PRINCIPES

Journal of The Palm Society

April, 1981
Vol. 25, No. 2

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Cover Picture

The smallest of the elfin chamaedoreas of the Costa Rican montane forests at Las Cruces Tropical Botanical Garden. See page 49 and Figure 5. Photo by Walter H. Hodge.

PRINCIPES

JOURNAL OF THE PALM SOCIETY
(ISSN 0032-8480)

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

Subscription price is $9.00 per year to libraries and institutions. Membership dues of $15.00 per year include a subscription to the Journal. Single copies are $3.00 each. The business office is located at **P.O. Box 368, Lawrence, Kansas 66044.** Changes of address, undeliverable copies, orders for subscriptions, and membership dues are to be sent to the business office.

Second class postage paid at Lawrence, Kansas

Mailed at Lawrence, Kansas
June 12, 1981

Principes, 25(2), 1981, pp. 47–53

Finca Las Cruces, a Costa Rican Garden

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For the palm enthusiast, whether amateur or professional, one of the most interesting new gardens to visit in the tropics is Finca Las Cruces or the Las Cruces Tropical Botanical Garden, situated in southern Costa Rica, close to that country's frontier with Panama. Finca Las Cruces is the residence of Bob and Catherine Wilson, horticulturists extraordinary and longtime members of The Palm Society. Their pleasant tropical garden home is located at about 4,000 ft elevation in an area formerly covered with montane rain forest. Finca Las Cruces thus offers a climate ideal for the successful culture of wet tropical palms, and especially representatives of such neotropical genera as *Bactris, Chamaedorea, Euterpe, Geonoma, Iriartea,* and *Socratea.* Certain of these taxa are native to Puntarenas, the Province in which Las Cruces is situated. Indeed one of the pleasures of a visit to this garden is that one can enjoy not only its collections of cultivated plants but also the rich flora of the adjacent forests.

The Wilsons, formerly active in commercial horticulture in the Miami area, "retired" to Costa Rica to live and to develop a new tropical botanical garden on a portion of a 336-acre plot acquired in 1962 near the village of San Vito de Java. Their new home and developing garden, overlooking the Talamanca Mountains, occupy about 50 acres of their property; the remainder has been left as a natural forest preserve. The latter has not been allowed to lie unused for its biota has been the subject of continuing teaching and research by scientific groups sponsored by the Organization for Tropical Studies (OTS). This consortium of American Universities, which maintains several field stations in Costa Rica, was "created to promote an understanding of tropical environments and their intelligent use by man."

To facilitate such studies at Las Cruces a Science Building, donated by the late Stanley Smith, was constructed in 1967. This facility, designed specifically for the needs of OTS, offers simple but comfortable accommodations for 32 people in its dormitory, dining, living, and laboratory areas.

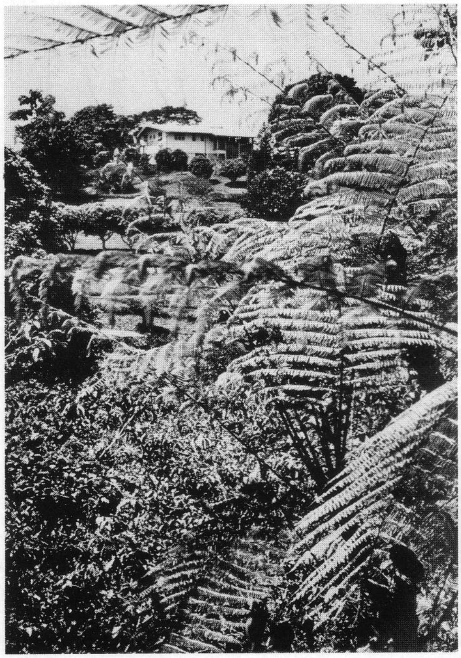
The Wilsons' garden has come a long way in the 18 years since the land was acquired, with a home and small power plant constructed and land cleared for botanic garden plantings. Special horticultural facilities including a lath and glasshouse for plant propagation have been erected; steep hillside pathways—contoured and drained for erosion control—have been laid out; while throughout the garden appropriate trees have been planted to either protect shade-loving plants or to serve as host trees for orchids, bromeliads, and specimens of other epiphytic groups maintained at Las Cruces.

1. Bob and Catherine Wilson (and *Heliconia wagnerana*) in their garden at Finca Las Cruces.

The palms early attracted the Wilsons as one of the important groups that should be featured. They recognized that the tropical rain forest palms could not be grown satisfactorily in most established North American gardens where these plants were featured. This was an easy task as they could start with the native Costa Rican forest palms. Mature specimens of the genera *Bactris*, *Chamaedorea*, *Euterpe*, *Geonoma*, *Hyospathe*, and *Prestoea* were already to be found as natives on their property.

Additionally, seed of exotic palms, obtained primarily from The Palm Society's Seed Bank as well as from individual collectors, produced juvenile specimens that soon crowded the garden's small plant houses. By 1974 over a thousand seedling palms, representing about 250 species in 83 genera, had been established in containers. Many of these are now growing in their permanent positions in the garden. *Arenga engleri*, *Bactris gasipaes*, *Euterpe macrospadix*, *Sabal umbraculifera*, and *Trachycarpus fortunei* are among species that have already developed into fine mature specimens. The last-named species seems to thrive just as well in the wet Las Cruces tropical climate as it does cultivated in such unusual cool temperate garden locations as Vancouver, Tokyo, Edinburgh, or Kalmar (Sweden)!

Whereas larger palms are to be seen set out throughout the Las Cruces Garden, there has been developed a special group planting of dwarf forest palms. These include, among others, species in the genera *Asterogyne*, *Chamaedorea*, *Geonoma*, *Neonicholsonia* and *Reinhardtia*. A number of these are characteristic understory palms of Central American rain for-



2. The Wilson home as seen from under some of their tree ferns.

3. *Arenga engleri* flowering at Las Cruces.

ests, and several of the most interesting species are endemic in the nearby forests.

These dwarfs include several still unnamed taxa of *Chamaedorea.* They must certainly be among the world's most diminutive palms. One of them is essentially stemless, with leaves arching to no more than a hand high, in size a far cry from the more familiar cultivated chamaedoreas. In nature these elfin palms with their arching pinnate leaves superficially resemble small terrestrial ferns, but the colorful fruiting spikes of jet black fruits on bright orange stalks show immediately, when they appear, that these are tiny palms and not pteridophytes.

As might be expected, these rain forest elves are proving to be exciting horticultural as well as botanical finds. However, with forest destruction now rampant in Costa Rica—as elsewhere throughout the tropics—such highly specialized palms which cannot survive forest destruction, would seem to be already in the class of endangered species. It is to be hoped that these unique palms, like their more familiar cousin, the popular *Chamaedorea elegans,* may eventually find permanent refuge as successful ornamentals either for the outdoor garden or as pot or terrarium subjects in the home.

Among other Costa Rican palms threatened by man—but for quite a different reason—is the local cabbage palm, *Euterpe macrospadix.* This stately (60′–70′) solitary palm with its conspicuous green crownshaft was once a familiar and dominant tree of the montane crests and ridges of the cloud forest belt. Like most species of *Euterpe,* the tender bud yields one of the tastiest of all palm cabbages, (the

4. *Asterogyne martiana*, an attractive understory palm of Central American rain forests, growing in the Wilsons' garden.

5. A ground cover planting of elfin chamaedoreas at Las Cruces.

"palmito" of Spanish America), and this fact has been its undoing.

Alexander Skutch, distinguished naturalist and long-time resident of Costa Rica, has recorded (Skutch, 1971—"A Naturalist in Costa Rica") what is happening to this once abundant species: "It is the palmito's misfortune [to be] . . . much sought by the local people at all seasons, but especially at Easter, when the rivers are bombed and poisoned and the forest despoiled to furnish the fish and 'palm hearts' for the traditional festivities. Sorrowfully, I step over many a fine, columnar trunk that lies rotting athwart the path, cut by trespassers. The growth of a century, the most elegant adornment of the forest, has been ruthlessly sacrificed for as much food as might be grown in a few months on a square foot of garden

6. Another dwarf *Chamaedorea* of the Punta de Arenas montane forest.

soil." And further, describing what has happened in the formerly isolated valley where he resides, Dr. Skutch adds: "One of the largest remaining tracts of forest in the valley is that of a hundred acres or so on this farm, which for nearly thirty years I have tried to preserve in its pristine state. What has happened to it will serve as an example of what has happened to the remnants of forest everywhere in the valley, for I am certain that none has fared better. The most obvious change is that thousands of tall palmitos have vanished—stolen. These elegant palms left enough seedlings to restore the stand, after many years, if they were permitted to grow undisturbed. But as soon as one becomes an inch thick, some trespasser comes along and slashes off its head for the few mouthfuls of food at its 'heart' or growing point. With the exhaustion of the palmitos, thieves have begun to attack the even taller chonta palms [*Bactris*], which formerly were neglected because their young tissues are bitter. Why not catch the thieves and get a judgment against them? One unfamiliar with heavy tropical forest can hardly imagine how difficult it is to learn what is happening a few hundred yards away. Two full-time watchmen would be required to properly guard even so small a tract as this. And who would watch the watchers?"

Fortunately at Finca Las Cruces the growth rate of *Euterpe macrospadix*—as well as certain other palmito-producing euterpes—is being informally studied. The idea is to learn whether this economically important palm might serve as a potential new crop plant for the montane rain forest areas of Central America. It is conceivable that palmito-producing species, if fast

7. A ground cover display of the preceding palm.

8. A white-fruited forest palm, *Synechanthus warscewiczianus*, at Las Cruces.

enough growers, could be regularly harvested for the edible cabbage. Thus they might then take their place along with the pejibaye, *Bactris gasipaes*, which is widely grown in Costa Rica for its starchy fruits.

Besides the palms grown at Las Cruces as garden specimens, there are also the wildlings, approximately a dozen species of native palms, which may also be of interest to the visitor. An informal descriptive list of these palms has been prepared by Hal Moore for the use of visiting students. Besides the species already mentioned (*Euterpe* and the dwarf chamaedoreas) this list includes: *Synecanthus warscewiczianus*, two geonomas (*G. gracilis* and *G. interrupta*) and a species in each of the genera *Bactris*, *Hyospathe*, and *Prestoea*.

Although the palm collection at Las Cruces may be of primary interest to readers of PRINCIPES, it should be emphasized that they are but one of a broad spectrum of plants to be seen in the Wilsons' garden. Actually there are about 5,000 species growing at Las Cruces and these represent some 600 genera in over a hundred plant families. Particularly well represented are the Araceae, Bromeliaceae, Cycadaceae, Gesneriaceae, Heliconiaceae, Marantaceae (especially *Calathea*), Musaceae, Orchidaceae, and Zingiberaceae. The ferns and their allies are also prominent with tree ferns making an especially fine display in what is essentially excellent tree fern country. Over 500 specimen tree ferns grow in the garden. They represent two dozen species, half of which are local natives. This fact focuses on one of the great values of Finca Las Cruces as a horticultural center: its emphasis on acquiring, growing, and evaluating native Costa Rican and Central American plants as potential garden subjects rather than simply duplicating in its collections tropical plants that are already widely grown in most tropical gardens.

As the plantings at Las Cruces mature, they will certainly attract increasing numbers of plant lovers, whether amateur or professional. After all, the garden is no farther away from Miami than is Chicago, Dallas, or New York. And once the visitor is in San José he can reach the Garden in a day's bus trip south along the fascinating Pan American highway, or in less than an hour by a small Cessna plane which skims over the rugged mountain crests in a dawn flight that ends at the little airstrip at San Vito de Java.

PALM LITERATURE

DRANSFIELD, JOHN. A Manual of the Rattans of the Malay Peninsula. 207 pp. Malayan Forest Records No. 29. Forest Department, Ministry of Primary Industries, Malaysia.

Comfortably reclining in a rattan chair, thoughts of tropical forests seep up through the arm rests and seat. Each piece of this light-weight and durable chair started off as a spine-covered climbing palm from Southeast Asia. Imagine that the original stem was 30 m tall and 185 m long! A rattan collector braved the spines and associated ants, yanked the stem from the treetops, stripped off the leaf sheaths, cut the stem into 3-m long sections, and carried the sections to the local rattan processor who promptly boiled them in oil. Some of the sections were split into strips for weaving and others had their silicified epidermis removed. Local food vendors used some of the strips to tie up their bundles, the collector saved a piece to replace the painter on the family dugout, and the rest was exported to a furniture manufacturer.

John Dransfield's rattan manual in hand, any one of us could go out into a forest on the Malay Peninsula and identify the rattan species collected. Technical vocabulary in the manual has been kept to a minimum and, when all else fails, a glossary is provided. Never mind if there are no flowers or fruits, the field key based on sterile material is quite easy to use. Since each species is illustrated, problems in interpreting the keys or matching specimens with descriptions are easily solved. Unfortunately the reproductions of the original line drawings leave a bit to be desired and some of the characters are not visible.

The taxonomy of rattans was a miserable tangle of synonomy further

(*Continued on page* 62)

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Chemotaxonomic Studies of Selected Cocosoid Palms

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Relatively few research studies on the chemotaxonomy of palms have been published. The most significant papers have dealt with flavonoids. Williams, Harborne, and Clifford (1973) surveyed the leaf flavonoid patterns of 125 species in 69 genera, including six genera and 13 species of cocosoid palms; and Harborne, Williams, Greenham, and Moyna (1974) investigated flavonoids in the flowers of 10 species in eight genera, including the following cocosoid palms: *Arecastrum romanzoffianum*, *Butia capitata*, and *Jubaea chilensis*. In the leaf study, negatively charged flavonoids, flavone C-glycosides (many of these were present as potassium sulphate salts), leucoanthocyanins, and glycosides of tricin, luteolin, and quercetin were common in many of the palms studied. Flavone sulphates are relatively rare in other monocotyledonous plants, having been detected mainly in Juncaceae, in certain grass genera, and occasionally in members of the Fluviales.

Our interest in this line of research grew out of recent monographic studies and revisions of certain genera in the *Cocos* alliance (*Butia*, Glassman 1970, 1979; *Syagrus* unit, including *Syagrus* and seven other genera, and *Cocos*, *Jubaea*, and *Jubaeopsis*, Glassman in preparation) and preliminary studies of other genera in the *Cocos* alliance, *Attalea*, *Orbignya*, *Scheelea*, and *Maximiliana* (Glassman 1977a, b, c, 1978a). Of the 125 taxa surveyed by Williams, Harborne, and Clifford (1973), only 13 species are included in the cocosoid genera mentioned above. Results of this survey showed that all five taxa of *Butia* plus *Jubaea chilensis* have four compounds in common: negatively charged flavonoids, flavone C-glycosides, tricin, and leucocyanidin; three of the five species of *Butia* also contain luteolin and quercetin, and one of these, *B. ?bonnetii* also has kaempferol; and *Butia yatay* and *Jubaea chilensis* contain five identical flavonoids and lack four others. Similarity in the flavonoid patterns of *Jubaea* and *Butia* may indicate a close relationship. The apparent alliance between the two genera is also corroborated by their strikingly similar leaf anatomy (Glassman in preparation). *Cocos nucifera* contains only three of the nine flavonoid classes studied, is the only one to contain leucopelargonidin, and is one of the few lacking negatively charged flavonoids. *Microcoelum weddellianum* also appears distinct because it has only three flavonoid compounds, negatively charged flavonoids, flavone C-glycosides, and tricin.

While doing monographic studies on a series of cocosoid palms, it became apparent that alignments between taxa frequently could not be determined by conventional taxonomic methods. It seemed that chemotaxonomy could be useful as another systematic approach to a more comprehensive understand-

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ing of phylogenetic relationships within this group of palms. Subsequently, a flavonoid survey of dried leaf material from 25 different cocosoid palms collected in Brazil and the Fairchild Tropical Garden, Miami, Florida was undertaken.

A chemotaxonomic approach that has not been used for palms is the analysis of epicuticular lipids (waxes), although somatic lipids of the fruit coat, pollen, and seed of 35 palm species have been studied with this aim in mind by Opute (1978). For other plant genera, several attempts have already been made to use the composition of individual wax classes as taxonomic criteria, but this method has only met with limited success (review by Martin and Juniper 1970, Tulloch 1976). Alkanes are most widely used (recent papers by Smith and Martin-Smith 1978a; Corrigan, Timoney, and Donnelly 1978a, b; Nordby, Nagy and Smoot 1979), but w-hydroxyacids (Corrigan et al. 1978b), α-diketones (Evans, Knights, Math, and Ritchie 1975) and triterpenoids (Smith and Martin-Smith 1978b; Manheim, Mulroy, Hogness, and Kerwin 1979) have also been examined. In the present work, however, we have carried out a preliminary survey of palms using thin-layer chromatography (TLC) on silica gel to evaluate the qualitative composition of the total epicuticular waxes, a profile technique first suggested for taxonomic purposes by Purdy and Truter (1961).

Materials and Methods

Flavonoid analysis: All voucher specimens were collected by S. F. Glassman and are on deposit in the University of Illinois Herbarium, Chicago Circle (CHI).

The procedures used are similar to those described in Harborne (1967, 1973). Dried leaf material was broken into small pieces and extracted with 95% ethyl alcohol. The flavonoid aglycones—tricin, luteolin, apigenin, quercetein, isorhamnetin and kaempferol—were identified in acid-hydrolyzed leaf extracts (2 N HCl for 45 min at 100°) by direct comparison with authentic markers. In order to remove interfering flavone *C*-glycosides, chromatograms on Whatman No. 1 paper were first overrun in water and then dried. Treated papers were then run individually in *n*-butanol-acetic acid-water (4:1:5, top layer), Forestal solvent (acetic acid-conc. HCl-water, 30:3:10), 50% acetic acid and chloroform-acetic acid-water (2:1:1, bottom layer). Comparisons with standards included R_f determinations in the above four solvents, together with a comparison of the color reactions in UV light in the presence or absence of ammonia vapor.

Flavone *C*-glycosides were confirmed by their resistance to 4 hr acid treatment, then extraction into amyl alcohol and paper chromatographic comparison with authentic *C*-glycosides in the above four solvents, together with water and 15% aqueous acetic acid.

Negatively charged flavonoids were detected by electrophoresis of alcoholic leaf extracts on Whatman No. 3 paper in 2.5% formic acid–7.5% acetic acid (1:1), pH 2.2 buffer for 3 hr at 400 mV. Positive records were made when anionic spots were detected which had all the characteristic color reactions of flavonoid compounds.

Proanthocyanidins were detected when a red color was formed in leaves heated in 2N HCl for 30 min at 100°C. This pigment was extracted into amyl alcohol, and this was concentrated to dryness. The residue was dissolved in methanolic-HCl and chromatographed in Forestal solvent against anthocyanidin (cyanidin, pelargonidin) markers.

*Table 1. Flavonoid survey from leaves of 25 different cocosoid palm taxa.***

Taxon Collecting Number		Negatively charged flavonoids	Flavone C-glycosides	Tricin	Luteolin	Apigenin	Quercetin	Isorhamnetin	Kaempferol	Pro-anthocyan
1. Allagoptera campestris 13033	BAHIA	–	+	±	–	–	+	±	–	++ (cy)
2. Attalea sp. 13006	MINAS GERAIS	–	–	+	+?	–	+	±	–	–
3. Attalea concentrista 13008	BAHIA	+	–	+	+?	–	–	–	–	–
4. Attalea sp. 13016	BAHIA	–	–	±	–	–	–	–	–	–
5. Attalea sp. 13034	BAHIA	–	–	++	–	–	–	–	–	± (cy)
6. Attalea sp. 13047	BAHIA	–	++	++	–	–	+	+	–	++ (cy)
7. Attalea sp. 13059	GOIAS	–	–	++	–	+	+	+	–	± (cy)
8. Butia hybrid 10402	*FTG	+	+	±	–	–	++	+	–	–
9. Cocos nucifera 10420	FTG	–	++	±	–	–	–	–	–	+ (cy) + (Pa?)
10. Orbignya sp. 13041	BAHIA	+	±?	±	–	–	–	–	–	++ (cy)
11. Orbignya cohune 10413	FTG	–	+	±	±	–	+?	–	–	± (cy)
12. Orbignya phalerata 10418	FTG	–	–	±	–	–	–	–	–	–
13. Polyandrococos caudescens 14010	FTG	+	–	±	–	–	–	–	–	±? (cy)
14. Scheelea sp. 13063	GOIAS	–	+	±	–	–	–	–	–	+ (cy)
15. Scheelea zonensis 14017	FTG	–	–	±	–	–	–	–	–	–
16. Syagrus vagans 14015	FTG	–	++	±	–	–	–	–	–	++ (cy)
17. Syagrus coronata 14016	FTG	–	++	±	–	–	+	–	–	–

Table 1. Continued.

Taxon Collecting Number		Negatively charged flavonoids	Flavone C-glycosides	Tricin	Luteolin	Apigenin	Quercetin	Isorhamnetin	Kaempferol	Pro-anthocyan
18. Syagrus glaucescens 13002	MINAS GERAIS	−	++	±	−	−	+	+	+	± (cy)
19. Syagrus flexuosa 13037–13040	BAHIA	−	++	±	−	−	+	±	−	+
20. Syagrus petraea 13043–13046	BAHIA	−	++	±	−	−	+	+	−	++ (cy)
21. Attalea borgesiana 13011	BAHIA		−				+		−	−
22. Scheelea 13089	MATO GROSSO		+				−		−	+
23. Butia purpurascens 13082	GOIAS		+				+		+	+
24. Butia archeri 13001	MINAS GERAIS		−				+		+	+
25. Syagrus microphylla 13024–13031	BAHIA		+				−		−	+

* Fairchild Tropical Garden. Other specimens were collected in Brazil and are designated by state.
** Flavonoids were extracted and identified using paper chromatography and other analyses for numbers 1–20 and paper chromatography alone for numbers 21–25. Details: cy, leucocyanidin; pa, leucopelargonidin.

Wax Analysis: All voucher specimens are the same as those used in the flavonoid analysis. A sample of dried leaf material was immersed for 30 seconds in redistilled chloroform. The chloroform extracts were filtered and evaporated to dryness using a rotary evaporator. Wax extracts were then dried to constant weight at 40° C. By using previously weighed samples, the weight of wax per unit dry weight of leaf tissue can be calculated. For TLC analysis, samples of specimens 21–25 were dissolved in chloroform and those of 1–20, in chloroform:diethyl ether (1:1, V/V), at a concentration of *ca.* 10 mg/ml; then 50–100 μg were applied with a narrow-bore glass pipette to the absorbent layer of the TLC plates (0.25 mm layer of silica gel G, activated at 120° C for one hour before use). Cabbage wax was used as a standard to give presumptive identification of the classes of com-

Table 2. Composition of wax samples of 25 species of cocosoid palms.

	Alkanes	Ester	Ketone	Aldehyde	Secondary Alcohol	Primary Alcohol
1	×	×	–	×	–	×
2	×	×	–	–	×	×
3	×	–	–	× (?)	–	–
4	×	×	–	–	–	×
5	T	×	×	×	×	–
6	T	T	–	× (?)	T	T
7	T	×	×	×	×	×
8	×	×	×	×	×	×
9						
10	T	×	–	×	T	×
11	T	×	–	×	–	×
12	×	×	–	×	×	×
13	×	T	–	–	×	×
14	×	×	×	×	×	×
15	×	T	–	–	T	×
16	×	×	–	–	×	×
17	×	×	–	×	×	×
18	×	×	–	×	×	T
19	×	×	–	×	×	×
20	×	×	–	–	–	×
21	T	T	–	T	T	×
22	T	T	–	×	T	T
23	×	T	–	–	T	×
24	×	T	–	–	T	×
25	×	T	–	–	×	T

Numbers on left are equivalent to those listed in Table 1.
– absent, × present, (?) signifies doubt in interpretation of the TLC pattern, T signifies small amount.

pounds present. The plates were held in benzene vapor for 30 minutes before being developed in benzene. After drying the plates, components of the wax were visualized by spraying with 5% sulfuric acid in ethanol and heating to 100° C until charring of the spots occurred.

Results

Flavonoid Analysis: Results of the flavonoid survey are shown in Table 1. Only four of 20 taxa contain negatively charged flavonoids, which is surprising in view of the high frequency of these compounds in the palm family as a whole; all five species of *Syagrus* yield flavone C-glycosides, but only one of six taxa of *Attalea* has this compound; tricin was found in all species examined, which is not surprising because it is considered to be a marker for the family. All species of *Attalea* show at least one difference, and some species have several compounds not possessed by the others. Each species of *Orbignya* shows at least three differences, and the species of *Scheelea* differ by two compounds. The first five flavonoid classes in Table I are the same for all species of *Syagrus*, but of the remaining four each taxon differs by at least one compound.

Wax Analysis: Of the 25 species examined (Table 2) only three (7. *Attalea* sp., 8. *Butia* hybrid and 14. *Scheelea* sp.) contain all six classes of wax components extracted. The least frequent class was the ketones, found in only four taxa (two spp. of *Attalea*, *Butia* hybrid and *Scheelea*). Alkanes, in at least trace amounts, were identified from all 25 taxa, and esters were found in all except one species (*Attalea concentrista*). Several taxa (*Orbignya* sp., *O. phalerata*, *Syagrus coronata*, *S. glaucescens*, and *S. flexuosa*) have mostly large amounts of all classes except ketones.

The three species of *Scheelea* (nos. 14, 15, 22) are well differentiated; the first one has large amounts of all six classes of wax components while the other two lack one or two of these completely and have trace amounts of other compounds.

All three species of *Orbignya* are similar in having prominent spots for esters, aldehydes, and primary alcohols, for the most part. *Orbignya cohune* is distinguished by lack of secondary alcohols, and the other two are differentiated from each other by the relative amounts of each compound.

As a genus *Attalea* shows the most variability. Alkanes are the only compounds found in all seven species. Of possible significance is the occurrence of ketones in two taxa (5, 7) which differ by the absence of primary alcohols in species number 5. The remaining five species of *Attalea* can be distinguished from each other mainly by the lack of one or more wax components and the relative amounts of each wax component present.

Syagrus appears to have a more homogeneous profile than some of the other genera. Alkanes, esters and primary alcohols are present in all six species studied, and secondary alcohols are lacking in one taxon, but only three of the six species contain aldehydes.

Both species of *Butia* are identical in having four of the six wax compounds extracted.

Discussion

Perhaps *Allagoptera campestris* (1) and *Polyandrococos caudescens* (13) may not be as closely related as formerly indicated. Both were placed in the *Allagoptera* unit by Moore (1973) and are characterized by having thick spikelike inflorescences. They are distinguished among other differences by the number of stamens per flower, fewer than 20 in *Allagoptera* and 90–120 in *Polyandrococos*. Chemically, they differ by at least four flavonoid compounds. On the other hand, *A. campestris* has a flavonoid pattern very similar to *Syagrus flexuosa* and *S. petraea*, and hence may be more closely allied to members of the *Syagrus* unit.

Differences between *Allagoptera* and *Polyandrococos* apparently are not as great for wax components as for flavonoids. They differ by two compounds, instead of four. As with flavonoids, *Allagoptera* also appears to show a closer relationship with *Syagrus* (four of its species differ from *A. campestris* by only one compound) than with *Polyandrococos*.

As a genus *Attalea* does not seem to be very closely knit chemically. The only compound found in all taxa is tricin; negatively charged flavones, flavone-C glycosides, and apigenin are found in only one taxon for each; and quercitin, isorhamnetin, and leucocyanidin occur in about one-half the taxa. Comparison of *Orbignya* and *Scheelea* with *Attalea* (all members of the *Attalea* unit) would be difficult because neither genus exhibits a distinct flavonoid pattern. Therefore, several additional species in each genus should be surveyed before more meaningful relationships can be ascertained.

For *Attalea*, results of the wax analysis were similar to the flavonoid survey because only one class, the alkanes, was common to all the species studied. The presence of ketones in two species may indicate the possible occurrence of this component in other members of the genus.

In contrast to the flavonoid study, *Orbignya* seems to show a more homogeneous profile in its waxes. Two species have five of the six wax components while the other species has only four. Likewise, *Scheelea* shows a more distinct pattern. Each species differs by one or two compounds. Results of the wax survey seems to indicate more clearly than the flavonoid analysis that *Attalea*, *Orbignya*, and *Scheelea* are distinct genera. Morphologically, these taxa are difficult to determine in the vegetative stage and are mainly distinguished by differences in staminate flowers. In fact, Wessels Boer (1965) lumped all genera now included in the *Attalea* unit under the genus *Attalea*. In any case, additional species in each genus should be studied to clarify relationships.

In contrast to *Attalea*, *Syagrus* appears to be a more cohesive genus because the first five flavonoid classes in Table 1 are the same for all species. *Syagrus vagans* and *S. coronata* differ by two compounds. Both species are sympatric over parts of the caatinga in Bahia and occasionally hybridize. They are not considered to be very closely related, however, because they have clear-cut morphological and anatomical differences. *Syagrus glaucescens* differs from other species in the genus primarily in having kaempferol. The significance of this occurrence is puzzling since kaempferol was also detected in *Arecastrum* and *Butia ?bonnetii* (Williams et al. 1973), and in *Butia archeri* and *Butia purpurascens* (see Table 1). Two species not considered to be closely related, *S. flexuosa* and *S. petraea*, have an almost identical flavonoid pattern. They are sympatric over parts of their range in central Brazil, but are not known to hybridize. As stated previously, *Allagoptera campestris* also has a flavonoid pattern very similar to the two species of *Syagrus* above, but this apparent relationship may be superficial because *Allagoptera* has not been treated as a genus closely allied to *Syagrus*. On the other hand, its alliances with *Syagrus* are apparently not as distant as with members of the *Attalea* unit. *Allagoptera* is distinguished from most species of *Syagrus* by its dense spike-like inflorescence and flowers with 6–19 stamens rather than predominately branched inflorescences and flowers consistently with 6 stamens, as well as a number of other important morphological differences.

Results of the wax survey for *Syagrus* are analogous to those found in the flavonoid study. Compared to *Attalea*, it appears to be a more closely knit genus. For example, three species (17. *S. coronata*, 18. *S. glaucescens*, and 19. *S. flexuosa*) contain the same waxes in more or less the same relative amounts. This pattern does not necessarily indicate a close alignment, but morphologically and anatomically they are probably more closely related to each other (all are arborescent) than to the remaining species of *Syagrus* which are acaulescent. In the flavonoid survey, *S. glaucescens* differed from all other species in having kaempferol, and *S. flexuosa* and *S. petraea* had an almost identical profile. In this study, however, *S. petraea* has the least variety of waxes and hence seems to be the most distinct. It is easily distinguished morphologically by its unbranched spadix, a characteristic found in only a few other species of *Syagrus*. *Syagrus vagans* and *S. microphylla* yield the same kinds of waxes, but in different amounts. A definite relationship may be indicated here because both taxa are part of a series of several species, mainly from Bahia, with a remarkably similar leaf anatomy pattern (Glassman 1978b).

Both *Butia purpurascens* and *B. archeri* contain the same kind of waxes in the same relative amounts, probably indicating a close relationship. They are from central Brazil and belong to the same subdivision of the genus, i.e., lacking petiolar spines (Glassman 1979). In addition the two species have three of four flavonoid components in common (Table 1), including the relatively rare kaempferol. Results of the wax study also indicate a fairly close relationship between *Butia* and *Syagrus*. *Butia* differs from three species by only one compound and has the same waxes as two others, but in different amounts. Morphologically, *Butia* is distinguished from *Syagrus* primarily by having nonsulcate or striate (when dry) rather than sulcate spathes. Even though *Butia* and *Syagrus* are included in different units, they are considered to be more closely related to each other than to members of the *Attalea* unit.

Interpretation of the above results should be made with some caution because of the limited number of taxa surveyed. Similarities and differences among species within a genus and between some genera certainly have been indicated. However, a much larger sampling of taxa for some of the genera may prove more significant. For example, *Syagrus* has 29 species. It is not possible to obtain enough leaf material for all of the taxa because several are rare or thought to be extinct, but a comparative study of at least 20 species would be more meaningful. Likewise, more taxa in the *Attalea* unit (about 60 species are thought to exist) should be surveyed. In addition to leaf material, palm flowers from some of the same collections are currently being investigated for flavonoids and further investigations are also under way to determine carbon chain lengths of each wax component extracted from individual species. Finally, expanded flavonoid and wax studies of additional members in the *Attalea*, *Syagrus*, and *Butia* units are contemplated for the near future.

Acknowledgments

The authors are grateful to Renee Grayer-Barkmeijer for valued experimental assistance in the flavonoid studies and to Dr. Merrill Gassman for valuable suggestions regarding the manuscript.

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PALM LITERATURE

(*Continued from page* 53)

complicated by scrappy and mixed collections. The large number of rattan species alone (104 species on the Malay Peninsula) makes their taxonomy difficult but the real problem is that collectors naturally shy away from such fiercely spined canopy-high plants. Dransfield has done much to ameliorate this situation with his own collections, manual, and advice for others willing to make herbarium specimens. He also passes along with often charming prose his enthusiasm and field botanist's feeling for each species and the group as a whole. Clearly we all benefit from his years in the forests of Southeast Asia.

Studies of rattan ecology and silviculture needed a firm taxonomic foundation upon which to build. Dransfield provides this and motivates the continued study of rattan biology with notes on their natural history, utilization, and cultivation. Malaysian economists will undoubtedly be interested in his discussion of the potential economic benefits from manufacturing rattan products within Malaysia rather than exporting the raw material.

Wild, forest-grown rattans have supplied the world markets for years. With the steady depletion of this forest resource and the diminution of forest area, rattan cultivation will increase in importance. Selection of species for planting will be facilitated by Dransfield's manual because, along with descriptions and illustrations, he presents the geographical and ecological range of each species. With the efforts of an active forestry research group in Malaysia, the work of John Dransfield will continue to yield a steady and abundant supply of rattan and rattan biology.

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Principes, 25(2), 1981, pp. 63–72

Pseudophoenix sargentii in the Yucatan Peninsula, Mexico

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Pseudophoenix is a typically Antillean insular genus with its original center of distribution on Hispaniola island (Haiti and Dominican Republic). The four species of the genus are found on this island; three of the species are endemic. The fourth one, *Pseudophoenix sargentii,* can be found in the Florida Keys, Cuba, Ambergris Key in Belice, Bahamas, Dominica, and Mexico where it occurs on the Yucatan Peninsula in the states of Yucatan and Quintana Roo, the only continental areas where the species occurs naturally.

The three endemic species from Hispaniola are *Pseudophoenix vinifera* (Martius) Beccari, *P. ekmanii* Burret and *P. lediniana* Read, each of them growing on different habitats (Read 1968). *Pseudophoenix vinifera* grows on dry limestone mountains and hills at 20–400 m elevation with an annual rainfall of 350–500 mm in inland places. *Pseudophoenix ekmanii* grew (so far as is known) in xerophytic conditions inland in an exceedingly dry area of the Peninsula of Barahona in the Dominican Republic. *Pseudophoenix lediniana* grows on outcrops of steep porous limestone cliffs at 150–300 m elevation in xerophytic conditions but with moderate seasonal rainfall, in a very small area of southwestern Haiti.

Pseudophoenix sargentii is a halophytic palm always growing at sea level near the coast, in both xerophytic and humid environments, on well drained soils or sand, sometimes in flooded places but almost always in places with a maritime influence (Read 1968).

The genus was proposed by Wendland and described by Sargent in 1886, typified by *Pseudophoenix sargentii,* and based on collections made by Sargent on the western side of Elliot Key, Florida (Ledin et al. 1958). The genus was traditionally placed in the heterogeneous subfamily Arecoideae. Read (1968) however created a new monogeneric subfamily: Pseudophoenicoideae, with *Pseudophoenix* as the type genus. Moore (1973) placed the genus in the pseudophoenicoid group in the arecoid line, providing neither with a taxonomic status.

Individuals of *Pseudophoenix sargentii* are distinguished by unbranched, erect and unarmed trunks up to 8 m tall; the leaves are pinnate, ascending or drooping with reduplicate pinnae, up to 3 m long, shorter to 2 m in Mexican specimens; the rachis edge and pinnae insertion bear groups of brown scales. Inflorescences are interfoliar, erect or drooping, with branches to the third or fourth order. Flowers are greenish with a pseudopedicel 5 mm long in Mexican specimens (the pseudopedicel is characteristic of the genus). The perianth is in two series of three lobes each; stamens are 6 in number with broad bases of filaments fused to form a very short cup united to the petals; the pistil is conical, with 3 glands at the base and 3 sessile stigmas, and the ovary trilocular with a single ovule in each locule. The fruit is a waxy-red drupe at maturity, mostly one-seeded but frequently 2–3-seeded; when 1 or 2 seeds mature, the abortive carpels can be seen at the base of the fruit. The epicarp is waxy and thin and the mesocarp fleshy and yellowish; the endocarp is hard and brownish in colour and encloses a free seed with hard endosperm and sub-basal embryo.

Read (1969) distinguished two subspecies and two varieties of *Pseudophoenix sargentii*, *P. sargentii* subsp. *sargentii* with inflorescence erect, and *P. sargentii* subsp. *saone* with inflorescence drooping. Subspecies *saone* was divided into *P. sargentii* subsp. *saone* var. *saonae* and *P. sargentii* subsp. *saonae* var. *navassana*. The same author (1968, 1969) recorded *Pseudophoenix sargentii* subspecies *sargentii* for Mexico.

Studied Area

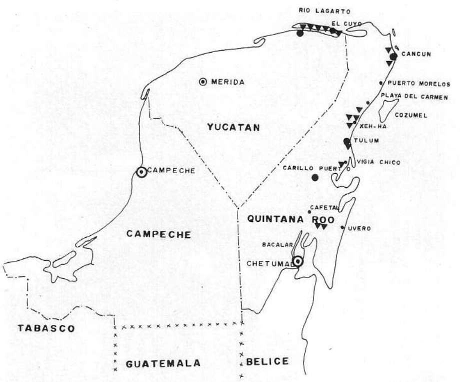
The Peninsula of Yucatan is a very interesting physiographic region. The northern region is almost flat while in the southern part there are some small hills (up to 400 m above sea level) and some depressions. There are no igneous rocks in the Peninsula, which is formed by beds of sedimentary rocks, mainly coralline limestone mostly of Tertiary or Recent origin. One of the most striking physiographic features of the Peninsula is the absence of surface streams. No permanent rivers exist except in the southwestern and southeastern ends. There are some seasonal streams, which carry water for a short time but, as soon as the rains cease, the water is quickly drained to the oceans or below the surface where it forms underground reservoirs called "cenotes," which are very abundant in the northern region. There are some small lakes formed during the rainy season that sometimes remain almost throughout the dry season. The underground water level is shallow, in some cases only 8 m or less deep.

In most of the Peninsula, the climate is warm-subhumid (Aw of Köppen) with several humidity levels and a mean monthly temperature between 20.5 and 30.5°C. The highest average annual rainfall (near 2,000 mm) occurs in the southeastern region, decreasing to the northwest, where the climate is dry (B of Köppen) with a lower average annual rainfall not more than 500 mm. The soils are shallow, calcareous, mainly red or black rendzinas, sands, or several hydromorphic types.

There are several vegetation types in the Peninsula according to Miranda (1964) these being optimum and non-optimum primary associations. As optimum, he distinguished High Evergreen Tropical Rain forest, High Forest with Boreal Elements, High or Median Subperennial Forest, High or Median Subdeciduous Forest, Median Deciduous Forest and Low Deciduous Forest, each one with several variants. The non-optimum primary associations are found in special conditions and are not widely distributed, among them are: corozal, botanal, tasistal, etc., each one characterized by a predominance of palms: *Orbignya*, *Sabal* and *Acoelorrhaphe* respectively.

The Yucatan Peninsula has a very interesting palm flora; 14 of the 21 genera of Mexican palms are found in this area:

Acrocomia
Acoelorrhaphe
Bactris
Chamaedorea
Coccothrinax
Chryosophila
Desmoncus
Orbignya
Opsiandra
Pseudophoenix



1. Map showing the distribution of *Pseudophoenix sargentii* in the Mexican portion of the Peninsula of Yucatan.

Roystonea
Sabal
Scheelea
Thrinax

Ecology

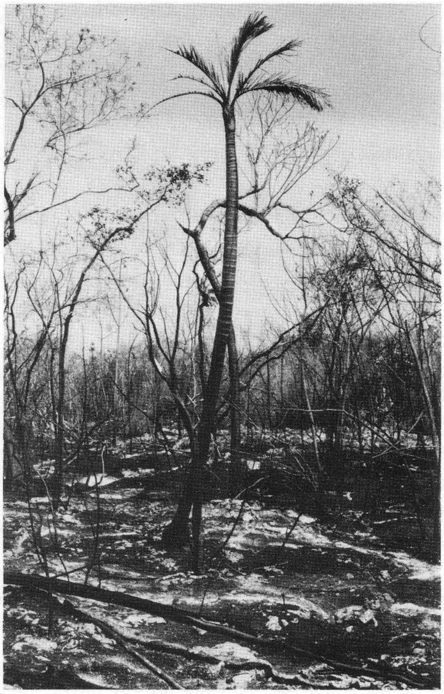
Pseudophoenix sargentii grows mostly near the coast, in Median or Low Subdeciduous Forest or in Coastal Dunes, from the southern part of Quintana Roo (north of Bacalar Lagoon) to the northern coast of the state of Yucatan (near Rio Lagartos). Its distribution is however discontinuous (Fig.1). In Median or Low Forest, the individuals are vigorous up to 8 m tall; these forest types with *Pseudophoenix* are found near the Caribbean coast, from the environs of Bacalar Lagoon to the environs of Cancun in the state of Quintana Roo.

In its southern growing range, this species occurs more than 30 km inland, the farthest inland record known in its range. In this region *Pseudophoenix* grows in a transitional zone between Median and Low Forest; the species is represented by scanty but vigorous individuals up to 8 m tall. The climate in this region (according to data from the nearest meteorological stations: Chetumal and Carrillo Puerto, Table 1) is warm-subhumid, with summer rainfall and a decrease at the middle of the rainy season, called "canicula" or "sequia intraestival". The average winter rainfall is 8.7%; the annual precipitation is 1,300 mm and the mean annual temperature is 26°C (Figs. 2, 3). The soils are well drained shallow clay loams overlying limestone, with abundant humus; other soil characteristics can be seen in Table 2-A.

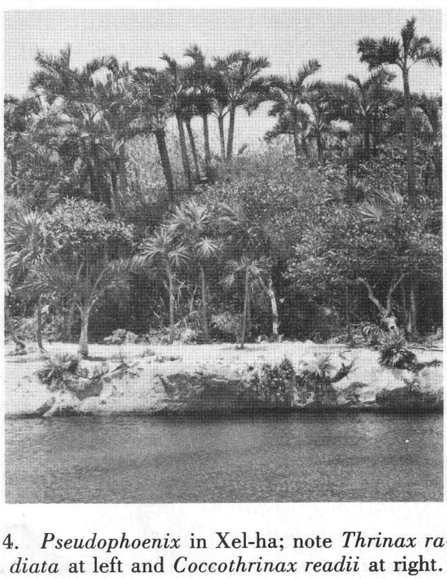
2. *Pseudophoenix* growing 30 km inland in a disturbed Median Forest near Bacalar Lagoon.

In this region, *Pseudophoenix sargentii* is associated with other palms: *Coccothrinax readii* and *Thrinax radiata* (Quero 1980). Other species growing in these forests are:

Alseis yucatanensis Standl.
Astronium graveolens Jacq.
Bravaisia tubiflora Hemsl.
Chrysophyllum mexicanum Brand



3. *Pseudophoenix* in the same locality as Fig. 2 after burning by man.



4. *Pseudophoenix* in Xel-ha; note *Thrinax radiata* at left and *Coccothrinax readii* at right.

5. *Pseudophoenix* associated with *Thrinax radiata, Metopium brownei* and *Agave angustifolia* in El Cuyo region.

Coccoloba spicata Lundell
Exostema mexicanum Gray
Hippocratea excelsa H.B.K.
Luehea speciosa Willd.
Manilkara zapota (L) Royen
Pimenta dioica (L) Merril
Piscidia communis (Blake) Johnst.
Pouteria campechiana (Kunth) Baehni
Protium copal Engl.
Sickingia salvadorensis Standl.
Talisia olivaeformis (H.B.K.) Radlk.
Zanthoxylum microcarpum Griseb.

The region of Xel-ha is striking in the abundance of *Pseudophoenix*, growing in a Lower Subdeciduous Forest from the coast to 1.5 km inland. The palm has great regeneration in this area and there are many young individuals around the mature parent plants (Fig. 4). The climate is very similar to that of the preceding region, with slight variation in the average an-

Table 1. Graphics from Meteorological Stations: Carrillo Puerto, Chetumal, Tulum and El Cuyo

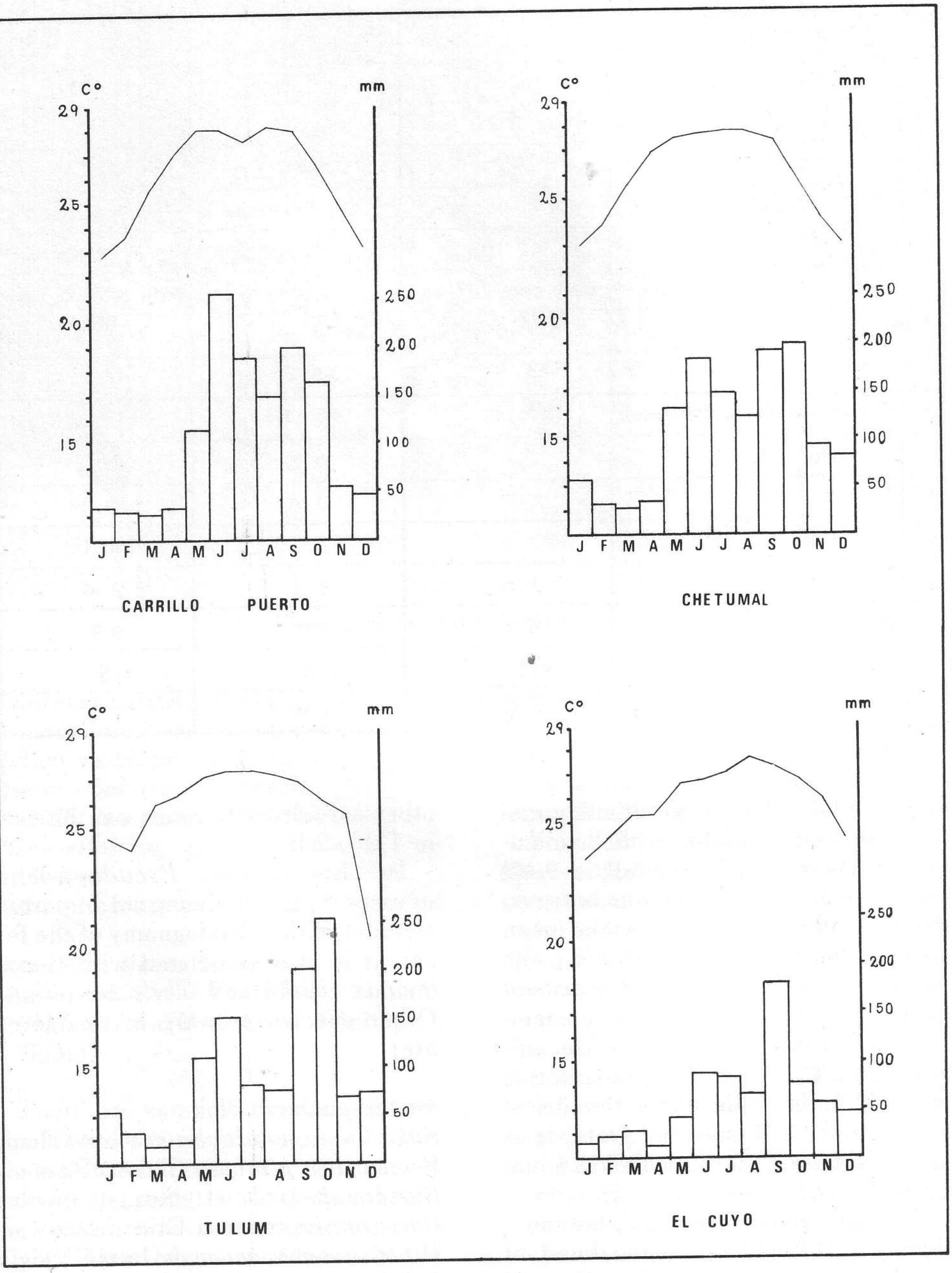


Table 2. Soil characteristics from: A. Environs of Bacalar Lagoon, B. 1.5 km north of Xel-ha, C. El Cuyo region

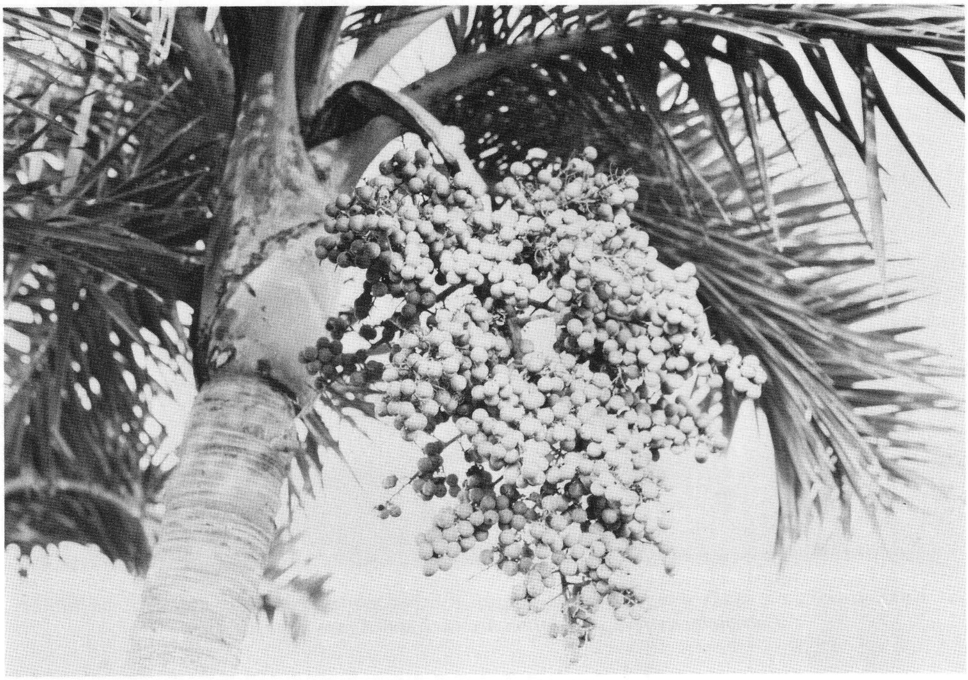
LOCALITY		A	B	C
TEXTURE	Clay %	38	10	10
	Loam %	20	30	6
	Sand %	42	60	80
	Textural Classification	Clay - loam	Sandy - loam	Loamy - sand
Color (dried)		very dark grayish brown	very dark grayish brown	grayish brown
Color (hydrated)		very dark brown	black	dark grayish brown
pH (H_2O) 1:1		7.6	7.4	7.6
Organic Matter %		15.8	33.3	4.9
Total Cation Exchange Capacity mg/100		55.4	45.1	17.6
EXCHANGEABLE BASES	Na^+ " "	0.4	0.5	0.8
	K^+ " "	0.3	0.4	0.1
	Ca^{++} " "	40.3	37.1	13.1
	Mg^{++} " "	3.5	2.1	2.4
Base Saturation		80	88	93
Na Saturation %		<15	<15	<15
P Availability ppm		2.8	1.8	1.4

nual rainfall, that is warm-subhumid with summer rainfalls, with "canicula". Average winter rainfall is 9.4% and there is scanty oscillation between mean monthly temperatures; the mean annual temperature is 25.8°C; the mean temperature of the warmest month June is 27.3°C; the mean temperature of the coolest month December is 20.5°C. The annual precipitation is 1,142.4 mm; March is the driest month with 16.3 mm and October is the most humid month with 254.4 mm (from Tulum station, Table 1).

The soils are very shallow, not more than 15–20 cm deep, with abundant coralline limestone outcrops. The soil is sandy-loam with abundant humus; other soil characteristics can be seen in Table 2-B.

In this region, *Pseudophoenix* reaches 5 m tall, being an important element of the physiognomy of the forest. It is also associated with *Coccothrinax readii* and *Thrinax radiata.* Other species growing in this forest are:

Acacia gaumeri Blake
Bakeridesia notalophium (Gray) Hook.
Beaucarnea pliabilis (Baker) Rose
Bursera simaruba (L) Sarg.
Caesalpinia gaumeri Greenm.
Diphysa carthagenensis Jacq.
Erythroxylon brevipes DC
Esembeckia berlandieri Baill.



6. Close-up of the curved fruiting inflorescence.

Exostema caribaeum (Jacq.) R. & S.
Gymnopodium floribundum Rolfe.
Helicteres baruensis Jacq.
Mimosa bahamensis Benth.
Piscidia communis (Blake) Johnst.
Pithecellobium guadalupense (Pers.) Chapm.
Pithecellobium platylobum (Spreng.) Urban
Randia aculeata L
Thevetia thevetioides (H.B.K.) Schum.
Torrubia linaribracteata (Heimerl.) Stand.

There are some other places where *Pseudophoenix sargentii* grows in this kind of Low Forest, but with scanty individuals; sometimes it is found near the coast behind the mangroves, as at Vigia Chico region; sometimes in the border of flooded soils as near Tulum but in this case 1 km inland; other times in the border of the Sandy Dunes Vegetation, as in the vicinity of Cancun and Tulum. In all these cases, the palms are less than 4 m tall, the leaves are less than 1.5 m long, and the trunks reach 20–25 cm wide.

This palm is most abundant in a littoral strip, 60 km long and 500 m wide on the northern coast of Yucatan. This strip limits a coastal lagoon from El Cuyo to Rio Lagartos. The climate is warm and dry (BS of Köppen), the mean annual temperature is 25.9°C, the coolest month is January 23.5°C, the warmest August 27.7°C, so there is a low thermic oscillation. The annual precipitation is 720.2 mm; April is the driest month (13.1 mm) and September the most humid (186.4 mm). A "canicula" is also present (from El Cuyo station, Table 1). The soils are loamy-sand with scant humus (Table 2-C). In the region of El Cuyo, the palm reaches 3 m tall, but it is com-

7. Kuká growing on sandy dunes near Rio Lagartos; other associated plants are: *Thrinax radiata*, *Coccoloba uvifera*, *Metopium brownei* and *Agave angustifolia*.

mon to find flowering and fruiting individuals not more than 1 m tall. Another interesting aspect of this palm population is the great regeneration, evidenced by abundant young plants around mature individuals. (Figs. 5, 6, 7). *Pseudophoenix sargentii* is one of the most important species growing in these sandy dunes; other associated species are:

Acanthocereus pentagonus Br. & Rose
Agave angustifolia Haw.
Amaranthus gregii Wats.
Ambrosia hispida Pursh.
Bumelia retusa SW
Caesalpinia caccalaco H & B
Cakile edentula (Bigel.) Hook.
Caparis incana H.B.K.
Coccoloba uvifera (L) Jacq.
Coccothrinax readii Quero
Cordia sebestena L
Croton punctatus Jacq.
Distichlis spicata (L) Greene
Ernodea littoralis SW
Gossypium hirsutum L
Hyperbaena winaerlingii Standl.
Jacquinia aurantiaca Ait.
Lycium carolinianum Wal.
Malvaviscus arboreus Cav.
Metopium brownei (Jacq.) Urban
Monantochloe littoralis Engelm.
Neea choriophylla Standl.
Pithecellobium albicans (Kunth) Benth.
Pithecellobium guadalupense (Pers.) Chapm.
Rhacoma gaumeri (Loes) Standl.
Suaeda linearis Moq.
Thrinax radiata Lodd. ex J. A. & J. H. Schult
Tournefortia gnaphalodes (L) R. Br.

Comments

Pseudophoenix sargentii is a typical littoral species that grows also a short distance inland in places with high marine influence. Read (1968) states that dry fruits have air spaces surrounding the seeds enabling them to float for some time, so they could have been transported by Caribbean ocean

8. *Pseudophoenix sargentii* in cultivation at Cancun.

currents from Hispaniola to those places where the palm grows at present.

As previously stated, Read (1968) reports *Pseudophoenix sargentii* subsp. *sargentii* characterized by the straight and erect inflorescence from Yucatan. However, a great variation in the inflorescence form can be found, some individuals bearing straight and some curved inflorescences, the straight ones being more abundant. This no doubt weakens the subspecific categories proposed by Read (Read pers. comm., Fig. 6).

The occurrence of this palm in the Yucatan Peninsula is very interesting. It presents discontinuous distribution and grows in two different conditions: in forest in the state of Quintana Roo and in dune vegetation in the state of Yucatan. The environmental conditions differ in soil and climate: the soils are loamy-sand in northern Yucatan and they are clayey-sandy-loam with abundant humus in forests of Quintana Roo. The climate is drier in the dunes, while it is humid in the forests. In my opinion, the presence of this palm in these two different regions is due to its arrival on the Yucatan Peninsula at two different times; it must have arrived earlier on the Caribbean coast of Quintana Roo. There are some geological maps of the Peninsula of Yucatan that suggest the occurrence of an ancient coastal line in those places where *Pseudophoenix sargentii* grows now, 30 km inland.

This population of *Pseudophoenix* is now under weak marine influence and this may be, in part, the reason for poor regeneration of the palm in the region. On the other hand, the region of sandy dunes on the northern coast of Yucatan is younger than the ancient coastal line of Quintana Roo. According to the maritime stream maps, the palm could have arrived directly from the Antilles or from the region of Quintana Roo.

Nevertheless this species is in much greater abundance in Mexico than anywhere else in its distribution (Read pers. comm.). It has been mentioned that there are two regions where *Pseudopheonix* is very abundant with high regeneration; accordingly, it might be expected that in a few more years the species would have a wider distribution. However, expansion is not possible due to natural circumstances and human intervention. In Quintana Roo, the distance from the coast, the mangroves, some flooded soils, and clay soils are limiting or restrictive factors for the establishment of *Pseudophoenix sargentii*; on the Peninsula the coastal lagoon in the northern Yucatan is restricting colonization by the palm.

Man, however, is the main limiting factor. The opening of new lands for growing various crops such as sisal and coconuts in the north of Yucatan, or the destruction of vegetation in order to establish new population centers results in new open lands that are barriers to *Pseudophoenix* colonization.

Man has also been directly decreasing the natural population of *Pseudophoenix sargentii*; in the last ten years, since the tourist complex of Cancun in Quintana Roo was created, this palm known as *kuká* and *yaxhalalche*, has been widely gathered and used as an ornamental palm, not only in Cancun, but commonly in places such as Cozumel, Isla Mujeres, Playa del Carmen, Vallodolid, Merida and in many other smaller towns near its natural habitats (Fig. 8).

The reasons for the widespread cultivation of *Pseudophoenix sargentii* are on the one hand the beauty of the palm, and on the other hand, the ease of culture. A person who cultivates them told me: ". . . es una palma muy noble, pues es muy facil de sacar y ademas puede estar tirada mucho tiempo en el suelo antes de ser plantada, resiste el transporte por mucho teimpo y no se seca . . . ."*

I have confirmed the "nobleza" of *Pseudophoenix sargentii* by growing some individuals at the Botanic Garden of the National University of Mexico. The specimens have survived traveling from the Yucatan to Mexico City (approximately 1,800 km), sometimes taking more than 15 days, and have grown well in cultivation. This has permitted the public visiting the Botanic Garden to get acquainted with a beautiful tropical palm, that in Mexico grows only on the Yucatan Peninsula.

Acknowledgments

I wish to express my appreciation to Dr. Ramon Riba of the Universidad Autonoma Metropolitana, Dr. Fernando Chiang of the Instituto de Biologia, U.N.A.M., and Dr. Robert W. Read of the Smithsonian Institution, for their assistance and for critically reviewing the manuscript.

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* ". . . it is a very noble palm, for it is easy to dig out of the ground and also it can lie on the ground for a long time before it is planted, it resists traveling for a long time and does not wither . . . ."

Principes, 25(2), 1981, pp. 73–77

Modernizing Date Production in Iraq

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Dates, the most nutritive, assimilable, and energy-producing food, have played a key role in the economy of Iraq from time immemorial. Existence of congenial natural conditions for the growth and development of dates has enabled Iraq to be the world's largest producer and exporter of them. Although Iraq still remains one of the leading producers and exporters, it has not witnessed great improvement in quantity and quality of dates. This is evident from the fluctuating annual output of dates in the last ten years and comparatively low yield per palm (Tables 1, 2).

Lack of employment of scientific research and modern farming technology seems to be contributing to the present level of productivity of dates. Modern horticultural practices, viz., timely irrigation, application of fertilizers, thinning, pruning, pollination (mechanical), vegetative propagation, etc., are not being followed commercially to restore vigor and productivity of old palm trees. Menace of pests and diseases is rising due to the absence of regular plant protection measures.

To maintain and raise the productivity of dates in the country, it is urgently needed to apply modern production technology. There is still an enormous untapped reservoir of yield in date palms that could be exploited by judicious employment of modern techniques. Steps are being taken in this direction to upgrade the traditional technologies and to adopt modern scientific practices to revitalize the date industry in the country. This article describes the approaches that are being followed to modernize date production in Iraq.

Rejuvenation

One of the main reasons for the present level of date production is that the majority of date orchards are very old and their fruit-bearing capacity has gone down. This is because attention has not been paid to rejuvenating old and unproductive orchards in the past. Under these circumstances, there is an urgent need to develop techniques to reform neglected orchards and to improve the production of unproductive orchards. Unlike other fruit trees, it is impossible to rejuvenate old date palm trees by "top-working" since it is a monocotyledonous plant. Modern agricultural practices (fertilizer and irrigation application, pruning, thinning, and insect/pest control) that have proved useful elsewhere are being applied to rejuvenate old and unproductive orchards.

Vegetative Propagation

The natural production of offshoots by palms is very slow and inadequate to meet the entire demand for offshoots. There are certain good cultivars ('Hallawi', 'Barhee') which produce few offshoots and it is difficult to make their offshoots root in the nursery. Some attempts have been made to improve the methods of vegetative propagation (Mohammed 1978; Mohammed, Shabana, Hamza, and Hussien 1978). The technique of tissue culture to propagate date palms is being developed. However, in view of the seriousness of the problem, scientific research on vegetative propagation is to be intensified (Mohammed and Shabana 1979a) to find a technique of vegetative propagation that is rapid, convenient, and economical. Also, modern date palm nurseries using "mist propagation" technique for offshoot propagation are to be created to ensure the supply of reliably good and healthy planting materials in sufficient amount.

Mechanization

Mechanization of date palm cultivation has not yet taken place despite its overriding importance. There is a strong need to mechanize partially or fully various operations of date production because labor has become very expensive and at times not even available. Besides, the nature of the plant is such that it is difficult and dangerous to carry out various horticultural operations. Also, a country like Iraq can afford to mechanize date palm cultivation because of availability of cheap oil. Thus machines could be very useful for better management of date palm trees leading to increase in good quality production. Machines suitable to Iraqi date orchards are being introduced. Plans are underway to test them for different operations in different regions of the country. A hydraulic lift machine capable of lifting persons to the top of a tree and allowing them to complete various horticultural operations is useful.

Pollination and Pollen Handling

Female palm trees are still pollinated in the traditional manner irrespective of metaxenic effect of pollen. Sometimes trees are left unpollinated due to scarcity of fresh pollen and labor. Especially designed pollinating dusters and sprayers that require further improvement are being used on an experimental scale. Aerial pollination by helicopter has been tried but proved unsatisfactory. Storage of pollen to avoid scarcity of fresh pollen and metaxenic effect of pollen on quality of dates are under investigation (Mohammed, Shabana, and Fawzia 1978; Mohammed and Shabana 1980b).

Table 1. Fluctuation of date production in Iraq during the decade 1968–1978

Year	Production (Metric Tons)
1968–69	360,000
1969–70	480,000
1970–71	300,000
1971–72	450,000
1972–73	310,000
1973–74	385,632
1974–75	496,000
1975–76	372,000
1976–77	578,000
1977–78	389,030

Other Cultural Practices

Pruning: Pruning is an important practice to be followed in date palm cultivation. Although pruning is practiced in general in Iraqi date orchards, it is not unusual to find areas under date palm culture where pruning is not practiced. An improper balance between number of leaves and amount of fruit exists and results in low quality. Thus pruning is important to maintain an adequate leaf/bunch ratio in a particular cultivar. Information on leaf/bunch ratio in different Iraqi date cultivars is lacking. Scientific research is likely to be initiated to study a proper leaf to fruit bunch ratio in different leading commercial date cultivars.

Thinning: Neither fruit nor bunch thinning is commonly practiced in

Table 2. Total number of trees and production of commercial date palm cultivars during 1978 in Iraq

Commercial Cultivar	Total Number of Palms (thousand)	Number of Productive Palms (thousand)	Av. Yield per Palm (kg)	Total Yield (10 Ton)
Zahdi	11,643	10,175	29.4	29,895
Khastawi	1,179	873	26.8	2,341
Khadrawi	913	799	7.9	628
Dayri	423	384	10.9	427
Sayer	3,220	2,874	7.1	2,032
Hallawi	1,837	1,650	5.4	893
Chipchap	345	239	16.6	397
Braim	119	98	15.2	149
Others	1,268	1,036	20.7	2,141
Total	20,948	18,138	21.4	38,903

Iraq. The beneficial effects of fruit and/or fruit bunch thinning on quality of fruit is well known. Fruit thinning helps improve size and quality and prevents alternate bearing. Application of thinning practice on a commercial scale in Iraqi date orchards is under consideration.

Bunch covering: Covering fruit bunches with white paper seems to cause less sunburn. Fruit bunches are usually left uncovered in Iraqi date gardens. It may be useful to investigate the effect of fruit bunch covering on control of the "Abukhshem" problem (physiological disorder in fruits) and to improve the quality of fruits in general.

Interplanting: The present system of interplanting date palms with other fruit crops (citrus, fig, pomegranate, etc.) is causing reduction in yield, increasing attacks of disease and insect pests, and hindering the use of modern machines. Therefore, there is a need either to improve or to avoid the system of interplanting. Improved systems of interplanting have been suggested (Mohammed and Shabana 1979a; Thrower 1977), which may prove to be better than existing ones.

Use of Growth Regulators

Application of synthetic growth regulators to improve size, quality, and maturity of various fruit crops has become an important technique in horticulture. Few attempts (Benjamin, Jawad, Shabana, and Al-Agidi 1973; Benjamin, Shabana, Al-Ani, Clore, Jawad, and Shaibani 1975; Mohammed and Shabana 1980a; Shabana, Jawad, Benjamin, and Al-Ani 1976) have been made to use growth regulators, particularly naphthaleneacetic acid, 2, 4, 5-trichlorophenoxy propionic acid, gibberellin, and ethrel, to improve size and quality of dates in Iraq. Encouraging results have been achieved from these investigations. However, more scientific research is needed to exploit beneficial effects of growth regulators in the improvement of quality and quantity of date palms.

Fertilizer Requirement

There is little or no information as to how much NPK should be applied to date palm trees under different agroclimatic conditions. Researches are underway to calculate fertilizer dose, type of fertilizer, and time of application of fertilizers (Rahim 1978; Shabana, Mohammed, Hamza, and Hussien 1979). Due to the absence of detailed information on this aspect, thorough investigations have been proposed (Mohammed and Shabana 1979a). Application of fertilizers through soil, foliage, and injection systems will be tested and compared for their performance. A survey of the nutritional status of date orchards in different parts of Iraq has been initiated to determine deficiency or excess of nutrients. Studies are being conducted to understand the root distribution system of palms in different zones. This will assist in proper placement of fertilizers.

Breeding and Improvement

Practically no research on breeding and genetical improvement of date palm cultivars has been carried out in Iraq. Although breeding and genetical improvement involve considerable time and expenditure, their importance can not be overlooked. This is the only way of creating new and superior cultivars that may be dwarf, resistant to drought and salinity, and resistant to insect pests and disease. In view of this fact, a research project aimed at improving existing cultivars and breeding new cultivars of date palm is likely to be initiated. Various modern breeding techniques such as selection, mutation, polyploidy, hybridization, and parasexual hybridization have been suggested (Mohammed and Shabana 1979a) to be employed for date palm breeding. Initially the research could be directed toward selection of superior and desirable plants from the existing germ plasm of the country. More than 450 date palm cultivars are found in Iraq but only eight of them are grown on a commerical scale. Some of the leading commercial cultivars are declining in their performance for one reason or another. Therefore, breeding and genetical improvement research will play a vital role in replacing inferior commercial cultivars with superior new cultivars.

Plant Protection

Disease and insect pests of date palm have not yet assumed serious proportions in Iraq. Apart from inflorescence rot (*Mauginiella scaettae*), no other serious disease of date palm is present. Among many pests found in Iraqi date gardens, only mite, bug, and lesser date moth *(Oligonychus afrasiaticus, Ommatissus bionotatus,* and *Batrachedra amydraula*) are harmful. Trunk borers (*Pseudophilus testaceus* and *Oryctes elegans*) are also a problem but are found mainly in neglected orchards. *Ephestia* moth caterpillars, beetles, and flies are common storage pests and cause considerable damage if fruits are not fumigated after harvesting.

Tuzet or Bentate at 5 g/gallon for *Mauginiella scaettae* (Al-Hassan, Abdalah, and Aboud 1977) and 50% acetallic @ 2 liter per hectare (Al-Safi, Dhiab, and Hussain 1977) for *Batrachedra amydraula* have proved successful chemical control. Research is being carried out to find control for *Ephestia* and other storage pests.

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CLASSIFIED

Principes, 25(2), 1981, pp. 78–80

COCONUT BREEDING: A REVIEW OF WORK SINCE 1972

NIU HAARI*

THE common coconut, or tall,
Is known to be quite variable[1].
The lack of uniformity,
Between the palms from each country,
Means no *Cocos nucifera*
Is typical var. *typica*[2].

INSTEAD, two types identify—
The 'Niu kafa' and the 'Niu vai'.
The first evolved to float, not sink,
The second, man selects to drink[3]
And on the prehistoric shore
This helped develop hand and jaw[4].

WHICH of the two predominate,
On beach, small farm or large estate,
Can be determined, any day,
By a statistical survey
That, with appropriate precautions,
Analyzes fruit proportions[5].

VARIABILITY is expressed
Where the two types have intro-
gressed.
Technically, in genetics,
To introgress just means genes mix[6].
Compare the data and proceed
To choose the palms from which to
breed[7].

DOMESTIC or industrial use
For copra, oil or the juice
As a refreshing drink, can be
Decided on more rationally
When all concerned appreciate
That there is more to nuts than
weight[8].

* * * * *

AS for the dwarf[9], it will be found,
In four years, to fruit near the ground.
Give weed control and fertilize
And people may not recognize,
In thirty years, dwarf palms that all
Are up to fifteen meters tall.

BUT better still, the breeders claim,
Are hybrid sorts, in which the aim
Is to combine the best of each[10, 11].
These types are now within our reach
By Mascopol[12] or, *en français*,
Pollinisation assistée[13].

GROW dwarf palms in isolation,
Daily make emasculation,
From other palms take pollen and
Blow it or dust it on by hand[14, 15].
Pollen for long distance despatch
Is dried and sent in vacuum packs.

* * * * *

DISEASE susceptibility
Must also have priority.
If resistance, say to MLO,
Evolved thousands of years ago[16]
Then palms and their diseases are
In active equilibria[17].

THAT means disease is still around,
Though epidemics are not found,

* Niu = coconut (Polynesian), Haari = coconut (Tahitian).

And where the balance is upset
Recurrent outbreaks may be met[18].
Despite the best intentions, this
May be the breeders' nemesis.

THOSE who wish to can arrange a
Way to minimise the danger.
Where introgression has occurred
Local selections are preferred[19]
To imports, under quarantine,
With all the problems these may
mean[20].

* * * * *

THE benefits that can accrue
From work that the plant breeders do
Will NOT ensure a higher yield
Unless the farmer, in the field,
Improves cultural management[21].
For that YOU can some rhymes invent.

* * * * *

Notes

1. "The hundreds of vernacular names are indicative of this variability." Child, 1974.

2. "Tall palms, sometimes referred to var. *typica* Nar. These are the most commonly planted cultivars for commerical production . . ." Purseglove, 1972.

3. ". . . one sort of coconut evolved naturally . . . another arose under cultivation." Harries, 1978.

4. ". . . it was not until the coconut reached the coast of southeast Asia that man's early ancestor, the apelike *Ramapithecus*, came down from the trees some 12 million years ago." Harries, 1979a.

5. "Fruit component analysis allows the principles underlying the system of classification to be tested on any material, anywhere at any time." Harries, 1978.

6. "Introgression: the entry or introduction of a gene from one gene complex into another." Webster's New Collegiate Dictionary, 1975.

7. ". . . the thick husk, thick shell and thick meat of the 'Niu kafa' are desirable for coir, charcoal and copra. Windstorm tolerance, disease resistance and high meat weight are desirable 'Niu vai' characteristics." Harries, 1979b.

8. "One criterion for classification that is common to each of the systems described . . . is the weight of endosperm (fresh or as copra)." Harries, 1978.

9. "The term dwarf implies that the first fruit are borne close to the ground. The palm is precocious. In 30 years a dwarf palm may reach the height of 15 meters yet it is never as high as a tall of the same age." Harries, 1978.

10. "One particular hybrid, the Malayan Dwarf × Panama Tall, has bigger nuts than the dwarf, together with satisfactory resistance [to lethal yellowing disease] and yield. It has been called Maypan . . ." Harries & Romney, 1974.

11. ". . . precocious trees producing a large number of nuts with copra/nut as high as the West African parent . . . Malayan Dwarf × West African Tall, which we have called 'Port Bouêt 121'." de Nucé & Rognon, 1975.

12. "Mass controlled pollination . . . allows a new hybrid to be produced simply by bringing a different pollen to the seed garden." Harries, 1976.

13. "Assisted pollination is usually applied in seed fields where the 'male' trees are temporarily or permanently rejected as parents." de Nucé & Rognon, 1972.

14. "A new method of drying male coconut flowers for pollen extraction, methods for conditioning and storing pollen are described." Rognon & de Nucé, 1978.

15. "Equipment and techniques have been developed to meet the needs of pollen collection, processing and application in coconuts." Arnold & Harries, 1979.

16. ". . . [coconut] varieties in Asia have already been subjected to natural selection for resistance." Harries, 1978.

17. ". . . the plant pathosystem could have reached equilibrium." Robinson, 1977.

18. "A disease of . . . coconuts in Sumatra and Peninsular Malaysia seemingly associated with the presence of a mycoplasma-like organism (MLO) is described . . . . It seems certain that the disease is endemic to the region . . ." Turner, Jones & Kenten, 1979.

19. "After introgression, 'Niu kafa' and 'Niu vai' are subordinate types within a variable population. With each succeeding generation they adapt to local conditions and in that respect they differ from, and are preferable to, similar types that can be found elsewhere." Harries, 1979b.

20. "The large size of the coconut palm and its perennial habit make control of pests and diseases difficult and elimination virtually impossible." FAO, 1978.

21. ". . . one of the major causes of this low [coconut] productivity is the total lack of concern for efficient cultural management." Prudente & Mendoza, 1979.

ACKNOWLEDGEMENT

Presented by Hugh Harries at the 5th Session of the FAO Technical Working Party on Coconut Production, Protection & Processing, Manila, Philippines, December 1979.

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Seed Bank Notes

Seed under accession #80PS253 as *Pinanga* sp. nov. has been identified as *P. sanarani.*

Numbers 80PS170 and 197 sent out as *Arenga mindorensis* are now identified as a variety of *A. pinnata.*

Principes, 25(2), 1981, pp. 81–85

Palms for Southeastern Virginia

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The palms belong to the family Palmae, which has a worldwide distribution through the tropical and subtropical regions, wherever climatic conditions are suitable (1). Members of the family are also found growing naturally far from these areas. The European fan palm (*Chamaerops humilis*) grows to 44°N. Latitude in southern Europe, and species of the genus *Trachycarpus* are found growing at altitudes of 2,400 meters in the western Himalaya where there is snow cover from November to March. Some palm species are found below 30°S. Latitude in South America and almost to 40°S. Latitude in Australia. Most, if not all, of these genera are coryphoid palms, the northern belonging to the *Trithrinax* alliance (*Trachycarpus, Chamaerops*) and the southern to the *Livistona* alliance (4).

In the United States, we have several genera of palms that extend in range well beyond what could be considered subtropical latitudes. The genus *Washingtonia* is found in the southwest desert areas of southern California and Arizona, and in the east species of the genus *Sabal* are found growing in southeastern North Carolina. One of these species (*Sabal minor*) is seen growing on the barrier islands of North Carolina north of 35°N. Latitude, and its range may extend even farther north, although I have been unable to locate any north of 36°N. Latitude (5).

The cultivation and landscape use of palms is commonly thought to be confined to latitudes much farther south than those of southeastern Virginia. The purpose of my research was to determine the possibilities of utilizing various palm species as ornamentals in southeastern Virginia. The major factor to consider in species selection for use as test plants was that of the prevalent climatic conditions for this area (6), the specific condition being temperature. Therefore, the initial purpose of my research was to determine the cold tolerance of the species selected when used in a typical landscape design scheme. For the purposes of my study, I shall define southeastern Virginia as that area of the state bounded on the north by 37° N. Latitude, on the west by 76°50′W. Longitude, on the east by the Atlantic Ocean, and on the south by the state line. This area roughly includes the cities of Norfolk, Portsmouth, Chesapeake, and Virginia Beach. The actual location of the test planting was at my residence, located at 1401 Meals Gate Court in the city of Virginia Beach at 36°48′N. Latitude. This entire area of Virginia enjoys a warm temperate climate with strong marine influences from the Atlantic Ocean and Chesapeake Bay.

The palm species selected for the test were *Trachycarpus fortunei* (Chinese windmill palm), *Butia capitata* (South American jelly palm), *Chamaerops humilis* (European fan palm), and *Rhapidophyllum hystrix*

1. Test planting arrangement. Front walk border, from left to right, *Rhapidophyllum hystrix* (two plants), *Trachycarpus fortunei*. Against house, from left to right, *Chamaerops humilis*, *Butia capitata*, *T. fortunei*. The author at left. First snowfall 6 January 1980.

(needle palm). I selected young plants as they would most probably be the types that would be both available and affordable, especially to the average homeowner (2, 3).

Method

Planting took place from late February until late July as the specimens were acquired in order to give the plants adequate time to adjust to soil conditions as well as to develop a good root system. Soil, planting, and fertilization were the same for all specimens. All received the same amount of water. The location for planting was the front side of the house which faces southeast. Some palms were planted near the house (*Chamaerops*, *Butia*, *Trachycarpus*) and others along a sidewalk border (*Trachycarpus*, *Rhapidophyllum*). No effort was made to protect the plants from weather, except in the selection of the planting location. No trees, bushes, hedges, fences, etc. were present in the front yard to serve as wind breaks.

The temperatures (minimum–maximum) were recorded for each calendar day at the test location using standard maximum-minimum thermometers. Temperatures were also recorded from weather data obtained from the U.S. Weather Bureau at the Norfolk International Airport located about six miles north of the test location at Meals Gate. This was done in order to have comparison temperatures from another location within the study area.

Results and Discussion

The winter of 1979–80 was to provide a good set of test conditions, with many daily average temperatures for the months of January and February well below normal. Mild temperatures prevailed up until the 30th of November, when the first freezing temperature and the first frost occurred at the test location. On the morning of November 30th, a minimum temperature of 25° F was recorded for my location and 26° F for Norfolk Airport with light frost. This was followed by five consecutive freezing degree days on the mornings of December 1st through 5th. See table below:

Throughout the investigation only minimum temperatures were recorded for Meals Gate unless the maximum for the day was at or below 32° F.

This initial onset of freezing conditions accompanied by frost, preceeded by a long period of relatively mild weather, provided a good test for cold shock and frost damage, especially since it was followed by another mild period until the morning of December 10th, when a very light frost occurred with a minimum temperature of 31° F at Meals Gate and 32° F at Norfolk Airport. On that day, the daytime temperature recovered to the mid-50's at both locations, and another period of mild weather occurred with no freezing temperatures recorded until the morning of December 15th, when a minimum of 26° F was recorded with light frost at Meals Gate and 28° F at Norfolk Airport. This freeze was again followed by a period of mild weather.

Each of the nine test plants (*Rhapidophyllum*—5, *Trachycarpus*—2, *Chamaerops*—1, and *Butia*—1) was carefully examined after each freeze and observations revealed no noticeable damage. I defined a freeze as an exposure to a temperature of 32° F or below.

Throughout the remainder of December and up until the end of January there were periodic frosts and freezing temperatures interspersed with periods of mild weather. All plants remained unaffected. Our first snowfall occurred on January 5th and ended early in the morning of January 6th (Fig. 1) with temperatures recovering quickly on the 6th with a rapid melt. However, on January 30th, this mild weather trend reversed itself with a morning low temperature of 23° F recorded at Meals Gate and 25° F at Norfolk Airport. Snow began around noon on the 30th and ended in the early morning on the 31st. The snow was accompanied by high winds and low temperatures. The temperature had dropped to below freezing by sunset on the 30th and reached a minimum of 22° F at Meals Gate and 24° F at Norfolk Airport on the morning of the 31st.

Table 1. Temperatures in southeastern Virginia, 1–5 December 1979

December	Meals Gate Minimum °F	Conditions	Max.–Min. Norfolk Airport
1	25	Heavy Frost	50–27
2	27	Light Frost	43–30
3	28	Light Frost	41–30
4	24	Light Frost	54–30
5	28	Light Frost	61–29

Table 2. Comparative maximum–minimum temperatures between test location and Norfolk Airport for period 30 January–5 February 1980

January	Meals Gate Max.–Min. °F	Norfolk Airport Max.–Min. °F
30	35–24	35–25
31	28–22	29–24
February		
1	28–16	30–17
2	29–16	30–18
3	31–18	31–20
4	30–22	31–23
5	36–21	37–24

Snow acts as an insulator; however, the winds exposed many leaves on the test palms including the terminal growth on a few plants. This drop in temperature to freezing on the 30th of January marked the beginning of the severest weather conditions that occurred all winter. The temperature did not rise above 32° F day or night from the afternoon of January 30th until February 5th when a daytime maximum of 36° F was recorded at Meals Gate and 37° F at Norfolk Airport (Table 2). Heavy frosts occurred during the latter part of this period. Another snowfall occurred on February 6th and ended early in the morning on February 7th. This proved to be the heaviest snowfall recorded this century, averaging 12 to 15 inches across the area and accompanied by high winds. Again the insulating effect of the snow was offset by the uncovering of leaves by wind. Temperatures of below 32° F were recorded every night from February 6 through the morning of February 15 both at Meals Gate and Norfolk Airport, although daytime maximums reached above freezing each day. The recorded low temperature was reached on the morning of February 11 when the thermometer read 8° F at Meals Gate and 9° F at Norfolk Airport. A moderation of temperatures occurred after February 15.

The condition of the test palms at the time of writing (25 February 1980) is as follows: *Butia capitata* (1), minor foliar damage, especially to extremities of leaves; *Chamaerops humilis* (1), very minor damage to leaf tips; *Trachycarpus fortunei* (2), minor damage to leaf tips of lower leaves only; *Rhapidophyllum hystrix* (5), unaffected. I have arranged these palms in what I would consider their order of hardiness for this area. My results indicate that the palm species tested are suitable for landscape use in southeastern Virginia, especially if appropriate microclimates are provided. I consider *B. capitata* a tender palm for use in our area; however, it can be used if properly planted in somewhat protected locations. I hope to continue my research with other species of palms that may prove suitable for landscape use in the southeast section of Virginia. I should mention that the blue or dwarf palmetto (*Sabal minor*), the cabbage palmetto (*Sabal palmetto*), and the Washington palm (*Washingtonia filifera*) are at present being grown in my area. The latter two, *W. filifera* and *S. palmetto*, based on my observations are very tender in this area and suffered severe foliar damage or loss of the plant when planted in exposed locations. However, when planted in protected locations *W. filifera* and *S. palmetto* can be successful as ornamentals. The blue palmetto seems to be quite suitable for landscape use, and I have acquired several specimens for experimentation.

The expanded use of palms as ornamentals in landscape design should become more common in this area as more species prove to be successful in the southeast section of the state of Virginia.

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LETTERS

7330 Parkdale Ave.
Cincinnati, Ohio 45237

3 June 1980

Three years ago, while on a business trip, my husband and I purchased a small *Trachycarpus fortunei* from a nursery in Houston, Texas. We brought it back to Ohio and planted it out in the open in early September of that year. Before the weather turned really cold, that newly transplanted palm grew another leaf. We protected it that first winter with only a bubble type shelter made of 2 by 4s and covered with clear plastic on the top and one side, and by dark plastic garbage bags on the other sides. The only heating source was one 100-watt light bulb that we turned on only when the temperature in the structure fell below 25°F. We kept a thermometer in the structure and monitored the temperature constantly. The light bulb, in combination with decaying mulch, kept the temperature within the bubble approximately 6° warmer than the outside air temp. Our records show that 1°F was when the first sign of leaf damage became apparent. The temperature fell to −2°F that winter, but although the outer half of each leaf turned brown the palm did not die. We removed the bubble in mid-March and by the end of the growing season the palm had grown six new leaves.

The following winter our experiment was suspended, because we had to uproot the palm in December to prepare for a move.

After we were settled in our new house we put the palm back into the ground in early July. We chose a southern exposure and planted the palm within three feet of a wall. This time we decided not to protect the palm at all for the coming winter, except to surround the rather thick, two-foot-tall trunk with a pile of mulch and wood clippings.

The palm survived this last winter unprotected and is thriving. Again we noticed that the first sign of leaf damage occurred at 1°F and not before. The temperature this winter fell to −10°F and the palm suffered even less damage than it had in the bubble. For an entire week the temperature remained below freezing without killing it.

We were surprised to note that ice and snow sitting on the leaves at various times did no discernible damage whatsoever.

In early April we removed the mulch and trimmed off the leaves that were the most damaged. Since then our marvelous *Trachycarpus fortunei* has produced two new leaves (each 2 ft across) and is well on its way with a third.

Because of our wonderful success with this palm, my husband recently purchased a *Butia capitata* while on another business trip to Texas and we plan to do the same experiment with it.

We would appreciate hearing from members of The Palm Society who have had similar experiences. We will keep you posted on the progress of our newest acquisition.

Sincerely,
TAMAR MYERS

Papeari, P. K. 50
Tahiti
French Polynesia
July 28, 1980

Dear Hal,

I hope that you received the material of *Pritchardia lanigera* in good shape and that it will be useful to you. I was extremely fortunate to have gotten into the Kohala Mts. to see it as the area is very rugged, there are few trails, and access is limited. I was able to go in only because a nurseryman from California, Mr. Ira Broome, was interested in obtaining seeds of this palm to grow in California. He hired a helicopter and he, his son, Mark, and I spent two hours flying around that amazing place called the Kohala Mts. I thought you would like to hear of our adventure.

The Kohala Mts. is a relatively level, boggy area from 3,500 ft to 4,500 ft elevation that is dissected by enormous canyons as Waipio, Waimanu, and Hookane that have vertical walls laced with silvery waterfalls falling over 3,000 ft to the valley floor. The area experiences over 300 in of rain annually. We helicoptered into the flat, boggy area behind the largest of these valleys, Waipio, to begin our search. The forest on this boggy plateau is quite stunted and degraded, being about 10 ft tall. It appears that at one time it must have been in much better shape as from just above tree top level in the chopper, one sees a sea of dead, white snags of *ohia (Metrosideros)* that are 25–35 ft tall stretching to the horizon. The palms actually stand out against this backdrop of dead snags with their fan-shaped leaves and can be seen from a considerable distance in the chopper, perhaps as far as one or two miles. The palms here have the fattest trunks I have ever seen in Hawaii, up to 18 in in diameter, indicating that at one time they, too, were thriving in the once tall but now dwarfed and stunted *ohia* forest. What is striking is the crown of leaves. With few exceptions, the crown of leaves atop the thick, robust trunk of 25–30 ft height is composed of two to three sickly leaves about 1½–2 ft in diameter, a far cry from the huge leaves 6–8 ft in diameter that Dr. Rock photographed in 1910 and illustrated on page 102 of *The Indigenous Trees of the Hawaiian Islands.* The trunk is not constricted at any point and maintains its robustness throughout its length. It's just topped with a miserable crown. It appears that the palms here are going the same route as the tall *ohia* forest that once surrounded them, but unlike the *ohia,* the palms don't die back to a 10-ft shrub leaving a 30-ft snag. Instead, they may be gone soon. Very few of the stunted, degraded palms were flowering and none had fruit.

A few of the trees in this flat, boggy area do have a decent crown with leaves 3–4 ft in diameter and were flowering at the time, but these are exceptions. These were found on slopes in ravines where there is a better-drained soil and protection from wind. Several of these trees with decent crowns had fallen over completely but the crowns had already turned upwards again. This falling over is probably the result of the dying back of the surrounding forest that has now left the palms more exposed to wind. Actually, the healthiest, most vigorous palms we saw were always found growing on the steep slopes of the 3,000 ft-deep valleys where there is excellent drainage. In terms of the number of trees, we saw about 100 in our two hours of helicoptering. I doubt if there are more than 1,000 specimens of *P. lanigera* remaining in the Kohala Mts. We were extremely fortunate to find the seeds for two reasons. First, of the 100 or so trees that we scanned from the chopper, only two had seeds and these just happened to be situated next to each other. Second and just as important, there was a clear level place to land the helicopter about 20 yards from these two trees. It is uncommon to find trees adjacent to each other; they are usually situated at intervals of several hundred yards. In addition, it is very important to land the chopper within 50 yards of the tree, for to fight your way through even 400 yards of the dense scrub forest would take an hour. If one has the funding, a helicopter is the only way to go in the Kohala Mts. To go in on foot and search out 100 palms would have taken several days.

We found the two trees with seeds and from which we collected the herbarium material for you after 45 minutes of helicoptering. As the pilot jockeyed the chopper into a small clearing near the two palms, we stirred up two large wild boars that thundered off through the mud into the forest like charging rhinos. Upon jumping from the chopper, we sank almost to our knees into mud and water. Large ruts and trampled areas gave evidence to the damage done by boars in this area. It is doubtful if any palm seedlings could survive. We moved as swiftly as possible to the two trees and began to collect seeds and herbarium material. We had just finished and were making our way back to the chopper when the pilot revved the engine, a signal that he must take off immediately as thick clouds were rolling in. By the time we had piled into the chopper it was too late and we were completely socked in. To our surprise, the pilot took off hesitantly and began to fly through the thick clouds where we were unable to see beyond 20 ft in any direction. He was flying on instruments alone. I was expecting at any moment to see a giant green canyon wall flash in front of us and that would be it. To our relief, clear skies appeared and we made for the opening by going down and out Waimanu Valley and out over the Pacific. Although we continued to search for another hour, always staying ahead of the advancing clouds, we found no more trees with seeds and only one more place to land. That made a total of only three places to land near palms in two hours of flying. By this time, we were all getting a bit air sick from the circling, hovering, and jockeying for position so we called it a day and headed down.

Although we didn't find trees with large and spectacular leaves as Rock photographed in 1910 (probably due to lack of protection from absence of surrounding forest and degradation of soil structure leading to poorly drained soils), we feel that with proper cultivation these palms could become like the magnificent ones Rock saw.

All in all, it was a great adventure, perhaps my greatest with *Pritchardia*, and rivals the excitement I experienced when I saw the tall ones in Honomalino, S. Kona for the first time.

Most sincerely,
DON HODEL

Edited by H. E. Moore, Jr. shortly before he died.

BOOKSTORE

Computer Listing of Palms for Sale

Palm Society Member Gary Wood is offering a computer assisted listing of rare and common palms for sale in the U.S. You may participate as a buyer or as a seller. Subscription to the listing is $10.00 for four quarterly issues. There is no charge to sellers. Address inquiries to: San Juan Tropicals, P. O. Box 601, San Juan Bautista, CA 95045.

DICK DOUGLAS