# Palms

Journal of the International Palm Society Vol. 46(1) March 2002

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**FRONT COVER**

*Pseudophoenix ekmanii* in the dry forest of the Barahona Peninsula, Dominican Republic. Visible in the background is *Coccothrinax ekmanii.* See article by S. Zona, p. 19. (Photo: C. Morici)

## Palms (formerly PRINCIPES)

Journal of The International Palm Society

An illustrated, peer-reviewed quarterly devoted to information about palms and published in March, June, September and December by The International Palm Society, 810 East 10th St., P.O. Box 1897, Lawrence, Kansas 66044-8897, USA.

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Manuscripts for PALMS, including legends for figures and photographs, should be typed double-spaced and submitted as hard-copy and on a 3.5" diskette (or e-mailed as an attached file) to John Dransfield, Herbarium, Royal Botanic Gardens, Kew, Richmond, Surrey, TW9 3AE, United Kingdom. Further guidelines for authors are available on request from the Editors.

Annual membership dues of US$35.00 for Individuals and US$45.00 for Families include a subscription to the Journal. Subscription price is US$40.00 per year to libraries and institutions. Dues include mailing of the Journal by airlift service to addresses outside the USA. Single copies are US$15.00 each, US$48.00 a volume, postpaid surface delivery in the USA. Add US$2.00 per issue for delivery to addresses outside the USA, or add US$5.00 per issue for faster delivery via airmail.

Periodical postage paid at Lawrence, KS, USA.

Postmaster: Send address changes to The International Palm Society, P.O. Box 1897, Lawrence, Kansas 66044-8897, USA.

PALMS (ISSN 1523-4495)

Mailed at Lawrence, Kansas March 18, 2002

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**This publication is printed on acid-free paper.**

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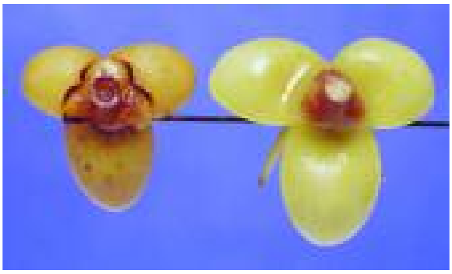


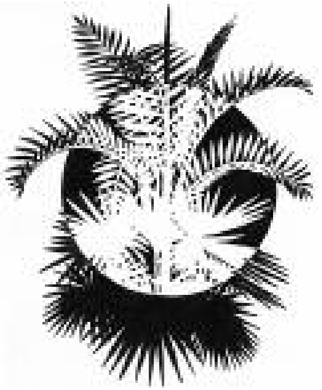
*Pseudophoenix lediniana* (far left) and *Pseudophoenix vinifera* (left) showing differently shaped calyx. Photo by S. Zona.

## Features

*Coccothrinax boschiana* in the Dominican Republic. Photo by C. Morici.

**BACK COVER**

Silhouettes of adult *Coccothrinax boschiana* in the early morning. Note that some tall stems have been bent by hurricanes. See article p. 14. Photo by C. Morici.



# NEWS FROM THE WORLD OF PALMS

The Second European Palm Biennial was held in early December 2001 in the Italian Riviera city of San Remo. Over 200 participants, mostly from Italy, France and Spain, gathered in the elegant surroundings of the Villa Ormond for two days to hear a broad range of papers on palms, varying from biodiversity to disease control and the use of palms in landscaping. There were large delegations from our chapters Fous de Palmiers and La Asociación Española de Amigos de las Palmas and the Italian palm Society, Beccariana. Of particular interest were papers relating to the alarming spread of two major pests of palms, the weevil *Rhychophorus ferrugineus* and the moth *Paysandisia archon*, both of which are believed to have been introduced to southern Europe with mature palms imported for landscaping projects, the former in *Phoenix dactylifera* from Egypt, the latter with *Trithrinax campestris* from Argentina. In a future issue of PALMS, we hope to include detailed reviews about these pernicious insects. The whole symposium was organised by Claudio Littardi and hosted by the Commune di San Remo, a city where ornamental palms are valued as a major feature of the Riviera landscape. On the third day of the conference, there were demonstrations of various methods of climbing and pruning tall palms, including a spectacular "rescue," in which a climber high in the crown of a tall *Washingtonia filifera* feigned an injury and was rescued by a colleague climbing up and lowering him to the ground, all within four minutes.

Botanical artist Lucy Smith, whose paintings of Queensland palms were featured in PALMS 45(3 ) and who prepared the line drawing of *Dypsis* "stumpy" described in this issue, recently won a gold medal from the Royal Horticultural Society in London UK for an exhibition of her line drawings of New Guinea palms, which she has prepared for the multi-author book that was described in PALMS 44(4), the New Guinea Issue. Congratulations, Lucy!

Researchers from Egypt and England reported recently on an interesting archaeological finding in Qasr Ibrim, southern Egypt (Proceedings of the Royal Society London, B. 268: 593–597. 2001). Using sensitive analytical techniques, they found traces of palm oil on ancient pottery dated to the post-Meroitic period (ca. AD 35–600). The chemical signatures of these traces match those of modern palm oils from dates (*Phoenix dactylifera*) and doum (*Hyphaene thebaica*). Their results provide the first physical evidence of the exploitation of palm oil in antiquity and the use of pottery vessels in its processing.

2001 saw the reopening of one of the most beautiful glasshouses in Britain, the Palm House in Sefton Park, Liverpool. This circular palm house, a classic of the Victorian period, was extensively renovated and now holds a small collection of palms. More recently, the refurbished Conservatory of the U.S. Botanical Garden opened in Washington, D.C. Its central exhibit is the Jungle, which includes a collection of palms and other tropical plants. We expect an article on the new Conservatory and its palm collection in a future issue of PALMS.

THE EDITORS

# Cold-Hardy Palms in Southwestern Ohio: Winter Damage, Mortality and Recovery

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**Previous experiences suggested that several palm species could be grown successfully with minimal winter protection in southwestern Ohio. Here we report data on an expanded experimental design that included additional palms and several new experimental plots.**

Francko (2000) reported preliminary data on first-year survivorship and vegetative growth of cold-hardy palms in SW Ohio, U.S.A. Palm survivorship, foliar damage, and subsequent recovery were analyzed through the 1999 growing season, the winter of 1999–2000, and the 2000 growing season. We also evaluated the efficacy of several published winter protection strategies and of a modified pot-planting technique in reducing winter damage and mortality.

## Materials and Methods

*Study Sites.* Detailed geographical and climatological information about the Miami University main campus and off-campus areas in Oxford, southwestern Ohio were reported in Francko (2000). Winter temperature minima data from 1989–90 through 1999–00 demonstrate that rural areas around Oxford, including home garden palm plots (WK sites: forest and near house; Francko 2000) are mid-Zone 6a microhabitats. Urbanized areas (campus and the small city of Oxford) are consistently 1.4–2.4°C (2.5–4.3°F) warmer and represent Zone 6b microhabitats. Sheltered areas near large buildings on the Miami University campus, including the original Hardy Palm Demonstration Plot (HPDP), are consistently 5.0–6.7°C (9–12°F) warmer than rural areas and effectively Zone 7a to 7a/b microhabitats. In spring 1999 we established eight additional Zone 7a test plots on the Miami campus, expanded planting areas at the rural WK site, and integrated small-scale palm plantings into a church garden (Zone 6b) and a private residential landscape in Oxford (Zone 6a).

*Site Preparations and Palms Utilized:* Soils in the new plot areas, in contrast to the original HPDP, are reasonably fertile, circumneutral to slightly acidic clay-loam and were not amended extensively prior to installing plants. New planting beds at the WK site which were sited in compacted heavy clay were amended with compost, humus, and topsoil.

In our pilot study we focused on seedling-sized palms (Francko 2000). Nearly all of the new palms

planted in 1999 (N = 97) were larger-diameter specimens (3 to 15-gallon containers) purchased in Georgia, USA (Neotropic Nursery). Species included *Rhapidophyllum hystrix* (needle palm), *Sabal minor* (dwarf palmetto), *Sabal minor* "Louisiana" (blue-stem palmetto), *Trachycarpus fortunei* (Chinese windmill palm), *Trachycarpus takil* (Himalayan windmill palm), *Sabal palmetto* (cabbage palm), *Sabal etonia* (scrub palmetto), *Sabal bermudana* (Bermuda cabbage palm), and *Serenoa repens* (saw palmetto). In addition, we obtained bare-root seedlings of *Trachycarpus fortunei* "Norfolk" and "Greensboro" from Plant Delights Nursery in North Carolina. Finally, we purchased 7-gallon specimens of *Livistona chinensis* (Chinese fan palm) from a local discount store. A few specimens of *R. hystrix* (N = 5) and *S. minor* (N = 1) planted very late in the 1998 growing season (Francko 2000) were also included in the data matrix.

Palms were obtained and planted by the end of April 1999. Each palm was fertilized two times (early May and mid-July) with a granular, slow-release (3 month) fertilizer containing micronutrients. We attempted to provide a combination of rainfall and irrigation water equal to approximately 2.5 cm per week throughout the 1999 growing season and into the late fall and winter, but this proved problematic due to extreme drought and heat conditions.

*Pot-Planting and Winter Protection:* Tollefson (1999) provided evidence that pot-planting – setting a containerized palm directly into a planting hole without removing the container – may reduce root shock set-back and early mortality in larger palms, and encourages downward root growth through the lower drain holes of the container during the first growing season. He suggested that this planting technique could provide superior results for palms being grown near the limits of their hardiness range. To test this view, we employed a modified pot-planting technique in all containerized palms installed in 1999. Containers were slit ca. 5 cm down from the top, and the lower drain holes on the sides and bottoms of containers were carefully slit and expanded prior to placing the container in the ground. Care was taken not to cut or otherwise damage the root ball. The top of each container was also trimmed so that it was flush with the elevation of the root mass. After containers were set into the ground, planting holes were backfilled with soil, and fertilized and watered through the 1999 growing season as above.

Francko (2000) reported that minimal winter protection strategies (heavy mulching, use of antidessicant sprays, snow cover) were effective in mitigating winter damage to palms grown either in Zone 6a or Zone 7a microhabitats. In contrast, burlap wind screens and heat cables draped loosely around the base of small palms were probably ineffective. In fall 1999 and through the winter months of 2000, we employed and evaluated two palm protection strategies cited in gardening books (e.g., Roth & Schrader 2000) and palm society newsletters (e.g., Hilley 1999) for growers located in USDA Zone 7 and warmer: 1) trunk/foliar wrapping with C9 Christmas lights (so-called "mini-lights), and 2) trunk/foliar wrapping with lightweight landscape fabric.

In mid-December 1999, palms located on the Miami campus and in off-campus plots were treated with antidessicant spray (Wilt-Pruf), mulched heavily (ca. 5–8 cm), and crowns and crown cavities were treated with liquid copper-based fungicide to minimize fungal/bacterial leaf and crown rot. With the exception of *R. hystrix*, which has a clumping habit that makes wrapping difficult, approximately equal numbers of palms of each species were then either; 1) wrapped with C9 light strings at an approximate density of one string (50 lights) per meter of plant height, producing roughly 85 watts of heat energy $m^{-3}$ canopy volume, 2) wrapped with lights and then with a double layer of lightweight synthetic landscape fabric (ReMay), 3) wrapped with landscape fabric alone, or 4) left unwrapped as controls.

We used a variation of the third strategy to overwinter *Livistona chinensis* and evaluate its potential as a "deciduous" palm for Zone 6 and 7 cultivation. *Livistona chinensis* specimens at both the HPDP and at WK ( N = 2 at each site) were allowed to undergo foliar senescence throughout the fall of 1999. By late December 1999 overnight temperatures had dropped below -12°C (10°F),

facing page:

1(top). Palms at the HPDP, late summer 2000. Left to right; seedling *Trachycarpus fortunei*, three seedling *Rhapidophyllum hystrix* surrounding a sexually mature individual, sexually mature *S. minor* surrounded by three immature *Sabal minor*, and 1.5 m trunked *T. fortunei* installed in spring 2000.

2 (bottom). Palms in the HPDP alcove, late summer 2000. Foreground center/right are *Butia capitata* and *Washingtonia robusta* installed spring 2000. Background specimens of *T. fortunei*, *R. hystrix*, *S. palmetto*, and *S. bermudana* installed 1999. For scale, the *Musa basjoo* in the rear left is approximately 2.8 m tall.

resulting in leaf necrosis down to the petiole/spear leaf bases. At this point, dead foliage was cut off, and plants were covered to ground level with a double layer of landscape fabric and then a loose covering of bark mulch. Preliminary experiments (Francko 2000) suggested that fabric/mulch coverings thus applied created an interior environment approximately 13–17°C (23–31°F) warmer than ambient air temperatures, and allowed enough light penetration and air circulation for palms to retain some green tissue through the winter months. Beginning in late March 2000, palms were gradually uncovered and shoot/foliar recovery was monitored throughout the 2000 growing season.

*Temperature Measurements:* Temperature data were collected in all plots to determine winter minima and quantify microclimatic variations (Francko 2000). Calibrated thermometers were mounted approximately 20 cm above ground level on wooden dowel rods. Thermometers with inside-outside probes were mounted so that the inside probe was within a fabric-wrapped palm or in the foliage of a plant wrapped with C9 lights. Care was taken to ensure that temperature probes were kept at least 5 cm away from the nearest light bulb. Temperatures were recorded approximately 30 min prior to dawn. A minimum of three thermometers were used at each site, and mean temperature data were recorded to the nearest degree F.

*Quantifying Winter Foliar Damage:* Persons attempting to grow palms in marginal climates require information not only on minimum survival temperatures but also on the degree of foliar damage to be expected under defined, sub-lethal winter conditions. In the temperate palm literature, foliar damage is usually discussed using qualifiers such as "minor" or "severe" to describe foliar burn and leaf tissue death (reviewed by Francko, in press). In this study, we attempted to provide a semi-quantitative, relative estimate of winter foliar damage for various hardy palm species.

Winter damage in palm leaves often manifests itself in necrotic spotting, margin burn, and other localized and diffuse tissue damage difficult and very labor-intensive to quantify with leaf area meters, as well as complete necrosis of leaf tissue from the leaf tip toward the petiole. Our experimental palms are genotypically and thus phenotypically variable and our sample sizes are relatively small, making for inherently noisy foliar damage data sets. Accordingly, we elected to use a less quantitative but easier to employ method to assess leaf damage as a function of microclimate and winter-protection techniques. Damage assessments of each individual palm were conducted in early April 2000, when all winter damage was easily visualized and before growing season recovery commenced. A numerical ranking of foliar damage was created by scoring each plant on the basis of leaf foliage killed (visual observation of the areal extent of brown and/or necrotic tissue) versus the total foliar area. The data were grouped into broad numerical rankings: 1 = essentially no foliar damage, 2 = 15% or less leaf tissue area killed , 3 = 15 to 30% killed, 4 = 30 to 75% killed, 5 = 75 to 90% killed, 6 = greater than 90% leaf destruction, but petiole bases green, and 7 = all above ground tissue killed. Numerical scores for each plant were interpolated to the nearest 0.5 unit. Data for all specimens were pooled by species and mean damage estimates were computed as a function of microclimate and winter protection. Individuals that lost spear leaves were also noted.

## Results and Discussion

*Microclimatic Variables:* The 1999 growing season and subsequent winter was the second year of a persistent La Nina event that markedly affected the SW Ohio climate. Extreme summer and fall heat stressed newly planted palms. Mean high temperatures for summer and fall were several degrees C above historical means, and temperatures reached or exceeded 37.8°C (100°F) in Oxford, Ohio on three occasions. A persistent drought occurred from mid-June through October 1999; during a six-week period in mid-summer no rainfall occurred. As noted in the Methods section, we attempted to provide approximately 2.5 cm of irrigation water per week to each experimental plot during the growing season, and with rare exceptions this goal was met.

Nonetheless, most palms were planted in full sun habitats or in shadier plots where root competition for moisture from established vegetation was extreme. Nearly all of our palms suffered visible drought stress during summer and early-mid fall 1999 (folding leaves, yellowing and premature leaf senescence) and entered the cooler months of fall and the winter season in less than ideal condition.

facing page:

3 (top). Relative growth of first year *Trachycarpus fortunei*. Specimen in front of meter stick was approximately the same size as the containerized individual in the foreground when installed in spring 2000.

4 (bottom). Regrowth of *Livistona chinensis* (early Oct 2000) after being killed back almost to ground level during winter 1999–2000. Keys on ground in front of plant illustrate scale.

This was especially true of 3-gallon-sized specimens of *Trachycarpus takil* (N = 11), which were just beginning to develop trunks. Several specimens lost their spear leaves during the summer and in all specimens approximately 30 to 70% of extant foliage was yellowed by October 1999. However, unless leaves were totally senesced prior to winter they were included as "live" tissue for purposes of winter foliar damage estimation the following spring.

Winter conditions in Oxford, Ohio during 1999–2000 were similar to those reported for 1998–99 (also a La Nina year; Francko 2000); relatively mild overall, but including a prolonged, extreme cold spell in January. From 16 to 31 Jan 2000, air temperatures in the coldest Zone 6a palm plots (WK site) remained below 0°C for all but a few hours. Beginning on 21 January, overnight low temperatures at the WK Forest site reached -18°C (0°F) or lower for eight consecutive nights, the longest sub-zero F event since at least 1983–84. The winter minimum of -24°C (-12°F) on 27 January 2000 was considerably lower than the average for the 1990s (-21.6°C/-6.8°F). As in previous years (Francko 2000), Miami University campus plots represented much warmer microclimatic regimes, consistently 5° to 6°C (9° to 12°F) warmer than the WK site on the coldest nights.

*Effect of C9 lights and Fabric Wrapping on Cold Exposure:* Air temperatures near the leaves of palms wrapped with landscape fabric and C9 lights, either singly or together, were significantly higher than those of unwrapped control palms, at both campus and WK sites. Fabric wrapping alone yielded inside-wrap temperatures that were 3.3–6.7°C (6–12°F) warmer than temperatures outside the wrapping; lower temperature gradients were noted under windy conditions. For wrapped palms in the HPDP and other campus sites, the minimum temperature to which foliage was exposed to was -15.0°C (5°F) compared with -19.4°C (-3°F) in unwrapped control plants. *Livistona chinensis* plants covered to ground level as described earlier were approximately 14°C (25°F) warmer than ambient throughout the duration of sub-zero F cold.

Palm foliar canopies wrapped with C9 lights alone were approximately 1.1–2.2°C (2–4°F) warmer than unwrapped plants in calm air, but thermal

**Table 1. Winter damage in first-year palms, Miami campus (Zone 7a) and WK/Oxford plots (Zone 6a/b), 1999–00. Assessments conducted using the following scale of leaf area destroyed: 1 = no damage, 2 = 15% or less destroyed, 3 = 15–30%, 4 = 30–75%, 5 = 75–90%, 6 = greater than 90%, but petiole bases green, 7 = all above ground tissue killed.**

| Palm | Microclimate | Mean +/- SD (N) | # Losing Spear | # Dying |
|---|---|---|---|---|
| *R. hystrix* | 7a | 1.3 +/- 0.8 (18) | * | 0 |
| | 6a/b | 3.2 +/- 0.5 (7) | * | 0 |
| *S."Louisiana"* | 7a | 2.8 +/- 0.8 (3) | 0 | 0 |
| | 6a/b | 4.0 +/- 0.5 (3) | 0 | 0 |
| *S. minor* | 7a | 2.8 +/- 0.9 (10) | 0 | 0 |
| | 6a/b | 5.0 +/1 0.5 (2) | 0 | 0 |
| *T. fortunei* | 7a | 4.8 +/- 0.9 (23) | 10 | 3 |
| | 6a/b | 5.7 +/- 1.0 (10) | 1 | 0 |
| *T. takil* | 7a | 5.3 +/- 1.1 (7) | 6 | 3 |
| | 6a/b | 5.9 +/- 1.0 (4) | 2 | 1 |
| *S. palmetto/* | 7a | 5.3 +/- 0.8 (7) | 0 | 0 |
| *S. bermudana/*<br>*S. etonia* | 6b | 7.0 (1) | 1 | 0 |
| *S. repens* | 7a | 5.3 +/- 0.3 (2) | 1 | 0 |
| | 6a/b | 6.5 (1) | 1 | 0 |
| *L. chinensis* | 7a | 6.0 +/- 0.3 (2) | 0 | 0 |
| | 6a/b | 6.0 +/- 0.4 (2) | 1 | 0 |

* approximately 25% of leaf bases in these clumped palms lose their spears in year 1 and 2; all but one leaf base among all *R. hystrix* above regenerated a new spear.

enhancement was nil when sustained wind speeds exceeded a few km per hour. Not surprisingly, C9 lights coupled with an outer landscape fabric wrap produced the largest thermal gradient, ranging from 9.4–17.8°C (17–32°F) above ambient inside the wraps compared with unwrapped control palms. In the coldest WK sites, temperatures never dipped below -9.4°C (15°F) when lights were on, even when the outside air temperature dipped to -24°C (-12°F).

*Palm Survivorship, Damage, and Recovery:* Despite the warmer temperatures produced by C9 lights and fabric wraps, foliar damage assessment data in spring 2000 failed to produce any statistically significant differences ($P < 0.05$; paired sample t-tests) between wrapped palms and unwrapped controls, for any of the treatment variations employed or for any taxa. Accordingly, Table 1 presents foliar damage indices for pooled samples of all treatments of each species collated by microclimate. Although there was less damage overall noted in plants sited in Zone 7a microclimates, these differences were statistically significant ($P < 0.05$; paired sample t-tests) only in *Rhapidophyllum hystrix*.

The relative degree of leaf tissue damage we observed in palm species closely paralleled the consensus minimum survival temperatures for these species recorded in the literature (SEPEPS 1994, Walters 1998, Noblick 1998, Avent 2000, McKiness 2000, Francko 2000). Specimens of *R. hystrix*, generally recognized as the most cold-hardy palm species in terms of survival, were virtually undamaged by winter conditions on the Zone 7a-microclimate Miami campus, and approximately 1/3 of the foliage was winter burned on plants exposed to colder temperatures at WK sites. *Sabal minor* and *S. minor* “Louisiana” foliage was slightly more sensitive to cold than *R. hystrix* at both sites. Both *Trachycarpus fortunei* and *T. takil* were damaged to similar extents, with approximately 75 to 80% defoliation noted at both the campus and WK sites. Several plants lost their spear leaves. Although our sample size (N = 3) was too small for statistical comparisons, *T. fortunei* sited in campus plots that never received direct afternoon sun were less damaged (approximately 25% foliar burn) than plants sited in full sun locations. *Sabal palmetto, S. etonia,* and *S. bermudana* specimens sited in fun sun campus plots were almost completely defoliated, even when wrapped with landscape fabric, although one C9 light/fabric wrapped *S. palmetto* in the HPDP retained perhaps 25% of its green foliage through the winter. A single *S. etonia* growing in the same campus “shade” plot as *T. fortunei* above retained significant green foliage, even though it served as an unwrapped control specimen. The single *S. etonia* grown at the WK site was defoliated and lost its spear and all green above ground tissue, despite the observation above that temperatures inside the foliar wraps did not drop below -9.4°C (15°F). Damage to *Serenoa repens* on campus was similar to that noted in *Trachycarpus* species, and the sole specimen of *S. repens* planted at WK was defoliated but retained green petiole bases.

*Recovery During 2000 Growing Season:* The 2000 growing season, in contrast to 1998 and 1999, produced near-ideal conditions for plant growth. Rainfall was slightly above average, mean high temperatures in summer were a few degrees C cooler than average, and the longest period of summer drought was approximately two weeks. Despite sometimes major foliar damage and, in some cases loss of spear leaves, all but seven of the plants survived and recovered in spring-summer 2000 (Table 1, Figs. 1 and 2). Palms began producing new leaves in mid-April 2000, and at that time we pruned damaged leaves to remove dead tissue. A few *Trachycarpus* specimens that survived the winter with fairly intact foliage lost their spear leaves well after the onset of warm weather. We suspected that this was caused by a fungal/bacterial infection in the crown cavity, and after a 2-week treatment with copper-based fungicide, these plants began to develop a new spear and subsequently recovered completely.

Although plant aspect and form are somewhat subjective criteria, sufficient regrowth had occurred by late May 2000 that palms at both the campus and WK sites looked normal and healthy to the casual observer. By late summer all surviving individuals of *R. hystrix*, *S. minor* (both varieties), *T. fortunei* and *T. takil* had visibly grown larger than they were at the end of the 1999 growing season (Fig. 3). In general *R. hystrix*, *S. minor* varieties, and *T. takil* produced three or four fully expanded leaves and an expanding spear by early October 2000. *T. fortunei* specimens grew four to six new leaves and a spear and added or developed 5 to 10 cm of new trunk.

*Sabal palmetto, S. etonia* and *S. bermudana* specimens on campus also added three to four new leaves and a spear during the summer and by the end of the growing season were approximately the same size or a bit larger that they were at the end of 1999. The containerized, completely defoliated, and spearless *S. etonia* specimen growing at the WK site was excavated in April 2000. Dead tissue was removed and the crown cavity was sprayed with copper-based fungicide. A nascent spear leaf began to grow from this plant by early May. The palm was removed from its container and replanted in a different WK location. By the end of the 2000 growing season this palm was approximately a meter tall, with three fully expanded leaves and an expanding spear, although the first leaf to emerge in the spring remained severely stunted.

*Serenoa repens* and *Livistona chinensis* specimens at both sites produced two or three new expanded leaves and an expanding spear per trunk during the 2000 growing season. In both species, plants grew to approximately 50% and 75% of the overall size they were at the end of the 1999 growing season, respectively. *Livistona chinensis* is seldom grown outdoors in areas colder than USDA Zone 8b (SEPEPS 1994, Riffle 1999). Our specimens were typical, greenhouse-grown 'tropical' plants with characteristically lush foliage. The observation that properly overwintered *L. chinenis* could recover from near complete defoliation to produce 50 cm-tall plants with a crown spread exceeding one meter (Fig. 4) suggests that this species and perhaps similar palms may have utility in temperate gardens as deciduous understory specimen plants.

*Efficacy of Pot Planting:* As noted above, pot-planted palms were severely drought stressed entering the winter season. Although C9 lights and fabric wraps reduced the level of cold exposure in our palms, enhanced thermal regimes did not translate into reduced foliar damage. It is possible that these two observations are interrelated and consistent with the view that our decision to pot-plant 1999 specimens adversely affected their viability during the 1999 growing season and into the winter season.

By expanding the lower drain holes and partially slitting the sides of containers we hoped to facilitate root growth into the surrounding soil. We also thought that this strategy would permit at least some capillary flow of water from surrounding soils into the containerized root mass. Some palm species, most notably *L. chinensis, R. hystrix* and *S. minor,* rooted rapidly through the lower drain holes and slit sides and were solidly anchored to the soil within 4 to 6 weeks after planting. Other species, including *T. fortunei*, *T. takil*, *S. palmetto, S. etonia* and *S. bermudana*, were clearly not well rooted even by the end of the 1999 growing season.

In spring 2000, we excavated dead specimens of *Trachycarpus* as the severely damaged WK specimen of *S. palmetto* described earlier. Root growth outside of the containers was nonexistent in every plant. These plants could access soil moisture only from within their containers and had not developed roots that extended below the soil freeze line during the mid-January 2000 cold spell. Under such conditions, it was not surprising that summer drought stress and winter foliar injury or mortality occurred in many of our palms, even those protected by foliar wraps and C9 lights. With a frozen root zone, the warming effects of C9 lights and foliar wraps might actually have caused more harm than good, due to enhanced photosynthetic water demand in the relatively warm and well-lit leaves. Taken together, our data do not support efficacy of pot-planting in enhancing first-year palm survivorship or reducing damage, at least under the rigorous environmental conditions that characterized our 1999–2000 experimental season.

*Additional Considerations:* Although our data did not support the hypotheses that pot-planting or artificial heating and wrapping could significantly reduce winter injury and mortality in first-year palms, some additional considerations are necessary. In contrast to pilot-year data reported in Francko (2000), where palms were almost completely covered by drifted snow during the coldest periods of the winter, palms described here were covered only with a few cm of snow during the severe January freeze. In addition, the duration of the extreme cold event was much longer than that of 1998-99. Palm foliage was thus almost completely exposed for more than one week to the full effects of extremely cold air, very low wind chills, and in most cases full winter sun. Under these conditions C9 light wrapping may have been counterproductive in that they melted the snow that might have provided at least partial foliar and trunk insulation from sun and damaging winds. Strings of lights can provide a heat boost of several degrees C, thus protecting marginal palms under the short-duration, relatively minor freeze events characteristic of USDA Zone 7b and warmer locales. They may be much less effective in protecting newly planted palms under the more extreme and longer duration cold events in Zone 6.

It is also critical to note that our dataset deals solely with palms that have not been in the ground long enough to become well established and develop deep and vigorous root systems. After 3 to 4 growing seasons a well-established palm should possess a root zone that extends well below the typical soil freeze depth in winter, even in Zone 6 sites, and such plants would likely benefit from foliar wraps and other active-protection strategies.

## Acknowledgments

This work was supported the Ohio Plant Biotechnology Consortium and by the Department of Botany and Campus Services Office

of Miami University. We thank Gerry McKiness for his willingness to find and provide outstanding specimen palms.

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# *Coccothrinax boschiana*

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1. Adult *Coccothrinax boschiana.*

***Coccothrinax boschiana* M. Mejía & R. García, a robust solitary palm with heavy shiny leaves of golden and silver hues, is endemic to a small coastal area of the Dominican Republic.**

About 52 species have been described in the genus *Coccothrinax*. The most recently discovered species, *Coccothrinax boschiana* (Fig. 1), was described in early 1997 by the staff of the Botanical Garden of Santo Domingo.

### A marvelous place

*Coccothrinax boschiana* is restricted to a single mountain ridge of solid grey limestone, located in the deep south of the Dominican Republic, in the dry peninsula of Barahona, 5 km south of the small rural town of Barreras (Fig. 2).

The ridge is called Sierra Martín García and occurs at the seaward end of Sierra de Neiba that gently diminishes in height until it sinks into some of the clearest waters of the Caribbean sea. Breathtaking scenery frames a population of thousands of *Coccothrinax boschiana* that struggle for life between the rocky cliffs and the open sea (Figs. 2, 4). The authors of the description noted that the palm is much more abundant in the patches that are most exposed to the salty breeze.

Dawn is the best time of the day to visit the population, as the Caribbean sun paints the whole area with marvelous colors (Back cover). Furthermore, midday temperatures are unbearably hot and after about 10:00 am mosquitos start to look avidly for human beings.

These limestone slopes, densely populated by the palm, are of Eocene-Oligocene age(de León 1994). The local vegetation is indeed interesting. With little soil available, there is a clear tendency toward xeromorphism. It is a very diverse open scrub, with *Guaiacum sanctum*, *Melocactus lemairei*, *Plumeria obtusa, Bursera simaruba*, *Pilosocereus* and a giant species of *Consolea*, a genus of cactus closely related to *Opuntia*. *Coccothrinax* and *Consolea* are the most showy plants that emerge above the generally low scrub. Some of the palm trunks may appear bent or even slightly twisted. The south of the island is where hurricanes are more destructive and many of the tall palms have been damaged at various times in their lives.

The palm has no common name as the leaves are not used locally. It is known as *guano de Barreras*, simply because this “guano” (generic name for *Coccothrinax* species) grows close to this town. The population is called “guanal.”

*Coccothrinax boschiana* can be found between 5 and 200 m asl. Its locality is about 15 km NE of Barahona. Climatic data for this city (De La Fuente 1976) indicate an average annual temperature of 26.1°C and a yearly rainfall of 1071.3 mm. Records of extreme minimum and maximum temperatures are respectively 14°C and 37.5°C. The uppermost parts of the ridge, with deeper soils, are sheltered from the salty breezes and host a different vegetation, consisting of a semideciduous low forest with a large and widespread population of *Coccothrinax argentea*. Local people call this other palm species Guano Manso (“mild” or “tame coccothrinax”), because its floppier leaves are easier to work for handicrafts. Natural hybrids between the two species can be found along the boundary where the two *guano* species overlap.

### A marvelous palm

*Coccothrinax boschiana* is a beautiful species. Palms can bloom when only 1 m tall (Mejía & García, 1997) and can attain 12 m or more. Probably the most exciting character is the color of the leaves, which can be roughly described as golden above and silvery below (Fig. 3). The leaf shape is beautifully carinate, so the silhouette is reminiscent of that of a palm of the genus *Sabal*. Fibers are thick and woody, a feature which is unusual in Dominican species and more common in the Cuban ones. They coat the trunk forming striking rhomboid criss-cross patches (Fig. 5). The warty fruits are pinkish-purple. Fruit warts appear in a few species of *Coccothrinax* and are an unexplained adaptation that invites more research.

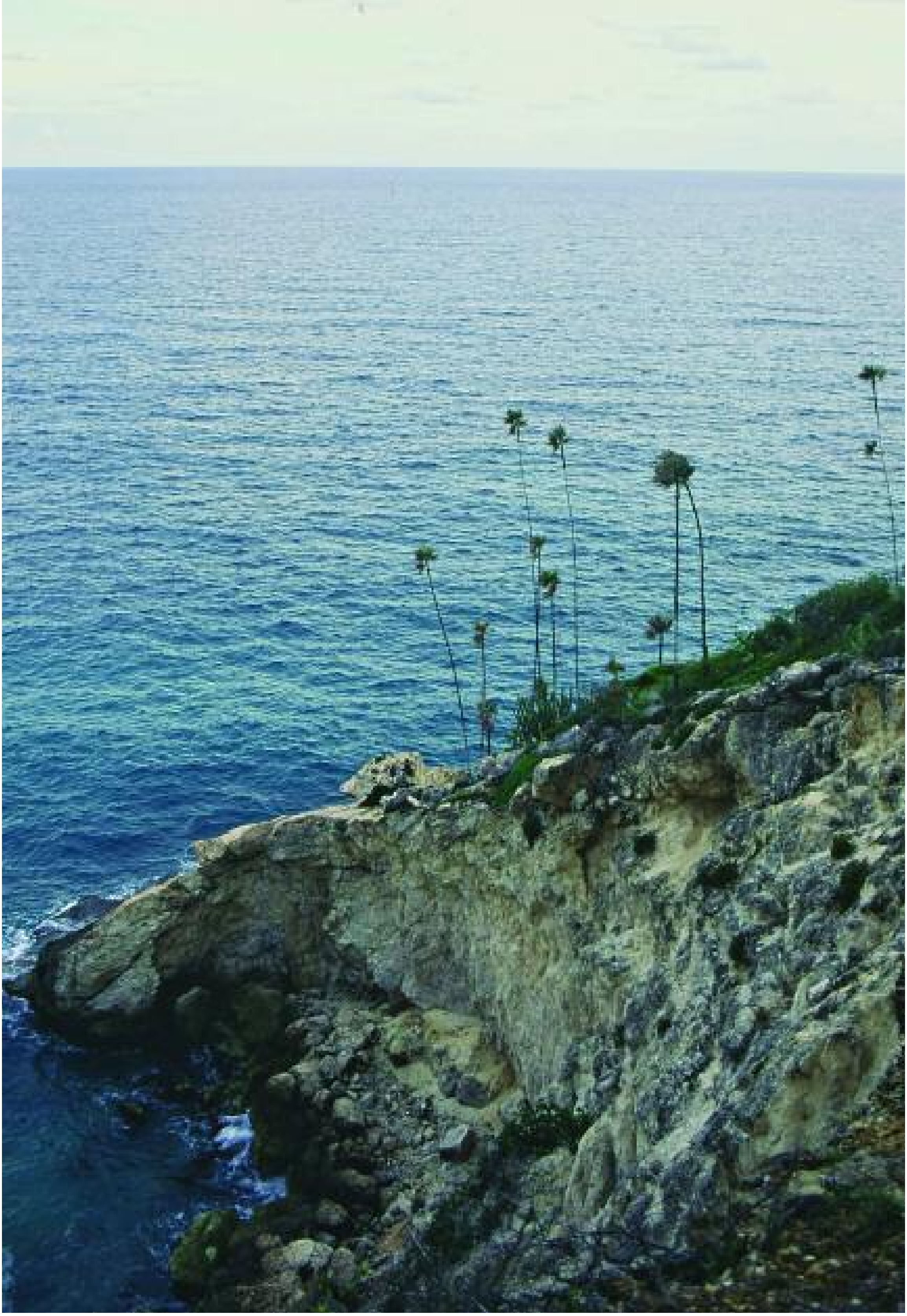
### The new species in cultivation

*Coccothrinax boschiana* is a promising ornamental species that is being tried in cultivation. It shows the usual hardiness typical of the genus, to which can probably be added a high tolerance to salinity. The oldest cultivated plant of *Coccothrinax boschiana* is a trunkless specimen grown at Fairchild Tropical Garden. It was erroneously tagged as *Coccothrinax gracilis*. Armando Reyes, an IPS member in Miami, advised me in 1999 that it was strikingly similar to the recently described new species. We quickly confirmed its identity. It grew from wild material collected by Zanoni in the type locality of *C. boschiana* long before it was recognized as a new species. Seedlings are growing in the Botanic Garden of Santo Domingo and in the Palmetum in Santa Cruz. Seeds collected and distributed by Leonel Mera germinated in many private collections.

### Acknowledgements

I wish to thank Milo Matos, the mayor of the town of Barreras, and his family. They gave me accommodation and took me twice to the palm population. I would like to express my gratitude to Ricardo García, Milciades Mejía and Leonel Mera who organized all my *Coccothrinax* adventures in the country, including this one. Financial support from the Palmetum of Santa Cruz de Tenerife is gratefully acknowledged.

2 (top). Population of *Coccothrinax boschiana* in front of the sea, near to the town of Barreras. 3 (bottom). Unripe infructescence of *Coccothrinax boschiana*. Note the shining papillae on the fruit skin. 4 (facing page). Tall *Coccothrinax boschiana* palms grow on rocks, close to the sea.



5. Fibrous leaf sheaths on the trunk of *Coccothrinax boschiana.*

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# A Revision of *Pseudophoenix*

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1. *Pseudophoenix lediniana* at Fairchild Tropical Garden displaying its characteristically ventricose trunk.

**This new revision recognizes only four taxa, *Pseudophoenix ekmanii* Burret, *P. lediniana* R.W. Read (Fig. 1), *P. sargentii* H. Wendl. ex Sarg., and *P. vinifera* (Mart.) Becc., based on examination of extensive herbarium holdings and living plants, both in the field and in cultivation. Complete descriptions, a key to the species, ranges and a review of previous work in the genus are provided. A neotype for the name *Sargentia ariococca* is designated.**

One might think that *Pseudophoenix*, which was revised by R.W. Read in 1968, is hardly worthy of another taxonomic revision. Nevertheless, a combination of circumstances makes such a revision not only possible but necessary. First, the accessibility of the islands of the Caribbean has never been easier, and areas not visited by Read have been better explored since 1968. Second, the collecting activities of several botanists such as A. Henderson, M. Mejía, H. Quero and T. Zanoni, have brought to light many new and important specimens. In 1968, Read had 57 specimens at his disposal; I was fortunate to have over 140 specimens available for this work. Third, *Pseudophoenix* species in cultivation at Fairchild Tropical Garden, many from seeds collected by Read, are now mature and easily studied. Last, *Pseudophoenix* is the focus of conservation interests in several areas of the Caribbean Basin. Regrettably, *Pseudophoenix* is more endangered now that it was in 1968, and a solid taxonomy must be the foundation of any conservation efforts.

This taxonomic revision examines *Pseudophoenix* from throughout its range, relying on data collected from both preserved and living specimens. Field work was carried out in Florida, Cuba, Bahamas, Mexico, and the Dominican Republic. Cultivated specimens were studied at Fairchild Tropical Garden, the Montgomery Botanical Center (Miami, FL) and private gardens in the Miami area. Specimens from the following herbaria were consulted: A, BH, CICY, FI, FTG, GH, HAJB, IJ, K, MO, NY, S and US (abbreviations follow Holmgren et al. 1990). Floral measurements were made from either pickled material or rehydrated material. Fruit and seed measurements were made from pickled or dried fruits.

## Distribution

*Pseudophoenix* is quintessentially Caribbean (Fig. 2), occurring on the Florida Keys (Elliott Key at present, but also Sands and Long Keys in historical times), the Bahamas, Cuba, and Hispaniola (Haiti and the Dominican Republic), and Puerto Rico (present only on Mona Island). In Cuba, it has been collected from Camagüey Province in the central northern coast and in the extreme eastern tip of Guantánamo Province (Maisí). *Pseudophoenix* also occurs in the Yucatan Peninsula, in Mexico (the states of Yucatán and Quintana Roo) and Belize (on Ambergris Cay). In the Turks and Caicos Islands and in the Bahamas, the genus is widespread. It is absent from Cat and Crooked Islands and the northern islands of Abaco and Grand Bahama. It is also absent from Jamaica and the Cayman Islands.

Small island populations of *Pseudophoenix* often appear marginally distinct from mainland populations, perhaps as the result of genetic isolation from the mainland and subsequent inbreeding and loss of dispersability. Island populations have been given formal taxonomic recognition. Saona (off the south-eastern coast of the Dominican Republic) is the type locality for a species once known as *P. saonae* Cook. This taxon occurs on several small islands around Hispaniola but is not found on the mainland. Populations of *Pseudophoenix* from Ile de La Gonâve (Haiti) were once distinguished as *P. gracilis* Ekman ex Burret. Navassa, a small island off the southwestern tip of Haiti (but administered by the U.S. Coast Guard) is home to *P. navassana* Ekman ex Burret. All of these species are included here within *P. sargentii*.

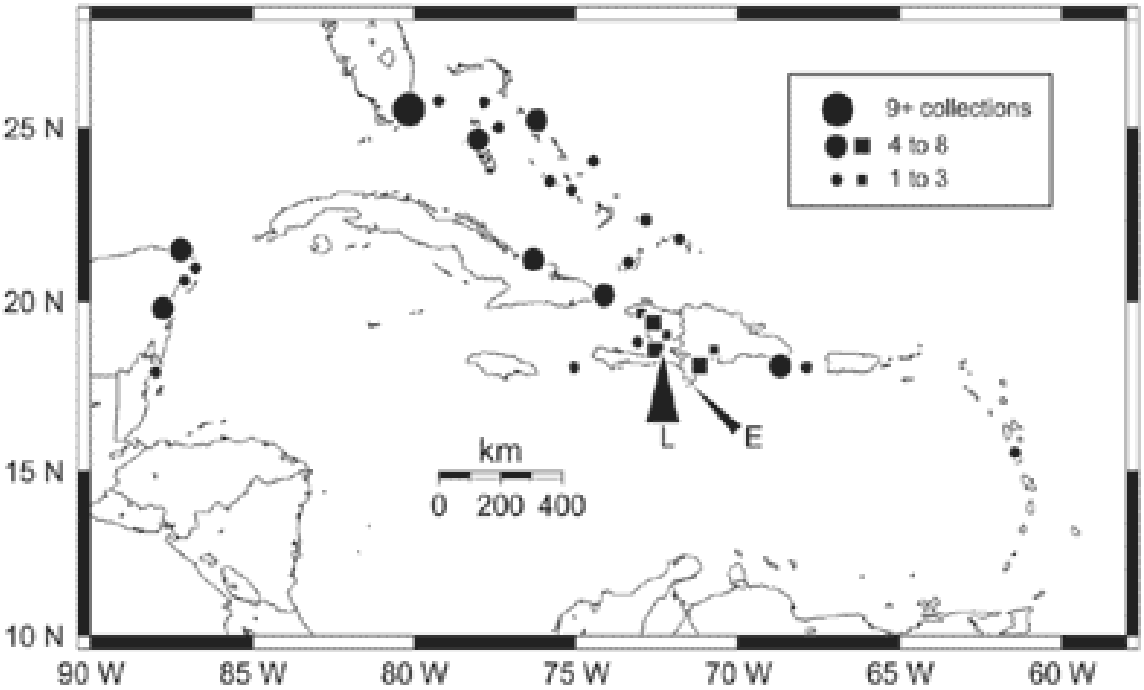
In an intriguing report, Read (1969) told of discovering a large population of *Pseudophoenix sargentii* on Dominica, although the genus is not mentioned in the flora of that island (Hodge 1954). Recently, Read's discovery has been confirmed by Bertrand Jean-Baptiste and Arlington James (pers. comm.) of the Dominica Forestry Department, who have found a substantial population of *Pseudophoenix* (>700 plants) in the vicinity of Mero. A single fertile specimen (*Garvue, Toussaint & Guye s.n.* at FTG), collected on 21 April 2001, confirms Read's thirty-two-year old supposition that this population is *P. sargentii*. The disjunction between the northern Greater Antilles and Dominica is remarkable.

## Previous Work

The history of the discovery of *Pseudophoenix* has been recounted several times (Curtiss 1887, Sargent 1888 and1896, Small 1920, Bailey 1939, Ledin et al. 1959a, Read 1968, Lippincott 1992), so another detailed retelling would be superfluous. Instead, a synopsis of the discovery is offered. On 16 or 19 April (accounts vary as to the exact date) 1886, C. S. Sargent, A. H. Curtiss, C. E. Faxon and crew members from the Navy Lighthouse Tender 'Laurel' landed on Elliott Key, at the pineapple plantation of Mr. Henry Filer. The botanists saw a small palm left standing in a clearing. They recognized immediately that it was new to the flora of North America. A specimen with unripe fruits was sent to Prof. H. Wendland, who concurred that it was new and bestowed the name *Pseudophoenix sargentii* on the palm.

Sargent's publication of *P. sargentii* H. Wendl. ex Sarg. in 1886 became the taxonomic foundation of the genus. Thereafter, several noteworthy botanists turned their attentions to *Pseudophoenix* with mixed success.

Odoardo Beccari was the first to conclude that the Hispaniolan palm illustrated by C. Plumier as



2. Distribution of *Pseudophoenix* in the Caribbean Basin. Circles = *Pseudophoenix sargentii*; squares = *Pseudophoenix vinifera*; narrow triangle = *Pseudophoenix ekmanii*; wide triangle = *Pseudophoenix lediniana*. Circle and square sizes indicate numbers of herbarium collections seen for this study: small = 1–3 collections, medium = 4–8 collections and large = 9 or more collections.

"Palma dactylifera et vinifera" and described by Martius in 1845 as *Euterpe ? vinifera* belonged to Wendland's new genus *Pseudophoenix*. In his account of the palms of Cuba, Beccari (1912) transferred *E. ? vinifera* to *Pseudophoenix*. He was uncertain whether the *Pseudophoenix* of Cuba, which he knew from only sterile fragments, belonged to *P. sargentii*, *P. vinifera*, or even a third, undescribed species. Britton and Millspaugh (1920) believed that *P. vinifera* and *P. sargentii* were identical, a conclusion accepted by Sargent in the second edition of his "Manual of the Trees of North America" (1922). In both publications the name *P. vinifera* was used. John K. Small (1922) provided a lucid historical account of the two known species and chronicled their discovery in Florida, Hispaniola, Cuba, and the Bahamas.

Orator F. Cook published three new species from Cuba and Hispaniola, as well as a segregate genus, *Cyclospathe* to accommodate *Pseudophoenix* from the Bahamas (Cook 1902, 1923). Cook (1902) placed *Pseudophoenix* and *Cyclospathe* in the tribe Cyclospatheae, but in 1913, he elevated the tribe to the rank of family, the Pseudophoenicaceae. In his over-reliance on trunk and foliage characters, he confused *Pseudophoenix* with *Gaussia* (which he called *Aeria*) (Cook 1923). Flowers were unknown for each of the three species described by Cook. Had he known flowers, it is unlikely he would have confused the two genera.

In 1929, Max Burret published several new species from material collected in Hispaniola by intrepid field collector Erik Ekman. Burret had the disadvantage of never seeing these palms in the living condition, either in the field or in cultivation, and hence relied entirely on Ekman's judgement and notes. Liberty Hyde Bailey (1939) provided a useful account of the history of the species known up to that time, along with a English-language description of the species.

Robert W. Read, working at Cornell University under the direction of H. E. Moore Jr., took up the revision of the genus as his M.Sc. degree project. Read reduced Cook's family Pseudophoenicaceae to subfamily Pseudophoenicoideae, and he recognized only four species: *P. sargentii*, *P. vinifera*, *P. ekmanii* and *P. lediniana*, which he described as new. He reduced several taxa to infraspecific status under the variable *P. sargentii*, giving us *P. sargentii* ssp. *saonae* var. *saonae* and *P. sargentii* ssp. *saonae* var. *navassana*. Although Read made field collections in Hispaniola and observed cultivated specimens at Fairchild Tropical Garden, he did not see living material of *P. ekmanii* or *P. sargentii* ssp. *saonae* var. *navassana*.

3 (left). The petioles, sheathing leaf bases and crownshaft of *Pseudophoenix sargentii*.

4 (facing page). The spectacular *Pseudophoenix ekmanii* in the juvenile condition with the waxy white internodes. These two palms were photographed in October, 1999, in their natural habitat in Barahona, Dominican Republic. (Photo: C. Morici)

Leaf and floral anatomy were addressed by Tomlinson (1961) and Read (1968). The species of *Pseudophoenix* are noteworthy for having a massively sclerotized, fibrous hypodermis on the adaxial surface of the leaf segments, along with a well-developed palisade layer. Pollen morphology was surveyed with both light and scanning electron microscopy by Ambwani and Kumar (1993). They found slight differences among their samples of *P. sargentii*, *P. vinifera*, and *P. ekmanii*; however, it is not known whether these minute differences in pollen wall sculpture and thickness would hold up with wider sampling.

Read (1966) reported on the chromosome number for *Pseudophoenix sargentii* and *P. vinifera*. He found both species have n = 17, a haploid number that is unique in the subfamily Ceroxyloideae and uncommon elsewhere in the family (Johnson 1985, Uhl & Dransfield 1987).

The phytochemistry of the genus is poorly known. Williams et al. (1973) examined *P. sargentii* and found none of the compounds that are common elsewhere in the family. They found no negatively charged flavonoids, no flavone C-glycosides, no tricin, luteolin, apigenin, quercetin, kaempferol, nor leuco-anthocyanins. Cyanogenesis, which is rare in the palms, was not detected in *P. lediniana* by Lewis and Zona (2000). Coumarins, which occur sporadically throughout the family, are present in *Pseudophoenix ekmanii* (Zona & Downum, pers. obs.).

The genus presents several unique morphological features (Uhl & Dransfield 1987), making its systematic placement difficult. Uhl and Dransfield (1987) justified its placement in the Ceroxyloideae by its multiple peduncular bracts and single phloem strand in the central vascular bundles of the petiole. Recent molecular studies (Uhl et al. 1995, Baker et al. 1999 Asmussen et al. 2000) argue for a more isolated position in the family, without close relationships with the remaining Ceroxyloideae. *Pseudophoenix* is, by all accounts, an isolated member of the palm family.

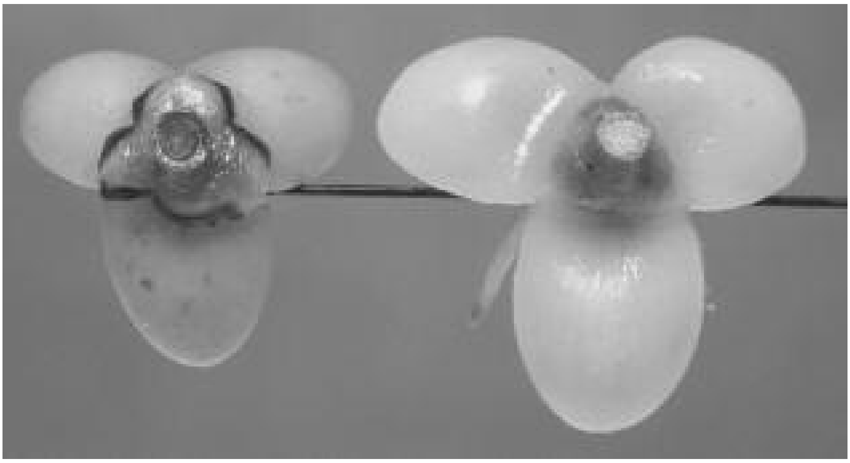
## Morphology

*Pseudophoenix* germinates in the remote-tubular mode and begins its life with a narrowly lanceolate

5 (left). Crown of *Pseudophoenix ekmanii*. Note the virtual absence of petiole. 6. (right) Ken Neugent, of Fairchild Tropical Garden, stands beside a decapitated juvenile of *Pseudophoenix ekmanii*. Although the population occurs in a national park, destructive poaching still threatens the species.

eophyll (Uhl & Dransfield 1987). It is always a single-stemmed palm, with the stem erect and cylindrical, weakly to grossly ventricose, or lageniform (bottle-shaped). In *P. vinifera* and *P. ekmanii*, reproduction does not commence until after their stems have produced their characteristic swellings. The stem may have conspicuous or inconspicuous leaf scars and internodes when young. The internodes in *Pseudophoenix ekmanii* have a white waxy bloom that contrasts markedly with the brown leaf scars. At maturity, stems are gray or brownish gray. No part of the stem bears spines or prickles.

The leaves are alternate and spirally arranged, although in juveniles the leaf arrangement is distichous. Each leaf has a sheathing base that forms a weak crownshaft. The two opposing edges of the sheath meet on the side of the stem opposite the petiole and are fused for a portion of their length (Fig. 3). The apex of the sheath is often



7. Spirit-preserved flowers of *Pseudophoenix lediniana* (left) and *P. vinifera* (right) showing the lobed calyx of the former and the triangular calyx of the latter species.

8 (left). One of the few remaining adult *Pseudophoenix sargentii* on Elliott Key, Biscayne National Park, Florida, USA. 9 (right). *Pseudophoenix sargentii*, Yucatan, Mexico.

clothed in both silvery and black scales. The leaf sheath splits on the side opposite the petiole and cleanly falls away from the stem. A petiole may be present (elongate on juveniles) or more-or-less absent. The leaf rachis is rounded abaxially, channelled adaxially (when young) or channelled with a low ridge running the length of the rachis (when mature). The segments of the leaf are arranged sub-regularly and displayed in more than one plane; each segment possesses a single midvein with 3–6 secondary veins on either side of the midvein, as well as numerous tertiary veins. Segments are lanceolate with acute apices. Segments near the base of the leaf are small and

10. The last remaining *Pseudophoenix sargentii* on Navassa Island. (Photo: M. Smith)

11. *Pseudophoenix sargentii* is stunted and dwarfed by the harsh growing conditions on Whale Cay, Bahamas.

slender but achieve full size a short distance above the base. They again diminish in size toward the apex. Plication is reduplicate. Leaf segments often bear ramenta along the midvein on the abaxial surface. The leaf is entirely unarmed, although juvenile leaf segments of *P. ekmanii* are stiff and their acute apices are almost spinescent. Leaves may be concolorous, slightly glaucous abaxially, or glaucous throughout. Variation in glaucousness is continuous and is given no taxonomic weight.

Flowering in *Pseudophoenix* occurs on infrafoliar or interfoliar, axillary inflorescences branched up to four orders. The posture of the inflorescence, given great taxonomic weight by Read (1968), varies continuously from erect to decumbent to pendulous. The stout peduncle is sheathed by a primary dagger-shaped bract (prophyll), bearing scurfy dark, caducous pubescence along the two keels but otherwise glaucous, opening apically. One or more additional bracts of similar

12. *Pseudophoenix sargentti* cultivated at Fairchild Tropical Garden from seeds collected on Elliott Key, Florida, in 1982. Note the erect leaves in these two plants (foreground and back right). The inflorescences are also erect, crowded among the leaves.

morphology are included within the primary bract. The proportion of the peduncle covered by the primary bract was used as a taxonomic character within *P. sargentii* (Read 1968), but this character now appears to be of no value.

Rachillae are divaricating in *Pseudophoenix ekmanii* and *P. sargentii* but are distally directed (lax rachillae pointing toward the apex of the more-or-less pendulous inflorescence) in *P. vinifera* and *P. lediniana*. The characteristic of the rachillae are therefore useful at making the "first cut" in keying out species. Flowers are borne singly along the rachillae. They may be hermaphroditic or staminate, with the latter more common at the distal end of the rachillae. The sexual expression of the palm is andromonoecious.

Flowers are borne on a pseudopedicel, the anatomy of which suggests it is composed of the elongated receptacle and fused base of the calyx(Cook 1902, Read 1968). Although each flower is subtended by a bract, bracteoles are absent from the pseudopedicel or its base. The calyx is a shallow, three-sided or three-lobed cupule, which persists in fruit. Petals are three, distinct, ovate, valvate, green, glaucous abaxially. The petals may have 6–24 major longitudinal veins. There is slight adnation between the petals and the stamens. The six stamens have slender filaments that are basally connate into a short tube. The apex of each filament is "inserted" into the connective of the anther; the anthers are dorsifixed but not versatile.

Anthers are large and conspicuous, yellow, and somewhat pointed at their apices. Dehiscence is latrorse-introrse. The gynoecium is superior, green, solitary, comprising three connate carpels, conical to ovoid with an acute apex. The stigma is inconspicuously trifid. The pistillode (in staminate flowers) is pyramidal or conical and inconspicuous. Flowers in *Pseudophoenix*, while not detectably fragrant, are colorful, secrete nectar and attract numerous hymenoptera. By all appearances, they are bee-pollinated.

Fruits are drupaceous and red when ripe. Each fruit has one, two or three separate endocarps, each endocarp bearing a single seed. The fruit is spheroidal if only one seed develops or deeply lobed if two or three seeds develop. The calyx, corolla, and filaments persist in fruits, providing useful characters by which to identify species. Whether the persisting petals are weakly to strongly reflexed or spreading has no taxonomic significance. The surface of the fruit is smooth and glaucous and may be shrivelled in dried fruits of *Pseudophoenix sargentii* and *P. ekmanii*. The mesocarp is fleshy; the endocarp is bony and brittle. The seed is spherical, brown with prominent raphe and fibers embedded in the testa. The endosperm is homogeneous.

Fruits are oily and colorful and, thus, likely to be animal-dispersed (Zona 1997). As fruits and seeds dry, they become buoyant – an air pocket develops as the seed shrinks from the endocarp – leading Read (1968) to suggest that they are adapted to water dispersal. Neither fruits, endocarps nor seeds are recorded among drift seeds (Guppy 1917, Gunn & Dennis 1976).

### Taxonomy of *Pseudophoenix*

*Pseudophoenix* H. Wendl. ex Sargent, Bot. Gaz. 11: 314. 1886. Type: *Pseudophoenix sargentii* H. Wendl. ex Sarg.

*Sargentia* H. Wendl. & Drude ex Salomon, Die Palmen 160. 1887. Type: *Sargentia ariococca* H. Wendl. & Drude ex Salomon = *Pseudophoenix sargentii.*

*Chamaephoenix* (H. Wendl. ex Sarg.) A. H. Curtiss, Florida Farmer & Fruit Grower 1(8): 1. 1887. Type: *Chamaephoenix sargentii* H. Wendl. ex Curtiss = *Pseudophoenix sargentii.*

*Cyclospathe* Cook, Mem. Torrey Bot. Club 12: 25. 1902. Type: *Cyclospathe northropii* [as "*northropi*"] = *Pseudophoenix sargentii.*

Pleonanthic, andromonoecious palms. Stem solitary, erect, cylindrical, ventricose or lageniform, gray at maturity, smooth or prominently ringed with leaf scars, glabrous or waxy. Leaves alternate and sprirally arranged (distichously arranged in juveniles), pinnately divided with leaf segments irregularly arranged along the rachis and displayed in multiple planes; sheath forming an incomplete crownshaft; petiole rounded abaxially, channelled adaxially (when young) or with a low ridge along the length of the adaxial channel (at maturity); segments greatly reduced at the base of the leaf, becoming largest at the middle of the leaf, and again reduced distally, lanceolate, lax or stiff; midvein prominent; secondary and tertiary veins numerous; transverse veins not evident; plication reduplicate. Inflorescence erect, ascending or arching, branched to 4 orders; peduncle dorsiventrally flattened, glabrous, bearing two bracts; prophyll oblanceolate, bearing scurfy dark scales along the two keels but otherwise glaucous, opening apically; inner bract bearing dark brown scales along both edges; inflorescence axis glabrous, with small bracteoles subtending each branch; rachillae divaricating or directed toward the apex of the inflorescence, glabrous. Flowers borne singly, subtended by a minute bract, borne on a pseudopedicel; calyx of 3 connate sepals, a shallow cupule with three spreading lobes or three-sided; petals 3, ovate, valvate, spreading in anthesis (spreading or reflexed in fruit); stamens 6 in two whorls, the outer whorl alternate with the petals, the inner whorl opposite the petals, basally adnate to the petals and sometimes briefly connate by their filament bases (forming a shallow staminal tube); filaments awl-shaped, with tips embedded in the connective; anthers elongate, somewhat gibbous, bilocular; dehiscence latrorse-introrse; pistillode (in staminate flowers) conical to pyramidal, green; gynoecium (in bisexual flowers) of 3 connate uniovulate carpels, trigonous-cylindrical to ovoid or conical, style absent, stigma apical, inconspicuously trifid. Fruit a drupe with 1–3 endocarps, globose with one endocarp, lobed with two or three endocarps, red, perianth and pseudopedicel persistent; mesocarp fleshy and juicy; endocarp globose or flattened globose, brown, smooth; stigmatic scar basal (in single-seeded fruits) or apical (in 2- or 3-seeded fruits). Seed globose or flattened globose, brown, with prominent impressed fibers radiating from the short, prominent raphe; endosperm homogeneous; embryo basal; germination remote-tubular, eophyll linear and undivided.

### Key to the Species of *Pseudophoenix*

1. Rachillae lax, distally directed (i.e., the rachillae pointing toward the apex of the inflorescence, and the axes of the rachillae parallel to the main axis of the inflorescence; not divaricating); mesocarp firm in fresh fruits, drying smooth . . 2

1. Rachillae divaricating; mesocarp watery in fresh fruits, drying wrinkled . . . . . . . . . . . . . . . . . . 3

2. Stem lageniform; calyx three-sided; petals 6.4–8.0 mm long; filaments 4.2–5.1 mm long, basally connate . . . . . . . . . . . . . . . . . . *P. vinifera.*

2. Stem weakly ventricose; calyx three-lobed; petals 5.5–6.0 mm long; filaments ca. 2.1 mm long, not connate . . . . . . . . . . . . . . . . . . . . . . *P. lediniana.*

3. Stem strongly ventricose; petioles absent; filaments 1.3–1.7 mm long . . . . . . . . *P. ekmanii.*

3. Stem cylindrical; petioles present; filaments 2.2–3.7 mm long . . . . . . . . . . . . . . . . *P. sargentii.*

**1. Pseudophoenix ekmanii** Burret, Sv. Vet. Akad. Handl. ser. 3: 19, t. 3A. 1929. Type: Dominican Republic: Barahona, *Ekman H-7055* (holotype: S!; isotypes: IJ!, K!, NY!, US!).

Stem 5–6 m tall, strongly ventricose, most slender above the swelling, ca. 60 cm dbh, with prominent brown leaf scars and waxy white internodes when young, gray when mature. Leaves ca. 12 in the crown, spreading (mature) or ascending (juvenile); leaf ca. 2–3 m long; sheath ca. 35 cm long, green with silvery gray scales near the apex; petiole absent; rachis ca. 161 cm long, often with brown scales along its margin; number of leaf segments per one side of the rachis not known; middle leaf segment 31.0–39.5 cm long, 1.7–2.3 cm wide, lanceolate with an acuminate tip, gray-green, densely glaucous on both sides, ramenta present on the abaxial surface of the midvein at the base of the leaf segment. Inflorescence erect, ascending or arching, branched to 3 orders, ca. 154 cm long; peduncle not extending far beyond the leaf sheaths, glabrous; prophyll not seen; inner bract not seen; rachillae 5.9–8.0 cm long and 0.8–0.9 mm diam., divaricating. Flower pseudopedicel 7.2–7.6 mm long, 0.4–0.5 mm diam., green to glaucous; calyx a shallow triangular cupule, 3.5–3.8 mm diam., green to glaucous, margins hyaline; petals ovate, ca. 7.0 mm long and 3.7 mm wide, green, glaucous abaxially, spreading, with ca. 13 major veins; filaments 1.3–1.7 mm long, briefly connate, anthers ovoid, ca. 2.8 mm long, ca. 1.5 mm wide, yellow; gynoecium and pistillode not seen. Fruit 11.8–14.3 mm long, 11.7–13.2 mm diam. (in single-seeded fruits); endocarp 11.7–13.2 mm long, 11.1–12.6 mm diam., ca. 0.2 mm thick. Seed 6.8–7.1 mm long, 8.5–9.4 mm diam. (Figs. 4–6, Front Cover)

DOMINICAN REPUBLIC. Pedernales: Barahona, *Ekman H-7055* (S, IJ, K, NY, US); 7 km S of Los Tres Charcos and ca. 7–8 additional km (by animal) toward Playa Blanca, *Zanoni, Mejía & Pimentel 36100* (NY); Isla Beata, *Loomis 94* (US). CULTIVATED. USA. Florida: Miami-Dade Co., Coral Gables, Fairchild Tropical Garden, 97-336, *Zona 785* (FTG).

This poorly known species is perhaps the most beautiful of all the *Pseudophoenix*. As juveniles, the trunks are waxy white with brown nodes and the leaves are gray and stiff (Fig. 4). At maturity, the stems become strongly ventricose to bottle-shaped (Front Cover). They are striking palms.

*Pseudophoenix ekmanii* resembles *P. vinifera*, in that they both have strongly ventricose trunks. Unlike that of *P. vinifera*, the trunk of *P. ekmanii* has waxy white internodes when young. *Pseudophoenix ekmanii* has a divaricating inflorescence and smaller fruits (<13.2 mm diam.), whereas the inflorescence of *P. vinifera* has distally directed branches and the fruits are larger (16.2–22.2 mm diam.). At any stage, *P. ekmanii* is easily distinguished from any other species by its absence of a petiole, that is to say, there is no obvious petiole between the sheathing leaf base and the leafy rachis (Fig. 5). Read (1968) reported that the stamen filaments are short (less than 1.5 mm long), but his observation was made from immature flower buds. The filament length reported here is based on the persistent filaments of the immature fruits of *Zanoni et al. 36100.*

*Pseudophoenix ekmanii* occurs at low elevations in the Parque Nacional Jaragua and Isla Beata. The vegetation in classified by Hager and Zanoni (1993) as Barahona Peninsula Dry Forest, and the substrate is limestone with little or no overlying soil. The region receives 630–800 mm of precipitation per year and has a distinct dry season from December to May (Hager & Zanoni 1993).

Although virtually the entire population of *Pseudophoenix ekmanii* occurs in a national park, the palm is still harvested for its sweet sap which is fermented into alcohol. Decapitated juveniles attest to the activities of sap poachers (Fig. 6). In addition, seed harvesting, if excessive, may threaten the reproductive health of the population.

**2. Pseudophoenix lediniana** Read, Gentes Herb. 10: 189, pl. 13C. 1968. Type: Haiti, Riv Levange, *Read & Pierre-Louis 1154* (holotype; BH!; isotype: FTG!).

13 (left). *Pseudophoenix vinifera* in Haiti. The palms are the only trees remaining on this deforested hillside. (Photo: C. Hubbuch)

14 (facing page). *Pseudophoenix vinifera*, Dominican Republic. Note abrupt tapering of the trunk that occurs after the individual has reached reproductive maturity.

Stem ca. 5 m tall, fusiform or ventricose, 25.1–32.5 cm dbh, gray, with prominent leaf scars when young. Leaves 15–17 in the crown, spreading; leaf ca. 270–310 cm long; sheath 36.0–58 cm long, green with silvery gray scales near the apex; petiole 25–60 cm long; rachis ca. 236 cm long, often with brown scales along its margin; leaf segments 140–160 per one side of the rachis; middle leaf segment 49.0–66.5 cm long, 1.6–2.5 cm wide, lanceolate with an acuminate tip, gray-green, glaucous abaxially, glaucous to glossy adaxially, ramenta absent on the abaxial surface of the midvein at the base of the leaf segment. Inflorescence arching to pendulous, branched to 3 orders, ca. 1.7 m long; peduncle ca. 95 cm long and 4.0 cm diam., glabrous; prophyll ca. 104 cm

long, ca. 8.5 cm wide, bearing dark brown scales along both edges (keels); inner bract not seen; rachillae 13.0–14.7 cm long and 1.5–1.7 mm diam., directed toward the apex of the inflorescence. Flower pseudopedicel 0.7–2.0 mm long, 1.4–1.7 mm diam., green to glaucous; calyx a shallow three-lobed cupule, 4.0–5.2 mm diam., lobe apices rounded, green to glaucous, margins hyaline; petals ovate, 5.5–6.0 mm long, 4.7–4.9 mm wide, green, glaucous abaxially, spreading, with ca. 12 major veins; filaments ca. 2.1 mm long, not connate, anthers ovoid, ca. 4.3 mm long and 2.1 mm wide, yellow; gynoecium (in bisexual flowers) ca. 3.2 mm long and 2.0 diam.(pistillode in staminate flowers smaller), green. Fruit 17.2–25.1 mm long, 14.8–21.7 mm diam. (in single-seeded fruits); endocarp 15.2–17.6 mm long, 15.6–17.3 mm diam., ca. 0.5 mm thick. Seed 12.3–14.6 mm long, 10.9–14.2 mm diam. (Figs. 1, 7)

HAITI. Ouest: Trouin, *Cook s.n.* (US), *Cook s.n.* (BH); Riv Levange, *Read & Pierre-Louis 154* (BH, FTG); Grand Goave, limestone cliffs, *Read 237* (BH); between Grand Goâve and Port-au-Prince, S of Fauché on old road to Jacmel, 18°24′N 72°44′W, *Henderson, Aubry, Balick & Vaval 1031* (NY); Grand Goâve, steep limestone cliffs, *Ekman H5860* (IJ, K, FTG, NY, S, US). CULTIVATED. USA. Florida: Miami-Dade Co., Coral Gables, Fairchild Tropical Garden, 53-198A, *Zona 782* (FTG), 96-947, *Zona 777* (FTG).

*Pseudophoenix lediniana* is similar in many respects to *P. vinifera*, but the lobed calyx of *P. lediniana* is markedly distinct from the unlobed calyx of *P. vinifera* (Fig. 7). The stem of *P. lediniana* is not strongly bottle-shaped, as in *P. vinifera*, but rather slightly ventricose (Fig. 1).

*Pseudophoenix lediniana* is known only from wet forest along small canyons around Riv. Levange (Dep. de l'Ouest), which is the type locality. The palm is not valued for wine-making, and the area is under no severe threats by human activities. Nevertheless, the species is highly vulnerable and without protection.

In cultivation, *Pseudophoenix lediniana* is said to be the fastest-growing of all *Pseudophoenix*. It makes a lovely ornamental palm, but it is not yet common outside the collections of botanical gardens and enthusiasts (Fig. 1).

3. **Pseudophoenix sargentii** H. Wendl. ex Sarg., Bot. Gaz. 11: 314. 1886. *Chamaephoenix sargentii* H. Wendl. ex A. H. Curtiss, Florida Farmer & Fruit Grower 1(8): 1. 1887. Type: USA, Florida, Elliott Key, 16 Apr 1886, *Sargent s.n.* (holotype: A!; isotype: GH!; photo: BH!).

*Sargentia ariococca* H. Wendl. & Drude ex Salomon, Die Palmen 160. 1887. Type: not designated. Neotype (designated here): United States, Florida, Elliott Key, *J. K. Small, P. Matthaus & C. A. Mosier 9499* (neotype: NY!).

*Cyclospathe northropii* Cook [as "*northropi*"], Mem. Torrey Bot. Club 12: 25. 1902. Type: Bahamas, Andros Island, *J. I. & A. R. Northrop 508* (lectotype: NY!; isolectotype: US!).

*Pseudophoenix saonae* Cook, Jour. Washington Acad. Sci. 13: 406. 1923. *Pseudophoenix sargentii* ssp. *saonae* (Cook) Read var. *saonae*, Gentes Herb. 10: 210. 1968. Type: Dominican Republic, Saona Island, *Taylor 513* (holotype: US!; isotype: NY!; fragment: BH!).

*Pseudophoenix linearis* Cook, Jour. Washington Acad. Sci. 13: 407. 1923. Type: Cuba, Cayo Romano, *Shafer 2644* (holotype: US!; isotype: NY!; fragment: BH!; photo: FTG!).

*Pseudophoenix gracilis* Ekman ex Burret, Sv. Vet. Akad. Handl. ser. 3: 28. 1929. Type: Haiti, Ile de La Gonâve, *Ekman H-9622* (holotype: S!; isotypes: A!, DA, K!, NY!, S!, US!).

*Pseudophoenix navassana* Ekman ex Burret, Sv. Vet. Akad. Handl. ser. 3: 27. 1929. *Pseudophoenix sargentii* ssp. *saonae* var. *navassana* (Ekman) Read, Gentes Herb. 10: 211.1968. Type: Navassa Island, *Ekman H-10302* (holotype: S!; isotypes: K!, NY!, US!).

Stem 1–8 m tall, cylindrical, 9.5–25.0 cm dbh, gray, with prominent leaf scars when young. Leaves 7–16 in the crown, spreading or ascending; leaf 0.9–2.2 m long; sheath 18–41 cm long, green with silvery gray scales near the apex; petiole 24–119 cm long; rachis 64–165 cm long, often with brown scales along its margin; leaf segments 37–122 per one side of the rachis; middle leaf segment 29–64 cm long, 0.9–3.2 cm wide, lanceolate with an acuminate tip, gray-green, glaucous abaxially, glaucous to glossy adaxially, ramenta present on the abaxial surface of the midvein at the base of the leaf segment. Inflorescence erect, ascending or horizontal, branched to 3 or 4 orders, 100–150 cm long; peduncle often hidden by the leaf bases, 60–88 cm long, 1.7–1.8 cm diam., glabrous; prophyll 24–105 cm long, 2.6–6.0 cm wide, bearing dark brown scales along both edges (keels); inner bract 10–74 cm long, 1.6–5.0 cm wide, bearing dark brown scales along both edges; rachillae 1.3–5.5 (–9.0) cm long and 0.4–1.4 mm diam., strongly divaricating. Flower pseudopedicel 2.2–7.6 mm long, 0.4–1.0(–1.7) mm diam., green to glaucous; calyx a shallow triangular cupule, 2.1–4.2 mm diam., green to glaucous, margins hyaline; petals ovate, 4.8–6.6 mm long, 3.2–4.8 mm wide, green, glaucous abaxially, spreading, with ca. 7–13 major veins; filaments 2.2–3.7 mm long, basally connate forming a short staminal tube, anthers ovoid, 2.4–4.1 mm long, 0.8–2.5 mm wide, yellow; gynoecium (in bisexual flowers) 3.0–4.2 mm long, 1.0–2.3 mm diam. (pistillode in staminate flowers smaller), green. Fruit 10.6–17.1 mm long, 9.1–16.1 mm diam. (in single-seeded fruits); endocarp 7.9–13.5 mm long, 6.8–11.8 mm diam., 0.1–0.2 mm thick. Seed 6.4–10.5 mm long, 6.6–9.6 mm diam. (Figs. 3, 8–12)

BAHAMAS. Locality unknown, *Nickerson & Gross 3044* (A, FTG, MO); Andros, High Point Cay, *Brace 5301* (NY), Purser Point, Wide Opening, edge of marsh, *Brace 6771* (NY), Big Cabbage Creek, west side, *Northrop & Northrop 671* (NY), Loggerhead Creek, *Northrop & Northrop 508* (NY, US), small key near Mastic Key, *Bailey 1047* (BH); North Andros, ca. 8 mi. S of Fresh Creek, coppice, *Correll, Fehling & Stevenson 49397* (FTG, NY); Berry Islands, Whale Key, coppice, *Britton & Millspaugh 2197* (NY); S. Bimini, *Millspaugh 2398* (NY); Eleuthera, S of Glass Window, scrub, *Webster & Williams 10727* (FTG, S, US), Cape Eleuthera, coppice, *Correll & Hill 45332* (FTG, NY), 0.5 mi SE of Glass Window, *Proctor 30906* (IJ); Hummingbird Cay, *Kessler et al. 2754* (A, FTG); Great Exuma, between George Town airstrip and the coast, *Correll & Correll 47937* (FTG); Inagua, Miner's Tent to Balsom Hill, scrubland, *Nash & Taylor 1290* (FTG, NY); Little San Salvador, *Britton & Millspaugh 5671* (NY); Long Is., 2–6 mi S of Galloway's Landing, along Diamond Crystal Salt Company road, *Hill 2398* (FTG, NY); Mayaguana, SE point, *Wilson 7563* (GH, NY); New Providence, S of Fox Hills, coppice, *Britton & Brace 547* (K, NY), ca. 3 mi E of airport, *Corell 44313* (FTG). BELIZE. Ambergris Cay, off the north coast, *Turner 33* (BH). CUBA. Oriente [Camagüey or Guantánamo], north coast, *Natenson 25008* (HAJB); Camagüey: Cayo Guajaba, hills SE end, *Shafer 2815* (NY) and *Shafer 680* (A, GH, NY); Cayo Romano, Lomo de Loro, *Shafer 2644* (NY, US; fragment at BH, photo FTG), Alto del Aji, *Shafer 2790* (NY); Cayo Sabinal, *Ekman 18572* (S); Guantánamo: Maisí, *León 16291* (GH, HAJB, US); Maisí, Sabana, *León 16662* (GH, HAJB, US) and *León 16748* (HAJB, US), Cuesta del Chivo, *Legrá s.n.* (FTG); Las Tunas: Puerto Padre, El Copey, *Curbelo 16660* (HAJB); Santa Clara: Caibarién, Cayo Francés, *Ekman 18572* (S). DOMINICA. Near Mero, dry hill overlooking Castaways Hotel, *Read 2008* (US); Mero Estates, Mero, *Garvue et al. s.n.* (FTG). DOMINICAN REPUBLIC. La Altigracia: Isla Saona, SW shore of island, *Loomis 23* (US), in woods, *Liogier & Liogier* 21878 (NY) and *Liogier & Liogier 27279* (NY), interior, N of Playa El Canto de la Playa (on S side, E of Mano Jaun), 18°07'N 68°40'W, *Zanoni, Mejía & Ramírez 15154* (NY), Banks of salt lake, *Taylor 513* (NY, US; fragment and photo at BH); 2 km N of Guaraguao on road to Bayahibe, in wetland, *Zanoni & Mejía 16970* (NY); Puerto Plata: Sosua at Punta Goleta, coastal thickets, *Ekman H14526* (K, NY, S, US). HAITI. Ile de La Gonâve, hills above Pointe à Raquettes, *Ekman H-9622* (A, FTG, K, NY, S, US). MEXICO. Quintana Roo. Res. Sian Xa'an, 8 km NE of Vigia Chico, 19°48'N 87°31'W, *Sanders & Frame 1720* (NY, FTG); 2 km inland from Puerto Juarez on road to Valladolid, *Moore 8087* (BH); Isla Mujeres, 21°15'27"N 86°45'06"W, *Flores & Ucán 8815* (CICY); 0.5 km N of Xel-Ha, *Quero 2373* (MO); Yucatán: W of El Cuyo, among dunes, *Read et al. 79-012* (US); Mpio. Río Lagartos, cruce de playa Las Coloradas hacia Río Lagartos, *Orellana et al. 396* (CICY); Parque Natural Ría Lagartos, near Las Coloradas, *Leal & Espejel 205* (CICY); Mpio. Tizimin, road to El Cuyo, *Espejel & Ucán 200* (CICY); 6 km W of El Cuyo, *Ucán & Espejel 779a* (CICY); entrance to town of El Cuyo, 21°30'45"N 87°40'46"W, *Chan 5179* (CICY), 3 km E of El Cuyo, *Quero 2382* (MO); 8–10 km W of El Cuyo, 21°32'00"N 87°45'50"W, *Escalante 733* (CICY). NAVASSA ISLAND (USA). *Kiem & Pitt s.n.* (BH), E of the lighthouse, *Ekman H10802* (FTG, K, NY, S, US) PUERTO RICO. Mona Island: 0.8 km WNW of Uvero, *Proctor et al. 45905* (FTG). TURKS & CAICOS ISLANDS. East Caicos. Jacksonville, *Buden s.n.* (A); Middle Caicos, *Proctor 34073* (IJ). USA. Florida: locality unknown (probably Elliott or Long Key), *Curtiss s.n.* (A), locality unknown (sent to Beccari by Sargent), *Anonymous s.n.* (FI); Miami-Dade Co., Elliott Key, *Simpson 541* (GH), *Small & Nash s.n.* (NY), Mr. Filer's place, 19 Apr 1886, *Sargent s.n.* (A; photo BH), ca. 2 mi south of northern end, in dense thicket, *Ward & Ward 1579* (BH), *Small, Matthaus & Mosier 9499* (NY, US); Long Key, *Curtiss (?) s.n.* (A), near E end, high sandy hammock, *Small, Bailey, Matthaus 11592* (MO, NY), *Bailey & Bailey 6128* (BH, FTG), *Curtiss 5637* (BH, GH, K, MO, NY, US), Sands Key, hammock, *Small & DeWin Keller 10770* (GH, NY). CULTIVATED. BAHAMAS. New Providence, Nassau, garden, *Brace 381* (K, NY). CUBA. La Habana: Santiago de las Vegas (cultivated?), *Anonymous 343* (US); La Habana: Menocal estate, near Havana, *Bailey & Bailey 12532* (BH). DOMINICAN REPUBLIC. Prov. unknown: Arenoso near Santiago, *Bailey 311* (BH); Puerto Plata: Puerto Plata, (cultivated?), *Read s.n.* (FTG). MEXICO. Yucatán: Mpio. Río Lagartos, Río Lagartos, *Espejo et al. 4614* (CICY); Mérida, *Espinosa 2* (CICY), *Espinosa 18* (CICY), *Narváez 1171* (CICY), *Narváez 1322* (CICY), 21°01'30"N 89°38'30"W, *Simá 1710* (CICY). USA. Florida: locality unknown,

15. An enormous cultivated specimen of *Pseudophoenix vinifera*, Coral Gables, Florida, USA.

imported as adult trees from the Bahamas, *Hudson s.n.* (FI); Miami-Dade Co., Miami, *Franceschi s.n.* (FI), *Anonymous s.n.* (US), *Bessey s.n.* (FI), *Read s.n.* (BH), Hotel Royal Palm, *Andrews s.n.* (A), old Miami cemetery, *Dahlbert s.n.* (BH), Key Largo, *Read s.n.* (BH); Fairchild Tropical Garden, *Moore 5838* (BH), Moore 5839 (BH), *Moore 5840* (BH), plot 113, CA-1104B, *Hull H-15* (BH, FTG), 58-872 (transplanted from wild population on Elliott Key), *Sanders 1667* (BH), plot 88, P4059D, *Hull H-31* (BH, FTG), 58-872, *Read 759* (BH, FTG), RM1522B (source: Cuba), *Zona s.n.* (FTG), 53-198A, *Zona 828* (FTG), 60-171C, *Balick et al. 3382* (NY), 58-80D, plot 166, *Houghton 1376* (FTG), 60-171N, plot 189B, *Zona & Kernan 798* (FTG), RM1522C, plot 68, *Hull H-82* (FTG), 59-504, *Balick 3383* (NY), 60-171J, *Beck & Beck 1106* (FTG, NY); Monroe Co., Upper Matecumbe Key, *Small & Britton 9326* (BH), transplanted from Long Key, *Miller 1703* (US).

Read (1968, 1969) recognized several infraspecific taxa whereas a recent field guide (Henderson et al. 1995) recognize only one. Read himself (as quoted in Lippencott 1992) suggested that the infraspecific taxa do not deserve formal taxonomic rank, a suggestion endorsed here.

The taxonomic disposition of this, the most widespread taxon, is not uncontroversial. Some populations from small islands (Navassa, Gonâve, Saona) were previously recognized at some taxonomic rank, e.g., *Pseudophoenix navassana*, *Pseudophoenix gracilis*, *Pseudophoenix saonae*. Indeed these populations share a morphological trait – slightly larger fruits and seeds – that allow them to be distinguished from other populations of *P. sargentii*. Recognizing each island population as a distinct taxon seems misleading, as specimens cannot be readily distinguished from one another without knowledge of their geographic origin. Placing all of the populations in a single taxon is equally unsatisfactory, as such an action would imply that these island populations share a single common ancestor. In fact, these island populations are likely to have polytypic origins.

The characters of the inflorescence posture and length, along with primary bract length relative to the peduncle length, were employed by Read (1968, 1969). While there is certainly variation in these characters, the variation appears to have no geographic or population base. One population that I examined on Whale Key, Bahamas, had palms in which the inflorescence was either erect, horizontal or pendulous, and one-third to one-half as long as the leaves and in which the primary bract was one-half the length of the peduncle. Although this population corresponds to Read's *Pseudophoenix sargentii* ssp. *saonae* var. *saonae*, the bract length character alone corresponds to Read's *P. sargentii* ssp. *sargentii*. Quero (1981) noted similar difficulties in applying Read's taxonomic criteria to populations in the Yucatan Peninsula, Mexico.

On the northern coast of the Dominican Republic, near Sosua, *P. sargentii* has been extirpated by coastal development. (Zanoni 1986). Several populations of this species are endangered, one critically so. In Florida, small populations (Fig. 8) remain on Elliott Key (Lippencott 1992), where they are protected, but have been extirpated from Long and Sands Keys, where they once grew. In Mexico (Fig. 9), populations are threatened by coastal develop-ment and agriculture (Quero 1981, Durán 1995). The most seriously threatened population is that from the island of Navassa. Zanoni and Buck (1999) reported that *Pseudophoenix* on Navassa is now reduced to a single adult palm (Fig.10). Introduced goats prevent reproduction by eating seeds and seedlings. Unless immediate action is taken, this unique population will be lost in the wild (offspring from Navassa palms survive in cultivation).

*Pseudophoenix sargentii* is found in coastal habitats, although one site in southern Quintana Roo, Mexico, is more than 30 km inland (where the palm population is thought to represent relic populations along an ancient coastline) (Quero 1981). It occurs on limestone or dune sand over limestone in seasonally dry forest, tropical hammock, coastal scrub, etc. (Seifriz 1943, Ledin et al. 1959, Read 1968, Quero 1981). Under harsh conditions, it grows very slowly such that mature individuals have trunks less than 50 cm tall (Fig. 11). It grows easily but slowly in cultivation (Fig. 12), a situation which has contributed to the destructive practice transplanting wild specimens to gardens and landscapes.

**4. Pseudophoenix vinifera** (Mart.) Becc., Pomona Coll. Jour. Econ. Bot. 2: 268. 1912. *Euterpe vinifera* Martius, Hist. Nat. Palm. 1: t. ZII, F. 18, 19. 1845. *Cocos vinifera* Mart., Hist. Nat. Palm. 3: 324. 1853. *Gaussia vinifera* (Mart.) H. Wendl. in Kerchove, Palm. 245. 1878. *Aeria vinifera* (Mart.) Cook, Jour. Washington Acad. Sci. 13: 399. 1923. Type: Plumier t. 20, 21, ined.

> *Pseudophoenix insignis* Cook, Jour. Washington Acad. Sci. 13: 400. 1923. Type: Haiti, Dept. de L'Artibonite, Passe Reine, *Cook 28* (holotype: US!; fragment, BH!).

Stem 5–15 m tall, strongly ventricose, most slender above the swelling, gray, with prominent leaf scars when young. Leaves ca. 24 in the crown, spreading; leaf 2–3 m long; sheath 34–49 cm long, green with silvery gray scales near the apex; petiole 11–30 cm long; rachis 270 cm long, often with brown scales along its margin; leaf segments 115–131 per one side of the rachis; middle leaf segment 53–83 cm long, 1.7–3.1 cm wide, lanceolate with an acuminate tip, gray-green, glaucous abaxially, glaucous to glossy adaxially, ramenta present on the abaxial surface of the midvein at the base of the leaf segment. Inflorescence erect, ascending or arching, branched to 2 or 3 orders, ca. 125 cm long; peduncle down-curved, extending well beyond the leaf bases, glabrous; prophyll 102–156 cm long, ca. 8 cm wide, bearing dark brown scales along both edges (keels); inner bract ca. 50 cm long, bearing dark brown scales along both edges; rachillae 12.0–19.5 cm long and 1.5–2.6 mm diam., directed toward the apex of the inflorescence. Flower pseudopedicel (0.8–)2.5–4.4 mm long, 0.8–1.5 mm diam., green to glaucous; calyx a shallow triangular cupule, 3.1–5.9 mm diam., green to glaucous, margins hyaline; petals ovate, 6.4–8.9 mm long, 4.6–5.8 mm wide, green, glaucous abaxially, spreading, with ca. 24 major veins; filaments 4.2–5.1 mm long, basally connate forming a short staminal tube, anthers ovoid, 5.1–6.1 mm long, 2.4–2.9 mm wide, yellow; gynoecium (in bisexual flowers) 4.4–6.1 mm long, 2.5–3.7 mm diam. (pistillode in staminate flowers smaller), green. Fruit 17.6–23.7 mm long, 16.2–20.2 mm diam. (in single-seeded fruits); endocarp 15.2–16.9 mm long, 13.9–16.0 mm diam., 0.2–0.4 mm thick. Seed 11.1–14.7 mm long, 10.6–14.5 mm diam. (Figs. 7, 13–15)

DOMINICAN REPUBLIC. Azua: NE of Azua, between Azua and Estebania, 18°28′N 70°40′W, alt. 300 m, *Zanoni, Ramírez, & Peláez 15371* (NY); Barahona: El Jimi de Maygi, near Naranja, 7 km from Cabral on road to Polo, 18°11.535′N 71°14.631′W, *Zona et al. 739* (FTG); near Barahona, *Bailey 276* (BH); 1 mi W of Barahona, dry thickets, *Liogier 13607* (GH, IJ, NY); Independencia: hillside of Loma Grande, in Arroyo de Río Las Damas, 5.7 km from Puerto Escondido on road to Duverge, 18°20.5′N 71°32′W, alt. 350 m, *Zanoni & Pimentel 26455* (NY); 2 km N from Puerto Escondito, on road to Duverge, 18°22′N 71°32′W, alt. 425 m, *Gentry & Mejía 50807* (FTG, NY). HAITI. Locality unknown, *van Sterson s.n.* (K); *Anonymous s.n.* (FI); Artibonite: mountains 2–4 miles NE of Poteaux, 500 m elev., *Read 277* (BH); Passe Reine, *Cook s.n.* (US); Between Gonaïves and Ennery, *Cook 28* (US; frag & photo: BH); Poteaux, *Bailey 146* (BH); Centre: Morne Cabrit, elev. 2000 ft., *Cook s.n.* (US); Nord-Ouest: Valleé des Frois-Rivières, Port-de-Paix, Bassin Bleu, *Ekman H3977* (S); Ouest: ca. 2 mi S of Cabaret, *Read 276* (BH); Fond Chaleur, near Etang Saumatre, *Henderson & Aubry 1184* (NY); 3 km N of Source Matelas, *Zanoni, Mejía & Pimentel 33602* (NY); Ciment d'Haiti, along coastal road from Port-au-Prince to St. Marc, *Henderson, Aubry & Vaval 1039* (NY); Croix-des-Bronquets, Morne-à-Cabrits, elev. ca. 400 m, *Ekman H5496* (A, K, NY, S), *Ekman & Barker 5496* (EHH, photo BH); 15 mi N of Port-au-Prince, *Read 211* (BH). CULTIVATED. DOMINICAN REPUBLIC. Province unknown: Arenoso near Santiago, *Bailey 311* (BH); Distrito Nacional: Santo Domingo, Parque Eriquillo, *Zanoni et al. 11409* (NY); USA. Florida: Miami-Dade Co., Coral Gables, Fairchild Tropical Garden, 96-1416, *Zona 776* (FTG); Miami, Montgomery Botanical Center, 91-444A, *Zona s.n.* (FTG), Baker 1002 (FTG); Miami, USDA Plant Introduction Station, *Read 1397* (BH, FTG).

*Pseudophoenix vinifera* is distinguished from its congeners by its strongly bottle-shaped stem at maturity (Fig. 13), its distally directed rachillae and its triangular calyx (Fig. 7). In gross appearance, it most closely resembles *P. ekmanii*, but in aspects of the inflorescence, flower and fruit, it resembles *P. lediniana*.

*Pseudophoenix vinifera* occurs in dry forest, at 300–400 m elevation, in Haiti and the southwestern Dominican Republic. In the past, this species was much exploited for the sweet sap that was fermented into "wine" (hence the epithet "*vinifera*"). The palm is still occasionally used for this purpose, but past exploitation has so diminished populations that the practice seems to have diminished as well. In Haiti (Fig. 13), *P. vinifera* survives in only two populations: between Poteau and Passe Reine (Dep. de l'Artibonite) and near Source Matelas (Dep. de l'Ouest) (Henderson et al. 1990). In the Dominican Republic, scattered palms are seen in the southern part (Provs. Azua and Barahona), but nowhere are populations large (Fig. 14).

*Pseudophoenix vinifera* makes a striking ornamental palm and is occasionally cultivated by collectors and botanic gardens (Fig 15).

### Unplaced Specimen

Dominican Republic. Santiago Rodríguez: Los Quemados, west of Santiago de los Caballeros, *Read & Jiminez 199* (BH).

This specimen is identified as *Pseudophoenix vinifera*, but as such, it is anomalous for at least two reasons. While the fruit (immature) shape and aspects of the calyx suggest *P. vinifera*, the rachillae are divaricating, as in *P. sargentii*. Moreover, the collection site, in the province of Santiago Rodríguez, is far north of the known range of *P. vinifera* and too far inland for *P. sargentii*. The identity of this specimen must await the collection of additional materials from the same locality or vicinity.

### Excluded Names

*Palma americana* Miller, Gard. Dict. Abr. ed. 4. 1754. Miller's description of this species suggests *Pseudophoenix vinifera*, but the identification cannot be made with certainty. See Moore (1963).

*Pseudophoenix elata* Cook ex Burret, Sv. Vet. Akad. Handl. ser. 3: 21. 1929, *in syn*. Nomen nudum.

## Acknowledgments

Many persons have contributed to this project from its genesis to its completion. In particular, I thank D. Evans, D. Garvue, G. Guala, C. Hubbuch, C. Kernan, A. Legrá, A. Leiva, C. E. Lewis, K. Maidman, M. Mejía, C. Morici, K. Neugent, R. Orellana, M. Smith, R. Verdecia and L. Woodbury. Field work in the Dominican Republic was supported by Fairchild Tropical Garden; work in Mexico completed while on a grant from Cactus & Succulent Society of America. This paper is contribution 44 to the Program in Tropical Biology at Florida International University.

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# Horticulture Column

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**Q**. I need advice as to when and how I should transplant two *Copernicia baileyana* that need to be moved on my property. These plants were obtained seven years ago as 2-gallon container plants, they were planted in the ground four years ago, and the crowns now stand 1.5 m (5 ft) and 2.4 m (8 ft) tall. They are healthy plants growing in full sun. Judith Evans Parker, Miami, Florida.

**A**. Due to their slow growth rate and few roots, *Copernicia* species are not among the more tolerant of palms when it comes to transplanting. The ideal situation would be to wait and move these palms once visible trunk development begins. At this stage of growth, the root initiation zone has completed development and can produce new adventitious roots, which contributes to root system regeneration and speeds reestablishment following the move. Of course, trunk elongation in *Copernicia baileyana* generally occurs around 15–20 years of age. Your plants have a few years before developing the maximum diameter that precedes trunk elongation, and you have told me they need to be moved in the coming year.

How safe is it to transplant then? I asked Keith Lane for some help in answering this question. Keith has broad experience transplanting palms for his business and has moved a number of smaller *Copernicia baileyana*. Depending on their health and site, he says young specimens like yours can be successfully transplanted with good care. Your robust plants in full sun should be in good condition for moving. You should begin the process in the Spring, once it is warm and the rainy season has commenced (April–May in South Florida). Transplanting at this time makes the best use of the growing season for recovery. For best results, the palms will need careful root-pruning and digging, and you should get experienced help for the transplanting. To minimize root system disturbance, Keith root-prunes in one-quarter increments, generally spaced across two months at this time of year. Watering is necessary throughout this time, in addition to any normal rainfall. Other practices to emphasize in this situation: when digging for the move, depending on the soil, wet it thoroughly first to keep the root ball together, or wrap the root ball with wire. Remove one-third of the older leaves to minimize water loss. During the first six months, water the palm in its new site to keep the root-ball evenly moist but not saturated.

# Mycorrhizal Associations in Three Species of Palms of the Yucatan Peninsula, Mexico

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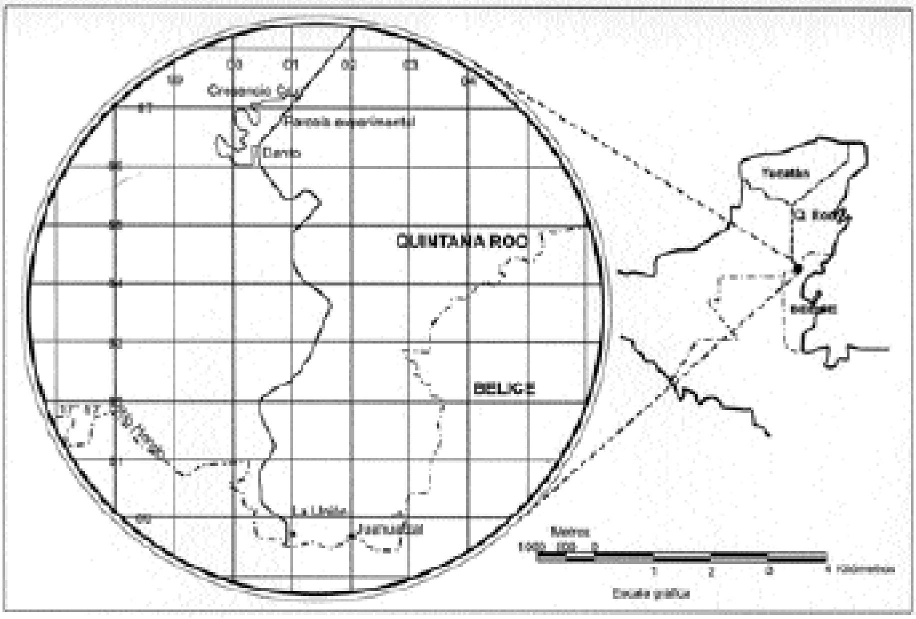


1. The study site at La Union, Quintana Roo, Mexico. The original vegetation in the area was evergreen tropical forest, but it currently is a disturbed zone.

**Known as the most perfect association in the world (Wilcox 1991), mycorrhiza is a symbiotic association between a fungus (symbiont) and the root of a vascular plant (host), from which both the fungus and the plant benefit.**

Different types of interactions exist in nature, which are able to change the relations of the plants with their environment; one of these is the association of mycorrhizal fungi with the roots of vascular plants. This association has been recorded since plants colonized the Earth in the Devonian period (Nicolson 1975, Raven et al. 1978, Simon et al. 1993, Remy et al. 1994). Mycorrhizal associations have been reported in more than 95% of living plant species examined (Salisbury and Ross 1994). For that reason it has been suggested that the mycorrhizal plants could be at an adaptive advantage over plants without mycorrhizal symbiosis, mainly plants that are under stress, either through nutrient deficiency, water stress or the presence of pathogens (Valdés 1989).

Vesicular-arbuscular mycorrhizal associations have been well reported in palms, such as *Cocos nucifera* L. (Johnston 1949), *Bactris gasipaes* Kunth (Janos 1977) and, more recently in some tropical palms (St. John 1988) and *Serenoa repens* (Bartr.) Small (Fisher & Jayachandran 1999) under natural conditions. Since it has been observed that the symbiosis is established shortly after the seed germinates, it has been suggested that mycorrhiza could bring some advantages for the establishment and development of seedlings (Read et al. 1976, Birch 1986, Jasper et al. 1989).

2. *Bactris mexicana,* species that only occurs in sites with humic soils and high humid conditions, as well as closed canopy.

*Desmoncus orthacanthos* Mart., *Bactris major* Jacq. and *B. mexicana* Martius have been traditionally used in some parts of Mexico and Central and South America to make hand baskets, hampers and other products (Quero 1992, Henderson 1993). Recently Orellana et al. (1999) considering the mechanical properties of their stems, which are very large, flexible and resistant, suggested these species could be used as potential substitutes for rattan.

*Bactris major* and *B. mexicana* grow slowly and their seedlings are difficult to establish. This fact is probably related to nutritional deficiencies not detected in the soil, or most likely, to the absence of the mycorrhizal symbiosis, which has been observed in these species in natural conditions.

It is necessary to develop basic knowledge to determine the degree of mycorrhizal infection in natural conditions. Such knowledge could be used to improve the establishment procedures of seedlings of palm species, making their management and production more efficient.

## Study site

The rhizosphere soil samples were taken from December 1995 to March 1996, in an area of evergreen tropical forest at La Unión, in southern Quintana Roo, México (Fig. 1). The climate is $Aw_2(x')$ according to the modified Köppen classification (García, 1988) warm and subhumid with precipitation during the summer season. Average total precipitation is from 1200 to 1500 mm; the mean annual temperature is 24.8ºC. The vegetation type according to Miranda (1958) and Granados (1995) is semi-evergreen tropical forest, and the dominant species are *Manilkara sapota* (L.) Van Royen (Sapotaceae), *Bucida buceras* L. (Combretaceae) and *Cryosophila stauracantha* (Heynh.) R. Evans (Arecaceae), as well as some deciduous species such as *Alseis yucatanensis* Standley (Rubiaceae), *Aspidosperma megalocarpon* Muell. Arg. (Apocynaceae), *Swartzia cubensis* (Britton & Wills) Standley (Leguminosae), *Vitex gaumeri* Greenman (Verbenaceae) and *Pseudobombax ellipticum* (Kunth) Dugand (Bombacaceae).

3. *Desmoncus orthacanthos*, a climbing palm in its natural habitat; stem lengths can reach more than 30 meters.

*Bactris major* inhabits wetlands at their edges and their populations form large associations called locally "jahuactales."

*Bactris mexicana* (Fig. 2) only occurs under a set of very specialized habitat conditions since it requires old and conserved vegetation or evergreen tropical forest in sites with humic soils and high humid conditions, as well as a closed canopy with low solar radiation. Currently, the populations of *Bactris mexicana* have been affected by forest exploitation for cattle settlements and agriculture in the area, and it is considered a locally endangered species.

*Desmoncus orhacanthos* (Fig. 3) develops inside the tropical forest as well as in secondary vegetation and disturbed areas around the forest, principally along the side of roads. In those sites, we observed that their stem lengths can reach more than 30 meters.

## Materials and methods

Rhizosphere and root segments of ten individuals of approximately the same size were collected from the three species of palms. Samples were collected during late autumn in December 1995 (rainy season) and early spring in March 1996 (dry season). For every specimen several segments of roots were collected and approximately 1000 g of topsoil (10–20 cm in depth). Five additional soil samples were collected from the rhizosphere of the plant specimen and were transported to the laboratory for subsequent analysis. The root segments were transferred to vials with formalin/acetic acid/alcohol (FAA) for preservation, until they could be examined for the presence of vesicular arbuscular mycorrhizae VAM.

Samples were processed with a modified Phillips and Hayman conventional method (1970) (washing roots with running water along 24 hours before the time-clearing and adjusted it to 25 minutes). The colonization percentage was evaluated according to the method suggested by Giovannetti and Mosse (1980); observations were made using a stereoscope. Spores were extracted according to the Gerdeman and Nicholson (1963) extraction and decantation method and the Sieverding and Toro (1983) sucrose gradient method. Spore determinations were done following the Shenk and Perez's (1990) handbook for mycorrhizal VAM fungi spore identification. Vouchers and stains were deposited in the YUC herbarium.

## Results and discussion

### *Stained root analysis.*

Judging from the results obtained, we determined the association present in the roots of the three palm species to be of the VAM type. Both, vesicules (Fig. 4) and arbuscules (Fig. 5), the typical structures in this kind of association, were observed in the inner cortex of the second and third order roots.

The presence of mycorrhiza in the three palm species was observed consistently in all samples.

**Table 1. Comparison analysis of infection percentages for every palm species between the two contrasting seasons: dry (D) and wet (R).**

| Species | Mean % R) (D) | P | Significantly different |
|---|---|---|---|
| *Bactris major* | 70.5–63.4 | 0.0690 | No |
| *Bactris mexicana* | 51.3–32.9 | 0.0001 | Yes |
| *Desmoncus orthacanthos* | 52.0–30.6 | 0.0012 | Yes |

**Table 2. VAM species obtained in each soil sample associated with palm species.**

| VAM species | *B. major* | *B. mexicana* | *D. orthacanthos* |
|---|---|---|---|
| *Acaulospora scrobiculata* | X | X | X |
| *Glomus geosporum* | X | | X |
| *Glomus* sp. 1 | X | X | |
| *Glomus* sp. 2 | X | X | |
| *Gigaspora margarita* | X | | |
| *Scutillospora* sp. | X | | |

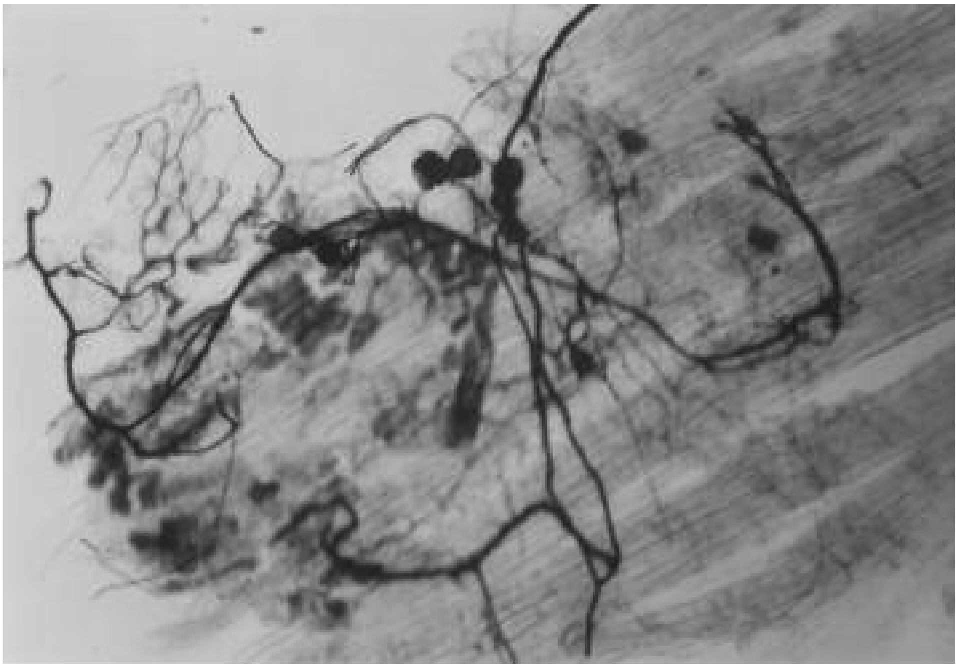
**Table 3. Density analysis of three palm species. (Density = spore number per gram of soil). P= probability of a significant difference in spore number between wet and dry seasons (a= 0.05).**

| Palm species/VAM species | Wet season | Dry season | P |
|---|---|---|---|
| ***Bactris major*** | | | |
| *A. scrobiculata* | 68.5 | 54.6 | <0.0001 |
| *Glomus geosporum* | 36.5 | 35.0 | 0.8798 |
| *Glomus* sp. 1 | 37.5 | 36.9 | 0.66 |
| *Glomus* sp. 2 | 44.1 | 16.5 | <0.0001 |
| *Gigaspora* sp. | 0.5 | 0.0 | 0.28 |
| *Scutellispora* sp. | 7.8 | 3.2 | 0.0042 |
| ***Desmoncus orthacanthos*** | | | |
| *A. scrobiculata* | 47.5 | 62.5 | <0.0001 |
| *Glomus geosporum* | 20.0 | 62.5 | <0.0081 |
| ***Bactris mexicana*** | | | |
| *A. scrobiculata* | *61.6* | *48.9* | <0.0001 |
| *Glomus* sp. 1 | 25.5 | 23.4 | 0.53 |
| *Glomus* sp. 2 | 26.0 | 15.5 | 0.06319 |

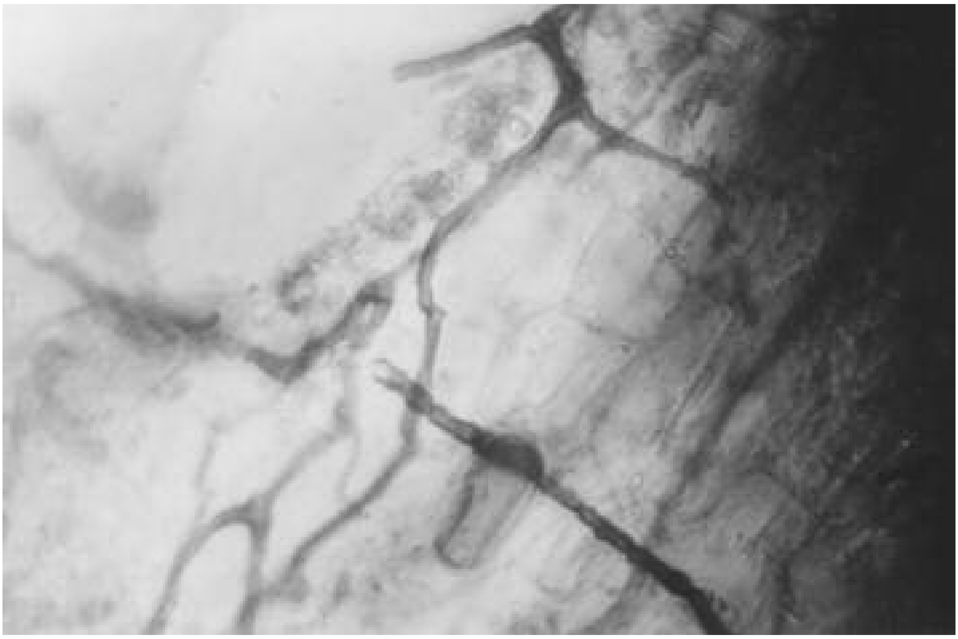
This fact suggests that this association is necessary or even indispensable for optimal development of the palm species. The latter suggestion is possible since the chemical analyses (Olsen's P test for alkaline soils) of the soil samples collected in the field indicated a poor soil. This soil was particularly poor in phosphorous (P, 11 ppm), a key mineral for the proper development of the plants and a mineral that influences mycorrhizal infection (Varela & Estrada-Torres 1999). Under conditions in which P is not limiting for the development of plants, colonization by mycorrhiza is limited; when conditions are low in P abundant colonization might be produced (Hayman 1983). Furthermore, it has been shown that P above its optimum level for the growth of a plant renders colonization by mycorrhiza reduced or absent (Siqueira 1988). It has also been shown that there exists a negative association between the concentration of available P and the presence of fungi of the arbuscular type (Morita and Konishi, 1989). At the same time, vesicular-arbuscular mycorrhiza are of the type found in the evergreen tall forest where the three palm species grow. This habitat type has been suggested by Read (1983, 1984) as the ideal for arbuscular mycorrhiza to occur.

### *Colonization percentages*

Applying the Giovannetti and Mosse (1980) method to determine the mycorrhizal infection percentage in palm roots, we obtained the



4. Vesicules and mycelium on *Bactris major* roots stained with trypan blue, according to the Phillips and Hayman method.

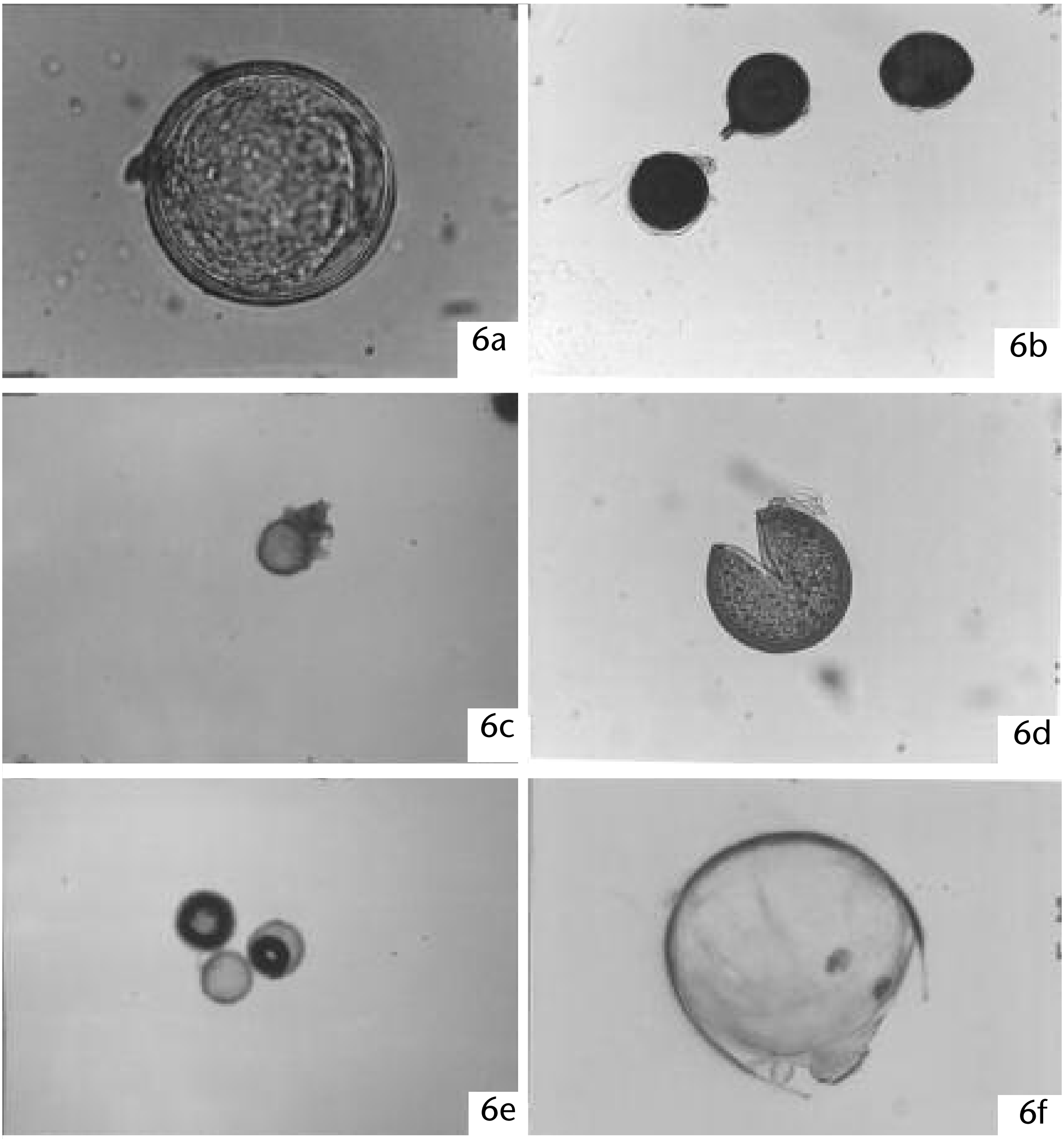


5. Arbuscules in root cortex cells of *Desmoncus orthacanthos*.

following figures for the taxa involved in the study: *Bactris major* = 62%; *Bactris mexicana* = 42%; *Desmoncus orthacanthos* = 51%.

The results obtained (40–60% percentage of colonization) suggest an intermediate level of dependence of the association. When colonization percentages are higher than 75%, total dependence on association is suggested (Bethlenfalvay et al. 1984). The intermediate dependence level encountered seems to suggest that the presence of mycorrhizae confers more benefits on the palm species than mere absorption of nutrients. Such advantages could be resistance to pathogens present in the soil and increased resistance to water stress during times of drought and waterlogging.

Table 1 shows the statistical analysis of the results. During the rainy season there are no significant differences regarding the degree of colonization between the three palm species. However, during the dry season, there are differences in the colonization percentage between species, possibly



6. Species of mycorrhizal fungi. 6a. *Acaulospora scrobiculata* (40×). 6b. *Glomus geosporum* (20×). 6c. *Glomus* sp. 1 (20×). 6d. *Glomus* sp. 2 (20×). 6e. *Scutellispora* sp. (20×). 6f. *Gigaspora margarita* (20×).

due to the lower density of spores in the rhizosphere and resultant lower colonization.

We can explain differences between the three types of soil: for *Bactris major* the soil remains flooded for most of the year, providing the spores a suitable environment year round to germinate and achieve quickly complete symbiosis before they die. This way, colonization percentages are steady year round. *Bactris mexicana* and *Desmoncus orthacanthos*, on the other hand, grow in a soil with humidity level fluctuations (according to season), which affects the mycorrhizal infection intensity.

*Determination of VAM species.*

From the rizosphere we obtained samples of six species belonging to four genera (see Fig. 6): *Acaulospora scrobiculata* Trappe (6a), *Scutellispora* sp (6e), *Gigaspora margarita* Becker & Hall (6f), *Glomus geosporum* (Nicolson & Gerdemann) Walker (6b), and two more species of the genus *Glomus*, not determined to species level (*Glomus* sp 1 (6c) and *Glomus* sp 2 (6d)). Table 2 shows the distribution of the VAM morphospecies that were obtained in the palm rhizospheres. In the soil samples of *Bactris major* there were all morphospecies, while in *Bactris mexicana Acaulospora scrobiculata* and the two *Glomus* spp were present. In the *Desmoncus orthacanthos* soil samples only *Acaulospora scrobiculata* and *Glomus geosporum* were found.

### *Spore density*

Table 3 shows clearly that the density of the spores, which depend on the environmental conditions at the time when we obtained the samples, were more abundant in the wet season than in the dry season. It is important to mention the high number of spores per g of soil found when compared with other tropical studies (2–10 spores /soil g), reported by Gay et al. (1982) and Sigüenza et al. (1996).

The high density of *Acaulospora scrobiculata* and *Glomus geosporum* suggests that these species could be more competitive or have greater affinity with their hosts, especially *Acaulospora scrobiculata*, which is present in the rizosphere of all palms and has the highest densities; it is important to consider that spores of *Acaulospora* have a wide range of adaptation to different conditions of the soil, such as fertility and stage (Siqueira 1988). This characteristic could explain the abundance and distribution of *Acaulospora scrobiculata* with respect to the other VAM species obtained.

It is important to mention that the area where the rhizosphere samples for *Bactris major* were taken from remains flooded for close to half of the year. Since all the mycorrhiza species identified were found in association with *B. major*, while only a fraction of the spore taxa grew consistently associated with the other two palm species, we assume that the local spore load is causing the floods prevalent in the soils where *B. major* grows.

On the other hand, since high levels of parasitism (mainly by pathogenic fungi) were detected in the spores of mycorrhizal fungi associated with all samples of *Bactris major*-associated soil. However it is apparent that "massive sporulation" (spore load carried by the heavy rains) is a successful strategy for survivorship under the conditions where *B. major* grows.

## Conclusions

From the previous data, we conclude the following for the cases of all three palm taxa involved in the study:

The mycorrhizal association that occurs in palm roots is of the vesicular-arbuscular type (VAM), also called arbuscular mycorrhizae (AM).

The rhizophere associated with *Bactris major* has the greatest abundance and heterogeneity of VAM fungi. The largest infection percentages occur in *Bactris major.* Even during the dry season, infection percentages of the root are high. *Desmoncus orthacanthos* and *Bactris mexicana* showed lower infection percentages than *Bactris major.* This last species did not show significantly different infection percentages when the two seasons of the year are compared, as opposed to the findings in the other two taxa, where infection percentages were larger during the rainy season.

*Acaulospora scrobiculata* spores were found in the soil samples associated with all three palms.

## Acknowledgments

This investigation was financed by the United States Man and the Biosphere Program OES / EGC / MAB, Department of State, Washington D.C. (MAB-RATTAN-117); we are indebted to Roger Sales. We are also indebted to Ingrid Olmsted and German Carnevali (CICY) for their helpful comments and assistance in English and to an anonymous reviewer.

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# *Dypsis* 'stumpy'

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1. *Dypsis carlsmithii*: transplanted, Hawaii (Photo: Bill Langer).

**A spectacular massive palm, found growing in a private garden in Hawaii, has flowered and fruited, providing seeds that have been widely distributed. For long known as *Dypsis* 'stumpy,' it is described here as a new species.**

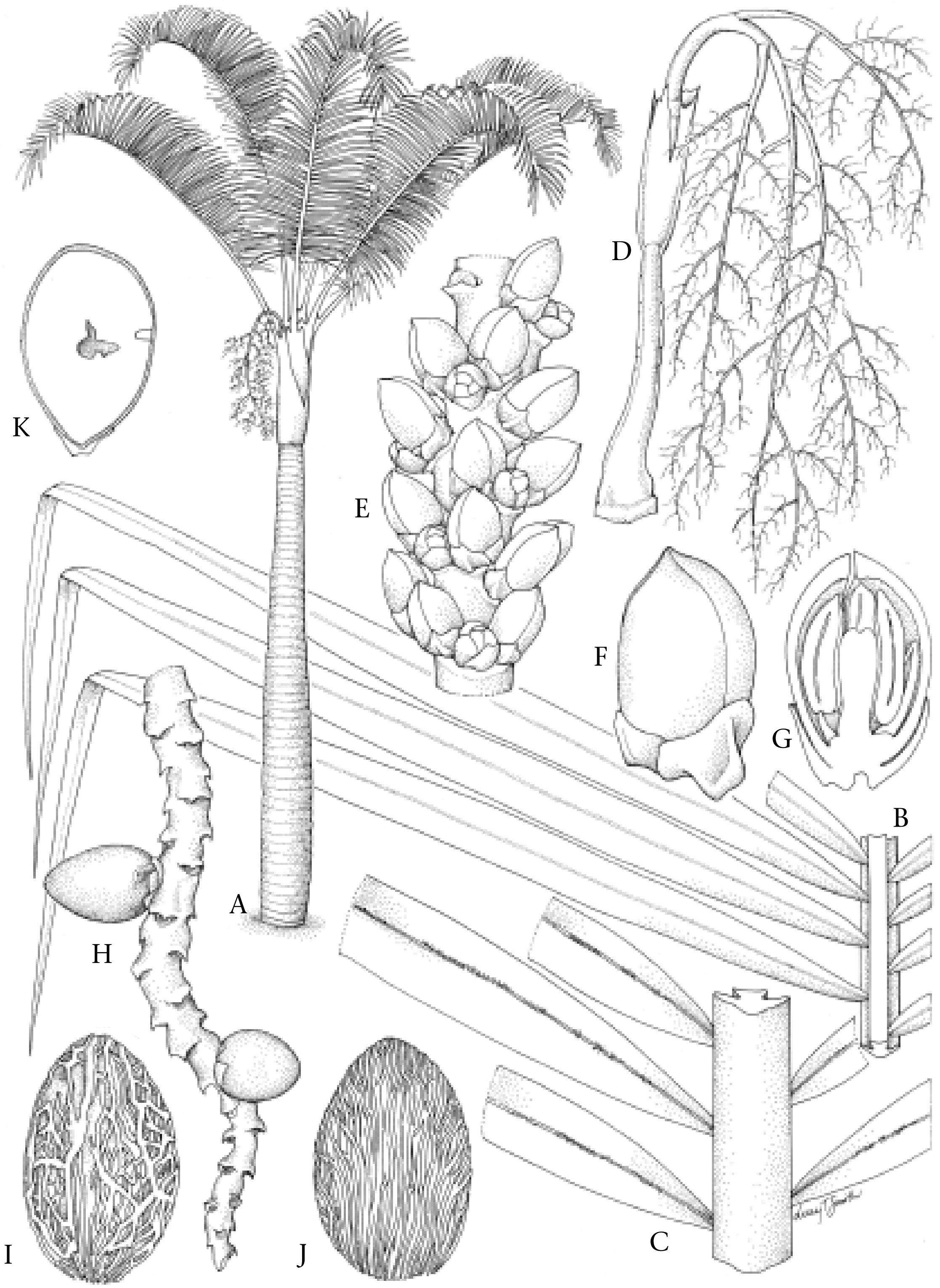
Over the past three decades there has been an almost insatiable demand for seeds of Madagascar palms. Seeds of even common, widespread species such as *Dypsis lutescens* and *D. madagascariensis* continue to be harvested in the wild and exported in large quantity, and seeds of many other species are widely available. Of course, there are often problems in identifying palms from their seeds alone, particularly in the case of large genera in which palms of markedly different vegetative appearance may have seeds that are virtually indistinguishable. Some of the seeds leaving Madagascar are undoubtedly correctly named. They have flowered and fruited and seem to belong to the designated species. Others, however, are either incorrectly named (not surprising given the problems mentioned above) or carry just nicknames. Sobriquets such as 'slick willy', 'mealy bug' and others are widely used by growers needing reference points when the scientific name is uncertain. In many instances there is absolutely no way of telling where in Madagascar the seeds were collected, information that might help in narrowing down the identity. When asked to try to identify such mystery plants, it has always been easy to say "Wait until it flowers and fruits and then let us know – we should then have little difficulty in naming it."

When Palms of Madagascar was published (Dransfield & Beentje 1995), we hoped that the identification of these mystery palms would immediately become possible, but, of course, this was not the case. In the Carlsmith Estate near Hilo on the island of Hawaii grows one such palm (Figs. 1–5), clearly a *Dypsis* and thus almost certainly from Madagascar. One of us (JM) knew the palm well and had dubbed it (in the days before Palms of Madagascar was published) *Chrysalidocarpus* 'stumpy' – or *Dypsis* 'stumpy' as we should really call it. However, it proved impossible to key out with certainty in Palms of Madagascar. The palm fruits regularly and has been used as a source of seeds, so *Dypsis* 'stumpy' is beginning to be known among palm enthusiasts, and it seems important that its botanical identity should be established. JM sent material to JD at Kew in the hope that a name would be easily provided but, despite JD trying hard to squeeze it into the variability of known species, it has become obvious that it represents an undescribed taxon.

There is something rather unsatisfactory about describing a palm from cultivated material without knowing precisely whence the palm came. Given the circumstances of rather un-controlled palm seed collection from all over the island, we feel sure that this will not be the only undescribed taxon to be introduced into cultivation. There is, of course, already a precedent in the genus *Dypsis* for naming species from cultivation. *Chrysalidocarpus cabadae* (= *Dypsis cabadae*) was described from palms cultivated in the Caribbean and now well known in cultivation but still not known in the wild. *Neodypsis leptocheilos* (= *Dypsis leptocheilos*) was described from material cultivated in Tahiti and only very recently has a herbarium collection been made in the wild (Dan Turk, pers. comm.), and *Chrysalidocarpus glaucescens* was described from plants cultivated in Trinidad. This last name is currently regarded as a synonym of *D. lutescens.*

**Dypsis carlsmithii** J. Dransf. & J. Marcus **sp. nov.**, palma robusta compacta inter species arborescentias solitarias, foliolis numerosis regulariter dispositis, inflorescentia interfoliacea ramosissima, rachillis gracilibus brevibusque, endospermio homogeneo differt. Typus: Hawaii, Hilo, in horto Don Carlsmith, *J. Marcus s.n.* (Holotypus K).

Single-stemmed palm. *Stems* to 6 m tall, ca. 51 cm diam. at breast height, decreasing distally to ca. 40 cm diam. below the crownshaft; internodes ca. 10 cm long. *Mature leaf* curved and with a slight twist; *sheath* 140 cm long, ca. 80 cm wide when opened out, adaxially reddish brown, abaxially green to mid-brown with some wax and sparse scattered scales, with triangular lobes at the sheath mouth; petiole 45 cm long, proximally ca. 12 cm wide, distally 9 cm, abaxially waxy, abaxially convex, adaxially deeply grooved and with sharp margins; rachis ca. 3 m long, in mid-leaf 6 cm wide, abaxially with scattered scales, adaxially with a few scales, adaxially keeled, abaxially rounded; leaflets ca. 90 on each side of the rachis, regularly arranged, at intervals of ca. 4 cm, proximal ca. 90 × 3 cm, median ca. 92 × 4 cm, distal ca. 25 × 2 cm, adaxially glabrous or nearly so, abaxially with conspicuous crowded dark brown ramenta, main vein 1, apices attenuate. *Inflorescence* interfoliar, branched to 3–4 orders; peduncle ca. 3.5 m long, proximally 7 cm wide, distally 6 cm wide; prophyll at least 40 cm long, borne at ca. 60 cm above the base of the peduncle, glabrous or nearly so; peduncular bract inserted at 90 cm from the base of the peduncle, not preserved; rachis ca. 1 m long, with ca. 19 first order branches, the proximal of these with a secondary rachis of up to 70 cm long and 25 mm diam. at base, with very numerous rachillae; rachillae 6–8 cm long, 1.5–2 mm diam., glabrous, bearing short triangular bracts to 1 × 1.5 mm. *Staminate flower buds* 3.2 × 2.2 mm; sepals rounded-triangular, keeled and irregularly gibbous, 1.5 × 1.5 mm; petals 2.8 × 1.8 mm, minutely connate basally; stamens 6 with filaments 1.5 × 0.2 mm, inflexed at tip, anthers elongate, 1.9 × 0.9 mm, the connective ca. 0.2 mm



2. *Dypsis carlsmithii*: **A** habit ×ca.1/100; **B** mid portion of leaf viewed from above ×1/6; **C** leaflets viewed from below ×1/3; **D** dry inflorescence ×1/50; E detail of rachilla ×4; **F** staminate flower ×10; **G** staminate flower in section ×10; **H** detail of rachilla in immature fruit ×2; **I**, **J** seed ×2; K seed in section ×2. Drawn by Lucy T. Smith.

3 (upper left). *Dypsis carlsmithii*: details of crown. 4 (upper right). Details of crown showing dead inflorescence. 5 (lower left). Details of crown with fresh inflorescence, photographed before the palm was transplanted. 6 (lower right). Detail of trunk (all photos by Bill Langer).

wide, brown; pistillode columnar, 3-grooved, 1.5 × 0.5 mm. *Pistillate flowers* with sepals 1.5 × 1.5 mm; petals ca. 1 × 1 mm; staminodes at least three, toothlike, ca. 0.1 mm long; ovary ca. 1.2 mm diam. *Fruit* irregularly ovoid-ellipsoid, 16 × 9 mm, with stigmatic remains eccentrically apical; epicarp smooth, black; mesocarp thin fleshy; endocarp covered with a loose layer of broad anastomosing fibres. Seed 13 × 8 mm, endosperm homogeneous; embryo lateral. (Fig. 2).

SPECIMEN SEEN. HAWAII. Cultivated in the Carlsmith Estate, Hilo, December 1996, *J. Marcus s.n.* (Holotype K).

In *Palms of Madagascar* (Dransfield & Beentje 1995) this species keys out to the two couplets that include *Dypsis saintelucei, D. tsaravoasira* and *D. nauseosa*. It differs from the first two in having ruminate endosperm while from the last it differs in having much shorter, more slender rachillae. *Dypsis tanalensis*, an incompletely known taxon, is mentioned also at this point in the key, but this also has a ruminate endosperm. In general appearance *D. carlsmithii* does not resemble any of these. In some ways the inflorescence resembles that of *D. prestoniana* and *D. tokoravina*, but these two are even more robust and have fascicled leaflets.

## Acknowledgments

We should like to thank Don Carlsmith for access to his garden and permission to sample the spectacular palm that now bears his name. Lucy Smith prepared the analytical plate and Bill Langer took the photographs.

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