Asterisks indicate pairs of means significantly different by t-test (* $P = 0.05$, ** $P = 0.01$)*

		Months after inoculation				
		0	3	6	10	12
Inoculated	$\bar{x}$	1.00	2.50	2.57	2.86*	4.00**
	s	0.00	1.60	1.13	1.07	1.41
Uninoculated	$\bar{x}$	1.00	3.50	2.13	1.86*	1.33**
	s	0.00	0.53	1.13	0.90	0.58

that smaller leaves were used for measurement. Table 3 shows the declining mean number of leaves of uninoculated seedlings. The low point for the August mean height of uninoculated seedlings (Fig. 2) was due to sun-scald of the tips of the largest leaves. By the September measurement these had been supplanted by new largest leaves. Due to continued leaf production and growth of the inoculated plants, differences in mean height, mean largest leaf length, and mean number of leaves between the inoculated and uninoculated groups were all statistically significant (t-test, $P = 0.01$) at the end of the experiment. The final mean for the uninoculated group was based on only three surviving plants; however, significant differences also existed in December when seven plants were alive.

Microscopic examination of roots at the close of the experiment confirmed that the sampled inoculated plant had developed V-A mycorrhizae, and that the roots of the uninoculated plant were devoid of infection. Infection of the roots of the inoculated plant was light but evenly distributed over the penultimate order roots. While infection seemed limited to the epidermis and a few layers of outer cortical cells, typical features of V-A mycorrhizae (see Gerdemann, 1968) were observed. Ultimate rootlets were not infected. No root hairs were observed on either plant.

Discussion

Several authors have recorded cessation of growth of seedlings unassociated with mycorrhizal fungi (Baylis, 1959; Gerdemann, 1965; Kleinschmidt and Gerdemann, 1972). In a series of experiments similar to the one described here, the size at which uninfected seedlings of 28 tropical species ceased growing was strongly correlated with seed dry-weight (Janos, 1975b). Thus, the cessation of seedling growth and subsequent death after the exhaustion of seed reserves observed here and noted by Barry (1962) is emerging as a common pattern symptomatic of a lack of mycorrhizae.

The inoculated endocarp-removed seedlings were expected to manifest dependence on mycorrhizae sooner than those seedlings with the endocarp left attached. However, all of the endocarp-removed seedlings died. A lack of response to inoculation was similarly observed in seedlings of two other species from which I removed seed reserves. It may be that early seed removal reduces the likelihood of seedlings becoming infected (Janos, 1975b). Seed reserves may be important for production of an extensive root system that encounters enough fungal inocula for the plant to become adequately infected. In addition, a seedling without sufficient reserves may be less able to supply fungal associates with the substances required for their nutrition.

In view of the accumulating evidence that V-A mycorrhizae can greatly increase the growth of many plant species, the effects reported here are not surprising. They are expected at low levels of mineral availability, as in the soil used in this experiment, particularly for species lacking root hairs. Baylis (1970) found that six species that had extensive root hairs did not respond to mycorrhizal infection when grown in a soil in which a species with sparse root hairs did respond. Plant growth is increased because V-A mycorrhizae implement greater mineral uptake, especially that of phosphorus, in soils with low or imbalanced mineral availability (Mosse, 1973).

Barry (1962) suggested that he may have confused a lack of trace elements with lack of mycorrhizal fungi, although the application of trace elements did not help his plants. At high levels of mineral

availability some plant species may grow as well when uninfected as when infected (Murdoch, Jackobs, and Gerdemann, 1967). As mineral availability decreases, however, minerals may become increasingly inaccessible to the uninfected plant. There is a broad range in the ability of plant species to take up minerals when uninfected. A few, like rushes and sedges, are able to maintain their normal growth rates at very low levels of soil fertility and do not form mycorrhizae (Powell, 1975). At the opposite end of the spectrum we find dependent plants like Barry's: unable to grow when uninfected, even with micronutrients supplied.

What characterizes mycorrhiza-dependent plant species? They probably have little-branched root systems composed of coarse rootlets lacking root hairs. These root systems are likely surficial so that most rootlets are mycorrhizal; V-A mycorrhizal fungi require aerobic conditions and rapidly decrease in numbers with increasing soil depth (Gerdemann, 1968). A high percentage of infected roots may be especially important in tropical regions where extremely weathered soils and high leaching rates keep mineral availability low. In addition, dependent species may be large-seeded in order to insure that their seedlings have sufficient reserves to become mycorrhizal. Finally, such species are most likely of canopy or subcanopy stature, with rapid growth rates in juvenile stages. Low light levels in the understory may not permit sufficient photosynthesis to allow extensive maintenance of fungal associates, and rapidly growing plants may require rates of mineral supply which necessitates heavy infection. These characteristics—large-seeded, rapidly-growing canopy or subcanopy tropical species with little-branched, surficial root systems of coarse, hairless roots—describe many palm species.

Implications for the Palm Grower

Palms are an ecologically diverse group. Although some species may not need mycorrhizae, or will grow well without them when fertilized, others may not survive unless mycorrhizal. When a pattern of cessation of seedling growth after exhaustion of seed reserves is observed, even after fertilization, a lack of mycorrhizal fungi is indicated.

When a lack of mycorrhizae is suspected in seedling failures, the grower wishing to supply V-A mycorrhizal fungi will have to collect inoculum. Inocula are not now commercially available. Spores or sporocarps may be sieved from soil, although this requires some familiarity with technique and the ability to recognize V-A mycorrhizal fungi. Perhaps the easiest alternative is to add fresh chopped infected roots to the soil in the rooting zone. The species of roots used should not matter as long as they have abundant mycorrhizae. Soybean roots or those of other herbaceous V-A mycorrhizal crops are potentially usable, as are roots of tree crops such as *Citrus* spp. Unsterilized soil containing V-A mycorrhizal fungi can be used as a potting medium, but if rapid proliferation of mycorrhizae is desired, more concentrated inocula will work best.

Acknowledgements

I would like to thank S. Anderson, M. Baudoin, V. Chavarria P., G. Hartshorn, L. McHargue, G. Otis, A. Smith, J. Vandermeer, and S. Waltz for suggestions, discussions, and field assistance. I would also like to thank Jorge Campabadal of the Organization for Tropical Studies for his continued support.

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NATURAL HISTORY NOTES

The longest leaf in palms?

Leaves of some palms are said to be the longest in the plant kingdom but documentation of the claim is sparse. It seems possible that a leaf of *Raphia regalis* Becc. (*F. Hallé 1461*), measured in the Forêt de Bangou, Peoples Republic of Congo, on February 12, 1969 and reported in 1975 (Hallé, F. and R. A. A. Oldeman. An essay on the architecture and dynamics of growth of tropical trees, University of Malaya Press, Kuala Lumpur, p. 4) may set a record. The bases of the large leaves are buried about 80 cm in the soil, while the visible portion of the one measured consisted of a petiole 8.64 m long and a pinnate blade 16.47 m long. The entire visible portion measured 25.11 m or about 75 ft. This figure is greater than that given by Anderson and Mori (Turrialba 17: 221, 1967) for *Raphia taedigera* in Costa Rica, where they state leaves "may exceed 60–65 feet in length . . . ," and by McCurrach (Palms of the world 199, 1960) for *Raphia farinifera* (*R. ruffia*), reported to have leaves 65 feet long, 10 feet wide.

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Some Indonesian Palm Recipes

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Any visitor to South East Asia interested in palms will always be delighted by the many culinary uses to which palms are put. It seems a shame that not all palm enthusiasts can taste the palm delicacies of that region so we have prepared a few recipes, all including palm ingredients, for the home-bound palm enthusiast. Unfortunately, as with most cooking, experience only will produce the finest dishes, and as so much of Indonesian cooking involves guesswork we have had difficulty in adjusting recipes to western standards of precise measures. We hope the following recipes will not be the cause of too many stomach upsets and that they approximate to the delicious dishes eaten every day in Indonesia.

Before the recipes, certain basic ingredients need to be discussed.

1) *Santan*: *santan* is coconut cream (or coconut milk, as opposed to coconut water—the liquid endosperm). It consists of a milky emulsion of endosperm fats in water. In Europe it is possible to buy ready-made coconut cream in block form: all that is necessary then to make *santan* is to add hot water to the block and then strain, this producing a thick cream. Another method is to take desiccated coconut, soak in hot water, squeeze through the hands many times, and then strain and squeeze off the cream; this method is messy and time-consuming but produces much nicer *santan*. The very best method is to take fresh coconuts and grind up the endosperm and then proceed as for desiccated coconut. The more water used, the less creamy the *santan*. Generally speaking all recipes taste better made with thick *santan*. *Santan* should always be freshly made—it quickly separates on standing and also tends to go rancid quite quickly. For quantities, 1 lb. of desiccated coconut with 1¼ cups of water will give about 1 cup of thick *santan*, or 2 oz. of *santan* block with ½ cup water will give about ½ cup of thick *santan*.

2) *Palm sugar*: (*gula merah*, jaggery): this is made from coconut, sugar palm, borassus, or nypa in Indonesia. It is a delicious fudgelike, dark brown cake sugar. It is difficult to find a substitute for palm sugar (it is available in a few London shops). If quite unobtainable, soft dark brown sugar can be used; where a syrup is required, dark maple or corn syrup could be substituted but the particularly delicious aromatic tang of good palm sugar cannot be replaced.

Of course, if you have a coconut on your land, a good ladder, plenty of calabashes, a head for heights, and plenty of time, you could start from scratch and make your own sugar.

3) *Flavorings*: one flavor always used in cakes and desserts in South East Asia with *santan* and palm sugar is the deliciously musky flavor of *pandan wangi*, leaves of *Pandanus amaryllifolius*. This flavor is not generally liked at first by Europeans. When disturbed, the *luak* or *musang*, a relative of the skunk, discharges a scent very similar to that of *pandan wangi*. There is no substitute known to us for this lovely flavor; we perpetually bemoan its lack in Britain. Instead of *pandan wangi* a totally different but acceptable effect can be obtained by using vanilla essence.

4) *Colorings*: Leaves of *Cordyline* sp. (*hanjuang*) are used for coloring food green: green coloring in moderation can be used instead.

We have provided recipes for two savories, two desserts, and two drinks. Because of the richness of *santan* and palm sugar we recommend the eating of all at one sitting to confirmed gluttons only.

Palm Hearts (*Sayur umbud*; a mild curry recipe to use when your coconuts need to be felled).

1 large palm heart (*Euterpe*, *Borassus*, *Livistona*, or *Cocos* are all excellent)
1 cup *santan*
3 small shallots
1 clove garlic
½ tsp. coriander seed
½ tsp. turmeric powder
2 slices fresh ginger
1 tsp. palm sugar (to taste)
½ tsp. *blachan* (trassi—prawn paste; maybe you can substitute with anchovy paste)
fresh green chili to taste
1½ seeds *Aleurites moluccana* or *Macadamia* nut
salt

Take 1 large palm apex, trim until you have just crisp young tissue. Pound shallots, garlic, coriander, ginger, turmeric, macadamia nut, and *blachan* in a mortar and pestle until smooth. Cook with *santan* in a thick saucepan with the chopped palm heart—simmer gently, do not boil fiercely. Add palm sugar, salt, and fresh green chili. When the hearts are cooked but still firm, remove and serve. The mixture should be enough to cover one coconut apex. This dish is best eaten with fragrant white rice and, nicest of all, with crisp fried salt fish—though salt fish is not generally liked by Europeans.

Urap (vegetables with coconut dressing)

Dressing

½ lb. desiccated coconut (or freshly grated ½ mature endosperm)
½ tsp. ground chili pepper (to taste)
¼ tsp. *blachan* (see above)
salt to taste
1 shallot
1 slice *kencur* (rhizome of *Kaempferia galanga*—this is probably unobtainable—the *urap* will still be tasty without it)
1 tbsp. water
2 squeezes of lime juice
a pinch of palm sugar
1 bay leaf

Grind the shallot and garlic in a mortar and pestle: add *blachan*, *kencur*, palm sugar, salt, and chili pepper. Add 1 tablespoon of water and 2 squeezes of lime juice (if fresh endosperm is used, you need not use so much water). Mix all ingredients with the desiccated coconut. Wrap in tinfoil with a bay leaf and place in the oven for about ½ hour at 300° F. Remove from oven.

Vegetables

Take green vegetables such as cabbage, spinach, bean sprouts, french beans. Slice all but the bean sprouts thinly and blanch in boiling water for 2–4 minutes. Drain and toss with the cooked *urap* dressing until mixed thoroughly.

Delicious with rice and curry. This is a traditional feast food for weddings and anniversaries, usually eaten with saffron rice or rice cooked with *santan*.

Kelepon (pronounced klepon)

1 cup glutinous rice flour (can be made by grinding pudding rice in a blender)
grated or desiccated coconut

palm sugar cake
about 1 cup hot water
green coloring

Mix the rice flour with the hot water in a bowl with a few drops of coloring until thick and doughy (adjust proportions). Separate out into large marble-size portions of dough. Take chips of palm sugar cake and fold the dough portion around a chip of sugar until it is completely enclosed by dough. Drop the balls so made into boiling water in a large pan. When the balls are cooked they will float. Skim off the balls with a perforated spoon as they are cooked. Drain in a colander taking care not to squeeze the balls, and while still hot cover with desiccated coconut. Traditionally this is served in a little boat-shaped fold of banana leaf, 5 to a nest.

Watch out as you pop them in your mouth; if well cooked the balls will squirt thick palm syrup.

THREE PALM PUDDING

3 cups cooked pearl sago (from *Metroxylon sagu*)—ordinary pearl sago can be used
1 cup *santan* (from *Cocos nucifera*)
1 cup syrup of palm sugar (from *Nypa fruticans*)
1 leaf *pandan wangi* (if obtainable)

Boil sago until translucent. Strain off the water and turn sago into a mold. When cool turn out onto a plate. Make thick syrup of palm sugar (add a leaf of *pandan wangi* if you have it), cool. Make thick *santan*, cool. Serve the sago with *santan* and syrup.

This is the traditional gluttonous soporific dessert to finish off the typical planter's Sunday tiffin, a huge curry lunch, or rijstafel—quite delicious and fattening.

CENDOL (pronounced chendol; a popular drink-cum-dessert, often sold along roadsides)

½ cup of sago flour (if unobtainable, use corn flour)
1½ cups water
green coloring
santan with a pinch of salt
1 pandan leaf (or use vanilla essence)
a thick syrup of palm sugar

Mix corn flour with 1½ cups of water until smooth and boil gently, stirring all the time. Add a few drops of green coloring. When thick, remove from heat and pour into a metal colander with holes about 3–4 mm. diameter (this can always be made from an aluminum beer can with one end removed and the other end perforated by punching a large nail through several times). Fill a large saucepan with cold water and squeeze the porridge through the colander into the cold water to make short green "worms" about ¾ in. or 2 cm. long. Make a thick *santan* and a thick syrup. Flavor the *santan* with a drop or two of vanilla essence (or put 1 pandan leaf in the palm syrup).

Serve in large glasses (beer glasses)—2 tablespoons of green "worms," crushed ice, 2 tablespoons palm syrup, 3 tablespoons of *santan*, and top up with cold water. Stir and eat/drink with spoon/straw.

This is a really delicious drink for a hot summer afternoon.

BAJIGUR

1 cup strong black coffee
2 oz. *santan* block with ½ cup water
2 oz. palm sugar
a pinch of salt
3 drops vanilla essence

4 tablespoons of *kolang-kaleng* (young endosperms of *Arenga pinnata* boiled till tender, or substitute with very young raw coconut endosperm chopped small)

Make up the *santan*, strain. Mix in the salt, vanilla, coffee, and palm sugar, and add the coconut endosperm. Serve hot but do not boil as this will curdle the *santan*.

Enough for 4 servings. Makes a delicious snack with fried plantains or peanuts boiled in their shells served separately.

This is a hot drink-cum-dessert sold usually at nighttime on roadside stalls—popular during the rainy season.

PALM LITERATURE

DOWSON, V. H. W. 1976. Bibliography of the date palm. 139 pp., Field Research Projects, Coconut Grove, Miami, Florida 33133. Edited by Henry Field and William T. Gillis. $10.00 paperback.

This bibliography, which complements *The Date Palm* by Paul Popenoe (see *Principes* 18: 21, 1974), results from the accumulation of notes on literature concerning the date palm, *Phoenix dactylifera*, over a period of 60 years and covering all aspects of the palm.

HAROLD E. MOORE, JR.

PURSEGLOVE, JOHN W. 1972. Tropical crops: monocotyledons. 2 vols., 607 pp., Longman Group Ltd., London, Price £5.50 1 vol. paperback; Halsted Press Division, John Wiley & Sons., Inc., New York.

This is the second two volume part of Purseglove's authoritative introduction to tropical crops and completes his survey. This review deals only with Purseglove's treatment of the palms.

The account of the palms follows the same pattern as for the other families—a general introduction is provided (including a key to subfamilies) and then several palms and their products are described briefly, this being followed by a detailed account of the economically most important species. Key references may be found at the end of the major sections. In all, 94 pages of this 607 page part are devoted to the family Purseglove claims is second only to the grasses in economic importance.

The task of discussing palms and their economic products is a very daunting one. Almost all species are used in some way in their natural habitat—can they be regarded as crops? Undoubtedly certain very important species such as the wax palms deserve mention in any account of palms as tropical crops, even though the exploitation of wild stands may account for a greater percentage of the production than that of plantations. Yet in many areas, wild palms may be locally extremely important yet never cultivated. A palmologist is hence almost bound to disagree with any arbitrary selection of economically important palms. Purseglove discusses *Cocos nucifera*, *Elaeis guineensis*, and *Areca catechu* in detail and deals briefly with *Arenga pinnata*, *Astrocaryum murumuru*, *Attalea funifera*, *Borassus aethiopum*, *B. flabellifer*, *Calamus* spp., *Caryota urens*, *Ceroxylon alpinum*, *Copernicia prunifera*, *Corypha umbraculifera*, *Cyrtostachys lakka*, *Daemonorops* spp., *Bactris gasipaes*, *Hyphaene thebaica*, *Leopoldinia piassaba*, *Lodoicea maldivica*, *Metroxylon* spp., *Nypa fruticans*, *Orbignya* spp., *Phoenix dactylifera*, *Phytelephas macrocarpa*, *Raphia* spp., *Roystonea* spp., and *Salacca edulis*. Passing mention is made of other palms throughout these brief accounts. One may question

(*Continued on page 40*)

Morphology and Development of the Fruit and Seed of Jubaeopsis caffra Becc.

B. L. ROBERTSON
Department of Botany, University of Port Elizabeth, South Africa

According to Corner (1966) the majority of palm fruits generally have three common features, viz. they are all fairly large, they are usually one-seeded, and they are indehiscent. However, numerous exceptions occur and *Geonoma* and *Chamaedorea*, for example, have small fruit. Botanically too, various fruit types occur in the different groups of palms. In all cocosoid palms and many of the arecoid palms, drupes are encountered, while in *Phoenix* one-seeded berries occur (Corner, 1966; Murray, 1973). In certain species of *Borassus* the fruits are somewhat more complex, being two- or three-seeded and with each seed enclosed in its own endocarp within a common mesocarp (Corner, 1966). The fruits of the lepidocaryoid palms, e.g. *Raphia*, are botanically of great interest in that they are enveloped by hard scales. Most palm fruits develop a "pulpy" wall at maturity (Corner, 1966). The nature of this wall does, however, vary from the softness of the date to the fibrousness of the coconut.

Considering the extent to which palm fruits are known and used by the peoples of the tropics, it is strange that so little is known about the anatomy and development of the fruits and seeds. According to Murray (1973), these aspects have been studied in only two palm species, viz. *Cocos nucifera* and *Phoenix dactylifera*.

Murray gives three reasons for this general lack of information. Firstly, the long developmental time required by palm fruits; secondly, the geographical inaccessibility of most species, and thirdly, the intractable nature of the fruits themselves.

Until recently, so few data have been available that in the case of drupes it was not known whether the stone was compound and included the three original cavities of the ovary or whether it represented the endocarp of the functional cavity only (Corner, 1966).

Murray (1973), however, has made a major contribution in this regard and has described fruit development, especially with respect to the development of the endocarp, for 17 palm species from four subfamilies, viz. Coryphoideae, Caryotoideae, Arecoideae, and Cocosoideae.

Unfortunately, Murray discussed neither the anatomical nature nor the development of the germination pores that are characteristic of all cocosoid palm fruits. Apart from a very brief description by Juliano (1926) for *Cocos*, no information on this aspect of fruit development is available.

Not only is very little known about the anatomical aspects of fruit development, but there appears to be surprisingly little information available concerning the time required for the development of palm fruits, especially the wild species. In view of the lack of data concerning

fruit structure and development in the palms generally and the fact that no information on the development of *Jubaeopsis caffra* fruits is currently avaliable, a study of this aspect was undertaken.

Materials and Methods

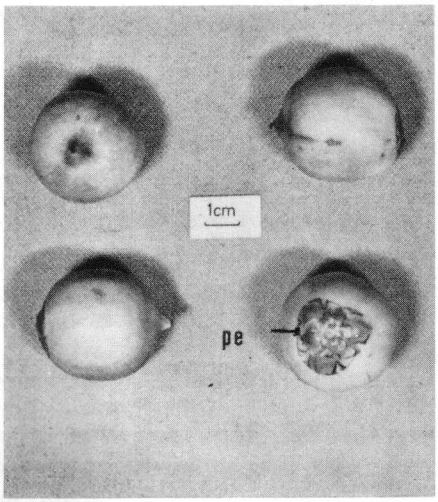
All the plant material used in this study was collected from a cultivated *J. caffra* tree (approximately 43 years old) in St. George's Park, Port Elizabeth. An inflorescence was selected and ten fruits were collected each 14 days from the date on which the inflorescence opened until the fruits reached maturity. These fruits were measured (length and breadth) and fixed in formaldehyde/ethyl alcohol/acetic acid (Sass, 1958).

Dehydration of the material and infiltration with paraffin wax (Carowax; melting point 54–58° C) was achieved by means of graded tertiary butyl alcohol (TBA)/ethyl alcohol and (TBA)/wax series, respectively (Sass, 1958). Ten μm sections were made on a rotary microtome (Brooks, Bradley & Anderson, 1950) and stained in either safranin/fast green (Höltzhausen, 1972) or iron-alum-hematoxylin/safranin (Brooks *et al.*, 1950). Hard, sclerified tissues were softened by soaking the embedded material in 20 ml glacial acetic acid/80 ml 60 percent ethyl alcohol for 24 hours before sectioning.

Results and Discussion

(a) *General morphology and growth of the fruit.*

The fruit of *J. caffra* is a drupe consisting of a fleshy exocarp and mesocarp and a lignified or bony endocarp. The size of the ripe fruit varies from tree to tree and from season to season. However, the average fruit size for the tree in St. George's Park is 4.0 cm long and 3.5 cm broad (Fig. 1, 4). The proximal or basal end of the fruit is covered by a

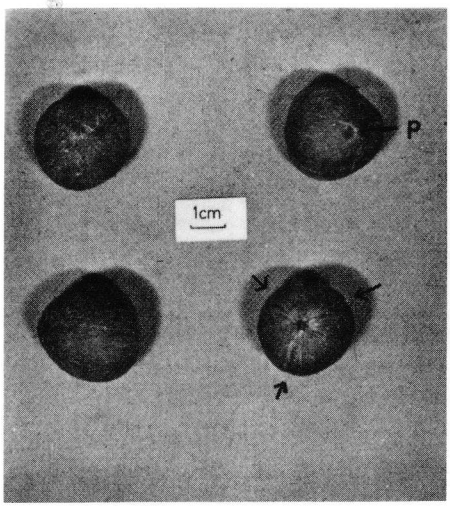


1. Mature fruits of *J. caffra* (pe, perianth).

persistent perianth comprising two trimerous whorls, viz. the sepals and petals. It would seem that the function of the perianth is to protect the soft, meristematic, basal portion of the ovary.

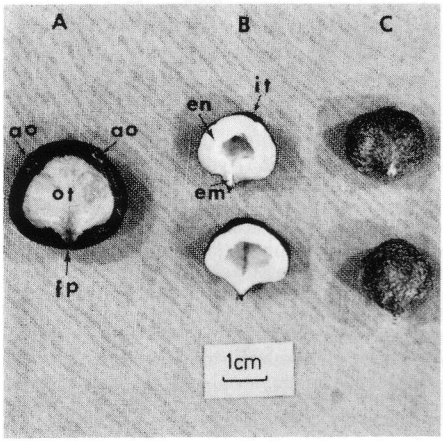
When the fruit is fully mature, it is abscissed, but the perianth, however, usually remains attached to the rachilla on which the fruit was borne. At this stage the fibrous mesocarp is very loosely attached to the endocarp and usually it starts to split from the basal end of the fruit. The exocarp and mesocarp of the fresh, mature fruit are approximately 3–4 mm thick. When the mesocarp is removed, the fruit has the appearance of a nut in that it consists of a hard, bony, covering structure around a seed (Fig. 2).

The endocarp is divided into three segments by three grooves along which fusion of the carpels took place (Fig. 2). While two of the segments are more or less of equal size, the third is very much larger and constitutes nearly half of the nut's circumference (upper right hand nut in Fig. 2). This latter segment represents the carpel which bore the functional ovule.

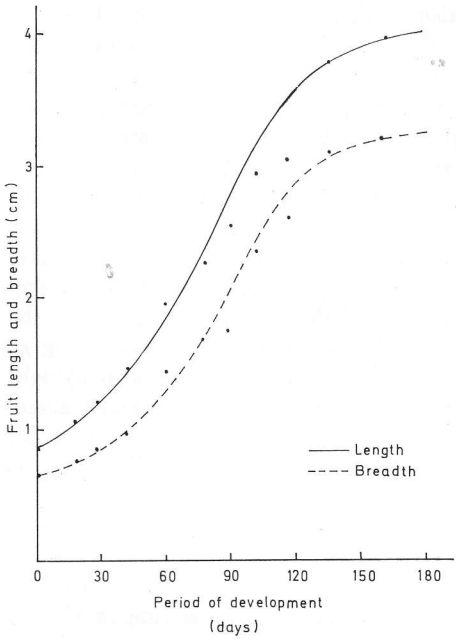


2. "Nuts" or "seeds" after removal of the exocarp and mesocarp (p, germination pore).

Each segment or carpel has a germination pore, but only the one opposite the micropyle of the functional ovule penetrates the endocarp completely. It is externally somewhat larger than the other two pores and, when pierced, provides access into the seed and the embryo. The remaining two pores are only 1–2 mm deep. All three pores are laterally or equatorially situated.



3. Endocarp and seed of *J. caffra*. A, transverse section through the endocarp shell of the fruit (ao, aborted ovules; fp, functional pore; ot, outer portion of testa); B, transverse section through the seed (em, embryo; en, endosperm; it, inner portion of testa); C, intact seeds.



4. Fruit growth of *J. caffra*. Data were obtained by measuring the length and breadth of 20 fruits at regular intervals and calculating the mean values for each day (black dots).

Removal of the endocarp exposes the kernel (Fig. 3C), which consists of a mass of endosperm covered by a thin brown skin (Fig. 3B). This skin, as will be shown in the subsequent section on the anatomy of the fruit and seed, is actually only a part of the testa and more specifically it is the inner integument. The remaining part of the testa, i.e. the outer integument, is fused to the inner side of the endocarp or shell and can be observed as a cream-colored to light brown lining on the inside of the endocarp. The thickness of the endocarp varies from 3–4 mm.

In a transverse section through the nut (Fig. 3A, 6) the two nonfunctional ovules can be observed in the endocarp.

Also evident is the large central cavity in the endosperm (Fig. 3B). This cavity is without liquid endosperm or "milk" in the mature fruit. In the mature seed, the endosperm is approximately 5 mm thick.

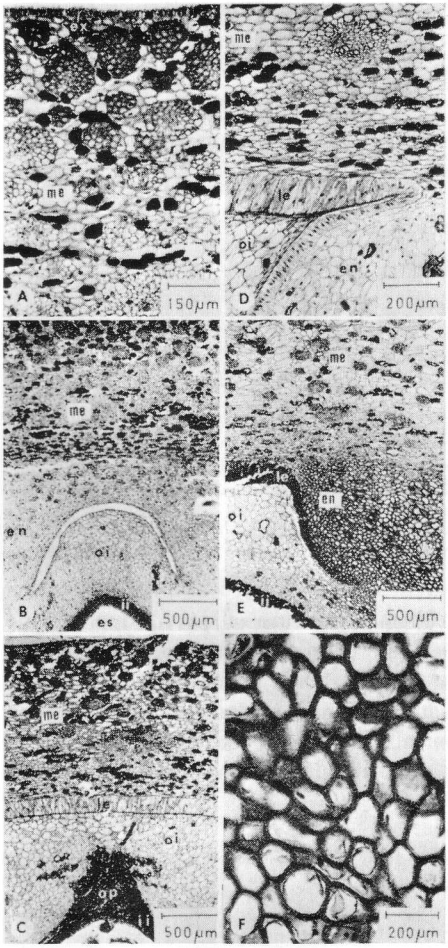
Growth of the fruit follows a sigmoidal pattern from the time of appearance of the female flower until the fruit is mature (Fig. 4). During the first 45 days after opening of the inflorescence, growth is relatively slow. This is followed by a second stage, lasting 90 days, in which growth is very rapid. In the last stage of fruit growth, the rate of increase in fruit size slows down dramatically. It is during this final period of fruit development that most of the growth of the embryo takes place (Robertson, 1976a). As shown in Fig. 4, growth takes place at more or less the same rate in all regions of the fruit and the rates of increase in length and breadth of the fruit are essentially the same.

Maturation of the fruit is basipetal, and the basal region of the fruit remains soft and does not differentiate fully until the fruit has newly attained its maximum size.

(b) *Anatomy and development of the fruit, germination pores, and testa.*

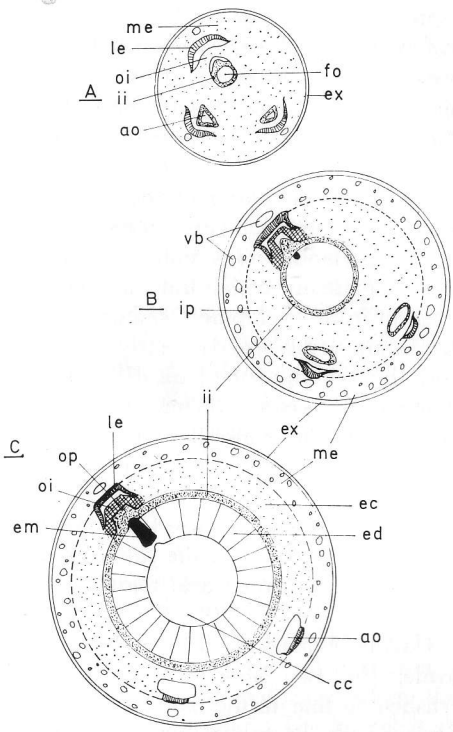
Like all other drupes, the pericarp of the *Jubaeopsis caffra* fruit consists of an exocarp, mesocarp, and endocarp. The exocarp in this genus is reduced to a single cell layer, viz. the epidermis of the fruit (Fig. 5A), and is covered by a cuticle. The cells of this layer are more or less block-shaped in a transverse section, with thickened outer tangential and radial walls. No significant changes occur in these cells during the course of fruit development.

The mesocarp, although termed fleshy, is extremely fibrous and is traversed by a large number of vascular bundles and fiber bundles (Fig. 5A–E). In a



5. Transverse sections through the pericarp of the fruit at various stages of development. A, exocarp and mesocarp; B, development of the germination pore in a fruit shortly after fertilization; C, mesocarp and germination pore of a fruit approximately 100 days after fertilization; D, mesocarp, germination pore, and endocarp shortly before lignification of the cell walls; E, as D but subsequent to lignification; F, endocarp cells subsequent to lignification or sclerification (en, endocarp; es, embryo sac; ex, exocarp; ii, inner integument; le, locular epidermis; me, mesocarp; oi, outer integument; op, operculum).

very young fruit, just after anthesis, the extent of the mesocarp can best be seen opposite the functional ovule where the mesocarp is bounded on the outside by



6. Schematic representation of fruit development, showing transverse sections through the fruit at various stages of growth. A, shortly after anthesis; B, before sclerification of endocarp; C, mature fruit (ao, aborted ovule; cc, central cavity; ec, endocarp; ed, endosperm; em, embryo; ex, exocarp; fo, functional ovule; ii, inner integument; ip, intervening parenchyma; le, locular epidermis; me, mesocarp; oi, outer integument; op, operculum; vb, vascular bundle).

the exocarp and on the inside by the locular epidermis (Fig. 6A).

Cell division and enlargement in the mesocarp is relatively slow and the cells of this region become tangentially elongated as the volume of the fruit increases so that the mesocarp, which is initially not clearly distinguishable from the endocarp, becomes well defined. At this stage, the cells of the endocarp are still more or less isodiametric, thin-walled, and meristematic (Fig. 5B, D), and it is possible to distinguish the limits of all three pericarp components not only in the vicinity of the functional germination pore, but in all regions of the fruit (Fig. 6B).

The vascular bundles in the mesocarp are initially not well differentiated, but as the fruit develops, they become surrounded by thick sclerenchymatous or fibrous sheaths, while fiber bundles not associated with any vascular tissue also differentiate in the mesocarp (Fig. 5A). There is a concentration of sclerenchyma in the peripheral region of the mesocarp and the fibrous sheaths of the vascular bundles in this peripheral zone tend to be thicker and better developed than the more deeply situated vascular bundles. While the number of vascular elements in most of the bundles is relatively small, a large, well-developed, dorsal, carpellary vascular bundle occurs opposite each germination pore (Fig. 5C, 6A–C).

Although only one of the ovules undergoes post-fertilization enlargement and development, all three ovules achieve maturity and contain fully differentiated embryo sacs. *Jubaeopsis caffra* has hemianatropous, crassinucellate, bitegmic ovules embedded in the placental tissues. The outer integument is a massive, dominant structure while the inner integument is only two cell layers thick laterally, with the innermost cell layer forming an endothelium (Robertson 1976b). At the micropyle the inner integument forms an operculum. As the functional ovule enlarges during fruit growth, the endothelial cells divide anticlinally (in relation to the embryo sac) and elongate periclinally, while the cells of the second cell layer in the inner integument divide periclinally, giving rise to approximately six cell layers.

A large number of tanniniferous idioblasts are present in most tissues of the fruit, but are especially abundant in the mesocarp and the inner integument. The latter structure, in fact, consists entirely of tanniniferous cells (Fig. 5B, C).

Shortly after anthesis the cells of the locular epidermis become elongated. Those forming the boundary between the mesocarp and the integumentary plug in the pore elongate radially, while those lateral to the integumentary plug become more or less tangentially (in relation to the exocarp) elongated (Fig. 5C, D; 6A–C).

This tissue, i.e. the locular epidermis, which does in fact constitute a portion of the endocarp, will, after lignification of the cell walls, differentiate into macrosclereids (Fig. 5E) and forms the lid and lining of the germination pore (Fig. 6B, C). The outer integument forms a parenchymatous plug which lies just beneath the lid of the germination pore (Fig. 5B–E). This plug remains parenchymatous throughout the lifetime of the fruit. The center of the plug is only five or six cell layers thick where it is penetrated by the tanniniferous operculum of the inner integument (Fig. 5C), and consequently it is easily ruptured by the emerging embryo during seed germination.

Although the inner integument, which eventually consists of four to six layers of tannin cells, remains distinguishable throughout the period of fruit and seed development, the outer integument can only be distinguished as a separate structure in the vicinity of the pore where it forms the plug. This integument is, however, almost entirely fused to the endocarp, the fusion starting at the point where the locular epidermis terminates (Fig. 5B, E; 6A–C). From this point onwards it cannot be distinguished from the endocarp. The endocarp in *J. caffra*, therefore, consists of the locular epidermis, the intervening parenchyma, and part of the outer integument and stretches from the mesocarp on the outside to the inner integument on the inside. It does not include any of the fibrous tissue of the mesocarp (Fig. 6B, C). Lignification of the endocarp cells is initiated when the fruit has reached approximately three-quarters of its maximum size and takes place basipetally. Numerous simple pits occur in the thick lignified walls of these cells (Fig. 5F).

The basal or proximal region of the fruit, i.e. the portion covered by the persistent perianth, does however remain meristematically active until a very late stage in fruit development and only when maximum fruit size is nearly attained does this region of the fruit differentiate into mature tissues. During development of the fruit, the ovules become displaced from their extreme basal position in the ovary at anthesis to a lateral or equatorial position in the mature fruit. This is a further indication of the rapid growth which occurs in the basal region of the fruit.

During expansion of the functional ovule, the two aborted ones become crushed so that in the mature fruit they remain only as two minute cavities or slits in the endocarp of the fruit. Each of these two small cavities has its own pore and lid (Fig. 3, 6C). The structure of these lids is precisely the same as that of the functional pore and consists of a single layer of macrosclereids of locular epidermal origin.

Conclusions

The drupaceous fruit of *J. caffra* is typical of the fruit of all cocosoid palms in that it consists of a fibrous mesocarp and a hard, bony endocarp which has three characteristic pores. The position of the pores, however, varies from genus to genus and is related to the position of the micropyle of ovules. According to Uhl and Moore (1971), the pores are basal in ovaries with anatropous ovules, lateral if the ovules are hemianatropous and above the middle if the ovules are orthotropous. They state further that

this feature is, to a large extent, used to separate the three major groups within the subfamily Cocosoideae, viz. the *Cocos*, *Bactris*, and *Elaeis* alliances. In the *Cocos* alliance, which includes *Butia*, *Cocos*, *Jubaea*, and *Jubaeopsis*, the ovules are hemianatropous to anatropous and the pores are consequently near the base of the endocarp (Uhl and Moore, 1971). Although this is true for *Cocos* and *Jubaea*, the pores in the endocarp of *Jubaeopsis caffra* are placed not basally but laterally. In this respect, *J. caffra* is thus similar to the bactroid palms, most of which are distinguished by lateral pores.

The seed coats of palm seeds in general are poorly developed (Corner, 1966) and in this connection *J. caffra* is no exception. According to Esau (1965) both integuments of a bitegmic ovule form the testa. The outer integument of *J. caffra*, however, is fused to the endocarp and is removed with the endocarp when the "nut" is cracked open. The kernel is in fact covered by the inner integument only and consequently the kernel itself does not represent the entire ovule.

With reference to Corner's (1966) statement concerning the composition of the endocarp, i.e. whether tissue around the functional cavity only or all three cavities is involved in construction of the endocarp, it would seem that in *J. caffra* all three cavities are involved, but in a restricted sense only. The locular epidermis of each cavity forms a separate germination pore lid. All three pores are, however, incorporated into the endocarp, and in view of the fact that the locular epidermis represents one of the components of the endocarp, it must be concluded that the locular epidermis of each cavity contributes to the formation of the endocarp and that this latter tissue is consequently a compound structure.

The composition of the endocarp in *J. caffra* is not in accordance with that suggested by Murray (1973) for other cocosoid palms. In *J. caffra* it consists of the sclerified locular epidermis, the intervening parenchyma, which also becomes sclerified, and the outer integument. The Type III (Murray, 1973) described for cocosoid palms provides for an endocarp that includes the sclerified locular epidermis, the sclerified and sometimes confluent sheaths of the inner vascular bundles, and the intervening parenchyma.

The findings of this study in respect to the remains of the aborted ovules, i.e. that they are present and clearly visible in the endocarp of *J. caffra* fruits, are contrary to those of Beccari (1913). In his original description of this species Beccari states that while ovular remnants are present and visible in the endocarp of *Jubaea* fruits, they are not present in that of *Jubaeopsis caffra*.

Acknowledgements

This project, which formed part of a doctoral thesis submitted to the University of Port Elizabeth, was supported by financial grants from the University of Port Elizabeth and the C.S.I.R.

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NEWS OF THE SOCIETY

Biennial Meeting, June 19–22, 1976

There can hardly be a more suitable setting for a meeting of the Palm Society than the campus of Florida Institute of Technology at Melbourne, Florida. Host Dr. Jerome P. Keuper, President of F. I. T. and former Palm Society president, has made the 125-acre campus a veritable palm garden, using these plants almost exclusively for the landscaping. The innumerable large specimens of hardier species with smaller and more tender ones interspersed, met the eye on every side, being used as specimen plants, massed along walls or walks, or silhouetted against buildings. The effect is overwhelming to a palm lover and it still seems incredible that this major palm collection was started just nine years ago. It is impossible to do justice to such a setting in this report of the Biennial Meeting. Those of you who have the April 1975 issue of PRINCIPES can look at it again to refresh your memory of what those of us who attended the meeting were privileged to experience.

Upon arriving at F. I. T. on Saturday, June 19, we checked into the commodious and convenient dormitories. For dinner we gathered in a large upstairs room over the cafeteria. The entire north side of the room is of glass and provided a fascinating spectacle as a typical midsummer thunder squall lashed torrents of rain on the palm tree tops in our field of vision.

Next morning, Dr. Oscar Rodriguez, new horticulturist at F. I. T., led groups of members along the Dent Smith Trail where in the shaded dampness the myriad smaller palms are thriving. So many unexpected Palm Society members showed up at the luncheon without reservations that the planned food finally ran out, though adequate substitutions were hastily produced.

There was a turnout of over 100 at the auditorium for the official meeting in the afternoon. After the business meeting (see minutes of the meeting on page 167 of the October issue for this important session.) we heard Dr. Fred Essig tell us about the palms, especially the ptychospermas he had studied while in New Guinea some years ago. Paul Drummond detailed the state of lethal yellowing disease, and noted that new coconut hybrids may hold the key to the replanting of these palms in South Florida, which has lost so much of its tropical appearance due to the death of approximately 500,000 coconuts and even more *Veitchia merrillii*. Next we were transported to the state of Georgia by Mr. William Manley who showed the beauty of hardy palms on his property. We saw how well many of the plants had recovered after he had had to transplant them when moving into a new home. Dr. Robert Read gave us the highlights of his treatise on the genus *Thrinax*, preparing those who would be going to Jamaica on what to expect to see there.

At the delicious banquet that evening, outgoing President U. A. Young was presented a plaque in recognition of his service as president. Incoming President Myron Kimnach greeted all and thanked those responsible for the most enjoyable

and competently planned meetings and accommodations. First, of course, was host Jerry Keuper who had made it all possible. Aiding him and handling all the innumerable complex details was Dr. Joseph Weil, who was almost overwhelmed by the many members who decided at the very last moment that they would come, reservation or no.

Then the room grew dark and quiet as Dr. H. E. Moore, Jr., showed us slides and told us about the many areas where man's impact is changing the face of the world, destroying what it has taken nature millions of years to produce. It is sobering to realize how much has already been lost and how much more is being lost to provide living space for the steadily increasing numbers of mankind. There is still so much to learn about the interrelationships of plants in their native environment, and so little time to do it. We left the banquet hall with many thoughts about our beautiful palms, happy to have shared so much with others whose love of these plants had brought them to this place.

TEDDIE BUHLER

The following account by Dave Besst of Maitland, Florida, starts with Monday, June 21, "a day to relax. A small group drove over to Disney World, others up the beach to visit Third Century, the Bicentennial Exhibition at the Kennedy Space Center with its excellent preview of what technology holds for America's third century. Others visited Joe Michael's and Bill Bidlingmayer's gardens noted for their extensive collections of the more tropical palms typical of the southern part of Florida. And, last but not least, a few attended open house with watermelon and cool drinks at the beachfront home of Dr. and Mrs. Jerome Keuper.

"When the evening cookout scheduled for F. I. T.'s houseboat on the river was threatened by a thunderstorm, the resourceful caterers promptly moved to the campus cafeteria, with hamburger and hot dogs cooked over a large grill on the cafeteria porch. Not to let the evening die so early, the Keupers invited all to their home to finish the beer and watch for sea turtles, which at this season bury their eggs in the beach sand directly in front of the property. Feeling somewhat like Dr. Archie Carr, the famous sea turtle expert from the University of Florida at Gainesville, we walked with lanterns and flashlights, hoping to come upon a mother turtle making her commitment to another generation of green sea turtles. No such luck, so we enjoyed the view, food, beer, and good company of our palm friends until it was time to head for bed.

"Tuesday morning the bus tour members and those traveling in their own cars rallied at the F. I. T. Jensen Beach campus for a tour of the grounds and expanding palm collection. Adjournment to Frances Langford's Outrigger Resort Hotel for an outstanding Polynesian lunch was in a setting that could not have been more to a palm lover's liking. We were seated in a waterfront dining room overlooking the Indian River with a view framed in coconut palms.

"From here we went to the nearby estate of Mr. Louis Dommerich, who, unfortunately, was out of town but had arranged for Mr. and Mrs. Wm. Lewis to conduct the group. Perhaps the owner might have had stories to tell about the many mature palms in his extensive collection. As it was, no one could decide which was the most striking specimen, there were so many unusually large, rare palms. Penetration of the dreaded lethal yellowing was much in evidence. Mr. Dommerich is trying to stave off the attack and most of his large stand of coconuts carry the stains typical of the terramycin injections.

"After having to crane our necks admiring the tops of tall palms it was a

pleasant change to visit the nearby home and palm collection of Mr. Rawson Lizars. His young and vigorously growing palms consisted of many choice plants, some grouped, others standing alone to show off their princely forms. Most of them had been grown from seed obtained from Lucita Wait and De Hull, our faithful trustees of the Seed Bank—a testimony to Mr. Lizars' patience and tender care.

"Coral Gables was the end of the day's trip where cool showers and a dip in the Howard Johnson pool were a welcome refreshment. Afterwards cocktails, palm talk and visiting were followed by dinner at the nearby Waterway Inn. Open air, canalside dining, gentle breezes and strolling musicians pleasantly ended another fine day of the Biennial."

Wednesday a tour at Fairchild Garden was followed by a quick bite at the Snack Bar. Then a visit to Paul Drummond's large and fascinating collection gave those present a chance to hear Dr. Moore identify his *Chamadorea falcata* with sickle-shaped seeds. Paul's *Pigafetta filaris* was the object of envy and wonder with its 12 feet of glossy green trunk. From here the tour continued to the magnificent garden of Nat DeLeon whose collection of bromeliads, staghorns and orchids enhanced the beautiful palms. He had lost two *Arenga engleri* to lethal yellowing, but one of his licualas, unidentified but perhaps *L. peltata*, had several beautiful spikes of cherry-red fruit which he generously distributed to all who wished them.

Thursday morning a heavy downpour kept all captive in the bus for at least 30 minutes at the Jennings Estate. Finally it let up enough for hardy souls to venture out but drizzle and insects soon drove them back and the bus continued to Chapman Field, the U.S. Plant Introduction Garden and Research Station with its old palms. However, the same rain and insects plagued the group here so the bus shortly continued to the Parrot Jungle where the cafeteria was a welcome haven with its views of the colorful parrots. Host Nat DeLeon gave a conducted tour, showing the many palms hidden here and there, among them a tall slender unidentified *Chamaedorea* with fragrant blooms, the huge *Raphia*, and an unidentified *Pholidocarpus* from Brunei. Dick Douglas of San Francisco, who had formerly lived in Miami, was a helpful tour guide for the Miami tours, while Dr. John Popenoe of Fairchild Garden showed members around the Jennings Estate.

Teddie Buhler

The Post-Convention Trips

Following the Biennial Meeting held at Melbourne, Florida on June 19–25, 1976, 36 persons who had attended the Meeting went to Jamaica on a post-convention trip. Those going on the short trip (Group A) were: Mr. & Mrs. T. C. Buhler, Mr. & Mrs. R. G. Douglas, Mr. Richard Douglas, Mr. Paul Drummond, Mr. & Mrs. Edward Simmons, Mrs. Ruth Shatz and Mrs. L. H. Wait.

Those taking the longer trip (Group B) were: Dr. & Mrs. Byron Besse, Mr. David Besst, Mr. Dale Boggy, Mrs. Cara Calvetto, Mr. Crafton Clift, Mrs. Gertrude Cole, Miss Mary Collins, Mr. & Mrs. A. J. Constantine, Mr. & Mrs. A. J. Constantine, Jr., Mr. & Mrs. John Jiretz, Mr. & Mrs. Norman Moody, Dr. Robert W. Read, Mr. & Mrs. Kermit Rossten, Mr. & Mrs. J. M. Schneider, Mr. & Mrs. Gordon S. Smith, Dr. Donald Stalker, Mr. Jaime White, and Dr. & Mrs. U. A. Young.

Accounts of the two trips follow:

JAMAICA TRIP—GROUP A—June 25–28, 1976

Friday, June 25: At mid-morning 37 Palm Society members met at the Air Jamaica counter at Miami International

Airport, ready for departure on what proved to be a fascinating trip to the beautiful island of Jamaica.

Upon arrival at Montego Bay we were warmly greeted by Melvin and Phyllis Sneed who had worked out and coordinated the details of our trip in a most professional manner. We were driven to the Doctors Cave Beach Hotel at the base of a steep hill planted with lush vegetation including a breadfruit tree and royal palms. Most of us donned bathing suits for a quick refreshing dip at Doctors Cave Beach across from the hotel. Then three minibusses drove us past beautifully planted gardens to the Sneeds' delightful, airy, hilltop home. We admired the many unusual tropical plants of all descriptions lushly growing on the sides of the ravine in the garden adjoining the house and driveway. Innumerable palms have been set out, most of them grown from seed by Mel himself since he became interested in palms about four years ago. He has the start of a truly magnificent collection. After viewing the plantings we gathered on the Sneeds' ample veranda, admiring the wide view and enjoying a pleasant social hour. The buffet dinner was highlighted by a large dish of fried akees (*Blighia sapida*) which met with great favor. We were most grateful to the Sneeds for their delightful hospitality.

Saturday, June 26: We met at an *al fresco* breakfast and then were separated into two groups, the ten who were on Trip A (returning to Miami on Monday morning) in the smallest bus with Dr. Robert Read as tour guide, while the 26 on the longer Trip B (returning on Thursday) followed in the other two. We headed west along the coast, stopping to look at a huge wooden waterwheel still turning, all that remains from an old sugarmill of 50 or more years ago. We saw many coconuts, most of them the golden dwarf Malayan, and here or there isolated *Roystonea princeps*. We made a short stop at a resort complex near Lucea (pronounced Lucy) to pick up our box lunches. Here *Coccothrinax jamaicensis* had been used extensively in the landscaping. Seeds were plentiful and eagerly gathered. Then on to Negril where we found a delightful spot on a nearby promontory above the deep blue sea to eat our lunch. Small *C. jamaicensis* grew among the craggy rocks. It was here, across the narrow road, that Paul Drummond found a pretty native cycad practically indistinguishable from other similar zamias. A further short trip brought us just outside Savanna-La-Mar on the southern shore to Paradise Park, a former plantation turned into a golf club but now in a sort of limbo, looking somewhat abandoned. There two open flatbed vehicles pulled by tractors took us to a stream which we crossed on foot to enter into what is normally a brackish marshy area of native mangroves and other large trees. We had been given permission to collect so hohenbergias, guzmanias, oncidiums, broughtonias, ferns, rhipsalis and a few others caught collectors' eyes. Unfortunately, the ground seemed cleared of debris, whether from the water that normally was to be found here or the feeding of the infinity of land crabs whose holes were everywhere. No seeds were to be found under the *Roystonia princeps* though Crafton Clift with great energy tried hurling stones to dislodge ripe seeds on the exceedingly tall trees. Nor did the others who ventured into a really wet area have more luck with the royals found there or the *Calyptronoma occidentalis*.

Sunday, June 27: The A group, accompanied by Phyllis Sneed as guide, was ready at 8 A.M. to take off eastward to Dunns River Falls, a delightful spot and almost completely deserted at 10 of a lazy Sunday morning. A few *C. jamai-*

censis with their silvery undersides were visible along the road, but seemed too small and too far away to get seeds from. *Thrinax parviflora* showed in the distance on hills, again too far away. We were all impressed by the many magnificent breadfruit trees planted everywhere; they are truly a memorable sight. We arrived at Castleton Gardens by noon and ate our delicious box lunches sitting on huge boulders under a canopy of enormous trees covered with veritable gardens of *Rhipsalis*, ferns and bromeliads. Nearby were several large old clumps of *Licuala spinosa* and *Pinanga kuhlii*. The garden itself, though small, was impressive for the size of its specimen trees and palms that towered so far overhead as to be nearly unrecognizable. Seeds were gathered, many for the Seed Bank, including *Nephrosperma vanhoutianum*. Some just-sprouted *Areca catechu* seeds lay among the many foot-tall seedlings. However, we were careful to leave seeds for the B trip group due here the next day. Mr. Uriah Bennett made an interesting guide, obviously proud of the famous old garden as well he might be, as he has tended it long and faithfully.

Returning by a slightly different route we did find an *Acrocomia totai* under which were some seeds, so all were satisfied with a most pleasant day and we left next morning having seen just enough to whet our appetites for a longer stay at another time on hospitable Jamaica.

We all wish to thank the Sneeds who prepared our two trips so well, even arranging for each of us to receive a big envelope containing a map of Jamaica, notes by Bob Read on the native palms we expected to see, a catalog of plants at "Sneedview," and a fascinating book on Jamaican plants called *The Blue Mahoe and other Bush* by C. D. Adams. What more could have been done for us?

TEDDIE BUHLER

JAMAICA TRIP—GROUP B—June 27 to July 1, 1976

June 27: We traveled with Dr. Robert W. Read (hereinafter referred to as Bob), who seems to know where each and every palm in Jamaica grows, to the Black River Area via Rat Trap and Middle Quarters. (Even Jamaican names made places intriguing, some so very English, some descriptive, though I failed to see either the trap or rats at Rat Trap.) The Black River flows into the Caribbean directly south of Montego Bay on the southwest side of Jamaica. At Rat Trap (which is about halfway) we stopped to see a large *Bactris jamaicana*. We saw *Roystonea altissima* at this higher elevation, so like its close relative *R. princeps* that the layman is hard put to see differences. Bob said, "If you see it near the sea or on lowland, it is *princeps*, if you see it in the mountain regions it is *altissima*." The trunks of both these are so very slender compared to royals seen in Florida. Both hold their leaves well above the crownshaft too. Nice *Calyptronoma occidentalis* were seen at lower elevations and a tall *Acrocomia spinosa* at Middle Quarters stopped us again. Cacao and cassava were interesting along the way.

From Middle Quarters we rode for several miles under arching bamboo toward Mandeville, which is 3,000 ft. above sea level. Somewhere along the way, in outcroppings of limestone, we could see *Thrinax parviflora* clinging to the high steep cliffs. In the "red dirt"' country as we climbed on hard-surfaced, narrow, much-curved roads we had a spectacular view below of bauxite mining. Bauxite is a major Jamaican export. We picked up box lunches at the Belair Hotel in Mandeville and at 3 P.M. Bob found a delightful place for us to eat—a cow pasture. We ate with two bullocks placidly looking on and chewing their cud.

At 6 P.M. we were in Cockpit country. This unique, indescribably beautiful country, largely unexplored, abounds in unusual vegetation. Across a chasm was Mango Tree Hill with *Thrinax parviflora* on the ridge. Do read descriptions of Cockpit country in Read's *The Genus Thrinax*. (Smithsonian Contributions to Botany No. 19, available from U.S. Superintendent of Documents, U.S. Gov't Printing Office, Washington, D.C. 20402, price $2.40, paper cover.) He tells how elevation, temperature changes, and rainfall affect the distribution of plant species.

We returned to Montego Bay in late evening and set out again at 8:30 A.M. June 28. It was a bright sunshiney morning as we headed east along the North Shore. Soon we saw the silver undersurface of leaves of *Coccothrinax jamaicensis*. We stopped along the road between Rio Bueno and Discovery Bay. Here we walked on limestone, jagged and honey-combed. In the thicket we saw beautiful fuchsia flowers of broughtonia orchids. The *Coccothrinax jamaicensis* were dwarfed compared to the tall specimens we could see in the distance along and on top of a high ridge.

By 11:30 we had arrived at Dunn's River Falls near Ocho Rios, a truly beautiful spot with its cascading waterfalls. Neatly trimmed coconuts tall and straight showed so well the marvelous symmetry of the leaf arrangement from below—a perfectly formed circle between the bole and the first pinna of each leaf. We ate at Roger's Bistro. The words "Barbecued Goat" gave some pause but generous dashes of Pickapepper sauce whetted our appetites and 'twas a comedown to learn we were eating only beef. 2 P.M. found us riding through Fern Gully. The road has been built over an old river bed and meanders for four miles with high cliffs on either side covered with ferns, tall trees, and other vegetation. It was very dry; this area was experiencing a drought and wasn't mistly and humid as we'd expected it would be.

We stopped again between Ewarten and Worthy Park in the Mt. Diable area. Here we saw the two extremes in leaf variation of *Thrinax parviflora* (see Read, *The Genus Thrinax* for illustrations). Naturally we took pictures for our own slide libraries. We hurried along through Bog Walk and Spanish Town where we glimpsed beautifully bricked buildings supposed to be outstanding examples of Georgian architecture. We would have liked to stop but no palms and it was getting late. Then, after fighting crowded Kingston's 5 o'clock traffic, we arrived at our hotel, Tera Nova. We had a delicious dinner at 7, under the stars.

June 29: Tuesday was a more leisurely day. We left the hotel at 8:45, drove through grounds of the University of West Indies (where Bob received his doctorate), and soon were at Hope Botanical Gardens. We oohed and aahed at the male *Lodoicea maldivica*, which is over 60 years old, flowering away so manfully with no female in sight, as well as over the row of tall *Corypha* palms and the shades of yellow through red of the *Delonix regia*. Then we went on to the Governor General's House where swallows had built mud nests atop the great pillars at the entrance. The size of the *Enterolobium* (elephant's ear tree) took our breath away. Next came a brief stop at Devon House where quick purchases were made at craft stores. While taking on fuel at the Manor Shopping Plaza we saw real cannonballs on the cannonball tree. Hope's fine tree had only flowers.

Soon we were in Castleton, and under the shade of magnificent trees we ate our ample box lunches. (I gained 5 lbs. on this trip.) Then Mr. Uriah Bennett

and his brother, both of whom had worked for the gardens over 25 years, pointed out trees and shrubs of particular interest. His English had us stumped when he pointed out the "arse" tree. Not recognizing it, someone asked for the spelling. It was "horse"—you have your dog wood, we our "horse" wood. Group A having been before us, we had little hope of finding many palm seeds but with Uriah's help, we soon had many *Licuala elegans*, *Areca triandra* and *A. catechu*, *Livistona rotundifolia* and *L. saribus* (*L. hoogendorpii*), *Pinanga kuhlii*, *Nephrosperma vanhoutteanum* and many, many more. Castleton is a small garden but old and the palms and other trees are large, awesome and most handsome. Beneath one massive tree, his eyes far sharper than ours, old Uriah's cane opened the door of a trap-door spider. I knew it was there, he said modestly.

June 30: A smaller group set forth on Wednesday. After struggling through Kingston's traffic again, we went along the southern shore, through very dusty air where limestone is mined for export, by the bauxite blot, crossed the very dry area, the Yallahs, where no bridges were needed over the dry river beds. When it rains (as it may after six months) the rivers change their courses at flood stage. We observed the placid salt ponds. At Morant Bay we saw a huge area of coconuts dying of lethal yellowing. Areas of this nature had been observed along the sea before, always heartbreaking. More resistant varieties have been planted in several places. Then we turned northeast away from the magnificent sea and drove through Airy Castle (don't you like that name?) to Bath. The botanical garden here is nearly 200 years old. Only a garden in St. Vincent is older, the oldest in the Western hemisphere. A great huge *Barringtonia speciosa* native to Ceylon, with shaving brush flowers and peculiar fruit immediately attracted our attention. There was a talipot in fruit but no seeds had fallen yet, and even strong Palm Society members can't shake a *Corypha*. Tall, tall Cuban royals and two extra tall cannonball trees were other highlights. We picked up seed from a palm labeled *Coccothrinax barbadensis*.

On to Wheelerfield and Johnson Mountain, the southern tip of the John Crow Mountains which run North and South, while the Blue Mountains run East and West. Here, high in a cloud forest, we ate our box lunches and then the more rugged individuals climbed the steep limestone cliffs for the prize of prizes, *Thrinax excelsa*. The vegetation was so thick, fallen leaves underfoot so slippery, and the mountain so steep it was most precarious climbing. Bob admonished "Don't worry if you get lost, just go down, you'll eventually come to the road and the bus driver will find you." With that, he was off. *Thrinax excelsa* was at the top and so was Bob when the other climbers reached there. He was laughingly taking pictures of the exhausted "for my next slide program for The Palm Society." This gal wasn't up to the arduous climb, so reading Bob's copy of James Bond's "Birds of the West Indies" with one eye, I watched humming birds with the other. When the explorers returned, a dirtier crew would be hard to find. Wet from exertion, light rainfall, and dripping vegetation, they had fallen and slid down the mountain, the seats of their pants mute evidence, but carrying gigantic circular leaves of *T. excelsa*. Bob performed a fan dance with two huge leaves, slides of which will be shown at Palm Society meetings. By 4:30 we were down to the beach again and heading back to Tera Nova.

July 1st: We took off on Air Jamaica 023 to Miami where each went his separate way, glad to be home after a most

exciting and rewarding trip to Jamaica, The Beautiful Island. We still had before us the overwhelming task of planting all our palm seeds, bromeliads, orchids, and fern spores.

GERTRUDE COLE

P.S. When Ruth Shatz gave her version of our Guyana trip before Bob Norris and I showed our slides I thought: Ye Gods, was I on that trip? Above is my version, will others recognize it?

New Officers

Biographical notes and photographs of the President and the Executive Secretary have appeared in Principes 18: 157, 1974, and 17: 27–28, 1973, respectively. Other new officers are introduced here.

New Vice President

Donn W. Carlsmith, new Vice President of The Palm Society, was born in Hilo, Hawaii, on March 17, 1929. A graduate of Stanford University (A.B., 1950) and Harvard Law School (J.D., 1953), he now lives at Onomea Bay, Hawaii, with his wife Jean and two children.



1. Donn W. Carlsmith, new Vice President.

Mr. Carlsmith has been a partner in Carlsmith, Carlsmith, Wichman and Case of Honolulu and Hilo since 1959. He has also been Managing Director, Dillingham Investment Corporation and Capt. Cook Investment Company since 1958, Capt. Cook Cattle Company since 1967. He is also a Director of Hawaii Planing Mill, Ltd. (since 1954) and of Magoon Estate, Ltd. and Magoon Brothers. Affiliations include Board of Governors, Hawaii Preparatory Academy, member of District of Columbia Bar Assn., American and Hawaii Bar Assns., Theta Delta Chi, and Navy League. He is a Director of the Pacific Tropical Botanical Gardens and the Lyman Museum.

New Secretary

Pauleen Sullivan, newly elected Secretary of The Palm Society, was born in Oregon but moved to Ventura, California, at an early age. She attended Fresno State College, majoring in business. At the start of World War II, being a bit adventurous, she took an accounting job, which took her to the land of the midnight sun, 20 miles from the Arctic Circle.

In 1943, she married her childhood sweetheart, the late Joe Sullivan. Following him around the country, she held many different types of office jobs. Returning to Ventura in 1947, she designed their Polynesian home and unique swimming pool. Along with raising a family, her hobbies were sewing and growing any tropical plants. When she contracted polio in 1950 while pregnant, she cried through the window of the isolation ward to Joe, "Please don't let my tropical plants die." Forced to care for the plants, Joe became so intensely interested that in 1954 Joe and Pauleen established a nursery called "The Tropical Garden." Pauleen, as Joe's "gal Friday," worked



2. Pauleen Sullivan, new Secretary, with *Johannesteijsmannia altifrons* in the Malaysian jungle.

in the nursery caring for the plants, landscape designing, and doing the bookwork. They joined the Palm Society in 1956.

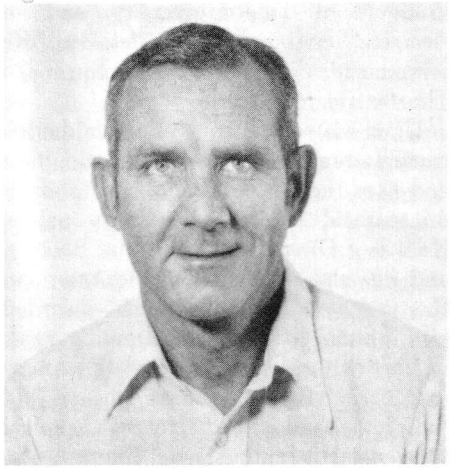
With a strong desire that California should have more palms, Joe raised 45,000 palms from seed, planting them out on 15 acres, later to be balled and sold from San Francisco to San Diego. In promoting palms, Pauleen worked with the State Architect for Freeways and Beaches, and urged the City Manager and Superintendent of Parks to plant palms on the freeway, at the beaches, and around Ventura, which now makes Ventura a very "palmy" city. When she and Joe retired from the nursery business, she designed a Polynesian apartment called "Tonga," which is beautifully landscaped with many rare palms and exotic plants.

Vacation time was always spent traveling to botanical gardens and other countries to collect palm seeds and see palms in their native habitat. She has had many interesting experiences for a person in a wheelchair, such as going down the Amazon on a motorized canoe, having lunch served on a banana leaf on the floor of a native hut on the island of Tonga, and finding herself alone in the jungle of Sumatra when Joe went off in search of palm seeds, but quickly surrounded by curious natives.

Pauleen has been very active in the Southern California Chapter of The Palm Society for the last six years. She has a unique way of gardening, as she has to swim across her pool to water and groom her many rare tropical palms.

New Treasurer

Paul A. Drummond was elected Treasurer of The Palm Society at the biennial meeting. Mr. Drummond has been a resident of Florida since 1948 and since 1952 has lived at his present address where members of the society have twice been privileged to visit his gar-



3. Paul A. Drummond, new Treasurer.

den and collection of palms. He was born in New York City, graduated from Fordham University with a B.A. degree, and served as a naval officer (UNSR) in the Western Pacific Theater during World War II. Paul is now engaged in real estate sales and has been a "palm nut" for close to 20 years. Of late, he has been active in a campaign to combat the lethal yellowing disease that is devastating palms in southern Florida.

California News

The Southern California Chapter tried out a new idea at their September 19, 1976 meeting at the Ventura College Swimming Pool, with a tour later to the Sullivan gardens. Members could reserve a table from which to sell plants, the chapter to get 20% of the gross sales. After the sales were completed, John Tallman, instructor at the college, presented a surprise in-the-ground memorial in memory of Joe Sullivan to Pauleen Sullivan and The Palm Society. Chairman Ralph Velez said a few words about Joe for the benefit of those who did not know him. He was a wonderful man and his loss is a great one not only to his family and friends, but to all palm lovers.

A tour of the new Palm Garden at the college disclosed the fact that in less than a year John Tallman already has an outstanding palm collection. (See next issue of PRINCIPES for this story.)

After a lunch of barbecued hot dogs and soft drinks, tours were organized into groups to visit Pauleen Sullivan's home garden and the plantings at her Tonga, Baylor, and Luna apartment units. These areas are beautifully landscaped with many rare large palms, including coconut-look-alike *Jubeopsis caffra*, *Arenga engleri*, *Rhopalostylis* species, a royal, a *Ceroxylon*, a large *Pritchardia rockii*, a white-crownshafted *Areca*, beautiful howeias and many others, all growing outdoors. Pauleen's pool room houses more in the way of truly tropical palms with a specimen red-crownshafted *Cyrtostachys lakka*.

This chapter, also, under the direction of Lois Rossten, placed 2nd in the category of Society Exhibits in the Exotic Plant and Fern Show at Los Angeles. Included in the beautiful design were specimen plants of *Phoenix roebelinii*, howeias, *Linospadix*, *Neodypsis*, Chamaedoreas, licualas, cycads, and many others. Many members gave of their time and plants to make this exhibit a success.

Florida Notes

The South Florida members group was asked, on somewhat short notice, to participate in the local South Florida Fern Fair on October 24. Hank Taylor, Richard Wolczak, ably aided by Alan Fernandez, did a yeoman job of providing enough palms to have a fine offering and only a few plants remained after the successful sale. Local nurserymen complain that the public is afraid to acquire palms because of the disastrous effects of lethal yellowing, but buyers were eager to replant with dwarf Malay coconuts of which 100 were sold shortly; we were sorry we did not have

more. Other palms sold well too, even some subject to the disease but suitable for indooor culture, or in a screened patio since plants in those locations so far seem not to be affected.

On Friday, October 29, quite a few members, mostly from the southern part of Florida, attended a meeting at the home of Dr. and Mrs. R. Maliner in Hollywood, Florida. Dr. Maliner says he has been growing palms for only about four or five years yet it is hard to believe for he has such a multitude of lovely palms, many already mature. He has only small areas still planted in grass and is working at eliminating them in order to cut down on his work. Stepping stones of cement and wood are used, with pebbles or wood chips as ground cover in the various areas. The effect is very lush and tropical. He has two large specimens in containers—one of *Phoenicophorium borsigianum*, and one of *Verschaffeltia splendida*—which are at least 10 feet tall, with sizeable trunks and magnificent entire leaves that were not wind-torn because of protection. He has framework erected to provide a means of covering the plants during a cold spell. Immediately after dark the group came indoors for the talk illustrated with colored slides given by former president Ken Foster about his recent trip to the Amazon. All were kept spellbound as he described the plants he found. Ken is a good speaker so we hope many other members will be able to enjoy his talk. Afterward a delicious cold buffet was set up by our hosts and then a palm raffle seemed a fitting close to a most pleasant occasion.

Teddie Buhler

Billings McArthur

It is with deep regret that we have to announce the death of one of our most dedicated members, Billings M. McArthur of Winter Park, Florida on October 1, 1976. He was a native of Chicago, graduate of Yale University, and an electrical engineer by profession. He served with distinction in the European Theater during World War II.

Upon his retirement to Florida, he became interested in tropical horticulture and over the years became an authority on tropical plants, particularly palms. He was a Director of The Palm Society, and was also a member of the American Horticultural Society, which awarded him a citation for his outstanding work in horticultural photography, the American Association of Botanic Gardens and Arboreta, and the Fairchild Tropical Garden. His enthusiastic interest was largely instrumental in the establishment of regional meetings of the Central Florida members of The Palm Society.

His greatest pleasure was in sharing both his knowledge and his plants, and today in gardens, both botanical and private, there are many specimens that are living memorials to his dedication and interest.

G. C. Bucher, Sr.

(*Continued from page 22*)

the inclusion of *Cyrtostachys lakka*, restricted as an ornamental, and the exclusion of *Chrysalidocarpus lutescens*, a much more widespread ornamental, the exclusion of *Livistona* spp., though locally very important in village economies as building, thatching, and wrapping material and as food, and the inclusion of *Lodoicea maldivica*, surely of very limited potential except as one of the greatest palm marvels. One could go on suggesting additions and deletions. However as a general selection of palm species to illustrate the varied habits, distributions, and uses of the palms, Purseglove's selection is certainly comprehensive.

The detailed discussions of *Cocos*, *Elaeis*, and *Areca* are very concise and must rank as some of the best brief introductions to the botany and agronomy of these most important plants. The dis-

cussion of the origin of the coconut is particularly good.

The introduction, however, contains several errors resulting from the great difficulty in providing a watertight general description of this most diverse of all angiosperm families—for example, several coryphoid species are dioecious, though the bulk of the subfamily is monoecious, not all caryotoid palms are monocarpic (or hapaxanthic for that matter), nor will some species of *Arenga* key out because they do not have wedge-shaped leaflets, *Nypa* has 3 (or occasionally more) free carpels in the flower, not a unilocular ovary, and several phytelephantoid palms are acaulescent so this habit character should not be used to distinguish *Nypa* from the phytelephantoids.

In the brief accounts several rather questionable statements are made. *Arenga pinnata* is described as growing wild throughout Malesia and sometimes cultivated, whereas its wild origin is probably not known and it either receives some rudimentary cultivation, or grows in natural habitats only where the possibility of escape from cultivated stands cannot be ruled out. No mention is made of *Calamus trachycoleus*, the most important cultivated rattan, though data does exist in Heyne concerning this species. Wax in *Copernicia* is described as being collected from wild stands though plantations have been in existence for over 100 years. *Hyphaene* is not the only aerially branching palm by any means, and this generic account gives no mention of the extraordinarily confused taxonomy and great variability in the genus—the East African taxon, which may have up to 32 heads, can scarcely be called *H. thebaica*. No mention is made of the genus *Korthalsia* which is possibly more important as a rattan cane producer than the genus *Daemonorops*. These are however rather minor points which do not detract much from these brief accounts.

My most serious criticism is that the nomenclature of the palms mentioned is not always satisfactory. It is most unfortunate that Moore's scholarly list of cultivated palms was not consulted before publication of incorrect names in this standard text which will, no doubt, have very wide circulation. Thus *Borassus aethiopicum* should be *B. aethiopum*, *Ceroxylon andicola* should be *C. alpinum*, *Copernicia cerifera* should be *C. prunifera*, *Metroxylon sagus* should be *M. sagu*, and the account of *Raphia* leads one to believe there are no other species than those discussed. Furthermore, author citation is not always correct. It is regrettable that the peach palm is named *Guilielma gasipaes*, when it is more satisfactorily accommodated in *Bactris* where it was originally placed —a name much easier to learn, spell, and remember.

However, apart from these criticisms, this is a very good introduction to palms as tropical crops, with the accounts of *Cocos*, *Elaeis*, and *Areca* being excellent. No doubt this now completed treatise on tropical crops will have a deservedly wide audience, even wider, may we hope, than the wide dispersal of the coconut and its products.

STEVENSON, GEORGE B. 1974. Palms of South Florida. 251 pp. Published by the author. Obtainable from the Fairchild Tropical Garden, 10901 Old Cutler Rd., Miami, Florida 33156. Price $5.00.

This book has been designed for those interested in palms who have not yet mastered the technical vocabulary used by botanists—"the approach herein is not the scientific one, nor is the vocabulary the accepted 'botanese' of the professional." Mr. Stevenson, throughout his book, reminds us of his intention to

write for amateurs and beginners in as simple a way as possible. The result, a highly individualistic guide to the palms present wild and in cultivation in South Florida, is most attractive and will undoubtedly be used by many in Florida and elsewhere.

The guide consists of a very brief introduction (with not a few "digs" at the use of excessively recondite terminology by palm scientists), a group of pages entitled "Beginners' Pages" in which the author introduces the beginner to the concept of a palm as opposed to cycads and bananas through the commonest species, and then a preliminary key. Following the preliminary key is a more detailed key to the species to be seen in South Florida and brief descriptions of the palms. The book concludes with a list of palms not recommended for Florida, a list of additional species, a brief account of palm classification, botany, geography, cultural notes, notes on cold and salt tolerance, a list of palms for containers, a pronunciation guide, a short bibliography, and two indexes. The book is copiously illustrated by line drawings and maps of the Fairchild Tropical Garden pin-pointing the position of each species.

The book is so cautiously and diffidently introduced with its apologia for being an introduction for beginners that one is surprised and delighted by the thoroughness and general accuracy throughout. Mr. Stevenson obviously knows the palms of South Florida extraordinarily well and also understands the problems faced by the beginner in getting to know them. He has considerable ability in capturing the "feel" or "hang" of the palm habits in his sketches—the drawings of *Neodypsis*, *Hyophorbe* and *Astrocaryum* are some of the most pleasing.

My main criticism of the book is that the drawings are very incompletely labelled, particularly in the illustrations to the main key where no labels occur; this results in some confusion to the key user, though if one already knows what features occur in the dichotomies, the meaning of the drawings is then obvious. It would be no difficult matter in a subsequent edition to add cross references here.

Some minor points I have noted are as follows: *Chamaerops* is not "Europe's only palm"—the relatively recently described *Phoenix theophrasti* of Crete is regarded as Europe's No. 2 palm; *Lodoicea* does not have the largest fruit of the plant kingdom—that pride of place belongs to the pumpkin, though *Lodoicea* does have the largest seed; and similarly, a *Reinhardtia* described as having the smallest seed 1/10″ long (though I doubt whether any *Reinhardtia* has a seed as small as this) certainly is not the smallest seed in the plant kingdom, or perhaps even the smallest palm seed. The "hastula" is confusingly and rather inaccurately defined as the "point where segments meet," whereas it is a flange of tissue at the point where the segments meet the petiole (here rather unnecessarily called "leaf stem"—why not "leaf stalk" if "petiole" is too abstruse?). The difference between the costapalmate and palmate leaf is not clear enough in nature for a major key dichotomy based on this character to work satisfactorily though I am sure few will go too wrong at this point. (e.g., *Livistona rotundifolia* seedlings are scarcely costapalmate and would not key out correctly).

The standard of nomenclatural is high though *Asterogyne* is spelled "*Astrogyne*" throughout.

However, these are quibbles; all in all this is a most attractive and potentially useful palm book for beginners in Florida, and it is hoped that it will introduce more people to the delights of palmology. Its usefulness should not be confined to Florida—it could be very useful in other

areas with similar climates. Mr. Stevenson has shown how, as long as the differences between palms are well appreciated, a simple and accurate guide can be produced by a self-professed amateur relatively cheaply. The format he has so successfully exploited could be used elsewhere in the world for popular guides.

J. Dransfield
Royal Botanic Gardens, Kew.

NOTES ON CULTURE

Member J. Garrin Fullington has had good success in growing *Ceroxylon* to the three- and four-leaf stage in Richmond, California. He writes: "I attribute my success to several factors: (1) I live in an area with cool nights 50°–55° during even the warmest part of the year, (2) I have used a very porous soil mix containing decomposing wood and forest soil at the suggestion of Dr. Mardy Darian, (3) I have kept the plants very moist and semishaded with weekly, dilute foliar feeding. If there is a need for a fungal association with the roots, as has been suggested, the soil mix I use apparently provides it."

Transplanting Seedlings of Wild Palms

This note concerns the collector who is in the field, but cannot find seed or is not sure of the seed available and wishes to bring back living seedlings from the wild.

First bear in mind that when digging or pulling out a seedling you may be destroying over 90% of the roots. With most of the roots gone, the remaining leaves will transpire water dehydrating the seedling into irreversible shock, so even if you return with a beautiful seedling full of leaves, it is often only a matter of time before the leaves show their ultimate color, brown.

The following steps are based on the premise that the functional root hairs and their relationship to dehydration are the critical keys to transplanting survival.

1) Most important, cut off *all* foliage above the petioles, leaving the petioles to protect the bud during shipping. This effectively reduces transpiration.

2) Do not try to get the complete root system, especially if the seedling is relatively large (i.e., has 5 or more leaves or is 1 inch thick at the base). Instead be content to get just the maximum amount so that, when packed into plastic bagging, roots won't be crushed or smashed during shipment home. Long, broken roots are worthless.

3) If possible dip the remaining roots in root-stimulating hormones (do not use dry powders) before packing the roots in damp sphagnum or even wetted newspaper.

4) Packing in damp, airy, medium sphagnum is best, because of the fungus-inhibiting properties of this moss. If sphagnum isn't available, a very dilute solution of Dexon may be used.

5) Ship the plants, preferably by air freight, and if you cannot be there upon their arrival try to obtain competent help to perform the next step.

6) Again soak the seedling's roots in root-stimulating hormones, allowing 20-30 minutes for the soaking using *warm* water, about 100° F.

7) Replant in highly organic soil or soil mix and pour the warm soaking solution thoroughly through the repotted seedling's medium.

8) If the seedling is very rare or known to be difficult to transplant, a high humidity chamber should have been prepared before the arrival of the seedlings. This chamber should be capable of producing bottom heat as well as high humidity. The purpose of the bottom heat is to help the plant direct its ener-

gies toward the life-sustaining function of reestablishing root hairs, which may occur within 24 hours, especially if the root-stimulating hormones were applied immediately after collecting. The *very* highly saturated air retards transpiration, which in turn avoids the shock of dehydration, the killer of seedlings.

The final step of air-moisture saturation can easily be accomplished by the use of steam-producing humidifiers, sold through drug stores, especially during winter months.

It is best to get a plastic water chamber of at least 1½ gallons capacity. Do *not* constantly add water when the level drops to a point where steam production ceases. Instead, empty out the remainder and replace with fresh water; this prevents the build-up of salts that prevents steam production in areas where water is hard. In areas of soft water, adding baking soda will help produce more steam.

If foliage has not been removed and you decide to take the risk of leaving it on, then be sure to *keep the humidifiers working around the clock*, and water with warm water a minimum of every 12 hours or better four times every 24 hours. This manner of watering with warm water was recently advocated by John Turner. If the seedling or plant to be transplanted is set at its final site, then erecting a wooden frame and covering it with polyethylene to create an individual greenhouse for the seedling works very well.

I have successfully applied these principles on *Cyrtostachys lakka* and on pritchardias from the Hawaiian islands which required over 10 days from collected time to replanting time. The same system worked on ceroxylons, chamaedoreas, etc. from Colombia.

To summarize the most basic points: remove all foliage, soak roots in root hormones immediately, slip in sealed plastic bags, reestablish over bottom heat, saturate air with steam, and water frequently with warm water. If dipping in rooting hormones is impossible in the field, then spray the hormones on the roots from a spray bottle immediately upon returning to your lodging, in any case before packing and shipping.

M.E. DARIAN, D.V.M.

Classified

WANTED TO BUY: air parcel post-size palm seedlings for beginning collection; also *Amherstia nobilis*. Lewis F. Knudsen. Jessups Estate, Nevis, West Indies.

STATEMENT OF OWNERSHIP MANAGEMENT, AND CIRCULATION OF PRINCIPES, JOURNAL OF THE PALM SOCIETY, REQUIRED BY ACT OF 23 OCTOBER 1962: SECTION 4369, TITLE 39, UNITED STATES CODE, FILED 11 SEPTEMBER 1967.

PRINCIPES, JOURNAL OF THE PALM SOCIETY is published quarterly at 1320 S. Venetian Way, Miami, Florida 33139. General Business Offices: 1320 S. Venetian Way, Miami, Florida 33139. Publisher: The Palm Society, 1320 S. Venetian Way, Miami, Florida 33139. Editor: Dr. H. E. Moore, Jr., Cornell University, Ithaca, N.Y. 14853. Managing Editor: None. Owner: The Palm Society, 1320 S. Venetian Way, Miami, Florida 33139.

The known bondholders, mortagees, and other security holders owning or holding 1 per cent or more of the total amount of bonds, mortages, or other securities are: None.

CIRCULATION:	Average number of each issue during preceding 12 months	Actual number of copies of single issue published nearest to filing date
A. Total no. of copies printed	1600	1600
B. Paid circulation		
1. Sales through dealers	—	—
2. Mail subscriptions	1166	1216
C. Total paid circulation	1164	1214
D. Free distribution by mail carrier		
1. Samples, complimentary	2	2
2. Copies distributed to news agents	None	None
E. Total distribution	1166	1216
F. Office use, left-over	434	384
G. Total (Sum of E & F)	1600	1600

I certify that the above statements made by me are correct and complete. Signed, Mrs. Theodore C. Buhler, Executive Secretary.