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Cover Picture

Palms overhang the rock walkway on the second terrace of the Erickson House, Nassau, Bahamas. See pp. 99–107.

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The Survivors Observed

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No one who met Mrs. A. Wentworth Erickson, O.B.E., on her 1950's and 1960's visits to Miami ever forgot the occasion. The honorary title fitted her perfectly. She was a tall, handsome woman, a commanding figure in any group. She wore long dresses, flowers at her waist, chokers, and often large flowered hats. And she brought with her, we believed, the aura and elegance of her Colonial Nassau.

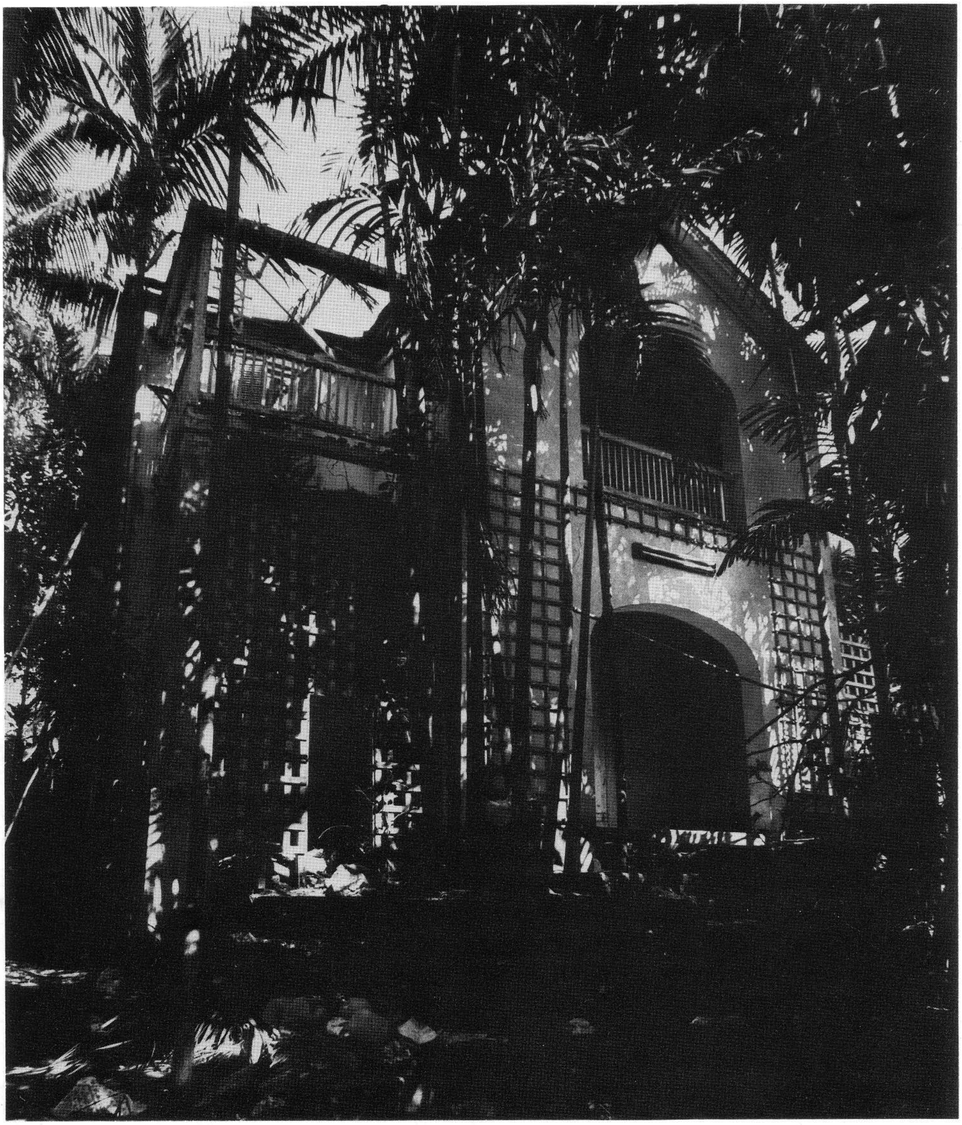
During the period when my wife and I knew Dame Cecile, her great energies and attentions were focused upon palms. She talked with charm on many other matters, but the subjects of palms and her Nassau palm garden were persistent.

Mr. and Mrs. Erickson moved from Massachusetts to Nassau in 1935, purchasing a handsome house (Fig. 1) on East Hill Street above the town and overlooking the harbor. In 1939 Mr. Erickson died, but Dame Cecile continued to live there. Her New England work ethic and gardening tradition, the terraced hillside of land sloping down from the house and the flat stretches below, as well as new friendships with generous palm lovers, Arthur and Margaret Langlois and David and Marian Fairchild, all conspired to produce her fascination with palms and an ambitious garden.

In Nassau there could hardly have been more different garden sites than those of the Langlois' Retreat with the flat 'coppice' and numerous solution holes for planting palms, and that of the Erickson's windy, bare rock hillside. Mrs. Erickson caused great amounts of planting soil to be placed on the hillside, behind concrete curbs. Elegant steps (see cover and Fig. 2) connected terraces from which to view the ranks of palms. Later there came rock-lined pools which lacked the self-consciousness of so many such works. This was clearly Dame Cecile's garden, but her son Douglas Erickson told me that there was a gathering of the clan in Nassau in 1959 to help with "digging the pools." As Dame Cecile became less easily able to visit the terraces to inspect her palms, an electric track and traveling platform with seats was erected alongside the house. Doug Erickson believes the house, from its appearance on early navagation charts, dates from the 1700's.

When I married Dr. David Fairchild's granddaughter, Helene, in 1958, our honeymoon to Nassau and the Exuma Islands included a visit to Mrs. Erickson's home and her garden. We remember walking easily from terrace to terrace, gazing at the palms, feeling the sun on our heads, and being met below by Dame Cecile on her electric platform, with whom we ascended again to the house for tea.

Twenty-six years later, fifteen years since Dame Cecile's death, we learned from Doug Erickson that the property was still owned by the family, and without hesitation asked permission to revisit the garden. He said that no care of any kind had been available for the palms for those fifteen years, that the pools had long been dry, and that he didn't know if anything of interest would be left. Several weeks later he found what was for us to be an invaluable, undated list of species and sources of palms compiled by his mother, probably in the late 1950's. He clarified



1. The east face of the Erickson house from the second terrace.

locations on a survey of the property with us. We asked our friend Don Evans, Superintendent of Fairchild Tropical Garden, to research early *Principes* for mention of the Erickson garden and to help us with palm identification on the trip. Helene agreed to be the photographer. In Volume 10: 40, 1966, Don found the following paragraph:

After a most pleasant visit at Mr. and Mrs. Russell's delightful home and lunch at Montague Beach Hotel, they drove to "Glenwood", the home of Mrs. A. Wentworth Ericson (*sic*), O.B.E. The garden is on a slope, and a number of terraces lead to level ground. Although we were impressed with the lush look of the growth, with palms of many sizes

2. Palms tower above the central steps between the second and third terraces as D. Evans and L. Pancoast approach them.

featured on each terrace, Mrs. Erickson, who graciously came out to greet us, grieves for the plants that were destroyed by the severe hurricane of September, 1965. One of the most interesting palms to be seen there is *Arenga undulatifolia*, with wide, wavy-edged leaflets, of an almost steel-blue color, and long strands of immature fruit.

Don, Helene, and I imagined that we would find few of the drier-growing palms intact, growing here and there among the scuffy Bahamian weeds and bushes. The dry pools would be cracked, the site deserted. We hedged these grim expectations with a visit to the Retreat, and a long, enthralling walk from sink hole to sink hole with Mrs. Langlois' loving monologue about her many "children." Mrs. Langlois had admired Dame Cecile, whom she warmly characterized as "The General." Although she had not visited the hillside garden since shortly after Dame Cecile's death, she astonished us by reciting from memory her own list of the garden's more unusual palms.

The very old house on East Hill Street was still looking out over Nassau Harbor. A friendly caretaker lounged on its veranda. He would have shown us more of the empty interiors, but we were already astounded at what we beheld through the windows: a rich, lush, dense, high, vertical jungle of what were obviously the survivors of all the palms Dame Cecile had planted in her garden: triumphant *Ptychosperma elegans* and *Heterospathe elata.*

Ptychosperma elegans has gone wild where we live in Coconut Grove; at the Retreat we had talked with Mrs. Langlois about her many volunteer "hetties," as she called her *Heterospathe.* But this was a forest of both palms, evenly mixed (Fig. 3). Although a landscape architect might not choose to relate them visually, the birds of Nassau did not hesitate, dropping their small seeds everywhere. Even the unbroken stone walks and terraces had sprouted tall, slender trunks, confusing architectural intentions and greatly filling in the open lawns on each terrace. The pools were half full of water. There were men burning refuse and hacking crudely at the smaller plants of *Heterospathe* so that people might pass. And there was a surprising sign: "Glenwood Garden Tours. Adult $1.00. Children $.50. Open 9:00 to 4:00."

We moved through the smoky air to search out the palms which had withstood the dry Nassau winters and competition from Ptycho and Hetero. The smaller palms, the shade and water lovers, were gone. Many of the taller kinds had reached the upper canopy to thrive there, but were difficult to see from below. One can strain ones eyes looking for a missing *Howea* in a forest of *Heterospathe.* We could not help indulging in wondering how Dame Cecile would have felt about her beloved garden today. Would the sadness of the palms lost overcome the thrill of seeing the startling growth of the survivors? I think that if she had been there, she soon would have had all of us working to bring Glenwood back into balance, rather than counting species or writing sentimental articles about the past. And, of course, we also began to wonder which palms of our own gardens would ultimately turn survival into triumph.

An unterraced, sloped area of rock eastward of the terraces was called "The Rockery." It appears to have been the place where shade-loving palms were grown, but they do not now remain. If the hillside terraces and rockery were intensely supplied with palms, either by Dame Cecile, or, later, by the birds, there were also palms in the level land below. Sabals, Royals, and the magnificent coconuts, which we Floridians must now envy, were mixed with good specimens of breadfruit, spice trees, avocados, mangos, citrus, Spanish limes and guava.

A trellis and concrete walkways continue to give parts of the level portions of the land some feeling of organization, in spite of the ubiquitous volunteer *Ptychosperma* and *Heterospathe.* As Doug Erickson had told us we would, we found

3. L. Pancoast (left) and D. Evans at the east end of the third terrace.

the flat gravestone of an early Englishman "who fought pirates" dated 1722 to 1764, which prodded our sense of history. We also found a stone lined rectangular pit, which the survey showed as "bamboo," but which was full of smoldering garbage. Don surmised that the bamboo which had grown there had blossomed, died and spread its seed to start the smaller bamboo which now surrounded the pit. Helene stalked photographs.

We shook hands with *Elaeis oleifera*

4. L. Pancoast beside the silk cotton tree in the lower garden.

and two *Arenga undulatifolia* mentioned in *Principes*. We had agreed to mark with an "X" those palms which were in place but dead; we never used that symbol once.

Finally, we sat under a shockingly massive 80-foot, elephantine *Ceiba pentandra* (Fig. 4), beside beautifully conceived and constructed pools filled with intensely yellow-green duckweed and white water lilies, surrounded by superb palms. At mid-afternoon in the wet heat of July, we were truly reluctant to leave.

Below is Dame Cecile's list, with symbols supplied on our visit. "+" indicates healthy survival; "±" less healthy. "?" indicates that we found no trace of that palm. Also provided is a short list of palms encountered by us in the garden, but not included by Dame Cecile.

Table 1. Palms growing in Glenwood Gardens Nassau-Bahamas.

	Name [Listed Name]	Origin of Plant	Location in Garden
+	*Aiphanes caryotifolia*	Langlois—grown from seed from Rio B.G.	Lawn—Third Terrace
±	*Arecastrum romanzoffianum*		Third Terrace
?	*Arenga undulatifolia*	Langlois—grown from seed from St. Clair, Trinidad	Second Terrace
+	*A. engleri*	Langlois—grown from seed from Trinidad B.G.	Third Terrace
+	*A. wightii*	Langlois—grown from seed from Castleton Gardens, Jamaica	Slat House
±	*A. undulatifolia* [species F.T.G. 244]	Langlois—grown from seed from Archibold Expedition to Moluccas (vicinity Gorontalo, East Coast of Celebes)	Lower Gardens
+	*A. pinnata*	Florida	Lower Garden
?	*Butia capitata*	Florida	Third Terrace
+	*Caryota mitis?*	Locally	Third Terrace and Lower Garden
?	*Chamaedorea stolonifera*	Langlois—offshoot from plant received from Barry, Cal.	Rockery
?	*C. tepejilote*	Langlois—grown from seed from tree growing in Retreat Garden	Rockery
?	*Chamaedorea ernesti-augusti*	Langlois—grown from seed obtained from Br. Honduras by P.W.D.	Vicinity Pool
?	*Chambeyronia macrocarpa*	Langlois—grown from seed from Rio B.G.	Lower Garden
+	*Chrysalidocarpus lutescens*		Rockery by Pool
+	*C. madagascarensis* ssp. *lucubensis*	Langlois—grown from seed from Trinidad B.G.	Slat House
	species	Langlois—grown from seed from plant found in a park in Bahia, Brazil	Lower Garden
+	*Coccothrinax argentea ?*	Florida	Lower Garden
+	*Cocos nucifera*	Local	Many
	Cocos nucifera Golden Coconut		Third Terrace
+	*Cryosophila argentea*	Langlois—grown from seed collected from forests Belize Dis., British Honduras	Vicinity Rockery—Second Terrace
+	*C. nana*	Langlois—grown from seed from St. Clair, Trinidad	Lower Garden
?	*Desmoncus* species	Florida	Rockery by Pool
?	*D. quasillarius*	Langlois—grown from seed collected from forests at Maskal's, British Honduras	Rockery—Second Terrace
+	*Dictyosperma album*	Miss Matthews	Third Terrace and Lower Garden
+	*Elaeis guineensis*	Florida	Lower Garden

Table 1. (Continued).

	Name [Listed Name]	Origin of Plant	Location in Garden
+	*E. oleifera*	Langlois—grown from seed from Summit Experimental Station, Canal Zone	Lower Garden
+	*Gaussia attenuata*	Langlois—grown from seed from tree growing in Lotmore Garden, Nassau	Second Terrace
+	*Heterospathe elata*		Third Terrace
	[species (green heart) ?]		Third Terrace
?	*Howea belmoreana*	Government Nursery, Nassau	Slat House
+	*Hyophorbe lagenicaulis*	Govt. Nursery	Second Terrace
?	*H. verschaffeltii*	Govt. Nursery	Second Terrace
+	*Latania* sp.	Langlois—grown from seed from Trinidad B.G. (Plants of *L. loddigeesii* and *L. commersoni* got scrambled (it is one or the other)	Lawn and Third Terrace
+	*Licuala* sp.	Langlois—grown from seed collected from a plant under name of *L. spinosa* in Trinidad B.G.—not that palm	Vicinity Rockery—Second Terrace
+	*Licuala grandis*		Lower Garden
+	*Livistona chinensis*		
?	*Opsiandra maya*	Dr. Fairchild	Lower Garden
	O. species	Langlois—grown from seed collected in forests at Jones' Landing, Sabun River, British Honduras	Lower Garden
?	*Orbignya cohune*	Govt. Nursery, Nassau	Flower Garden
+	*Phoenix canariensis*	Florida	Lower Garden—Third Terrace
	P. roebelinii		
?	*Pinanga kuhlii*	Langlois—grown from seed collected Rio B.G.	Slat House
?	*P.* sp. F.T.G. 207	Langlois—grown from seed from Archibold Exp. to Moluccas (from Minabasa, Celebes)	Slat House
?	*Pritchardia pacifica* ?	Govt. Nursery, Nassau	Lower Garden
?	*Pseudophoenix sargentii*	Local	Lower Garden
+	*Ptychosperma elegans* [possibly *P. kersteriana*]	Local	Second and Third Terrace
	P. sp.	Langlois—grown from seed collected from Dade Gar., Trinidad	Slat House
+	*Ptychosperma macarthurii*	Florida	Third Terrace by Coach House
+	*P.* variety	Langlois—grown from seed from Rio B.G. from three named *Balaka seemanii*	Rockery—Second Terrace
+	*P.* sp.	Langlois—grown from seed from Trinidad B.G. from tree by name of *Coleospadix oninensis*	
+	*Rhapis excelsa*		Rockery by Pool—also on 2nd level
?	*Rhopaloblaste augusta*	Langlois—grown from seed collected from Dade Gar., Trinidad	Lower Garden (Pit)
+	*Roystonea elata*	Local	Many
+	*Sabal palmetto*	Local	First Terrace—Lower Garden
	S. sp.	Found on property	
?	*Synechanthus fibrosus*	Langlois—grown from seed collected forests Stann Creek, Br. Hon.	Rockery, Second Terrace

Table 1. (Continued).

	Name [Listed Name]	Origin of Plant	Location in Garden
?	*Thrinax radiata* *T. morrissii*	Langlois—grown from seed from Barry, Cal.	Lower Garden Rockery, Second Terrace
+	*Veitchia merrillii*	Langlois—small plant from Gardens, Jamaica	Lawn—Third Terrace
There were a number of additional palms which we found that were not included on Dame Cecile's list above:			
+	*Livistona woodfordiana*		Second Level
+	*Bactris major*		Slat House
+	*Veitchia winin*		Lower Garden

Principes, 29(3), 1985, pp. 108–114

Raphia hookeri: A Survey of Some Aspects of the Growth of a Useful Swamp Lepidocaryoid Palm in Benin (West Africa)

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The genus *Raphia*, considered as "the most distinguished African contribution to palms" (Corner 1966) is known in Europe and North America for its fiber (raphia, raffia) obtained from young leaves. In fact, many other products of the tree are used by man in the *Raphia* palm distribution area (Moist Tropical Africa, Madagascar, parts of South America—Moore 1973). This genus includes 28 species, none of which is present in Asia, although Asia has the largest range of genera and species of

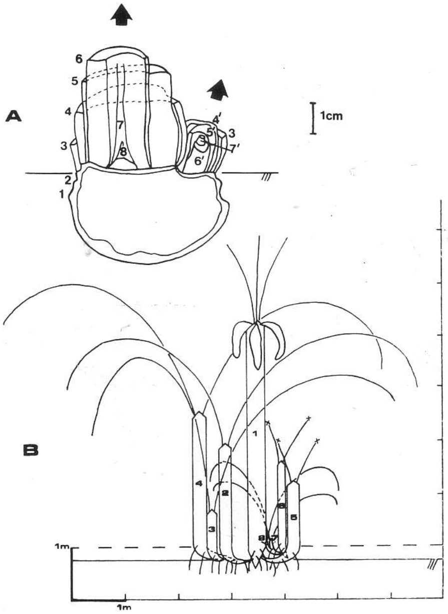
1. A *Raphia* swamp, *Raphia hookeri* is the dominant species after destruction of the swamp forest at Sélé-Podji (21 km east from Cotonou). Ground flora consists of *Cyclosorus striatus* (Schum.) Ching (Thelypteridaceae) and *Cyrtosperma senegalense* (Schott) Engl. (Araceae).

2. Herbaceous swamp with isolated clumps of *Raphia hookeri* at Cococodji (10 km west from Cotonou). Dominant herbaceous species: *Typha australis* Schum. & Thonn. (Typhaceae).

the lepidocaryoid line (Moore 1973). Apart from central Africa, most certainly the biggest center of *Raphia* speciation (Otedoh 1977a), only seven species are found in all West Africa (Russell 1965, Tuley and Russell 1966, Russell 1968). In Benin, lying along the Gulf of Guinea, four species have been recorded; in the southern area of the country *Raphia hookeri* Mann & Wendland and *Raphia vinifera* P. de Beauvois constitute an important element of the swamp forest flora localized in the talwegs of the sedimentary soil type, "terre de barre", and also in the plateaus and in depressions of Quaternary barrier beaches (de Souza et al. 1983). In the center and the northern part of the country grow the other two species: *Raphia sudanica* A. Chevalier, and according to the same author *Raphia humilis* A. Chevalier, two species which are confined to the seasonal swampy depressions of savannahs. *Raphia* species are not equally used by the population: in the South of Benin *Raphia hookeri* is the most popular species. The people use the rachis of leaves as poles and to build houses, and also use the leaves for roofing and making fiber (raphia and piassava). The sap is transformed into palm wine and further distillation gives the spirit called *Sodabi*. The exploitation of *Raphia hookeri* consists of a simple gathering of the products; in some places however (mainly swampy areas) it is done in an arboricultural zone.

The aim of this paper is to present botanical and ecological data, collected during a study of this important species. The data given here will be accompanied with an inventory of human uses of *Raphia* in Benin and other countries within its distribution area (Profizi 1983,

3. Transition from Herbaceous swamp to *Raphia* swamp at Cococodji. Herbaceous layer with *Thalia welwitschii* Ridl. (Marantaceae) and *Cyclosorus striatus.*



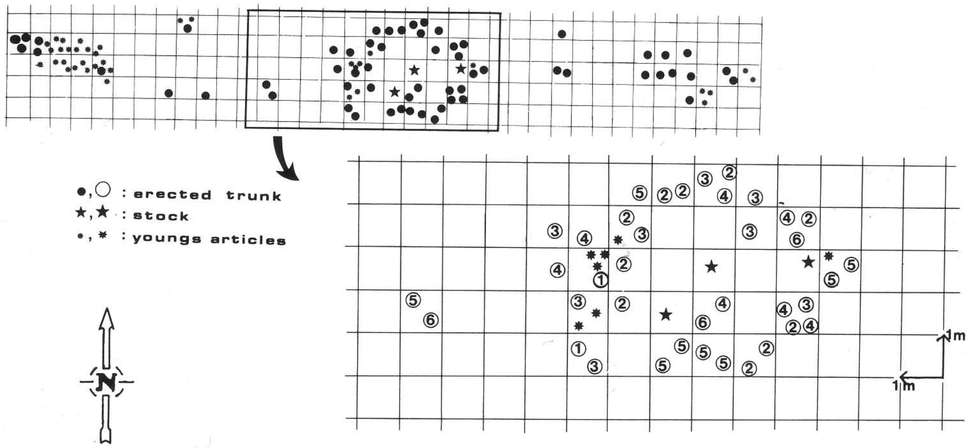
4. Genets of *Raphia hookeri.* A. Seedling developing a sucker 26 months after transplantation. The numbers represent the order of development of the primary axis leaves (1, 2, 3 . . . 8) and those of the sucker (4′, 5′, 6′, 7′). B. A clump in a swamp. The leaves are represented by a single rachis. The numbers represent the order of trunk development.

human uses in Profizi 1984). From an economic point of view, the use of swampy areas, nowadays neglected by modern agriculture, can be extended favorably as far as *Raphia* products are concerned, and this study aims at a better knowledge of *R. hookeri.*

Seedling and Juvenile Phase

Germination is adjacent-ligular and can occur very quickly; it requires 20 to 40 days according to Otedoh (1977b) and personal observations in the field, jointly with S. de Souza's experiment (pers. comm.). Accordingly the seeds are not always completely extricated from the pericarp when germination starts. In the natural environment germination seems low and only a few seedlings survive and reach the adult stage. Specialized producers collect seeds and after thoroughly controlled germination, transplant the seedlings into a clearing near the swamps. The pinnate leaves of the seedling bear spines on the rachis and nerves and are similar to those of the adult but much smaller. Aerial roots soon develop; their number grows and they become important near the bases of the trees. These special roots, containing alternate pneumatozones (de Souza 1984) have the same structure as that of the South American palm, *Mauritia flexuosa* L.f, studied by de Granville (1974) and perhaps *Raphia farinifera* (Gaertn.) Hylander in Cameroon (Cardon 1978).

Young *Raphia* plants consist of an aerial clump of leaves; the juvenile phase consists of subterranean growth in stem diameter (2 to 3 years). The diameter of the adult erect trunk varies and depends



5. Circular structure in a swamp: several *Raphia hookeri* stems grow around original stocks. The numbers represent the height of the trunks (1 below 1 m, 2: 1–2 m, 3: 2–3 m, 4: 3–4 m, 5: 4–5 m).

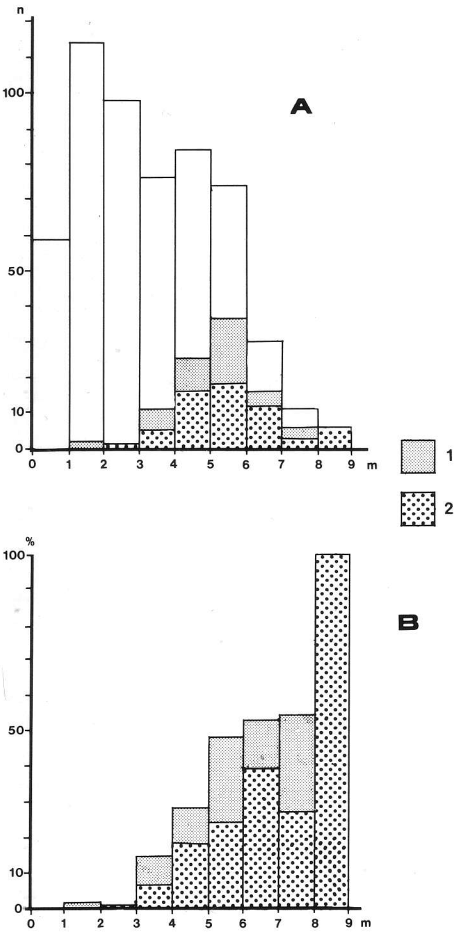
on ecological conditions; *Raphia hookeri* growing in swamps that are regularly flooded have a very short stem (1 or 2 m) and a small diameter (less than 0.1 m). In other cases trunks are rather taller (8 or 9 m) and wider (0.17 to 0.3 m) (See Figs. 1–3). The unexpanded sword-leaves are collected for making *Raphia* fiber; this fiber consists of the epidermis and an underlying sclerenchymatous zone.

The species has an architecture conforming to the model of Tomlinson (Hallé et al. 1978) and it forms a clump (genet according to Harper 1977) of several ramets in different stages of growth. While still a seedling, it produces several basitone suckers in the swamp. A seedling germinated on May 17th 1981 will develop a sucker 26 months later (February 1983). A vertical section of this genet shows that the ramification appears quite early as the stem diameter begins to increase (Fig. 4A).

Even when the ramification starts later, it does not appear after an erect trunk is produced. The result of this is apparent when several ramets develop their trunks as in Fig. 4B. Colonization of the swamp develops centrifugally from the single seedling axis, resulting in a colony as observed in a swamp (Fig. 5). This colony probably results from a single seedling, represented by one of the several stocks found in the center. This form would be an extension of a less extended clump that has been observed elsewhere. This method of growth also involves the death of each trunk of the genet after flowering (the palm is hapaxanthic), but the whole genet is of course polycarpic.

Adult Phase

Phyllotaxy is spiral with four orthostichies; four to eight new leaves are produced in one year. The leaves from the adult trunk are generally 9.5 to 11 m long (with leaf stalk 2 m). According to farmers, the trunk becomes completely erect 5 or 6 years after planting (7 to 9 years after germination). Measurements of 551 trunks gathered during the ecological study (Fig. 6) and divided into 9 categories indicate that the number of trees by categories decreases as the height increases (Fig. 6A). This phenomenon is related to the progressive increase in the proportion of trunks flowering or exploited for tapping



6. Measurements of 551 trunks observed in the ecological study. A. number of trunks; B. proportion of trunks exploited by tapping for palm wine (1) or in flower (2).

palm-wine. The extraction of palm-wine is made just before the appearance of the inflorescences (Fig. 6B). One first notes the high mortality of juvenile stages and there is a flow back of the structure of the number of clumps with several young stems surrounding some erect stems. The proportion of flowering trees and others that have been tapped (potentially flowering) indicates that trunks do not have an equal height under different ecological conditions. For example those that grow in lagoon borders have a short height (3–4 m); in cultivation they can reach 8 to 9 m tall.

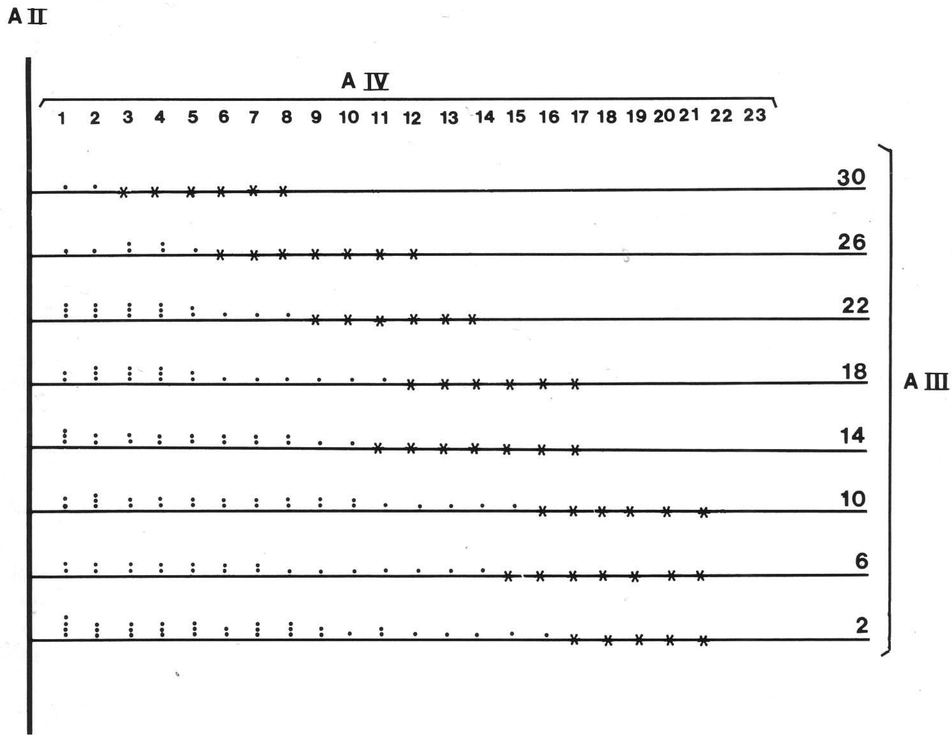
The imminent production of inflorescences is indicated by the presence of short leaves held sub-vertically. Each of these leaves subtends an inflorescence. At this time, palm wine is collected by tapping the meristem of the trunk. If not tapped, the trunk develops inflorescences (two in 6.45%; three, 67.74%; four, 20.27%; five, 1.61% of flowering trunks analyzed).

The second order of branching of the inflorescence bears male and female flowers. The first measure 8.5 to 9 mm, and contain 16 or more (15 to 24, Russell 1968) functional stamens. The second measure 15 to 20 mm and scarcely open at anthesis, but the stigmas project beyond the corolla. Three ovules are present but usually only one of them is fertilized. Female flowers are more numerous towards the base of the inflorescence and they are always situated in the proximal region of the rachillae, the male being confined to the distal area. Fig. 7 represents one orthostichy of the flowering axis, A IV (ramification of A III, borne by A II, the inflorescence axis), with the number of female flowers (number of points); all male flowers are indicated by a cross.

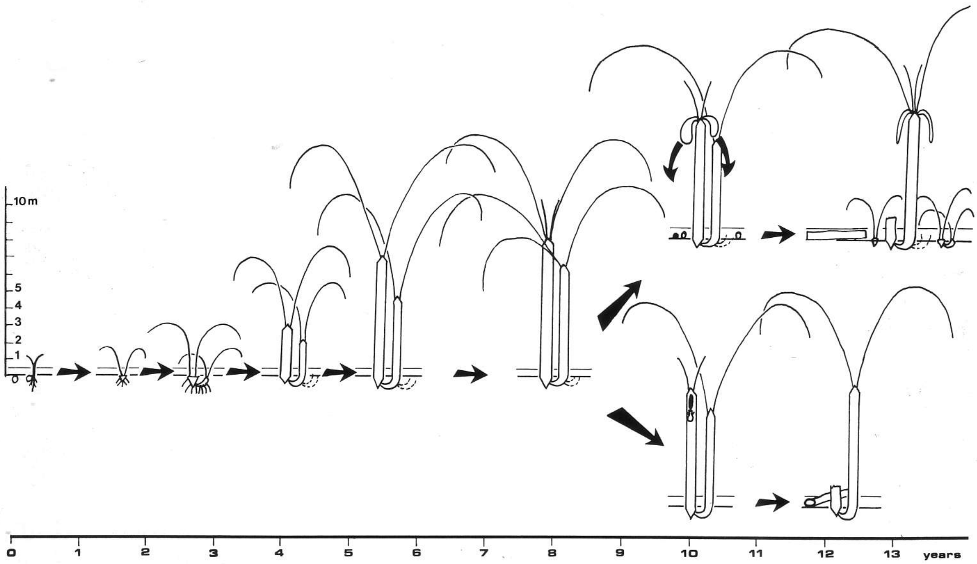
The fruits are covered in 12 vertical rows of scales and take long to mature. Dispersal by animals or by simple falling and rolling begins one year after flowering and ends with the collapse of the inflorescence two years later. Under the scales, the mesocarp is rich in edible oil and is eaten by striped ground squirrels (*Xerus erythropus*), bats, and birds. The ruminate endosperm is also very rich in oil.

A senescent phase occurs 3 or 4 years after the falling of the fruit. The trunk then dies completely and falls into the swamp, soon to be covered by lianas.

Sketches in Fig. 8 give a resumé of the life of a plant of *Raphia hookeri*; although the first axis eventually dies, other axes of the clump continue to grow in the swamp.



7. Proportion of staminate and pistillate flowers along one orthostichy of the rachilla.



8. The life cycle of *Raphia hookeri*, showing its fate when tapped (lower part of diagram) or allowed to flower (upper part of diagram).

Acknowledgments

I wish to thank Professor F. Hallé, Montpellier (France) for his continual encouragement during this survey; my thanks also go to S. de Souza, Benin National University, for her help in the field.

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Palms are Preferred Hosts for Baya Weaverbird Colonies

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The baya weaverbird (*Ploceus philippinus* Linn.), noted for its complex, retort-shaped, dangling nest woven from strips of palm leaves and grass blades, is familiar throughout India. It is also widespread in Bangladesh, Burma, Bhutan, Nepal, Pakistan, Sikkim, Sri Lanka, Thailand, Malaysia and Indonesia. Three other species, *P. manyar* (Less.), *P. megarhynchus* (Hume) and *P. benghalensis* (Linn.) are distributed in Asia, but the majority of weaverbirds are native to Africa.

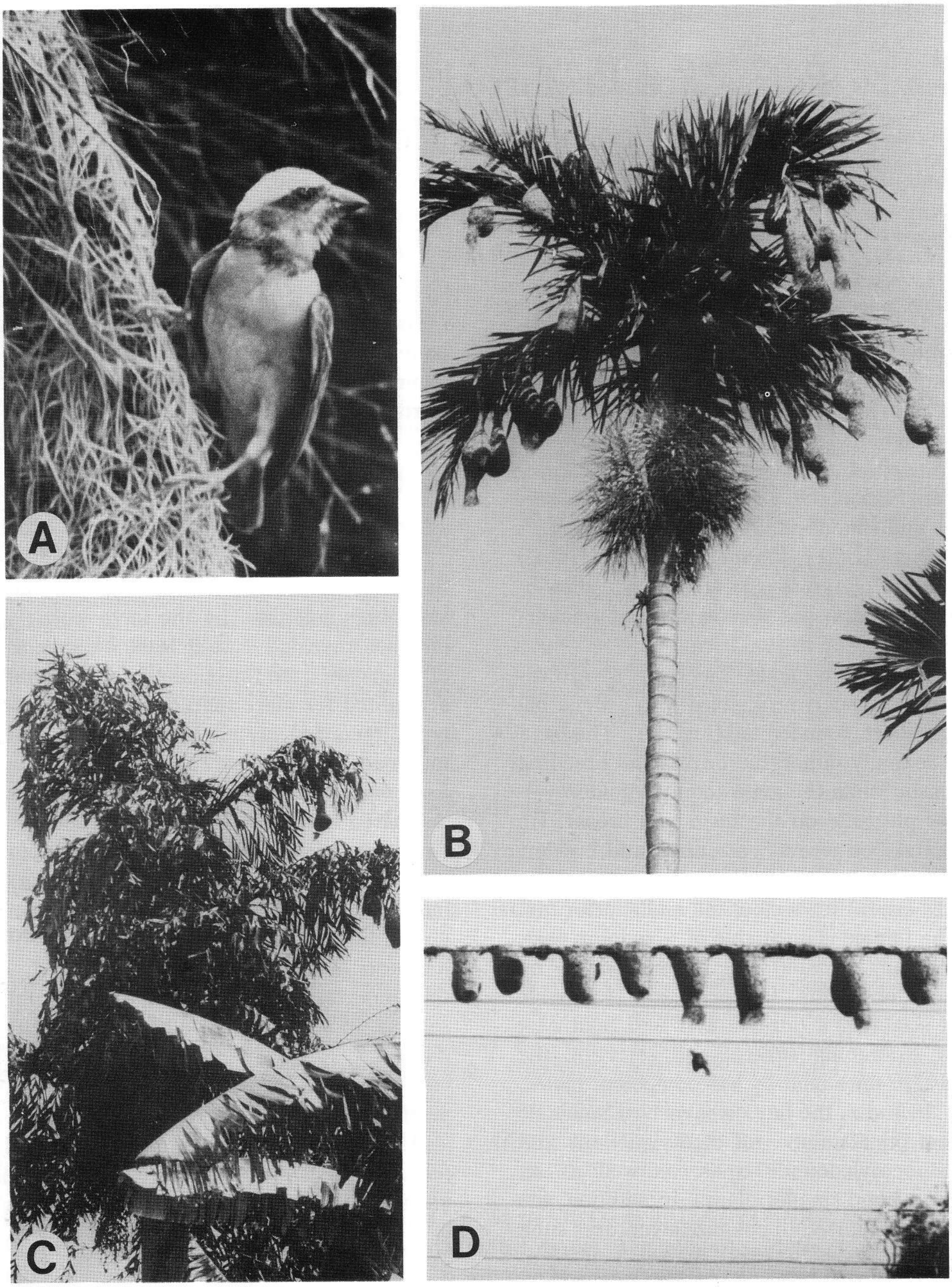
The adult male baya is a brown-streaked, sparrowlike bird with a thick bill and short, rounded tail (Fig. 1A). The baya is sexually dimorphic during the breeding season when the male acquires golden-yellow plumage on the head and breast. He is a skilled weaver, architect and builder. The female baya is similar to a hen sparrow except for a stout bill and shorter tail. The female is incapable of weaving a nest, contrary to what has been reported by some observers. However, she is capable of selecting a durable and well built nest by examining several and rejecting the weaker ones built by less competent males.

In India, the baya weaverbird builds its nest on a number of dicotyledonous and monocotyledonous trees, as well as on shrubs and smaller plants. In addition, the bird is reported to colonize structures such as the eaves of rural houses and compound walls (Jerdon 1863, Davis 1971a), the sides of irrigation wells (Ali 1931, Crook 1960, 1963), telegraph lines (Ambedkar 1964, 1970), and power lines (Davis 1971b). Among the sites where nests were observed, palms were the most common trees for colonies, especially in peninsular India and extending north-eastward to Assam.

Importance of Palms for the Baya Weaverbird

A survey covering most of the Indian States to determine the host plants and structures colonized by the baya weaverbird has revealed that at least 11 species of palms are used for building nests. These accounted for more than one-half the colonies recorded on all trees, bushes and manmade structures (Table 1). The data from one state or region cannot be directly compared with those from another because I may not have covered the same amount of area in each. Nevertheless, the survey has brought out clearly how in different states different trees are preferred for siting nests. The map of India (Fig. 2) shows the important nesting palms in different regions. In areas where palms do not occur naturally, especially in the northwestern part of India, *Acacia* spp. are the main nesting trees for the baya.

The tall swaying trunk of *Cocos nucifera,* the smooth slippery trunk of the introduced *Roystonea regia* and the stems of *Phoenix sylvestris* and *Borassus flabellifer* with their thorny leaf-bases and spiny protuberances help protect the nests. The fact that the last two palms may be in standing water for a considerable length of time each year adds to their attractiveness for establishing baya colonies. The



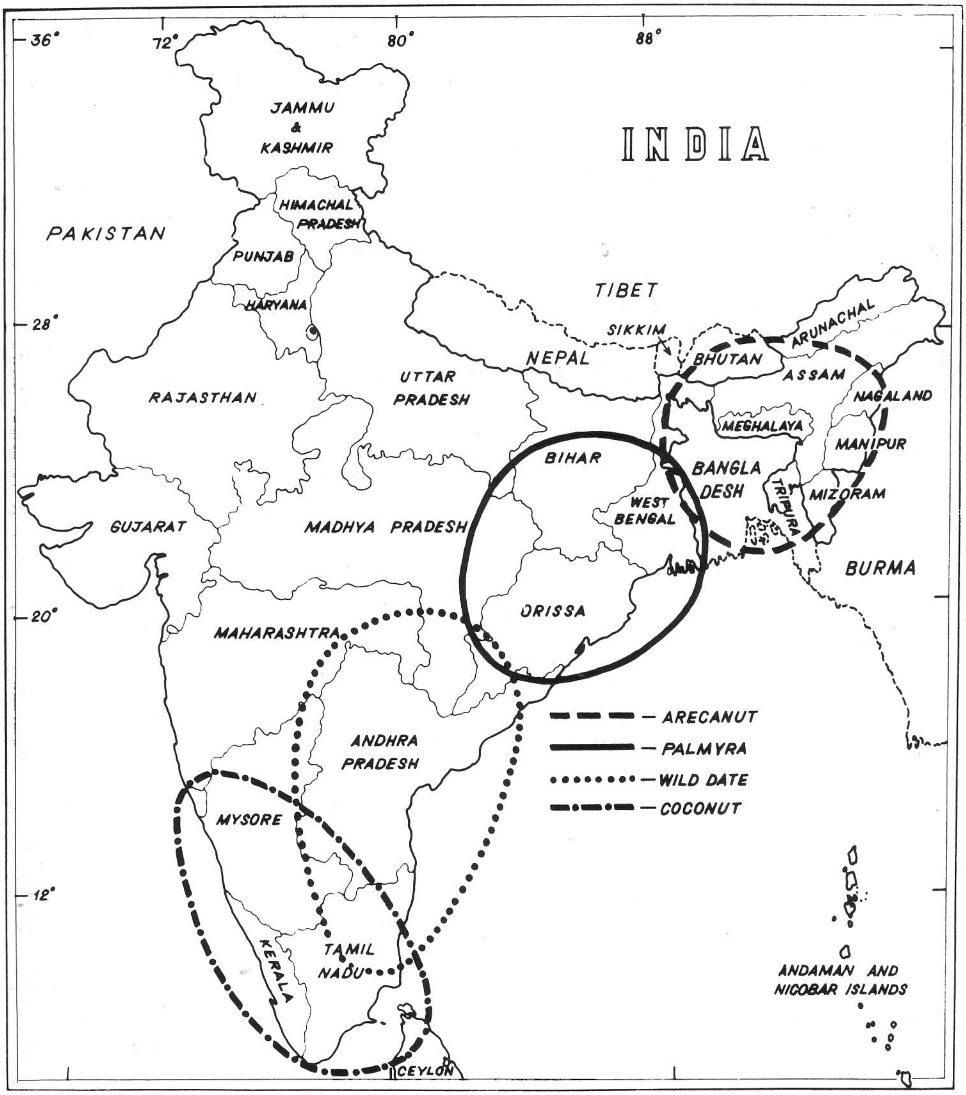
1. A, Male baya weaverbird in breeding plumage, perched on a partially built nest, awaits a female searching for a mate; B, A relatively short *areca* palm near Gauhati (Assam) with more than 25 baya nests attached to the leaves; C, *Caryota urens* with six nests in a forest area of Assam; D, Baya nests having no suspension and with short entrance tubes, attached to a telegraph line in Assam. Nests are built close to each other and connected by wads of fiber.

Table 1. Baya weaverbird colonies on palms and other trees/structures in different regions of India.[1]

Palms and Other Nesting Plants and Structures	Assam Region	Andhra Pradesh	Bihar State	Gujarat State	Haryana & Delhi	Jammu & Kashmir	Kerala & Karnataka	Madhya Pradesh	Maharashtra	Orissa State	Punjab State	Rajasthan	Tamil Nadu	Uttar Pradesh	West Bengal	Total
1. *Phoenix sylvestris*																
2. *Borassus flabellifer*	3	242	7	—	29	1	—	20	5	9	2	—	16	33	—	367
3. *Areca catechu*	—	32	16	—	—	—	17	—	4	15	—	—	21	12	64	181
4. *Cocos nucifera*	119	—	—	—	—	—	—	—	—	—	—	—	—	—	—	119
5. *Phoenix farinifera*	8	3	—	—	—	—	64	—	—	3	—	—	28	—	3	109
6. *Roystonea regia*	—	3	—	—	—	—	—	—	—	—	—	—	—	—	—	3
7. *Caryota urens*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3
8. *Hyphaene dichotoma*	2	—	—	—	—	—	—	—	—	—	—	—	—	—	3	3
9. *Phoenix dactylifera*	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	2
10. *Arenga pinnata*	—	—	—	—	1	—	—	—	—	—	—	—	—	1	—	2
11. *Livistona chinensis*	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
12. Other trees and	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	1
structures	37	119	10	43	66	19	17	46	20	4	53	54	25	209	11	733
Total	170	399	33	45	96	20	98	66	29	31	56	54	90	255	81	1,523

N.B. In Rajasthan no palm could be seen bearing baya nests.

[1] Includes North Bengal, Assam, Meghalaya, Nagaland, Manipur, Tripura, Mizoram and Arunachala.



2. Map of India: in the south and east coastal regions of India, palms are the chief hosts for baya colonies. Important hosts are *Areca catechu*, *Borassus flabellifer*, *Cocos nucifera*, and *Phoenix sylvestris*.

massive well-spread fronds of *Cocos*, *Phoenix*, *Areca* and *Roystonea* also provide the essential nest-weaving material for building the dangling nests. Furthermore, because palms are evergreen they offer shelter for the birds and provide nest-weaving fiber throughout the year. By comparison, grasses are seasonal, especially cereal grains that constitute additional sources of nesting fiber in the northern and northwestern parts of India. However, sugarcane yields nesting fiber continuously for about 8 months during its vegetative phase.

In Assam, *Areca catechu* is the most common host tree. Table 1 shows that

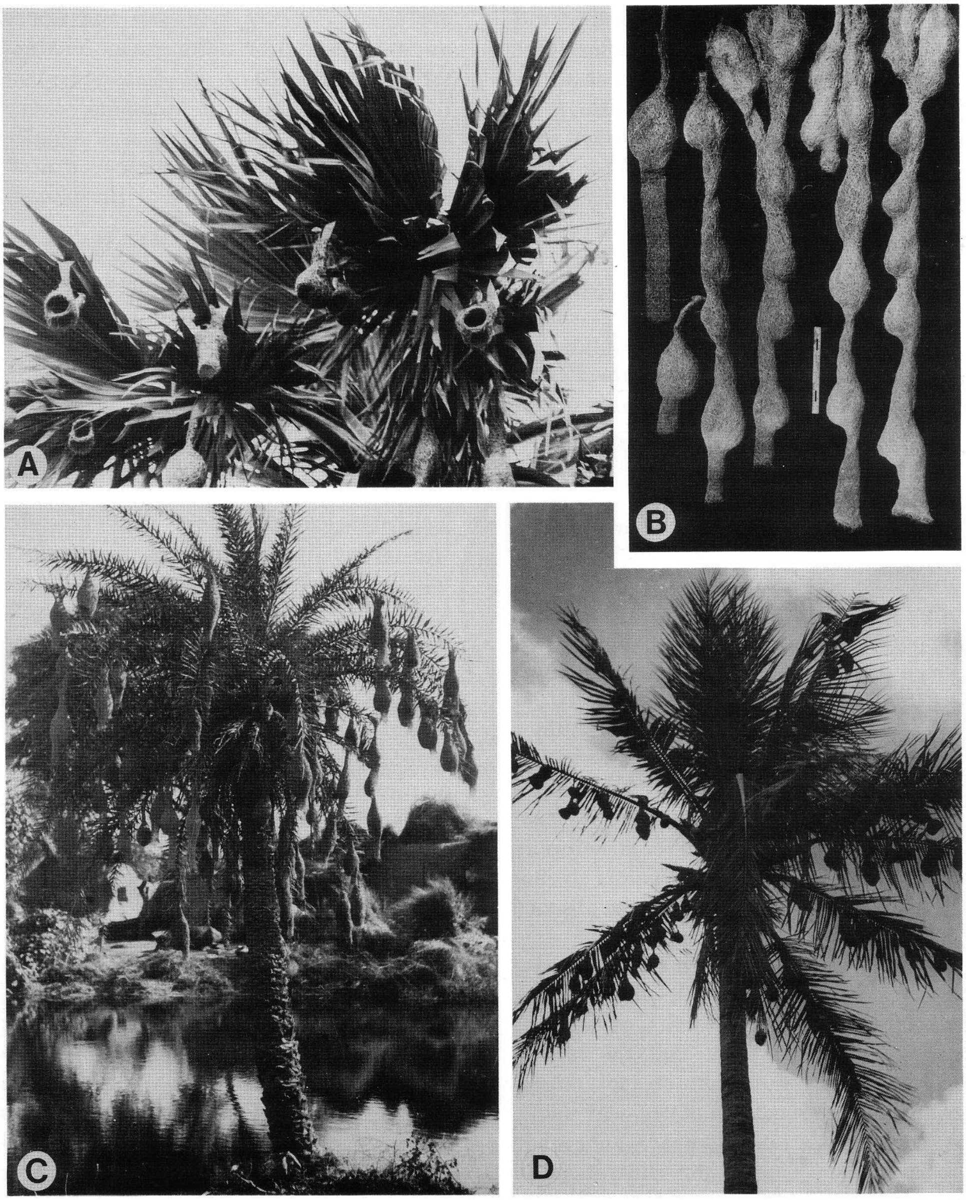
119 of the 170 colonies observed in the region were found on areca palms (Fig. 1B). This species does not appear to be ideal for attaching nests because it is unarmed and moreover its stem is not slippery due to the presence of prominent nodes. Hence predators can easily climb the short stem. Even though fiber-strips from areca leaves are liberally used for weaving nests, they are of poor quality. In fact, many bayas use strong coconut fiber for establishing the foundation for the nest (where coconut palms are present nearby) and weave the remainder of the nest from areca leaf fiber. The lack of physical barriers discouraging predators is compensated for by the fact that most areca palms grow near houses. Furthermore, the people offer the baya needed protection since they consider the bird to bring good luck. The Brahmaputra River supports groves of areca palms within which there are numerous hamlets; this creates an intimate association between baya colonies and rural houses. Another unique feature of Assam is that the greatest number of baya colonies on telegraph lines were observed there. Nests established on telegraph lines differ structurally from those built on areca palms by not having any suspension and by the absence of a long entrance tube (Fig. 1D).

Only in this region were *Caryota urens* (Fig. 1C) and *Arenga pinnata* found as hosts for the baya. The leaflets of *C. urens* are so hard and thick that the bird is unable to strip them into strands. Moreover, they are short and of irregular shape. A lone *Arenga pinnata* near Gauhati had 5 baya nests. One of the illustrations of *Arenga* sp. in Corner (1966) has an incomplete nest of the baya.

In Orissa, Bihar and the southern portion of West Bengal, *Borassus flabellifer* is the most popular host for baya nests (Fig. 3A). In these locations, about 66% of the colonies observed were on *Borassus*. It is difficult to understand why the bird prefers *Borassus* in areas where there are many *Phoenix sylvestris* and *Cocos nucifera* palms for nesting. One characteristic favoring *Borassus* seems to be that the distal portion of its segments is very strong and stiff and serves as a suitable substratum for the foundation of a nest. Another is that the petiole of *Borassus* is strongly armed.

In Andhra Pradesh, *Phoenix sylvestris* is the most important tree for siting baya colonies. Moreover, in all but four of the states or regions surveyed, baya colonies were observed on the wild date palm. In fact, about one-half of all colonies found on palms were on *Phoenix sylvestris* (Fig. 3C). Apparently, this species is very important because of its spininess. Sharp leaf-bases, leaflet spines on the petiole and the spine-tipped leaflets themselves together prevent even marauding monkeys from climbing the trees. The wild date palm can withstand flooding for long periods, and the baya favors trees surrounded by water which keeps away non-swimming predators such as snakes and rodents. *Phoenix sylvestris* also supplies a plentiful amount of nesting fiber, although it is very short in length. The baya prefers this very short fiber for filling up the dome of the nest. Where it is available, the bird uses long coconut fiber for the suspension of the nest and for the entrance tube. In order to increase the strength of nests woven with short fiber, the male baya applies cementing agents such as mud, cattle dung and even human feces at vantage points (Davis 1972). An overwhelming majority of colonies established on palms in Andhra Pradesh were on the wild date palm, although the most common palm of the state is *Borassus*, followed by the coconut palm.

In Kerala, and in parts of Tamil Nadu and Karnataka, the coconut palm is more frequently used by the baya than any other tree for building colonies. Usually tall coconut palms are selected for nesting (Fig. 3D). One characteristic of nests built on the coconut is that they have a very long



3. A, Young colony on *Borassus* in rural east Benghal. Many incomplete nests, each having two openings, can also be seen in the photograph. B, Normal and multi-storied nests of baya weaverbird, lower left, a normal nest, upper left, nest having a long entrance tube. The multi-storied nest at the extreme right had at least nine females during one season. C, Several baya nests on *Phoenix sylvestris* growing in a pond. The leaves are partially defoliated for weaving nests. D, Early stage of large colony of baya on a coconut palm.

entrance tube (Fig. 3B), which keeps tree snakes from entering the nest and eating the eggs or young. Coconut leaf fiber is the strongest and longest available in India for the baya, and it gives strength and elegance to nests made with it.

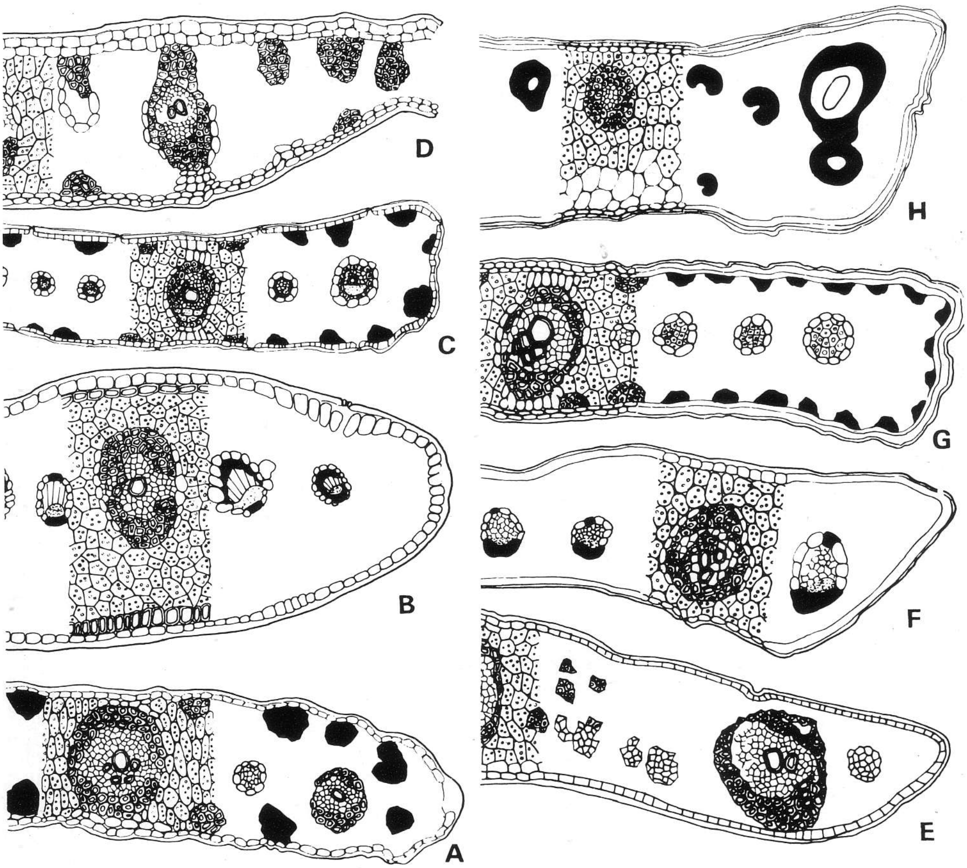
The remaining species of palms selected for siting colonies by baya birds in India are *Phoenix farinifera* (Mathew 1972), *P. dactylifera*, *Livistona chinensis*, *Roystonea regia* and *Hyphaene dichotoma*. Apparently the leaves of *P. dactylifera* and *H. dichotoma* are too hard for the bird to extract fiber strips. The numerous nests of a baya colony on a *P. dactylifera* growing in Uttar Pradesh were woven entirely from grass blades. The only other colony observed on this species was on a tree growing in the campus garden of Delhi University. A group of closely-spaced *Livistona chinensis* near Chandigard (Punjab) carried a baya colony. Two colonies were observed on wild *Hyphaene dichotoma* palms growing in the Kutch region of Gujarat state.

Discussion

The typical roofed or domed nest of weaverbirds, and many other families of tropical birds with altricial young, affords protection against high predation, excessive rainfall and intense solar radiation (Collias and Collias 1963). Among weaverbirds, the dangling nest of the baya provides more efficient protection against predators than do the ball or cup nests of other birds which are fixed on more immobile branches or reeds. Since most baya nests have a narrow suspension they can be attached conveniently to the tip of a palm leaflet, beyond the reach of nearly all predators. The palm crown is such that leaves develop from the crowded heart portion and radiate in all directions. The tip of one leaf hardly touches another. Taking advantage of this unique arrangement, the baya usually builds its nest at the tips of the distal leaflets. When a male baya carrying fiber, or a female with feed for the young, approaches the colony, the nest is entered directly without alighting first on a leaf or branch. This is facilitated when nests are built at the tip of a palm leaf. By contrast, baya nests with fairly long entrance tubes built on *Acacia* trees often become choked with thorns from adjoining shoots of the host plant so that entry into the nest is very difficult or impossible.

The male baya is capable of changing the nest structure to suit differing ecological niches and thereby safeguarding the survival of the nestlings. The absence of suspension and a long entrance tube in nests attached to telegraph or power lines is striking evidence (Fig. 1D). In parts of Assam, during the same breeding season, the same male baya builds one type of nest on telegraph lines and a very different one on nearby palms, thus making the best of both situations. A long entrance tube is woven under circumstances where the tree snake is a potential predator. This fine sleeve can be woven only with long, strong fiber such as that provided by the coconut leaf. Thus, palm fiber directly helps reduce predation in baya colonies. When only short fiber is available, as in the wild date, the bird resorts to the use of cementing materials to fortify the nest.

The structure of leaflets of *Borassus flabellifer*, *Phoenix dactylifera*, *Caryota urens* and *Livistona chinensis* is shown in Figure 4. The male baya is unable to tear these leaflets into strands because the many sclerenchymatous strands make them too thick and hard. Nevertheless, these same palm species are used as safe sites for establishing colonies. Among palms, the quality of the leaf fiber varies. For example, the fiber from *Roystonea regia* and *Areca catechu* is clearly inferior to that derived from *Cocos nucifera* and *Phoenix sylvestris* (Fig. 4). The amount of time required to extract and



4. Camera-lucida drawings of transverse sections of leaflet tips of A, *Livistona chinensis*; B, *Caryota urens*; C, *Phoenix dactylifera*; D, *Borassus flabellifer*; E, *Phoenix sylvestris*; F, *Cocos nucifera*; G, *Areca catechu*; H, *Roystonea regia*.

weave long fiber is greater than to tear and weave short fiber (Davis 1974). Hence, males incorporate the lengthier, stronger coconut leaf fiber into making the suspension and entrance tube portions of the nest and fill the dome with the short fiber of the wild date palm. Such strong nests permit the attachment of one nest below another (Fig. 3B); these multi-storied nests have been reported by Ambedkar (1980) and Davis (1982).

Although the female baya is incapable of weaving, she makes a major contribution by selecting the most durable and well-constructed nest. This selection is vital to the survival of the young because the male departs as soon as the female starts to brood her eggs, and she is not capable of repairing a damaged nest. Palms are preferred nesting trees because they provide the baya with many of the requirements necessary for successfully rearing chicks.

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NOMINATIONS AND ELECTIONS

The Charter of the Society provides that:

ARTICLE IV, Sec. 1—. . . the new Board of Directors shall appoint a three-member Nominating Committee, including at least one Board Member, . . . and announce their names to the general membership. Members may send names to the Nominating Committee for consideration as candidates for the next election.

Sec. 2—The slate of candidates prepared by the Nominating Committee shall be made known to the membership in time to permit the nomination of additional candidates to appear on the final ballot. Such additional nominations must be made in writing to the Secretary of the Society by a member in good standing. It must be accompanied by the written consent of the proposed candidate to serve if elected, and must be seconded, in writing, by another member. If the above conditions are met, the Secretary shall forward the candidate's name to the Nominating Committee for inclusion on the final ballot.

Sec. 3—Voting shall be by mail only. Ballots shall be mailed in time for the results to be announced at the Biennial Meeting.

The appointed members of the Nominating Committee are: Jim Cain, Texas, Garrin Fullington, California, and Teddie Buhler, Florida, Chairman. The Secretary of the Society is Jim Mintkin, California.

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Going Palmy in Ohio

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People seem to have a penchant for toting their horticultural history with them. Thus it comes as no surprise to hear of Hawaiian gardens consisting exclusively of junipers, and of South Floridians doing their darnedest to establish maple groves. But 36 species of palms planted permanently in the ground in Ohio? Surely you jest! After all, southwestern Ohio is in an area of the United States where winter extremes are likely to level out somewhere between 0° F and −10° F. Just who would be crazy enough even to consider such a scheme?

I would. I was born in the then Belgian Congo, at a remote river-boat stop almost exactly 5 degrees south of the equator. When I was two years old we moved fifty miles due west to a plateau with an elevation of 2,000 ft. This place had, in my opinion, the perfect climate. In the fourteen years that I lived there the lowest temperature we ever recorded was 55° F, and the highest 90° F. Although there were not many species of indigenous palms in the area, the native *Elaeis guineensis* grew by the millions in nearby oil plantations. Even our Christmas tree was a "palm"—a wooden pole with the fronds of an Oil Palm cut to size and inserted into holes.

No wonder then that my first winter in the Midwest region of the United States was an absolute shocker. Nothing could have prepared me for the sight of the entire landscape shutting down, so to speak, for a third of the year. This part of the country receives only sporadic snow, so that the predominant winter colors are, by and large, brown and gray. Every time I looked out of the window that first winter and saw the leafless trees silhouetted against a cold-burnt horizon, I was sure that never in my past experiences had I ever seen nature present herself quite so uglily. Even the man-caused devastation of a savannah fire could not compete in desolation, for there, after a few weeks, not months, the green springs up more vigorous than before. One day, as I stood at the window watching the frozen drabness get even more so, I resolved that, since I could not move back to the tropics, I would do what I could to move the tropics to me.

So, I did what I could. Of course I couldn't import warm weather fronts, or alter the path of the jet stream, but I could, I had a hunch, find some plants that reminded me of home and that might possibly survive the winter outside. The search for these plants, particularly palms, was a long and disorganized process. I didn't even have an inkling at the time that there was a Palm Society, and it was quite by chance that I stumbled across two *Trachycarpus fortunei* growing in Victoria, British Columbia. When I enthusiastically shared my discovery with a fellow tourist, ironically a Canadian, I was assured (somewhat erroneously) that the palms were taken indoors for the winter. It wasn't until a decade after my quest had begun, that a nurseryman in Texas reluctantly confided that the Windmill Palm could tolerate perhaps a few degrees of frost. In retrospect, my quest then had only just begun.

A *Trachycarpus fortunei* is not, of course, an *Elaeis guineensis*, but it is a tough little critter. Needless to say, we (by this time I had acquired a non-palmy husband) bought a small specimen and rushed it a thousand miles back home, as if it were a rare and extremely valuable discovery, which of course it was. That was in May. In September of that same year we sold our house and moved to an apartment. Of course the palm came with us, and thanks to an understanding landlord, was planted in the open behind our ground-floor patio.

Neophytes that we were, that first winter we protected the experimental *Trachycarpus* with a plastic-covered wood frame heated by a single 100 watt light bulb. The palm was less than 3 ft. high, as was the shelter, and we figured that the heat produced by the light would add sufficient heat to keep our poor victim alive. The plan was to switch the light on when the outside air temperature hit 25° F. We picked this figure arbitrarily, but as it turned out, the addition of extra heat at that point was indeed enough to keep the inside shelter temperature approximately 6° F higher than the outside air.

As fate would have it, that first winter proved to be the snowiest, and one of the coldest, on record. The snow was actually beneficial, as it served to seal the shelter to the ground, as well as provide overhead insulation. But despite the snowcover and light bulb, the inside temperature finally fell to −2° F, at which point the hapless palm was 50% defoliated. But it was also 50% undamaged, and so in our eyes (mine, at least) the experiment had been a resounding success.

The next logical step seemed to be experimenting with the palm out in the open—no light bulb, no shelter, nothing but the mercy of Mother Nature. I must add here that this by now somewhat confused palm had been moved again, and now found itself situated against the south side of a brick house, some 30 miles south of its previous location, and in a much more urban, and consequently warmer, area. This was fortunate, because nature was temperamental that year, and what was basically a mild winter was, alas, punctuated by a reading of −10° F in late January. However, to our delighted astonishment (mine, at least) this determined little *Trachycarpus* showed about only 25% damage, and with the advent of spring began growing like a weed. It was my inexperienced opinion, and still is, that the early morning sun in the southern location minimized the length of time the leaves were exposed to subzero temperatures, and since the roots were heavily enough mulched to prevent freezing, transpiration was not a real problem.

Well, as every true palmateer already knows, collecting palms can fast become a full-blown addiction, and it wasn't long before I *had* to try out another species. At this point I was still ignorant of The Palm Society, so, my next inspiration was drawn from a trip I had once taken to Florida. On that trip the first palms I had spotted on my way south were *Butia capitata.* With the aid of a generous husband (he bought the palm while on a business trip and carried it back on the plane) I was able to obtain a 5 gallon sized specimen and promptly planted it out in the worst location possible. I must actually blame the *Butia* for this poor choice of planting sites. It was just so beautiful I had to show it off to the world, and the world, unfortunately, promenaded by on the west side of the house. In our area, this is the direction whence come the howling winter winds. Unfortunately, as the palm literature well knows, *Butia capitata* cannot withstand temperatures below zero. Fortunately, however, this particular *B. capitata* could not read, and with the aid of a plastic-covered wood frame withstood an ensuing temperature of −21° F. I must admit that by spring the poor thing resembled a giant spider more than it did a palm, but nonetheless it lived. This is far more than I could have done under similar circumstances.

1. This *Butia capitata* survived −21° F unscathed in the coziness of a lean-to shelter.

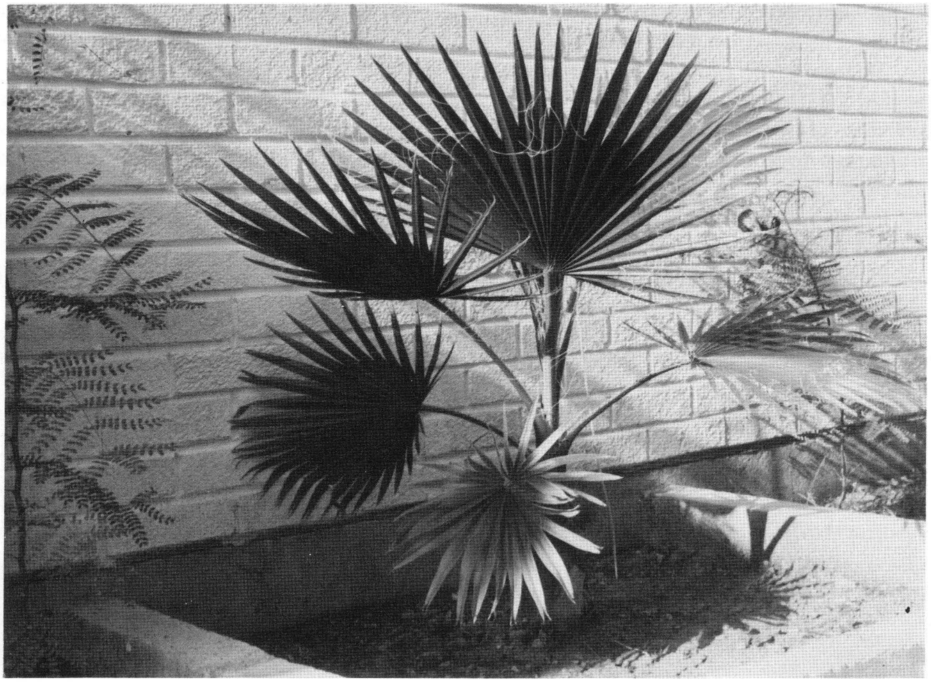
2. Although totally defoliated, with the center spear pulling loose, this *Chamaerops humilis* has made a complete recovery.

Then I discovered that I was not the only palm nut in the world and much too late, in my opinion, joined The International Palm Society. All at once big words like *Rhapidophyllum hystrix* were tripping over my tongue and much too late, in his opinion, my husband made a futile lunge for my pocketbook. *Much* too late. Palm fever had already struck, and being highly contagious, the disease rapidly enveloped him as well.

A mere seven years after that initial purchase in Texas finds us with 36 species of palms, ranging in height from 2 inches to 12 feet, and all planted permanently in the less than hospitable Ohio soil. How do we do it? Are we wizards? Of course we use a variety of gimmicks and techniques, ranging from simple piles of mulch for the hardiest species, to a portion of the backyard that is open in the summer and converted to "housedom" in the winter for species that don't even like to shiver. Now, in all honesty, our property resembles more the Belgian Congo of my memory than it does my neighbor's yard just feet away.

Do we ever incur losses? This past winter, the winter of 1983–84, we tied our all-time record low at this locality with a frond-numbing −21° F! Even a good deal of our palms that couldn't read succumbed to that. Are we discouraged? In no way! In spite of our heavy losses, we also experienced many successes, including some rather miraculous recoveries. Following are just three of many examples.

The *Butia* in Figure 1 survived unscathed in a shelter constructed out of old storm doors, 2 × 4's and the ubiquitous plastic. This shelter abutted the house at a junction with a window, and when the worst of the weather hit we simply opened the house window a crack. A piece of cake! The *Chamaerops humilis* in Figure 2 was slightly less fortunate. It shared the shel-



3. This *Washingtonia sp.* survived −21° F under an unheated plastic cover. The trunk had to be amputated half way down, but after just one growing season the palm has more than recovered its former size.

ter with the *Butia*, but it had the misfortune of being planted at the end of a "wing" of the shelter that extended around the side of the house—well away from any heat giving window. Hit by the cold while in active growth, this palm became defoliated and its emerging spear rotted back several inches. However, following a liberal dousing with fungicide and several months of hot weather, the palm has recovered and now sports a new crown of over a dozen leaves. The *Washingtonia* without a last name in Figure 3 survived −21° F in a totally unheated shelter! To be sure, the palm was defoliated, and in fact, the top half of the trunk turned to mush and had to be amputated. But now, with two months of the growing season still remaining, the palm has regained its trunk height, and more.

Well, does the above information intrigue you? Does it make you want to rush out and plant a palm in your now palmless plot? Have you long been green as a palm with envy while reading of other people's palm experiences in *Principes*? Have you always just assumed that a palm couldn't grow in your very own yard, and that you had to content yourself with a life of palm-voyeurism?

Well, fret no more! I am pleased to announce the official establishment of The Temperate Zone Chapter of The International Palm Society, Inc. We now have 120 members in 3 countries, and publish a quarterly journal devoted specifically to the issue of raising palms in frigid lands. As editor of this publication, and erstwhile leader of this enthusiastic flock, I will be more than happy to mail a free copy of *The Palm Quarterly* to anyone who requests one (persons living outside the U.S., Canada and Mexico please include $1 for postage). Our newly formed Chapter welcomes everyone interested in growing palms in less than balmy climes, and who, for whatever reasons of their own, feel that this special interest group is just their cup of tea. Membership, which is tantamount to subscribing to *The Palm Quarterly*, is a mere $3 a year for persons living in the U.S., Mexico and Canada, and $5 for subscribers in other areas. This fee just covers costs for North Americans, and does not quite cover postal rates to other places.

My hope is that palmateers everywhere who have up until now been only vicarious participants on the palm scene, will take heart and do as much experimenting as their means allow. Sure, there will be bad winters and losses from time to time, but in my opinion there is nothing quite as satisfying as seeing a palm tree growing out in your own yard—especially if it is not supposed to be able to grow there in the first place. Happy planting!

The coast of northeastern Brazil has considerable numbers of coconut palms as well as active sand dunes. At Jenipabu Beach, some 8 km north of Natal, Rio Grande do Norte, there are both, but a sand dune has gained the upper hand. Beneath the dune in the photograph is a row of beach dwellings; the partially-buried coconut palms were formerly yard trees. According to the owner of the only remaining house, in the background, the dune has been slowly migrating to its present position over the last forty years. Eventually the coconut palms will be killed by the sand; in fact, most of those pictured are no longer producing mature fruits.

DENNIS JOHNSON

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A Reconsideration of Gronophyllum and Nengella (Arecoideae)

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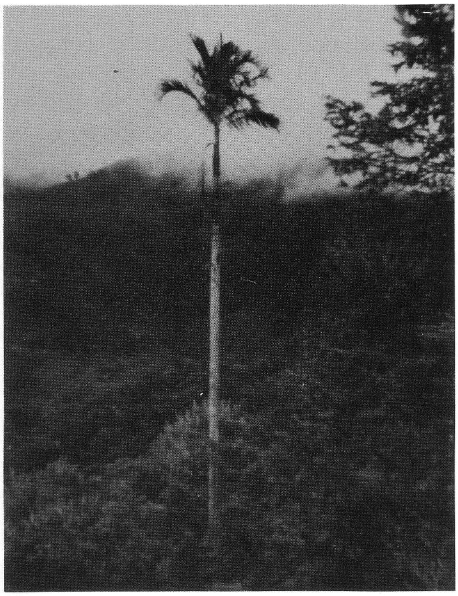
Gronophyllum and *Nengella* have long been recognized as two closely related genera and are included in the *Areca* alliance of Moore (1973). With *Gulubia* and *Hydriastele*, they form a natural subunit within the alliance, an affinity recently reconfirmed by a study of their fruit anatomy (Essig and Young 1979). The *Gronophyllum* subunit, as it might be called, is characterized by the following: leaflets notched or praemorse, often irregularly grouped; inflorescence broomlike, with long, pendulous rachillae, the flowers mature when the inflorescence bracts open, staminate and pistillate anthesis being completed within a few days; flower triads arranged in verticels of three or more, commonly decussate, in four vertical rows; staminate flowers asymmetrical, with broadly lanceolate, loosely valvate petals; fruit with apical stigmatic residue, pericarp fibers straight and little branched, outer pericarp densely tanniniferous, raphides and brachysclereids lacking, vascular bundles with extensive fibrous sheaths, fibrous bundles intermixed with the vascular bundles and sometimes forming a separate series external to the tanniniferous layer, locular epidermis sometimes developed into a thick palisade layer; seed with homogeneous or ruminate endosperm.

Gronophyllum and *Nengella* are distinguished from *Gulubia* and *Hydriastele* on the basis of their protandrous rather than protogynous habit and consequent differences in the structure of the pistillate flowers. In the first two genera, staminate flowers are at anthesis soon after the bracts of the inflorescence open. By the second day, all staminate flowers have fallen and the pistillate flowers are at anthesis. Pistillate flowers have broadly lanceolate petals, imbricate at the base and loosely valvate in the upper part, so that they are closed over the stigmas before anthesis. In *Gulubia* and *Hydriastele*, the situation is reversed. Pistillate flowers are receptive at the time the bracts open, and the petals are too short to cover the stigmas. On the second day, stigmas are withered and staminate flowers shed their pollen. Apart from this fundamental difference, it is often difficult to separate specimens of *Gronophyllum* from specimens of *Gulubia*.

Both *Gronophyllum* and *Nengella* were formerly divided into two genera each, based on the condition of the endosperm, *Gronophyllum* with ruminate endosperm, and *Kentia* with homogeneous endosperm, and similarly, *Nengella* with homogeneous endosperm and *Leptophoenix* with ruminate endosperm. In both instances, the differences were eventually regarded as too trivial to warrant a generic distinction, by Burret (1936) for *Nengella* and by Moore (1963) for *Gronophyllum*.

A perusal of the literature, however, leaves one in the dark as to exactly what the distinction between *Nengella* and *Gronophyllum* is. In Papua New Guinea, where both authors became familiar with the two genera, *Gronophyllum* is most commonly encountered as the robust *G. chaunostachys*, which grows at high ele-



1. *Gronophyllum chaunostachys* growing at about 6,000 ft. elevation in the mountains around Aseki, Morobe Province, Papua New Guinea. (Reprinted from Principes 24(1): 20. 1980.)

2. *Gronophyllum pinangoides*, growing at the Botanic Gardens, Lae, Papua New Guinea. (Reprinted from Principes 24(1): 19. 1980.)

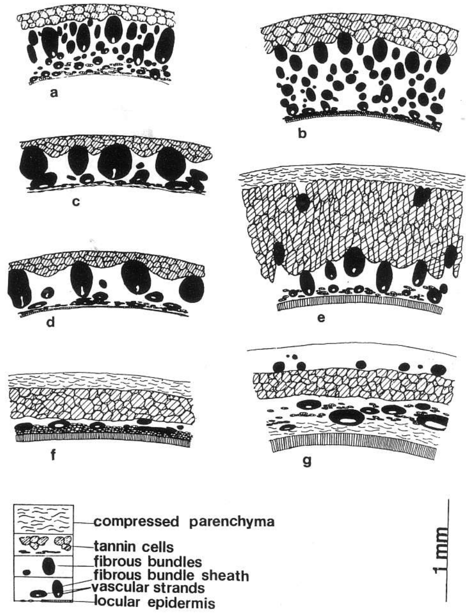
vations and lifts its crown above the cloud forest (Fig. 1). It has stems ca. 30 cm in diameter, inflorescences ca. 1 m long, and leaves with many narrow, regularly arranged pinnae. *Nengella*, on the other hand, is found as one of several species of diminutive, often clustering palms, with stems 2–3 cm in diameter, with small inflorescences consisting of only a few rachillae, and with pinnae broadly cuneate and irregularly arranged along the leaf rachis (Fig. 2). This perception of the two genera, arising from the most frequently visited part of their common range, apparently influenced the separation of the two genera, for overall size differences seem to be the only distinguishing criteria that can be inferred from the literature.

There was also a geographical bias involved in originally considering these to be separate genera. *Gronophyllum* was initially a Moluccan genus, the large New Guinea palms were *Kentia*, and the dwarf New Guinea palms were *Nengella/Leptophoenix*. Neither Burret nor Moore fully recognized at the time of their respective publications that the Moluccan species of *Gronophyllum* effectively bridged the gaps between all four genera. Moore (pers. comm.) suspected this in later years, and in fact had intentions of combining *Nengella* and *Gronophyllum*. In reassessing these taxa for "Genera Palmarum," John Dransfield also realized that they could not be maintained as distinct and, sharing his findings with us, encouraged us to make the formal combination.

An examination of herbarium specimens from throughout the ranges of the two genera, including important material of the Moluccan species at Kew, confirms that the two genera, apparently distinct in the easternmost part of their joint range, represent the extremes of a continuum of variation with respect to overall size, as well as to pinnae shape and arrangement. A few examples of intermediates will suffice. *Gronophyllum microspadix* from Sulawesi in eastern Indonesia, is a diminutive palm, reaching 3 m in height, with a stem diameter of 5 cm, and with clustered, erose-tipped pinnae. Its inflorescence consists of 3 simple rachillae, scarcely 15 cm long. It is not clear to us why it was put into *Gronophyllum* rather than *Nengella* in the first place. The only reason apparently was the geographical bias mentioned earlier.

Gronophyllum apricum, a new species from north-central New Guinea (Young, accompanying article), is a diminutive, single-stemmed palm, with stem ca. 3 cm in diameter, with narrow, clustered pinnae, and fruit anatomy similar to *G. chaunostachys* (see below). *G. brassii*, from south-central New Guinea, is tall, reportedly attaining 19 m, but with the trunk only 9 cm in diameter. It has irregularly arranged pinnae with praemorse tips and simply branched inflorescences. *G. microcarpum*, from the Moluccas, is somewhat larger, growing to 10 m tall, but with inflorescences considerably smaller than those of *G. chaunostachys*, with pinnae clustered only at mid-rachis, and fruit anatomy similar to that of *G. chaunostachys*, but lacking the palisade layer. *G. selebicum* is apparently of about the same dimensions as *G. apricum*, has clustering stems, clustered pinnae, and fruit anatomy that appears to be very similar to that of *Nengella pinangoides*.

Variation in the structure of the fruit has been found to be taxonomically important in several alliances of palms, including the *Areca* alliance (Essig 1977, Essig and Young 1979), so we examined a number of specimens of *Gronophyllum* to



3. Diagrams of pericarp in cross-section. Species with ruminate endosperm: a. *Gronophyllum pinangoides*; b. *Gronophyllum papuanum*. Species with homogeneous endosperm: c. *Gronophyllum pleurocarpum*; d. *Gronophyllum gracile*; e. *Gronophyllum apricum*; f. *Gronophyllum ramsayi*; g. *Gronophyllum chaunostachys*.

compare with the extensive survey of fruit structure in *Nengella* done by Young (1982, master's thesis, unpublished). There is some variation in the size and shape of the fibrovascular bundles, variation in the thickness of the palisade layer derived from the locular epidermis, and a tendency in some species to form a separate series of fibrous bundles external to the tanniniferous zone (Fig. 3). These characters do not correlate with other characters that might be used to separate the two genera, however. The outer series of bundles is found in both large (*P. chaunostachys*) and diminutive (*G. apricum*) species, and in species with homogeneous (*G. chaunostachys*) and ruminate (*G. microcarpum*) endosperm. Homogeneous endosperm and ruminate endosperm are both found in large palms of traditional

Gronophyllum and in diminutive species of the *Nengella* type.

For all of the above reasons, we deem it appropriate to combine the two genera under the older name of *Gronophyllum*, and make the necessary new combinations. We should emphasize that this is only a very preliminary report, based on a survey of the literature and examination of a limited number of specimens. In most instances type specimens were not available for examination (only those marked with an exclamation point in the list that follows were seen by us). A thorough revision of this genus is thus still needed.

This report also incorporates information from a Master's thesis by Brad Young (1982, unpublished), which included a detailed study of the species of *Nengella* occurring in Papua New Guinea. A number of species are placed in synonymy by him. In particular, the concept of *Nengella pinangoides* (now *Gronophyllum pinangoides*) has been considerably broadened, and is now viewed as a widespread and variable species.

Gronophyllum Scheffer in Ann. Jard. Bot. Buitenzorg 1: 135, 153. 1876. Type species: **G. microcarpum** Scheffer.

Kentia Blume in Bull. Sci. Phys. Nat. Néerlande 1: 64. 1838; Rumphia 1843 (non Adanson 1763). Type species: *Kentia procera* Blume.

Nengella Beccari in Malesia 1: 32, fig. 1. 1877. Type species: *Nengella montana* Beccari.

Leptophoenix Beccari in Ann. Jard. Bot. Buitenzorg 2: 82. 1885. Type species: *Leptophoenix pinangoides* (Beccari) Beccari.

As now constituted, *Gronophyllum* consists of about 25 species, distributed from Sulawesi and Seram in the Moluccas, throughout New Guinea and in northern Australia (Arnhem Land).

Key to the species of *Gronophyllum*

This key is based partially on the unpublished notes of H. E. Moore, Jr. Parts of it are based on extremely fragmentary information, and must therefore be considered strictly tentative.

1. Seed with ruminate endosperm.
  2. Rachillae with flower triads in alternating verticels of 3.
    3. Branches of the inflorescence all simple. South-central New Guinea. .... 2. *G. brassii*
    3. Branches, at least the lower ones, divided.
      4. Petals of pistillate flowers blunt and thickened at apex; pinnae with thickened marginal nerves. Seram, Indonesia. .... 12. *G. microcarpum*
      4. Petals of pistillate flowers acute and not thickened at apex; pinnae without thickened marginal nerves. Pulau Mangoeli, Indonesia. .... 15. *G. oxypetalum*
  2. Rachillae with flower triads usually decussately arranged.
    5. Inflorescences small, with fewer than 10 rachillae.
      6. Trunk single; pinnae narrow, linear, clustered along the rachis; rachillae about 10. Sulawesi. .... 13. *G. microspadix*
      6. Trunks multiple; pinnae cuneate, regularly arranged except for an interruption at ½ to ¾ the length of the rachis; rachillae 7 or fewer.
        7. Pinnae narrowly cuneate, nearly regularly arranged, with ramenta along the lower third of the midrib. South-central New Guinea. .... 9. *G. leonardii*
        7. Pinnae broadly cuneate, markedly interrupted in their distribution, without ramenta. Widespread in New Guinea. .... 16. *G. pinangoides*
    5. Inflorescences large, with many rachillae.
      8. Pinnae arranged in distinct clusters of 4–5; petioles covered with scurfy, dirty-brown scales. Southwestern New Guinea. .... 10. *G. luridum*
      8. Pinnae regularly or somewhat irregularly arranged; petioles variously scaly.

9. Rachillae slender, markedly flexuous apically; fruit 8 mm long with perianth, 4 mm in diameter, ovate above the perianth. Sulawesi. .... 7. *G. kjellbergii*
9. Rachillae thicker, not flexuous apically.
   10. Fruit elongate, ca. 10 mm long with perianth, 6 mm in diameter. Sulawesi. .... 21. *G. sarasinorum*
   10. Fruit globose, 6 mm in diameter. Sulawesi. .... 22. *G. selebicum*

1. Seed with homogeneous endosperm.
   11. Palms large, emergent, single-stemmed; trunk more than 10 cm in diameter.
      12. Rachillae markedly flexuous at internodes. Northeastern New Guinea. .... 8. *G. ledermannianum*
      12. Rachillae not flexuous.
         13. Sepals marginally ciliate. New Guinea, Arfak Mtns. .... 5. *G. gibbsianum*
         13. Sepals not ciliate.
            14. Tips of pistillate petals scarcely longer than the broad basal part.
               15. Fruit 10–12 mm long, 7 mm in diameter without perianth. North-central New Guinea (Torricelli and Cyclops Mtns.). .... 11. *G. mayrii*
               15. Fruit 15–18 mm long, 7–7.5 mm in diameter; pistillate flowers 10–14 mm long. Australia. .... 19. *G. ramsayi*
            14. Tips of pistillate petals exceeding the broad basal part in length; fruit 12–15 mm long.
               16. Staminate flowers with 9–12 stamens; flower triads 2–3 cm apart; fruit 15 mm long, 10 mm in diameter. Northeastern New Guinea. .... 3. *G. chaunostachys*
               16. Staminate flowers with 6 stamens; flower triads 4–7 mm apart; fruit 12–14 mm long, 6 mm in diameter. Southwestern New Guinea. .... 18. *G. procerum*
   11. Small palms, mostly of the forest undergrowth; stems less than 10 cm in diameter.
      17. Inflorescence with 4 or more rachillae; leaves with 15–23 pinnae per side; pinnae with numerous ramenta along the lower midrib; fruit spherical. Upper Sepik River Basin. .... 1. *G. apricum*
      17. Inflorescence with fewer than 4 rachillae; leaves with fewer than 10 pinnae; pinnae without (?) ramenta; fruit elongate.
         18. Inflorescence divided into 2 rachillae. Northeastern New Guinea. .... 17. *G. pleurocarpum*
         18. Inflorescence spicate.
            19. Fronds simply bifid. Northwestern New Guinea. .... 4. *G. flabellatum*
            19. Fronds divided into a number of pinnae.
               20. Pinnae linear, 8–9 on each side of the rachis. Northwestern New Guinea. .... 14. *G. montanum*
               20. Pinnae cuneate.
                  21. Pinnae about 6 on each side. Northeastern New Guinea. .... 20. *G. rhopalocarpum*
                  21. Pinnae 2–3 on each side. South-central New Guinea. .... 6. *G. gracile*

A listing of the species of *Gronophyllum*

1. **Gronophyllum apricum** Young in Principes 29(3) pp. 138–141. Type: *Essig & Young LAE 74082*, (holotype LAE!, isotypes BH!, USF!).
2. **Gronophyllum brassii** Burret in J. Arnold Arbor. 20: 205. 1939.

Type: New Guinea, Papua New Guinea, Western Province, Palmer River, *Brass 7093* (holotype A!).

3. **Gronophyllum chaunostachys** (Burret) H.E. Moore in Gentes Herb. 9: 264. 1963.
   Kentia chaunostachys Burret. Notizbl. Bot. Gart. Berlin-Dahlem 13: 328. 1936. Type: New Guinea, Papua New Guinea, Morobe Province, Sattelberg, *Clemens 526* (holotype B).
4. **Gronophyllum flabellatum** (Beccari) Essig & Young, **comb. nov.**
   Nengella flabellata Beccari, Malesia 1: 34, tab. 1. fig. 1–2. 1877. Type: New Guinea, West Irian, northwestern Vogelkop Peninsula, Ramoi, *Beccari P.P. 427* (holotype FI).
5. **Gronophyllum gibbsianum** (Beccari) H. E. Moore in Gentes Herb. 9: 265. 1963.
   Kentia gibbsiana Beccari in L.S. Gibbs, A contribution to the phytogeography and flora of the Arfak Mountains 91. 1917. Type: New Guinea, West Irian, Arfak Mtns., *L. S. Gibbs 5951* (holotype FI).
6. **Gronophyllum gracile** (Burret) Essig & Young, **comb. nov.**
   Nengella gracilis Burret in J. Arnold Arbor. 20: 207. 1939. Type: New Guinea, Papua New Guinea, Western Province, Palmer River, *Brass 7083* (holotype A!).
7. **Gronophyllum kjellbergii** Burret in Notizbl. Bot. Gart. Berlin-Dahlem 13: 203. 1936. Type: Indonesia, Sulawesi, Palahari, *Kjellberg 912* (holotype B).
8. **Gronophyllum ledermannianum** (Beccari) H. E. Moore in Gentes Herb. 9: 265. 1963.
   Kentia ledermanniana Beccari in Bot. Jahrb. 58: 442. 1923. Type: New Guinea, Papua New Guinea, East Sepik Province, Mt. Hunstein, *Ledermann 11229* (holotype B).
9. **Gronophyllum leonardii** Essig & Young **nom. nov.** [Note: a new name is necessary because the combination *Gronophyllum brassii* has already been published. The new epithet also honors Leonard Brass].
   Leptophoenix brassii Burret in Notizbl. Bot. Gart. Berlin-Dahlem 12: 339. 1935. Type: New Guinea, Papua New Guinea, Central Province, Kubuna, *Brass 5631* (holotype A!).
   Nengella brassii (Burret) Burret in Notizbl. Bot. Gart. Berlin-Dahlem 13: 316. 1936.
10. **Gronophyllum luridum** Beccari in Nova Guinea 7. Botanique. 207. 1909. Type: New Guinea, east-central West Irian, *G. M. Versteeg 1388* (holotype FI).
11. **Gronophyllum mayrii** (Burret) H. E. Moore in Gentes Herb. 9: 265. 1963.
    Kentia mayrii Burret, Notizbl. Bot. Gart. Berlin-Dahlem 11: 707. 1933. Type: New Guinea, northeastern West Irian, Cyclops Mtns., *Mayr 658* (holotype B).
12. **Gronophyllum microcarpum** Scheff. in Ann. Jard. Bot. Buitenzorg 1: 153. 1876. Type: Cultivated, Indonesia, Bogor Botanic Gardens, from seed collected by Teysmann in Seram (holotype BO).
13. **Gronophyllum microspadix** Burret in Notizbl. Bot. Gart. Berlin-Dahlem 12: 44. 1934. Type: Indonesia, Sulawesi, Linkobale, *Kjellberg 2232* (holotype B).
14. **Gronophyllum montanum** (Beccari) Essig & Young, **comb. nov.**
    Nengella montana Beccari, Malesia 1: 33, tab. 1, fig. 2–11. 1877. Type: New Guinea, West Irian, Arfak Mountains, *Beccari s.n.*

1875 (filed under accession number 11171 in FI (holotype FI).

15. **Gronophyllum oxypetalum** Burret in Notizbl. Bot. Gart. Berlin-Dahlem 13: 474. 1936. Type: cultivated, Indonesia, Bogor Botanic Gardens, *#XIII A 32* (holotype B), seed collected from Pulau Mangoeli, Moluccas, Indonesia, *Furtado Singapore Field No. 30929*, (SING).

16. **Gronophyllum pinangoides** (Beccari) Essig & Young, **comb. nov.**

Nenga pinangoides Beccari, Malesia 1: 28. 1877. Type: New Guinea, Northwestern West Irian, Ramoi, *Beccari P.P. 430* (Lectotype FI).

Leptophoenix pinangoides (Beccari) Beccari in Ann. Jard. Bot. Buitenzorg 2: 82. 1885.

Nengella pinangoides (Beccari) Burret in Notizbl. Bot. Gart. Berlin-Dahlem 23: 315. 1936.

Nenga calophylla K. Schumann & Lauterbach, Fl. Deutsche Schutzgeb. Sudsee: 208. 1901. Type: New Guinea, Papua New Guinea, Morobe Province, Sattelberg, *Lauterbach 564* (holotype B).

Nengella calophylla (K. Schumann & Lauterbach) Beccari in Bot. Jahrb. Syst. 52: 17. 1914 (excl. vars. *rhopalocarpa* Beccari and *montana* Beccari).

Leptophoenix minor Beccari in Webbia 1: 298. 1905. Type: New Guinea, Papua New Guinea, Central Province, San Giuseppe River, *Loria 10 XI. 1892* (holotype FI).

Nengella minor (Beccari) Burret in Notizbl. Bot. Gart. Berlin-Dahlem. 13: 315. 1936.

Gronophyllum densiflorum Ridley in Trans Linn. Soc. London 9: 232. 1916. Type: New Guinea, South-central West Irian, Mt. Carstenz, *Kloss s.n.*, (holotype K).

Nengella densiflora (Ridley) Burret in Notizbl. Bot. Gart. Berlin-Dahlem 13: 316. 1936.

Leptophoenix incompta Beccari in Bot. Jahrb. Syst. 58: 452. Type: New Guinea, Papua New Guinea, East Sepik Province, Ettapenberg, *Ledermann 9017* (holotype B).

Nengella incompta (Beccari) Burret in Notizbl. Bot. Gart. Berlin-Dahlem 13: 316. 1936.

Leptophoenix pterophylla Beccari in Martelli in Atti. Soc. Tosc. Sci. Nat. Pisa Mem. 44: 20. 1934. Type: Cultivated, Indonesia, Bogor, *Hort. Bog. X D 114* (holotype FI).

Nengella pterophylla (Beccari) Burret in Notizbl. Bot. Gart. Berlin 13: 316. 1936.

Leptophoenix yulensis Beccari in Martelli in Atti Soc. Tosc. Sci. Nat. Pisa Mem. 44: 19. 1934. Type: New Guinea, Papua New Guinea, Central Province, *F. v. Mueller 8. XII. 90* (holotype MEL).

Nengella yulensis (Beccari) Burret in Notizbl. Bot. Gart. Berlin-Dahlem 13: 316. 1936.

Leptophoenix macrocarpa Burret in Notizbl. Bot. Gart. Berlin-Dahlem 12: 240. 1935. Type: New Guinea, Southern Papua New Guinea, *Brass 5299* (holotype B).

Nengella macrocarpa (Burret) Burret in Notizbl. Bot. Gart. Berlin-Dahlem 13: 314. 1936.

Leptophoenix microcarpa Burret in Notizbl. Bot. Gart. Berlin-Dahlem 12: 342. 1935. Type: New Guinea, Papua New Guinea, Central Province, Dieni, *Brass 3998* (isotype A!).

Nengella microcarpa (Burret) Burret in Notizbl. Bot. Gart. Berlin-Dahlem 13: 314. 1936.

Nengella rhomboidea Burret in J. Arnold Arbor. 20: 208. 1939. Type: New Guinea, Papua New Guinea, Fly River Province, Palmer River, *Brass 7201* (isotype A!).

17. **Gronophyllum pleurocarpum** (Burret) Essig & Young **comb. nov.** *Nengella pleurocarpa* Burret in Notizbl. Bot. Gart. Berlin-Dahlem 13: 314. 1936.
    Nengella calophylla var. *montana* Beccari in Bot. Jahrb. Syst. 52: 27. 1914. Type: New Guinea, northeastern Papua New Guinea, Madang area, *Schlechter 16291* (holotype B).
18. **Gronophyllum procerum** (Blume) H.E. Moore in Gentes Herb. 9: 265. 1963.
    Kentia procera Blume, Rumphia 2: t. 106. 1838–39; 94. 1843. Type: New Guinea, southwestern West Irian, *Zippelius s.n.* (holotype L).
19. **Gronophyllum ramsayi** (Beccari) H.E. Moore in Gentes Herb. 9: 265. 1963.
    Gulubia ramsayi Beccari in Webbia 3: 159. 1910. Type: Australia, Northern Territory, Port Essington, *Ramsay s.n.* (holotype ?MEL).
    Kentia ramsayi (Beccari) Beccari in Webbia 4: 148. 1913.
20. **Gronophyllum rhopalocarpum** (Beccari) Essig & Young **comb. nov.**
    Nengella rhopalocarpa (Beccari) Burret in Notizbl. Bot. Gart. Berlin-Dahlem 13: 314. 1936; *Nengella calophylla var. rhopalocarpa* Beccari in Bot. Jahrb. Syst. 52: 28. 1914. Type: New Guinea, Northeast Papua New Guinea, Waria River, *Schlechter 17466* (holotype B).
21. **Gronophyllum sarasinorum** Burret in Notizbl. Bot. Gard. Berlin-Dahlem 13: 202. 1936. Type: Indonesia, Sulawesi, Posso Lake, *Sarasin 896* (holotype B).
22. **Gronophyllum selebicum** (Beccari) Beccari in Ann. Jard. Bot. Buitenzorg 2: 82. 1885.
    Nenga selebicum Beccari, Malesia 1: 30. 1877. Type: Indonesia, Sulawesi, Kandari, *Beccari s.n.* (holotype FI).

Dubious species:

The following species are poorly known and considered dubious in Young's dissertation. They are therefore not included in the key to the species. A new epithet for *Nengella mayrii* is however necessary to avoid duplication with *Gronophyllum mayrii.*

Gronophyllum affine (Beccari) Essig & Young **comb. nov.**

Nenga affinis Beccari, Malesia 1: 29. 1877. Type: New Guinea, northwestern West Irian, Kapaor, *Beccari s.n.*, under accession numbers 11218–11218A at FI (holotype FI).

Leptophoenix affinis (Beccari) Beccari in Ann. Jard. Bot. Buitenzorg 2: 82. 1885.

Nengella affinis (Beccari) Burret in Notizbl. Bot. Gart. Berlin-Dahlem 13: 316. 1936.

Gronophyllum cyclopensis Essig & Young **nom. nov.**

Leptophoenix mayrii Burret in Notizbl. Bot. Gart. Berlin-Dahlem 11: 709. 1933. Type: New Guinea, northwestern West Irian, *Mayr 24* (holotype B).

Nengella mayrii (Burret) Burret in Notizbl. Bot. Gart. Berlin-Dahlem 13: 314. 1936.

Gronophyllum micranthum (Burret) Essig & Young, **comb. nov.**

Leptophoenix micrantha Burret in Notizbl. Bot. Gart. Berlin-Dahlem 11: 710. 1933. Type: New Guinea, West Irian, Wandammen Mtns. *Mayr 253* (holotype B).

Nengella micrantha (Burret) Burret in Notizbl. Bot. Gart. Berlin-Dahlem 13: 314. 1936.

Excluded species:

Leptophoenix parvula Beccari in Martelli in Nuov. Giorn. Bot. Ital. 42: 57. 1935. Martelli cited this name from unpublished notes of Beccari. The species was never validly described or typified. It was based on a cultivated specimen from the Bogor Botanic Gardens, Indonesia, *Hort. Bogor XI B (XIII) 7*. It is not known whether this specimen still exists or is represented in any herbarium.

Nengella paradoxa Beccari, Malesia 1: 32, 1877. =**Pinanga paradoxa** Scheffer in Natuurk. Tijdschr. Ned. Ind. XXXII:31, fide Beccari in Martelli in Nuov. Giorn. Bot. Ital. 42: 61. 1935.

Acknowledgments

Support of the National Science Foundation (Grants GB-20348X and DEB 77-17319) are gratefully acknowledged, as is the generous assistance provided by Michael Galore of the Division of Botany in Lae, and numerous other persons throughout Papua New Guinea who assisted in the work leading up to this publication. We thank the Royal Botanic Garden at Kew, England for the loan of herbarium material, and especially Dr. John Dransfield for arranging the loan and for his extensive assistance in shaping the manuscript. Thanks go likewise to the L. H. Bailey Hortorium and the late Dr. H. E. Moore for allowing the use of his extensive notes and the modification of his taxonomic key that appears in this paper.

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New Cycad Report Available from Traffic (U.S.A.)

SHERYL GILBERT. Cycads, Status, Trade, Exploitation, and Protection, 1977–1982.

This attractive overview of the order Cycadales explains how these plants have become one of the most threatened botanical groups on earth by examining the factors that have contributed to their decline. Import and export statistics provide information on the main cycad supplying and consuming nations from 1977 to 1982. Species currently the target of the most intense trade are highlighted.

The 75 page report is a must for cycad lovers and collectors. It is available for US $8.50 each. Make your check payable to World Wildlife Fund–U.S. and mail it to TRAFFIC (U.S.A.), 1601 Connecticut Avenue, N.W., Washington, D.C. 20009, U.S.A. (Normally we include only information on palms, but we have made an exception here for the benefit of our members who also grow cycads.—Eds.)

Principes, 29(3), 1985, pp. 138–141

A New Species of Gronophyllum (Palmae) from Papua New Guinea

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In 1978, I participated in a botanical collecting expedition to a remote area of the Sepik River Basin of north central New Guinea, with Fred Essig and botanists from the Papua New Guinea Division of Botany. We were guests of the Carpentaria Exploration Company, which graciously provided us with food, lodging, and helicopter transportation at no charge. Upstream from the base camp along the Frieda River we encountered an interesting locality where a crystal clear stream emerges from some limestone hills. Several unusual palms were found there, including some still unnamed species of *Calyptrocalyx* (see Essig and Young 1981).

While scrambling up one of the treacherously pitted limestone hillsides one day, we quite unexpectedly discovered a striking new palm (Fig. 1). At first, it appeared obviously to be a species of *Nengella*, similar to other common species in the genus. It differed in a number of ways, however. It was a very slender, single-stemmed palm, with a trunk about 3 cm in diameter. It was growing on an exposed ridge under the full glare of the tropical sun, in itself a very unusual habitat for *Nengella*; most species in this genus occur in the undergrowth of dense forests. We later found other populations growing in the same sort of habitat on neighboring mountains.

Flowers (Fig. 2) of the new species were lavender-tinged rather than the pink usual in *Nengella*; fruit were quite globose (Fig. 3), not elongate as in *Nengella*, and as it turned out, the anatomy of the fruit was quite different from that in known species of *Nengella*. Other distinctive, though not unique, features of the new species are the numerous ramenta on the pinnae, the large number of narrowly cuneate pinnae (Fig. 4), the globose fruits, the seeds with homogeneous endosperm, and the extremely elongate valvate tips of the petals of the pistillate flowers.

Later examination of the fruit anatomy of the new species revealed a structure (see accompanying paper) quite similar to that of *Gronophyllum chaunostachys*, which also has homogeneous endosperm. The well developed palisade layer, derived from the locular epidermis, in both these species, is unknown in *Nengella*, as is the development of an outer series of fibrous bundles separate from the inner fibro-vascular system. This gronophyllum-like fruit structure, in combination with typically nengella-like vegetative features, contributed to the decision to combine *Nengella* with *Gronophyllum* (Essig and Young, accompanying article). Therefore, the species is described as a species of *Gronophyllum*, although its exact affinities with other species in the genus, including those formerly placed in *Nengella*, remain somewhat unclear.

Gronophyllum apricum is a distinctive species, not easily confused with any other. The fruit, including the seed with homogeneous endosperm, is most like *G. chaunostachys* but the slender habit is very different from that giant palm. Vegetatively, the new species differs from other

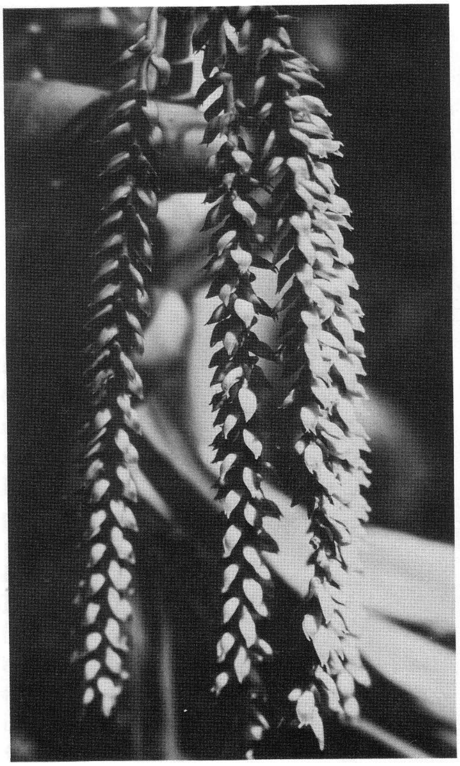
1. *Gronophyllum apricum* growing in its natural habitat on an exposed limestone ridge near the Frieda River (reprinted from Principes 25(1):13, 1981).

species in Papua New Guinea by its longer fronds with more numerous leaflets, its unusual exposed habitat, and its lavender flowers. Comparisons might be made with *G. microspadix* or *G. leonardii*, but these both have seeds with ruminate endosperm and are geographically remote from the known range of *G. apricum*. Furthermore, *G. leonardii* has multiple trunks, and *G. microspadix* has more linear leaves. Flower color is not known for either species. The epithet "apricum" refers to the sun-loving habit of the new species.

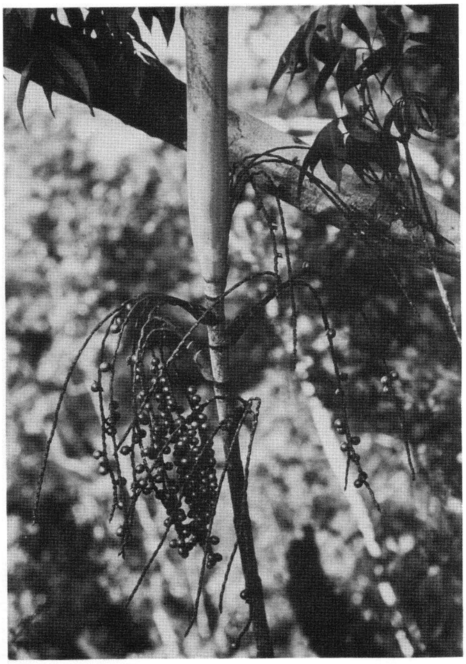
Gronophyllum apricum Young sp. nov.

G. chaunostachys affinis sed habitu multo minori, foliis irregulariter pinnatis, pinnis anguste cuneatis, floribus staminatis cremeis apicibus purpureis, floribus pistillatis atropurpureis, fructibus fere globosis, 8 × 7 mm differt. Typus: Papua New Guinea, West Sepik Province, on ridge above Frieda River, near Carpentaria Exploration Co. airstrip, alt. ca. 300 m, *Essig & Young LAE 74082* (Holotypus LAE; isotypi BH, USF).

A solitary, slender palm to 5 m in height; stem ca. 3 cm diam. Leaves ca. 7 in crown; sheath 21–23 cm long, sparsely covered with dark red lacerate-peltate scales; petiole 12–18 cm long, convex abaxially, concave adaxially, thickly covered with red lacerate-peltate scales; rachis 36–62 cm long, abaxially convex at the base, concave adaxially with pinnae inserted along lateral ridges, becoming shallowly convex toward the apex, ridge single adaxially with pinnae inserted laterally, scaly as above at the base, more sparsely so toward the apex; pinnae 15–



2. The inflorescence of *Gronophyllum apricum*.

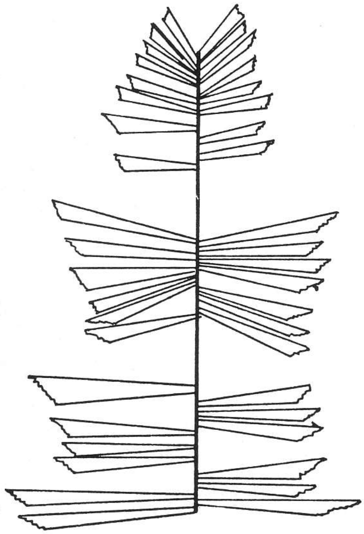


3. The infructescence of *Gronophyllum apricum*.

23 per side, narrowly cuneate, truncate, 0.8–3.5 cm wide, 9–24 cm long, recurved, becoming shorter apically, irregularly clustered, lower surface with large ramenta along the midvein. Inflorescence branching to 1 order, peduncle 3.2–5.5 cm long; prophyll and first peduncular bract 20–29 cm long, purplish, covered with red lacerate-peltate scales apically and along the edges, second peduncular bract small, inconspicuous, to 0.8 mm and triangular; bracts subtending rachillae small, inconspicuous; rachillae 14–25 cm long; triads opposite, each pair alternating at 90° with previous pair, forming 4 rows, 2 bracteoles associated with each triad, one under the triad, the other between one lateral staminate flower and the central pistillate flower. Staminate flowers cream-colored with purple tips, pedicellate; sepals connate at the base, keeled, ca. 1 mm long, more-or-less equal, petals valvate, acuminate, 7 mm long, 1.5–3.0 mm wide, anther filaments connate around a very short 1-, 2-, or 3-lobed pistillode, free portion of filaments very short, anthers bilocular, locules well separated on a tanniniferous connective. Pistillate flowers dark purple, 6–7 mm long; sepals imbricate, ca. 2 mm high, petals highly imbricate, with long, thin valvate tips, staminodes generally 3, toothlike. Fruit red, nearly globose, 8 × 7 mm, pericarp thick, tanniniferous; seed top-shaped, 5 × 4 mm, endosperm homogeneous, embryo basal. Vernacular names: none known.

Distribution: known only from a few limestone ridges in the vicinity of the Frieda River, West Sepik Province, Papua New Guinea.

Specimens Examined: PAPUA NEW GUINEA: West Sepik Province: Tele-



4. Drawing of the leaf of *Gronophyllum apricum.*

fomin Subprovince. Rain forest below Carpentaria Exploration Company helicopter pad K-27, on exposed ridge, 900 m alt., *Essig & Young 74082* (Holotype LAE; Isotype BH); on ridge above junction of "clear-water" stream with Frieda River, ca. 2 km upstream from Carpentaria Exploration Company airstrip camp, 300 m alt., *Essig & Young LAE 74049* (BH, LAE, USF); on exposed ridge near Carpentaria Exploration Company "Antap Mountain" helicopter pad, 1,200 m alt., *Essig & Young LAE 74072* (BH, LAE, USF).

Acknowledgments

I am indebted to the National Science Foundation (Grant #DEB 77-17319) for support of the work leading up to this publication. Also, I thank Michael Galore of the Division of Botany in Lae, Papua New Guinea, and the Carpentaria Exploration Company for their generous hospitality and assistance in the field, and Drs. Essig and Dransfield for help with the manuscript. Finally, I thank my parents, Dr. and Mrs. U.A. Young, for the financial assistance that made my trip to Papua New Guinea possible.

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Founder of Society Dies

Dent Smith, founder of The International Palm Society, died on April 23, 1985. *Principes* 30(1), January 1986, will be dedicated to him. Friends are urged to send notes or remembrances of any kind to the editors.

Principes, 29(3), 1985, pp. 142–146

Above-Ground Branching of the Stilt-Rooted Palm, Eugeissona minor

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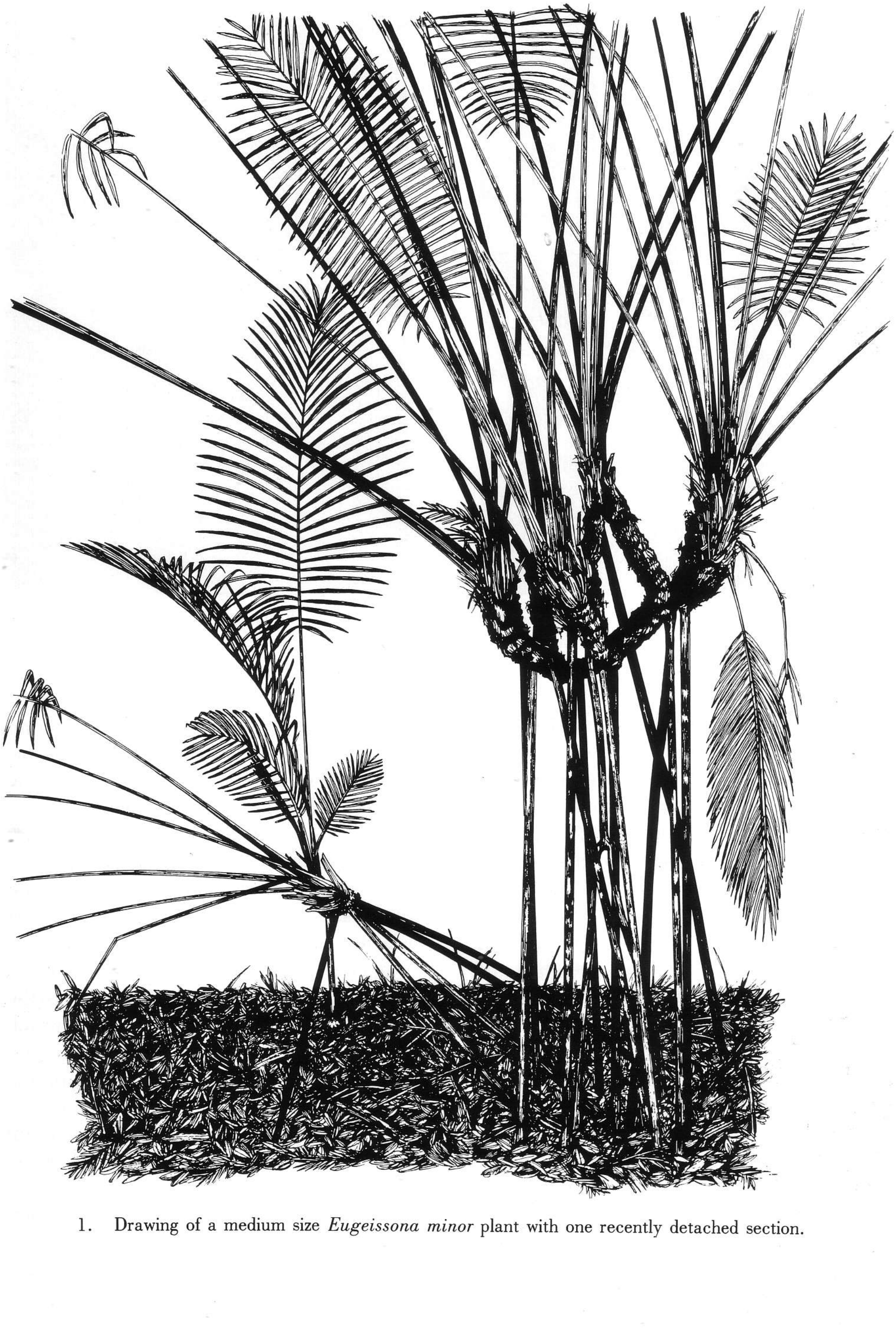
Although branching in palms is not a rare phenomena, it continues to attract much attention (Ridley 1907, Holttum 1955, Dransfield 1978). This sustained interest is perhaps due to the fact that branching in most palms is subterranean and thus not easily observed. In his review of the growth forms of palms, Dransfield (1978) describes one species, *Eugeissona minor*, which is both branched and stilt rooted, a combination which results in an "elevated yet basically acaulescent branching system." In this paper we offer further observations on the branching pattern of this unusual palm and discuss some of the ecological consequences of this unique growth habit.

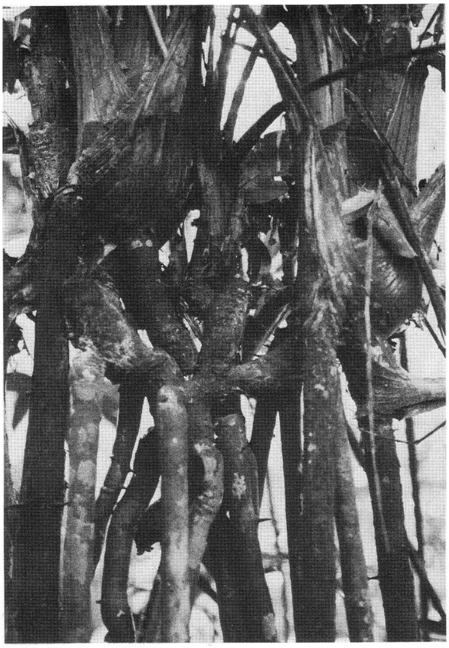
Observations were made in Lambir Hills National Park, Sarawak, East Malaysia (4°03′N, 114°03′E). *Eugeissona minor* is common in mixed dipterocarp forest on gently sloping ridges. A survey of five 0.1 ha plots revealed an average density of 30.2 (sd = 3.3) *E. minor* plants/ha. Soils in the area are primarily a clay-rich fine sandy loam. The mean rainfall in the nearby town of Miri is approximately 3,200 mm per year (Walter et al. 1975).

The branch system of *E. minor* develops sympodially, with small leaf rosettes (branches) forming adjacent to larger shoots (Fig. 1). Each shoot segment generally initiates one (sometimes two) new rosettes, usually oriented towards the exterior of the shoot system. Stem segments sometimes achieve 6 cm in diameter and 25 cm in length before branching but interbranch distances are usually less than 15 cm. Mature leaves on large plants are usually 4–5 (6) m long. Unlike palms that branch on or beneath the ground, there are no scale or otherwise modified leaves along the stems of *E. minor*. Internode lengths average 1.5 cm, except on the terminal flowering axes where interleaf distances up to 16 cm obtain. Although there is no set pattern of branching in *E. minor*, the stem systems tend to be linearly oriented, often developing a candelabralike appearance (Figs. 1–3). The vertical angle of branching varies between 30° and 80° and does not appear to be related to the height or overall size of the plant. Branching begins at ground level and continues with approximately the same frequency and pattern throughout the life of the plant.

The local Iban name for *E. minor* is "tunjang pipit" meaning the legs of a small bird, which its conspicuous stilt roots certainly resemble (Fig. 3). These roots are 1.5–2.5 cm in diameter and up to 4.5 m long. Locally they are carved into fine walking sticks. Young roots are initiated immediately below each living rosette on all sides of the stem with one root produced every two to three internodes. The roots are oriented within 10–15° of ver-



1. Drawing of a medium size *Eugeissona minor* plant with one recently detached section.



2. Close-up of the shoot system after removal of litter showing branch and stilt root initiation.

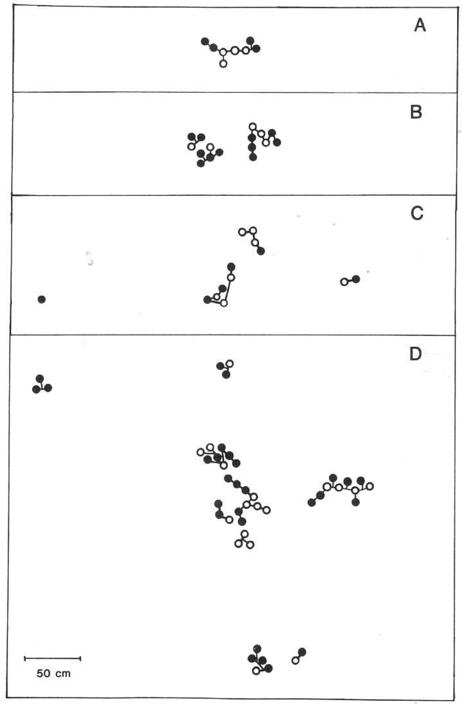
3. A tall, divided *Eugeissona minor.*

tical and often become interwoven and closely pressed together. As the roots grow towards the ground the exposed root tip is protected by a thick, shaggy cap. If injured, however, branching proximal to the damaged tip occurs. The mature stilt roots are protected by whorls of 2–4 cm long modified roots which function as spines.

The configuration of the branches and leaves and the cagelike projection of stilt roots trap a substantial amount of leaf litter and other decaying organic matter (Fig. 4) and qualify *E. minor* as a "trash-basket plant" (Granville 1977, Ng 1980, Raich 1983). The extent to which *E. minor* derives nutrients from the entrapped litter, however, is unclear as aerial feeder roots (Nadkarni 1981) growing in the crown litter were not observed. Yet this trapped litter does represent a nutrient source because nearby plants frequently have roots that grow up into *E. minor* crowns. Termites of several species commonly construct nests within *E. minor* crowns (Fig. 4). Removal of litter and organic debris inevitably turned up carton trails and other evidence of termite activity. In one case a bird's nest was discovered among the branches, stilt roots, and accumulated litter among the branches of a large plant.

A consequence of a growth form which combines branching with stilt roots is the fragmentation of stem sections which occurs as the older portions of the stem decay (Figs. 1, 3). Decomposition of the lower (older) stems often occurs in stilt-rooted palms which then maintain contact with the soil only through their stilt roots (Corner 1966). In *E. minor* this process is accelerated by termites which feed upon the dead roots and stem. Even after the connecting stem section has been severed, interlocking leaves and stilt roots help to keep the plant balanced in its original con-

4. An undisturbed *Eugeissona minor* crown with trapped litter and a termite nest.



5. Diagram of four *Eugeissona minor* plants: A = intact; B = separated; C and D = fragmented. Solid circles represent living apices, open circles represent dead shoots.

figuration. However, stem fragments which are supported by only a few stilt roots eventually become unsteady and fall to one side under their own weight (Fig. 1). The maximum distance traversed is determined by the length of the existing roots which remain anchored in the soil in their original position. The fallen stem sections reorient and produce new, more-or-less vertical stilt roots. Eventually, as the older roots die and rot away, the once intact plant (genetic individual) comes to appear as several independent plants growing 1–3 m or more apart. This process of vegetative reproduction through stem fragmentation is sometimes aided by disturbances such as tree and branch falls which help to unbalance stem sections and push them apart. However, the primary reason for fragmentation lies not with such disturbances but is inherent in the growth habit of the plant.

In order to determine the extent and frequency of vegetative fragmentation in *E. minor*, a survey was conducted. The first 50 plants encountered growing within 2 m of a ridge-top trail in an area with abundant *E. minor* were sampled and the number of living shoot apices, height to the lowest and highest apices, reproductive status, and percent canopy cover overhead were recorded. In addition, each plant was classified as either "intact," "separated" (having at least 2 unconnected stem segments separated by <50 cm), or "fragmented" (having at least one stem segment separated by >50 cm and which initiated new roots in the new location) (Fig. 5). Plants growing within 2 m of each other without showing any clear signs of having once been connected were difficult to classify and were not included in the survey. Of the 50 plants sampled, 20 (40%) were intact, 13 (26%) were separated and 17 (34%) were fragmented. Six of the fragmented plants had obviously been knocked apart by falling tree branches. The largest horizontal distance observed between two separated sections was 1.9 m.

Fragmentation by decay and natural senescence occurs in many vegetatively regenerating plants (e.g., Leakey 1981). Its significance in the case of *E. minor*, however, is unclear. Flowering and viable seed production were observed within the study area but seedlings were extremely rare. Furthermore, vegetative expansion in *E. minor* is somewhat limited in spatial extent and appears effective primarily for exploiting local environmental heterogeneity and surviving disturbances, rather than as a colonizing strategy. On the other hand, fragmentation of *E. minor* plants does provide some release from within-plant crowding and competition.

Branching in palms, even in the absence of fragmentation, can be considered both as a safety mechanism against terminal bud damage and as a means to offset the disadvantages of apical flowering (Dransfield 1978). Stilt roots have been considered advantageous due to reducing the length of the ground-level establishment phase and thus exposure to terrestrial predators, ability to survive tree-falls (Bodley and Benson 1980), increased stability on steep terrain or in swampy habitats (Corner 1966), and for increasing rooting area (Ashton in Dransfield 1978). The unique co-occurrence of stilt roots and branching in *E. minor* results in a distinct form of clonal growth and vegetative spread which provides benefits to the plants and confirms the intimate relationship between morphology and demography (e.g., White 1979).

Acknowledgments

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Principes, 29(3), 1985, p. 147

NEWS OF THE SOCIETY

A New Botanical Garden in Hawaii

The Hawaii Tropical Botanical Garden in the lush setting of Onomea Bay on the Island of Hawaii has opened to the public. This 17 acre Nature Preserve is the newest Botanical Garden in the Hawaiian Islands and shows promise of being an outstanding example of tropical horticulture.

Among the collections presently on inventory at the Garden is a surprisingly diverse collection of palms. Thanks to the help of many friends and supporters the collection includes *Areca triandra, Elaeis guineensis, Hyophorbe lagenicaulis, Reinhardtia gracilis,* and *Veitchia winin.* The inventory showed 44 genera represented by 74 species. A further inventory of currently unidentified species as well as the steady acquisition of other species adaptable to the cultural conditions of this tropical valley will increase the listing.

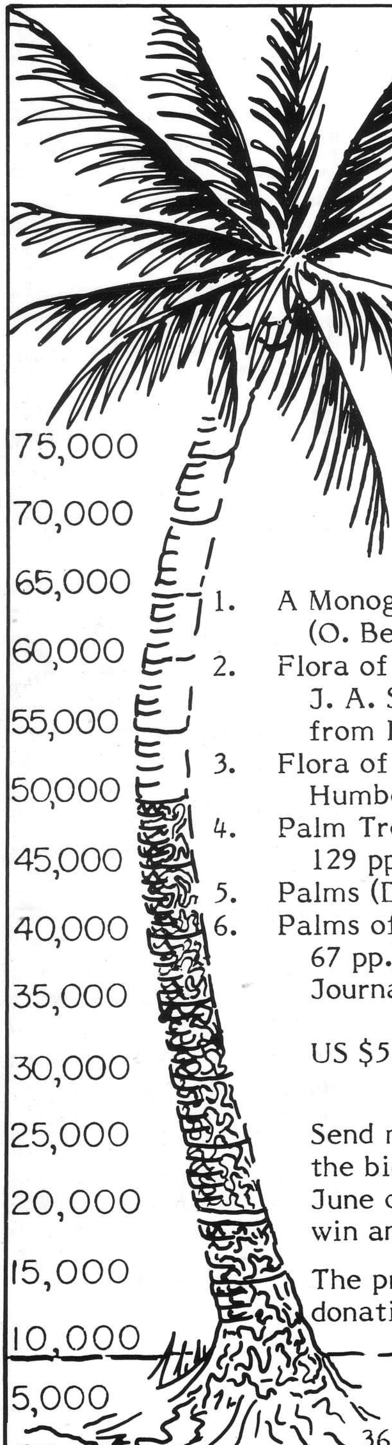
The Hawaii Tropical Botanical Garden began in 1978 as the dream of Dan and Pauline Lutkenhouse. Retiring to Hawaii from San Francisco they fell in love with the unspoiled charms of the 'Big Island' (Hawaii) and made plans to preserve at least a small part of it for future generations. Establishing the Nature Preserve and Botanical Garden required hundreds of hours of dedicated labor and a considerable amount of money (nearly a million dollars). As the years went by the Garden began to emerge from an untamed jungle into a series of micro-climates enhanced by the ever-growing collections of tropical and exotic species. Graceful palms created overstories for other genera and highlighted the paths and ponds in the Garden. Literally hundreds of plants were collected from the gardens of Asia, donated by residents of Hawaii, or acquired from institutions across the United States. Finally, in 1984 the Garden reached the state where it could be opened to the visiting public. In the few months it has been open, the Garden has been enjoyed by several hundred visitors from the United States and nearly every other country in the world.

The Garden is a federally approved nonprofit organization funded entirely by gifts and admission donations. A restriction on the number of visitors that are allowed each day helps to preserve the peaceful environment of the Garden while still providing the financial base needed for basic operations. All expansion projects and special programs are based on other donations.

A permanent staff of four oversees the Garden operations. Gary A. Powell, formerly of the Waimea Falls Park on Oahu, has accepted the position of Curator for the new Garden and Terence Takiue, who has overseen the physical development from its inception, is the operations manager.

Dan and Pauline Lutkenhouse remain as the Directors of the Garden and are very active in day-to-day affairs. Their foresight and dedication will enable future generations to enjoy and perpetuate the beauty of Onomea Bay and the Hawaii Tropical Botanical Garden.

GARY A. POWELL



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