PRINCIPES

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THE INTERNATIONAL PALM SOCIETY

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PRINCIPES

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Contents for April

Cover Picture

Phoenix theophrasti, pistillate plant in flower, Vai, Crete. Photo by John Dransfield.

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Editorial

This year the International Palm Society's Biennial meeting will be held on the island of Hawaii in mid June. We hope that many of you will be able to attend and enjoy what is bound to be an exciting week of meetings and events. For us, the editors, living as we do in cold temperate parts of the world, this is one of the few times when we have the opportunity to meet with members of the Society, and we find it exciting and rewarding. At the Biennial we can discuss face to face the contents and production of *Principes*. The Biennial is also a time for enjoying palms in the wild and in collections. Fittingly our April issue begins with a foretaste of the palm delights of Hawaii: Norman Bezona's introduction to the palms in the mountain cloud forests of Kona.

California member Don Hodel has been preparing an account of the species of *Chamaedorea* in cultivation. This book for which we have all been waiting will be published in the near future. See page 99 of this issue for more details and the need for help with color. In his studies Don has discovered that several species in cultivation have not yet been described; these new species must be named before the book goes to press. In the first of several planned papers, he describes with Natalie Uhl two new species from Mexico.

Rational plans for conserving rare palms in their natural habitats demand detailed knowledge of their ecology—details which are obtainable only by long and painstaking field work. Keith Clancy and Michael Sullivan provide just such information in their study of the needle palm, *Rhapidophyllum hystrix*.

Another article deals with a curious and geographically isolated palm. Bill Gunther and Paul Mahalik present an account of a visit to the remote islands of Juan Fernandez to see the endemic palm, *Juania australis*. This handsome genus, adapted to a cool oceanic climate, is related to the palms of the Andes. The article has sad overtones. Paul died early this year and the trip was his last palm collecting expedition. For more about Paul see p. 78.

Two palm workers from the Nigerian Institute for Oil Palm Research have provided a paper on methods for handling pollen of *Raphia hookeri*. Controlled pollination is an essential part of breeding, and in the huge inflorescences of *Raphia*, this is not a simple matter.

Those of us who attended the splendid last Biennial in Queensland, Australia, will remember the fine new Palmetum in Townsville. Robert Tucker describes how the Palmetum was developed—may it continue to flourish.

Finally this issue ends with much news from the Chapters as ably prepared by Jim Cain. It shows that interest and enthusiasm for palms is growing apace.

We look forward to a grand Biennial with the chance to meet many old and new friends. We'll see you there!

JOHN DRANSFIELD
NATALIE W. UHL

Principes, 34(2), 1990, pp. 56–57

Palms in the Mountain Cloud Forests of Kona, Hawaii

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Palm Society members visiting the Island of Hawaii for the Biennial Meeting in June will be amazed at the climatic diversity here. The east side of the Island is predominately tropical rainforests, macadamia orchards, and sugarcane. Mauna Loa volcano and Mauna Kea, rising almost 4,300 meters above sea level, create microclimates from warm, wet and humid to desert conditions. Elevations above 1,500 meters are cool temperate to almost alpine.

The west or leeward slopes are home to Kona coffee, citrus, macadamia nut, banana, and many other tropical and subtropical fruits. Palms, both rare and common, are found throughout the Island up to about 600 meters elevation. However, since most Island residents live in the lowlands, very few palms are found at higher elevations. Of the 30 odd species of endemic *Pritchardia* only *P. beccariana* is found naturally at 1,000 or more meters.

Since very little research has been done with palms in the mountains, a 40 acre site at Kaloko Mauka, Kona is being developed for the testing of the many palms being introduced into Hawaii. The site is in the subtropical cloud forest at 1,000 meters above sea level. The predominant vegetation is the native Ohia, Koa, treefern complex. The Ohia (*Meterosidos polymorpha*) forest is the home of several rare endemic Hawaiian birds. Koa (*Acacia koa*) is a rare wood used in making canoes and furniture. Treeferns (*Cibotium* species) are up to 10 meters tall and in solid stands.

Kaloko Mauka is a 2,000 acre native forest above Kailua Village on the slopes of Hualalai volcano. It extends from approximately 500 meters to 2,000 meters above sea level. Although the area is sparsely populated, gardens are a fascinating mixture of Heliconias and Hydrangeas—Calatheas and Camellias. Frost may occasionally occur at 2,000 meters, but temperatures at 1,000 meters never fall that low. It is the drier side of the Island with most precipitation occurring in summer as it does in Florida. The annual average is approximately 175 centimeters.

After seven years of testing we have found that the area is particularly suited to cool, cloud forest palms, native to similar island environments such as Central America, South America, Australia, Southeast Asia and the Pacific. Palms from warm, dry, sunny areas do poorly because of a lack of heat, I suspect. However, nutrition may also be a problem since the young, high organic soils are deficient in most nutrients. Competition for light is also exacerbated by the heavy growth of ferns and forest trees.

More than 2,500 palms have now been planted in the area representing over 50 genera. Most *Chamaedorea* species do well as do *Pinanga*, *Livistona*, *Aiphanes*, *Rhapis*, *Drymophloeus*, *Synechanthus*, *Geonoma*, *Reinhardtia* and other shade lovers.

Laccospadix australasica thrives as do *Archontophoenix alexandrae* and *A. cunninghamiana*, *Howea forsteriana* and *H. belmoreana*, *Rhopalostylis*, *Ptychosperma*, *Caryota*, *Trachycarpus fortunei*, *Chamaerops humilis*, *Mackeea magni-*

fica, and *Ravenea robustior*. Surprisingly, even some *Iriartea* and *Socratea* species do well.

With sun, *Phoenix* species thrive as do *Washingtonia robusta*, *Wallichia disticha*, *Neodypsis decaryi*, most *Syagrus*, *Veitchia joannis*, *Chrysalidocarpus lutescens*, *C. madagascariensis*, *C. cabadae*, *Normanbya normanbyi*, *Clinostigma*, *Chambeyronia macrocarpa*, *Arenga* and *Pigafetta filaris* along with many others.

Palms that are slow but healthy include *Sabal* species, *Licuala spinosa*, *L. ramsayi*, *Thrinax microcarpa*, *Areca vestiaria*, *A. triandra*, and *Dictyosperma album*. *Syagrus romanzoffiana*, *Bactris gasipaes*, *Euterpe edulis*, *Latania verschaffeltii*, *Roystonea regia*, and *Hyophorbe* are also quite slow growing in this area.

Palms that did not succeed include such lowland species as *Cocos nucifera*, *Verschaffeltia splendida*, *Veitchia merrillii*, *Carpentaria acuminata*, *Gulubia costata* and *Neoveitchia storckii*.

We of the Volcano Island look forward to hosting The Palm Society in June so that we can all learn more about the cultivation of palms.

Principes, 34(2), 1990, pp. 58–63

Two New Species of Chamaedorea from Mexico

DONALD R. HODEL AND NATALIE W. UHL
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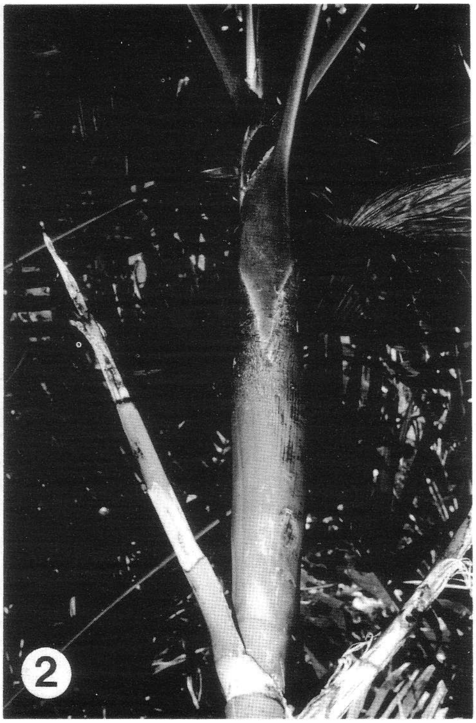
Recent work in support of a project on *Chamaedorea* that will be published by the International Palm Society in 1990 has yielded two new species. Native to Oaxaca, México, they are well established in cultivation hence names are proposed here.

Chamaedorea vistae D. R. Hodel & N. W. Uhl, sp. nov. (Figs. 1–3).

Insignis floribus femineis aurantiacis, inflorescentiis pedunculatis longis, foliis pinnatis longis, habitu solitario, distincta; *C. carchensi* Standl. & Steyerm. affinis sed pinnis ascendentibus numerosioribus (paribus 36 versus 20) nervis 5 prominentibus primariis, inflorescentiae masculinis rachillis numerosioribus (80–100 versus 40), fructibus oblongis aurantiacis maturitate nigris differt. Typus: México, *H. E. Moore, Jr. & G. S. Bunting 8913* (holotypus BH; isotypus MEXU).

Stem solitary, erect, stout, to 5 m tall, 5–10 cm diam., green, ringed, nodes white and prominent, to 2.5 cm wide, internodes to 20 cm long, prop roots evident (at least in some cultivated material) to 60 cm up the stem. Leaves 4–6, erect-spreading, pinnate (Fig. 1); sheath 40–80 cm long, green, somewhat swollen, tubular (Fig. 2), tightly clasping, obliquely open at the apex, longitudinally striate-nerved; petiole to 30 cm long, green and flattened or grooved adaxially especially toward the base, green and rounded abaxially with a pale yellow or yellow-green band extending onto the rachis; rachis 1–1.5 m long, green and angled adaxially, pale and rounded abaxially; blade with the pinnae ascending slightly but conspicuously off the rachis to appear wide-angled, v-shaped in cross-section; pinnae to 36 on each side of the rachis, regularly arranged, linear-lanceolate, 30–65 × 3.5–4 cm, dull dark green, ±straight, falcate, acuminate, a prominent midrib and 2 secondary nerves on each side of this somewhat recessed (only midrib prominent adaxially in dried material), all 5 nerves more prominent abaxially, tertiary nerves numerous and faint.

Inflorescences emerging from below the leaves, erect but nodding when laden with fruits; peduncles to 75 cm long, stoutish, 2.5–3 cm wide at the base and there flattened, 1–1.5 cm diam. at the apex and there ±rounded, erect and greenish in flower, orange apically and nodding in mature fruit; bracts 5, these tubular-sheathing, fibrous, brownish at anthesis, often fallen in mature fruit, acute-acuminate, bifid, longitudinally striate-nerved, prophyll to 12 cm long, 2nd bract to 30 cm long, 3rd to 35 cm long, 4th to 6 cm long, this exceeding the peduncle and concealing smaller 5th bract that is to 12 cm long. Staminate inflorescences large (Fig. 3) with a rachis to 60 cm long, erect, straight, green, longitudinally ridged; rachillae to 100, basal ones the largest, to 30 cm long, mostly unbranched but sometimes furcate, becoming progressively shorter toward the apex of the rachis, drooping, green. Pistillate inflorescences with a rachis to 40 cm long, greenish and erect at anthesis, orange and downward pointing in mature fruit, basal branches ramified 1–2 times; rachillae to 50, these to 30 cm long, erect or ascending and dark



1. *Chamaedorea vistae* in fruit at Wahiawa Botanic Gardens, Honolulu, Hawaii. Note the pinnae ascending off the rachis, the long-pedunculate infrutescence, and conspicuously ringed stem. 2. Prominent, tubular leaf sheaths of *Chamaedorea vistae* and newly emerging inflorescences, Lyon Arboretum, Honolulu, Hawaii.

green at anthesis, orange and downward pointing in mature fruit.

Staminate flowers ± densely arranged but not contiguous; sepals 0.75 × 1.25 mm, slightly connate at the base and forming a shallow cupule with 3 rounded lobes, margins brown; petals 3.0 × 2.5 mm, erect, valvate, moderately thick, free and spreading apically at anthesis; stamens with short, to 0.3 mm, triangular filaments adnate basally to the petals, anthers 1.5 × 1 mm, ±basifixed, divergent at the base, latrorse; pistillode slender, to 2.0 mm long, slightly longer than the stamens, wider at the middle, tip small, ±3-lobed; stamens ca. ⅔ the height of the pistillode, both shorter than the petals. Pistillate flowers 1.5 mm apart in 4 irregular rows, ±globose, 2.5 × 2.5 mm; calyx ringlike, low, orange-yellow, sepals briefly connate in basal ¼–½, lobes 0.5 × 1.75 mm, rounded, margins brown; petals orange-yellow with whitish margins, strongly imbricate, ovate, 2.0 × 2.0 mm; staminodes lacking or if present, 6, minute, dentiform, white, adnate to petals; pistil greenish, rounded, 2.0 × 1.5 mm, stigmas erect, reflexed, yellowish, just protruding from open petal tips. Fruits golden-orange ripening black, oblong, 10–12 × 7–9 mm diam.

Distribution: MÉXICO. Oaxaca: dense, wet montane forest on the Atlantic slope, 1300 m elev., probably endemic.

Specimens Examined: MÉXICO. Oaxaca: Vista Hermosa, *H. E. Moore, Jr. & G. S. Bunting 8913* (holotype BH; isotype MEXU); *D. R. & R. J. Hodel 945* (BH; MEXU). CULTIVATION. United States. New York: Ithaca, grown in the

3. Large staminate inflorescence of *Chamaedorea vistae* has a rachis 80 cm long with 100 drooping rachillae, Lyon Arboretum, Honolulu, Hawaii.

conservatory of the L. H. Bailey Hortorium as *BH61-1178, H. E. Moore, Jr. & G. S. Bunting 8913 bis* (BH); *O. J. Blanchard s.n.* (BH).

The specific epithet is taken from the type locality, Vista Hermosa, an area of rugged, steep, densely forested slopes with panoramic views or vistas.

Chamaedorea vistae is a handsome and rather robust species. It is particularly striking when pistillate plants are bearing clusters of not-yet-mature, golden-orange fruits at the ends of long, arching peduncles. It differs from all other members of the genus in its combination of orange-yellow pistillate flowers, long-pedunculate inflorescences, long-pinnate leaves with prominently nerved pinnae, and solitary habit. *C. vistae* appears closest to *C. carchensis* from the Atlantic slope of Guatemala but can be distinguished by the more numerous (up to 36 versus 20), stiffly ascending pinnae with five prominent primary nerves, the larger staminate inflorescence with more numerous (up to 100 versus 40) rachillae; and the fruits first conspicuously golden-orange then soft-ripening black. In addition, *C. vistae* quickly develops a prominent above-ground stem while *C. carchensis* remains essentially acaulescent and flowers and fruits at this stage, forming a short stem much later.

Chamaedorea vistae is cultivated in gardens and collections in Hawaii, California, Florida, Australia, Costa Rica and, perhaps, elsewhere. Fruiting plants occur in Hawaii at Wahiawa Botanic Garden of the Honolulu Botanic Gardens, Waimea Arboretum, and Lyon Arboretum. Fruiting plants were also observed at Jardín Botánico Robert y Catherine Wilson (formerly Las Cruces Tropical Botanical Garden) near San Vito de Coto Brus in Costa Rica. These fruiting plants have been grown from seeds collected from plants growing in the conservatory of the L. H. Bailey Hortorium at Cornell University as *BH61-1178*. These were grown from seeds gathered by Moore when he first collected the species in México. From time to time, seeds produced on the plants at Cornell have been distributed by Moore and the Seed Bank

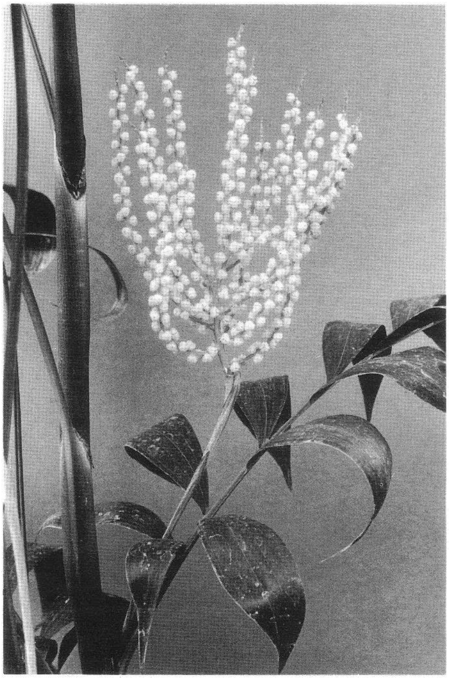
4. *Chamaedorea whitelockiana, D. R. Hodel 853,* in the garden of L. M. Whitelock, Los Angeles, California.

of the International Palm Society. Recently, Lyon Arboretum has begun to distribute seeds and seedlings of *C. vistae* under the number *BH61-1178.*

Chamaedorea whitelockiana D. R. Hodel & N. W. Uhl, sp. nov. (Figs. 4,5).

C. digitatae Standl. & Steyerm. et *C. pachecoanae* Standl. & Steyerm. et *C. parvisectae* Burret affinis sed segmentorum apicibus pendulis differt; a *C. digitata* segmentis pluribus, inflorescentiae rachidibus longioribus, rachillis masculinis pluribus differt; a *C. pachecoana* habitu non acaulescenti, vaginis magis clausis tubulosis, inflorescentiae rachidibus multo longioribus differt; a *C. parvisecta* caudicibus crassioribus, floribus masculinis grandioribus, rachillis femineis tenuibus apicibus spiniformibus differt. Typus: México, *D. R. & R. J. Hodel 935* (holotypus BH; isotypus MEXU).

Stem solitary, erect, to 2 m tall, 1–1.3 cm diam., green, ringed, internodes to 10 cm long, often covered with old persistent leaf bases; plants occasionally flowering with a much reduced inflorescence when very small and appearing acaulescent but actually having at this time a short subterranean caudex to 20 cm long, overall height at this stage including leaves less than 30 cm. Leaves 5–7, spreading, pinnate (Fig. 4); sheath to 17 cm long, tubular, tightly clasping, obliquely open apically and there the margin brownish and ragged with a brown ligule 5–8 mm long on either side of the petiole, below this the margin whitish and green, longitudinally striate-nerved; petiole 10–20 cm long, green and finely grooved adaxially, rounded and with a pale band abaxially extending from the rachis onto the sheath; rachis to 35 cm long, green and angled adaxially, pale and rounded abaxially; the blade to 40 × 15 cm; pinnae 7–9(13) on each side of the rachis, opposite or subopposite, lanceolate, falcately long-acuminate, thin-papery, the apical one-third of each pinna drooping and curling down and under, con-



5. Staminate inflorescence of *Chamaedorea whitelockiana, D. R. Hodel 852,* emerges from the leaf axils. Note the apices of the pinnae curving downward and under.

tracted at the base and there a hard knob or callus at the point of attachment, slightly iridescent gray-green adaxially, paler abaxially, lower middle ones the longest, to 15 × 3 cm, a prominent midrib and 2 ± inconspicuous secondary nerves on each side of this or the secondaries lacking, tertiary nerves faint and inconspicuous, pinnae progressively smaller toward the apex of the rachis, 2 basal pinnae smaller, apical pair the shortest of all with 2 prominent primary nerves; or when young and acaulescent, leaves finely divided, sheath 3–5 cm long, very open, completely sheathing only near the base; petiole 5–8 cm long; blade 20 × 12 cm; pinnae linear-lanceolate, straight, slightly falcate, 7 × 0.8 cm, only a midrib prominent, secondary and tertiary nerves inconspicuous.

Inflorescences interfoliar but often infrafoliar in fruit, erect. Staminate inflorescence (Fig. 5) with peduncle 25–30 cm long, 7–9 mm wide at the base and there flattened, 3–4 mm wide at the apex and there rounded, erect, greenish or pale at anthesis; bracts 7–8, tightly sheathing, obliquely open apically, longitudinally striate-nerved, drying brownish and papery at anthesis, acute-acuminate, to 3.5 cm long, 2nd bract to 6 cm long, 3rd to 9 cm long, 4th–7th to 10 cm long, 8th to 4 cm long; rachis to 5 cm long, slightly to strongly curved, lime-green at anthesis; rachillae 12–15, to 10–12 cm long, simple, erect, ± stiff, 1.5–2 mm diam., lime-green at anthesis. Pistillate inflorescence with peduncle to 40 cm long, erect, slender, 5 mm wide at the base and there flattened, 2.5 mm diam. at the apex and rounded, pale or greenish at anthesis, orange in fruit where exposed; bracts similar to those of the staminate; rachis 1–3 cm long, greenish at anthesis, orange in fruit; rachillae 6–8, to 10 cm long, erect, stiffish, slender, 2 mm diam., longitudinally ridged or angled or finely grooved, slightly spinose-tipped, greenish at anthesis, orange in fruit.

Staminate flowers in rather dense spirals, slightly immersed in elliptic depressions, 2–3 mm apart, depressed-globose, 3 × 4 mm; calyx low, 0.5 × 2.5 mm, pale yellow-green, shallowly 3-lobed; corolla 4 mm wide, bright yellow, petals valvate, free nearly to the base, broadly acute, incurved but not connate at the tips, 4–5 × 3 mm; stamens leaning away from and not exceeding the pistillode, filaments pale, 1–1.5 mm long, anthers 1–1.5 mm long; pistillode broadly columnar, lime-green, 2–2.5 mm high. Pistillate flowers arranged in lax spirals, slightly immersed in elliptic depressions, 4–5 mm apart, globose, 3 × 3 mm; calyx coroniform, 1–1.5 × 2–2.5 mm, prominently 3-lobed, lobes broadly rounded, green; petals imbricate basally and spreading apically, 3 × 2–2.5 mm, acute, glossy yellow; staminodes lacking; pistil globose, green, 2 × 2 mm, flattened apically, styles lacking or reduced, stigmas pointed, short, dark green or brownish. Fruits black, globose, 7–8 mm diam.

Distribution: MÉXICO. Oaxaca: moist pine-oak forest on steep and rocky substrate on the Pacific slope; 1,400–1,900 m elev., probably endemic.

Specimens Examined: MÉXICO. Oaxaca: beyond San Gabriel Mixtepec along road from Puerto Escondido to Oaxaca, *D. R. & R. J. Hodel 935* (holotype BH; isotype MEXU). CULTIVATION. United States. California: Los Angeles, in the garden of L. M. Whitelock, *D. R. Hodel 687, 852, 853* (BH), all grown from seeds originally collected at the type locality.

Chamaedorea whitelockiana is named for Loran M. Whitelock of Los Angeles, California who, in 1981, collected the species in Oaxaca, México. Whitelock returned to Los Angeles with seeds and plants and established them in his garden where they were first brought to our attention.

A dainty and attractive plant, *C. whitelockiana* is close to *C. digitata, C. pachecoana*, and *C. parvisecta*, all from Guatemala. It can be distinguished from all in the drooping, downward-recurving tips of the pinnae. Probably closest to *C. parvisecta, C. whitelockiana* can also be distinguished from it by the much stouter stem; inflorescences interfoliar and not breaking through the sheaths; distinctly larger staminate flowers with broadly ovate petals; and much more slender, spinose-tipped, pistillate rachillae with laxly disposed flowers. It also differs from *C. digitata* in the greater number of pinnae, the much longer rachis of the inflorescence, and the staminate with many more rachillae. From *C. pachecoana*, it can be distinguished by its trunked habit, more tubular leaf sheaths, and the inflorescences with many more rachillae and a much longer rachis.

Chamaedorea whitelockiana exhibits a growth phase best described as juvenile, with plants characterized by their virtually acaulescent habit and finely divided leaves with numerous, narrow pinnae not unlike that of *C. elegans* Mart. Plants are not truly acaulescent during this period but actually possess a short, curving, rooting subterranean stem with highly congested nodes. Although remaining acaulescent for several years, they begin to flower and fruit during this phase with much reduced inflorescences until later forming a visible stem with normal-sized inflorescences and broader pinnae. This juvenile phase may allow the plants to become anchored securely in their substrate before developing an erect, above-ground stem.

Acknowledgments

We thank Richard W. Palmer, Pauleen Sullivan, Bill Gunther, and the International Palm Society for supporting and encouraging Hodel's work on *Chamaedorea* and John Dransfield who reviewed and offered helpful suggestions on the manuscript.

Errata

In *Principes* October 1989, p. 194. Lynn Muir's name was misspelled as Lynn "Mier"; this error was continued in the separate ballot for voting for Directors 1990–1994. The editors apologize.

Principes, 34(2), 1990, pp. 64–78

Demography of the Needle Palm, Rhapidophyllum hystrix, in Mississippi and Alabama

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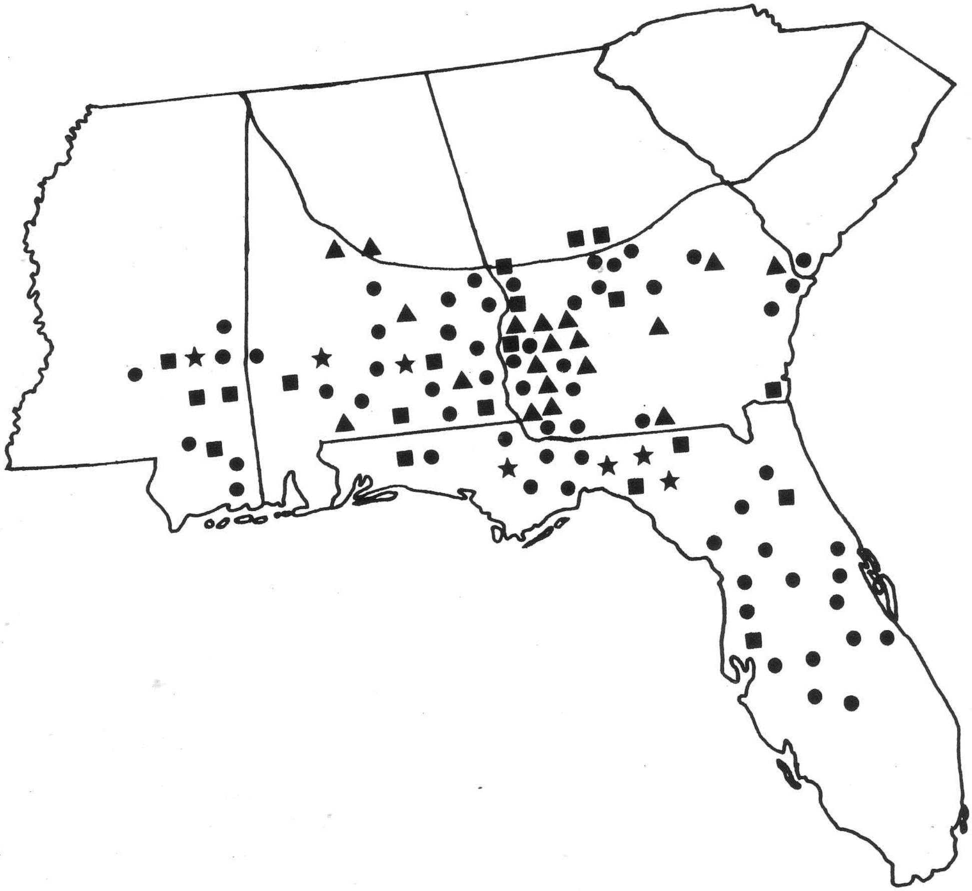
ABSTRACT

The demography of populations of the acaulescent, cespitose and dioecious needle palm, *Rhapidophyllum hystrix* (Pursh) H. A. Wendl. & Drude, was studied at the northern end of its range. A total of 867 palms were censused on the Souinlovey Creek floodplain in northern Mississippi where the population density was 299 palms/ha. Of the censused individuals 478 were adults and 389 were juveniles. All seedlings were found growing on the parent or in the soil beneath the parent and were not censused. A staminate : pistillate ratio of 1.05 was measured. Growth data were obtained from 15 mature individuals. The mean number of new leaves entering the crown from the "sword" stage was 2.29 during a 10 month sampling period (2.76 per annum). There were no apparent differences between the sexes, for this small subset of the population, for any morphometric characteristic (e.g., leaf dimensions). The proportion of plants in flower each year varied considerably; 39% of the staminate plants flowered in 1984 and 96% flowered in 1985 whereas 35% of the pistillate plants flowered in 1984 and 83% flowered in 1985. Staminate plants produced 1.5 times more inflorescences per plant than pistillate plants. Demographic patterns observed in Mississippi were similar to those characterizing a second site in Alabama.

The needle palm, *Rhapidophyllum hystrix* (Pursh) H. A. Wendl. & Drude, is an uncommon species restricted to five states (Florida, Georgia, South Carolina, Alabama, and Mississippi) in the southeastern United States (Clancy and Sullivan 1990). This palm occurs as an understory, usually acaulescent and frequently cespitose species in mesic habitats of deciduous forests and bottomlands, along floodplains, and in ravines, swamp forests, and hammocks. The needle palm has been described as "one of those plants which is on the verge of extinction through natural agencies" (Small 1923) and as a "slowly vanishing relict species" (Shuey and Wunderlin 1977). Although the needle palm is not currently on the U.S.D.I., Fish and Wildlife Service (1985) special concern plant list (this is an update of the Smithsonian Institution list by Ayensu and DeFillips 1978) its status could quickly change to threatened if habitat that supports this plant is destroyed. This ongoing threat was recently, and dramatically, illustrated when one of two *Rhapidophyllum* populations, only recently "rediscovered" (after 100 years) in South Carolina by K. Wurdack and R. McCartney, was partially destroyed shortly after its discovery by logging operations (McCartney, pers. comm.).

While threats to habitats that support the needle palm are real, it is encouraging to note that over the past 12 years there has been a substantial increase in the number of counties known to contain the needle palm (see Fig. 1 and compare with Shuey and Wunderlin 1977). However, this substantial increase in localities should be treated with caution as it does not necessarily mean a significant increase in total number of individuals. Many populations of *Rhapidophyllum* contain less than a



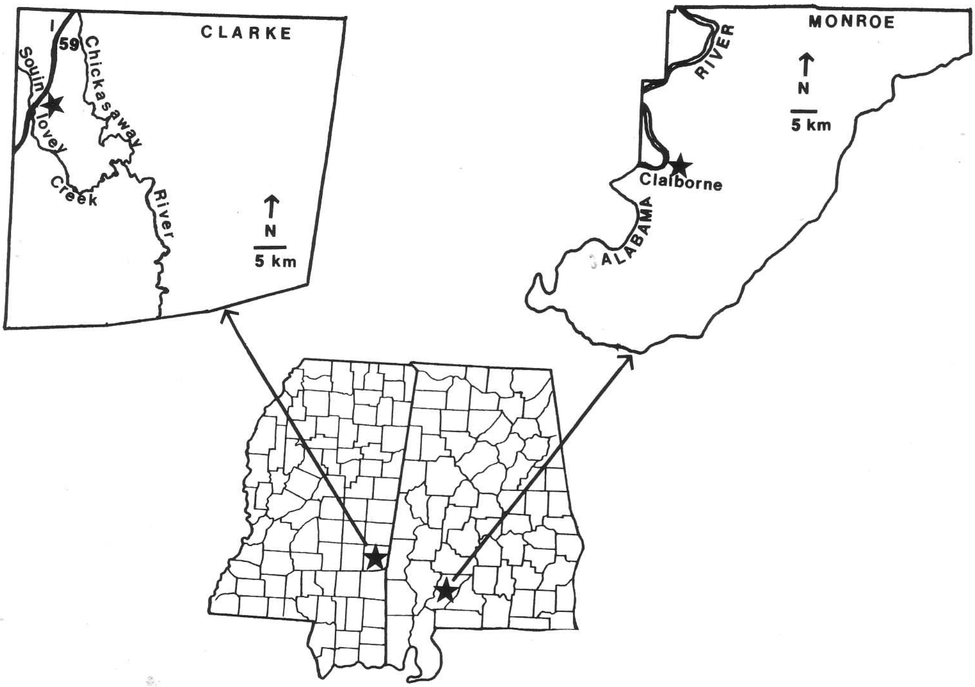
1. The distribution of *Rhapidophyllum hystrix* in the southeastern United States. Solid circles represent its distribution as reported by Shuey and Wunderlin (1977). Squares represent county records added since 1977. Triangles represent literature or sight records. Stars represent county records recently discovered by the senior author. Line extending across Alabama, Georgia, and South Carolina represents the northern limit of the Coastal Plain.

dozen individuals and some consist of a single individual.

This paper examines the demography of the needle palm at two sites located at the northern part of its range. In recent years there has been an increase in demographic studies in the palm family. A few of the more notable studies include Sarukhán (1978), Piñero and Sarukhán (1982) and Piñero et al. (1986) on their long-term studies of *Astrocaryum mexicanum* Liebm. in Mexico, Anderson (1983) on *Orbignya martiana* Barb. Rodr. in Brazil, De Steven (1986) on *Oenocarpus mapora* Karst. and De Steven et al. (1987) on 13 palm species in Panama, and Myers (1981, 1984) on *Raphia taedigera* in Costa Rica. There is a paucity of demographic data on palms growing in the temperate zone as compared to those that inhabit the tropics.

Materials and Methods

Mississippi Site. This site was located on the flat (slopes <5°) floodplain on the north side of Souinlovey Creek at its inter-



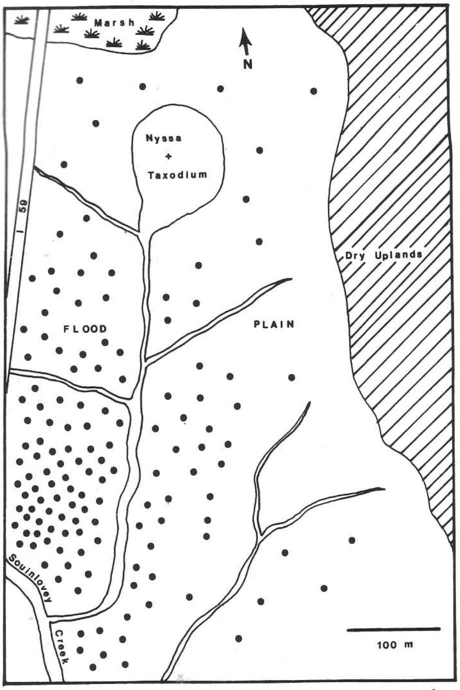
2. Location of the Mississippi (along Souinlovey Creek in Clarke County) and Alabama (along the Alabama River in Monroe County) sites.

section with Interstate 59 in northwestern Clarke County, Mississippi (32°06′N, 88°54′W) (Figs. 2,3). Floristically, the site supports a mixed deciduous hardwood forest on sandy, well-drained soil. This site covers approximately 30 ha and contains well over 1,000 needle palms.

Alabama Site. This site was located at Claiborne Bluff above the Alabama River (Figs. 2,4) in Monroe County, Alabama (31°55′N, 87°50′W). Several deep ravines characterize this site. This site, like the one in Mississippi, supports a mixed deciduous forest. The soils are well-drained, calcareous, and very sandy. *Rhapidophyllum* is restricted here to one narrow, steep-sided ravine covered by thallose liverworts, maidenhair ferns, and an occasional needle palm. Most needle palms are found along the lower half of the west/northwest-facing slopes (Fig. 4). The Alabama site comprises an area of ca. 2.5 ha and contains 53 needle palms.

Collection of Demographic Data. The majority of demographic data for *Rhapidophyllum* was collected at the Mississippi site. An area measuring 240 × 120 m (2.9 ha) was staked off and divided into 32 quadrats, each 30 × 30 m. This part of the site contained the greatest concentration of needle palms. A census of the needle palms within this area was made in January 1985 to determine their density.

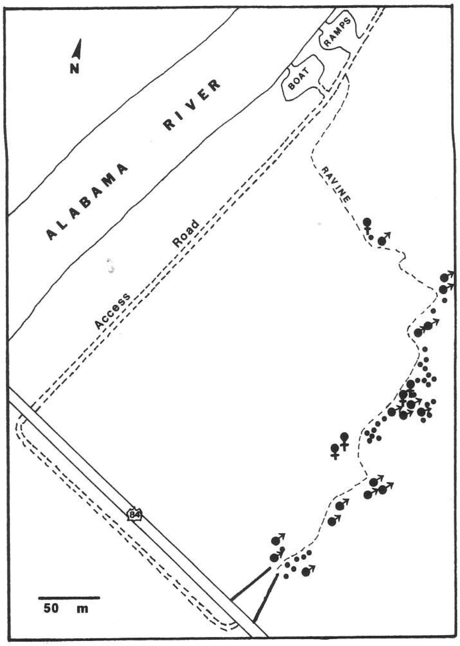
In May 1985 all palms within the 2.9 ha area were tagged and their life stage recorded (adult or juvenile). Plants which were sexually mature were classified as adults, while plants that showed no evidence of sexual maturity and had divided leaf blades were classified as juveniles. Seedlings, for purposes of this study, were those plants possessing narrow, undivided leaf blades only. In the case of mature plants the sex was also recorded. Some of the plants classified as juveniles may have been adults which had not flowered for a



3. Distribution of *Rhapidophyllum* at the Mississippi site. Each solid circle represents ca. 10 plants.

number of years. No seedlings were observed established in open areas away from parent plants. However, many of the pistillate plants had dozens of seedlings growing among their leaf bases or in the soil at their bases. Since few, if any, of these seedlings were expected to contribute to a replacement of the population, they were not included in the determination of life-stage distribution.

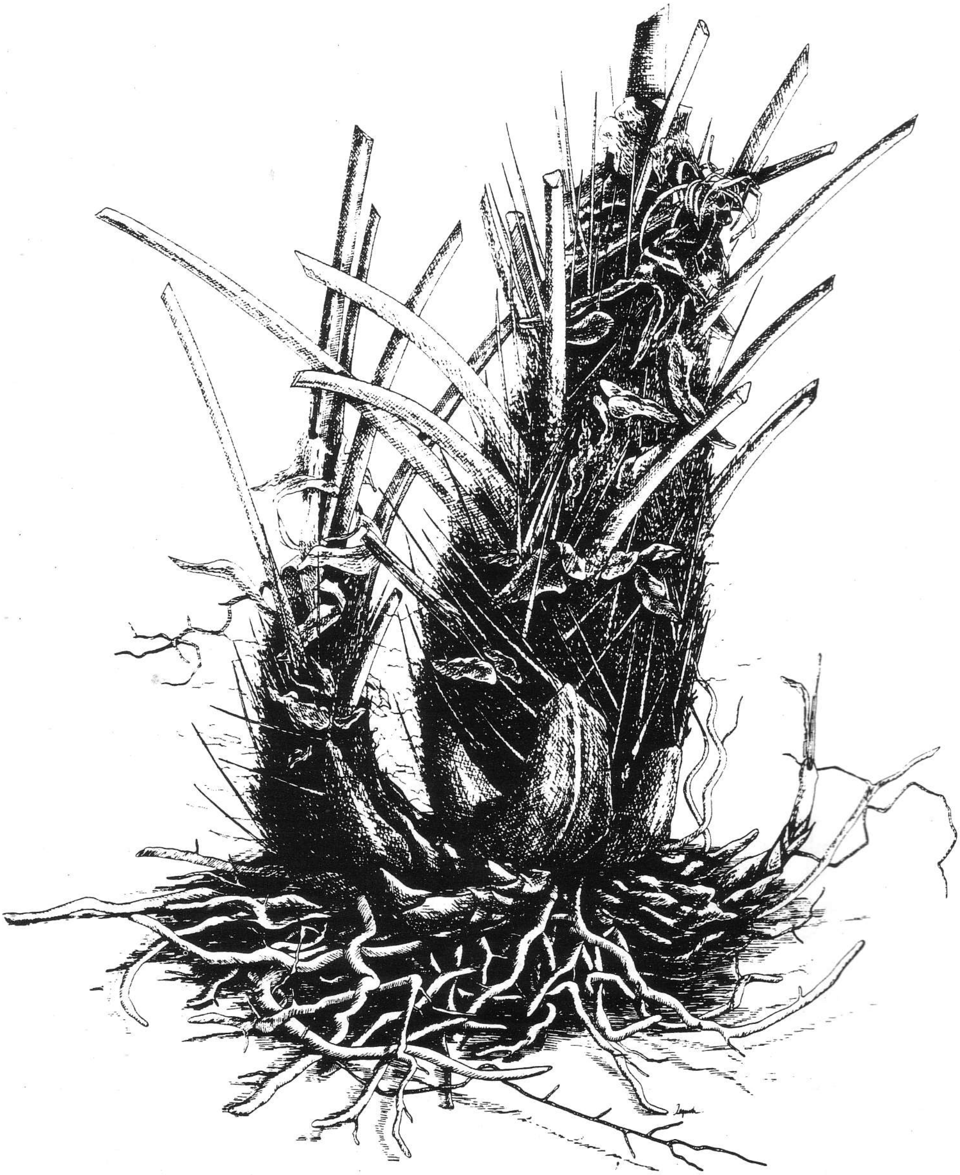
The majority of needle palms at the Mississippi site were in the cespitose (i.e., multiple-stemmed) condition. Branches are produced from basally located subterranean buds. Some individuals exhibited a proliferation of branches or ramets (in some cases >10 ramets), as confirmed from excavations of several cespitose plants. The height of the largest axis (measured to top of uppermost leaf) within a cluster was recorded, as well as the number of leaves and the number of ramets. For purposes of this study all mature plants were cen-



4. The distribution of staminate, pistillate, and juvenile plants of *Rhapidophyllum* along the ravine at the Alabama site.

sused and treated as separate genetic individuals, even if in fact they were not. Because of the growth habit of *Rhapidophyllum* it is difficult to determine the exact genetic composition of clusters without undertaking elaborate and ecologically destructive techniques (i.e., excavations), and this does not always result in a correct determination. In well established palm clusters sufficient time could have elapsed for the connections between ramets to have decayed resulting in independent but still genetically equivalent shoots. One might then confuse the separate axes as representing different genomes, when in fact they are part of a clone. Alternatively, it is equally possible to have a large cluster, that originated from two or more seedlings growing in close proximity to each other, mistakenly interpreted as representing a single genet.

Mature individuals were examined for presence and type (staminate or pistillate) of inflorescence(s), and whether or not they



5. Drawing of the base of a *Rhapidophyllum* plant: a mature axis and a ramet on the left.

had flowered only in 1984 (previous year), only in 1985 (current year) or in both 1984 and 1985. It was possible to tell whether an old inflorescence was from the previous year or was at least two years old based on its position on the plant and condition of decay. Pistillate plants were easy to distinguish from staminate plants by the presence of fruits or morphology of the inflorescence (condensed among the spines).

To estimate leaf production, 15 mature individuals (eight staminate and seven pistillate) were randomly selected at the Mississippi site. Their growth was measured monthly for a 10 month period (12 June 1985–19 April 1986). Growth in this case was a measurement of leaf production from the "sword" stage until the leaf actually entered the crown. Initially, every leaf was numbered and measured. A marking pen was used to number each leaf and this served as a permanent record of the leaf and its position in the crown and prevented mistakes in marking new leaves and measuring growth rates. After the initial measurements only the youngest leaves, which were obviously still developing, were remeasured. This additional growth usually represented increased petiole length and leaf expansion. In addition, plant height and width, and the number and dimensions (including petiole length) of fully expanded leaves were recorded for each of the 15 mature plants.

At the Alabama site all palms in the ravine were censused during May 1985 and their life stage (adult, juvenile, or seedling) recorded. In addition, their height, number of leaves, presence and type of inflorescence, and number of ramets were noted. Flowering was observed directly in 1985 but not in 1984, but a determination of whether or not individuals had flowered in 1984 could be made based on presence, condition, and position of inflorescences or infructescences. Finally, the spatial distribution of the palms was also mapped (Fig. 4).

Results

Mississippi Site: Palm Density. There were 867 needle palms within a 2.9 ha area (299 palms/ha). As mentioned previously, clusters (a mature axis and its ramets) were treated as single individuals. However, in large clusters containing several flowering axes, each mature axis was censused. In cespitose individuals, the number of ramets (including the parent axis) per individual ranged from as few as 3 to as many as 16. Figure 5 shows a mature axis of *Rhapidophyllum* with a well developed ramet on the left. *Rhapidophyllum* conforms to Tomlinson's Model of tree architecture (Hallé et al. 1978), the most common type of architectural model found in palms. Of 867 needle palms, 694 were branched (429 adults and 265 juveniles). Of the remaining 173 single-axis plants, 124 were juveniles while 49 were mature. Twelve percent (27) of the pistillate plants and 9% (22) of the staminate plants were single-stemmed.

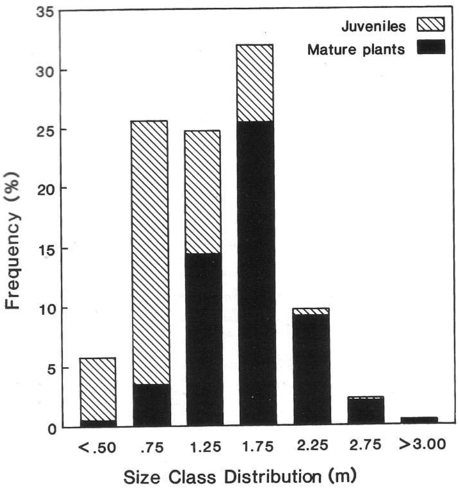
Life Stages and Sex Ratio. A total of 478 (55%) of the 867 needle palms were mature (Figs. 5,7) while the remaining 389 were classified as juveniles (Figs. 6,7). The sex of 12 mature individuals (all of which were cespitose) was uncertain because the remains of old inflorescences were too fragmentary for a positive determination. Of the 466 palms in which their sex was known, 51% (239) were staminate and 49% (227) were pistillate (Fig. 8), resulting in a staminate : pistillate plant ratio of 1.05.

Very few individuals reached sexual maturity until they were at least 1.0 m tall (75% of plants >1.0 m were mature) (Fig. 7). Most individuals greater than 2.0 m high were mature, while only 2 of the 50 individuals less than 0.5 m in height were mature. There was a slight trend for more pistillate than staminate individuals to be found in the larger size classes, while the opposite was true for the smaller size classes (Fig. 8).

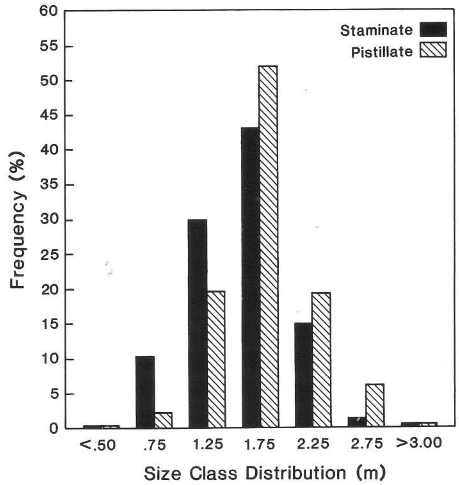
Leaf Production and Life Span. One measure of growth in *Rhapidophyllum* is based on leaf production. Table 1 lists morphometric characteristics and growth data, including number of fully expanded leaves produced per year, for 15 selected mature plants. There were no apparent differences between sexes for any of the measured morphometric characteristics. The range in leaf number per plant varied from 13 to 20 for the eight staminate plants and from 11 to 20 for the seven pistillate plants. Number of fully expanded leaves per plant

6. Morphology of a typical juvenile *Rhapidophyllum*.

for a randomly selected group of mature plants (N = 274) varied from 6 to 30 (Fig. 9) with a mean of 15.7 (SD = 4.5), which was slightly less than a mean of 16.2 (SD = 3.7) for the 15 plants on which leaf production was measured. Leaf growth was seasonal with the greatest amount of leaf expansion and petiolar growth occurring from mid-June to late-September, followed by a period of slow growth from November through February represented by petiolar extension only through the activity of an intercalary meristem (Figs. 10,11). Leaf expansion and petiole elongation then resumed in March. The mean number of leaves entering the crown from the "sword" stage for the 15 plants (staminate and pistillate) was 2.29 for the 10 month sampling period (2.76 per annum). However, the actual time interval to produce a leaf from



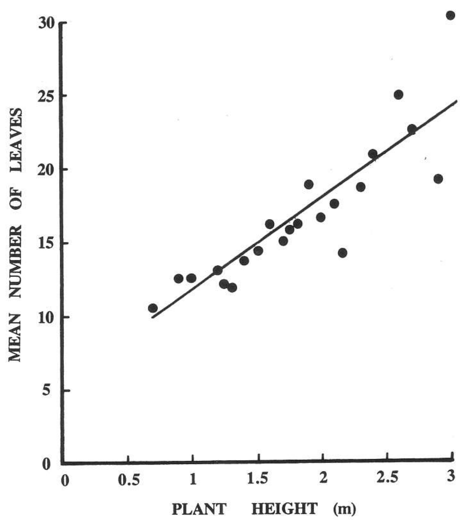
7. Size class distribution of 867 mature and juvenile plants of *Raphidophyllum* from the Mississippi site. Size class numbers in m represent mid-point values (except for the smallest and largest classes) for each class.



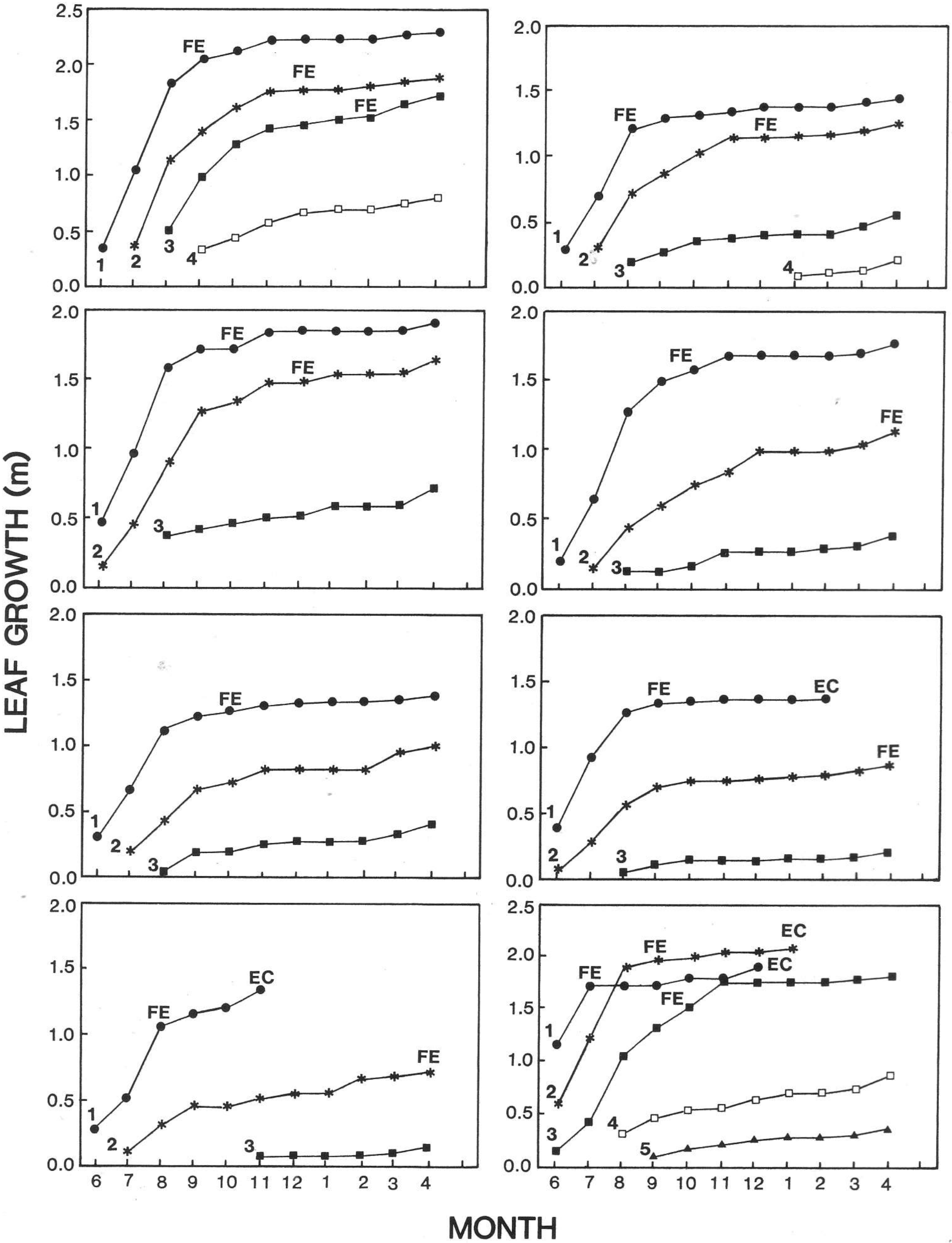
8. Size class distribution of 466 tagged staminate and pistillate plants of *Rhapidophyllum* from the Mississippi site. Size class numbers in m represent mid-point values (except for the smallest and largest classes) for each class.

its inception (as a primordium) at the stem apex until it reaches the crown is much longer (5.9 years for a plant with 16 leaves in the crown). There are typically the same, or nearly the same, number of leaf primordia in the bud as there are mature leaves in the crown. Several stem apices were dissected for leaf developmental studies and in each case the number of leaf primordia equaled, or differed by only one, the number of mature expanded leaves. As one leaf enters the crown, another leaf is produced by the apical meristem, and the oldest leaf dies. On an average sized plant (i.e., one with 16 leaves) at the Mississippi site, a leaf remains in the crown almost 6 years before it dies; only the spiny leaf base and fragments of the petiole persist after leaf senescence. Life spans of leaves in larger individuals (i.e., ones with more leaves) would be longer. Based on the above information the total time span from leaf initiation to senescence for an average sized individual is 11.8 years, while the life span of a leaf from the time it enters the crown is 5.9 years.

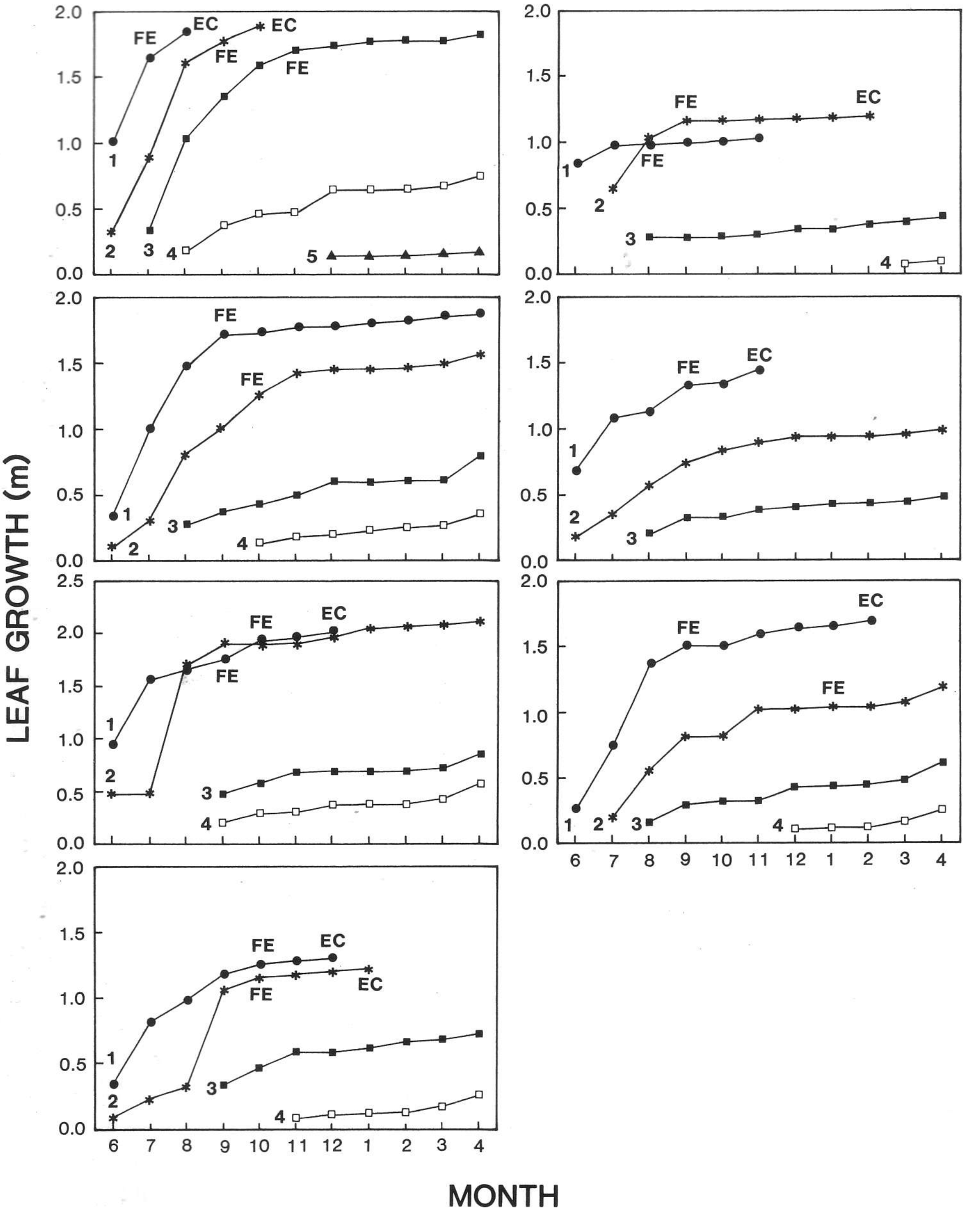
Flowering. Flowering in *Rhapidophyllum* was irregular (i.e., every individual did not flower each year) during 1984–85. Anthesis occurred during the last part of April in 1984 and over an approximately two week period at the end of March



9. Mean number of leaves as a function of height for mature plants of *Rhapidophyllum* at the Mississippi site. Range of leaf number was from 6 to 30 and the overall mean was 15.7 ($N = 274$; $Y = 6.04x + 5.43$; $r^2 = 0.35$).



10. Leaf production in eight staminate plants at the Mississippi site from 12 June 1985 to 19 April 1986. Leaves are numbered successively as they develop; growth is represented by leaf blade and petiole elongation. FE = date at which leaf is fully expanded; EC = date at which leaf elongation ceases. Leaves without FE and EC designations were still developing. There were from one to three sword leaves present at any one time.



11. Leaf production in seven pistillate plants at the Mississippi site from 12 June 1985 to 19 April 1986. Leaves are numbered successively as they develop; growth is represented by leaf blade and petiole elongation. FE = date at which leaf is fully expanded; EC = date at which leaf elongation ceases. Leaves without FE and EC designations were still developing. There were from one to two sword leaves present at any one time.

Table 1. Summary of morphometric characteristics for 15 mature individuals of Rhapidophyllum *at the Mississippi site.* Data collected from 12 June 1985 to 19 April 1986. S.D. = standard deviation.

Characteristic	Staminate Plants (N = 8)			Pistillate Plants (N = 7)		
	Mean	S.D.	(Range)	Mean	S.D.	(Range)
Leaves						
No. fully opened	16.2	2.8	(13–20)	16.3	4.5	(11–20)
No. unopened (sword stage)	2.3	0.7	(1–3)	2.0	0.6	(1–2)
Blade length (m)	0.6	0.1	(0.41–0.84)	0.6	0.8	(0.43–0.85)
Blade width (m)	1.0	0.2	(0.58–1.33)	1.1	0.1	(0.70–1.36)
Petiole length (m)	0.9	0.2	(0.47–1.68)	0.9	0.2	(0.53–1.35)
Leaf segments	13.4	3.9	(7–21)	15.2	3.6	(9–23)
No. added per year[1]	2.8	0.4	(2.25–3)	2.7	0.6	(2–3.5)
No. plants with ramet	7			5		
Plant dimensions						
Height (m)	1.9	0.3	(1.4–2.3)	1.9	0.3	(1.5–2.4)
Width (m)	2.5	0.5	(2.0–3.4)	2.6	0.3	(1.9–3.8)

[1] Fractions based on leaves not fully expanded.

and beginning of April in 1985. Of 466 adults, 122 flowered in both 1984 and 1985, 50 flowered only in 1984 and 294 flowered only in 1985 (Table 2). In both 1984 and 1985 the total percentage of staminate plants in flower (38.9% and 95.8%, respectively) was greater than that of pistillate plants (34.8% and 82.3%, respectively). Staminate plants outproduced pistillate plants by a factor of 1.5 inflorescences per plant (Table 3). Staminate and pistillate plants had a range of 1–6 inflorescences, but only one pistillate plant had 6 and none had 4 or 5. A single inflorescence characterized most pistillate plants while 1 or 2 inflorescences were equally common on staminate plants.

Alabama Site. The density of *Rhapidophyllum* at this site was calculated as 21 palms/ha, much less than the 299/ha at the site in Mississippi. The entire population included only 5 pistillate, 17 staminate and 31 juveniles (Fig. 4) in a 2.5 ha area. The ratio of staminate : pistillate plants was 3.4 compared with 1.05 at the primary study site. Only 2 seedlings were established in the soil away from a parent. Both were less than 0.5 m in height with 3 or 4 undivided leaves. *Rhapidophyllum* plants at the Mississippi site were slightly larger and more robust than those of the Alabama site (compare Tables 1 and 4). Flowering took place in late April to early May 1985, one month later than at the

Table 2. Frequency of staminate and pistillate Rhapidophyllum *plants in flower at the Mississippi site during 1984 and 1985.* Total staminate plants = 239, total pistillate plants = 227.

	Staminate % (no.)	Pistillate % (no.)	All Adults % (no.)
Year flowering			
1984 only	4.2 (10)	17.6 (40)	10.7 (50)
1985 only	61.1 (146)	65.1 (148)	63.1 (294)
Both years	34.7 (83)	17.2 (39)	26.2 (122)

Table 3. Number of inflorescences per staminate and pistillate Rhapidophyllum *plants at the Mississippi site.*

No. Inflor./Plant	Staminate Plants % (no.)	Pistillate Plants % (no.)
1	41.0 (98)	81.5 (185)
2	40.6 (97)	13.7 (31)
3	14.6 (35)	4.4 (10)
4	2.1 (5)	0.0 (0)
5	1.3 (3)	0.0 (0)
6	0.4 (1)	0.4 (1)
Total no. of inflorescences	438 (239)	283 (227)
Staminate : pistillate inflorescence ratio	1.47	

site in Mississippi. The palms at this site showed similar irregular flowering behavior as those of the Mississippi site. Of interest is the fact that 20% of the pistillate and 29% of the staminate plants did not flower during 1984 and 1985 at the Alabama site whereas all mature plants at the Mississippi site (except the 12 unknowns) flowered at least once during this period.

Discussion

Life Stages. A majority (55%) of *Rhapidophyllum* plants at the Mississippi site were sexually mature, while the remainder consisted of juveniles. There was no evidence of seedlings established in the population (those present were found growing on the parent or at its base with little chance of surviving). This suggests that seedlings were not contributing to a perceptible increase in the population but instead died before reaching the juvenile stage. There was no apparent transitional series from seedling to juvenile. Shuey and Wunderlin (1977) reported similar findings for *Rhapidophyllum* seedlings in Florida populations. However, they did report on one location where seedlings (established away from parents) outnumbered adults, perhaps indicating that at this site fruits of *Rhapidophyllum* were being dispersed or the site characteristics were different.

Senescence has been invoked to explain the poor reproductive success of the needle palm by Shuey and Wunderlin (1977). Senescence in plants is a complex phenomenon that is thought to occur as individual plants and populations build up deleterious genes. It has been defined by Willson (1983) as "the phenotypic manifestation of deleterious effects accumulating in old age." However, at least at the Mississippi site, where more than 1,000 individuals occur (many of which are cespitose and robust), senescence seems unlikely, especially if Harper's (1977) comment that species with clonal growth seldom show signs of senescence is true. But, the fact that seedlings are contributing little, if at all, to the population structure at this site is of concern for the long-term status of this population. The needle palm's ability to form clones (at least in plants of more northern latitudes) may be enough to preclude senescence. Some taxa that are clonal, long-lived and apparently

Table 4. Summary of morphometric characteristics of the Rhapidophyllum *population at the Alabama site.* Measurements were taken during May 1985. Means plus one standard deviation (in parentheses) are given.

Characteristic	Staminate Plants (N = 17)	Pistillate Plants (N = 5)	Juveniles (N = 31)
Plant height (m)	1.2 (0.3)	1.4 (0.4)	0.6 (0.2)
No. fully opened leaves	12.3 (3.7)	12.2 (5.8)	7.5 (2.8)
No. unopened leaves	1.3 (0.5)	1.6 (0.5)	1.0 (0.0)
No. plants with ramets	13	5	9

do not become senescent are the bracken fern *Pteridium aquilinum* (L.) Kuhn and the quaking aspen *Populus tremuloides* var. *aurea* Daniels, which form clones thought to be 1,400 and 8,000 years old, respectively (Oinonen and Cottam cited in Harper 1977).

Sex Ratios. Large populations of dioecious species should theoretically favor the maintenance or increase of the population size by virtue of a greater probability of pollen transfer from staminate to pistillate plants and a resultant increase in seed recruitment. At the Mississippi site more than half (55%) of the population was sexually mature and the staminate : pistillate ratio was found to be near unity (1.05). This finding agrees with Willson's (1983) statement that there is no basic tendency for one sex to outnumber the other in most natural populations. However, at the Alabama site, where the population is much smaller (only 22 mature individuals), the staminate : pistillate ratio was 3.4 and skewed towards staminate plants. Both small sample size and stochastic processes probably explain the departure from unity at this site. The sex ratio of juveniles is of course unknown, and these plants represented a significant proportion of the population at both sites. There is some evidence that individual plants of *Rhapidophyllum* are capable of switching sexes (H. O. Whittier, pers. comm.); if this proves to be true it could have tremendous consequences for the population biology of this palm.

Leaf Production and Life Span. Our estimate of leaf production for *Rhapidophyllum* is probably conservative as growth was not measured in May and June of 1986. Growth during this period likely would have been more than the average taken for the 10 month period, a period which included about 5 months of very slow growth (Figs. 10,11). Annual leaf production in more southerly located populations (e.g., central Florida) of *Rhapidophyllum* is probably even greater. Our calculations of a leaf life span of 5.9 years is an extrapolation from growth data and is based on a plant with a mean leaf number of 16.2. The life span of *Rhapidophyllum* leaves is longer, with the exception of one taxon, than other palm species which have been measured. Corner (1966) reported the following life spans (from the sword stage) for leaves of several palms: *Actinorhytis* (2 yr), *Elaeis* (3.5 yr), *Cocos* (5 yr), and *Lodoicea* (18 yr). Bullock (1980) found that the understory palm *Podococcus barteri* produced an average of one leaf per year which remained on the plant about 5 years.

Determining the age of a *Rhapidophyllum* plant is problematic. The acaulescent habit, short internodes and overlapping leaf bases, many of which are not individually distinguishable (specifically the oldest ones), are drawbacks in attempts to age the needle palm. The spiny and fibrous interwoven leaf bases of the oldest, abscissed leaves make it impossible to count individual leaves without destroying the plant. The largest, and possibly oldest, *Rhapidophyllum* plant observed at the Mississippi site possessed 30 leaves in the crown and 38 leaf bases which were discernible (giving a total of 68 leaves); this represents an estimated 24.6 years of growth. If our 1:1 correspondence of leaf primordium to mature leaf holds true then an additional 30 leaves, representing 10.9 years of growth, occur in the bud. Thus, this portion of the plant represented 35.5 years of growth. Because it was not possible to count leaves from a large part of the base, this particular plant must be substantially older. A long-term study is necessary to determine age in *Rhapidophyllum* more accurately.

Flowering. Flowering data (Tables 2, 5) support the statement by Shuey and Wunderlin (1977) that flowering in *Rhapidophyllum* is irregular (i.e., individuals do not necessarily flower each year). Piñero and Sarukhán (1982) also found irregular flowering in the palm *Astrocaryum mex-*

Table 5. Percent staminate and pistillate Rhapidophyllum *plants in flower at the Alabama site in 1984 and 1985.* Total staminate plants = 17, total pistillate plants = 5.

Year Flowering	Staminate Plants % (no.)	Pistillate Plants % (no.)
1984 only	5.8 (1)	20.0 (1)
1985 only	29.4 (5)	20.0 (1)
Both years	35.3 (6)	40.0 (2)
Did not flower	29.4 (5)	20.0 (1)
Total no. of inflorescences produced in 1985	16	4
Staminate : pistillate inflorescence ratio	4.0	

icanum. They studied the phenology of flowering in 414 individuals over five years and found that 40% failed to flower, while the remaining 60% flowered one, two, three, four, or all five years. Our flowering data was not nearly as dramatic but the large number of flowering individuals in 1985 (416) versus the small number in 1984 (172) is somewhat inexplicable. It does, however, point out the need for a long-term study of flowering behavior in *Rhapidophyllum.* The apparent irregular flowering in the needle palm may contribute to its poor reproductive success.

Acknowledgments

Funding for this research was provided in part by a grant from Sigma Xi and the Department of Biological Sciences, Mississippi State University. We wish to thank Mr. Maurice Hall for providing access to the site in Mississippi. We thank Drs. P. B. Tomlinson, F. E. Putz and an anonymous reviewer for critically reviewing this manuscript. The authors wish to thank Ms. Anna Asquith for her excellent drawings (Figs. 5 and 6). The contribution of MJS was sponsored in part by NOAA Office of Sea Grant, Department of Commerce under Grant #NA85AA-D-SG005, the Mississippi-Alabama Sea Grant Consortium and Mississippi State University. The U.S. Government is authorized to produce and distribute reprints for governmental purposes notwithstanding any copyright notation that may appear hereon.

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Paul Y. Mahalik

Paul Y. Mahalik, 33, a noted landscape architect who designed gardens in Balboa Park, died of cancer early this year at his home in Solana Beach.

His offices, Paul Y. Mahalik and Associates, are in Del Mar.

He was born in Bridgeport, Conn., and earned his degree at the University of Connecticut, specializing in architecture and horticulture. He studied in France and came to San Diego 12 years ago. He obtained his architect's license and continued to take courses in landscape architecture and horticulture at area universities.

In addition to design of gardens in Balboa Park, his work has included design of Phase 2 and the still unbuilt Phase 3 of the waterfalls at Quail Botanical Gardens in Encinitas.

He also designed the Transportation Center, still unbuilt, at Polomar College in San Marcos.

He was a director of the International Palm Society and friend of many of us. He was also a former member of the San Diego County Arts Commission and a member of the Quail Botanical Gardens Foundation and of the American Society of Landscape Architects.

Memorial contributions in his name may be sent to Quail Botanical Gardens Foundation, P.O. Box 5, Encinitas, Calif. 92024, designated "for Phase 3 of the Waterfalls."

Note: This article was adapted from an obituary by Bill Gunther in the San Diego Union.

Principes, 34(2), 1990, pp. 79–81

Juania australis in Habitat

BILL GUNTHER AND PAUL MAHALIK
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Robinson Crusoe Island lies in the South Pacific about 500 miles west of Santiago, Chile. Its location near 33 degrees south latitude equates with the 33 degrees north latitude of our gardens in southern California. Three oceanic islands make up the Juan Fernandez Archipelago: Isla Santa Clara, Isla Marinero Alejandro Selkirk, and Isla Robinson Crusoe, the only inhabited one and the largest.

The 400 inhabitants are of Spanish descent; they are very friendly and simple-living folk, mainly making their living by lobster fishing. Except for the townsite and the distant airport, the terrain consists largely of steep cliffs rising from the sea up to altitudes of 3,000 to 5,000 feet; the islands are remnants of volcanoes which erupted from the deep surrounding sea 4,000,000 years ago.

Robinson Crusoe Island gets its name from the fact that in 1704 a Scottish sailor named Alexander Selkirk, a crewman aboard a sailing ship, displeased his Captain, for which reason he was put ashore and abandoned on this then uninhabited island. But he was young and energetic, and the island was provident, so he survived well until he was finally rescued four and a half years later by another sailing ship. The narrative of his experience was later published by a newspaper in London, and this account the novelist Daniel Defoe greatly embellished in the classic novel "Robinson Crusoe," which since then, all over the world, has become a well known adventure story.

The staff of CONAF, the National Chilean Forest Service, explained that the flora and fauna of the archipelago is unique because it evolved without pressure from mainland populations. The islands are out of reach of the frigid Humboldt Current which follows close to most of the Chilean mainland; the water temperature ranges between 13 and 18° C; the air temperature between 12 and 20° C at sea level throughout the year. Very certainly, the Juan Fernandez Islands are one of the most picturesque and unspoiled of the world's undeveloped subtropical lands.

The native flora consists of about 140 species of vascular plants, of which 101, or about 70%, are endemic—growing nowhere else in nature. However, although the vegetation suffers no problem from people, it does suffer from feral browsing animals (horses, donkeys, goats, rabbits, rats, and mice), which have brought 30 of these endemic plants to the endangered status, and which have completely exterminated one.

Happily not seriously endangered is *Juania australis,* a beautiful slender-trunked feather palm which grows to approximately ten meters tall (Fig. 1). The trunk is straight, strongly ringed, and a bright light green. It is very shiny in youth, though the shine is lost in the oldest trees due to lichen growth. The head of foliage is about four meters across; the tree does not have a crownshaft. Flower clusters are branched and borne amidst the foliage. Each tree is either male or female; the fruit is the size of a grape (20 mm diam.) and reddish orange when ripe, taking about four months to germinate. The palm grows very slowly in its youth; several trees known to be 14 years old had about two meters of trunk covered to their bases by persis-

1. This young specimen of *Juania australis* grows on an unfavorable site on Robinson Crusoe Island, as evidenced by its solitariness, its closely spaced leaf scars, its ragged wind-damaged foliage, and its companion plants of rough brush rather than of ferns. Note the presence of a semi-crownshaft.

tent leaf sheaths. We were told that from this point the palm sheds its oldest leaf sheaths and bolts to its mature height of up to 13 meters. This might explain the pristine gloss which we observed on the young trunks. The palms are thought to live for about 200 years.

This palm is found principally on the upper ridges of the wet side of Isla Robinson Crusoe. There are thousands of trees in total; they are described as populations of different ridges. These various populations flower and fruit at different times and are thought to be site-specific to poorly understood microclimates. Conservation efforts to plant palms of one population in another location have often failed. Mr. Silva, the Park Administrator for CONAF, explained that they now are very careful to label all seed collections as to their specific sources and to replant those seedlings in the same locale. The results have greatly improved efforts to repopulate specific habitats.

The habitats are heavily vegetated and almost jungle-like. The palm is found randomly in virgin forests of hardwood trees, principally *Myrceugenia fernandeziana* and *Drimys confertifolia.* These trees average about 12 meters in height, with broad canopies. The undergrowth is mainly ferns, principally *Dicksonia berteriana, Blechnum cycadifolium, B. sibotii,* and *B. chilense.*

We reached the subject habitat after a four hour mule ride that was adventurous and very clearly dangerous. The trails up the ridges are very steep and narrow; we often were perched on barren cliffs thousands of feet above the crashing surf. The real test was at the habitat—where there is no trail left. One learns quickly that the only way to get a mule to blaze a trail on steep ridges is to kick "mule" hard!

The palm has little value to the human population; its wood was used for carving in the past. We observed only two specimens under cultivation in private gardens in the town and two more in the public square. The townsfolk live in simple frame houses with charming and cluttered gardens of exotic Mediterranean plants. All of the flora of the island is and has been completely protected since 1935 under the Chilean National Park System. In 1977 the islands were designated as a Biosphere Reserve, and recent conservation efforts have been recommended by the staff of the Royal Botanic Gardens, Kew, England, and financed by the World Wildlife Fund.

Juania australis in its native habitat is so well isolated from "civilization" and now so well protected by the Chilean National Forestry Service that it is not endangered. Nonetheless, because it is a very beautiful palm there have been continuous efforts to bring it into cultivation. Most of these efforts in the past have failed, but with better understanding of its special requirements there is real hope that in the future, in special compatible locations, *Juania australis* will be available for viewing under cultivation.

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Controlled Pollination in Raphia hookeri: II. Handling of Pollen

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Abstract

Unopened male flowers of *Raphia hookeri* were handpicked from its inflorescence two weeks after female flower anthesis and oven-dried for 72 hours at 30° C in sealed paper bags. Pressure was applied on each bag by rolling a bottle over it several times in order to release the pollen from the flowers. The contents of the bags were sieved and the pollen was collected. *In vitro* pollen germination was highest in agar medium with 13.50% maltose concentration. Pollen thus processed and screened was successfully used in controlled pollination in the palm. Over 50% viability was recorded in pollen stored over 14 weeks in both $CaCl_2$ desiccators at room temperature and deep freezers at −8° C.

Raphia hookeri Mann & Wendl. is of great economic importance to the peoples in the riverine and forest areas of West Africa (Otedoh 1972, 1973). The palm is also currently proposed as an alternative source for long fiber for pulp and paper production.

R. hookeri is monoecious and protogynous and, thus, cross-pollinated. It is principally anemophilous. Its massive inflorescence has been described by Otedoh (1985) and the terminology herein follows this work. Though the palm suckers occasionally, giving rise to twin palms, propagation is generally by seeds.

The palm flowers only once after five to seven years of vegetative growth and dies after fruit maturation. Flowering is therefore terminal and it takes about three to four years from onset of flowering to maturation of fruits (Otedoh et al. 1980).

Certain desirable characters such as early maturity, vigorous growth and high wine yield have been identified in some lines in NIFOR progeny trials at Otegbo *Raphia* Experimental Station. For varietal production, there is therefore the need to develop an efficient controlled pollination technique that will be adopted during crosses. Otedoh et al. (1980) have reported the sequence of inflorescence development. Based on the abundance and distribution pattern of flowers on the inflorescence, Okolo (1988) recommends that only the upper one third of each primary branch inflorescence should be prepared for isolation for both pollen collection and pollination. This paper reports investigations carried out to determine efficient methods of pollen collection, processing, storing and *in vitro* testing of the viability of pollen collected.

Materials and Methods

As soon as one or two male flowers had opened, usually about two weeks after female anthesis, the entire primary branch inflorescence (isolated through bagging) was harvested. All the unopened male flowers were handpicked in the laboratory. Equal volumes of the flowers were put in separate paper bags and the bags sealed. These were oven-dried either at 30° C or 40° C for the following periods: 24 hours, 48 hours, 72 hours and 84 hours. On drying, each bag was placed on a flat surface and pressure applied by rolling a bottle over it several times in order to release the pollen from the flowers. The contents of the bags were sieved and the pollen collected, noting the volume. All these were done in the NIFOR pollen room to avoid contamina-

Table 1. Mean volume of pollen collected after 24 hours, 48 hours, 72 hours and 84 hours drying of male flowers at 30° C and 40° C.

	Volume (cc) of Pollen			
Temperature ° C	24 Hrs.	48 Hrs.	72 Hrs.	84 Hrs.
30	9	13	24.5	25
40	23	22.5	24	24

tion with foreign pollen. Pollen thus collected was put in test tubes and tightly plugged with cotton wool.

Various combinations of maltose and agar boiled in distilled water were used as media to determine the most appropriate for *in vitro* pollen germination (Table 2). The pollen collected after drying the flowers for 72 hours at 30° C was used for this. The pollen was blown on a drop of each medium on slides. The slides were then placed in petri dishes lined with wet filter paper to maintain high humidity. Different temperature regimes, viz., 20 ± 2° C, 30 ± 2° C, 40 ± 2° C, were used for incubation. Germination counts were taken after four hours. A pollen grain was considered to have germinated if the tube length was at least twice the diameter of the pollen grain.

Pollen collected after different periods of drying at 30° C and 40° C were tested for their germinability with the medium in which the highest germination percentage was obtained.

To enhance germination, 0.01% or 100 ppm of boron in the form of boric acid was added to the medium and incubated at 30 ± 2° C. Germination percentage was recorded every hour. Two storage conditions, viz., $CaCl_2$ desiccators at room temperature and deep freezer temperature of between −6° C and −8° C, were used for pollen storage. The pollen was kept in test tubes tightly plugged with cotton wool. Germination counts were taken every two weeks on 13.50% maltose and 2% agar medium.

Table 2. R. hookeri *pollen germination percentage on various maltose/agar media at different temperatures, after 4 hours without boron and 2 hours with boron.*

Medium		Percentage Germination					
		20 ± 2° C		30 ± 2° C		40 ± 2° C	
% Maltose	% Agar	2 Hrs. With Boron	4 Hrs. No Boron	2 Hrs. With Boton	4 Hrs. No Boron	2 Hrs. With Boron	4 Hrs. No Boron
	1.0	0	0	24	23	18	18
	1.5	0	0	25	26	15	16
6.75	2.0	0	0	31	30	17	16
	2.5	0	0	25	25	17	14
	1.0	0	0	52	55	32	31
	1.5	10	9	70	63	29	34
13.50	2.0	11	11	100	100	47	45
	2.5	8	8	70	74	30	39
	1.0	0	0	66	65	15	20
	1.5	0	0	65	60	26	25
20.25	2.0	12	10	65	65	27	27
	2.5	0	0	60	63	24	25
	1.0	0	0	41	40	19	18
	1.5	0	0	42	39	20	20
27.50	2.0	0	0	40	36	23	22
	2.5	0	0	35	30	15	18

Table 3. Pollen percentage germination after storage in $CaCl_2$ desiccator and deep freezer.

Storage Condition	Initial Viability	Storage Period (Weeks)							
		2	4	6	8	10	12	14	16
$CaCl_2$	100%	100%	88	65	60	56	52	50	38
Deep freezer	100%	100%	91	85	80	78	70	70	55

Results

The volumes of pollen collected after drying male flowers at either 30° C or 40° C for different periods are shown in Table 1. Maximum quantity of pollen was collected after 72 hours drying at 30° C and 24 hours drying at 40° C.

Of the various combinations of maltose and agar media used to germinate pollen it was found that 13.50% maltose and 2% agar recorded 100% germination at 30 ± 2° C after 4 hours. Generally very low percentage germination was obtained for both 20 ± 2° C and 40 ± 2° C (Table 2).

Over 50% viability was obtained after 16 weeks with pollen stored in deep freezers, while there was a sharp drop in viability between the 14th week and 16th week with pollen stored in $CaCl_2$ desiccator (Table 3).

Discussion

Though maximum quantity of pollen may be collected at a shorter period of drying at 40° C, the pollen has been rendered inviable by heat. This is shown by the low percentage germination obtained from this pollen lot. At 30° C, it takes 72 hours to collect a similar quantity of pollen and the lot also exhibits high germinability in the appropriate medium, also at the same temperature regime. This temperature regime is very close to the natural temperature of the tropical wild groves of the *Raphia*.

The reduction of maximum germination time observed with the addition of boron is not surprising, because the trace element has been implicated both in pollen development and germination in a number of plant species (Stanley and Linskens 1974). It therefore follows that in screening *Raphia hookeri* pollen, for viability, a two hour incubation period is enough to achieve maximum germination. It is pertinent to mention that pollen grains thus screened have been used in artificial pollination in NIFOR and dense fruit sets have been obtained.

The fact that over 50% viability can be obtained after 14 weeks in both storage conditions of $CaCl_2$ desiccators and deep freezers shows that effective crosses can be made with pollen stored over that period. Also the success with the $CaCl_2$ desiccator at room temperature is noteworthy as it eliminates the problems of storage in stations without electricity supply.

Acknowledgments

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LETTERS

The Editor, *Principes*:

In view of my past association with research in Jamaica into the cause and control of Lethal Yellowing Disease, I read with interest the paper by Howard and Barrant, "Questions and Answers about Lethal Yellowing Disease," in *Principes*, Volume 33(4): 163. I have some information on their question "Can LY be carried in the seed of palms?"

In March, 1971 (11th Annual Report of the Research Department of the Coconut Industry Board, Jamaica) seeds were collected from visually healthy Jamaica Tall palms and from Jamaica Talls with clear early symptoms of LY and set separately in the nursery. Germination was good. In November, 1971, 244 seedlings of each group were planted in a disease-free area in Kingston city and 500 of each in a disease-free area near Montego Bay. These plants were maintained and regularly observed.

Up to 1981, when I left Jamaica, not one palm had shown any symptom of Lethal Yellowing. This experiment strongly supports the statement of Howard and Barrant that "there is no evidence that MLOs can be transmitted via the seed of plants."

In fact, in both Jamaica and the mainland of Tanzania (where a disease occurs with symptoms similar to LY), it is allowed to carry coconut seeds from the diseased to non-diseased areas. However, the transfer of coconut *plants* is not permitted because of the risk of carrying the disease organism, either in one of the plants which might be incubating the disease or in an infectious insect vector carried on one of the plants. Of course, the experiment described above does not disprove finally the possibility of seed transfer of MLOs, and it would be most unwise to bring to the U.S.A. seeds of any palm from a country where coconuts suffer from MLOs believed to be a strain different from those causing LY, e.g., Ghana, Nigeria, Cameroons, Togo, Tanzania, Kenya, Mozambique.

DAVE H. ROMNEY

Dear Dr. Uhl,

Those members of the IPS who are going to the biennial meeting in Hilo in June have the opportunity to see two special coconut palm trees. They are both of enough interest to IPS members to be worth looking for.

Hilo has the largest coconut tree in the United States. It was accepted as such by the Big Tree Register of the American Forestry Association in 1980. It is 92 feet 5 inches high with a crown spread of 27 feet 10 inches, and at breast height the circumference of the trunk is 5 feet. It produces viable nuts. At the base there is a plaque which gives this information, and also my name and the name of my husband as the nominators of this tree.

It is very easy to see this palm tree for it is the tallest one in a row of tall palms along Waiolama Canal, just off Kamehameha Avenue between Ponohawai and

(*Continued on p. 93*)

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The Palmetum: Its Objectives and Development

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As Australia's 1988 Bicentenary approached, a Federally funded authority was established to instigate and support heritage oriented projects nationwide. The resulting Australian Bicentennial Authority consisted of a national center in Canberra, with State Capital and Regional Committees to evaluate project proposals then solicited from interest groups. Project criteria were broadly defined as those which preserved or enhanced Australian heritage. Numerous projects were proposed.

The Townsville City Council submitted two major proposals, both being centered upon providing lifestyle enhancing green space within the city area. The Palmetum was one of these, and here I will attempt to define its origin and objectives and describe the methods used in its development.

Origin of the Palmetum

Through a generous bequest, Council obtained the 25 hectare site in the transitional region between suburban Annandale and Douglas. This site was originally a dairy farm and had been left, after initial clearing of the original mixed open woodland, in a relatively undisturbed state. A mango orchard was planted sometime after the turn of the century and tamarind and raintrees added in several locations. Presumably through some form of resumption, the site became part of the massive military installations in Townsville during World War 2, having a hospital sited near the present-day closed forest area. After the war the site became neglected, an overgrowth of various exotic weeds soon dominated the ground. The planted rain and tamarind trees invaded the mango orchard, making the bulk of the closed forest.

As suburban residential developments took place around the site in the late 1960's, various proposals were put forward for its development. During this period, Council performed some management in the form of slashing, but did not consider any development until the idea of a palm collection was proposed sometime around 1983, apparently by local plantsman Jim Darley. Impetus for the crucial furthering of the palm collection goal came via the enthusiasm of the then Parks and Recreation Department Director, Jim Thomas.

Thomas was a member of the Bicentennial Environment and Gardens Sub-Committee when fellow member Darley proposed a palm garden for a project. Thomas was responsible for selecting the current site and suggested forming a local Palm Society to generate public interest and support. Darley provided in his submission a concept termed "The Meridian" (palmetum). From these beginnings arose both "The Palmetum" and the North Queensland Palm Society.

The inaugural meeting was attended by members of the Bicentennial Environment and Gardens Sub-Committee and interested public, including the current President of The Palm and Cycad Societies of Australia, John Batterham. The City's Mayor, Mike Reynolds, who later opened The Palmetum, attended and spoke. The support of the Mayor and Council was undoubtedly the major factor contributing to the project's eventual success.

Thomas recommended forming a Technical Committee to steer the project and was the first Chairman of the new North Queensland Palm Society (N.Q.P.S.). The Committee consisted of N.Q.P.S. members and Parks and Recreation Department technical staff. Thomas insisted that public participation was vital for the project, which turned out later to be something of an error. Various proposals were put forward and Federal Community Employment Program funds were obtained to begin site works in 1984.

While some works were progressing, it became apparent that major development could not proceed without substantial funding. In 1985 Council submitted The Palmetum proposal, which was then still undefined by any specific design or objective criteria, for Bicentennial Grant funding. The Parks Landscape Officer, Helen Paulsen, is credited with obtaining grants for the construction of a water feature, The Lake. Bicentennial funds amounted to $171,950.

By late 1985 it became apparent that progress was not satisfactory, and despite N.Q.P.S. and Council commitments to the project, no development objectives or plans had been devised beyond the conceptual stage. In looking through our files I can find various correspondence from N.Q.P.S. dealing with the need for a development plan, but because of unfortunate internal problems within both The Society and the Department, no plan of any merit was produced.

I feel it is important to look into the problems that can arise through public participation in civic projects, if only to avoid making similar mistakes in the future. It is clear from our records that the N.Q.P.S. had taken the project very seriously and were frustrated by our Department's lack of steering right from the start. This was due partly to understaffing at a time when pressure to produce other important projects was heavy, creating a feeling of apathy at times. To make matters worse, Townsville was experiencing a prolonged drought and water resources were dwindling fast.

My involvement with The Palmetum begins here, when hopes about its development were being abandoned. I had returned from nearly six months in the United States and had contracted Ross River Virus, a long-term mosquito-borne disease, named after the very river that provided a boundary to The Palmetum site. I was unable to work and involved myself in the issue of the project only because I felt it should succeed. Thomas asked me if I would co-ordinate the project, but knowledge of the worsening situation that existed between Council and the N.Q.P.S. made me decline initially. It was not until I rode my bicycle out to the site on a fine day after drenching rain in December 1985 that I realized the site's potential and accepted the position, which Thomas had kept open for me.

When I saw Thomas and said I was keen to tackle the project, he immediately asked for a report on my recommendations for its development and reorganized the Palmetum Technical Committee.

I began working on a Master Plan in January 1986, with the new Technical Committee which then had a single N.Q.P.S. representative. I have to admit here that progress never went fast enough for my liking and that I eventually took responsibility for planning in terms of the objectives and layout. Although an overall concept came quickly, its details and lateral objectives and benefits took some nine months to formulate.

The Site—The Plan

The Palmetum site is remarkable for its topographic and vegetation features which immediately attracted attention. The land lay in a large triangular expanse of undulating alluvials and black podzols with a meandering tributary of the Ross River winding through one boundary. To the south were open grassland with small hills and moist depressions and flats. Centrally located was a seasonal lagoon overlaying a deep claypan and on the north between a lateral drainage gully and the creek system was a large closed forest containing impressive rain and mango trees. The site demanded an aesthetic goal, its natural beauty could be too easily compromised by artificiality. Our budget, on the other hand, demanded a cost-effective approach, having less than $240,000 to develop nearly 50 acres.

The planning was guided almost exclusively by the site's mosaic of "habitats." This is how the design concept, later to be termed Environment Preference Planning, evolved. Following discussions with other staff, I decided that we could develop most of the land inexpensively and provide a diverse environment-oriented layout and collection by providing as little modification as possible, such was the variety of habitat types presented by the site. The recognition of this potential leads to the formulation of the objectives which are summarized thus:

1. Create a landscape and concept that are substantially different from other palm collections.
2. Make the site appealing and multipurpose.
3. Provide the broadest array of palm morphologies and adaptations obtainable within the limitations of the site/funding.
4. Provide reduced maintenance requirements through design.
5. Limit hybridization amongst the plantings.
6. Provide germplasm conservation of threatened species.
7. Provide ongoing development opportunities.
8. Avoid mistakes evident in other palm collections.

Although it is difficult to define the planning strategy, it is best outlined in this way: the plantings should only be located where conditions are, and will remain, largely suited to the subjects (within their natural tolerances) and that broader areas (i.e., habitats) should maintain an overall appearance in accordance with their natural expressions. Strict adherence to these guidelines allows the achievement of most of the objectives outlined above. Firstly, the layout being entirely environmental differs substantially from all the palm collections I have seen or read about. The use of the natural features, rather than their contradiction, achieves the aesthetic goal with a minimum of cost. Using natural vegetation associations and population densities makes for considerable interpretive and educational purpose while lowering running costs as the plantings become relatively self-maintaining. The idea that the place should convey information about palms primarily through its layout plantings is one that can be expanded further, limited only by the designer's knowledge of palms and palm habitats.

The objective of limiting hybridization among the plantings is one that needs elaboration. My own experience with collecting palms for the project soon indicated that many Botanic Gardens and private collections are major sources of hybrid seeds, most often unknown to the people at the source. Hybridization among palms is in reality a problem, the seriousness of which is rarely realized. I decided that The Palmetum would not contribute to the threat of extinction in cultivation by hybridization now facing many palms.

Working in the drafting office with Helen over the next nine months, while pursuing plants for the collection and getting ground works initiated, proved to be a complete learning experience. Not only did a complex and new irrigation system have to be designed, but new irrigation requirements had to be foreseen. From the beginning, it was obvious that the closed forest would serve as an area for tropical rainforest species. As the majority of palms come from this environment, the area of about 2.5 hectares was not large enough to get a truly representative collection housed, and the natural rainfall was quite insufficient to support such growth. I devised a system that creates a rain-like irrigation from high in the tree canopy; using the various negative examples I had seen as indications of what not to do, designing this was relatively simple.

Because funds were not sufficient to irrigate the whole site, I decided to omit irrigation from the southernmost section of the savannah area, making it a seasonally arid habitat. Helen designed the lake and supervised its construction, including specially-made shelf-like areas to accommodate semi-aquatic palms. Gradually the land began to take on an organized appearance whilst the Master Plan took shape on the board.

Plant Collecting and Planting

Despite having a reasonably extensive background in palms and tropical vegetation, I found researching the appropriateness of the subject species to be difficult. Apart from the palms I knew as wild plants, which were a small minority of the 2,800 or so known species, most were relatively mysterious plants about which scant concrete ecological or environmental information could be found. Many months were spent using all the available "spare" time I had reading published accounts in a multitude of sources. I found *Principes* the single most helpful resource in this endeavor. Not until "Genera Palmarum" arrived did I gain an understanding of some species.

Having decided that a particular species was suited to a site within the area, I then had to obtain plants. It was fortunate that palm collecting had become so popular in north Queensland, for at any time I surveyed the available stocks between early 1986 and mid 1988, I found that on average about 200 species could be had. Some were not suited, others were already commonplace. Palm collectors in tropical Australia tend not to collect rugged palms, those large, armed, shaggy plants, particularly those from drier environments. I had to write to contacts in Africa and the Americas, most of whom did not respond. Some very valuable species were freely donated by collectors in Townsville, Brisbane, and Darwin. When it came to obtaining palms from Cairns, however, there seemed to be a reluctance on the part of some collectors to send their goods to Townsville. The majority of species came from commercial suppliers, unfortunately lacking origin data, which is important in cataloguing the materials. Some collectors openly stated that they did not feel that Townsville should have a good public palm collection, that Cairns was a "better" candidate. However, Townsville can accommodate any high rainfall palm grown in Cairns, but has the added advantage of dryness sufficient to enable some near-xerophytic palms to thrive.

My most rewarding correspondence resulted from contacting the Seychelles Department of Forestry. I simply asked about the availability of *Lodoicea* seed, explaining the project, only to have five seeds donated in short order. The already germinating seeds were airfreighted at our expense, but unfortunately three had been damaged in transit and were functionally dead. The remaining two, however, grew well. We had to construct huge containers to germinate them under lock and key. The results of my careful and regular observation of the germination process were published in *Palm and Cycads*. Germinating seeds of many palms required much experimentation and occasioned some losses which we could not afford, given the meagre funds to buy replacements.

The site posed various problems, particularly when we were denied the use of water due to local water restrictions. I could never accept being charged with the development of a new Botanic Garden without the necessary water. We had to hold plants

1. The seasonally moist savannah section of the Savannah Area with *Hyphaene coriacea*. 2. A walk in the Rainforest Area leading to the Swampforest Section with *Pinanga scortechini* on the right.

in the nursery until they became impossible to move through repotting, to avoid stunting. Some palms were tough enough to be planted out and given occasional hand waterings. The problem of trying to gain progress without essential water could have been worse if not for some very dedicated workers and Environment Preference Planning. Despite having installed an irrigation system valued at over $120,000,

3. *Livistona saribus* in a swampy section of the Rainforest. 4. Tropical Queensland Community in the Rainforest with *Normanbya normanbyi* (foreground) and *Archontophoenix* 'Mt. Lewis'.

the site remained parched and ugly. Men labored in the hot sun, dragging heavy hoses around day in and day out, just keeping some of the plantings alive.

When we were finally allowed to use the water, after Cyclone Charlie dumped enough rain to top up the shrinking Ross Lake, we had only seven months to plant nearly all the gardens and the rainforest and green up the lawns. Some planting areas turned out to be difficult to work on, heavy clays and termites being conspicuous problems.

Donations and Thefts

As funds dwindled it became obvious that sponsors for certain works could be found. Although many collectors, some nurseries and The Palm and Cycad Societies of Australia donated seeds and plants, there were materials and services we needed that we could not afford. I soon became adept at getting boulders, nuts and bolts, railway sleepers, truck and crane hire, and loads of river stones donated. Many local businesses were quick to supply materials or services when presented with a reasonable request. A full list of donors was read by me at the Opening Ceremony.

Less warming was the repeated plundering of the planted collection by palm collectors and others who saw the unsecured site as an easy way of augmenting their stocks. On one occasion nearly all the fruiting females of all the *Chamaedorea* spp. in the rainforest area were taken during the night. Some of these plants were clumps of over 2 m height. Theft continued until I convinced Council to hire security patrols, which are still in operation, and to declare the site closed to the public during construction. The most disappointing theft was of a fine plant of *Pelagodoxa henryana* from the nursery. The plant had been donated by the well known Townsville plantswoman Patricia Coutts. It was an unpleasant task to inform her that the plant had been taken by some selfish thief.

Gearing Up for the Opening and the Future

As early as mid 1987 we had decided upon 18th September 1988 as the date for the opening of The Palmetum. As the site slowly took form and it appeared that it would reach a presentable level of establishment, preparations were made for the Opening Ceremony. While plantings continued (all of which were transported to the site in vehicles borrowed from other sections of the Department, as we had no transport of our own) arrangements were made to focus attention on the project.

As The Palmetum was to serve an educational purpose, I decided to gather materials to make an exhibition conveying the importance of palms both to mankind and as elements of the environment. The subjects covered included economic palms: Dates, Oil Palm, Coconut, Sugar Palm, Sago, Rattans, Palmyra, Betelnut and Carnauba; other Botanic Gardens' palm collections: Kew, Singapore, Honolulu and Fairchild; palm botanists: H. E. Moore, Jr., von Martius; and various environment aspects.

In April 1987 I decided to invite the International Palm Society to hold their 1988 Biennial in Townsville and sent out a form letter to various I.P.S. members and officials. Support for the idea was sought from The Palm and Cycad Society of Australia as well as many friends in the I.P.S. in the U.S.A. After months of uncertainty, the I.P.S. decided in favor of an Australian Biennial and handed organization of the event over to P.A.C.S.O.A., who widened the itinerary to include the Cairns area and made the event so successful and enjoyable for the participants.

In writing to Dennis Johnson, soliciting materials for the Carnauba display in the exhibition, I decided it would be advantageous to have authorities like Dennis come out to lecture on palms, particularly those that are relatively unknown here, like Carnauba. I wrote to Johnson Wax, the company that has a history of exploration and research into Carnauba, and managed to obtain sponsorship for Dennis. Fortunately, John Dransfield, Andrew Henderson and Natalie Uhl were also participating in The Biennial, so we finally had an array of authorities from overseas who provided enlightening lectures at The Biennial functions.

I also tried to get the local Department of Primary Industries and The North

Queensland Palm Society to organize a workshop on agricultural and horticultural aspects of palms, for north Queensland interests. Unfortunately neither body could devote the time or funding necessary to arrange this, which could have been a great benefit locally.

The effort that went into the Opening Ceremony culminated on September 18th with an international gathering of palm people, sampling foods made from palms, wearing Palmetum "T" shirts, enjoying the mild spring sunshine amongst hundreds of young palms. Prior to the opening, many Australian and overseas visitors came to look at the site, which was the scene of much frantic activity right up to the morning of the 18th. Many people who had seen the site in previous years were quite amazed at its progress.

Considerable enthusiasm came from the founding members of P.A.C.S.O.A. who still donate seeds and plants to the project. Having had experiences with the relationships between the South Florida chapter of The I.P.S. and Fairchild Tropical Gardens, and The Friends of Foster Garden and Honolulu Botanic Gardens, I thought a Friends of The Palmetum group could be formed. On a visit to Brisbane during the P.A.C.S.O.A. Show and plant sale at Mt. Coot-tha Gardens, I talked to David Tanswell, Greg Cuffe, and John Dowe about The Friends group. They were enthusiastic and immediately set up the initial membership drive. We now have over thirty members and are about to formalize The Friends base in Townsville.

Conclusion

While detailing the events and motions that contributed toward the making of a Botanic Garden involves far too much written information for all but a special publication to cope with, I have here tried to compile, in as brief a form as possible, the important and generally unrecorded aspects of the project.

I would like finally to again thank those groups, societies, and individuals who assisted. It is important to acknowledge the impetus given to worldwide interest in palms throughout the years of dedicated work by the I.P.S., which is largely responsible for bringing various levels of awareness about palms to vast numbers of people.

Footnote: In November 1987 The Palmetum was awarded a Certificate of Merit in The Royal Australia Planning Institutes inaugural Awards of Excellence in Environmental Planning and in 1988 was awarded merit in the annual Greening of Australia awards.

LETTERS *(continued from p. 85)*

Pauahi streets in downtown Hilo. At the time the American Forestry Association accepted this palm for registry the runner-up in Florida was 65 feet tall, so it is a tall tree. But it doesn't look so very tall because there is nothing near to it to give a comparison as to its height.

Hilo also has a planting of a San Ramon variety of coconut at the Tree Nursery on Kilauea Avenue. This tree is known locally as a "gallon coconut," for the nuts are so huge that they will displace about a gallon of liquid. Mature nuts of this tree are rather scarce for the nuts are so very heavy that they are easily displaced from the tree in a storm. This tree was planted in 1939 from a seed sent from Zamboanga on the island of Mindanao in the Philippines.

So don't stand under the coconut trees, but do notice them from a distance when you are in Hilo in June.

JANE F. ROBINSON

PALM LITERATURE

COCK, M. J. W., H. C. J. GODFRAY, AND J. D. HOLLOWAY (*eds.*). Slug and Nettle Caterpillars: The Biology, Taxonomy and Control of the Limacodidae of Economic Importance on Palms in South-east Asia. 270 pp. C.A.B. International, Wallingford, Oxon., 1987. (UK £48.00, Americas $99.00, elsewhere £53.00)

This volume's title suggests that the information presented will pertain mainly to entomologists. Indeed, some will find this work indispensable, but it is also intended for plantation managers and field workers. And many landscape and greenhouse gardeners, horticulturists, and hobbyists fascinated by palms will be interested in this attractive book.

Caterpillars of the Limacodidae, a small family of microlepidoptera, are important leaf-feeding pests of many palms, including coconut, oil palm, and other species grown commercially for their products. The various insecticides that have been used to combat outbreak infestations, frequently nonselective and detrimental to natural enemies, have been implicated in triggering and maintaining pest resurgences. Control of limacodids thus challenges practitioners of integrated pest management (IPM).

Slug and Nettle Caterpillars is the result of a study of Philippine coconut pests, funded from 1976 to 1985 by the Food and Agriculture Organization (FAO) of the United Nations. Emphasized was the biocontrol of limacodids, which included intensive taxonomic and biological studies in the Philippines and elsewhere in Southeast Asia. The results of this project, directed by the United Kingdom's C.A.B. International Institute of Biological Control (CIBC), are presented in 17 chapters by 13 researchers.

Chapter 1 sets the stage by outlining the typical limacodid life cycle and reviewing morphology. It also characterizes their natural enemies—predators, parasitoids, and pathogens—and discusses population dynamics. In chapter 2 it is pointed out that knowledge of Southeast Asian limacodids is incomplete and that additional species and their natural enemies will be encountered on palms. Workers are encouraged to submit unfamiliar specimens following the collection and preservation techniques suggested.

Representing nearly half the book's text is chapter 3, a systematic account of economically important Limacodidae associated with coconut and oil palms in Southeast Asia. This amounts to a revisionary study that includes descriptions of four new genera, 35 new species, one new subspecies, and various nomenclatural changes (new synonymies, new combinations, etc.). For convenient reference, all new taxa and taxonomic changes are listed in Appendix 2. I suggest that it might have been more appropriate to publish descriptions of new taxa and changes in nomenclature in a widely accessible journal.

This key chapter, however, appears well prepared and includes for each species a taxonomic diagnosis and, where known, a summary of distribution, biology (including immature stages, feeding damage, and food plants), pest status, and natural enemies. Contrary to what is stated on the dust jacket, there are no keys to species. But facilitating identification are descriptions or illustrations of intraspecific differences in moth color pattern (within-population and geographic variation) and, in species having caterpillars of different forms, illustrations of the young and mature larva. Thirty-six plates accompany this chapter: 18 (192 figs.) with black and white photographs showing male genitalia of most species and female genitalia of a few; 4 (155 figs.) with color photographs of moths; and 14 (107 figs.) in color showing mostly larvae but also eggs, cocoons, adults, damage to coconut and oil palms, and natural enemies. The generally excellent images of bizarre, but attractive, caterpillars are an outstanding feature of the book.

Chapter 4, three pages on limacodid

pests of tropical Australasia, completes the systematic treatment. It is based on material submitted from coconut in Papua New Guinea.

Information on insect natural enemies of Limacodidae is composed of nine short chapters (5–13). Chapters 5–7 treat the principal groups of parasitic wasps: Ichneumonidae, Braconidae, and Chalcidoidea. Keys to genera associated with slug and nettle caterpillars appear in all three chapters, and for the larger ichneumonid and braconid genera there are keys to limacodid-parasitizing species. Chapter 5 includes line drawings of ichneumonid wing venation; chapter 6, line drawings and photomicrographs of braconid morphology. The new species described, two in Ichneumonidae and three in Braconidae, and nomenclatural changes are listed in Appendix 2. As I noted in remarks about chapter 3, such descriptions of new taxa seem somewhat out of place here.

Other parasitic Hymenoptera are covered briefly, Ceraphronidae in chapter 8 and Chrysididae in chapter 9. Tachinidae and Sarcophagidae, and Bombyliidae, the only important dipteran parasitoids of Southeast Asian limacodids, are discussed in chapters 10 and 11. A two-page write-up (chapter 12) on true bugs (Hemiptera) and a single page on the lepidopteran family Pyralidae (chapter 13) complete the section on parasitoids and predators.

Following chapter 14 on classic biological control, including a review of previous releases of exotic natural enemies against limacodids and potential for biocontrol of these Southeast Asian palm pests, are two chapters on pathogens. Pathogenic organisms often are dealt with summarily in considering natural enemies of particular pests, but they are covered thoroughly here—fungi in chapter 15 and viruses in chapter 16. The need for further research on fungal pathogens and viruses, especially viral epizootiology, is emphasized.

A review of the economic importance of slug and nettle caterpillars on palms and their control by chemicals (chapter 17) concludes this volume. All insecticides known to have been used against these pests are listed in a table; application methods, proper timing, and adequate monitoring of pest populations are discussed; and the importance of developing economic injury levels or thresholds is stressed. Alternatives to chemical control, such as the use of pheromones and plant resistance, are only briefly noted.

Back material consists of three appendixes: recorded food plants of the limacodids mentioned, with an alphabetical arrangement by botanical and common name; a list of acronyms, which fortunately were used sparingly in the text; and the previously noted list of new taxa and name changes. The bibliography of 368 references includes many from the 1980s. There also is an index to all Limacodidae, their natural enemies, and associated species, with bold type indicating main entries.

The CIBC, editors, and chapter authors are to be commended for placing limacodid taxonomy and that of their natural enemies on a firmer basis, for synthesizing biological data on these groups, and for calling attention to areas requiring additional investigation. It is through such intensive study that populations of major crop pests can be better suppressed and IPM strategies best implemented. Similar surveys of other tropical crop communities undoubtedly would be equally productive.

Applied entomologists, biocontrol workers, ecologists, and systematists will find much of interest in this book. Anyone involved in the commercial production of coconut and oil palms will benefit from it. Even though the contents may be only marginally relevant to many members of the International Palm Society, I predict that some of the more ardent palm fanciers will want a copy for their personal library.

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Principes, 34(2), 1990, pp. 96–97

Regeneration of Severed Roots in Washingtonia robusta and Phoenix reclinata[1]

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Transplanting large field grown palms typically requires cutting all of the existing roots at some distance from the trunk. Commercially, some palms are dug with fairly large root balls, while others may have their root severed within a few cm of the trunk. The fate of these remaining root stubs has been debated for years. Many nurserymen cut the roots of palms close to the trunk, believing that the cut roots will die back to the trunk and must therefore be replaced with new roots originating from the trunk. Tomlinson (1961) believed that if a palm root is severed, a new growing apex will be formed just behind the cut. Broschat and Donselman (1984) found that the response varied with the species and the length of the remaining root stub. They found that virtually no cut roots of *Sabal palmetto* survived, regardless of their length, while about half of all *Cocos nucifera* cut roots regenerated apical meristems, regardless of their length. *Syagrus romanzoffiana* and *Roystonea regia* roots had higher survival rates if they were cut at greater distances from the trunk.

Since the root regeneration response varies among species, it is impossible to predict how any given species will respond. Two palm genera, *Washingtonia* and *Phoenix* are widely planted in landscapes of the southern United States, yet nothing is known about their root regeneration response. The purpose of this experiment was to determine how roots of these two palm genera respond when cut at varying distances from the trunk.

Materials and Methods

Six replicate 8–10 m tall field grown *Washingtonia robusta* and six 4–6 m tall *Phoenix reclinata* were utilized for this experiment. A trench 1.5 m long, 30 cm wide, and 60 cm deep was dug through the root system of each palm tangential to the trunk using a mechanical trencher. Root stubs exposed by the trench varied from 6 to 100 cm in length. The trenches were filled with perlite and covered with a porous polypropylene fabric. The palms were irrigated three times weekly to keep the perlite moist. After nine weeks the perlite was removed from the *Washingtonia* palm trenches and the new roots rinsed free of perlite and soil. The same was done for the *Phoenix* palms 13 weeks after trenching. The number of new roots produced from the trunk, as well as the percent of cut roots that had branched and continued growth was recorded for four different root length classes: 0–15 cm, 15–30 cm, 30–60 cm, and 60–90 cm.

Results and Discussion

Only about 2% of the *Washingtonia* roots cut to lengths of 15 cm or less sur-

[1] Florida Agricultural Experiment Station Journal Series No. 9548.

Table 1. Average percentage of cut roots branching in four different length classes.

Species	Root Length				Avg. No. New Roots
	15 cm	15–30 cm	30–60 cm	60–90 cm	
Phoenix reclinata	0.0	2.1	7.9	32.4	62
Washingtonia robusta	2.0	14.3	31.0	58.5	144

vived and continued to grow. This percentage increased to about 14% for roots cut 15–30 cm from the trunk, 31% for those 30–60 cm long, and 58% for those 60–90 cm in length (Table 1). The average number of new roots produced from the trunk was quite high (144/palm) compared with other species evaluated by Broschat and Donselman (1984). The linear increase in the percentage of cut roots surviving with increasing root stub length, as well as the large number of new roots produced by *Washingtonia robusta* is very similar to the response reported for *Roystonea regia* (Broschat and Donselman 1984).

Very few of the roots of *Phoenix reclinata* cut to lengths of less than 60 cm survived, whereas nearly one-third of those cut 60–90 cm from the trunk branched and continued growing. Thus, 60 cm appears to be the minimum threshold length for good cut root survival in this species. Although a moderate number (62/palm) of new roots were produced from the trunk, the root regrowth response of *P. reclinata* was generally more similar to that of *Roystonea regia* than that of other species examined.

From a practical standpoint, this study suggests that *Washingtonia* palms to be transplanted would benefit by having a large rootball with roots cut at least 30 cm from the trunk. *Phoenix reclinata* would benefit from even larger rootballs having roots cut 60 cm or more from the trunk. The large number of new roots produced by these two palm species suggests that root pruning 4–6 weeks prior to digging may be helpful in stimulating new root production by the trunk, although additional field studies are needed to confirm this.

Literature Cited

Broschat, T. K. and H. Donselman. 1984. Root regeneration in transplanted palms. Principes 28(2): 90–91.

Tomlinson, P. B. 1961. Palmae. Vol. II. *In*: C. R. Metcalfe (ed.). Anatomy of the monocotyledons. Clarendon Press, Oxford, pp. 47–52.

DIRECTORS BALLOT

Since many members did not receive their January issue and Directors Ballot until mid to late March, all ballots received by the Secretary as of May 1st have been recorded and counted.

BOOKSTORE

COCONUT PALM FROND WEAVING (Wm. H. Goodloe, 1972, 132 pp.) 4.95
COCONUT RESEARCH INSTITUTE, MANADO (P. A. Davis, H. Sudasrip, and S. M. Darwis, 1985, 165 pp., 79 pp. color) 35.00
CULTIVATED PALMS OF VENEZUELA (A. Braun, 1970, 94 pp. and 95 photographs.) 7.95
EL CULTIVO DE LAS PALMAS EN EL TROPICO (in Spanish, A. Braun, 1988, 65 pp., some color and line drawings). 9.95
EXOTICA (4) (A. Graf, pictorial encyclopedia, 2 vols., including 250 plant families, 16,600 illust., 405 in color, 2590 pp.) 187.00
FLORA OF PERU (Palms) (J. F. MacBride, 1960, 97 pp.) 8.00
FLORIDA PALMS, Handbook of (B. McGeachy, 1955, 62 pp.) 2.95
FLORIDA TREES AND PALMS (L. and B. Maxwell, 30 palm species, 120 pp.) 6.00
GENERA PALMARUM (N. W. Uhl and J. Dransfield, 610 pp.) 74.95
HARVEST OF THE PALM (J. J. Fox, 1977, 244 pp.) 24.00
INDEX TO PRINCIPES (Vols. 1–20, 1956–1976, H. E. Moore, Jr., 68 pp.) 4.00
MAJOR TRENDS OF EVOLUTION IN PALMS (H. E. Moore, Jr., N. W. Uhl, 1982, 69 pp.) 6.00
OIL PALMS AND OTHER OILSEEDS OF THE AMAZON (C. Pesce, 1941, translated and edited by D. Johnson, 1985, 199 pp.) 24.95
PALMAS DEL DEPARTMENTO DE ANTIOQUIA (Palms of Colombia, in Spanish; G. Galearno and R. Bernal, 1987, 207 pp.) 18.95
PALMAS PARA INTERIORES, PARQUES Y AVENIDAS (in Spanish, A. Braun, 1983, 83 pp., 39 pp. color) 8.95
PALEM INDONESIA (in Indonesian) (Sastraprdja, Mogea, Sangat, Afriastini, 1978. 52 illustrations, 120 pp. For English translation add $2.00) 5.50
PALMAS AUTOCTONAS DE VENEZUELA Y DE LOS PAISES ADYACENTES (in Spanish, A. Braun, and F. D. Chitty, 1987, 138 pp., some color) 12.95
***PALMS OF THE WORLD** (Formerly **PALMS,** A. Blombery & T. Rodd, 1982, 192 pp., 212 color photographs) 34.95
PALMS IN AUSTRALIA (David Jones, 1984, 278 pp., over 200 color photographs) 30.00
PALMS IN COLOUR (David Jones, 1985, 93 pp.) 8.95
PALMS OF THE NORTHERN TERRITORY (AUSTRALIA) (A. White, 1988, 41 pp., 21 photographs, some color) 5.95
PALMS FOR THE HOME AND GARDEN (L. Stewart, 1981, 72 pp., some color) 19.95
PALMS OF MALAYA (T. C. Whitmore, 1973, 132 pp.) 31.00
PALM SAGO (K. Ruddle, D. Johnson, P. K. Townsend, J. D. Rees, 1978, 190 pp.) 10.00
PALMS OF SUBEQUATORIAL QUEENSLAND (Robert Tucker, 1988, 91 pp., 12 pp. color, many black and white photographs and maps) 20.00
REVISIONS OF THE PALM GENUS *SYAGRUS* MART. AND OTHER SELECTED GENERA IN THE *COCOS* ALLIANCE (S. Glassman, 1987, 222 pp.) 19.95
SECRET OF THE ORIENT DWARF RHAPIS EXCELSA (L. McKamey, 1983, 51 pp.) 3.95
THE GENUS PTYCHOSPERMA LABILL. (F. B. Essig, 1978, 61 pp.) 6.50
THE INDIGENOUS PALMS OF NEW CALEDONIA (H. E. Moore, Jr., N. W. Uhl, 1984, 88 pp.) 12.00
TROPICA (A. Graf, 7000 color photos, 1138 pp.) 125.00
***TROPICALS** (G. Courtright, 1988, 144 pp., all color, good descriptions) 34.95

PALM PAPERS (Postage Included)

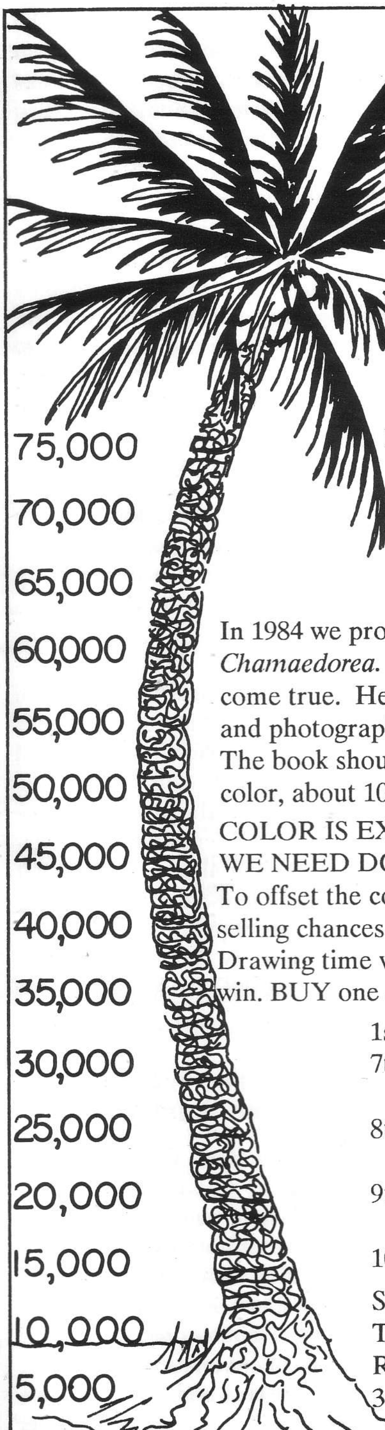
A NEW PRITCHARDIA FROM KAUA'I, HAWAI'I (Reprint from *Principes*, R. W. Read, 1988, 4 pp.) 2.00
FURTHER INFORMATION ON HARDY PALMS (J. Popenoe, 1973, 4 pp.) 2.00
NOTES ON PRITCHARDIA IN HAWAII (D. Hodel, 1980, 16 pp.) 2.50
RARE PALMS IN ARGENTINA (reprint from *Principes*, E. J. Pingitore, 1982, 9 pp., 5 beautiful drawings) 2.75
PALMS FOR TEXAS LANDSCAPES (R. Dewers & T. Keeter, 1972, 3 pp.) 1.25
PINANGA ISSUE OF PACSOA (#16, 1987, 17 pp.) 2.50
THE HARDIEST PALMS (J. Popenoe, 1973, 4 pp.) 2.00

* New arrival

The palm books listed above may be ordered at the prices indicated plus $2.00 extra per book to cover packaging and postage. (California residents please add 6.25% sales tax.) Foreign checks must be in U.S. dollars and payable on a USA bank. In some countries it is possible to send International Money Orders through the Post Office. Please include your International Palm Society membership number. Send check payable to The International Palm Society to Pauleen Sullivan, 3616 Mound Avenue, Ventura, CA 93003, U.S.A. ALL SALES FINAL.

WHAT HAPPENED TO OUR PALMETER?

WE HIT THE TOP!!



Establishing the Revolving Publication Fund and publishing "Genera Palmarum" by Uhl & Dransfield was EXCITING! DARING! AND, best of all, SUCCESSFUL! We have sold over 3500 books. The publishing cost was paid from the pre-sales offer and the Revolving Publication Fund. The Fund has risen back up to $80,000.

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8th Prize: Palms of the World (McCurrach, 1960)
9th Prize: Supplement to Palms of the World (Langlois, 1976)
10th Prize: A "Palmy" surprise package!

SEND DONATIONS TO:
The International Palm Society, Inc.
Revolving Publications Fund
3616 Mound Ave., Ventura, CA 93003 USA

Principes, 34(2), 1990, pp. 100–102

CHAPTER NEWS AND EVENTS

New Palm Society Groups Forming Worldwide

It seems that there has been increased interest in the formation of local Palm Society Chapters around the world in 1989. The *Fous de Palmiers* Chapter in France became formally affiliated with the IPS under the active leadership of Alain Herve, subject to formal IPS Board approval. Alain reports that their 58 active members include eminent botanists as well as the current French Minister of the Environment. The group publishes a nice newsletter (in French, of course) and plans a number of activities over the next few years. The *Palm Society of India* has an Executive Committee of twelve members and has requested information on formal affiliation with the IPS. Gertrude Cole reports that a new *Palm Beach Chapter (Florida)* of the Palm Society is under formation. The PACSOA Chapter reports the affiliation of two more Australian Palm Groups, *The Palm Society of Western Australia* and *The Palm Society of South Australia*, with their chapter, and the Pacific Northwest Chapter has announced the creation of four branches within their chapter: *B.C. Mainland*, *Vancouver Island*, *Washington*, and *Oregon*. Hopefully the decade of the 1990's will bring expanded growth of Palm Society Chapters around the globe. The new ability to pay IPS membership dues by VISA card makes international membership growth easier to achieve, removing the problems associated with currency exchange.

Hunter Region Botanic Gardens (New South Wales, Australia)

The New South Wales Chapter of IPS (and of PACSOA) announced recently that the Palm Garden Development within the Hunter Region Botanic Gardens is proceeding very nicely with recent plantings of 40 *Livistona australis* and 15 *Archontophoenix cunninghamiana* along with a number of other preliminary plantings. The site provides a variety of habitats spanning a swamp margin on the south and open forest to the north. While the Palm Garden is in its infancy, several improvements including watering system, footpaths and basic service framework are fully in place.

Local Appreciation of North Queensland Palm Society (PACSOA)

The North Queensland Palm Society Chapter of PACSOA was proud to receive a certificate from the Townsville City Council for their participation in Entertainment in Parks during the 125th year of Townsville. The North Queensland president, Terry Hart, accepted the certificate during the final Entertainment in Parks event of 1989. The North Queensland group has also been instrumental in the creation and support of the Townsville Palmetum: The North Queensland Palm Society group of PACSOA also held their First Annual Palm and Plant Sale at the Townsville Palmetum on September 17, 1989, drawing approximately 4,000 visitors and netting about A$2,000 for Friends of the Palmetum.

1989 Activities in South Queensland, Australia

The South Queensland Group of PACSOA held a field trip to Lake Poone, Cooloola National Park in mid October 1989. Members enjoyed a pleasant walk through rainforest, featuring many palms and other interesting plants, to a beautiful freshwater lake (swimming available) with stands of *Macrozamia miquelii* on its shores. A side tour to Fairhill Nursery and Botanical Garden in Yandina was also conducted. Earlier in mid-1989 the group toured the Mooloolah River forest with John Dowe guiding the group through an interesting area featuring all four of South Queensland's native palms (*Calamus muelleri, Linospadix monostachya, Livistona australis,* and *Archontophoenix cunninghamiana*). The South Queenslanders also held a guided tour of Mt. Coot-tha Botanical Garden in Brisbane in August. These field trips were in addition to others held earlier in the year and the regular meetings held every other month. The Annual Palm & Cycad Show and Sale was held in March at the Mt. Coot-tha Botanical Garden and was a great success as usual.

1989 Activities on the Australian Sunshine Coast

The Sunshine Coast (Queensland) Group of PACSOA held bi-monthly meetings throughout 1989 with some palm activity occurring almost every month. The group heralded their Second Anniversary at the September meeting with IPS Board Member Stan Walkley as guest speaker. The group toured Mt. Tinbeerwah Mountain Nursery in October and held an outing at Characters Restaurant on November 10—in addition to their regularly scheduled November 6 meeting in Nambour.

Activities in Northern Territory, Australia

The Northern Territory Palm Society Branch of PACSOA has been instrumental in encouraging palm plantings in the Top End of Australia. In 1986 the group started planting palms at the Fred Pass Palm Garden with continued plantings in 1987 and 1988. In 1987 some 160 palms and a dozen cycads were donated by the Northern Territory Society to the Memorial Palm Garden for the new Darwin North R.S.L. sub-branch. In April 1989 the local Society presented the park with 37 *Ptychosperma bleeseri,* with members and park staff then digging the holes and planting the palms. The palms were planted near a stand of *Carpentaria,* which grow in the moist areas along Berry Creek, amidst the beautiful rainforest. The IPS commends this branch of PACSOA for their activities on behalf of the community.

New Zealand Chapter Activities

Keith Boyer of the New Zealand Chapter, reported that the chapter now has about 150 members throughout New Zealand, publishes a local magazine four times a year and operates a seed bank for local members. Their plans include palm plantings at three public areas around Auckland and a number of small seminars for local landscapers and city councils. The first project will be new plantings in an Auckland city park where a large number of 60-year-old palms have now produced an acre of "rain forest."

South African Palm Society 1990 Congress

The South African Palm Society will be conducting its 5th Annual Congress in May 1990, at Buffelsoord, near Pretoria. Activities include lectures and slide presentations, discussions, competitive palm exhibition and palm sales and raffles. Enquiries regarding venue, costs, etc., may be directed to: The Secretary, South African Palm Society, 12 Grosvenor Crescent, Durban North 4051, South Africa.

Pacific Northwest Chapter News

The Pacific Northwest Chapter held its last 1989 meeting at the Van Dusen Botanic Gardens in Vancouver on November 27. The main event of 1989 for the Vancouver group was a booth at the Pacific National Exhibition (which is the equivalent to a state fair) lasting two weeks. In the words of Richard Woo, "The Palm Society booth stood out well in spite of heavy competition from many older and much larger garden clubs. We may be young, but we've proved that we can hold our own against some very stiff competition." Congratulations on a job well done.

Meetings scheduled for 1990 include: February 26, May 29, August 27, and November 26. All will be held at the Van Dusen Botanical Garden, 5241 Oak Street, Vancouver, B.C. Visitors are welcome.

Florida First Coast Holds First Regular Meeting

The Florida First Coast held its first regular meeting on September 9, 1989 at the Palm Garden, South Campus of FCCJ in Jacksonville. Meeting included a garden walk-through, a palm sale, and a cultural clinic on palms by Dr. Kyle Brown, Chapter President. The Chapter also held a Christmas dinner at a member's home in December as its second meeting. Both meetings were well attended with good times had by all. Meetings scheduled for the first half of 1990 are: March 10, 1990, Spring palm fling at a member's home and May 12, 1990, TLC meeting at South Campus Palm Garden.

California Chapters Fall 1989 Meetings

The Southern California Chapter held their November 1989 meeting at the San Diego Zoo, hosted by Charles Coburn, chief horticulturalist at the zoo, who led a visit to the Tiger River, where his goal was "to capture the action of water and the rain forest and its role in relation to plant life and land forms." Other palm areas visited included Sun Bear Forest, Elephant Mesa, and the Cycad Garden. There are over 6,000 different species of plants at the zoo including 270 palm species. After the meeting many visited Palm Canyon in Balboa Park adjacent to the zoo. This meeting set an all time attendance record with approximately 225 people attending!

The Northern California Chapter held their November 1989 meeting in the Vista Room of the Lakeside Palmetum. This meeting was the annual "Companion Plant Sale" where members were encouraged to bring favorite non-palm plants as well as palms to sell. The Lakeside Palmetum has a *Parajubaea cocoides* with two flower spikes and Ceroxylons with leaves 12 feet long along with a number of other palms with maturing crowns.

California Chapters Annual Palm Society Banquets

The Southern California Chapter of the IPS held their 14th Annual Banquet at Sam's Seafood Restaurant in Huntington Beach on January 20, 1990. This was accompanied by palm raffle, auction and a slide show. Dr. Mardy Darian spoke on "Palms of Madagascar."

The Northern California Chapter scheduled their banquet for February 4 at the Atrium Restaurant in San Francisco. The Atrium at 101 California Street contains an extensive collection of tropical and subtropical palms and also has an excellent bar. Warren Dolby spoke on "a new look at Palms in the California Landscape."

Houston (Texas) Area Chapter Activities

The Texas group held their last meeting of 1989 in October at the home of Gordon and Shirley Hintz. Members enjoyed touring the Hintz gardens filled with various cold-tolerant palm species and eucalypts, followed of course by good food and drink. Plans for early 1990 include a late February meeting with a program by Horace Hobbs and Jim Cain featuring slides of recent trips to Thailand and Venezuela. In April, Chapter President Horace Hobbs will present a public lecture on Palms at the Mercer Arboretum, with the chapter presenting free cold-tolerant palm seedlings to all attendees. The Houston Area Palm Show and Sale will be held at the Houston Arboretum on Saturday, April 21, open to the public from 10:00AM to

5:00PM. Cold-tolerant varieties and indoor palms will be stressed, but there will be a number of exotic specimens for sale or on display. All palm lovers are invited to come and visit and/or buy.

OTHER NEWS

International Cycad Symposium

While not truly a "PALM" event, the following meeting may be of interest to Palm lovers throughout the world, who often also have a love of cycads. Cycad '90, An International Symposium, Townsville, Australia, July 22–28, 1990. Those interested in further information should contact MRS. PAT COUTTS, M.C., Box 5495, Townsville, Qld. 4810, Australia.

Palm Tour to Solomon Islands

The Palm & Cycad Society of Australia (PACSOA) announces that Colin McQueen is prepared to lead a tour for palm and/or orchid enthusiasts to the Solomon Islands around September 1990. The proposal would be to hire an inter-island vessel to visit Ysabel, Vangunu and Tetepari in Western Province, Russell Islands, and Guadalcanal. Tetepari is a large uninhabited island which has not been botanized previously. On Vangunu it is possible to climb to the 900 meter volcano summit. Seed collecting will be possible.

The tour would be strictly for the adventurous, as facilities outside Honiara are generally primitive to non-existent, but it would be an unforgettable experience of these beautiful tropical islands.

Time estimate is two and one-half to three weeks and "ballpark" cost estimate around A$3,000 (Australian Dollars) from Brisbane. If you are interested, please write to: MR. COLIN MCQUEEN, 342 Thomas Lane, Broken Hill, NSW 2880, Australia.

The Christmas Freeze of 1989—A Preview

As 1989 came to a close, palm lovers all over the southeastern United States were wondering how many of their prize specimens and new plantings would come back from the record breaking cold weather encountered December 20–27, 1989, with the wave of extremely cold weather moving from west to east, setting record lows from Texas to Florida. The temperature reached 7° F (−14° C) in Houston, Texas and 30° F (−1° C) in Miami with all areas in between being badly affected.

JIM CAIN

U.S. Postal Service

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Back Cover

Pinanga veitchii, Bt. Patam, Brunei. Photo by John Dransfield.