Palms

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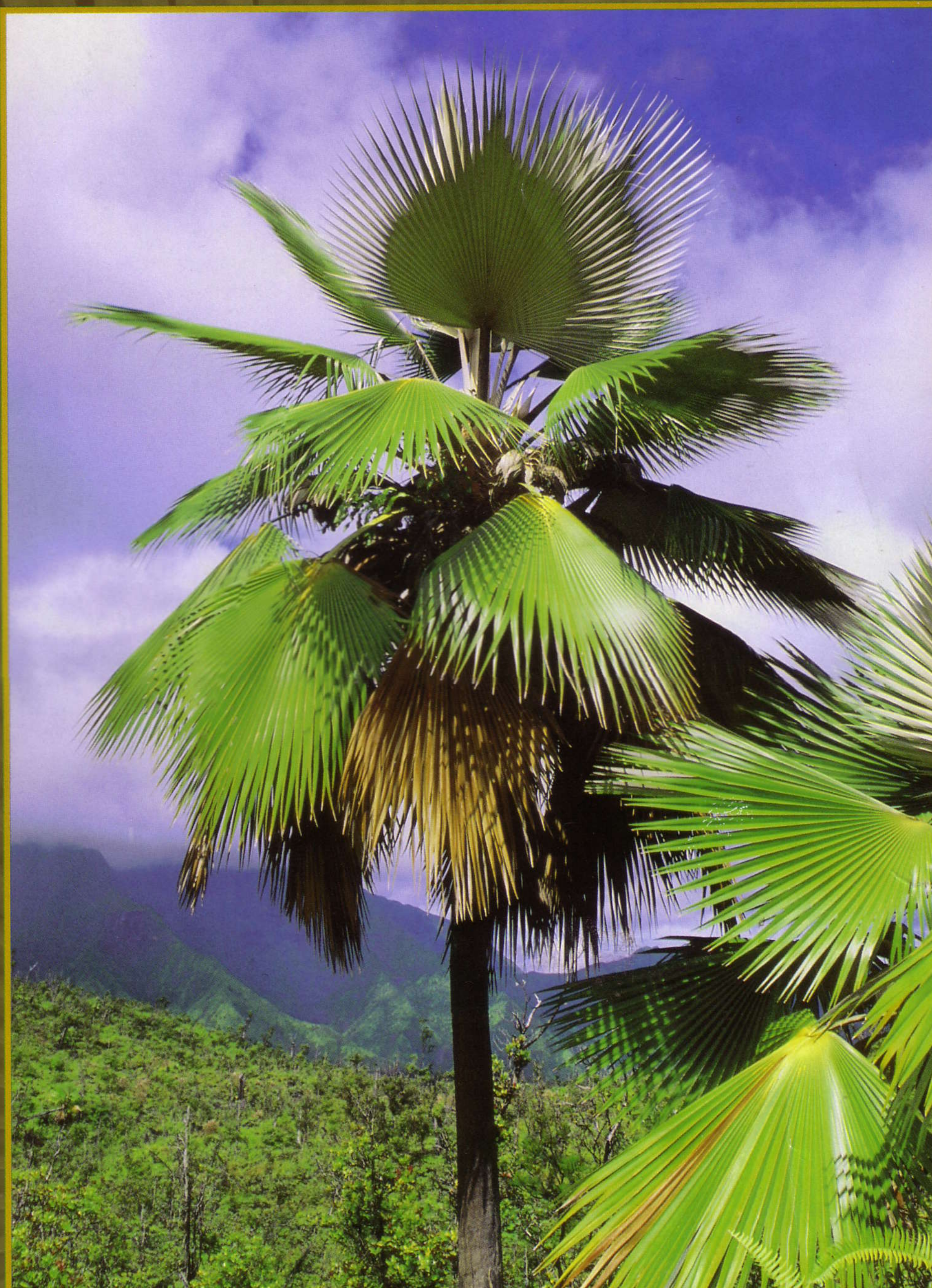

THE INTERNATIONAL PALM SOCIETY, INC.

The International Palm Society

Founder: Dent Smith

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FRONT COVER

Pritchardia viscosa, two of only six individuals known in the wild, Powerline Trail, Kauai, Hawaii, USA. Photo by John Dransfield, October 1999.

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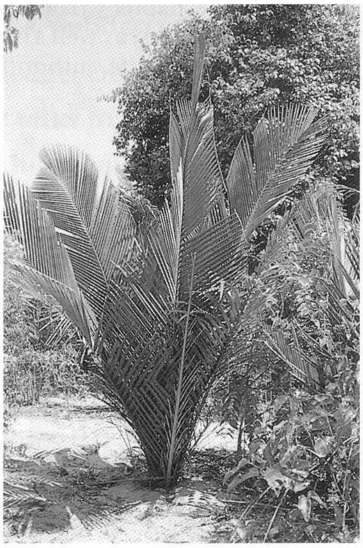

Attalea spectabilis growing in pure sand on the shores of the Rio Nhamundá. See article page 25. Photo by A. Henderson.

In the Supplement to PALMS... Election ballot and news about the 2000 Biennial Meeting in New Caledonia and the post-meeting trip to Queensland, Australia!

President's Message and Important Announcements

In addition to the news from local Chapters and Affiliates, the Supplement to this issue of PALMS contains two very important items. The first is the **ballot for Directors** to the IPS. We have elections every two years. Terms are for four years, and you will be electing half the Directors this year. Officers are elected from the pool of Directors elected by the membership. The future of our Society is determined by the Directors that you elect. Please vote now before you forget.

The second important part of the Supplement is the information on the **Biennial 2000 and the Post Biennial Tour.** Those who attended the 1998 Biennial in Thailand know what a great Biennial is all about. Many left saying it was "the best Biennial ever!" Our hosts for this year's Biennial and Post Biennial tour want to top 1998. They promise you will never forget these events.

The Biennial will be on the exotic island of New Caledonia, October 8–14, 2000. The Post Biennial Tour will be in the Cairns region of northern Queensland, Australia, October 16–23/24. The itineraries for both events, costs, activities, etc. are described in the Supplement, along with registration forms and payment information. Please note that the registration fees for both the Biennial and Post Biennial Tour include your hotel room and many meals. **Air fares are not included.**

Although not a large island, New Caledonia has some of the most beautiful palms in the world. Our host, the IPS Chapter Chambeyronia, has arranged for attendees to view native species in both private and public gardens, as well as in natural habitats. We shall also enjoy fine French cuisine and hear from some of the top palm authorities from around the world. This is not a Biennial to miss!

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Changes to PALMS

This issue represents a passing of the baton, so to speak. Dr. Natalie W. Uhl, who has served as an Editor of Principes/PALMS for twenty years, has chosen to retire from the position so that she can spend more time on her palm research and other projects. For her many years of outstanding service to the Society, Natalie was presented with the Dent Smith Memorial Award last year. She will continue to serve the IPS as Associate Editor. Dr. Scott Zona, formerly the Associate Editor, has joined Dr. John Dransfield as Co-Editor. These changes have led to some reorganization in the way manuscripts are received and processed. From now on, all materials for publication in PALMS should be submitted to Dr. John Dransfield at the Royal Botanic Gardens, Kew. John will handle correspondence with authors, and Scott will work with Allen Press in producing the journal. Both editors will continue to seek high-quality articles on all aspects of palm horticulture, biology, and natural history. The editors promise that there will be something for everyone in every issue of PALMS.

With volume 44, the editors are now using desk-top publishing methods to prepare the manuscripts for submission to our printer. This change will result in considerable financial savings for the IPS and will streamline the publication process, allowing greater flexibility in producing the journal. We hope that you will find the layout of the journal attractive; we believe that the better placement of illustrations and the new fonts used throughout this issue will make for improved readability. We would like to acknowledge gratefully the expertise of John Stone, Graphic Designer, Royal Botanic Gardens Kew in redesigning the cover and layout of our journal. We are also grateful for the layout assistance provided by Lee Kline and Susan Knorr.

Preparation of PALMS involves much discussion. Of course, this is easiest when the Editors actually meet face to face. We were very fortunate to have had the opportunity to meet in Miami, together with Natalie Uhl in January, at the crucial moment when the change to desk-top publishing needed to be put into effect. During the visit, JD and NWU stayed at the Montgomery Botanical Center, and we would like to acknowledge formally the immense help that the Director, Dr. Terrence Walters, and his staff have been over the last few years in providing an unparalleled facility for palm research and, coincidentally, an excellent venue for editorial meetings for PALMS.

John Dransfield and Scott Zona

Palms 101: The Travelling Slide Show

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My employer (Indian River Community College, Fort Pierce, Florida) likes folks on the payroll to perform "community service." This means that teachers and administrators are encouraged to go out into the four-county area that the public college serves to speak on various topics about which they have some knowledge. One faculty member, who has lived in Taiwan and who speaks Chinese, regularly talks to civic groups about Chinese Culture. Another, an anthropologist, speaks on the paranormal. But most topics are less exotic, often having to do with some aspect of health and wellness. Program chairmen/women of organizations are always on the lookout for likely speakers; the college's speakers' bureau is a handy resource.

When it occurred to me that maybe I too should perform some "community service," I wondered what I should talk about. As a college English teacher with 30 years of experience, as an Irish(-American) man, as a Philadelphian, I had no doubt that I could talk for an hour (at least). But—on what? I had written two dissertations—one rejected, the other accepted—on the Victorian novelist, Anthony Trollope, and had read every one of his 47 novels. Was there an audience out there for Trollope? After all, I had given one talk to the local American Association of University Women (AAUW) group, some of whom had mistakenly thought I recommended for their delectation that 800-page, 1876 blockbuster novel, *The Prime Minister*. (An AAUW reading group had subsequently read and loved it!) I couldn't really think that audiences were longing to hear about Trollope's manifold virtues. I had also prepared and given another talk on "Reading for Pleasure," though this topic inspired similar reservations.

Palms! That's it! My wife, Ann, had joined the Palm Society—not yet the International Palm Society—in 1976. With the birth of our first child in 1979, her energies and attention were otherwise directed: I became the member of record, and chief resident enthusiast. Now that I had my topic, what could I say? Um.

I spent several months cruising the literature, trying to get a grasp on basic botany. What are the growth points, what (exactly) is inside the trunk? Few concessions were made to the non-botanist; authors of many palm books were so eager to talk about leaves, inflorescences, fruit, species, that other information was skimpy. Corner's *The Natural History of Palms* was most helpful. I soon realized that I didn't have to provide a botany lecture, that I wouldn't be addressing a class. But questions needed to be formulated and answered.

Who would be my audience? What did they need to know? How much information did I want to provide? The audience would likely be seasonal visitors—"snowbirds"—and transplants from the North, many of them retirees, to whom the climate, the plants, the gardening practices in Florida are totally foreign to their experience. Where else in the U.S, indeed, does someone plant a flower or vegetable garden in October, then watch it die in May or June? The audience would need to know how to select and to care for palms.

The information should be basic, straightforward, not confusing. A simple task to do all this, right?

I would have to recommend palm species, but which ones? I went through the books, looked at lists, thought about what had succeeded for me, asked palm friends for suggestions. I narrowed species down into two categories: commonplace palms for identification, and less commonplace palms readily obtainable and relatively undemanding in care.

And, of course, there had to be a slide show. Lordy, I didn't *have* any slides. Bernie Peterson, nurseryman extraordinaire, of Cocoa, Florida, came to my rescue. He had assembled quite a few palm slides for a talk he had given to a short-lived botanical society that was to nurture the palms planted on the Florida Institute of Technology campus in Melbourne by Dent Smith (IPS founder) and Jerry Keuper (then FIT president, later IPS president). I could have the slides on long-term loan.

In January, 1993, I gave my first presentation at Heathcote Botanical Gardens in Fort Pierce, whose director, Lib Tobey, had recently installed a section with some nicely labeled specimen palms. She happily informed me that more than 30 people had signed up to attend. A significant number were nurserymen. My heart sank. What kinds of questions might they ask? Don't worry, I was told, they don't know all that much about palms. (This reassurance turned out to be fairly accurate, for general nurseries and garden centers here usually sell a narrow range of palms: queens, washingtonias, Chinese fans, "pineapple palms" [juvenile *Phoenix canariensis*], *Phoenix roebelenii,* occasionally paurotis, *Rhapis excelsa,* and, more recently, majesty palms.)

My first palm talk wasn't quite a disaster. I spent too much time trying to talk about palm botany and about the latitudes within which palms grow. Some slides that I had added to Bernie's were almost too dark to be identifiable. My handout was a skimpy list of palm species suitable for planting in the area. The nurserymen bombarded me with almost non-stop questions, most of which I was fortunately able to answer. I almost lost control of the situation and my talk went on far too long, about an hour and a half. I was so late in finishing that the planned visit to the palm walk was over too quickly, and took place in the deep shadows of late afternoon.

I staggered home to lick my wounds and to figure out how to make repairs. Every teacher knows that the first time he/she teaches a course is a learning experience, frequently in what not to do. I streamlined the presentation to trim botany and geography. I got new and better slides. (If only all palms grew out in the open so that good pictures could be taken!) Eventually, I replaced about half of Bernie's slides with my own; some of his were on fascinating palm detail that was wasted on an audience just learning to tell a palm from a petunia. Viewers needed more generalized pictures.

I put together an expanded, more detailed 5-page handout that has been revised, tinkered with, and—hopefully—improved several times since. The first page was a list of palms by Latin and popular names, together with size, approximate cold-hardiness, and salt tolerance. The second page contained separate lists of native palms and of additional, less common exotic species obtainable from palm nurseries. Then, very **basic** general information about fertilizing, grooming (No, don't trim off green or even yellow leaves, watch out with the string trimmer, don't nail signs to palm trunks), what to do before and after a freeze, where to see palms (Fairchild, of course, and elsewhere).

All this came under the first-page title of "Suggested Palms for the Treasure Coast." The Treasure Coast is a tag given to three small counties on Florida's Atlantic coast: Indian River (my home county), St. Lucie, and Martin. Ships of the Spanish treasure fleet sank off this coast in the 18th century. The area is Zone 9B, the lower end of Central Florida, subject to occasional freezes not usually experienced in the balmier climes of West Palm Beach and Miami.

My major criterion for listed species was cold-hardiness; the Great Christmas Freeze of 1989, when the temperature fell to 18°F in my yard, was still horrifyingly fresh in my mind. The whole area, not just at my house, smelled for weeks of rotting vegetation. Not only palms, but also crotons, hibiscus, ixora, bougainvillea, and carissa browned as if blowtorched. A potential audience needed to know that palms seen in West Palm Beach (a mere hour's drive south) might be too tender to survive on the Treasure Coast. I reluctantly included queen palms and washingtonias on the list of suggested palms (for identification), but also pointed out some disadvantages in planting these; I was enthusiastic about *Bismarckia,* which grows well here.

I re-arranged slides to match the order of species on the handout. I didn't pretend to any knowledge of species outside my home area, concentrating instead on palms with which I had had experience or which friends had grown.

In four years I've given my palm talk about a dozen times, often to 50 or more people, to retirees in a mobile home park and to garden clubs, most notable of which was on Jupiter Island, an enclave of old money where George Bush's mother—remember, she made him eat his broccoli?—lived her last years. I gave the presentation locally several times for the Florida Yards and Neighborhoods program of the state extension service, the purpose of which is to promote xeriscaping. I've also spoken to two chapters of the Florida Native Plant Society (of which I am a member), emphasizing native palms, as well as in a local library program, and on my home campus. Most of the time I've had seedlings to give away: "freebies" are hard to resist. Usually, these have been *Livistona saribus* and, sometimes, *Chamaedorea microspadix*. I also set out forms for membership in the Central Florida Palm and Cycad Society and forms for membership in the IPS. Chapter membership is an easier sell to beginners, being cheaper and less of a commitment.

I present myself before the audience as low-keyed, good-humored, self-deprecatory ("I'm not an expert; the experts are botanists. I'm an English teacher, a hobbyist grower, who has learned a bit about palms by making real mistakes, unfortunately killing some palms in the process"). The trick with an audience of neophytes is to provide information without condescension or lecturing. Such a local presentation raises consciousness about palms; perhaps something similar to what I've been doing might work elsewhere. Yes, I have received a few calls at home (I don't give out my phone number but I am in the directory): I have directed callers to reference books and to nurseries.

I have been amused to discover that a Ph.D. in English Literature confers a credibility in my audience on what I'm telling them about palms. I could give them, if desired, an expert opinion on a verb or on a novel, but it is the magic and mystery of palms that draws them and that makes Florida distinguishable from New Jersey.

Editors' note: The handouts mentioned are available from the author who stresses that they were developed for local areas.

Instructions to Contributors

PALMS

Papers submitted for publication in PALMS must not have been published or submitted for publication elsewhere. Manuscripts will be reviewed by the editors and an outside reviewer. Manuscripts should be in English.

Authors should examine a recent copy of PALMS and follow the format established therein.

The hard-copy of the manuscript, including figures and captions, and the electronic copy should be sent to Dr. John Dransfield at the address below. Artwork may consist of line drawings, halftone or color photographs, or color illustrations. For review purposes, the author may submit clean photocopies of the artwork, and forward the original art upon acceptance of the manuscript. For color photographs, slides are preferable to prints. Vertical format is preferable to horizontal (landscape) format. The editors reserve the right to reproduce color photos as black-and-white halftones. Photographs must be clear, with good contrast and sharp focus.

Manuscript Preparation Checklist

Hard-copy

Manuscript title, author's full name and mailing address, and author's e-mail address, if available, on page 1.

Text should be typed, double-spaced, with page number in the upper right-hand corner.

Latin names should be underlined or written in Italics.

Literature Cited should follow the format established in PALMS vol. 44 (2000)

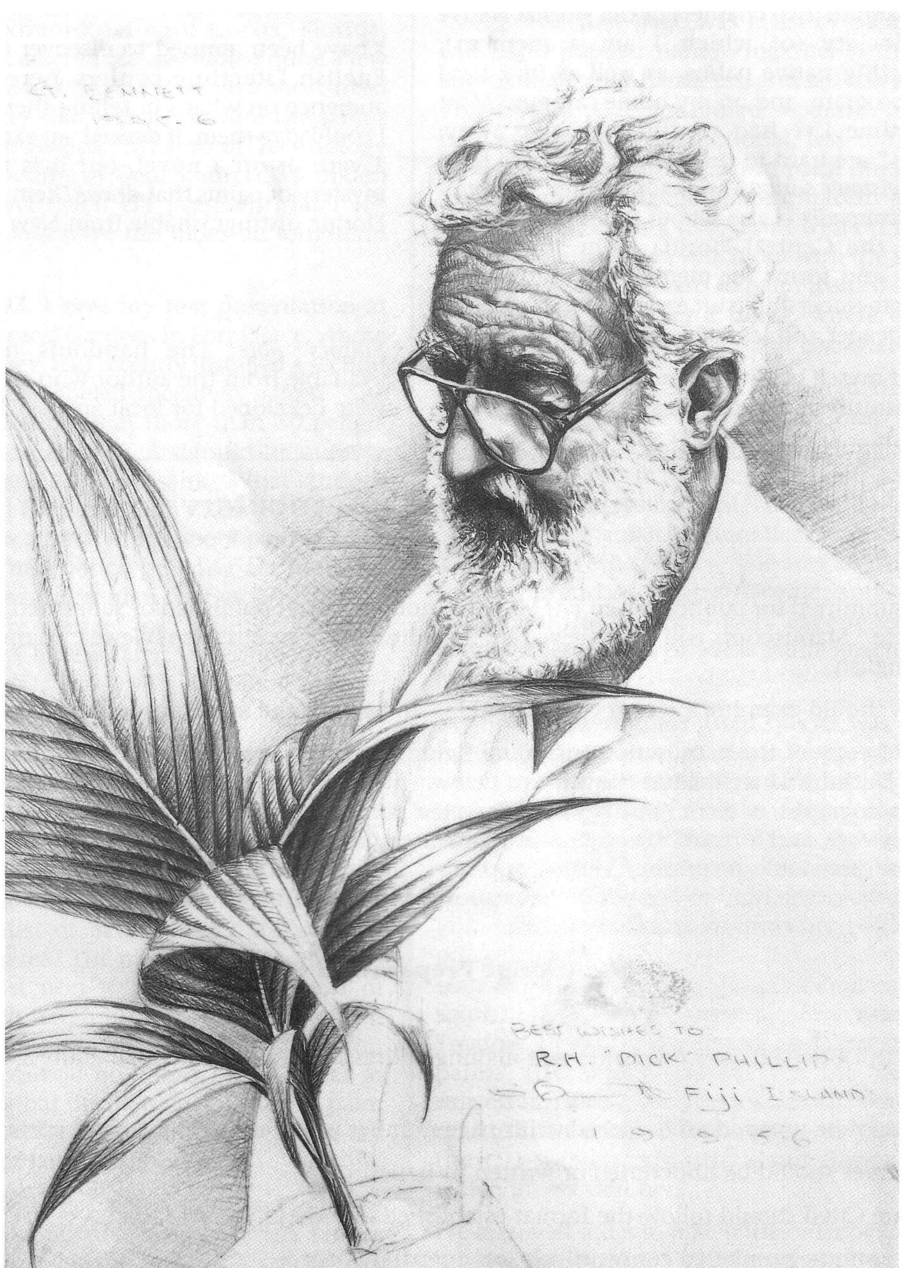
Figure captions, numbered consecutively, on a separate page.

continued on page 36

Richard H. (Dick) Phillips

1923–1999

It is with great sadness that we report the death of Dick Phillips in Fiji. Dick was a staunch supporter of the International Palm Society and was for several years a member of the Board of Directors. A generous and prolific correspondent, Dick championed the palms of Fiji and the western Pacific. He was a most gracious host and source of knowledge about palms and other tropical plants for all enthusiasts who visited the archipelago. The drawing of Dick by George Bennett that so perfectly captures his appearance is reproduced with kind permission of Di and Roger Phillips. Dick will be greatly missed, for his enthusiasm, sense of humor, deep interest in West Pacific palms, and generous spirit.–Natalie Uhl



Occurrence of Coconut '*Lixas*' in Brazilian Native Palms in the Northeastern Coastal Plain

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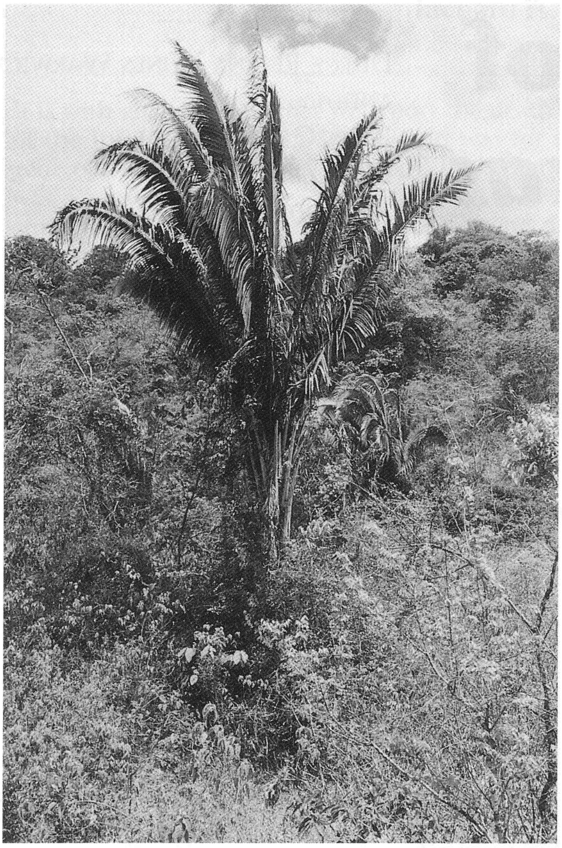
Some native palms of Brazil may serve as a reservoir for these fungal diseases of coconuts.

Coconut (*Cocos nucifera* L.) was first introduced into Brazil by the Portuguese in 1553 and today is widely grown along the coastal areas of the northeastern region, which provides 92 per cent of national production. In more recent years, there is a vast interest for growing dwarf coconut trees for water utilization, only in São Paulo State a daily consumption of 100 000 tender fruits has been estimated. On average, yearly production of coconut is 3,377 fruits/ha (Cuenca 1994), a consequence of irregular rainfall distribution, low yielding varieties and attack by a number of insect pests and diseases.

Two leaf diseases are responsible for considerable losses in different growing regions of Brazil: *lixa pequena* or small verrucosis, caused by *Phyllachora torrendiella* Subileau [= *Catacauma torrendiella* Batista (Batista, 1948 and Subileau, 1993)] and *lixa grande* or large verrucosis, caused by *Sphaerodothis acrocomiae* (Montagne) von Arx & Muller [= *Coccostroma palmicola* (Speg) von Arx and Muller (Joly 1961)]. Lesions are diamond-shaped with a long axis parallel with the venation of the leaflets, having a crusty, black, wart-like texture and measuring 4–6 mm × 2–4 mm for *P. torrendiella* and 5–7 mm × 3–4mm for *S. acrocomiae,* which has brown stromata. A chlorotic yellow halo surrounds the infected spot and the disease incidence can be quite high, such that large areas of tissue become necrotic.

There are two other species of *Catacauma* reported to occur in palm trees, *C. mucosum* in *Butia, Cocos* and *Syagrus* spp., while *Acoelorrhaphe wrighii, Livistona chinensis, Sabal causiarum, S. etonia, S. mexicana, S. minor, S. palmetto, S. umbraculifera, Syagrus romanzoffiana* and *Washingtonia robusta* have been reported as hosts of *Catacauma sabal* (Chase & Broschat 1991). Joly (1961) reported the fungus *S. acrocomiae* in *Acrocomia aculeata* but this palm is the only one reported as host for *lixa grande* disease.

Since coconut was introduced from the Old World and the two fungi are obligate parasites, our work was to discover which palm species native to Brazil are natural reservoirs, to compare the distribution of the two diseases with the natural occurrence of the susceptible palm species, and also to find different species of *Phyllachora* or *Sphaerodothis*.



1. *Attalea funifera.*

2. *Syagrus coronata.*

Field surveys

Field trips were carried out in the states of Sergipe, Alagoas, Pernambuco and Bahia. Leaves were collected, samples of the material found infected by the fungi were placed under the microscope and fungal structures were carefully examined. Surveys were conducted mainly during the rainy season. *Attalea funifera,* known as Piassava Palm, present in the states of Alagoas, Bahia and Sergipe, was collected in Piaçabuçu County (Al) and Itaporanga d'Ajuda (Se). This palm tree has a stem around 15m and the leaves are long, the crown being funnel-shaped (Figure 1). The fronds serve as roofing material and the fiber used for broom manufacture.

Two *Syagrus* species were collected, 1. the ubiquitous *Syagrus coronata* (Fig. 2). It is known as *arikury, ouricuri, licury,* or *licurizeiro* palm and 2. *S. schizophylla* (*coco babão* or *arycurioba*). Arikury palm has potential for landscaping in regions with low rainfall, as it occurs in a region of transition between the forest and the bush land . The fronds of the palm provide material for roofing, hats and other handicrafts. The mesocarp is edible and the leaves yields wax. *Syagrus schizophylla* is found in sandy soil near the seashore, and can be used as an ornamental and has a sweet mesocarp which can be eaten (Fig. 3).

Acrocomia intumescens was collected from the State of Pernambuco, where it occurs in forest; its fruits are used as a source of oil (from the endosperm) and the mesocarp is edible.

Samples of *Allagoptera brevicalyx,* known as *caxandó* or *buri-da-praia*, were found in the County of Itaporanga d'Ajuda, Pirambu and Estância. It is a small acaulescent palm that occurs on loose sand on beaches, on dunes and in scrub woodlands (Uhl & Dransfield 1987). In Brazil it occurs mainly in the States of Bahia and Sergipe, and can be used for landscaping. The sweet fruits are appreciated by small animals (Fig. 4).

Bactris ferruginea (Mané-veio) was collected in Sergipe and Bahia, it occurs in the coastal forest land, and has a potential for landscaping; the leaves yields a good fiber and the fruits can be eaten.

Disease distribution

The surveys indicated differences in the occurrence of *lixas* in the different palm species and are

Table 1. Occurrence of the different *lixas* in the native palm trees of the northeastern coastal plain region of Brazil, with the natural distribution of Palm species in the country.

Species	*P. torrendiella*	*S. acrocomiae*	Distribution
Acrocomia intumescens	absent	absent	AL,CE,PB,PE
Allagoptera brevicalyx	present	absent	BA, SE
Attalea funifera	absent	present	Al, BA,SE
Bactris ferruginea	present	absent	AL,BA,PB,PE,SE
Syagrus coronata	present	absent	AL,SE,BA,PE,MG
*Syagrus schizophylla**	absent	absent	AL,BA,ES,PE,SE

* This palm species was found to be host to another *Phyllachora,* which produces similar symptoms to *lixa pequena.*

reported in Table 1; also the distribution of the palm species can be seen in the map of Brazil (Figure 5). *Acrocomia intumescens* was the only species found to be free from both fungi.

Lixa pequena (*Phyllachora torrendiela)* was the fungus with the wider host range. It was collected from *Syagrus coronata, Allagoptera brevicalyx* and *Bactris ferruginea.*

The first symptoms of this disease are small black, charcoal-like fruiting bodies formed superficially on the leaflets, midribs or even on the fruits. This formation, known as stroma is either found isolated, in lines, or in a diamond shape, the number of the formations is usually very high and difficult to count (Fig.6). Later, the plant tissue around the stroma forms brown, necrotic lesions, which enlarge to about 2 × 15 cm. Numerous brown areas coalesce, the leaflets become necrotic and the whole leaf collapses. *Lixa pequena* is widespread in the different coconut regions from the Amazon area to the State of Rio de Janeiro (Renard, 1988 and Warwick, 1989).

3. *Syagrus schizophylla.*

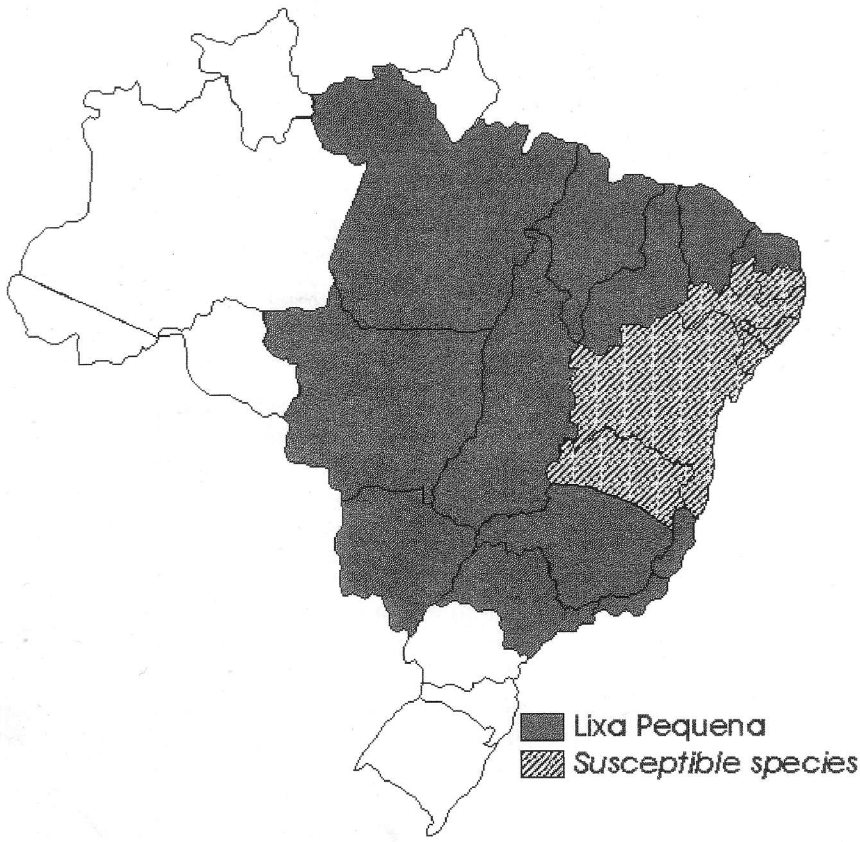
Sphaerodothis acrocomiae was found only in *Attalea funifera.* As a coconut disease it occurs in a most restricted area along the Atlantic Ocean (eight States), while *P. torrendiella* occurs from Pará to São Paulo State (17 States) (Fig. 5, 8). The stromata of this fungus are brown, larger and more superficial than in the previous fungus described. The fungus has a claviform ascus and the spores, brown when mature, are surrounded by mucus.

A different species of *Phyllachora* was found in *Syagrus schizophylla* (Fig. 7). It has been sent to a mycologist for identification.

Inoculation tests

Pathogenicity tests were carried out in a coconut nursery; seedlings of the palms were placed near coconut palms which were contaminated by the two *lixas* for natural inoculation. Symptoms were

4. *Allagoptera brevicalyx.*



5. Distribution of *lixa pequena* (*Phyllachora torrendiella*) in relation to the natural occurrence of susceptible palm species.

6. Fruiting bodies (stroma) of *lixa pequena.*

7. A species of *Phyllachora* on *Syagrus schizophylla*.

8. Distribution of *lixa grande* (*Spaerodothis acrocomiae*) in relation to the natural occurence of susceptible palm species.

recorded three months later. The inoculation trial confirmed the data; none of the palm species was infected by the two fungi and the host range was the same as found in nature.

Conclusion

The two *lixas* are particular to palm species – in another words, a host to *lixa grande* was not found to be host to *lixa pequena*, only coconuts can be infected by both fungi. The capacity of *lixa pequena* to infect more palm species may explain the fact that the disease has a wider distribution in Brazil than *lixa grande*. It can be concluded from this work that coconut planting done in areas where these other palm species do not occur should be carried out with seedlings free from both *lixa* diseases. Surveys in other regions of Brazil will be continued in order to understand better the distribution of these two fungi.

Acknowledgments

We would like to thank Luiz Fernando Brito de Carvalho for preparing the maps and Erivaldo Fonseca for helping to collect the palm samples.

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Arenga micrantha: A Little-Known Eastern Himalayan Palm

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From Bhutan, high in the eastern Himalayan mountains, comes *Arenga micrantha*. It is likely to be the most cold-tolerant member of the genus.

When I visited Bhutan in 1991, I took a rather distant photograph (Fig. 1) of a stemless palm growing on an inaccessible slope. The transparency was shown to John Dransfield who identified it provisionally as *Arenga westerhoutii* Griff., and it was included under this name in the account of the palms in the *Flora of Bhutan* (Noltie, 1994). I was slightly wary of this at the time as *A. westerhoutii* is a much larger palm, which normally develops a trunk and had been, until then, known only from Thailand, Burma and Malaya. A fragmentary vegetative specimen of the same species had been collected in Bhutan by Andrew Grierson and David Long in 1979 (*G & L* 1651, E), who had identified it as the widely cultivated *A. saccharifera* Labill. (= *A. pinnata* (Wurmb) Merrill).

On a recent visit to Bhutan this puzzling palm was found to be not uncommon in warm-temperate, broad-leaved forest throughout the central and southern zones of the country. It grows on steep, highly inaccessible, forested slopes, but all the specimens that could be seen from roadsides appeared to be sterile. However, I was fortunate to be accompanied on the trip by Sherub, who had observed a flowering specimen above Rongthong, near Tashigang in eastern Bhutan in 1996. This specimen was relocated and reached by scaling a small tree and a slippery cliff! Photographs were taken (Figs. 5–7) and a specimen collected (*Noltie, Pradhan, Sherub & Wangdi* 201, E).

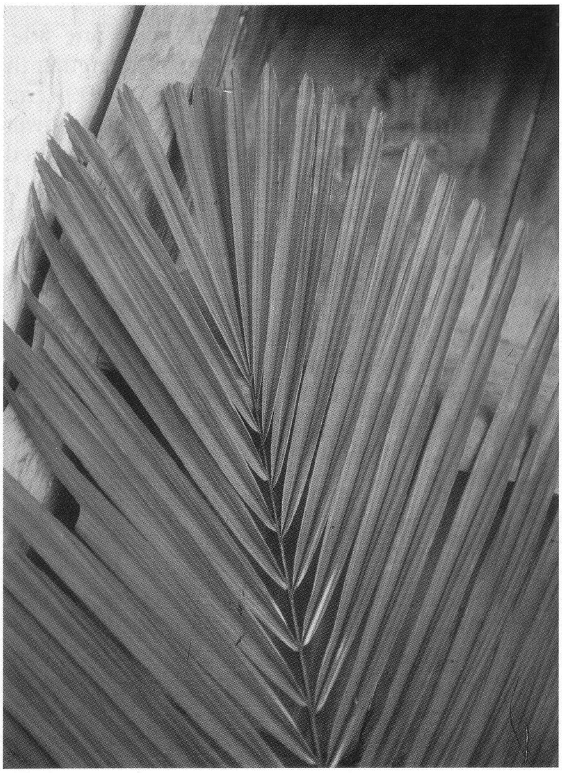
The palm is the little-known *Arenga micrantha* C.F. Wei, a species described recently from SE Tibet, some 400 km NNE of the eastern border of Bhutan (see Map). Whereas the type specimen was male, the single fertile Bhutanese specimen bore only female inflorescences. Although the specimen had been flowering for at least two years, none of the flowers appeared to have set fruit, indicating that the species cannot be agamospermous and requires pollination to set fruit.

The genus *Arenga* is usually monoecious and 'very rarely apparently dioecious' (Uhl & Dransfield, 1987), but from the above evidence this species appears to be truly dioecious. Further observations, however, are required. It is possible, for instance, that the palm could have different sexual phases developmentally. However, this seems unlikely as the fertile specimen seen had a (pseudo-)terminal female inflorescence and all the lateral ones (even those near the base) were also female, so it is difficult to imagine when a male phase could occur. The species is also similar to *Wallichia*, but that genus is characterized by having connate sepals in the male flowers.

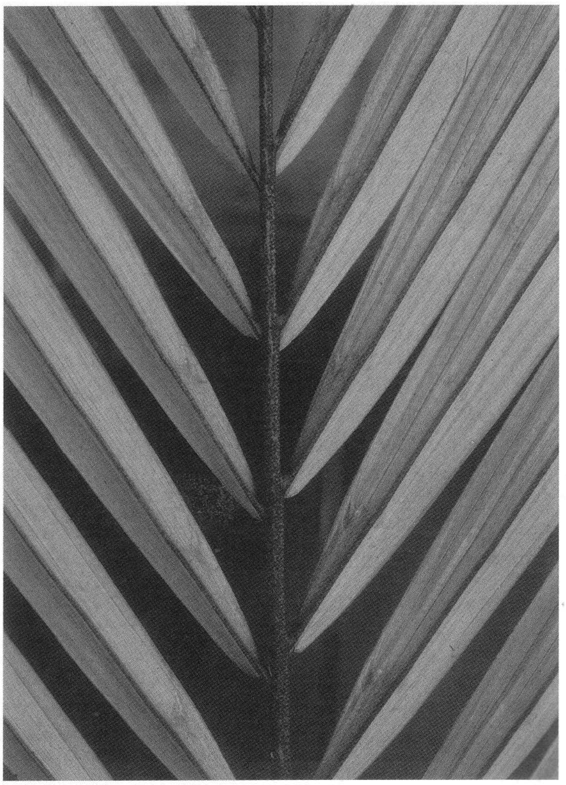
The palm is mysterious in various respects—why does it flower so rarely? Why was it not collected earlier? It seems particularly surprising that William Griffith missed it—he visited Bhutan in 1838, was especially interested in palms, and went through parts of the country where it occurs. Its

1. *Arenga micrantha*: habit.

2. *Arenga micrantha*: whole leaf.



3. *Arenga micrantha*: close up of leaf upper surface.



4. *Arenga micrantha*: close up of leaf lower surface.

5. *Arenga micrantha*: leaf sheaths.

6. *Arenga micrantha*: pseudo-terminal female inflorescence.

distribution is also unusual. Whereas there are several palms that occur in Sikkim/Darjeeling immediately to the west of Bhutan that have not so far been found in Bhutan, this is the first that appears to have a western limit short of the Sikkim/Darjeeling border. If it did occur in the Darjeeling area, it would almost certainly have been collected in the nineteenth century.

Description

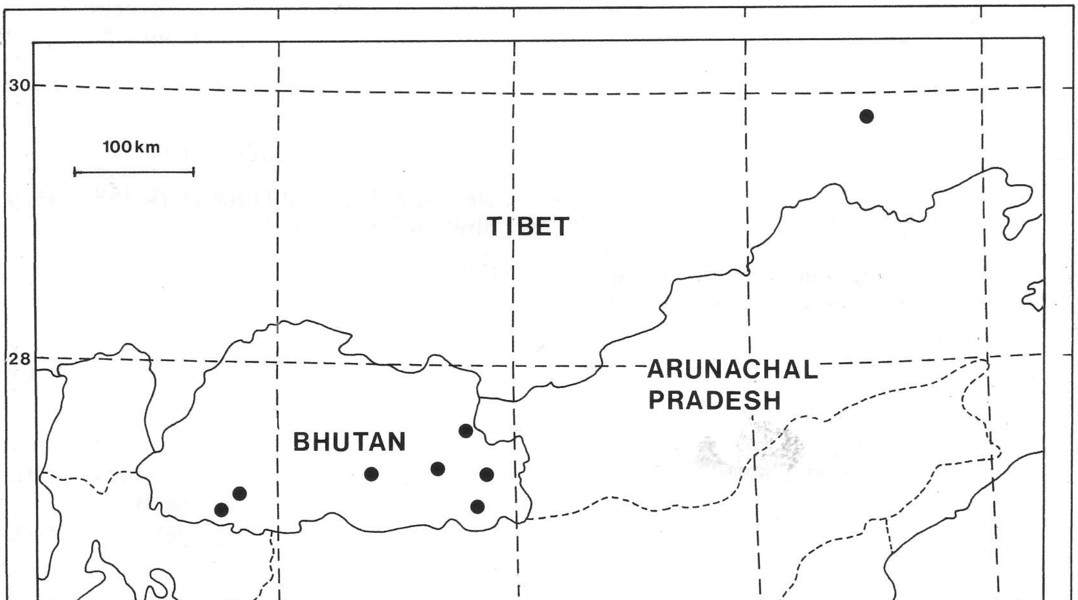
As this palm has only been described in Latin (Wei 1988) and Chinese (Pei & Chen 1991), it seems worthwhile to give a fuller description in English, and to describe the female inflorescence for the first time. It has not been possible to see the type, which could not be found at the herbarium in Beijing (PE), but from the illustration accompanying the protologue, there seems little doubt about its identity with the Bhutanese plant.

Arenga micrantha C.F. Wei, in Acta Phytotax. Sinica 26: 404–405 (1988).

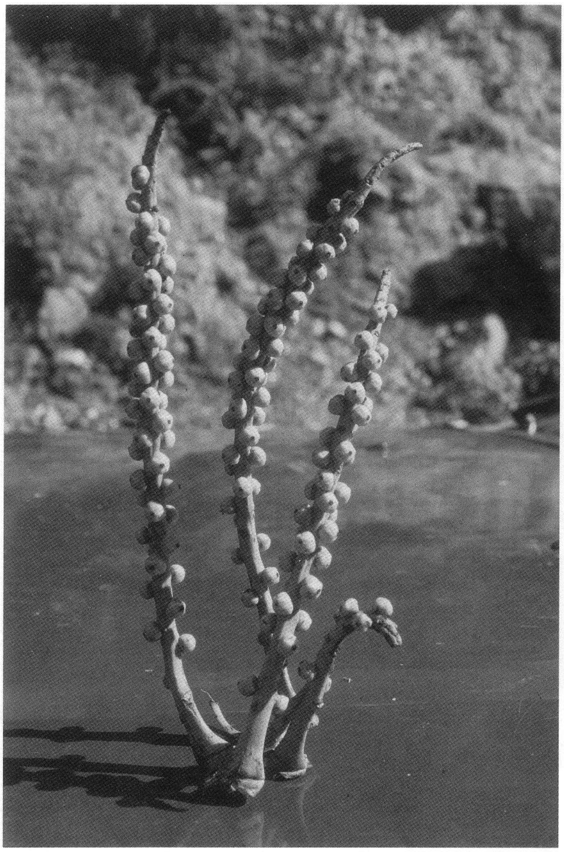
Type: China, Xizang (Tibet), Medog, Gelinpendi, 1600 m, 12 Aug 1980, *W. L. Chen* 14214 (holo. PE, *n.v.*).

Hapaxanthic, dioecious, dwarf, solitary palm. Stems to 2.1 m, to 13 cm in diameter. Leaf sheath fibers blackish-brown. Leaves to 3 m, pinnate, blade 80–180 × up to 65 cm, curved to one side, green above, whitish beneath; rachis triangular in section, brown-scurfy; petiole 35–50(–100) cm, brown-scurfy, upper surface slightly concave, lower side strongly convex; lateral leaflets arranged singly, held in one plane, to (30–)48 × 2.5–3.5(–4) cm, narrowly oblong, narrowed to irregularly erose apex, margins very weakly praemorse; base asymmetric with minute auricle sometimes developed on lower side; terminal leaflet 21–24 × 4–18 cm, narrowly to widely flabellate. Flowering basipetally. Female inflorescences pseudoterminal and lateral, branched to 1 order; primary axis of terminal inflorescence to c. 90 cm, stout, those of lateral ones shorter; branches to 32 cm, stout, flattened at base; bracteoles minute (under 1.5 mm). Flowers c. 10 mm diam; sepals swollen, coriaceous, free, broadly oblong, margins dark brown, c. 3.2 × 5.5 mm; petals pale yellowish, coriaceous, broadly rhombic, subacute, fused in lower half, strongly concave; immature ovaries orange, weakly hexagonal in outline, depressed, with three, weak radial ridges; stigmas 3, very low, dark brown; staminodes 0; locules 3, ovules 1–2, basal. Male inflorescence (after Wei 1988): a narrow panicle, 80–100 cm, branches in 2–4 rows, the lower c. 17 cm, the upper decreasing to c. 5 cm. Flowers 4–5.5 mm, oblong; sepals c. 2 × 2.5–3

7. *Arenga micrantha*: lateral female inflorescence.



Map showing distribution of *Arenga micrantha*.



8. *Arenga micrantha*: close up of part of female inflorescence.

mm, broadly rounded, free; petals yellow, oblanceolate or obovate, coriaceous, slightly unequal; stamens 9–23, filaments short, slightly connate at base; anthers 2.7–3.2 mm, narrowly oblong, acute.

Note: two specimens (from the same locality) are mentioned in the protologue—one is described as a 'shrub of 3 m' and the type as a 'tree of 8 m'. A trunk is not described and no explanation given of how this 'height' is made up (i.e. what proportion of trunk: leaf). If the 8 m is accurate, this seems larger than any of the Bhutanese specimens seen.

Distribution. CHINA. SE Xizang: Medog. BHUTAN. South: Phuntsholing (below Suntlakha), Chukka (Gedu to Sinchula) and Deothang (between Narfong and Deothang) districts; Cental: Mongar (above Lingmethang), Tongsa (5 km SE of Shemgang), and Tashigang (S of Tashi Yangtsi, above Rongthong) districts.

The palm is almost certain to occur in Arunachal Pradesh.

Habitat. Warm broad-leaved forest (sensu Grierson and Long 1983), between 1400 and 2150 m. This is an interesting intermediate forest type, basically a drier form of subtropical forest which occurs at lower altitudes, and composed of a mixture of evergreen and deciduous trees. This forest is also the habitat of *Musa sikkimensis* Kurz, the most temperate member of the genus in the E Himalaya, and the rattan *Plectocomia himalayana* Griff. From the altitude at which *Arenga micrantha* grows, it is likely to be the most cold-tolerant member of the genus, and therefore of considerable interest/potential for growers in warm-temperate countries.

Uses. Near Deothang the leaves were seen being used as the sides of a roadside shelter. The lack of large, flowering specimens suggests, perhaps, that the stems of mature plants might be being harvested for some other use, but no information could be obtained on this.

Acknowledgments

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DNA and Palm Evolution

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Palms have always been regarded as special plants with many distinctive features, so it comes as no surprise that botanists continue to recognize them as a well-defined family. The fossil record indicates that palms have been around for at least 65 million years, but we still don't know how the major groupings within the family are related to one another and to other plants.

Only recently, botanists have gained insight into some of the early evolutionary changes that may have given rise to the palms from within a group of related flowering plants (the monocotyledons). This research has been fueled by recent advances in phylogenetics, the field of biology that examines relationships among living things. Relationships are represented in the form of phylogenetic trees, which are branching diagrams of species groupings (e.g., Fig. 1E, Fig. 2, Fig. 4). The newest trees of monocot relationships (e.g., Chase et al. in press) show that the palms share an ancestor with familiar cultivated plants including spiderworts, gingers, bromeliads and grasses.

As phylogenetic research helps to pinpoint the origin of palms, the same techniques allow us to explore the pattern of evolution that gave rise to the incredible diversity within the family. This is an exciting time to be involved with palm evolutionary studies, because we now have the ability to access information stored within the genetic material of palms and to analyze this information using specialized computer software. We are now poised to answer questions about how the 189 genera of palms (Dransfield & Uhl 1998) arose in relation to one another, and we can also begin to tell the story of how the genera attained their present distribution across the world.

Evolutionary trends in the palm family have been investigated previously (e.g., Moore 1973, Moore & Uhl 1982), and the ideas laid down in these and other papers formed the foundation for the classification scheme in *Genera Palmarum* (Uhl & Dransfield 1987). At that time, however, the authors did not have access to the molecular techniques and the powerful computer technology that are available so readily today.

Why study DNA?

Like all other organisms, palms have a finite number of observable structural characteristics. Features such as stem, leaf, and inflorescence structure are relatively easy to observe, but more detailed morphological and anatomical features can be physically and technically difficult to study. Many researchers (e.g., Barfod et al. 1999, Henderson 1999, Pintaud 1999) have overcome these difficulties, collecting vast amounts of structural information and producing valuable phylogenetic trees. Still, these studies are limited by a shortage of data and by complexities in their interpretation. It is clear that structural features alone cannot answer all of our questions about palm evolution.

The main advantage of studying DNA is that the available data are almost limitless. Each DNA molecule is a long chain of chemical units called nucleotides. Only four kinds of nucleotides (abbreviated A, C, T and G) are used to build the chain, and the sequence (arrangement) of these nucleotides is a code containing an organism's genetic information. We can access small amounts of this information by reading DNA sequences, such as the one shown in Figure 1C. Although today's technology allows us to explore only a tiny fraction of a plant's total DNA, we are able to gather sequences containing hundreds of nucleotide positions.

Changes have arisen in DNA sequences throughout evolutionary history, so we often find different sequences in different species. For example, one nucleotide may be substituted for another, or nucleotides can be added, removed, or rearranged within a sequence. These changes can be seen when sequences from a set of species are compared (Fig. 1D). When we see a particular change shared by two or more species, we have evidence that those species may be related.

DNA Sequencing

The first, and often the most difficult step, is to collect palm specimens suitable for DNA study. Each specimen consists of two parts: (1) a small amount of leaf tissue preserved by rapid freezing or rapid drying, so that DNA is held intact within the cells, (2) a larger sample collected as a voucher, consisting of leaves, inflorescences, fruits and any other distinguishing organs. The voucher is stored in a herbarium, allowing future researchers to verify the specimen's identification, and to repeat experiments when necessary.

DNA is extracted from leaf samples using a combination of mechanical and chemical procedures, resulting in a pure solution of DNA (Fig. 1A). Specific pieces of DNA can be isolated using a method called the polymerase chain reaction (PCR), which produces millions of copies of the specified region of DNA (Fig. 1B). The sequence of nucleotides in the region can then be determined using automated DNA sequencing equipment (Fig. 1C).

For each DNA region studied, sequences from many species are gathered together and aligned with one another in a matrix (Fig. 1D). The matrix allows sequence data to be viewed in tabular form, so similarities and differences between species can be detected. Specialized computer programs evaluate all of the different ways the species can be related to one another, searching for the arrangements that most closely match the sequence data. The best of these alternatives are used to build the final phylogenetic tree for the species (Fig. 1E).

What are we learning from DNA?

We now have complete data from three DNA regions, and our current knowledge about palm evolution based on these data is summarized in a phylogenetic tree (Fig. 2). The tree confirms many of the groupings defined in *Genera Palmarum*, but there are several surprises which we discuss below.

Relationships among subfamilies within the palm family

Each branch in Figure 2 represents a separate lineage, or a line of evolution containing all descendants of a common ancestor. For example, subfamilies Calamoideae (yellow triangle) and Phytelephantoideae (orange triangle) are well-defined lineages in the tree of relationships. However, subfamilies Ceroxyloideae (blue triangles), Arecoideae (red triangles) and Coryphoideae (green triangles) do not appear to be single lineages because they do not form discrete groups derived from a shared ancestor. On this tree, subfamily Phytelephantoideae (orange triangle) is related to parts of subfamily Ceroxyloideae (blue triangle). There are still areas of doubt and ambiguity that may be clarified with the addition of further data. These include the relative positions of the Calamoideae and the Nypoideae, and the relationships among the five lineages of subfamily Coryphoideae.

Hyophorbeae in Arecoideae

Tribe Hyophorbeae (*Chamaedorea*, *Gaussia*, *Hyophorbe*, *Synechanthus* and *Wendlandiella*) has a peculiar Neotropical and Indian Ocean distribution, yet it is a clearly-defined group of palms. Among other things, the group is characterized by flowers that are usually arranged in rows, although the flowers of *Chamaedorea* are generally solitary. Subfamily Arecoideae, on the other hand, is characterized by flowers usually arranged in groups of three composed of a central female flower flanked by two male flowers (triads). One of the surprising results of DNA analysis has been the placement of the Hyophorbeae within subfamily Arecoideae, rather than with *Pseudophoenix* and tribe Ceroxyleae (e.g., *Ceroxylon*, *Juania*, *Oraniopsis* and *Ravenea*), which also lack triads. As a result we are reconsidering the concepts of inflorescence evolution in this interesting group of palms.

Affinities of caryotoid palms

The three genera *Caryota*, *Arenga* and *Wallichia* form a group that Uhl and Dransfield (1987) recognized as tribe Caryoteae. Any caryotoid palm can be recognized instantly by the presence of pinnate leaves (twice pinnate in the case of *Caryota*) with induplicate leaflets (leaflets V-shaped in section) with jagged tips. This remarkable group of palms has long been recognized as a distinct lineage, and yet its affinities with other palms have remained uncertain. In *Genera Palmarum*, Uhl and Dransfield placed the caryotoids in the Arecoideae, a decision based on the shared characteristic of flowers arranged in triads.

Despite the morphological evidence placing the caryotoid palms within the Arecoideae, the new DNA data indicate that the Caryoteae is most closely related to a lineage of familiar palmate-leaved palms that includes tribe Borasseae (e.g., *Borassodendron, Lodoicea, Hyphaene* and *Satranala*) and the genus *Corypha*. This revolution in palm classification has profound implications not only for our concepts of palm relationships, but also for our ideas of palm morphology. Our confidence in this link between caryotoid and borassoid palms is increasing as more DNA data are collected and yet few morphological connections can be made. The mutual possession of induplicate leaflets in both Caryoteae and Borasseae could be construed as a link, but anatomical differences argue against this. Further shared characters can be found only in the anatomy of female reproductive structures. This novel relationship cries out for closer examination.

Relationships among calamoid palms

Few palm botanists would dispute the fact that the calamoid palms constitute a lineage derived from a single common ancestor. The beautifully scaly fruit is the most striking feature common to all 22 genera of subfamily Calamoideae, indicating a close relationship between them. However, within the subfamily, almost all possible palm growth forms are found, namely tree palms (e.g., *Mauritia, Raphia, Pigafetta* and *Metroxylon*), shrub palms (e.g., *Lepidocaryum*), stemless palms (e.g., *Salacca, Eleiodoxa*) and climbing palms or rattans (e.g., *Calamus, Plectocomia, Korthalsia, Laccosperma*). Furthermore, there is a great diversity of inflorescence structure ranging from the congested heads of catkin-like flowering branches in *Eleiodoxa* through to the immensely extended, whip-like inflorescences of *Calamus* that may grow to a length of 8 m or more. To cap it all, though the majority have pinnate leaves, three genera, *Mauritia, Mauritiella* and *Lepidocaryum*, have palmate leaves. These patterns of variation conflict with one another, and the relationships among these palms are by no means obvious.

Recent efforts aimed specifically at clarifying this confusion using a combination of DNA and morphological evidence have disclosed three major lineages within the Calamoideae, rather than the two proposed by Uhl and Dransfield (1987) based on the presence of either pinnate or palmate leaves. The new scheme indicates a group comprising all African and American calamoids, a second comprising all Asian calamoids (except for the extraordinary genus, *Eugeissona*) and a third consisting of *Eugeissona* alone (Baker et al., in press a).

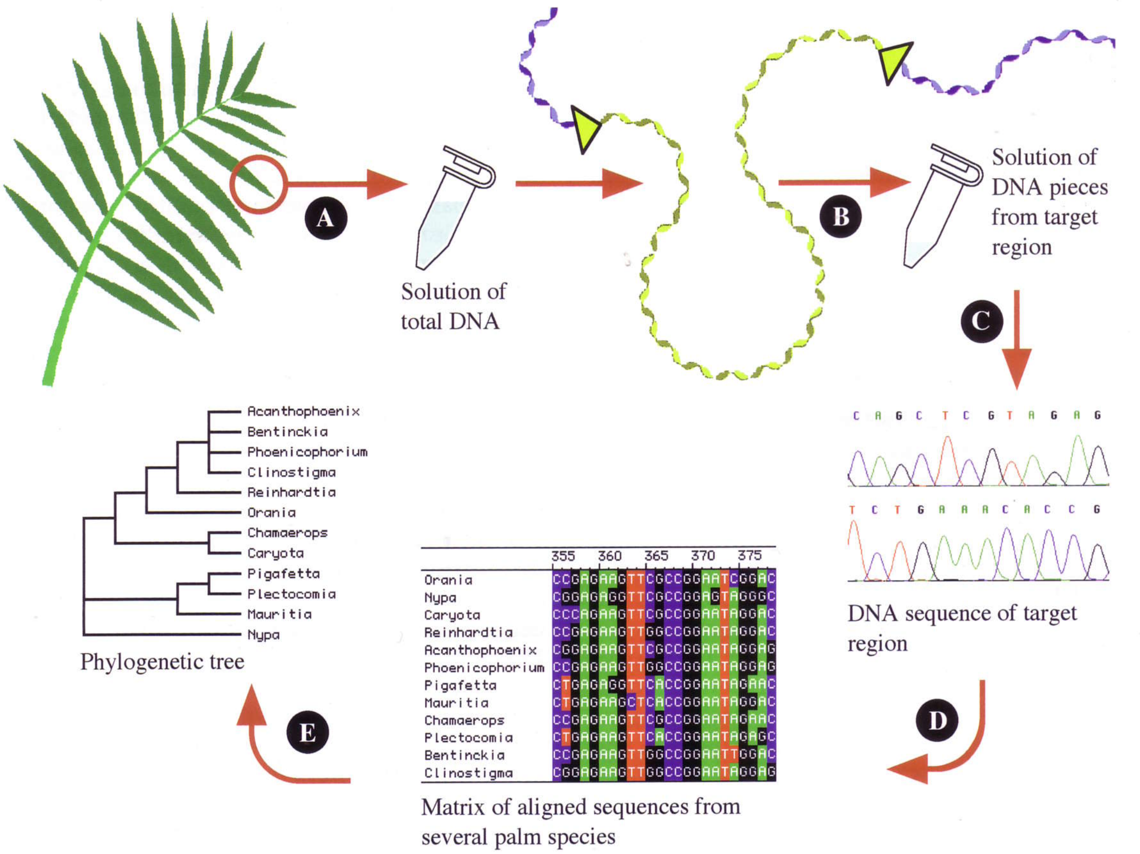
The 13 rattan genera are of special interest because they are not as closely related to one another as one might have expected. Rather the geographical division of calamoid genera divides the rattans into at least two groups (Fig. 3), separating the three African genera (*Laccosperma, Eremospatha* and *Oncocalamus*) from the remaining Asian genera (e.g., *Calamus, Plectocomia* and *Korthalsia*). These two groups are not close relatives within Calamoideae and consequently it seems that the climbing habit, for which the subfamily is so well known, has evolved independently on at least two occasions (Fig. 3). There is good morphological evidence for these two distinct groups; for example, the climbing whip, or cirrus, that extends from the end of the leaf is quite different in the two groups of taxa. In the African rattan genera, the cirrus is armed with reflexed thorns derived from reduced leaflets, whereas the cirrus of Asian rattans lacks such thorns and possess only grapnel-like spines, usually arranged in groups like a cat's claws.

Challenges

Progress in molecular studies of the palm family has been limited by an unusually slow rate of DNA evolution in the family. It has been necessary to gather sequences from several different DNA regions in order to find enough nucleotide changes to resolve relationships. The choice of which regions to use is difficult, and requires consideration of various aspects of DNA evolution (see Soltis & Soltis, 1998 for a review).

It is important to find DNA regions that evolve at a useful rate. If a region evolves too slowly, there will be too few nucleotide changes to provide information about relationships. If a region evolves too rapidly, the overwhelming number of changes makes it difficult to find comparable regions among sequences from different species.

For phylogenetic studies of the entire palm family (e.g., Baker et al. 1999, Asmussen et al. in press,



1. Overview of DNA sequencing and analysis: A. DNA is extracted from leaf tissue. B. The target region is isolated and copied using PCR. C. Copies of the target region are sequenced. D. Seqences from different species are aligned together in a matrix. E. Computer software is used to select the best tree or trees of relationships for the species.

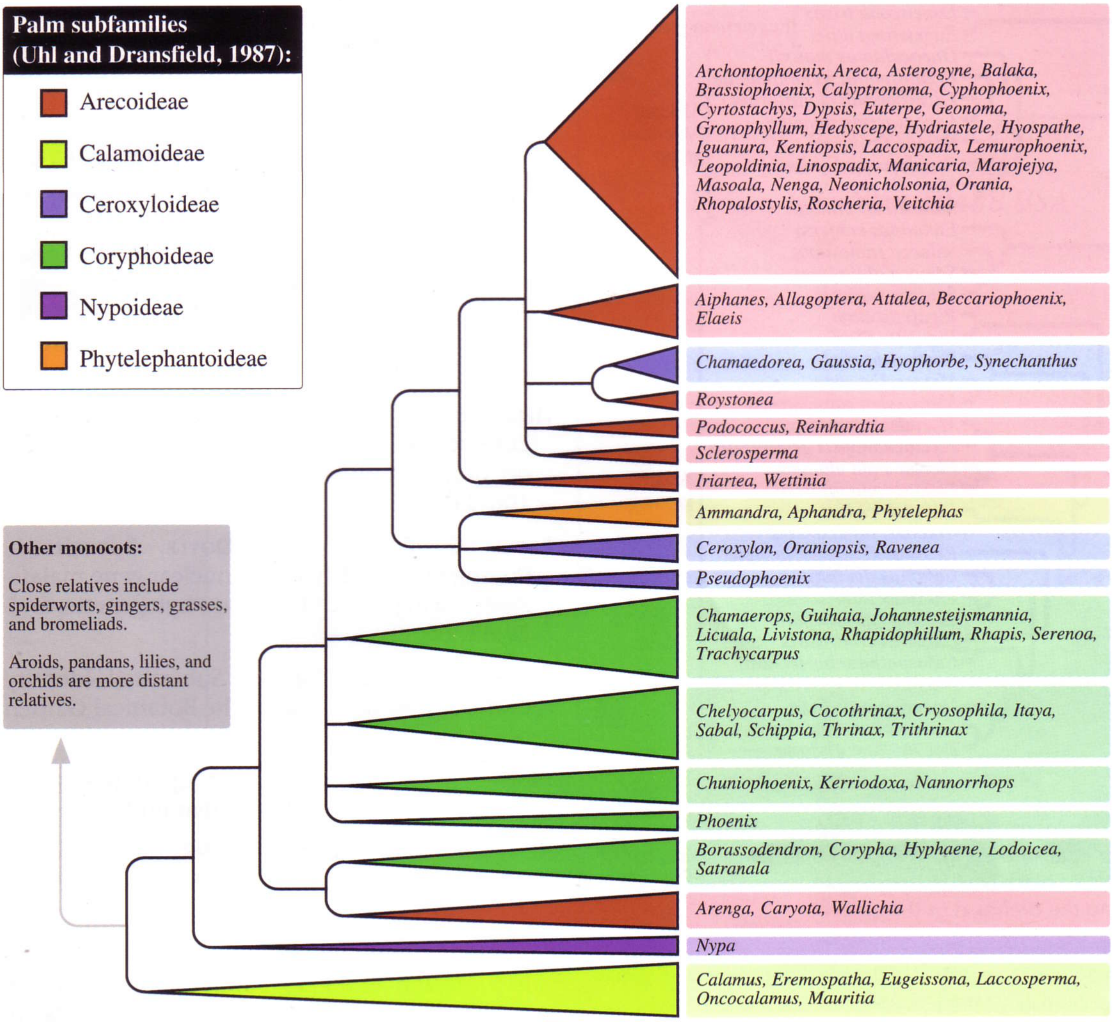
Asmussen & Chase in press), the most useful data have come from regions of DNA located on the single chromosome within the chloroplasts of plant cells. Certain regions of DNA from the nuclei of plant cells may also be appropriate for these studies (Lewis & Doyle submitted, Hahn 1999) and for analyses of more recent lineages, such as groups of species or genera (Baker et al. in press b, Lewis & Martinez submitted).

Another challenge that we face in this research is the limited availability of specimens. Access to wild populations requires extensive travel and collaboration abroad, both of which can be difficult to arrange. For many years, collectors have worked under laws that restrict access to biodiversity in individual countries. Now, precise guidelines on the collection and transport of specimens have been formalized on a global scale in the Convention on Biological Diversity (CBD), ratified by the United Nations in 1992. The CBD stipulates that each country has control over the genetic resources within its borders, and that collectors must make clear arrangements with local governments before collecting and exporting biological samples. These guidelines were designed to protect countries from unrestricted removal and exploitation of their genetic resources. As a result of the CBD, however, collectors often face complex application procedures and long waiting periods before they can obtain permission to work in a country.

We are fortunate that palms are represented well in cultivation, and many of our DNA samples have been gathered (with permission) from botanic gardens. There is also a great diversity of species grown by hobbyists, but it is often difficult for researchers to gain access to private collections. We hope to begin working with palm growers as we gather samples for future research projects.

Conclusion

As we continue to build and analyze data sets of DNA sequences, a clearer picture of palm evolution is emerging. The new DNA-based phylogenetic



2. A simplified DNA-based phylogenetic tree showing the relationships of representative palms sampled from across the family (after Asmussen & Chase in press). Each triangle represents a lineage derived from a common ancestor, and the branches of the tree show how these lineages are related to one another.

trees largely confirm the groupings proposed in recent classifications, but interesting relationships among some genera are indicated for the first time.

The technology for phylogenetic research has improved dramatically over the past decade, and we can assume that new advances will continue to arise at the same pace. We will find it easier to gather data as DNA sequencing methods become more streamlined, and new sources of data will become available as we learn more about plant genes. So far we have explored just a tiny fraction of the total DNA information, and our future phylogenetic research will focus on the unexplored palm DNA that still holds a wealth of information about palm evolution.

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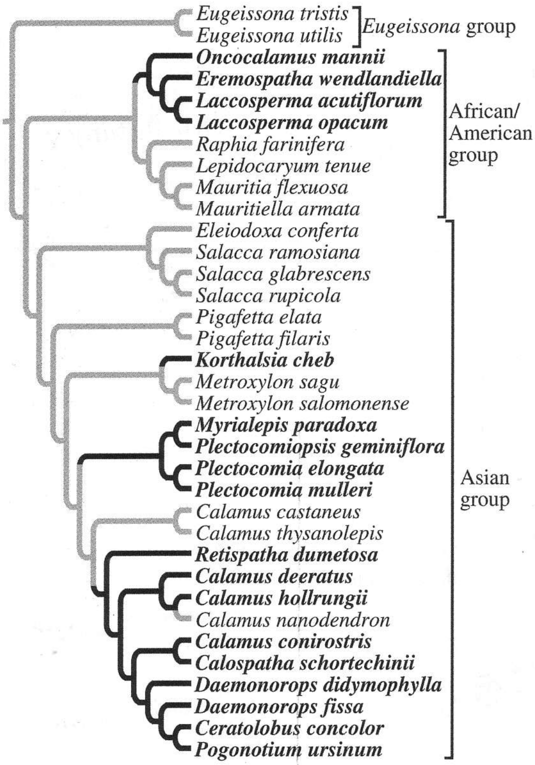

4. A phylogenetic tree for subfamily Calamoideae (after Baker et al. in press a). It appears that the climbing habit, shown as black lines in the diagram, arose multiple times during the evolution of the group.

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Palms of the Amazon Ecotours

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1. The "Harpy Eagle"

For the last three years, small groups of International Palm Society members and others have been participating in the "Palms of the Amazon" ecotours. These tours are organized by the New York Botanical Garden and originate in Miami. Our groups, consisting of 15-20 people, are very mixed; we have had participants from Australia, Brazil, England, New Caledonia, Spain, Switzerland, and, of course, the United States. They all have one thing in common, a desire to see the Amazon and its palms.

We fly from Miami to Manaus, in the heart of the Brazilian Amazon. From the airport we are taken directly to the "Harpy Eagle" (Fig. 1), a small but comfortable Amazon river boat. The boat is owned and operated by Moacir Fortes, a legendary guide who has been introducing tourists to the Amazon region for more than 25 years. Our tours are planned for the dry season, when the river is at its highest, so we can take motorized canoe trips through the flooded forests.

Our schedule is very informal, and we often make it up as we go along. A typical day might start early in the morning with a cup of Brazilian coffee and then off in the two small motorized canoes to listen to the forest awakening. We find a small channel and drift past the forest, listening to the incredible early morning sounds. Everyone is very impressed with the howler monkeys and various birds. Back to the boat for breakfast, and then we may continue along the river. If we see a promising place we may stop and hike in the forest. We will usually ask a local person what palms grow in the area, and we always get some interesting leads. One of the great pleasures of the

2. *Bactris elegans* in western Amazon forests.

3. *Geonoma stricta* in western Amazon forests.

trips is interacting with the unfailingly friendly local people along the river. Often we are off on a wild goose chase, looking for some rare palm or other that grows "not too far away." Back to the boat for a swim before lunch, and then we relax on the upper deck during the hottest part of the day while continuing along the river. We may go for another hike in the afternoon, and another small boat trip in the evening to look for night life. On our trips we have seen birds, river dolphins, sloths, monkeys, and the first year we even saw an anaconda. Moacir has also been known to do a spot of fishing, and usually he has a few volunteers to join him. We often travel during the night, and its a real pleasure to go up on deck the next day and watch the sun rise over some new early morning landscape. Our trips end with a day in Manaus. We visit the markets, especially the fish market, and then go on and see the famed opera house and various other local attractions.

On our first trip, in 1997, we traveled from Manaus up the Rio Negro to the small town of Barcelos and a little way beyond. The Rio Negro is an extremely beautiful river, with very low human population levels and a very distinctive flora and fauna. It is also free of biting insects. Moacir tells a funny story about a party of German tourists he took up the Rio Negro some time ago, and the leader of the group complained that they had not been bitten by any mosquitoes! We saw about 55 species of palm on this trip. Highlights were all three species of *Leopoldinia, L. pulchra, L. major* and *L. piassaba*, and also the unusual *Barcella odora*. In the forests we saw a great variety of *Geonoma* and *Bactris*, including *G. baculifera*. We also found *Bactris campestris* on sandy soils not far from Manaus, much further south than previously recorded. There were many plants of *Lepidocaryum tenue* and *Iriartella setigera* in the Rio Negro forests. The banks of the river are lined for hundreds of miles with stands of *Astrocaryum jauari, Leopoldinia major* and *Mauritiella aculeata*.

The next year, 1998, we flew on from Manaus to Tabatinga, in the extreme western part of the Brazilian Amazon. We joined Moacir and the crew of the "Harpy Eagle" there, and traveled downstream to Manaus. We saw lots of different species of palms on this trip, about 58 in total. I remember the great diversity of understory palms in those western Amazon forests, *Bactris* (Fig. 2), *Chamaedorea,*

4. *Oenocarpus simplex* in the western Amazon.

5. *Bactris simplicifrons* in lower Amazon forest.

Geonoma (Fig. 3) and *Hyospathe*, as well as a good number of species of *Astrocaryum*. Also memorable were the huge plants of *Iriartea deltoidea* with their distinctive swollen stems and stilt roots, and the beautiful stands of *Euterpe precatoria* lining the river. Our most exciting discovery on this trip was *Oenocarpus simplex* (Fig. 4). This small but very attractive relative of the large and common *O. bacaba* and *O. bataua*, had not been recorded before from Brazil, and was known only from a site in Colombia several hundred kilometers to the north. Growing with *O. simplex* was another unusual plant of *Oenocarpus* that I did not recognize. I wondered if it was a hybrid between *O. simplex* and *O. bacaba*. The wonderful stands of the Amazon water lily, *Victoria amazonica*, in full bloom were also one of the high points of this trip.

In 1999 we traveled from Manaus downstream, to explore some of the eastern tributaries of the Amazon. We spent most of our time on the Rio Nhamundá. Like the Rio Negro, the Nhamundá is a black water river (which means no biting insects!). Like the Rio Negro it is also a very beautiful, with many interesting palms. I especially liked the contrast between the "forests" of *Leopoldinia pulchra* growing in the river and the large stands of *Attalea spectabilis* (see page 3) growing in full sun on pure sand along the banks. In nearby forests we saw a number of *Syagrus*, and we all admired two small species of *Bactris* growing side by side, *B. simplicifrons* (Fig. 5) and *B. cuspidata*. Our local guide showed us stands of the rare *Manicaria saccifera* and *Mauritia carana*. Also memorable was a daylong "short cut" we took through a flooded landscape dotted with *Bactris riparia* and *B. bidentula*. We saw about 55 species of palm on this trip. In fact, we liked the Rio Nhamundá so much we plan to return there this year. The local people talk of different palms further up the river. On our return trip to Manaus we traveled close to the shore, to avoid the currents of the middle of the river. An advantage of this was that we could admire close up the palms along the banks, *Attalea speciosa* (the babassu palm), *Elaeis oleifera* (the American oil palm), *Oenocarpus mapora* and *Euterpe oleracea*. I suspect that many of these palms were planted by local people, since all are useful species.

For me these trips have been especially rewarding. Apart from good company, good food and the beautiful Amazon landscape, there are the palms.

The Amazon is full of surprises, and there is always something new.

For more information on this year's tour, 31 July–11 August 2000, please contact Myrna Alvarez, Institute of Systematic Botany, New York Botanical Garden, Bronx, NY 10458. Telephone 718 817 8628. E-mail malvarez@nybg.org. Andrew Henderson is at the same address, telephone 718 817 8973, e-mail ahenderson@nybg.org

(continued from p. 4)

The Post Biennial Tour will hosted by the IPS Affiliated Society, Far North Queensland Palm and Cycad Association. As you will notice, the itinerary is full of exciting visits to gardens and palm habitats. Our Australian friends guarantee that the Post Biennial Tour will be one of the best ever. Included will be a visit to Mt. Lewis, which is the habitat of *Archontophoenix purpurea*. Attendees will also visit many fabulous gardens, other natural habitats, and exotic palm nurseries. Who knows, perhaps an authentic Australian BBQ might await us?

Don't be another member who ends up saying "I should have gone"! The registration fees are quite affordable for what attendees will receive. Airfare can be obtained at a discount from our designated travel agency. Also, remember that the 2000 Olympics precede us by two weeks in Australia. Last minute registration may be difficult. **Register now and book your airline tickets**. See your there!

PHIL BERGMAN, IPS PRESIDENT

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CLASSIFIED

The Rediscovery of *Calamus harmandii*, a Rattan Endemic to Southern Laos

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***Calamus harmandii* Pierre ex Becc., long known from a single record, is rediscovered in Laos and shown to be a very peculiar rattan.**

Since 1992 the Department of Forestry in Laos has been working on a catalogue and manual of the country's rattans. In 1997 I joined the team to help them expand and complete this work, funded by the UK government through the Darwin Initiative for the Survival of Species. Since then we have been collecting the length and breadth of the country, from the Chinese border in the north to Cambodia in the south.On our travels we have always had an eye out for the one endemic rattan described from Laos, *Calamus harmandii*. When described this plant was considered bizarre enough to be given a new genus of its own, *Zalacella*, and it wasn't until recently that it was placed in *Calamus* (Dransfield 1984). For a long time we had little idea where it came from, because the notes on the type specimen were so sparse, and the locality, Phou Lekfay, was not on any modern map.

Then, by lucky chance, my wife Laura gave me a book for Christmas which solved the mystery. It was the recently translated account of a journey by Dr François Jules Harmand himself, back in 1877 (Harmand 1979). Rattans aside it is a remarkable book, a self-penned portrait of a man who embodied all the worst of the old colonial explorers. It is liberally scattered with tirades about the character of the 'savages' he met, and enhanced by pictures with titles like 'Punishing a mandarin in the pagoda of Song Khon' and 'Clandestine disinterrments in Attapu'. Loneliness, severe financial hardship, genuinely unwelcoming locals and the differing cultural standards of the time can all be offered in Harmand's defence, but it has has to be said that he formed a very different opinion of South Laos from the sympathetic writings of another explorer, Dr. Garnier, who crossed the same ground twelve years earlier (Garnier 1869–1885).

In March 1877 the cantankerous Dr. Harmand found himself in Attopu, the Lao province adjoining Vietnam and Cambodia. He was searching for routes through the Mekong basin in the hope of extending French colonial influence to the hinterland of Indochina. As he went he collected plants, birds, animals and cultural artefacts. His time in Attopu was cut short by a cholera epidemic which emptied villages and killed three of his local assistants, but among the collections from this brief visit was the curious spiny palm which now bears his name.

The published account doesn't mention this plant but does devote several pages, a map and an engraving to Phou Lekfay. The long scenic boat ride up the Xe Kaman river to the feet of the Annamite mountains where he camped and collected seems to have been one of the high points of Harmand's trip. His map of the Xe Kaman's meanderings was so accurate that we could easily locate his camp on modern maps, and it was with this information that we set off

1. *Calamus harmandii* growing in an area of shady understory.

2. *Calamus harmandii* with leaf litter trapped on the petiole spines.

for Attopu in May 1999 to see what was left on Phou Lekfay.

Attopu province and its capital, also called Attopu, are a long way from anywhere (Fig. 8). It takes two days drive to get there from the Lao capital, Vientiane. Attopu is a tiny market town with electricity from a generator each evening and more than its fair share of malaria. However, in common with other Lao provincial towns it offers two unexpected French luxuries: excellent filter coffee and locally-baked baguettes for breakfast. Once there we met Mr Sukaserm, chief of the Provincial Forestry Office. With his famous dynamism he took us in hand, wined and dined us, presented us to his chief, Mr Khamdii and organised our travel papers. Then he escorted us into the field, just in case our aging pick-up didn't make it.

After crossing the great Xe Kong river by ferry our route took us across a plain still mainly covered with deciduous forests, some dense and varied but most open, their understorey dominated by the weedy bamboo 'pek' (possibly *Vietnamosasa pusilla*, J. Dransfield, pers. comm.). As the rains had already begun, many plants were in flower, most

3. The ocrea of *Calamus harmandii*.

4. An adult plant of *Calamus harmandii*, with the Darwin Initiative Lao Rattan Project team.

conspicuously great sweeps of the white-flowered shrub *Holarrhena*. Rice-farming villages of stilted houses occupied clearings along the road. The last of these before the hills was Ban Paam, where we planned to base ourselves.

Soon after arriving, and with formalities observed, we began to discuss the local palm flora with the village chief. To our delight he immediately seemed to know of *Calamus harmandii* and confirmed it when shown a photo of Harmand's specimen from Paris. We could hardly believe our luck. After a hasty lunch we began our search. Ban Paam and Phou Lekfay lie on a dirt road winding over to Khontoum in Vietnam. Barely used now, it was once the scene of intense activity. Until 1975 it was a key strand of the network of roads called the Ho Chi Minh trail and used to transport supplies from Communist North Vietnam to guerillas in the capitalist South, bypassing the demilitarised zone between the two. As such it was carpet bombed by American B-52s flying in from Thailand and royalist areas of Laos. The debris and craters have disappeared under the vegetation now, but a decommissioned 8 m long rocket launcher in the centre of Ban Paam forms a stark reminder. Mindful that perhaps 30% of the millions of bombs and bomblets the Americans dropped never went off, we were very careful to watch our step when we left established trails!

As soon as we reached evergreen forest we stopped the car to look at a large rattan which proved to be *Myrialepis paradoxa*. Wandering 5 m into the forest from there one of us immediately stumbled on an adult *Calamus harmandii*. It was that easy. Looking around we saw another, and another, and within 20 minutes had found perhaps 30 plants. We were euphoric and it took us a while to calm down enough to start preparing specimens.

Calamus harmandii is distinctive firstly by being a non-climber. Its uplifted whorl of meter long pinnate leaves stand on a stout trunk no more than a meter tall (Fig. 4), making it look more like a cycad than a rattan. It lacks any kind of climbing organ, even on the inflorescence, and seems content to sit in the deep shade of the understorey of closed forest (Fig. 1). The long petiole spines together form a crude net which traps leaf litter (Fig. 2); this may be an adaptation to capture extra nutrients. But oddest of all are the inflorescences themselves, which stand erect in the crown and bear only short, appressed, spicate partial inflorescences (Fig. 5), quite unlike the long exuberantly branching partial inflorescences of most other *Calamus* species. The spikes, which we noticed do occasionally branch a little, are

5. The spicate partial inflorescence of *Calamus harmandii.*

6. Partly ripe fruits of *Calamus harmandii,* May.

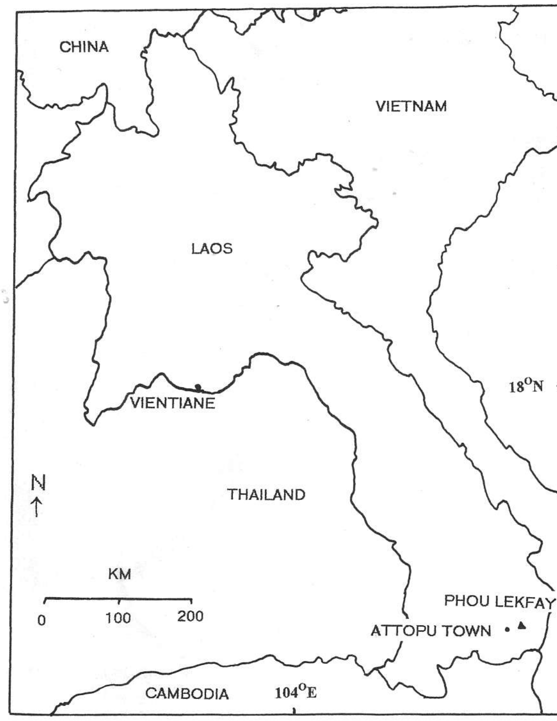
crowded with flowers nestled amongst a felt of grey brown hairs (Fig. 7). They reminded us a little of *Korthalsia* catkins. There seemed to be two types of inflorescence – a larger one with the spikes larger and more widely spaced being the female and smaller, more congested ones presumably the males. Sadly, most inflorescences we found were old and dry but by careful searching we did track down one in fruit and one female with open flowers. The petals were very inconspicuous, leaving the three naked green pistils widely exposed. As in other *Calamus* the female flower is accompanied by a male flower, which is presumably infertile as it is in other *Calamus* (Uhl & Dransfield 1987). On the spikes these pairs are arranged in a jumbled, barely discernible spiral.

The fruiting spikes were mostly covered in mud brought by nesting ants. These stung us with great enthusiasm as we evicted them. The small bronzy fruits (Fig. 6) are covered in the overlapping scales which distinguish the whole subfamily Calamoideae.

One other point of interest is the ocrea which is fragile and densely bristly (Fig. 3). It recalls the ocrea of another, much larger, erect species, *Calamus erectus* Roxb.

Our guides from Ban Paam explained that their name for this tree was 'nyaa seui' which, loosely translated, is 'weedy *Daemonorops*'. There is no local use for the plant – it has no flexible cane, no large juicy palm heart and the leaves are too sparse for thatching. Although the little fruits are edible it is hard to imagine anyone making a special effort to gather them. So the plant remains most interesting as a Lao endemic rarity and as a biological oddity, marking an extreme edge of the diverse, sprawling genus *Calamus*.

Time was sadly too short to determine the conservation status of *Calamus harmandii*. It is under no direct harvesting pressure, but habitat loss is a possible threat. Ban Paam is a village swollen with people who have moved down from remote hill villages to attempt paddy cultivation on the plain. If this fails they may turn to Phou Lekfay to restart shifting cultivation. The province as a whole is heavily forested and Phou Lekfay lies at the edge of a vast tract of forest, much at comparably low altitudes, stretching off into



7 (above). The inflorescence of *Calamus harmandii.* 8 (right). Map showing place names.

equally poorly-botanized areas of Cambodia and Vietnam. If *Calamus harmandii* is present widely in this area, as seems likely, it would be safe for the foreseeable future. However, the Lao name of the mountain refers to the presence of flints or something similar (it literally means 'the mountain of stones for striking fire') which suggests that it has peculiar geology. If *Calamus harmandii* was restricted by soil chemistry to this one ridge it would be in a much more precarious situation. Botanists penetrating more deeply into the area in the future would do well to report on how widely they find this distinctive species, which has remained unseen for so long.

Acknowledgements

I am very grateful for the opportunity to work with my three Lao colleagues, Khamphone Sengdala, Oulathong V. Viengkham and Banxa Thammavong and two supervisors, Dr. John Dransfield and Dr. Nick Brown. Mr. Khamdii, Mr Sukaserm, Joost Foppes, Sounthone Ketphanh, the chief of Paam village and our guides Tiao and Mam all gave indispensable help. The Director of the Herbarium of the Musée d'Histoire Naturelle, Paris kindly lent the type specimen of *Calamus harmandii* to the Royal Botanic Gardens, Kew. The fieldwork was a part of the project 'Diversity and Sustainable Use of Rattans in Lao PDR' funded by the UK government through the Darwin Initiative for the Survival of Species. The work of Walter E. J. Tips and the White Lotus Press in making Harmand's account available to a wider audience is also gratefully acknowledged.

Note added in press: Dr. J. Maxwell of Chiang Mai University reports that he has just found *C. harmandii* in Nan Province, Northern Thailand, an amazing range extension. We did not have a chance to see this specimen before the publication of this article.

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Natalie Uhl: A Portrait of a Scientist

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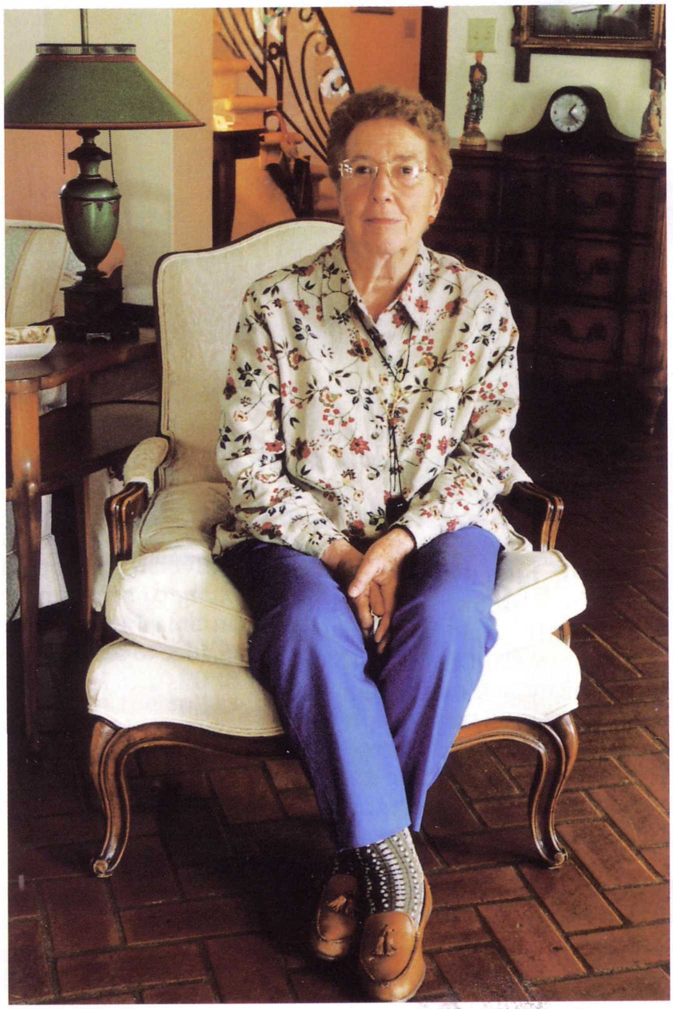

Natalie W. Uhl, June 1999. Photo by Deena Decker-Walters.

Last June, while attending the Palm Symposium at Fairchild Tropical Garden, I was honored to have the opportunity to speak at length with Cornell University Professor Emeritus Natalie W. Uhl, the retiring senior editor of Palms and the *grande dame* of palm research and taxonomy. Our conversation focused on her six decades of research on palms and her place in history as a pioneer in her field, long-time co-editor of Principes and Palms, and the co-author of *Genera Palmarum*.

To follow Dr. Uhl's career through time is to follow the modern history of botany. Beginning with her work with Dr. Vernon Cheadle at the University of Rhode Island in 1939, through the frenzy of scientific activity spurred by the Soviet conquest of space, she worked side by side first with Dr. Harold Moore, Jr. of Cornell University and later with Dr. John Dransfield of the Royal Botanic Gardens, Kew. She also credited Dr. George H. M. Lawrence, the first director of the Bailey Hortorium (at Cornell), for her successful career. As she put it, "I feel very fortunate. I just happened to be in the right place at the right time to have a chance to undertake a really big job.... And, also, I was lucky all through [my career] in that I worked with really excellent people...."

Dr. Uhl's work with palms began after she had "retired" from research. She had met her husband, Dr. Charles Uhl, a noted specialist in succulent plants of the family Crassulaceae, while at Cornell. They had married, and she had spent 13 years raising a family of four children. It was the success of the Soviet satellite Sputnik that brought her back to the laboratory. The Cold War and the US government's fear of losing the Space Race to the Soviets resulted in millions of dollars flowing to research institutions. Grants from the National Science Foundation in 1964 allowed Dr. Uhl to return to Cornell University, where she joined Dr. Harold Moore in his studies of the palm family. First Dr. Liberty Hyde Bailey, and then Dr. Moore dreamed of producing a *Genera Palmarum*, but there was so much work to be done. Dr. Uhl's specialty was plant anatomy, and the anatomy of palms was a field largely uncharted at that time.

Dr. Uhl has very fond memories of the exciting times during those early days of palm work. Commercial air travel was beginning to make the tropics accessible to scientists, so Dr. Moore began making trips to see and collect palms in their native habitats. He prepared for ten years for his first around-the-world trip by studying specimens in various European museums and herbaria. With his localities chosen and his "must see" list in had, Moore set out.

Madagascar, Malaysia, New Guinea, Solomon Islands, Australia, Fiji and the Pacific islands–every place he went, he carried liquid preservative for collecting flowers and fruits, which he air-mailed back to Dr. Uhl's laboratory. Every week, Dr. Uhl prepared incoming specimens by immersing them in more preservative and labelling the samples. Dr. Uhl began preparing the samples for anatomical study, a time-consuming process that involves dehydrating the material, embedding it in paraffin, cutting paper-thin sections, and staining them with special dyes. Samples were also sent to Marian Sheehan, a botanical illustrator who prepared the drawings and illustrations for the *Genera Palmarum* project. They were heady days for palm research.

Dr. Uhl recalled, "When I first started working the year that Dr. Moore was sending back palm materials from all around the world, the interesting thing to me was that when he went to Fiji, I thought there really couldn't be any more palms that he had not already sent to Cornell. But, oh, there were over 10 different genera, including some new ones found in Fiji, and that, of course, was the reason that he had to make the trip."

The anatomical studies of palm material progressed rapidly with every shipment received from Dr. Moore in the field. She has no regrets not being able to accompany Moore on his expedition, because she was making so many exciting discoveries in her anatomy lab. For example, palms are believe to have evolved from ancestors with three pistils in each flower. The flowers of *Thrinax* and its relatives have only one, but is that pistil one reduced from three, or is it three pistils fused into one single structure? The anatomy revealed elegantly and convincingly that the pistil of *Thrinax* is really one separate pistil, not three fused together. Dr. Uhl's anatomical studies revealed unexpected diversity in the palm family, too. For example, several groups of palms have many stamens, over 100 stamens per flower. Her studies revealed that *Phytelephas* develops its many stamens in a way that is completely different from that of *Ptychosperma*, which also has many stamens. Prior to her ground-breaking work, botanists assumed that *Ptychosperma* and *Phytelephas* developed their stamens in the same way.

In 1978, Dr. Uhl and Dr. John Dransfield were appointed associate editors of Principes. They were brought on board, in part, to lighten the workload of Dr. Moore, the journal's editor, who had suffered a heart attack some years earlier. After Moore's untimely death in 1980, Drs. Uhl and Dransfield became the full time co-editors of the journal. The work that Dr. Moore began, collecting and documenting every genus of palms, was continued by Drs. Uhl and Dransfield. The IPS funded the purchase of a computer, the first personal computer in the Bailey Hortorium, for Dr. Uhl to continue Moore's work. The IPS also funded technicians who prepared black-and-white photos. As Dr. Uhl recalled, "It was a very exciting time when were doing *Genera Palmarum*, because we discovered at least three new genera then.... We had a glorious time. We were chopping up seeds and fruits with hammers and saws, the way you have to with palms, and writing descriptions [of each palm genus]."

Genera Palmarum was published in 1987 and immediately became a best-seller among IPS members. It was a shot in the arm for palm research around the world. Dr. Uhl recalled, "Before *Genera Palmarum*, when there wasn't a generic treatment of palms worldwide, the scientists in any particular country couldn't really identify the palms. They didn't have the literature. They didn't know what palms were elsewhere. So, one reason for doing *Genera Palmarum* was to give people a chance to work more widely in palms, and that has really happened. That's one of the great satisfactions that John and I have for getting the book out."

Genera Palmarum stands as the definitive reference on the palm family, although several changes (including new genera, such as *Satranala* and *Lemurophoenix*) have come to light since that time. Drs. Uhl and Dransfield are continually updating their notes for an eventual second edition of *Genera Palmarum*. They hope to have it available electronically with interactive keys.

Dr. Uhl explained, "We are waiting at the moment for the many palm students to finish some molecular and other studies, because certainly there will be major changes in some of the classification."

When asked what might be left to do in the field of palm research, Dr. Uhl was quick to reply, "What we found with palms is there is something to be discovered at almost any level within the family. There is still basic taxonomy to be done. There's fieldwork to be done. We're lacking much in ecology, in pollination, and it just depends on what area [in which a researcher] is interested. If you're interested in utilization, there's a tremendous field there, in agroforestry, which will relate directly to conservation."

Dr. Uhl is a study in determination and dedication rarely seen in today's world. Despite her humble denials, her research laid a foundation for all future work of palm anatomy and classification. All of us who love palms owe Dr. Uhl a debt of gratitude for her selfless dedication to the IPS and her enormous contribution to the knowledge of palms. Her many years of service to the IPS as co-editor of our journal were recognized last year, when the IPS Board of Directors presented Dr. Uhl with the Dent Smith Memorial Award. Dr. Uhl may be retiring from the editorship of Palms, but she is certainly not retiring from palm research. I am sure all IPS members eagerly await what she does next.

(continued from page 7)

Tables should be placed, one to a page, at the end of the manuscript.

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Should consist of a single file, in WORD (97 or earlier) format, or saved in ASCII DOS TEXT.

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Effect of Microclimate Variation on Cultivation of Cold-Hardy Palms in Southwestern Ohio

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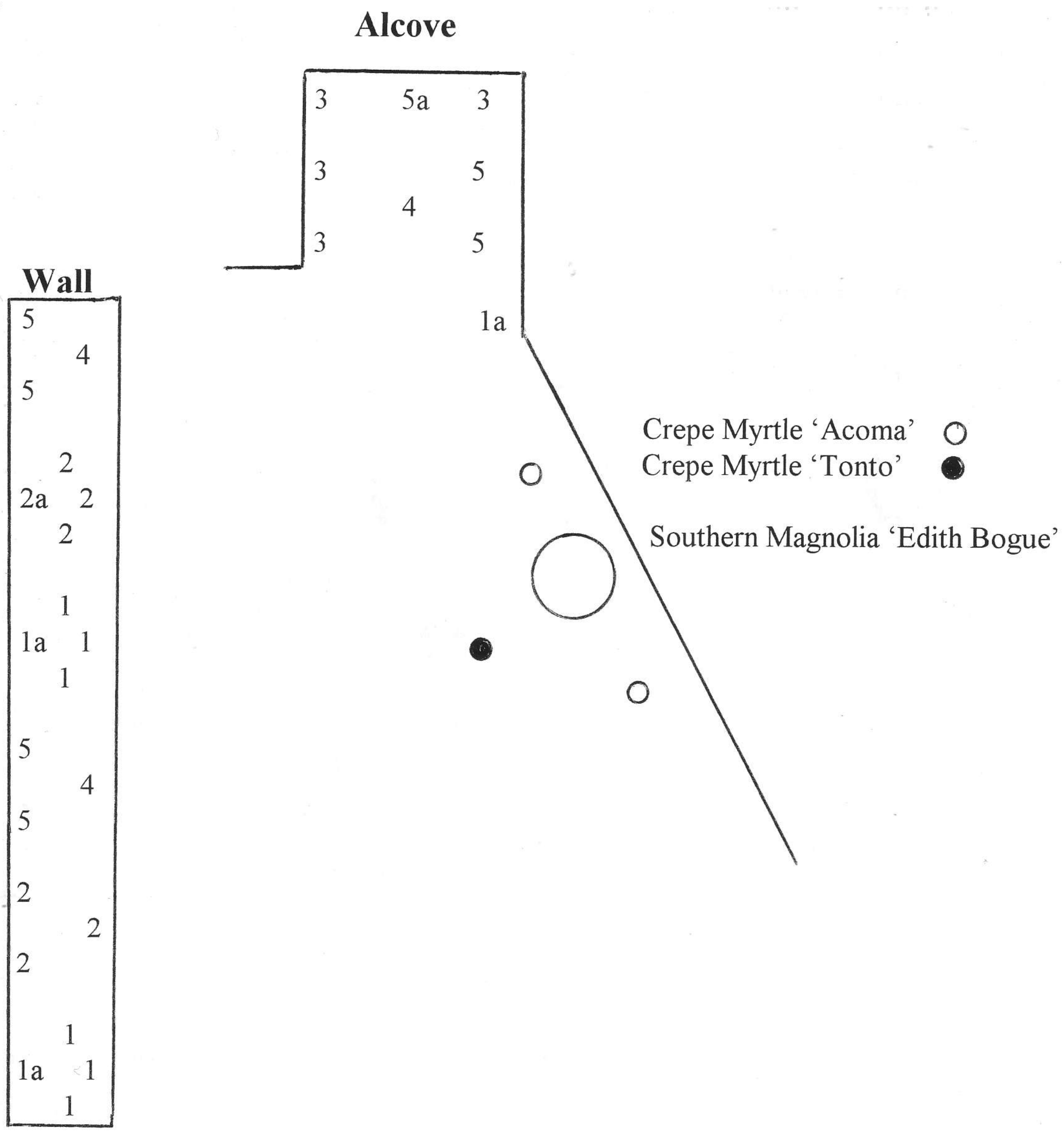
Although the great majority of palms are tropical to subtropical in distribution, several cold-hardy genera are being grown successfully in warm-temperate gardens world-wide (reviewed by Gibbons & Spanner 1999). The term 'cold-hardy palm' is subjective and can be used to describe plants that survive brief exposure to light frost to those that are leaf-hardy in sub-zero (Fahrenheit) temperatures (Riffle 1998). In this paper, I focus on cold-hardy palms that have been reported to survive approximately -15 to -29°C (ca. 5 above zero to -20°F) temperatures.

Not surprisingly, most of the literature dealing with cold-hardy palm horticulture in North America focuses on plants grown in USDA Zone 7b and south (reviewed in SPEPS 1994, Riffle 1998), and even in Zone 7b palms are still considered somewhat of a novelty by most landscapers and the gardening public. Nonetheless, the references above, numerous Internet websites, newsletter publications (e.g., *Rhapidophyllum*) and published reports from a few individual growers (e.g., pioneering work of Myers 1985) provide evidence that several palm species may be grown in Zone 7 and even farther north, provided that attention is given to site selection, proper cultural practices and some winter protection.

Despite these insights, there remains a dearth of primary literature that critically evaluates the success of cold-hardy palms, in the context of microclimatic variations, in USDA Zones 6a through 7a. Here I report data on first-year survivorship and vegetative growth of several cold-hardy palm species and varieties at the Hardy Palm Demonstration Plot of Miami University, Oxford Ohio (USA), and replicated plots at my somewhat colder home garden a few km southwest, with specific relationship to winter season microclimatic variation at each site.

Materials and Methods

Study Sites. The Miami University Main Campus in Oxford is located in Butler County, southwestern Ohio (39° 30′ N, 84° 42′ W) approximately 50 km northwest of Cincinnati and 35 km north of the Ohio River. This area lies primarily in USDA Plant Hardiness Zone 6a, although urban areas and the immediate Ohio River valley are classified Zone 6b (USDA 1990). The growing season in Butler County ranges from approximately 180–195 days depending on



1. Summer 1998 plant location grid for the Alcove and Wall subplots at the Hardy Palm Demonstration Plot (HPDP), located on the SE corner of Pearson Hall, Miami University. 1 = *Rhapidophyllum*, 4-year old seedling; 1a = *Rhapidophyllum*, ca. 7–8-years old; 2 = *Sabal minor*, 2–3-year old seedling; 2a = *Sabal minor*, 6–7-years old; 3 = *Sabal palmetto*, 2-year old seedling; 4 = *Sabal* sp. Brazoria palmetto, 2-years old; 5 = *Trachycarpus fortunei*, 2–3-years old; 5a = *Trachycarpus fortunei*, 6–7-years old.

microclimate. The mean annual temperature is approximately 12.2°C (54°F), with typically hot, dry summers and cool to cold winters. Total annual precipitation and snowfall average about 195 cm and 43 cm, respectively. From a phytogeographic perspective southwestern Ohio, northern Kentucky and southeastern Indiana represent a vegetational ecotone representative of both northern and southern U.S. flora, including stands of beech-maple forest and mixed mesophytic forest interspersed with row crop agriculture and a few prairie remnants (Vankat 1979).

The Hardy Palm Demonstration Plot (HPDP) was sited on the SE corner of Pearson Hall, a four-story brick building that houses the biological sciences departments at Miami. The site includes a 15 m^2 alcove plot and a rectangular plot (ca. 1 x 10 m) immediately adjacent to a 2.5-m high brick wall (Fig. 1). The building itself and wall extending south from it largely block the cold west and northwest winds of winter storms. I hypothesized,

Table 1. Winter minimum temperatures at rural Western Knolls site, Oxford, Ohio, years 1989 through 1999.

	1989–90	90–91	91–92	92–93	93–94	94–95	95–96	96–97	97–98	98–99
°C	-28.9	-21.1	-18.9	-17.7	-18.9	-31.1	-25.5	-18.3	-13.9	-25.5
°F	-20	-6	-2	0	-2	-24	-14	-1	7	-14

based on some limited winter minimum temperature measurements collected in previous years, that these campus plots would effectively represent Zone 6b–7a microhabitats.

A second set of plots was established at my home garden in the Western Knolls (WK) area of Oxford, located ca. 5 km southwest of Pearson Hall in a rural area at the edge of the city limits. Winter minimum temperature data I had collected during the past nine years in this neighborhood suggested that the low-lying forested part of the property on the west and north sides of our home likely represented a Zone 6a microhabitat, while areas near the house on the south and east side were likely Zone 6b.

Site Preparation and Palms Utilized. In conjunction with the Miami University Campus Services Office, the HPDP sites were tilled in July 1998 and the heavy clay soil was amended with equal parts of leaf compost, topsoil and sand to a depth of about 15–18 cm, resulting in a well-drained soil of slightly acidic pH. At the WK plots, soils away from the house are well-drained, fertile forest loam (pH ca. 6.8) and were not amended with organic matter or sand, but planting beds near the house were amended with compost, sand and humus.

In this pilot project, palms were obtained from several sources. Smaller, 2 to 3-year-old, bare-root seedlings of *Rhapidophyllum hystrix* (needle palm; N = 7), *Sabal minor* (dwarf palmetto; N = 6), Trachycarpus fortunei (Chinese windmill palm; Charlotte variety, N = 7), *Sabal* sp. (Brazoria palmetto; N = 3), and *Sabal palmetto* (cabbage

2. Appearance of the HPDP in August 1998 showing general site and smaller palms. The larger dwarf palmetto and needle palms had not yet been installed.

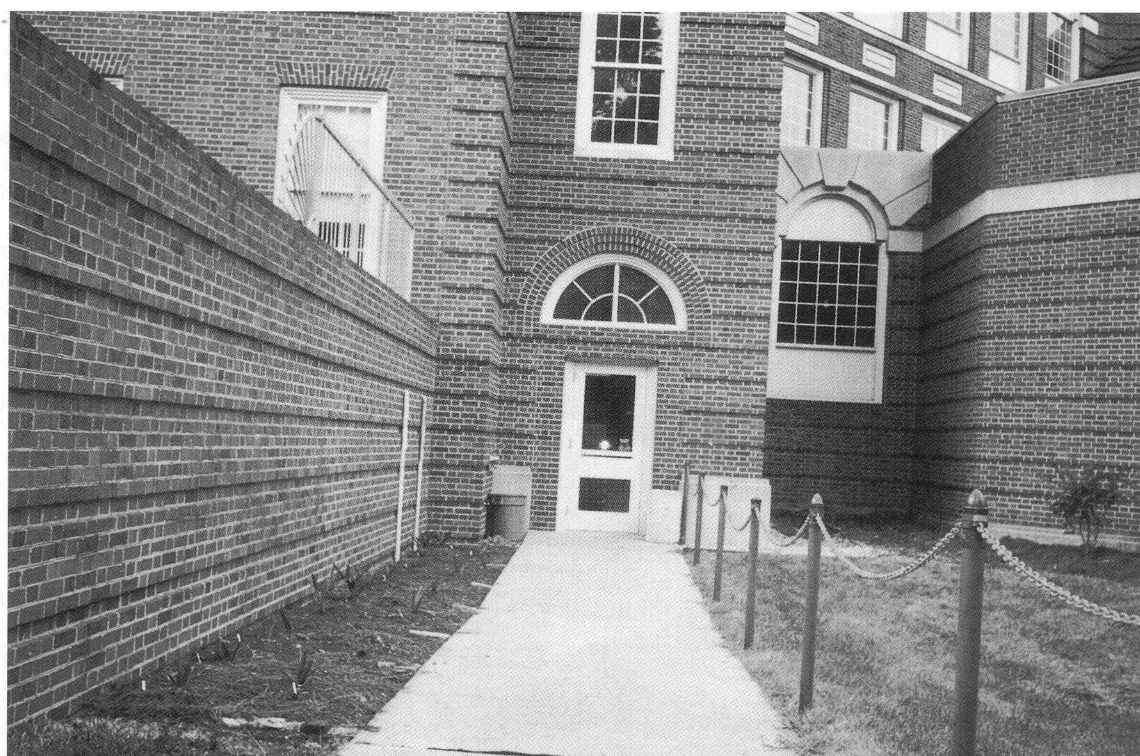


Table 2. Winter minimum temperatures and mean low temperatures at various sites on the Miami University campus and at the Western Knolls (WK) site for the 9 coldest nights from December 1998 to March 1999. Mean values computed for three temperature recording stations each at WK Forest/Near House and Upham courtyard, and two stations each for Pearson Wall, Irvin. Cincinnati and Hamilton as per National Weather Service data reported in the Cincinnati Enquirer for the same dates as campus/WK data.

		WK Forest/Near House	Pearson Control/Alcove/Wall	Upham	Irvin	Hiestand	Cincinnati	Hamilton
Min	°C	-25.5/-23.9	-22.8/-19.4/-19.4	-19.4	-18.9	-19.4	-22.2	-22.2
	°F	-14/-11	-9/-3/-3	-3	-2	-3	-8	-8
Mean	°C	-17.3/-21.7	-21.4/-23.3/-23.2	-23.5	-23.8	-23.4	-21.2	-22.4
	°F	3.1/7.0	6.6/9.9/9.8	10.3	10.8	10.1	6.1	8.4

palm; N = 4) were obtained via mail order from Plant Delights Nursery, NC. Larger specimens of needle palm (6–7 years old; N = 4) and Chinese windmill palm (10 gallon size; N = 2) were obtained via mail order from Forest Sound Nursery in NC. In addition to these demonstrably cold-hardy species, I included a *Livistona chinensis* (Chinese fan palm) purchased from a local discount store. Also included in the WK plot analysis was a small specimen of *Trachycarpus fortunei*, originally purchased in Georgia in March 1995 and moved to its current location at my present home (west side of house next to a small ornamental pond and ca. 1.5 m from the

3. One of the large needle palms and *S. minor* during mid-January 1999 showing maximal extent of snow drifts.

foundation) in October 1997. This plant had received winter protection from a plastic shelter but had been grown outside continually.

Although it is advisable to plant palms early in the growing season, especially in marginal climates (SPEPS 1994), plant availability and other logistics prevented us from getting plants in the ground until early–late August 1998. At the HPDP site (Fig. 1) bare-root plants were planted directly into soil and were mulched with pine straw. Larger palms were carefully removed from pots prior to planting and mulched as above. At the WK site, one larger needle palm was planted near the front of the house (SE exposure) roughly 3 m from the foundation. A 10-gal *Trachycarpus* was also planted on the front side near the SE corner of the home and next to the foundation. The *Livistona* was planted on the SE side of my home next to a porch and next to the foundation. At the edge of the Zone 6a forested area at the back of my property I planted one each of the small *Trachycarpus* and needle palm specimens. All palms were fertilized in late summer with a slow-release granular fertilizer containing micronutrients.

In December 1998, a burlap wind barrier (75 cm height) was placed around plants at the both the HPDP and WK sites. Each plant was treated with antidessicant spray (Wilt-Pruf) and root zones were mulched to a depth of ca. 8 to 10 cm with pine straw. The *Livistona* specimen at WK was enclosed within a plastic lean-to. Since most plants were very small and were planted late in the growing season, and since I had no way of knowing how cold it might get in the plots, I elected the option of being able to provide a small amount of supplemental heating to protect spear leaves and bud tissue during the coldest weather. I ran 15 ft (4.6 m), 30-watt heat cables through the plots so that the cable was adjacent to the growing spear of each plant. In larger *Trachycarpus* and *Sabal* specimens and in the *Livistona* enclosure, the cable was draped loosely around the base of the plant. Since the cables used generated ca. 2 watts of heat per foot (0.067 watts/cm), the amount of supplemental heating ranged from < 1 watt in smaller plants to perhaps 15 watts in the larger clump palms. Although the heat cables were equipped with thermostats that activated at approximately 2.7°C (38°F), they were plugged in only when nighttime lows were forecast to be below -12.2°C (10°F). The bare-root needle palm and *Trachycarpus* were grown in the cold forest site at WK without supplemental heat.

Temperature Measurements. Winter temperature data were collected within the HPDP and WK plots in order to provide definitive microclimatic parameters for the first-year experimental plots. Simple thermometers with inside-outside probes were placed on wooden dowel rods approximately 20 cm above the ground. Each thermometer was calibrated prior to use with a YSI thermistor temperature meter and field temperature readings were corrected accordingly. Two thermometers were sited in the wall plot at the HPDP, one ca. 5 m from the building and the other at the distal end of the plot. Another temperature station was located in the alcove at the HPDP.

Although 1998 palm plantings on campus were confined to the HPDP, my intent was to introduce new experiemental palm pots on the Miami University campus in 1999. To evaluate microclimatic variation on campus and propertly site these plots, additional measurement sites were established on campus in two groups of settings: 1) sheltered areas where large buildings blocked the north and west winds (Upham Hall, Irvin Hall, and Hiestand Hall courtyards) and 2) an open area control exposed to normal winter wind patterns (w. side of Pearson Hall).

At the WK site, temperatures were recorded in palm plots near the house and at the forest control site. Temperature measurements were recorded to the nearest Fahrenheit degree within 30 min prior to dawn, at the coldest period of the overnight hours, both outside and inside burlap enclosures. Since the Miami campus does not have an official weather reporting station, I also collected published temperature data for the official reporting stations at both the Greater Cincinnati-Northern Kentucky International airport (the official National Weather Service site for Cincinnati, ca. 45 km south of Oxford in Hebron, KY) and the Hamilton-Fairfield Airport (ca. 25 km southeast of Oxford). Both of these sites lie at the interface of USDA Zones 6a and 6b, but because such larger-scale climatic maps do not reflect the heat-island effect of large airports, these sites almost certainly reflect mid-Zone 6b conditions.

Results and Discussion

Microclimate Determinations. As noted earlier, I have collected winter temperature minima data for the rural Oxford habitat in WK since the winter of 1989–90. Thus, with data from the winter of 1998–99 I had a ten-year minimum temperature data set which could be used to place 1998–99 data in historical context. On the basis of winter minimum, 1998–99 proved to be the third coldest in the past decade (tied with 1995–96), with a low of -25.5°C (-14°F) recorded in the predawn of 5 Jan 1999 at the WK forest site (Table 1). The ten-year mean winter minimum of -7.5°F (-22°C) that I recorded for the rural WK area, away from houses and other structures, lies in the mid-range of USDA Zone 6a (-5 to -10°F), in agreement with Oxford's Zone 6a classification in USDA Zone maps of the United States. However, Table 1 also suggests that simple mean winter minimum data do not tell a complete story. Rather, the ten-year data set was markedly bimodal. Only a single year (1990–91) featured a minimum temperature within the Zone 6a range; five years were warmer (including the El Niño winter of 1997–98) and four were colder (including the winter of 1994–95, which tied the all-time record low for Oxford of -31.1°C (-24°F). Furthermore, the duration of cold spells, an important variable in plant viability, is not obvious simply from winter minima data. In 1998–99, for example, I recorded nine nights where the temperature at the coldest recording station (the forest at WK) dipped below -9.5°C (15°F); no nights save 5 Jan 1999 were below zero Fahrenheit, and only four nights reached lows of -17.8° to -15°C (0 to 5° above zero F). Over the past ten years, I can reliably estimate than no more than eight to ten nights have dropped to -23.3°C (-10°F) or below at WK. Put another way, if a given plant is killed by temperatures below -23°C, it would have been at risk only eight to ten days out of more than 3600.

Winter minimum temperatures and the mean low temperature for the nine coldest nights in 1998–99 varied greatly between sites, suggesting that the microclimate on the Oxford campus sites and at WK sites with respect to minimum temperature at the Miami campus sites and at WK sites varied at least a full USDA zone (Table 2). In the HPDP, the winter minimum outside the burlap barriers was -19.4°C (-3°F) at both recording stations along the wall and in the alcove. Although the heat cables were activated on the coldest nights, the temperature within the barriers was generally the same or at most 1–2°F warmer. Since nightly heat radiation from the wall and the building undoubtedly contributed some heat, I conclude that the heat cables were likely ineffective at the HPDP site, although I could not rule out a small heat differential immediately adjacent to the cables.

Winter minima and the mean low for the coldest nine nights at the other protected campus sites (Upham, Irvin, Hiestand) were similar to those at the HPDP (Table 2). Winter minima and the mean winter low temperatures at the exposed control site on campus (-22.8°C; -9°F), sites near our house in WK (-23.9°C; -11°F) and the official NWS sites in Cincinnati and Hamilton (-22.2°C; -8°F) were similar to each other and consistently a few degrees F colder than the warmest sites on campus (Table 2).

Based on a comparison with the ten-year data set for the cold forest temperatures at WK (mean winter minimum = -21.9°C (- 7.5 °F), the winter minimum in 1998–99 of -25.5°C (-14°F) represented a departure of -3.6°C (-6.5°F) from normal. The official 1998–99 winter minimum readings from Cincinnati and Hamilton of -22.2°C (-8°F) were similarly on the order of 4–6 degrees F lower than the mid-Zone 6b rating for these sites. Hence, my data suggest that the protected sites on the Miami campus, which reached -18.9 to -19.4°C (-2 to -3°F) minima, might be expected to drop to ca. -16.1 to -15.5°C (3–4 above zero °F) in a statistically normal winter, and thus represent mid-USDA Zone 7a microhabitats. By the same reasoning the exposed areas of campus and areas immediately adjacent to houses at WK are probably best considered Zone 6b microhabitats, and rural Oxford away from structures is clearly Zone 6a.

Survivorship and Condition of Palms. Photographs of palms during summer 1998, winter 1998–99, and spring 1999 at the HPDP and at WK are shown in Figs. 2 to 7, respectively. All of the small seedling palms, whether grown at the HPDP or at WK sites, survived the winter of 1998–99 and were growing well by mid-spring 1999 (Figs. 4, 5 and 7). Damage to small seedling palms was confined to leaf tip burn on all plants and margin burn on most plants. No spear leaves were lost in small *Trachycarpus*, *Rhapidophyllum*, *S. minor*, *Sabal* sp. (Brazoria) or *S. palmetto* seedlings at either plot. By the end of the 1999 growing season (mid-Nov), seedling palms of all species had approximately doubled in height, leaf number and trunk diameter.

Similarly, the large *Sabal minor* and three large *R. hystrix* installed at the HPDP suffered tip and margin burn, especially to leaves that were completely exposed to drying winds (Fig. 4). Of a total of 16 needle palm trunks among the three large plants, five trunks partially defoliated and lost their spear leaves. Despite immediate treatment with fungicide (Myers 1999), only two of the five trunks regenerated new spears by the end of the 1999 growing season (mid-Nov), although each of the large needle palms developed several new lateral trunks. Each of the other 11 undamaged trunks grew at least two expanded leaves and a spear leaf in 1999.

One of the large *Trachycarpus* specimens planted in the HPDP alcove succumbed in mid-fall 1998 to an unknown malady. Despite care in planting and adequate water, leaves began to yellow and senesce on this plant almost immediately.

4 (above). The same large needle palm and *S. minor* as in Fig. 3, plus seedlings of the same species and a seedling *Trachycarpus* (far right) in June 1999. 5 (below). The alcove area of the HPDP in June 1999, with 1998 plants plus new specimens of *Sabal palmetto, S. minor, S. bermudana, Washingtonia filifera, Butia capitata* and *Trachycarpus fortunei.*

Although it was treated with fungicide and a pyrethrin-based insecticide, it was defoliated, and live bud tissue was absent before winter began. Similarly, the second large *Trachycarpus*, which was planted on the SE side of our home at the WK site, began to senesce soon after planting. It did appear to recover somewhat, and entering the winter season still had six to eight reasonably green and healthy-looking leaves. Late fall 1998 was extremely mild, with some high temperatures reaching the 23°C (mid-70s °F) in early December. However, late December brought the first real cold of the season, with 72 hours of continuous below freezing temperatures and nighttime lows in the high single digits F. At the end of this cold snap, this palm was approximately one-half defoliated, and became completely defoliated after exposure to -17.8°C (0°F) outside the enclosure; the inside probe was covered with light snow and reached only -14.4°C (6°F) on 1 Jan 1999. Despite fungicide treatment the spear could be pulled loose by the end of February and no live bud tissue remained in cut cross sections of the trunk in March 1999.

At the WK plots, the large needle palm planted on the southeast side of the house suffered leaf injuries similar to but no worse than the larger needle palm specimens at the HPDP and only one of five trunks lost its spear (Fig. 7). This was somewhat surprising, since the minimum temperature I recorded within burlap enclosure surrounding the WK needle palm reached -24.4°C (-12°F) on the morning of 5 Jan 1999, or ca. 5°C (9°F) colder than the minimum at the same time in the HPDP plot (Fig. 6). By mid-May, this plant had several expanded new leaves and new spears growing in. The *Trachycarpus* specimen growing near the ornamental pond on the west side of our house appeared undamaged prior to 5 Jan 1999, but most of the leaf tissue above the middle of each petiole was killed by a temperature that dropped to ca. -23°C (between -9° and -10°F) in the leaf crown that predawn. Although the bases of the petioles remained green, the terminal spear ultimately came loose from this palm by late winter. Liquid fungicide was poured down into the crown approximately monthly beginning in January (Myers 1999), and by mid-May 1999, the palm had begun to recover, with two new spear leaves apparent. By November 1999, this plant had five fully expanded leaves and an expanding spear leaf.

The needle palm and *Trachycarpus* seedlings planted in the Zone 6a forest area of WK both survived the winter. Although the latter was defoliated, its spear never pulled loose and it now has one new expanded leaf and a second expanding spear. Except for some minor leaf spotting, the needle palm was undamaged by exposure to the -25.5°C (-14°F) minimum at this site. Foliar growth will be slower at this site due to the deciduous tree canopy and part shade light regime.

Amazingly, the *Livistona chinensis* specimen planted near our house and covered with a plastic lean-to survived the winter. The temperature inside the enclosure dropped to a low of -10.5°C (13°F) on the morning of 5 Jan 1999, approximately 11.1–12.2°C (20–22°F) above that outside the enclosure due to heat from the house and the heat cable wrapped around the plant base and a layer of insulating snow on the top of the enclosure. At this temperature, defoliation was complete. I had noted severe scorching of most leaves on this specimen when temperatures inside the enclosure first dropped below about -3.9°C (25°F) in late December. Despite complete defoliation, new spear growth commenced in mid-May from all five trunks of this plant and by late-June 1999, it possessed five small fan leaves ca. 15–20 cm across. These leaves continued to enlarge during 1999, and by mid-November the plant was ca. 50–60 cm tall and a meter across. My data suggest that *Livistona chinensis* may be a 'deciduous' palm in Zone 6, capable of regenerating new foliage in the spring as long as bud tissue is not destroyed by cold.

Additional Considerations: Some additional considerations are necessary in order to fully assess the data. In addition to minimum temperature, several environmental factors can affect winter injury in broad-leaved evergreens. The wind chill factor dictates how rapidly leaves lose water and are therefore subject to dessication and winterburn. The presence of snow or ice cover reduces wind-induced dessication and also insulates the ground and plant tissues from cold exposure.

As noted earlier, the winter of 1998–99 was a very mild until the last week in December and the first measurable snowfall (ca. 1 cm) occurred on 30 Dec 1998. Although the air temperature never dropped below the high single digits above zero F even in the coldest areas and the high teens in warmer areas, the recorded wind chill temperatures were ca. -18 to -20°C (0 to-5°F, data from the Hamilton-Fairfield Airport). The following night an additional 6–7 cm of snow fell, and on 2 Jan 1999 this was supplemented by 18–20 cm of fresh powder. Both the amount of snow and the direction of the storm winds (from the east and southeast, gusting above 20 mph) were unusual for this area, and the HPDP and WK

6. Needle palm on the front side of the house at the WK plot in mid-Jan 1999, showing snow drifts around the enclosure.

7. The same palm as in Fig. 6, fully recovered and actively growing plant, July 1999, with newly installed *Sabal palmetto* in background.

plots on the southeastern side of our home, which are protected from prevailing north and west winds of winter, were hit by the brunt of the storm. Windchill readings reached -23 to -26°C (-10 to -15°F) for long periods of time (gusts produced -35°C [-30°F] windchills) and snow drifted heavily over the burlap barriers and on top of plants (Figs. 3, 6), covering all but the upper one-half of the larger palms. Continued cold and additional snow plus an ice storm on 8–10 Jan 1999 produced the longest continuous snow/ice cover duration (nearly three weeks) recorded in Oxford since the winter of 1977–78. Based on the inability of my burlap barriers to prevent snow drifting inside the enclosures and the aforementioned observation that temperatures inside the burlap enclosures were nearly identical to those outside, I conclude that simple burlap barriers probably represented an ineffective winter protection strategy under these conditions.

The long-term snow/ice cover had two effects of importance for palm damage and recovery. First, the fact that most plants were completely covered by snow and ice for nearly three weeks undoubtedly contributed to some of the leaf damage noted on all plants. However, plant tissues covered by snow and ice were also insulated from the worst of the cold to a remarkable degree. On the coldest morning of the winter (5 Jan 1999) I took temperature measurements approximately 8–10 cm below the surface of the snow in the forest plot area of WK. The readings of -9.4 to -8.9°C (15–16°F) were fully 17°C (30°F) warmer than the air temperature above the snow. Similarly, temperature readings under the snow inside the snow-covered burlap enclosures at the HPDP never went below -5°C (23°F), again some 14°C (25°F) above ambient. Windchill factors were by definition not operative in plants sheltered by a covering of snow and ice. Thus, although the tips of larger plants at the HPDP and approximately the upper one-half of the foliage of larger palms at the WK site were exposed to extremely low wind chill temperatures as well as below zero F ambient temperatures, entire smaller plants and the basal portions of larger plants were not thus exposed.

The dual effect of snow and ice cover has important ramifications to potential palm growers in the Upper South or Lower Midwest. In these parts of the United States, snow cover is sporadic in most years, and extremely cold temperatures (i.e., below -17°C or 0°F) almost never occur unless the relatively warm ground is covered by snow or ice, which promotes high radiational cooling and rapid temperature drops after sundown. The fact that none of my snow-covered small palms was killed, even the *S. palmetto* seedlings, suggests that the same meteorological conditions that foster extreme, potentially killing cold also can also insulate small plants from those conditions.

In summary, I report a high degree of success in first-year survivorship and subsequent growth of all palm species and varieties examined, even under winter conditions that were more rigorous than typical in SW Ohio. Moreover, the effective microclimate to which plants were exposed ranged over a full USDA zone (6a to 7a), suggesting that the hardiest of the cold-hardy palms, including *Rhapidophyllum hystrix*, *S. minor* and perhaps some of the hardier *Trachycarpus* varieties should be able to be grown with little or no winter protection in SW Ohio, so long as attention is given to microclimate.

Future Directions: Based on 1998–99 trials and the temperature profiles for campus and WK microhabitats, we have expanded the scope of the palm cultivation trials to include more varieties, a larger range of plant sizes, and several new experimental plots (Fig. 2F). A total of ca. 70 palms were planted on the Miami-Oxford campus, at the WK site, and at Miami's Middletown campus (ca. 30 km E. of Oxford) during April–early June of 1999. Most of the new plants were obtained from Neotropic Nursery in Georgia in person (i.e., not mail order), and included not only more representatives of species/varieties already under cultivation, but also large (i.e., 10-gal. size) specimens of *Sabal palmetto*, *S. bermudana*, *S. minor*, *Serenoa repens* and larger specimens of *Trachycarpus fortunei*. I was also fortunate to obtain from Neotropic Nursery several fairly large (3-gal) specimens of *Trachycarpus takil* and *Washingtonia filifera*. In addition, we obtained via mail order, bare-root seedlings of *Trachycarpus fortunei* (Plant Delights' varieties "Norfolk" and "Greensboro") and *Butia capitata* in late winter 1999. These were immediately potted into one-gallon peat pots and placed in the Botany department greenhouse in order to recover from root shock for 3–4 months before being planted outside.

In addition, I am employing a modified pot-planting technique in all 1999 plantings to reduce root shock set-back and early mortality in larger palms, as well as to encourage downward root growth during the first critical growing season (Tollefson 1999). I am slitting the sides of containers 5 cm from the top and carefully slitting and expanding the lower drain holes on the side and bottom of the containers prior to placing the pot in the ground. I can only report at this stage that I have noted no setback in pot-planted palms, and that vigor and growth in the first few months after planting (especially in the larger *Trachycarpus* specimens) are far superior to what I noted in last year's experimental plantings. Further data will of course be reported as I analyze new and 2-year old plots after the winter of 1999–2000 and subsequent spring/summer recovery.

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On the Pruning of Palms

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In pruning our palms, we must realize that we are in effect defeating the mechanics of an evolved system. Our primary consideration with any pruning activity must be proper tool choice and sterilization, coupled with an understanding of system dynamics.

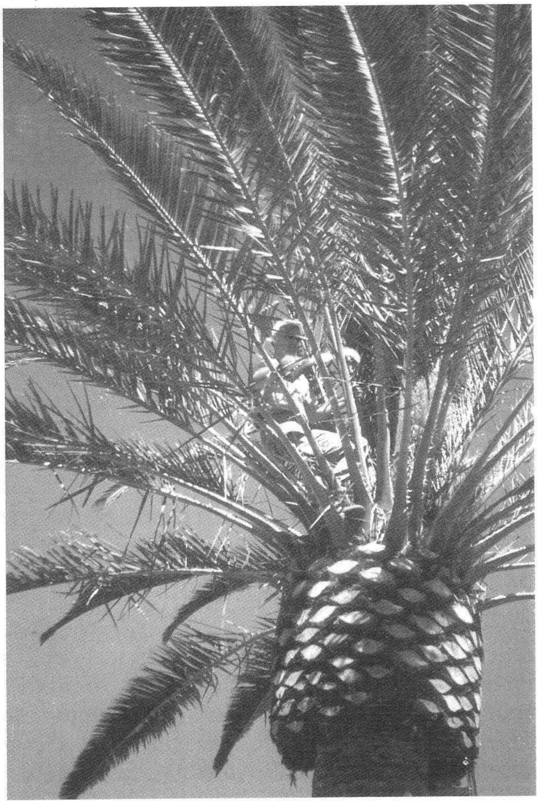
Use of chainsaws in the pruning of palm crowns is a questionable technique in that it is impossible to sterilize a chainsaw. Handsaws, date hooks, spades, and climbing gaffs can be sterilized via immersion for 5 minutes between specimens in a 50/50 solution of bleach and water (Simone & Cashion 1996). Use of chainsaws and general disregard for sterilization practices are quick ways to place your palm at risk. Just as one who does no pruning is subject to the danger of being struck by a falling leaf, one who overprunes initiates a series of potential hazards as well.

A discussion of crown system dynamics is important at this point. The palm crown has an obvious role in "starch" or photoassimilate production. The crown mass consists of mature and juvenile members. Maturity in palm leaves (Hilgeman 1951) occurs below the current season's fruit/flower structures (infructescence/inflorescence). The mature leaves (sources) provide assimilates to inflorescence, juvenile leaves, and roots (sinks or assimilate draws). Studies of source sink relationships (Bangerth 1989) suggest fruit as the dominant sink, followed by developing leaves, then roots. In removing the inflorescence, we are not only attempting to prevent stains to our cool decks and avoid seedling growth in our planters, we are also making the assimilates which would have gone to the development of the inflorescence available to developing leaves and, ultimately, roots.

Research tells us the following: juvenile leaves are dependent upon mature leaves for structural support (Tomlinson 1990), protection from desiccation (Zimmerman & Sperry 1983), a portion of their macronutrient demands (Hambidge 1941), and photoassimilates. Juvenile leaves outnumber mature leaves in some crown systems, with *Phoenix dactylifera* an example at a ratio of 2:1 (Dalrymple & Fisher 1994). The developmental period needed for a leaf to reach a position below the inflorescence in the crown (vascular maturity) can be as long as 66 months, with *Phoenix dactylifera* again the example (Hilgeman 1951). Juvenile leaves are structurally, photosynthetically, and hydraulically inadequate. The next time you look at the crown of a *Phoenix dactylifera*, understand that you are seeing a system of some fifteen years in the making, from the newest leaf developing in the "bud" to the oldest leaf in the low crown.

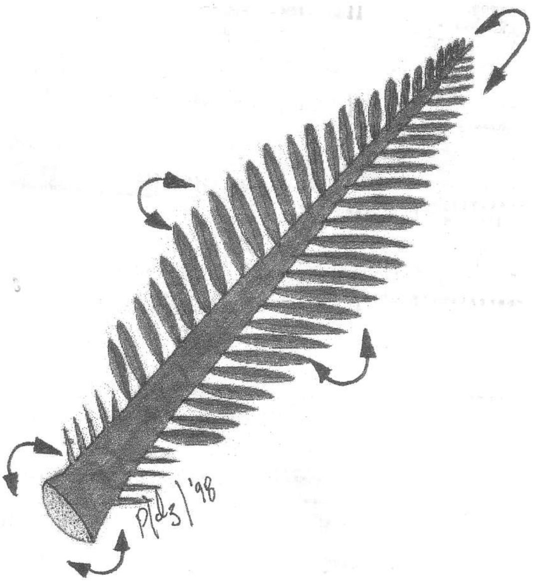
So what happens when we prune palms so drastically that we get into the higher portions of the crown, where the inflorescence is developing? In reducing photosynthetic capacities, we promote unnecessary mobilization of stem storage reserves (Mendoza et al. 1987). We promote wind related failures of juvenile leaves lacking the support and protection of mature leaves below (Tomlinson 1990). And most importantly, we promote the developmental impairment of leaves (i.e., smaller leaves) developing to become the crown of the future. Considering that the leaves ultimately feed the trunk, we must see that smaller leaves make a smaller trunk.

In understanding the structural considerations important in dispersing forces placed upon tall palms via wind loads, we see twist and bend as



1. Author removing inflorescence, and dethorning *Phoenix canariensis.*

destructive forces. Research tells us that twist loads are addressed in the crown by the cantilevered beam design of the petiole which allows leaves to twist into the wind, complimented by the leaf's ability to reconfigure (cup) itself to reduce surface drag (Vogel 1996, 1989). The individual leaves work well in unison, complimented by the spiral arrangement of the leaves on the stem (phyllotaxis). As twist is reduced in the crown, the result can be seen as side loading of the stem, or bend. This bend load is dispersed over the surface of a gradually tapering column, with the helical arrangement of the stem bundles playing a role in resistance to longitudinal splitting (Tomlinson 1990). Stem tissue density is suggested to increase (become harder) at lower portions of the stem (Rich 1987). Thus, wind loads are addressed in the palm system via the crown's ability to transform twist into bend, which is proportionately dispersed along the "shock absorber" trunk and harnessed at the lower stem portion. One has but to watch a tall palm in the wind to witness the mechanical perfection of the palm system. The crown bunches up, the stem sways to and fro, with the swaying stopping about 6 feet up the stem.

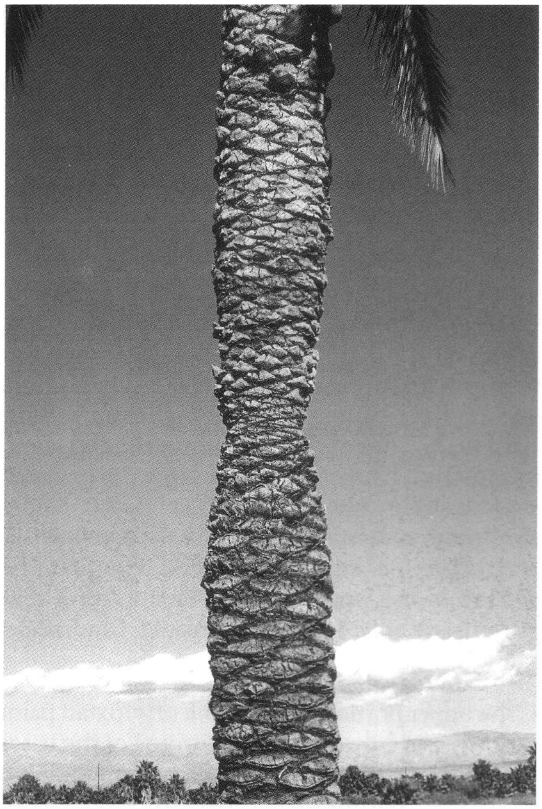


2. Leaf of *Phoenix* sp. showing planes of orientation to reduce surface drag under wind load.

So what does all of this have to do with overpruning? In removing large portions of mature crown mass, we promote wind failure of juvenile leaves via exposure. Reductions in photosynthetic capacity promote a developmentally impaired system. This impairment must ultimately result in an area of reduced stem diameter (negative stem taper variance). Sudden decreases in diameter defeat the mechanism of a gradually tapering column through isolation of the bend load, by eliminating the lower portion of the stem's ability to harness the bend load. This returns twist to the equation, resulting in load isolation. If severe, one could expect this load isolation to be displayed by a linear series of vertical, superficial splits in the area of a negative stem taper variance. Upon seeing this condition, a manager should have the structural integrity of the specimen reviewed.

Before climbing a palm with gaffs, we should have exhausted every option to use lift equipment. We must have sterilized tools. We should never climb under a skirt of old leaves as is commonly experienced in *Washingtonia* palms. We should carefully inspect the stem for signs of structural inadequacy. We must inspect our rigging and see to it that proper rigging is used in the vicinity of utilities. While working the crown we should note abnormal development of inflorescences, changes in the orientation of new leaves, and abnormal dieback, which are early signs of pathogen activity.

We are often not given the luxury of being able to remove leaves one at a time as they decline,



3. Reduction in stem diameter, *Phoenix dactylifera* 'Zahidi.'

especially in the resort or municipal setting. Liability or budgetary constrains often make annual pruning operations a "one shot deal". Physiology aside, can we be smart enough to understand that most palms put on about a "row" a year. Why on earth then, would we remove more than a row at the low crown? The status of our landfills should promote environmental responsibility here.

As collectors, we can appreciate the palm system enough to let it work with minimal interference. As horticulturists we can understand the importance of proper tool sterilization. As contractors we must see the clouds of litigation looming on the horizon.

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Horticulture Column

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Q. I have a 20-year old *Arenga engleri* in my garden, but it is not setting seeds. While it was still in a pot it did produce seeds, so in the hope that it would produce even more seeds, I put it in the ground. It has since grown profusely but has stopped flowering or setting seeds. Could you advise me as to what to do? Shri Dhar, Calcutta, India.

A. As you probably know already *A. engleri* has a hapaxanthic flowering habit, that is, each individual trunk grows to a stage of maturity and then begins to flower, first at the top of the trunk, and thereafter successively at each node, down the trunk. This process of flowering and producing fruits and seeds takes several years for each trunk, and once it begins, that trunk is unable to produce any new foliage. Existing foliage begins to show wear and tear and may begin to look unsightly. For this reason some growers might prefer that their *A. engleri* do not flower. However the flowers of this palm are very fragrant, and if you wish to produce seeds for propagation, then you will want them to flower. It should be mentioned that in order to set seeds you will probably need to have at least two trunks, or two seperate palms, in flower at about the same time, since, on a given inflorescence, the male flowers open, shed their pollen and fall well before the female flowers become receptive. Alternatively one could collect and preserve the pollen and apply it to the female flowers when they are receptive.

Perhaps the stress of being confined in a pot brought on the flowering (prematurely, perhaps) of some of the trunks of your *A. engleri* when it was still relatively young, and now that it has found itself in a more congenial situation in your garden the trunks that have since grown are able to reach their full potential. I am certain that eventually your palm will flower and produce seeds once again as long as it is not in an extremely shady location and the most mature trunks are not being removed for any reason.

Q. My foxtail Palms, *Wodyetia bifurcata*, are dropping their leaves prematurely. What is troubling me is that the upper portion of the trunk appears to be splitting through several layers at once, rather than the typical loss of one leaf at a time. Is this some kind of deficiency with nutrients? I have been using a time release, encapsulated palm fertilizer along with chelated iron and sulfur, and my soil pH is 7.5–8.0. Before using these materials the palms were yellowish, their color has since improved. It is just the splitting of the upper portion of the trunk that concerns me now. Tony Kaniewski, Ft. Lauderdale, Florida.

A. The upper portion of the trunk of a foxtail palm is known as a crownshaft, it is formed of the bases of the leaves with the oldest one being visible on the outside. Within this crownshaft is the apical meristem or bud of the palm. This area is where new leaves are formed.

When you corrected the nutrient deficiencies that had caused your palm to have yellow leaves, no doubt the bud, inside the crownshaft, began to grow larger and more vigorously as well. On the outside of the crownshaft are the leafbases that were formed when your foxtail palms were still undernourished; they no longer fit. If you have ever put on a pair of pants that were too tight before sitting down to Thanksgiving dinner then you know the feeling. I do not think you have to worry. The fertilizer that you described is a quality product, and you should continue to use it according to directions. After a transition period, your foxtail palms should resume normal appearance and growth.

The pH of your soil is perhaps a little higher than it should be for foxtail palms, but do not apply any more sulfur to lower it. You should wait at least six months before testing the pH level to determine if more sulfur is needed. Too much sulfur could cause unjury to your plants. Likewise, it is probably not necessary to apply chelated iron to your palms, as it is contained, in the correct proportions, in the fertilizer that you are using.

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