

PRINCIPES

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THE INTERNATIONAL PALM SOCIETY

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Cover Picture

A palm believed to be *Gronophyllum procerum* (New Guinea), Indonesia. Photo by Melvin W. Sneed (see pp. 47–54).

PRINCIPES

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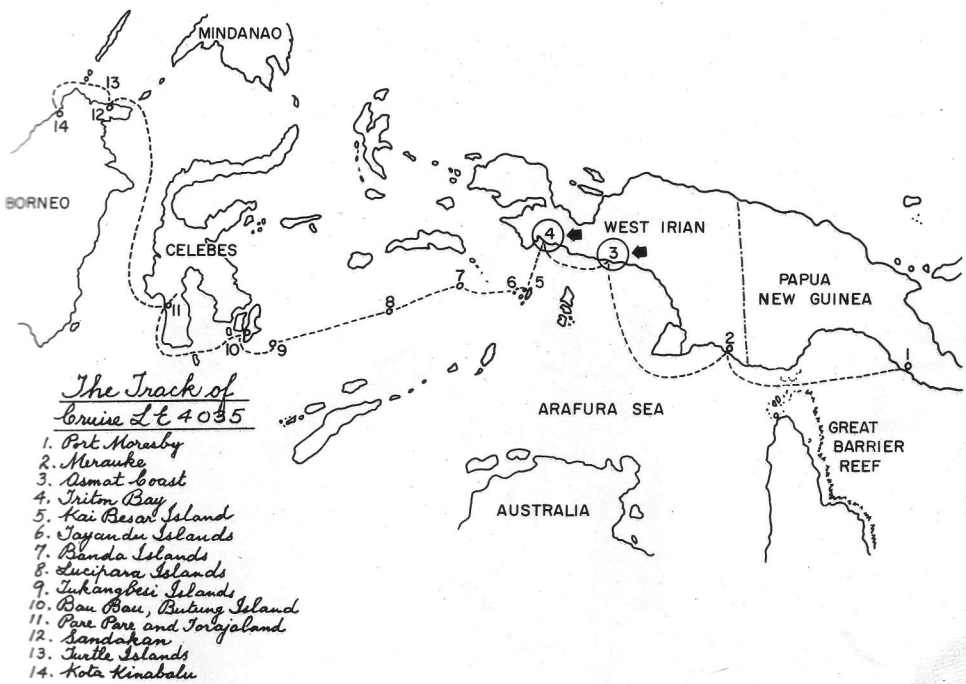
Principes, 29(2), 1985, pp. 47–54

Gronophyllum procerum, People and Places, Pictured in their Stone Age Habitat

MELVIN W. SNEED
8107 S. W. 72nd Avenue, Apt. 113 E, Miami, FL 33143

This brief pictorial article is devoted to one palm. Few palm enthusiasts have seen the species. Yet there are thousands of the trees growing naturally, indeed flourishing, in a remote, largely inaccessible area along the west coast of Irian Jaya, Indonesian New Guinea. Detailed maps of the area are non-existent, especially any which might pinpoint small native villages or rivers leading to them. But we have duplicated a sketch drawing (Fig. 1) which may be helpful.

Approximately a century ago there was an intrepid naturalist and explorer, Alfred Russel Wallace, who set sail from England. He was a compatriot of Charles Darwin, to whom he dedicated his early book, *The Malay Archipelago*, first edition circa 1870, a later edition 1890, and now, in paperback, published by Dover Publica-



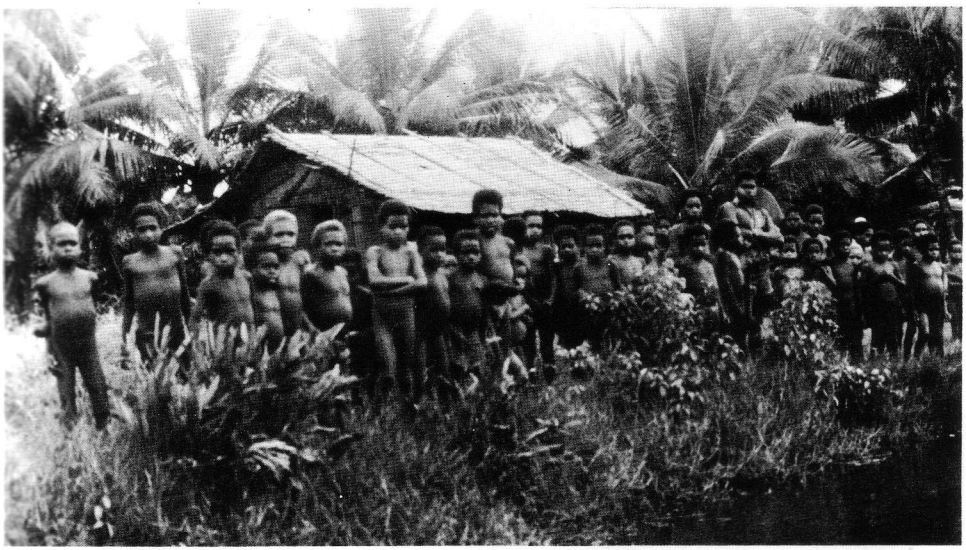
1. From *The Log Of The M. S. Lindblad Explorer Expedition Through The Spice Islands*; Port Moresby, New Guinea, to Kota Kinabalu, Borneo, March–April 1984. The dotted line indicates track of the cruise, some 4,000 miles. (Dennis Puleston, Naturalist, Lecturer, and Artist, who made the Log available has our heart-felt appreciation.)



2. Asmat men sculled rapidly down river from their village in dugout war canoes and on out to sea to greet our intrusion into their domain—rarely disturbed by outsiders. The man seated was a chief and "coxswain" of his vessel. Canoes swarmed around us, many of the "warriors" transferred themselves to our zodiacs, and we went on, towing their abandoned canoes.



3. The closer they came, the more one wondered what might befall an unwary, perhaps unwelcome, unescorted palm hunter, especially one still at sea without linguistic ability to explain his mission!



4. The village, fronted by a phalanx of young greeters, was situated on the only small area we saw above swamp level. The whole place became a spongy morass after a sudden rain shower drenched everything just after our up-river landing there. The inhabitants still indulge in "head-hunting" forays among the tribes; happily, our group left with all heads in place. Native venders had some skulls for sale, primitive art carvings, and objects made from leg bones of the indigenous, beautifully-plumed Cassowary bird. Sometime in the past the Asmats were nomadic, moving in quest of sago palms as a food source. The beetle (weevil) larvae of *Rhynchophorus cruentatus*, found on some of these palms appears to have been their "gourmet" food. These people obviously had cultivated coconuts (a large-trunk species that appears in the background) as well as sago palms.

tions, Inc., New York. In our judgment, Alfred Russel Wallace may not have been given sufficient appreciation for his explorations, meticulous descriptions and contributions to our knowledge about this area of the world stretching over the vast expanse of the far-west Pacific Ocean, embracing more than 13,000 islands and in distance perhaps 5,000 miles. Today, the area remains essentially faithful to his early descriptions and observations.

Mr. Wallace refers to "lofty palms" in the forests, and even describes in detail how the natives make palm sugar and wine. But of course he didn't know the names of all the palm genera and species that he must have seen during his eight years in the area.

We sailed from Port Moresby, Papua New Guinea on the Lindblad Explorer, late afternoon 30 March 1984. Generally the ship followed, with some navigation through treacherous waters, the route along the dotted line in the map (Fig. 1). We were at sea through 31 March, the 1st and 2nd of April, sailing nearly 1,000 miles.

Before dawn on the 3rd, the ship anchored some six miles from shore off the Asmat coast of Irian Jaya (see No. 3 on map). In the murky, shallow waters a zodiac (rubber raft) was off-loaded from the Explorer in the darkness, and our cruise leader went ashore near the mouth of the Ewta River, up which was located the village of Pirian. Despite already having been cleared by Indonesian immigration, it was essential to get permission to land from local villagers. After being assured a friendly welcome, we set out in zodiacs for the two-hour trip to shore, acquiring a bit of sunburn as we went in. Approaching the river's mouth, we were met and surrounded by an armada of dugout war canoes filled with dark, slender figures with painted faces and bodies, and



5. There is no easy access to the West Coast of Irian Jaya. We did it, of course by small ship, off-loading on zodiacs to go ashore through shallow waters. From the Asmat area we sailed on to Triton Bay, a name seldom found on maps of the area. With the ship remaining well off-shore, our zodiacs went into the Bay via entrances camouflaged by small limestone islets. Your author and Phyllis got into this picture (not planned). The man at the tiller, Tom Ritchie, led our expedition and is a member of the Palm Society.

adorned with feathered regalia, sculling with long-handled paddles. It was a startling, if not frightening sight (Figs. 2 and 3). Proceeding up the narrow, tea-colored river, we left the mangrove trees of the swampy coast for jungle-lined, still, swampy banks, beyond which we saw an occasional large *Caryota*, *Metroxylon*, and a few coconuts. We believed there were some rattans, but otherwise as far as our limited opportunity to explore permitted, we saw no additional palms. As we approached the village, most of the younger inhabitants lined up en masse to forefront the coconuts which were under cultivation (Fig. 4). Incidentally, this Asmat area is where the late Michael Rockefeller disappeared while on an expedition pursuing his heartfelt devotion to archaeology and primitive art.

Back on board the Explorer, we sailed overnight approximately 300 miles up the coast to Triton Bay, which Mr. Wallace's map of 1868 places at approximately 134° longitude and 4° latitude. The scope of this extremely scenic area is not apparent from the bay's entrance, as the Bay itself encloses dozens of small, upthrust, limestone islets, most of which are eroded at the waterline to form mushroom-like shapes. These islands are densely vegetated almost exclusively with one palm species. Dr. John Dransfield has suggested this is most probably *Gronophyllum procerum*, first collected by Zippelius in 1828, described by Blume in 1843 and probably



6. Inside the Bay, large and small islands protruded out of clear waters as far around as the eye could see, most of them eroded at the waterline to form odd-shaped, toadstool-like creations. They were completely overgrown with *Gronophyllum procerum*, which exhibited such enthusiasm for its habitat that little room remained for other plants.

only very rarely collected since. Many things were astonishing about this unusual and beautiful hidden Shangri-la, Triton Bay. Its mysterious expanses stretched on, beckoning beyond each island which we circumnavigated in the zodiacs. It seemed like another world, and to imagine such a dense population of a single palm covering every islet to the almost total exclusion of other trees, was incredible! These limestone mushrooms in such a remote location probably have more mature palms growing per acre than any other palm area we know. Though we couldn't climb the steep cliffs, nor scramble over the myriad islands in the Bay to look for others, and though *Gronophyllum procerum* predominates, it is highly probable that other palms are waiting there to be found.

Pictures, of course, speak louder than words. What follows expands our vision of this relatively unexplored and exciting area, where one of our infrequently seen palms has been hiding and thriving.

The pictures (Figs. 2–11) have detailed legends that supplement our story.

Exploring the many islets and interesting formations in Triton Bay we found various plants though none of them came close to competing with the palms. But frequently we saw individual specimens of a lovely cycad, despite the preponderance of palms. Reluctantly, our zodiac wove around and out of the unique formations to one of the Bay's entrances, and on back to our ship, thence on to another leg of our journey through the Spice Islands. We exited the Bay through a larger entrance



7. One of the few signs of habitation visible inside the Bay was this half-finished shack, though no natives were in sight. Of more interest, the palm in back of the shack was probably cultivated.



8. One can look from inside the Bay outward through narrow entrances to the open Arafura Sea. Exploring inside the Bay soon involved us in such a labyrinth that we wondered if our experienced leader was a good enough navigator to get out of the maze. See the palms silhouetted.



9. This picture enhances description of how much *Gronophyllum procerum* dominates the area. One really must see it with his own eyes to absorb the beauty of it all.



10. The only population we encountered during some two hours cruising the Bay first loomed up in the form of a lone fisherman paddling a very crudely constructed outrigger, dugout canoe. He was wary of us, as we were of him, and any verbal communication was of little avail since there was an uncrossable language barrier.



11. More of the beauty of the seemingly endless palm, *Gronophyllum procerum*, which covers the islets that dot Triton Bay.

than the one we entered. Near the exit we paused to admire some of the peculiarities of the plant life, such as a lovely species of *Nepenthes* (pitcher plant), climbing and clinging to the limestone as well as to palm roots populating the islets. Perhaps one day someone will get to this area at a time when *Gronophyllum procerum* is fruiting, and will honor the Palm Society Seed Bank with the gleanings.

BOOKSTORE

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Principes, 29(2), 1985, pp. 56–63

Oraniopsis appendiculata, a Previously Misunderstood Queensland Palm

JOHN DRANSFIELD, A. K. IRVINE, AND NATALIE W. UHL

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ABSTRACT

Orania appendiculata is shown to be misplaced in *Orania* and to belong to a new genus, *Oraniopsis*, belonging to the tribe Ceroxyleae (subfamily Pseudophoenicoideae) rather than to the tribe Areceae (subfamily Arecoideae). The discovery provides an extraordinary trans-Pacific or trans-Indian Ocean link to the distribution pattern of the Ceroxyleae.

Frederick Manson Bailey, Colonial Botanist to the Government of Queensland, based his new species, *Areca appendiculata*, on a palm collected on the Bellenden-Ker Range, Queensland, during the Government Scientific Expedition in 1889. The palm is referred to, but without name, several times in the official report, and in A. Meston's delightful popular account first published in the "Courier" (the Brisbane newspaper). On Thursday 20th June 1889, at "about 4 o'clock we arrived at 4,000 feet, and camped under a splendid palm tree about 20 feet high, shading a circle 30 feet in diameter. This palm Mr. Bailey may find to be a new species" (Meston 1889). "The point we stopped at is known as the 'Palm Camp,' from a superb palm, beneath the spreading top of which we made our fire and slept."

The palm was duly described as *Areca appendiculata* in 1891. In the protologue, several features stand out as being discordant in *Areca*, especially the position of the inflorescence (Fig. 1B,C), the flowers and the three or four peduncular bracts (Fig. 2B). Bailey added "In many respects this plant resembles *Hydriastele wendlandiana*. I have, however, thought it advisable to keep it under *Areca* for the present, hoping to receive better specimens, those I collected being much damaged by wet." In 1909, Bailey published the illegitimate name *Orania beccarii* clearly citing *Areca appendiculata* as synonym, and commenting "Dr. O. Beccari, the greatest living authority on palms, writes me that this is a distinct species of *Orania*, hence this change of genus. The specific name is changed because it might no longer be found applicable, in which case I hope botanists will allow me this privilege. The first description stands." Domin (1915) transferred the correct specific epithet to *Orania*. In Bailey's 1909 account, *Orania* is correctly described as having two bracts in the inflorescence; the one or two extra bracts of *A. appendiculata* were thus bibliographically lost. The palm is also mentioned by Miss Gibbs in her account of the phytogeography of the Bellenden-Ker (Gibbs 1917).

Orania appendiculata is peculiar in possessing congenitally open flowers, and it was this character, unique to *O. appendiculata* in the genus, and of rare occurrence elsewhere in the palms, which prompted Beccari to suggest in manuscript that *O. appendiculata* should be accommodated in a new subgenus *Oraniopsis*. Beccari's manuscript name was eventually published (Beccari and Pichi-Sermolli 1955) with the commentary that subgenus *Oraniopsis* is quite aberrant, and has some analogies with *Louvelia* in Madagascar by virtue of the congenitally open

flowers, and with *Juania* of Juan Fernandez. Beccari further commented that when the fruit is known, it might be convenient to consider *Oraniopsis* as a distinct genus. However, Essig in his recent synopsis of *Orania* (Essig 1980) made no mention of the generic discordance of *O. appendiculata*, or even of the subgenus *Oraniopsis*.

Good fruiting material collected by H. E. Moore and preserved in the Bailey Hortorium prompted J. Dransfield and N. W. Uhl to look again at the generic affinities of this well-known but little understood Queensland palm and we were immediately struck by the similarities to *Ceroxylon* rather than to Arecoid palms. A. K. Irvine in the meantime had independently realized that many features of *O. appendiculata* are quite anomalous; the present paper is a result of collaborating since December 1982. During 1983 and early 1984 A. K. Irvine collected complete material, including staminate and pistillate inflorescences and ripe fruit, allowing us to confirm affinity with *Ceroxylon* rather than *Orania*. In fact we believe *O. appendiculata* to represent a new genus, closely related to *Ceroxylon* and adding an extraordinary trans-Pacific or trans-Indian Ocean link to the distribution pattern of the tribe Ceroxyleae (subfamily Pseudophoenicoideae). We have chosen to use Beccari's subgeneric name *Oraniopsis* for the new genus, although we must emphasize that there is no relationship between the new genus and *Orania*, except that caused by misunderstanding.

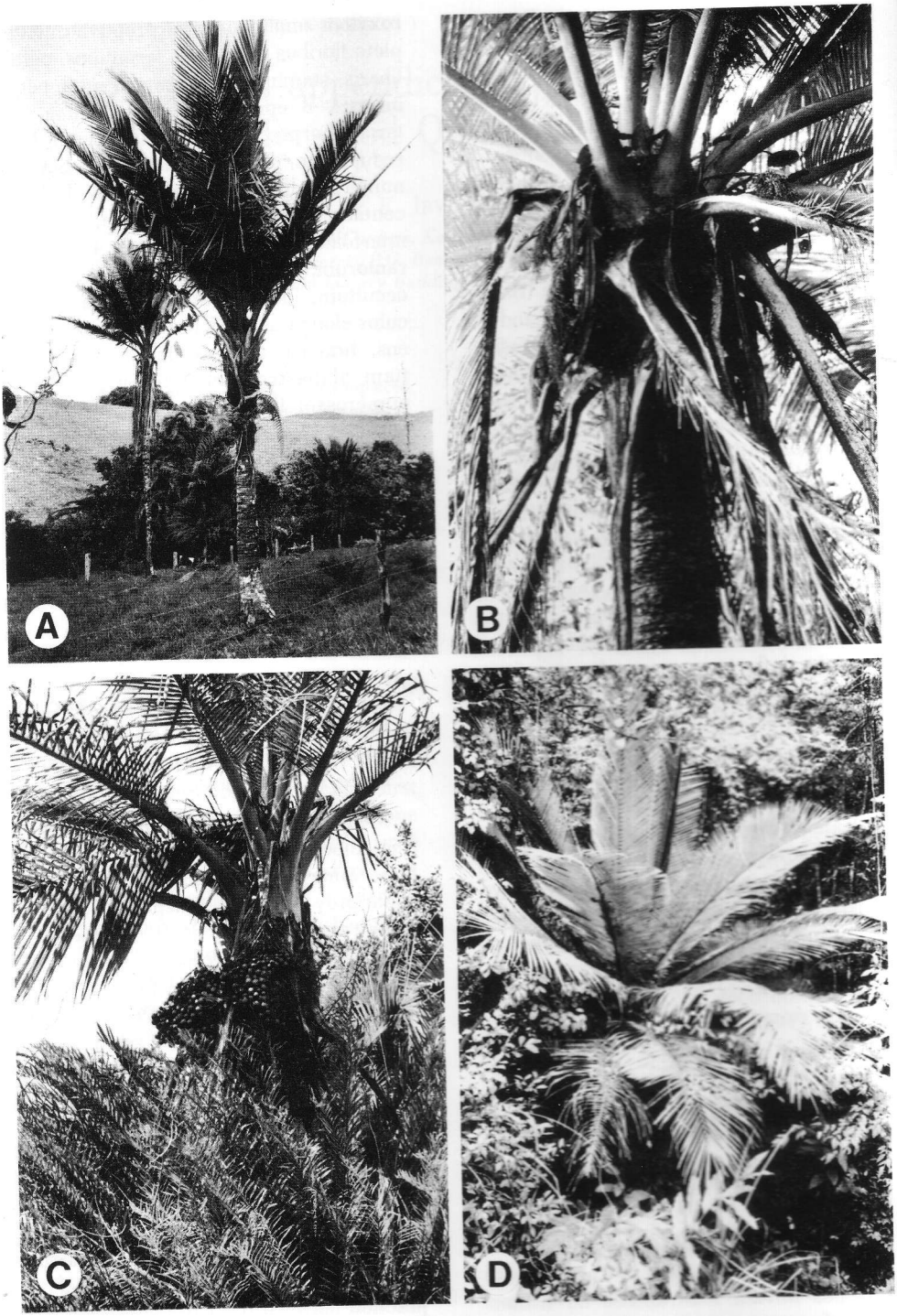
Oraniopsis (*Beccari*) *J. Dransfield, A. K. Irvine & N. Uhl* **gen. nov.** (Figs. 1, 2)

Orania Zippelius subgenus *Oraniopsis* Beccari in Beccari & Pichi-Sermolli, Webbia 11: 172. 1955.

Genus novum Australiense ad tribum Ceroxylearum pertinens et ut videtur Ceroxyloni simillimum sed prophyllo incompleto floribus bracteolas ferentibus, petalis liberis, staminibus egregiis, 3 inter petala insertis, 3 epipetalis differt. Palma solitaria, inermis, pleonantha, dioeca. Folio reduplicate pinnata, foliolis discoloribus, numerosis, regulariter dispositis. Inflorescentiae unisexuales, solitariae, axillares, interfoliaceae, foliis breviores, 4-ordinibus ramorum; prophyllum vaginis foliorum occultum, incomplete tubulosum; pedunculus elongatus, 3–5 bracteas magnas ferens, bracteis 2–3 distalibus inflorescentiam alabastro includentibus; rachillae numerosae; flores solitarii, spiraliter dispositi vel subdistichi, unusquisque bracteolam ferens. Flos staminatus calyce cupulari, petalis 3 carnosis, staminibus 6 et pistillodio parvo vel magno. Flos pistillatus staminato similis sed antheris vacuis et ovario magno trilobato. Fructus rotundatus, vestigio stigmatis basi, endospermio homogeneo, embryone subbasali.

Species unica: **Oraniopsis appendiculata** (F. M. Bailey) J. Dransfield, A. K. Irvine & N. W. Uhl (*Areca appendiculata* F. M. Bailey).

Medium, solitary, unarmed, pleonanthic, dioecious palm. Stem erect, sometimes quite tall, becoming bare, leaf scars apparently not very conspicuous. Leaves numerous, reduplicately pinnate, ± upward-pointing, marcescent, several dead leaves hanging vertically for some time, forming a skirt below the crown before falling completely (Fig. 1B); sheath apparently tubular at first, soon splitting opposite the petiole, the leaf base then open; petiole short, adaxially channeled, ± glabrous, abaxially rounded, densely covered with scales and tomentum, the margins smooth and rather sharp; rachis ± stiffly held, adaxially flattened or channeled near the base, abaxially rounded, distally angled adaxially, a minute flange present at the junction between the flattened and angled areas of the rachis, both surfaces of the


A
B
C
D

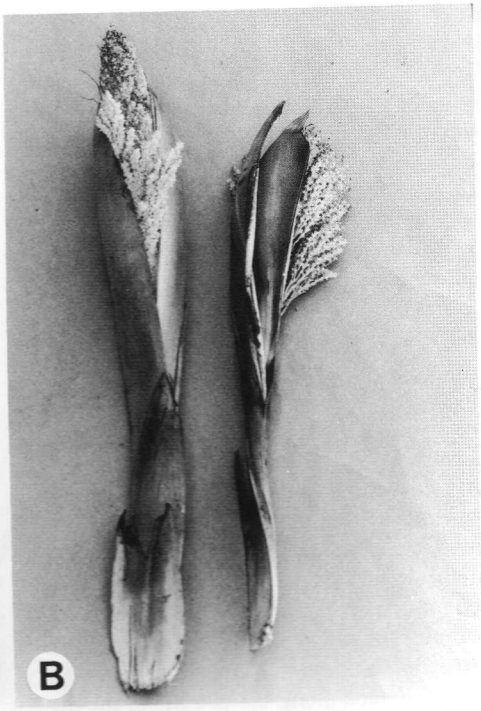
rachis bearing scattered scales; leaflets very numerous, single-fold, regularly arranged, ± stiff, ± linear, unevenly acute or acuminate, the basalmost few on each side short, narrow and crowded, adaxial surface ± glabrous or with scattered scales along the midrib, abaxial surface covered with dotlike scales and a dense felt of indumentum (Fig. 2D); transverse veinlets not evident.

Inflorescences solitary, axillary, interfoliar, shorter than the leaves, staminate and pistillate superficially similar, branching to 4 orders; prophyll short, obscured by the leaf bases, incompletely tubular, 2-keeled, ± leathery, becoming fibrous and disintegrating distally, sparsely tomentose, the basal margins decurrent; peduncle elongate ± flattened and winged at the base, distally ± elliptical in cross-section, sparsely to densely tomentose; peduncular bracts 3–5, elongate, the first inserted near the prophyll, the rest ± evenly spaced along the peduncle, the distal 2–3 ± enclosing the inflorescence in bud, ± beaked, leathery, tubular at first, then splitting longitudinally and becoming flattened, sparsely to densely tomentose, eventually caducous, leaving circular or crescentic scars; rachis slightly shorter than the peduncle; rachis bracts numerous, inconspicuous, short, triangular, acute or acuminate, membranous, incomplete, each subtending a first-order branch; first-order branches with a basal bare portion, distally bearing spirally arranged second-order branches each subtended by a minute incomplete bract; rachillae crowded, ± twisted or zigzag at anthesis, (the pistillate spreading but remaining rather zigzag in fruit), bearing rather distant, spirally arranged or subdistichous, minute triangular bracts, each subtending a short stalk bearing a minute, membranous, incomplete, triangular bracteole and terminating in a solitary flower. Staminate flowers symmetrical, or somewhat misshapen from close packing, open from early in development; sepals 3, very small, triangular, membranous, connate basally and forming a cup; petals 3, free, fleshy, much longer than the sepals, narrow, triangular; stamens 6, almost as long as or longer than the petals, the antesepalous inserted between the petals in, apparently, the same whorl (? by displacement), the antepetalous epipetalous, filaments very fleshy with ± conical, swollen bases, tapering to the connective, anthers ± oblong, ± versatile, basally somewhat sagittate, latrorse; pollen elliptic, monosulcate, exine semitectate, the distal face perforate, the proximal face reticulate; pistillode usually very much shorter than the filaments, 3-angled, apically trifid. Pistillate flowers as the staminate but with slightly broader sepals and petals; staminodes as the stamens, the empty anthers large; gynoecium tricarpellate, triovulate, conspicuously 3-lobed, stigmas apical, short, becoming recurved; ovules laterally attached, ? hemianatropous. Mature fruit developing from 1 carpel, rounded, the stigmatic and carpel remains basal; epicarp smooth, yellow at maturity; mesocarp ± fleshy, with horizontal fibers and stone cells; endocarp obsolescent. Seed, rounded, the integuments thick, ± woody,

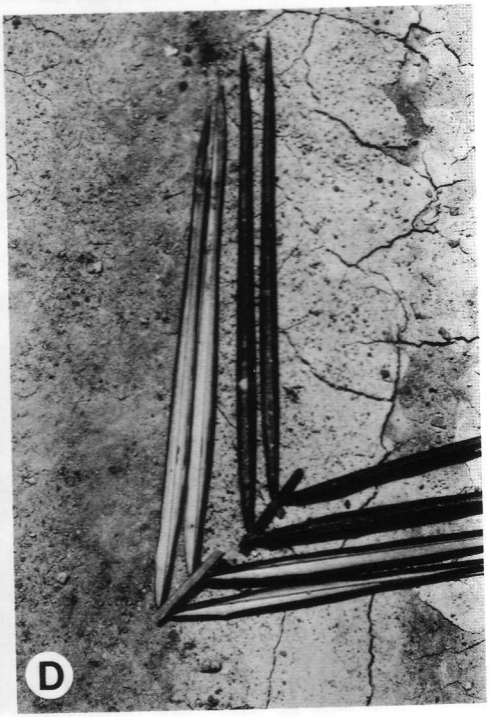
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1. *Oraniopsis appendiculata.* A. Watson Road Millaa Millaa, Atherton Tablelands, North Queensland. Form of palms left exposed after clearing land for dairy farming, some 60–70 years earlier. The palms are 9 meters tall × 20 cm stem diameter, and would have at least been taller than the reach of cattle 60–70 years ago and noticeable enough for the farmer to leave standing. B. Kelly Road, Millaa Millaa, North Queensland. Old inflorescences in axils of leaves. C. Watson Road, Millaa Millaa, North Queensland. Exposed palm with full size but ⅗ mature, green fruit. Foreground: *Drynaria rigidula*, an epiphytic fern growing on the palm. Background right: *Calamus moti.* D. Topaz, North Queensland. In rain forest gully near edge. Overall height 9 meters. 1-12-1984. Photos by Tony Irvine.


A


B


C


D

with a basal short spur, and few sparsely branched, impressed vascular strands; endosperm homogeneous with a narrow central hollow; embryo sub-basal. Germination adjacent-ligular; seedling leaf bifid with entire tips.

Oraniopsis appendiculata (*F. M. Bailey*) *J. Dransfield, A. K. Irvine & N. W. Uhl*, **comb. nov.**

Areca appendiculata F. M. Bailey, in Dep. Agric. Bot. Bulletin 4: 18. 1891. Type: Queensland, Bellenden-Ker, *F. M. Bailey* s.n. in 1889 (BRI).

Orania appendiculata (F. M. Bailey) Domin in Bibliothec. Bot. 85: 498. 1915.

Orania beccarii F. M. Bailey in Queensland Agric. Journal 23: 35. 1909. Type as for *A. appendiculata*.

Trunk up to 20 m tall, 20–45 cm diam. at breast height, gray, irregularly marked with leaf scars. Leaves ca. 8–15 in crown, up to ca. 6 m long; sheathing base cup-like, rather short ca. 20 cm wide at the base, tapering to ca. 15 cm wide, and then narrowing into the petiole; petiole up to ca. 65 cm long, up to ca. 7.0 × 6.0 cm in section, the margins ± winged, ca. 1–2 cm deep, sharp, abaxially brown tomentose; rachis becoming adaxially ridged at ca. half its length; leaflets up to ca. 110 on each side of the rachis, the apical pair composed of 2–4 folds, the rest all single-fold, basal leaflets ca. 15–20 × 0.5–0.8 cm, mid-leaf leaflets to ca. 100 × 4.5 cm, apical pair up to ca. 43 × 4.5 cm, leaflets held at ca. 60° from the rachis except near the tip where ca. 30°; adaxial surface dark green, abaxial surface mealy, grey-white, tinged brown, with numerous small, dark brown scales. Inflorescences 80–120 cm long; peduncle up to ca. 75 cm long, up to ca. 4 × 2 cm in cross-section, strongly flattened and winged at the base; prophyll borne near the base of the peduncle, ca. 25 × 6 cm, abaxially open to the base, adaxially splitting irregularly; peduncular bract 1 inserted 6–13.5 cm above the base, up to ca. 60 cm long, split abaxially, opening out somewhat, ca. 10 cm wide at widest point, strongly keeled; peduncular bract 2 inserted ca. 20–26 cm above the base, 60–135 × 8–12 cm; peduncular bract 3 inserted ca. 25–50 cm above the base, slightly smaller than bract 2; peduncular bract 4, where present, inserted up to 70 cm above the base, either similar to bract 3, up to 87 cm long or dissimilar, triangular, membranous, ca. 5 cm long, incompletely sheathing with long decurrent margins; peduncular bract 5, where present, inserted up to 70 cm from the base, membranous, subulate, ca. 6 cm long; rachis ca. 35–45 cm long; rachis bracts triangular, membranous, easily disintegrating, the basal to 4 × 1 cm, the distal very small and inconspicuous; first-order branches ca. 70 in staminate, 30–40 in pistillate inflorescence, spirally arranged; rachillae very numerous, staminate ca. 3–5 × 0.15 cm, pistillate ca. 4–10 × 0.2 cm. Staminate flowers cream-colored, borne on pedicels ca. 1.2 × 1.2 mm; calyx ca. 1 mm high with lobes to 0.5 mm; petals ca. 6 × 2 mm; filaments ca. 3–3.5 mm long, ca. 1

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2. *Oraniopsis appendiculata*. A. Watson Road, Millaa Millaa, North Queensland. An exposed staminate palm 7 meters tall, stem diameter 22 cm, on land cleared 60–70 years earlier for dairy farm. Note epiphytes: *Drynaria rigidula* (a fern) and *Schefflera actinophylla* (Araliaceae) Umbrella Tree. Background left: *Calamus moti*. Note the palms would have at least been taller than the reach of cattle 60–70 years ago. B. Keith Davis's farm, Watson Road, Millaa Millaa, North Queensland. Staminate inflorescence left, pistilate inflorescence right. C. Leaf, Topaz, North Queensland. Taken at Timberlea, Atherton (Irvine's home), daughter Rina (nearly 10 years old) and son Ian (4 years old). D. Kelly Road, Millaa Millaa, North Queensland, Australia. Upper and lower leaflet surfaces, greyish white below, green above. 1-12-1984. Photos by Tony Irvine.

mm diam. at the base, anthers ca. 5 × 1 mm; pistillode ca. 1 mm high, sometimes longer. Pistillate flower similar to staminate; pedicel ca. 2 × 2 mm; calyx ca. 1 mm high with lobes to 0.5 mm; petals 5 × 2.2 mm; filaments of staminodes 1.5 × 1 mm, empty anthers ca. 3 × 0.8 mm; ovary strongly 3-lobed, ca. 2 × 3.5 mm, the stigmas ca. 0.8 × 0.3 mm, mature fruit 2.7–3.4–2.3 × 2.4–2.9 cm borne on pedicels 3 × 3–4 mm; epicarp bright yellow; mesocarp ca. 2.7–3.0 mm thick, the outer ca. 1.7 mm wide layer semi-clear, the inner layer white pulpy; seed globose, ca. 2.2 cm diam., the integument black, ca. 0.5 mm thick; endosperm with a small central hollow ca. 2 mm wide.

SPECIMENS EXAMINED: AUSTRALIA: North Queensland: Upper Mossman River, 20.9.1936, *H. Flecker 2324* (QRS); Eastern slope of Mt. Bartle Frere, 29.10.1939, *H. Flecker 6405* (QRS); Harvey Creek, 9.11.1947, *H. Flecker 11788* (♀) (QRS); Boonjie Logging Area, State Forest Reserve 1230, Western foothills of Mt. Bartle Frere, 4.4.1972, *A. K. Irvine 179* (♂) and *180* (♀) (QRS); Mt. Lewis, State Forest Reserve 143, 22.8.1972, *A. K. Irvine 310* (♀) and *311* (QRS); Boonjie Logging Area, State Forest Reserve 1230, 23.1.1973, *A. K. Irvine 444* (♀) (QRS); Topaz, 7.2.1983, *A. K. Irvine s.n.* (♀) (BH, BRI, K); Millaa Millaa, Watson Road, 13.3.1984, *A. K. Irvine s.n.* (♀) and (♂) (K); Topaz, 14.3.1975, *G. Unwin 2* (♀) and (♂) (QRS); Mt. Bellenden-Ker, 1914, *L. S. Gibbs* 6316 (K);

Distribution: *Oraniopsis appendiculata* occurs in rain forests of mountain ranges between the upper Tully River area (15°40′S), northwards to the Big Tableland (17°50′S) about 25 km south of Cooktown with the most inland occurrence being on the Great Dividing Range, southwest of Atherton, some 75 km inland, above 1,100 m altitude.

Ecology: The species occurs mostly above 300 m up to ca. 1,500 m altitude, and also in narrow gorges and gullies at the foot of abruptly descending coastal ranges, but does not extend on to the broader coastal plains. Rainfall is mostly above 1,800 mm per annum, with frequent cloud mist compensating rainfall in the 1,800 mm regions. Soil types are mostly of granitic and metamorphic origin; the palm also occurs on shallow basaltic soils with impeded drainage. The palm is usually absent from deep, well-drained basalt soils. It occurs in the following rain forest types (Tracey and Webb 1975): Simple Microphyll Vine Fern Thicket, Simple Notophyll Vine Forest, Upland Mesophyll Vine Forest and Complex Mesophyll Vine Forest.

Seeds begin to germinate after 200–400 days, but some may continue to germinate 3–4 years after sowing. The palm is very slow growing and seems to stay in the rosette stage for at least 20–30 years. In dense rain forest rosettes may even be twice this age with erect leaves 3–8 m long. Unless growth rates accelerate markedly when a trunk is produced, tall stemmed individuals must be several hundred years old.

Oraniopsis is very closely related to *Ceroxylon*; indeed the only differences between the two genera are the presence in *Oraniopsis* of a bracteole on the pedicel, the incomplete rather than closed prophyll, the free petals, and the curious position of the antesepalous stamens. The differences between the genera of the Ceroxyleae are best displayed in the following key.

Key to Genera of Ceroxyleae

1. Stigmatic remains basal in fruit 2
1. Stigmatic remains lateral to subapical in fruit 3
2. Petals basally united; stamens 6–15 or more. Andes of S. America ..... *Ceroxylon*
2. Petals free; stamens 6. Queensland ..... *Oraniopsis*
3. Androecium with united filaments. Madagascar ..... *Louvelia*
3. Androecium with free filaments 4
4. Pistillate flower with staminodes bearing rudi-

mentary anthers; staminate inflorescence often multiple; prophyll incomplete. Madagascar ..... *Ravenea*

4. Pistillate flower with staminodes lacking rudimentary anthers; staminate inflorescence solitary; prophyll complete. Juan Fernandez Is. ... *Juania*

It would seem at first that the discovery of a close relative of *Ceroxylon*, an Andean genus, in Australia suggests a strong trans-Pacific link; the presence of another member of the Ceroxyleae, *Juania*, on Juan Fernandez off the coast of Chile, would seem to emphasize a trans-Pacific distribution pattern of the tribe. However the two other Ceroxyloid genera, *Louvelia* and *Ravenea* are both confined to Madagascar and offshore islands, and the distribution of the Ceroxyleae might better be explained by an origin in Gondwanaland, followed by rafting on land destined to become present day Madagascar, Australia and South America. Whatever the ancient dispersal path, the presence of *Oraniopsis* in Australia is of great phytogeographic interest.

Acknowledgments

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CLASSIFIED

COLOMBIAN PALM SEEDS. May–Dec 85 I will make expeditions through Colombia in search of seeds of *Acrocomia, Aiphanes, Ammandra, Asterogyne, Astrocaryum, Attalea, Bactris, Catoblastus, Ceroxylon, Chamaedorea, Chelyocarpus, Copernicia, Cryosophila, Desmoncus, Dictyocaryum, Elaeis, Euterpe, Geonoma, Hyospathe, Iriartea, Iriartella, Jessenia, Leopoldinia, Lepidocaryum, Manicaria, Mauritia, Maximiliana, Metasocratea, Oenocarpus, Orbignya, Parajubaea, Parascheelea, Pholidostachys, Phytelephas, Prestoea, Raphia, Reinhardtia, Sabal, Scheelea, Socratea, Syagrus, Synechanthus, Welfia* and *Wettinia*. $.35 US per seed plus postage. List desired species and quantity (min order 100 seeds per species). Seeds sent as available, on a "first come first served" basis. GABRIEL DARIO BOLIVAR, Transversal 39 No 73 B-56, Medellin, Colombia.

Principes, 29(2), 1985, pp. 64–71

Pollination of Socratea exorrhiza and Iriartea ventricosa

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ABSTRACT

Inflorescence morphology, development, and insect visitors of *Socratea exorrhiza* (Mart.) H. A. Wendl. and *Iriartea ventricosa* Mart. were observed in southern Venezuela. Beetle and bee pollination, respectively, were found. The taxonomic significance of the results is discussed. Floral anatomy, pollen morphology, and the role of peduncular bracts are considered.

RESUMEN

La morfología, el desarrollo, e insectos visitantes de las inflorescencias de *Socratea exorrhiza* (Mart.) H. A. Wendl. y *Iriartea ventricosa* Mart. fueron observadas en el sur de Venezuela. Polinización por escarabajos y abejas fue encontrada, respectivamente. El significaco taxonómico de los resultados es discutido. Anatomía floral, morfología del polen, y el papel de las brácteas pedunculares es considerado.

The neotropical iriarteoid major group of palms is divided into two alliances (Moore 1973). The *Iriartea* alliance consists of four genera, *Socratea*, *Iriartea*, *Iriartella*, and *Dictyocaryum*. It has been suggested that the differences between taxa in this alliance are insufficient to merit generic separation. Macbride (1960) considered that *Socratea*, *Iriartea*, and *Iriartella* were so alike that they should be united in one genus. Wessels Boer (1965, 1972) also thought that the genera were little different, and reduced all four members of the alliance to a single genus, *Iriartea*. Moore (1963) disagreed with Macbride, and emphasized that there were significant differences which would be obscured by such a reduction.

Until now little was known concerning inflorescence morphology, development, and pollination of the genera, although Bullock (1981) reported that in Costa Rica *Socratea durissima* was protogynous and beetle pollinated, and *Iriartea gigantea* was protandrous and bee pollinated. The purpose of the present study was to investigate pollination syndromes in relation to taxonomy.

Materials and Methods

The study site was the Cerro de la Neblina Expedition's base camp, situated at the mouth of the Cañon Grande on the Río Mawarinuma, Departmento Río Negro, Territorio Federal Amazonas, Venezuela (00°50′N; 66°10′W). The altitude was 140 m. Both species were common in seasonally-flooded forest along the river (Figs. 1,2). Inflorescence morphology, development, and insect visitors were observed between 15 February and 13 March 1984. Palms, or adjacent observation trees, were climbed using climbing spikes (Ets Lacoste, 24160 Excideuil, France). Herbarium specimens of each species were collected, and are deposited in NY and VEN. A photographic record of inflorescence development was made. Representative specimens of insect visitors were preserved in alcohol.

Socratea exorrhiza: Inflorescence Morphology, Development, and Insect Visitors

The inflorescence consists of a peduncle, up to 35 cm long and 5 cm diam.,



1. *Socratea exorrhiza* growing along the Río Mawarinuma near Cerro de La Neblina.



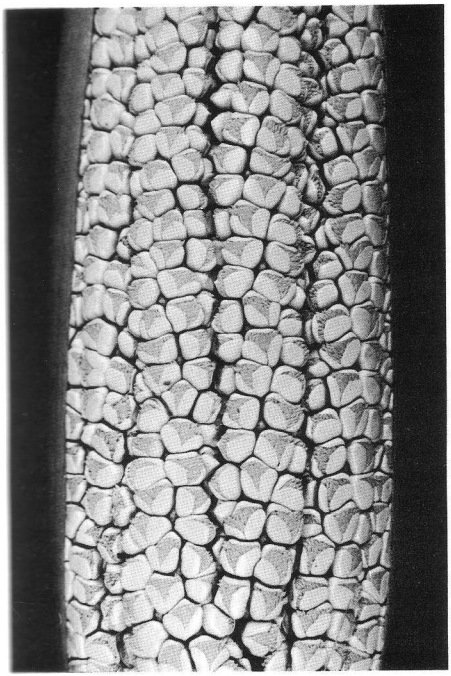
2. *Iriartea ventricosa* growing along the Río Mawarinuma near Cerro de La Neblina.



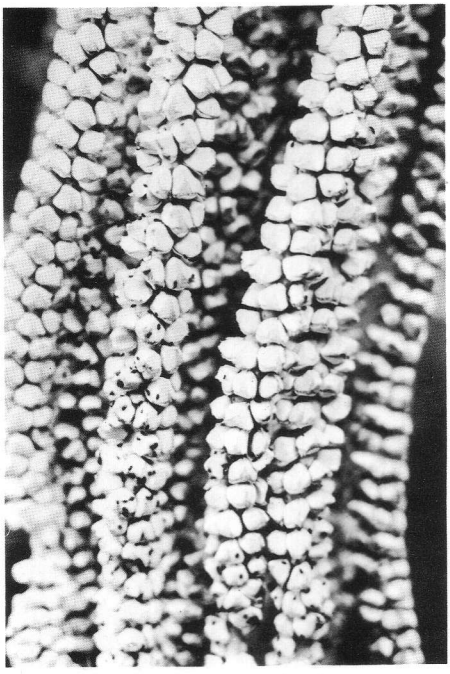
3. Inflorescence bud of *Socratea exorrhiza* after leaf abscission.

oval in cross-section, and covered with light brown trichomes. The peduncle bears a prophyll and five thin peduncular bracts, ranging from 10 cm to 60 cm long. The rachis is approximately 15 cm long, and bears up to 15 unbranched rachillae, each 30–40 cm long, covered with translucent trichomes. The rachillae are densely covered with triads of a central pistillate and two lateral staminate flowers, except for the distal 10 cm which bear only staminate flowers. On some inflorescences the distal 10 cm is separated by a short section of rachillae, 2 cm long, which bears no flowers at all. Staminate flowers have a 3-lobed calyx, the lobes are 2 mm long, and three free waxy petals, 10 mm long. Stamen number ranges from 65 in proximal flowers to 17 in distal flowers. Pistillate flowers have three imbricate sepals, 4 mm long, and three imbricate petals, 5 mm long, and a short, sessile 3-lobed stigma. Peduncle, rachis, rachillae, and flowers are all ivory-colored.

Developing inflorescence buds elongate vertically within their enclosing leaf-sheaths, and the lowest bud is only apparent as a swelling at the base of the crown-shaft. When the lowest leaf dies its sheath splits from the base opposite the bud and abscises. This reveals the vertical, dorsiventrally compressed, lanceolate bud. It is tightly enclosed at this time by its prophyll and five peduncular bracts. The bud remains in this state and position for the next 48 hours after leaf abscission (Fig. 3). Inside the bud the rachillae are closely pressed together, but both staminate and pistillate flowers are fully developed. Flowers on adjacent rachillae interlock with each other. Staminate flowers have their petals pushed apart and angled by internal pressure, so that the stamens are clearly visible (Fig. 4). Pistillate flowers have their



4. Inflorescence bud of *Socratea exorrhiza* with peduncular bracts removed. Note stigmas of pistillate flowers just visible between staminate flowers.



5. Inflorescence of *Socratea exorrhiza* during day between pistillate and staminate anthesis. Beetles are crawling over flowers.

stigmas exserted, so that they are just visible projecting between their two lateral staminate flowers (Fig. 4). Stigmas at this time are white and covered with glistening projections, and are presumably receptive.

Towards the second evening of the 48 hour vertical period the peduncle begins to bend through 180°, so that by nightfall the bud lies parallel to the trunk, pointing down. The prophyll and three proximal bracts split abaxially as the peduncle bends, and remain erect, while the remaining two distal bracts still enclose the bud. The bending of the peduncle does, however, cause these remaining two bracts to separate partially from the peduncle, thus forming an entrance to the rachillae and pistillate flowers at anthesis. Also at this time the inflorescence gives off a musty, fruity odor. During the following night numerous Coleoptera arrive on the inflorescence, and crawl into the center among the rachillae, through the opening formed by the bracts. These Coleoptera were mostly Nitidulidae and Curculionidae. On one inflorescence, at 0900, the following were collected:

2450 *Phyllotrox* sp.
(Curculionidae, Derelomini)
4700 *Mystrops* spp.
(Nitidulidae) 2, possibly 3, species
145 *Phloeonomus* sp.
(Staphylinidae, Omaliinae)
Unknown genus
(Staphylinidae, Aleocharinae)
Numerous mites *Rhinoseius* sp.
(Acari, Gamasina, Ascidae)

By morning the remaining two bracts have fallen from the inflorescence. During the following day the rachillae stay closely bunched (Fig. 5). Stigmas are brown and no longer receptive. The beetles contin-



6. Inflorescence of *Iriartea ventricosa* showing bifurcated rachillae, trichomes, and staminate flowers at anthesis.

ually crawl over the inflorescence, apparently eating the trichomes on the rachillae. Numerous small flies and bees also visit the inflorescence during the day. Staminate anthesis takes place the following night, starting with those flowers inside the inflorescence. By early next morning most staminate flowers have fallen, and all beetles have left.

Iriartea ventricosa: Inflorescence Morphology, Development, and Insect Visitors

The inflorescence consists of a peduncle, up to 30 cm long and 7 cm diam., round in cross-section, and densely covered with short brown trichomes. The peduncle bears a prophyll and 14 woody peduncular bracts, ranging from 9 cm to 230 cm long, and 5 mm thick. The rachis is approximately 25 cm long, and bears up to 60 rachillae, each up to 120 cm long, and densely covered with woolly trichomes. The proximal ten rachillae bifurcate at their junction with the rachis (Fig. 6). The rachillae bear spirally arranged triads of a central pistillate and two lateral staminate flowers, except for the distal 20 cm which bear only staminate flowers. Staminate flowers have three free sepals, 2 mm long, and three free petals, 5 mm long. Stamen number ranges from 11 to 13. Pistillate flowers have three imbricate sepals, 2 mm long, and three imbricate petals, 4 mm long, and three sessile stigmas. Peduncle, rachis, rachillae, and flowers are all ivory-colored.

Immature inflorescence buds are enclosed by the crownshaft at first, but most of their development takes place free from the leaf sheath, and the small buds are clearly visible on the trunk. They elongate horizontally at first, eventually curving downwards (Fig. 2). The prophyll and 14 peduncular bracts are deciduous, falling proximally from the peduncle as it elongates. When the last bract falls, the rachillae become visible, and hang straight down parallel to the trunk. At this time staminate anthesis begins. No particular pattern of flower opening was apparent, but rather, open flowers were randomly dispersed on the inflorescence. Only one flower per triad opened at any one time. Pollen was shed in sticky yellow masses, and often these adhered to the rachilla trichomes. Staminate anthesis continued for a period of at least ten days, although individual flowers were short-lived, and quickly fell from the inflorescence. During this time numerous bees, belonging to a species of *Trigona*, were observed collecting pollen from the anthers. Other less frequent visitors were halictid bees, vespid wasps, and syrphid flies. Pistillate anthesis began after all staminate flowers had fallen. Individual flowers became receptive sequentially, and dropped from the inflorescence if not pollinated. Pistillate anthesis continued for at least five days. Bees

of the same species of *Trigona* were observed visiting inflorescences at pistillate anthesis, but in fewer numbers.

Discussion

Correlation of inflorescence morphology, development, and insect visitors indicate that *Socratea exorrhiza* is beetle pollinated, and *Phyllotrox* sp. and *Mystrops* spp. are co-pollinators. The beetles appear to be attracted to the inflorescence by scent, and possibly by the prophyll and three vertical proximal bracts acting as a signal. Once on the inflorescence they appear to eat trichomes and pollen, and possibly breed. Some of the nitidulids appeared to be ovipositing. In the case of *Iriartea ventricosa*, although fewer observations were made, pollination appears to be effected by *Trigona* sp. These bees appear to be attracted to inflorescences at staminate anthesis by the pollen, which they collect. It is not known why they are attracted to inflorescences at pistillate anthesis, although it is possible that they collect trichomes. Schwarz (1948) reported that stingless bees collect a variety of resins, oils, and waxes from plants, and these are often contained in trichomes.

The results of this study agree with Bullock's (1981) findings in Costa Rica. What is their taxonomic significance? Apart from clear and obvious morphological differences between the two species, the differences in inflorescence morphology, development, and pollination strongly support Moore's (1963) contention that these palms should be recognized at the generic level. Although Wessels Boer argued against this, it is clear from his discussion (1965) that he did not take into account inflorescence position and development, presumably because his field observations were limited to *Socratea exorrhiza*. Faegri and van der Pijl (1979) have pointed out the taxonomic dangers of either over- or under-emphasizing morphological differences associated with pollination, in the case of *Socratea* and *Iriartea* the differences appear major rather than minor.

Two other aspects of these palms should also be considered in relation to pollination; pollen morphology and floral anatomy. Thanikaimoni (1970) described *Socratea exorrhiza* pollen as monosulcate, intectate and echinate, and *Iriartea ventricosa* pollen as monosulcate, intectate and clavate. It does not yet seem possible to make any correlation between pollen morphology and pollination mechanism of these two palms. The anatomy and histology of pistillate flowers of *Socratea exorrhiza* has been described by Uhl and Moore (1971, 1973). The gynoecium has large tannin cells around the base, fiber-sclereids around the vascular traces in the upper part, and raphides scattered throughout. Sepals and petals contain fibers. Uhl and Moore (1973, 1980) described anatomy and histology of staminate flowers. Neither sepals nor petals are very fibrous, but petals are large and fleshy. Petals contain an abaxial layer of tanniferous cells. Anthers contain tanniferous cells in the epidermal layer and sclerotic areas. This appears to represent a similar anatomical condition to the beetle pollinated *Bactris* (Uhl and Moore 1977). The less fibrous staminate perianth may provide food for insects, while the better protected pistillate flowers may deter insect feeding. The abaxial layer of tanniferous cells in staminate petals may be positioned to protect anthers in the same way that fibrous bundles do in *Bactris*. The exposed anthers are protected by tanniferous cells and sclerotic areas. The greater number of sclereids and raphides in the upper part of the gynoecium may represent increased protection in an area not covered by the perianth.

It is also of interest to compare the two genera in terms of the role of their peduncular bracts. *Socratea exorrhiza* has its inflorescence buds protected throughout their development by the enclosing leaf-sheath, and the buds are only exposed

externally during the 48 hour vertical period. Thus for protection the bracts are of lesser importance. However, they play an integral role in pollination, in that the distal two bracts funnel pollinators into the bud when pistillate flowers are at anthesis. By comparison, the inflorescence buds of *Iriartea ventricosa* are externally exposed throughout most of their several weeks of development. Thus the numerous, relatively thick, bracts play a protective role. However, being deciduous before staminate anthesis they contribute nothing to pollination. A third iriarteoid palm, *Iriartella setigera*, occurred sympatrically at the study site. This is a much smaller, stoloniferous, understory species. Although no information on the pollination of this palm was obtained, observations of inflorescence development showed that the four peduncular bracts played no part in either protection or pollination. Development of flower buds took place slowly after the slender green rachillae had become exserted from the bracts. Other morphological differences were observed between *Iriartella setigera* and the much larger *Socratea* and *Iriartea*. It could represent a reduced form of the other two genera, or it could be more related to another group. Moore (1973) noted the similarities, particularly in leaf morphology, of *Iriartella* to the podococcoid palms of West Africa. Sowunmi (1972) pointed out how the pollen of *Iriartella setigera*, monocolpate, pontoperculate and reticulate, differed from *Socratea* and *Iriartea*.

Pollination of *Socratea* and *Iriartea* may be contrasted with that of other palms. No obvious correlation is apparent between pollination mechanism and systematic position in the family. In the least specialized coryphoid major group wind pollination is known in *Thrinax* (Read 1975), beetle pollination in *Rhapidophyllum* (Shuey and Wunderlin 1977) and *Cryosophila* (Henderson 1984), and bee pollination in *Sabal* (Brown 1976). The present study and Essig's (1973) work show similar diversity in the iriarteoid and arecoid major groups, respectively. What is apparent is that a similar beetle pollination syndrome is widespread in the family, and this is similar to that of other angiospersms (Faegri and van der Pijl 1979). This syndrome may involve protogyny, inflorescences with light color, musty smell and temperature elevation, and relatively long pistillate anthesis separated temporally from a short nocturnal staminate anthesis. In palms the pollinators are often the same or closely related genera of curculionid and nitidulid beetles, which feed and breed on inflorescence tissue. There are many examples, and palm pollination will be the subject of a forthcoming review.

Insects and arachnids collected from the inflorescence of *Socratea exorrhiza*, and their behavior, indicate a complex pattern of interrelationships. The pantropical tribe Derelomini (Curculionidae) is usually associated with palm inflorescences (Essig 1973, O'Brien pers. comm.). The neotropical genus *Mystrops* (Nitidulidae) is also usually associated with palm inflorescences, and often several species are found on one inflorescence (Watrous pers. comm.). It is possible that both these groups of beetles spend the greater part of their life cycles on palm inflorescences, and a mutual interdependence may exist. The staphylinids collected are known to be predaceous on eggs and larvae of other insects (Herman pers. comm.), and this may explain their presence. They may also feed on pollen. Lastly, the mites collected, *Rhinoseius* sp., are apparently host specific to *Mystrops* (Kethley pers. comm.). They are related to the same flower mites that hummingbirds transfer between bird pollinated plants (e.g., Colwell 1979). The same type of mutualism between hummingbirds, mites and flowers may exist between *Mystrops*, mites and palm inflorescences. These preliminary observations and conjectures raise many interesting questions not only about the ecology of

the palms and their visitors, but also about their evolutionary history.

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Palm Research at La Selva, Costa Rica

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During the past 15 years, La Selva has been a busy hive of research on many aspects of tropical biology. Much of this research has been done by graduate students at U.S. and Costa Rican universities. Many investigations by students are initiated as individual or group projects during or following a field course offered by the Organization for Tropical Studies (OTS). For the past 5 years, OTS has funded numerous doctoral research projects through grants from the Jessie Smith Noyes Foundation. The development of improved research and housing facilities, such as a new air-conditioned laboratory and spacious cabins for long-term researchers, was made possible through grants from the National Science Foundation. The excellent research facilities at La Selva (including 2 microcomputers) and the easy accessibility of a diversity of rain forest habitats make La Selva one of the best sites in the world for tropical research. Furthermore, the site has been selected by the National Research Council Committee on Research Priorities in Tropical Biology as one of four worldwide tropical localities for intensive long-term ecological research.

1968–1980

Palm research at La Selva gained impetus soon after 1968, when OTS purchased the reserve from Leslie R. Holdridge, an internationally known tropical forester. This purchase opened the door to research at La Selva. Each year students in courses sponsored by OTS and other institutions visit the field station. Some return and add to the continually growing research base of the field station. Schmid's early studies of pollination in *Asterogyne martiana* were of the first to describe pollination in a rain forest palm species (Schmid 1970*a*, *b*). A long-term project on the demography of *Welfia georgii* was undertaken by John Vandermeer, Jean Stout, Steve Risch, and Gene Miller in the mid 70's. This project has produced several interesting publications (Vandermeer et al. 1974, 1979, Vandermeer 1977, see also Vandermeer 1983). Young (1973) studied the incidence of cicadas on various palm species at La Selva.

1980–1984

The 80's ushered in a new era of palm research at La Selva. Increased levels of research funding and improved facilities attracted graduate student research. James Beach (now of Duke University) conducted detailed investigations of the phenology of *Asterogyne martiana* and also studied pollination of *Bactris gasipaes* and *B. porschiana* (Beach 1984). The flowering phenology and insect visitors of eight palm species were studied by Steve Bullock, now of Universidad Nacional Autonoma de Mexico (Bullock 1981). Robin Chazdon (formerly of Cornell) studied the ecophysiology and architecture of *Asterogyne martiana*, *Geonoma cuneata*, and *G. congesta* (Chazdon 1984).

H. Elizabeth Braker (Univ. of Calif., Berkeley) investigated the feeding ecology of *Microtylopteryx hebardi*, a rain forest grasshopper that feeds on understory palm species and other understory plants. While

they were at La Selva together, Chazdon and Braker collaborated in studies of the interactions between this important herbivore and its palm food-sources. Andrew Henderson of the New York Botanical Garden studied beetle pollination of *Chryosophila albida* (Henderson 1984). Paul Rich (Harvard) is currently conducting research on the mechanical architecture of six canopy and subcanopy palm species at La Selva, including *Iriartea gigantea* and *Welfia georgii*.

Despite the recent surge of interest in studying palms in their natural environment, much work remains to be done. The reproductive biology of most of the geonomoid species at La Selva has not been investigated. The ecology of the swamp species *Astrocaryum alatum* and *Calyptrogyne sarapiquensis* and the liana *Desmoncus costaricensis* remains unstudied. Relatively little attention has been focused on studies of frugivory, seed dispersal, and seedling establishment of palm species. La Selva is also an excellent site for research on responses of palm species to habitat degradation and succession, a subject of increasing concern in view of the deforestation of many tropical areas.

There is always the continual need for further collecting of palms both inside and outside the borders of La Selva. The palm flora of the adjacent Zona Protectora altitudinal transect has not yet been described, and undoubtedly harbors new species. The future holds much excitement for the study of palms at La Selva and its environs.

Note: For more about the palms at La Selva see pp. 74–85.

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The Palm Flora of Finca La Selva

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Finca La Selva is a biological field station owned and maintained by the Organization for Tropical Studies, a consortium of 27 educational institutions in the United States and Costa Rica. La Selva is located in the Atlantic lowlands of northeastern Costa Rica (10°26′N; 84°00′W) at an elevation of 40–150 m. Annual precipitation averages about 4,000 mm (157 in), and mean daily temperature is 24° C (75° F). Since it was established in 1968, La Selva has been one of the world's most active centers of research and education in tropical biology. The biological reserve at La Selva comprises an area of 1,366 ha (3,500 acres) and supports a wide diversity of habitats. Most of the land area (71%) is primary tropical wet forest. Other areas include swamp forest, treeless swamps, and secondary forest in various phases of regrowth. Over 1,500 vascular plant species have been catalogued, compared with an estimated 12,000 in all of Costa Rica (which is the size of West Virginia). Almost one third of the plant species are trees (440 species at present count). The rain forest at La Selva also supports an extremely diverse fauna, including over 50 species of snakes and 388 species of birds.

One of the most striking characteristics of the rain forest here is the tremendous diversity and abundance of palms, making La Selva one of the richest areas in the world for this family. Thirty-one species of palms are found, most of which can be seen in an hour's walk along one of the well maintained trails. The palm flora of La Selva contains representatives of 16 genera and 6 major groups (Moore 1973; see Table 1). The largest genera are *Geonoma* with 7 species, *Bactris* with 5 species and *Chamaedorea* with 4 species. Most of the palm species that occur at La Selva are restricted to Central America; as many as 8 species are probably endemic to Costa Rica and southern Nicaragua, according to Standley (1937). The type specimens of *Geonoma ferruginea* and *G. longevaginata* were collected in the Sarapiqui region of Costa Rica where La Selva is located (Wessels Boer 1968). For these palms, and for hundreds of plant and animal species, the La Selva reserve is probably the only protected habitat in their geographic range.

Palms are found everywhere on the property, and occupy understory, subcanopy and canopy positions. While some species are found in second-growth forest, all of the species (except one cultivated species) occur in the undisturbed old-growth forest. Furthermore, all of the species have shade-tolerant seedlings. Few of the palms actually reach the highest level of the forest canopy. *Euterpe macrospadix* is the tallest species and may actually emerge above the level of the canopy. The smallest palm in Costa Rica, *Reinhardtia simplex* (see Fig. 2C), also occurs here. This dwarf palm produces flowers when only 30 cm high.

Most of the taller palms are found just below the canopy at about 15–20 m. The most common subcanopy palm is *Welfia georgii*, whose distinctive maroon-red new leaves contrast with the deep green forest background. *W. georgii* reaches densities up to 54 stems per hectare, and, by some estimates is the second most abundant tree

*Table 1. Palm species at La Selva according to major groups (Moore 1973).**

Arecoid

Euterpe macrospadix Oerst. (C)
Prestoea decurrens (H. A. Wendl.) H. E. Moore (U/SC)
Reinhardtia gracilis (H. A. Wendl.) var. *rostrata* (Burret) H. E. Moore (U)
R. simplex (H. A. Wendl.) Burret (U)

Chamaedoreoid

Chamaedorea exorrhiza H. A. Wendl. ex Guillaumin (U)
C. warscewiczianus H. A. Wendl. (U)
C. geonomiformis H. A. Wendl. (U)
C. sp. nov. fide H. E. Moore (U)
Synechanthus warscewiczianus H. A. Wendl. (U)

Cocosoid

Astrocaryum alatum Loomis (U)
A. standleyanum L. H. Bailey (SC)
Bactris gasipaes H.B.K. (C)
B. longiseta H. A. Wendl. ex Hemsl. (U)
B. porschiana Burret (U)
B. wendlandiana Burret (U)
B. sp. nov. fide H. E. Moore (U)
Desmoncus costaricensis (O. Ktze.) Burret (L)

Coryphoid

Cryosophila albida Bartlett (U)

Geonomoid

Asterogyne martiana H. A. Wendl. ex Burret (U)
Calyptrogyne sarapiquensis H. A. Wendl. ex Burret (U)
Geonoma congesta H. A. Wendl. ex Spruce (U)
G. cuneata H. A. Wendl. ex Spruce (U)
G. deversa (Poit.) Kunth (U)
G. ferruginea H. A. Wendl. ex Spruce (U)
G. interrupta (Ruiz & Pavon) Mart. (U)
G. longevaginata H. A. Wendl. ex Spruce (U)
G. oxycarpa Mart. (U)
Pholidostachys pulchra H. A. Wendl. ex Burret (U)
Welfia georgii H. A. Wendl. ex Burret (SC)

Iriarteoid

Iriartea gigantea H. A. Wendl. ex Burret (SC)
Socratea durissima (Oerst.) H. A. Wendl. (SC)

* C, canopy; SC, subcanopy; U, understory; L, liana.

in many areas of La Selva (Hartshorn 1972). The stilt palms *Socratea durissima* (Fig. 1D) and *Iriartea gigantea* are also common in the subcanopy. These species are capable of rapid growth in height because they lack a prolonged period of establishment growth. Stilt palms are often seen growing in canopy gaps, which are required for entrance into the upper levels of the forest (Vandermeer et al. 1974). *Prestoea decurrens* (Fig. 1B) is another common mid- to subcanopy species with graceful pinnate foliage and a slender green trunk.

Subcanopy palms interact in unique ways with other plants and with animals as well. The almond-shaped fruits of *W. georgii* are eaten and dispersed by at least nine species of mammals and birds, including white-faced monkeys and agoutis (Vandermeer et al. 1979). Because adult *Welfia* trees consistently attract foraging small mammals, they are favorite hunting grounds of the venomous bushmaster during periods of peak fruitfall (Harry Greene, personal communication). Subcanopy palms also have a major impact on the structure of the vegetation beneath them due to the physical damage caused by the abscission and dropping of the large, heavy leaves. This effect has been documented for seedlings of *Welfia georgii*, where 20% of seedling mortality in a 9-month period was due to damage by subcanopy palm leaves (Vandermeer 1977). Seedlings of other species are also seriously affected by physical damage from subcanopy palms (Hartshorn 1972).

Twenty-three of the 30 native palms at La Selva are understory species less than 10 m tall. These species occupy a range of habitats, from the most deeply shaded areas to more open canopy gaps and streambanks. Many of the understory palm species have distinct site preferences. *Calyptrogyne sarapiquensis* (Fig. 2B) and *Astrocaryum alatum* are more abundant in poorly drained swamp forest. *Calyptrogyne sarapiquensis* is also common along streambanks, which often flood during rainy periods. *Geonoma interrupta* and *Chamaedorea exorrhiza* tend to be



1. A. *Bactris gasipaes*; B. *Prestoa decurrens*; C. *Bactris wendlandiana*; D. *Socratea durissima*.



2. A. Thatch roof of *Geonoma congesta*, Manuel Antonio National Park, Costa Rica; B. *Calyptrogyne sarapiquensis*; C. *Reinhardtia gracilis* var. *rostrata*; D. *longivaginata*.

found only on the more nutrient-rich recent alluvium deposited by the Rio Puerto Viejo. *Geonoma deversa* is patchily distributed on hilltops on weathered basaltic soils in the southern half of the property. *Pholidostachys pulchra* is rather common in the southern half of the property on moderately well drained soils. The common understory species, *Asterogyne martiana*, *Geonoma congesta* (see Fig. 2A), *G. cuneata*, *G. longevaginata* (Fig. 2D), and *Synechanthus warscewiczianus* tend to occur in both deeply shaded habitats and in small to average-sized canopy gaps, although these species all require at least moderate shade.

Five species of *Bactris* are found at La Selva, including the cultivated *B. gasipaes* or peach palm, which is known locally as "pejibaye" (Fig. 1A). The fruits of this species are starchy, and are typically boiled and eaten with mayonnaise. The hearts ("palmito") of pejibaye are also quite delicious. All of the *Bactris* species here are colonial, and the clumps of *B. porschiana* and *B. longiseta* can be extensive. The dwarf species *B. wendlandiana* (Fig. 1C) is very striking, with its narrow stem, fuzzy bifid leaves, and bright red fruits. A new species of *Bactris* was recently described by Dr. H. E. Moore, Jr., but is currently unnamed. This species is the loveliest of the lot, with pinnate, glossy, dark green foliage and few spines.

Only one species of climbing palm occurs at La Selva. *Desmoncus costaricensis*, whose uppermost pinnae are modified into reflexed hooks which act as climbing organs, is not a species to fight with; the small black spines along the climbing stems are fierce.

It is likely that all the genera of palms at La Selva have been found; however, the absence of *Raphia taedigera* is enigmatic, since this species occurs nearby, across the Rio Puerto Viejo, and is extremely abundant in coastal swamps. In 1983, a small population of *Chamaedorea geonomiformis* was discovered in a relatively unexplored area of the reserve and a new species of *Chamaedorea* from La Selva was described by Moore several years ago. Species new to La Selva or to science may still be lurking out there somewhere.

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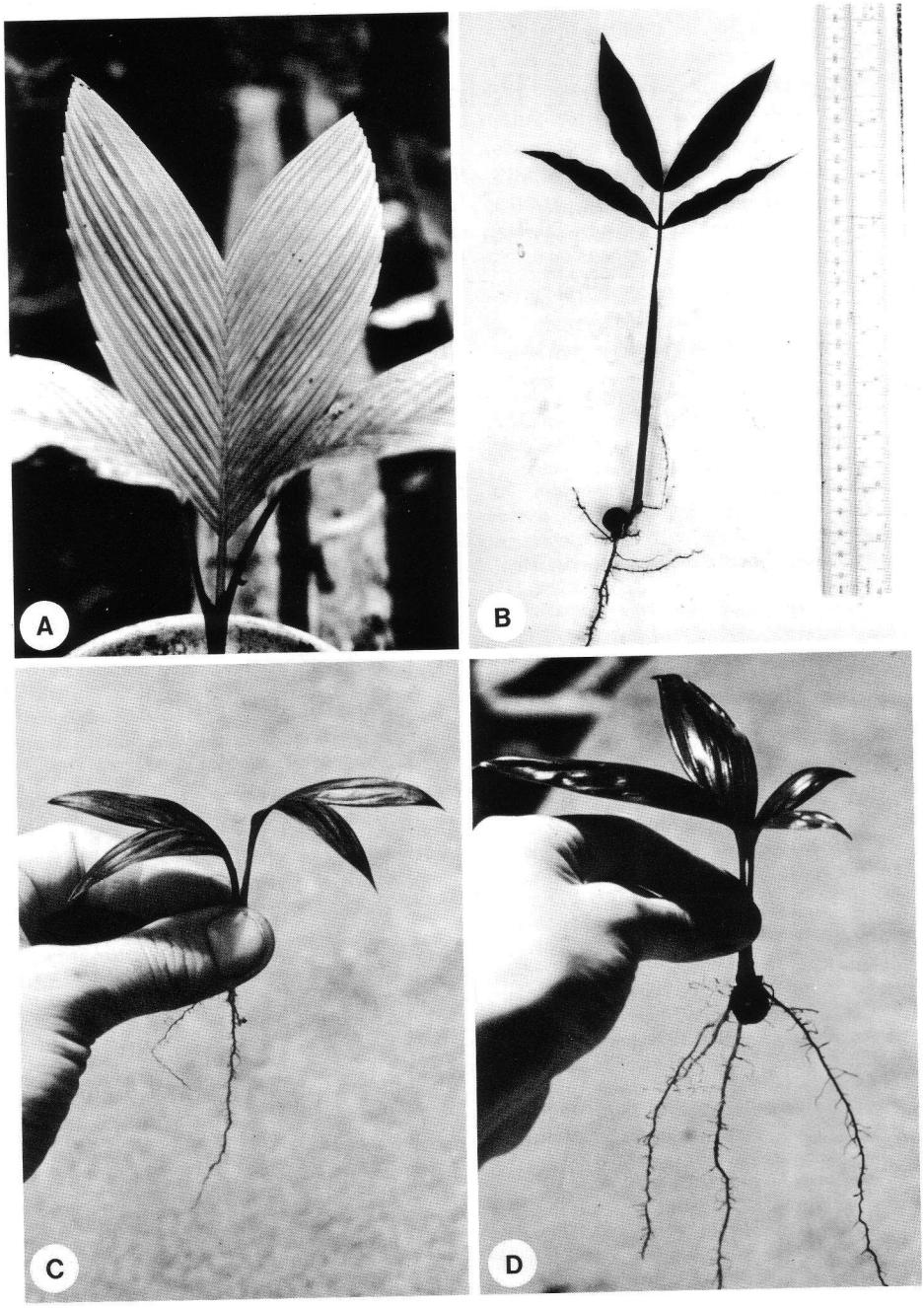
Principes, 29(2), 1985, pp. 79–82

Key to Seedling Palms of Finca La Selva

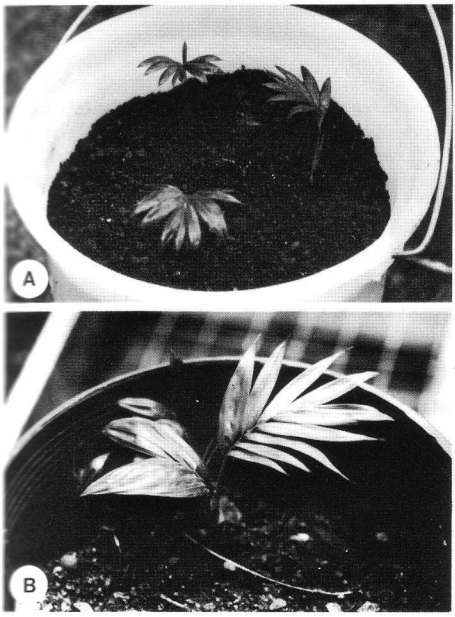
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1. Spines present on petioles, rachis, veins, and/or leaf margins, sometimes minute 2
1. Spines absent from petioles, rachis, and leaf blade 10
2. Leaves with erect pubescence on both surfaces, soft and fuzzy in texture; lamina entire and bifid ..... *Bactris wendlandiana*
2. Leaves glabrous or with appressed pubescence, entire and bifid, or pinnately divided .. 3
3. Leaves white beneath; spines, if present, flattened 4
3. Leaves green beneath; spines, if present, not flattened 5
4. Lamina length more than twice the width; angle between the leaf tips less than 20°; upper leaf surface deep green ..... *Astrocaryum standleyanum*
4. Lamina length less than twice the width; angle between leaf tips more than 20°; upper leaf surface light green ..... *Astrocaryum alatum*
5. Leaves bifid 6
5. Leaves pinnately divided 7
6. Lamina length more than twice the length of the midvein (Fig. 1D) ..... *Bactris porschiana*
6. Lamina length less than twice the length of the midvein (Fig. 2B) ..... *Bactris* sp. nov. fide Moore
7. Pinnae length more than 10 times width; pinnae in clusters of 3–4 along entire length of rachis ..... *Bactris porschiana*
7. Pinnae length less than 10 times width; pinnae evenly distributed along length of rachis, or clustered only along lower half 8
8. Spines on leaf margins, often minute 9
8. Spines lacking on leaf margins (Fig. 1B) ..... *Desmoncus costaricensis*
9. Spines along margin prominent, 3 mm long or more; tips of pinnae long-protracted; terminal pinnae partially fused ..... *Bactris longiseta*
9. Spines along margin minute, less than 1 mm long; tips of pinnae not long-protracted; terminal pinnae distinct ..... *Bactris* sp. nov. fide Moore
10. Leaf white beneath; entire and lanceolate, or palmately divided ..... *Cryosophila albida*
10. Leaf green beneath; entire and ovate, bifid, or pinnately divided 11
11. Terminal or entire portion of leaf margin irregular and deeply scalloped 12
11. Terminal or entire portion of leaf margin entire or shallowly toothed, but not deeply scalloped 14
12. Terminal pinna or entire leaf unsplit, round-ovate in shape ..... *Iriartea gigantea*
12. Terminal pinna or entire leaf bifid 13
13. Petiole and rachis densely brown pubescent; angle between leaf tips more than 30° ..... *Socratea durissima*
13. Petiole and rachis with sparse pubescence; angle between leaf tips less than 30° ..... *Reinhardtia gracilis* var. *rostrata* *Reinhardtia simplex*
14. Leaf entire and lanceolate ..... *Reinhardtia gracilis* var. *rostrata* *Reinhardtia simplex*
14. Leaf bifid or pinnately divided 15
15. Leaf regularly divided into narrow, 1-ribbed pinnae 16
15. Lamina bifid or irregularly divided into broad, several-ribbed pinnae 18
16. Pinnae length more than 9 times width; rachis glabrous 17
16. Pinnae length less than 9 times width; rachis tomentose (Fig. 1B) ..... *Desmoncus costaricensis*
17. Leaf outline ovate–oblong in shape; tips of pinnae long-protracted (Fig. 2A) ..... *Prestoea decurrens*
17. Leaf outline hemispherical in shape; pinnae acute, not long-protracted; plant grasslike in appearance ..... *Euterpe macrospadix*
18. Lamina length more than 4 times length of midvein; young leaves flushing red ..... *Welfia georgii*
18. Lamina length less than 4 times length of midvein; young leaves flushing red or green 19
19. Leaf margin shallowly toothed, especially toward apex; petioles terete 20
19. Leaf margin entire; petioles terete or rounded below and flattened above 23
20. Lamina length less than 2.5 times length of the midvein 21
20. Lamina length more than 2.5 times the length of the midvein 22
21. Prominent yellow stripe below petiole; larger



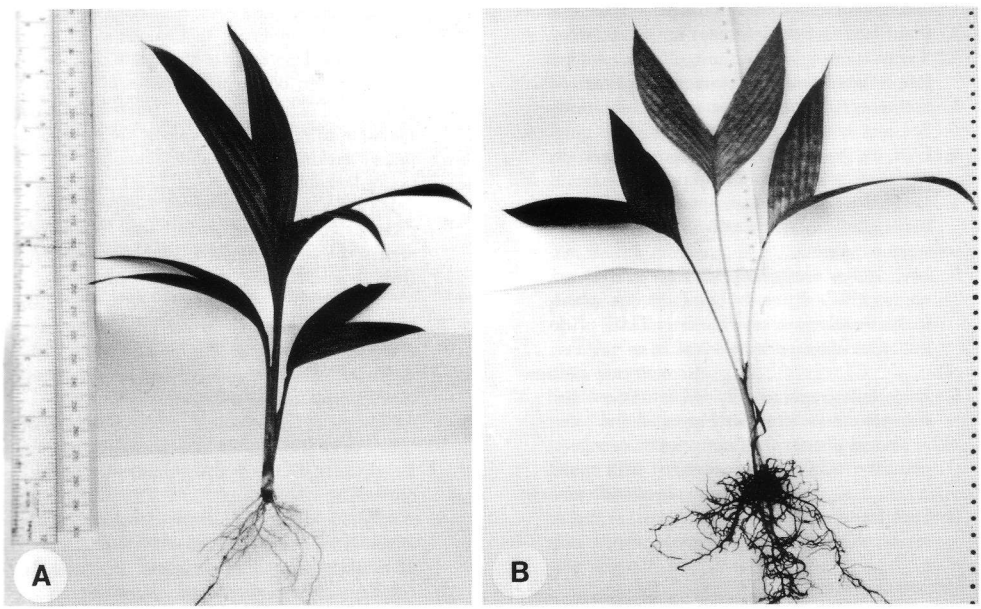
1. A. *Chamaedorea geonomiformis*; B. *Desmoncus costaricensis*; C. *Geonoma feruginia*; D. *Bactris porschiana*.



2. A. *Prestoa decurrens*; B. *Bactris* sp.

seedlings with pinnate leaves, the terminal portion of the lamina remaining unsplit ..... *Chamaedorea exorrhiza*

21. Petiole lacking a yellow stripe below; leaves always bifid (Fig. 1A) ..... *Chamaedorea geonomiformis*
22. Angle between leaf tips less than 40°; leaves with a pale white or green stripe below petiole ..... *Chamaedorea warscewiczii*
22. Angle between leaf tips more than 40°; petiole lacking pale stripe below (Fig. 3B) ..... *Synechanthus warscewiczianus*
23. Lamina length at least 3 times length of the midvein 24
23. Lamina length less than 3 times length of the midvein 25
24. Angle between leaf tips greater than 40° ..... *Geonoma interrupta*
24. Angle between leaf tips less than 40° ..... *Pholidostachys pulchra*
25. Angle between leaf tips less than 40° 26
25. Angle between leaf tips greater than 40° 27
26. Abaxial ribs yellow, raised from surface (Fig. 3A) ..... *Calyptrogyne sarapiquensis*
26. Abaxial ribs green, not prominently raised from surface ..... *Pholidostachys pulchra*
27. Adaxial ribs raised from surface, prominent; lamina not waxy in texture 28



3. A. *Calyptogyne sarapiquensis*; B. *Synchanthus warscewiczianus*.

27. Adaxial ribs not prominently raised from surface; leaves with a waxy texture 31
28. Lamina width at widest point less than ½ length of the midvein ..... *Asterogyne martiana*
28. Lamina width at widest point greater than ½ length of the midvein 29
29. Lamina length less than 2 times length of the midvein ..... *Geonoma congesta*
29. Lamina length greater than twice the length of the midvein 30
30. Leaves not papery in texture, pink-red when young; petioles with reddish-brown tomentum ..... *Geonoma deversa*
30. Leaves thin and papery in texture, green when young; petioles not tomentose ..... *Geonoma interrupta* *Geonoma oxycarpa*
31. Leaves wedge-shaped at base, red when young; larger leaves as wide below bifid split as above (Fig. 1C) ..... *Geonoma longevaginata* *Geonoma ferruginea*
31. Leaves long-attenuate at base, light green when young; larger leaves narrower below bifid split than above ..... *Geonoma cuneata*

Principes, 29(2), 1985, pp. 82–84

Key to the Palms of Finca La Selva, Costa Rica

H. E. MOORE, JR.[1] AND ROBIN L. CHAZDON

L. H. Bailey Hortorium, Cornell University, Ithaca, NY 14853 and Department of Botany, University of California, Davis, CA 95616

1. Leaves palmately divided, white below ..... *Cryosophila albida*
1. Leaves pinnately divided or undivided and pinnately ribbed, white or green below
2. Plants with spines on stem, leaf sheath, petiole, inflorescence, or on all parts 3
2. Plant lacking spines (except on stilt roots) 9
3. Stems climbing; uppermost pinnae modified into reflexed hooks ... *Desmoncus costaricensis*
3. Stems upright; uppermost pinnae not modified into hooks 4
4. Leaf blades whitish below; spines markedly flattened; robust subcanopy palms 5
4. Leaf blades green below; spines not markedly flattened; slender, usually clustered understory palms 6
5. Leaf blades irregularly divided into broad, many-ribbed segments borne in one plane; fruits densely covered with short, black prickles; trunk covered by old leaf bases ..... *Astrocaryum alatum*
5. Leaf blades regularly divided into one-ribbed segments, these irregularly grouped and borne in several planes; fruit not prickly, orange at maturity; trunk densely covered with spines ..... *Astrocaryum standleyanum*
6. Leaf blade softly pubescent below, entire or rarely divided basally; petiole and rachis unarmed or armed with stout spines; stems often less than 2 m in height and 1 cm diam. ..... *Bactris wendlandiana*
6. Leaf blade glabrous beneath, pinnately divided; stems more than 2 m tall and 1 cm in diam. 7
7. Pinnae with prominent thin spines along the margins and long caudate-acuminate tips; long spines present on rachis of leaves of mature plants ..... *Bactris longiseta*
7. Pinnae with minute spines along the margins; pinnae lacking long caudate-acuminate tips; rachis lacking spines 8
8. Small palm with glossy green foliage; pinnae grouped basally, more or less regularly arranged above the middle; long spines absent from lamina surface ..... *Bactris* sp. nov. fide Moore
8. Large palm with dull green foliage; pinnae clustered in small groups along rachis and displayed in several planes; long spines occasionally present on underside of pinnae ..... *Bactris porschiana*
9. Stilt roots present, or numerous, elongate, aerial, adventitious roots prominently developed 10
9. Stilt roots not prominently developed, but adventitious roots sometimes evident at base of trunk 14
10. Slender understory palms; pinnae sigmoid, 1- to several-ribbed; leaves with a pale stripe on lower surface of petiole and leaf base; crownshaft lacking 11

[1] This key was originally written by HEM, Jr. for use by students in field courses in Costa Rica. After he died modifications were made by RLC.

10. Subcanopy or canopy palms; pinnae not sigmoid, 1- to several-ribbed; leaves lacking pale stripe on lower surface of petiole; crownshaft prominent 12
11. Stem to 4 m in height, 2.5 cm diam.; prominent, aerial, adventitious roots; leaves often over 1 m long; prominent yellow stripe below petiole ..... *Chamaedorea exorrhiza*
11. Stem under 2 m in height, 1–2 cm diam., often creeping and rooting at the nodes; leaves less than 50 cm long; white or pale green stripe below petiole ..... *Chamaedorea warscewiczii*
12. Pinnae with scalloped or irregular margins; massive stilt roots developed 13
12. Pinnae with entire margins, 1-ribbed, linear; dense cone of adventitious roots present at base ..... *Euterpe macrospadix*
13. Stilt roots forming an open cone, sharp spines on roots; terminal pinna split ..... *Socratea durissima*
13. Stilt roots forming a dense cone, no spines on roots; terminal pinna entire ..... *Iriartea gigantea*
14. Leaves undivided except at the bifid apex .. 15
14. Leaves with 2 to many pairs of pinnae 18
15. Inflorescence unbranched; borne within the crown or below 16
15. Inflorescence branched, with several rachillae digitately arranged, borne within the crown ... 17
16. Outer margin of lamina entire; internodes short, often indistinguishable; inflorescence borne within crown; lamina long-attenuate at base ..... *Geonoma cuneata*
16. Outer margin of lamina toothed along apical half; internodes easily distinguished; inflorescence borne below leaves; lamina not long-attenuate at base ..... *Chamaedorea geonomiformis*
17. Apex of leaf deeply bifid; blade up to 1.3 m long, wedge-shaped, not decurrent at base, the margin entire; new leaves reddish ..... *Asterogyne martiana*
17. Apex of leaf briefly divided, blade less than 50 cm long, elliptic, margin prominently toothed above the middle; new leaves green ..... *Reinhardtia simplex*
18. Solitary, erect, robust palms with trunk to ca. 10 cm diam., or more; leaves ascending, large, regularly pinnately divided; inflorescence with 8–10 thick spikes bearing flowers in pits in vertical rows. Trunks orange with alternating dark bands (leaf scars); new leaves deep red. Subcanopy palms ..... *Welfia georgii*
18. Solitary or cespitose (clumped) palms with stems normally less than 10 cm in diam.; leaves divided or bifid; inflorescence branched or unbranched; trunks brown, tan or green 19
19. Pinnae toothed at the apex or above the middle, usually 2 on each side of the rachis, 2- to several-ribbed; stems less than 1.5 m tall and 1.5 cm diam.; leaves less than 50 cm long 20
19. Pinnae with entire margins, usually 3 or more on each side of the rachis, stems often over 1.5 m tall and 1.5 cm diam.; leaves more than 50 cm long 21
20. Pinnae with slits or "windows" at the base .. .. *Reinhardtia gracilis* var. *rostrata*
20. Pinnae without slits at the base ..... *Reinhardtia simplex*
21. Pinnae more than 20 on each side, slender, 1-ribbed, acuminate at tip; inflorescences branched, with many stiff rachillae, usually becoming orange-red in fruit; trunk green ..... *Prestoea decurrens*
21. Pinnae fewer than 20 on each side of the rachis, often several-ribbed; inflorescences branched or unbranched; trunk green, or brown, or tan 22
22. Stems solitary or plants appearing stemless 23
22. Stems clustered 29
23. Inflorescence spicate 24
23. Inflorescence branched 26
24. Peduncle long, erect, with a prominent circular scar at apex just below the spike; leaf blade deeply bifid, irregularly divided; stem very short or creeping; fruits less than 1 cm diam. ..... *Calyptrogyne sarapiquensis*
24. Peduncle lacking a prominent circular scar below the spike, stems short to tall, 7 m in height 25
25. Stems to 5 m in height; pinnae more than 5 per side; blade regularly divided, over 1 m long; fruits over 1 cm diam. ..... *Pholidostachys pulchra*
25. Stems short or not evident; blade irregularly divided with 2–5 pinnae on each side, or leaves bifid; blade less than 1 m long; fruits less than 1 cm diam. ..... *Geonoma cuneata*
26. Leaves with several-ribbed pinnae and 1-ribbed pinnae interspersed; trunk often tan brown, up to 10 cm diam.; flowers borne in pits in rachillae of a much-branched inflorescence 27
26. Leaves with all the pinnae except the apical pair 1-ribbed; trunks slender; flowers sessile on the rachillae of the inflorescence 28
27. Stem 6–8 cm diam.; rachillae with tiny branched hairs; pinnae not sigmoid ..... *Geonoma interrupta*
27. Stem 3–6 cm in diam.; rachillae with numerous simple hairs; pinnae sigmoid ..... *Geonoma oxycarpa*
28. Leaves with a pale stripe on lower surface of petiole and rachis ..... *Chamaedorea warscewiczii*

28. Leaves lacking a pale stripe on the lower surface of the petiole and rachis ..... *Chamaedorea* sp. nov. fide Moore
29. Plants without evident stems or the stems creeping; inflorescence spicate, long-pedunculate, bearing a circular scar just below the spike ..... *Calyptrogyne sarapiquensis*
29. Plants with stems 1–5 m tall; internodes prominent; inflorescence branched, peduncle without a scar at apex 30
30. Flowers borne in lines on the rachillae, not sunken in pits; leaves variously divided; petiole round; fruits yellow to bright orange-red when ripe, more than 2 cm diam. ..... *Synechanthus warscewiczianus*
30. Flowers borne in pits in the rachillae; fruits dark purple when ripe, less than 2 cm diam. 31
31. Inflorescence once-branched; rachillae thick, 6–7 mm diam.; lamina green at all stages; petiole rounded below, flattened above; fruits more than 1 cm diam.; stems green ..... *Geonoma congesta*
31. Inflorescence once- or twice-branched; rachillae slender, less than 4 mm diam., turning red in fruit; lamina pink-red during expansion; petiole terete or rounded below and flattened above; fruits less than 1 cm diam.; stems pale brown 32
32. Petioles terete, covered with a dense brownish wool; lamina lacking prominent veins on upper surface, sigmoid; leaves deep red during expansion, later turning dark green 33
32. Petioles rounded below and flattened above, not densely pubescent; adaxial veins prominent; leaves pink-red during expansion, later turning light green ..... *Geonoma deversa*
33. Lamina divided into 7 or more pinnae on each side of the rachis, 1- and several-ribbed segments intermixed ..... *Geonoma longevaginata*
33. Lamina divided into 3–5 broad pinnae, often up to 10 cm wide ..... *Geonoma ferruginea*

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Gliocladium and Fusarium Diseases of Palms

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Diseases caused by the fungi *Gliocladium vermoeseni* (*Penicillium vermoeseni*) and *Fusarium oxysporum* are responsible for causing severe damage and death of several palm species common in the landscape. Species of the genera *Washingtonia*, *Arecastrum*, and *Chamaedorea*, are most severely affected by *G. vermoeseni* while *Phoenix canariensis* is severely affected by *F. oxysporum*.

F. oxysporum and *G. vermoeseni* have been isolated from mature trees of *Phoenix canariensis* in California that were exhibiting symptoms of wilt and dieback (Feather et al. 1980). This disease has become severe in southern California and in the San Francisco Bay-Sacramento areas of northern California. With *P. canariensis*, the older, mature leaves are attacked initially, reducing the crown to the young, emerging leaves in the center bud (Fig. 1). Diagnostic symptoms include the death of pinnae on one side of the leaf, vascular browning, and a black-brown dry rot of petioles and rachises. Pink pustules formed from spore masses may be encountered on the surfaces of petioles. Infected trees may live for several years or die in a matter of months (Feather et al. 1979, 1980). The vascular browning and death of pinnae are attributable to *F. oxysporum* while the dry rot and masses of pink spores are attributable to *G. vermoeseni*. Although both fungi may be associated with wilt and dieback of *P. canariensis*, it is felt that *G. vermoeseni* by itself is not usually lethal on these palms since the latter fungus has been found on *P. canariensis* for years without serious loss (H. D. Ohr, per. comm.). *F. oxysporum* has been isolated by itself from diseased *P. canariensis* growing in nurseries in inland desert areas of southern California. This indicates that *F. oxysporum* can occur on diseased trees without *G. vermoeseni* and that *F. oxysporum* can establish itself and cause disease in inland desert areas of southern California where *G. vermoeseni* has not been recorded (Bliss 1938, Feather et al. 1980). Study is necessary on the interaction that exists between the two fungi in the wilt and dieback of *P. canariensis*.

Studies have indicated that wilt and dieback of *P. canariensis* are transmitted from tree to tree almost entirely by mechanical means through the use of pruning tools (Feather et al. 1980). In California, it is a common practice by landscape maintenance firms to prune drastically the crowns of *P. canariensis* to 25% of their original canopy. This practice increases the time between prunings thereby saving labor costs. Unfortunately, this periodic pruning serves as an ideal method of transmitting the disease. To reduce the risk of spreading the disease during pruning of *P. canariensis*, it is advisable to disinfect pruning tools before pruning each tree. Flat-bladed saws rather than chain-saws should be used for pruning since the former are easier to clean. To disinfect, saw blades can be immersed in a solution of equal parts of household bleach (5.25% sodium hypochlorite) and water for at least 5 minutes (Feather et al. 1980). Evidence exists also that *Fusarium oxysporum* can attack *P. canariensis* from the soil through roots. For this reason, it is not advisable to replant



1. *Phoenix canariensis* infected with *Fusarium oxysporum*. The leaves in the lower two-thirds of the crown are dead leaving only the upper one-third of the crown with live leaves. Photo by H. D. Ohr.

P. canariensis in the same location where diseased trees were since the soil may harbor the fungus. Use of chemicals has so far proved ineffective in treating this disease (Feather et al. 1980).

Gliocladium vermoeseni alone has been reported to be pathogenic on several species of ornamental palms in Florida, Belgium, France, and California (see references cited). Certain species of the genera *Chamaedorea*, *Washingtonia*, and *Arecastrum* are the most severely affected. Other genera with species reported to be susceptible include *Archontophoenix*, *Chrysalidocarpus*, *Howea*, *Phoenix*, *Metroxylon*, *Daemonorops*, *Pelagodoxa*, and *Scheelea* (Bliss 1938). Diseases on these palms caused by *G. vermoeseni* have been commonly called pink bud rot or *Penicillium* rot. Bliss (1938) provides an extensive review of literature and unpublished data pertaining to *Gliocladium* disease of palms although some of the symptoms on diseased *Phoenix canariensis* that he attributes to *G. vermoeseni* are probably attributable to *F. oxysporum* as was discussed earlier.

Although *G. vermoeseni* may play only a minor or secondary role in wilt and dieback of *P. canariensis*, it appears to play a major role in serious disease of *Arecastrum romanzoffianum*, *Washingtonia filifera*, and *Chamaedorea seifrizii*. With the first two species of outdoor landscape palms, the fungus attacks the newer leaves initially and may progress downward into the center bud area killing the tree. Specimens infected by the disease can be recognized by the tremendous pink spore masses on diseased tissue and stunted and deformed leaves and terminal growth (Bliss 1938). However, attacks of *G. vermoeseni* are not always fatal. It is not uncommon to observe palms that have had the disease at one time but have recovered and have been left with some stunted or deformed leaves in an otherwise healthy crown. *G. vermoeseni* also causes cankers or lesions on trunks of *Arecastrum romanzoffianum*. These cankers or lesions are sunken, darkened areas having a dry, punky consistency. Beneath these areas are zones of moist, reddish-brown tissue where the fungus is active. These cankers are unsightly and may prove fatal if they progress to where they weaken the trunk causing it to break (Bliss 1938).

G. vermoeseni on these palms in California is restricted to the coastal climatic zones from the San Francisco Bay area to the Mexican border. It does severe damage in these areas but has not been noted from inland desert areas (Bliss 1938). The fungus seems to be most active in a climate that is cool and moist with high atmospheric humidity for a considerable portion of the year as is found in coastal California. Unfortunately, these cool, moist periods that are accentuated during the winter occur when the palms are growing most slowly. These environmental conditions favoring the fungus at the expense of the host enhance disease development.



2A–D. *Chamaedorea seifrizii* infected with *Gliocladium vermoeseni.* A, Early stage of infection indicated by circular necrotic areas on leaf base. B, Advanced stage of infection showing dark, sunken areas and hard, sappy exudate on basal portion of stem. C, Basal sucker killed by advanced infection. D, Close-up of basal sucker showing hard, sappy exudate and pink spore masses (lower right on leaf base) appearing as white specks. Photos by J. Pusey.

Diseased tissues should be removed and destroyed where possible since they serve as sources of wind-borne spores. Trunk cankers on *Arecastrum romanzoffianum* have been treated successfully by mechanical removal during their initial stages of development. The use of *Washingtonia robusta* as a substitute for *W. filifera* in costal areas is advocated since the former is quite resistant to *G. vermoeseni*. The use of chemicals against the disease on these palms has not been documented but sprays or drenches of the buds and crowns using benomyl in combination with mancozeb and chlorothalonil may prove beneficial as a preventive treatment.

Gliocladium vermoeseni causes a serious problem on palms of the genus *Chamaedorea*. Species affected include *C. seifrizii*, *C. erumpens*, *C. elegans*, *C. metallica*, and *C. tepejilote* (Atilano et al. 1980, Humphrey et al. 1984, Keim and Maire 1975, Reynolds 1964). It is extremely troublesome on *C. seifrizii* where it was first recorded in Florida in 1964 (Reynolds 1964) and in California in 1975 (Keim and Maire 1975). The disease is a common and serious problem in nurseries in both areas. In fact, it is unlikely that there are nurseries in either area growing *C. seifrizii* that are totally free of the disease. The disease is characterized by a leaf-sheath rot found mostly on the lower and basal portions of stems although it may be encountered on the upper portions of the stem also. In addition, it is not uncommon to find dark brown necrotic areas on pinnae or leaf bases of the oldest or lower fronds (Fig. 2A). These lower fronds will die prematurely resulting in a bare looking stem. The disease has a tendency to work its way up the stem from older fronds to younger fronds. Severe and/or advanced infections often move into the hard, pithy stem tissue behind or inside the leaf sheath and may eventually kill that stem (Fig. 2B). Infected stems may have reduced "breaking" or basal suckering, resulting in a spindly, empty appearing plant (Fig. 2C). A dark, sappy exudate emanating from diseased areas is often associated with advanced infections (Fig. 2D). Pinkish brown spore masses are usually abundant and visible on lower and basal leaf sheaths.

Disease development is favored by moist, humid conditions and temperatures from 65–85° F (20–28° C). In addition, cultural practices which wound the stem of *Chamaedorea* palms such as removal of yellowing yet not dead leaf sheaths seem to enhance disease spread and development (Atilano et al. 1980).

Cultural controls include providing for good air movement around the plants, lowering humidity, avoiding practices which result in splashing or dripping water on the leaves, and wherever possible and practical adjusting temperature regimes to a range unfavorable to the pathogen. Cultural practices which cause wounds should be avoided or modified to minimize injury to the host plants. Thorough spraying of foliage and drenching of basal stem areas at 7–14 day intervals with benomyl, benomyl and mancozeb, and/or chlorothalonil may prove beneficial in suppressing the disease (Atilano et al. 1980, Humphrey et al. 1984).

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NEWS OF THE SOCIETY

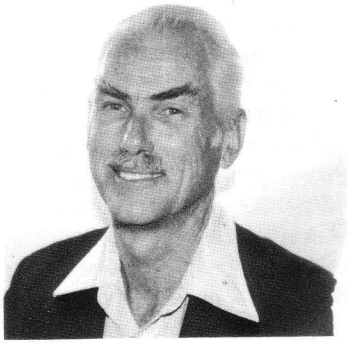
New officers and two members who deserve special mention.

Our New President

Al Bredeson, the new President of The International Palm Society, resides in the suburbs of San Diego, California. He is a public school teacher by profession; he is a "palm nut" by avocation. His home is so surrounded by exotic palms that from the street his house can be seen only via the opening created by his driveway. Al inherited his family name and his tall stature from his Norwegian father; he inherited his dark complexion, and he learned his fluent command of the Spanish language, from his Latin-American mother. Al and his very personable wife, Sylvia, have two beautiful teen-age children, Ramona and Diego. Diego has palms of his own—with which he already has won a big award at one of the palm shows which periodically are staged at the San Diego Wild Animal Park. Al Bredeson will preside during the next Biennial Meeting of The International Palm Society; it will be centered in San Diego, from June 23 to June 29, 1986. Almost certainly, it will attract a bigger attendance than that of any previous Biennial Meeting in the history of our Society. Mark your 1986 calendar and make your personal plans—now—to be there.

BILL GUNTHER





Ross I. Wagner—New Treasurer

The Society's new Treasurer, Ross I. Wagner, is a native of Los Angeles, California where he attended public schools. He graduated from UCLA with a degree in Chemistry and obtained his Ph.D. in Inorganic Chemistry from USC in 1953. While in graduate school he married Janet Struble and they have two daughters, a son, and now two grandchildren.

Dr. Wagner has worked in research and development for his entire career in the Los Angeles Metropolitan area—10 years with American Potash and Chemical and 21 years with the Rocketdyne Division. Rockwell International. His interest in plants began in childhood but did not focus on palms until about 1960. He built his greenhouse in 1971, joined the Palm Society in 1973 and has served as Treasurer of the Southern California Chapter from 1979–1984.

Jim Mintken
Secretary, 1984–86

Jim Mintken was born in Western Nebraska in 1930. Perhaps the treeless landscape and the persistent winds of the thirties' dustbowl inspired him to become interested in making the landscape more hospitable.

Jim was educated at Colorado State University and the University of Colorado. He has enjoyed a career in marketing; shares a partnership in an interior plant rental business; and finds time to operate a small commercial vineyard.

His interest in palms has centered on germinating nearly 250 species, many of which are cold-hardy in his frequently frosty home in Sonoma County, California. Additionally, he hopes to see The International Palm Society represented in every country in the world; a Revolving Publications Fund with the ability to continue to publish important palm literature; and an Endowment Fund sufficient to assist worthwhile public palm gardens; palm research; and match funds with environmental organizations to save endangered natural habitats.



Lois Rossten—Seed Bank

Lois Rossten, a trained bookkeeper, became interested in tropical plants, especially palms, when she moved from snowy Illinois to the warmth of Huntington Beach, California in 1962. She discovered that palms were scarce and information about them even scarcer, but finally learned of The Palm Society and became a member in 1968. She served as Chairperson of the Southern California Chapter for two years and became Seed Bank Coordinator in November 1979, when

Lucita Wait retired. Under her direction the Seed Bank is mailing 90 bags of seeds a week.

Lois's husband, Kurt, has been recruited to help with the Seed Bank and with their impressive palm collection which includes over 60 genera and 280 species. Lois has been a regular attendant of Palm Society Biennials and post-Biennial trips. "I love to travel," she writes, "but only to countries that have palms."

For more about the Seed Bank and the generous services provided by Lois and Kurt, see *The California Newsletter*, January 1985, pp. 6–7.



Pauleen Sullivan
The Revolving Publications Fund and The Bookstore

Pauleen Sullivan, secretary of The International Palm Society from 1976–1978, is now Chairwoman of The Revolving Publications Fund and operates a mail-order palm bookstore on a volunteer basis. Books about palms, especially those published in foreign countries, are difficult to obtain. Pauleen has furthered The Society's goal of increasing the knowledge of palms by establishing a bookstore. It began as the Southern California Chapter's Mobile Bookstore in 1973 and was so popular that she expanded it to The International Palm Society's mail-order bookstore in 1979. Pauleen obtains old and new books about palms and updates the Bookstore list for every issue of *Principes*.

Now as first Chairperson of a new Society venture, the Revolving Publications Fund, she has taken on the challenge of finding ways to raise money for the Fund's initial goal, the publication of *Genera Palmarum, The Classification of Palms*. Her impressive results are shown in the Palmeter, p. 92.

Pauleen is also a talented palm grower as all who have been privileged to visit her extensive collections will attest. For more about her see *Principes* 21: 37–38, 1977.

Special Notice

The South Florida Chapter has generously contributed $5,000 toward additional color pages in *Genera Palmarum: The Classification of Palms*. This was a challenge grant to members and other chapters of The International Palm Society, Inc. To keep this money we must MATCH IT! PLEASE HELP! Send donations to The International Palm Society, Inc. Revolving Publications Fund for Color, 3616 Mound Ave., Ventura, CA 93003.

The 1986 Biennial Meeting

The 1986 Biennial Committee has held four meetings, and thanks to the members of that committee we can announce the dates, the locale, the headquarters, and some of the highlights of the 1986 Biennial. The dates will be from June 23 to June 29, 1986. The locale will be San Diego, California.

The headquarters will be the Bahia



Hotel, a resort complex which is LOADED WITH PALMS (including some new Madagascar introductions), and which is surrounded on three sides by the palm-lined waters of San Diego's beautiful Mission Bay. Without question, no prior Biennial Meeting of The International Palm Society—ever—has enjoyed so palmy a headquarters.

The Biennial Meeting will be more hospitable than any before. That promise has been made by Bill Evans, personable, young and energetic member of The International Palm Society, who will be in attendance as our host. A palm nut, he is also the General Manager of the whole Bahia Hotel complex, and can therefore make his promise come true.

The Bahia Hotel owns and operates the "Bahia Bell," a sternwheeler riverboat with a well provisioned bar which takes passengers (usually for a price) on cruises around Mission Bay (Fig. 1). But for the opening event of the 1986 Biennial, there will be a "Welcome Aboard" sightseeing cruise around Mission Bay with an on-board reception, live music, and several free-drink coupons for everyone—all without charge.



In the short time since the Biennial Committee selected the Bahia Hotel as the headquarters for the 1986 Meeting, the Hotel has embarked on an expansion of its already impressive palm collection (Fig. 2). This expansion, now underway, involves the finding, acquisition, moving, and transplanting of palm specimens sufficiently large to be immediately prominent. A special article featuring the moving of these palms is planned for a coming issue of *Principes*.

San Diego County is a palmy area. Thus the Biennial Committee of necessity must tailor the tours to be sure that the schedule is pleasant rather than frantic. In addition to the grounds of the Bahia Hotel, the itinerary includes the extensive palm collection at the San Diego Zoo, the palm canyon in Balboa Park, the palm walk at the Quail Botanical Gardens, and the palm walk at the Quail Botanical Gardens, and the palm garden of Dr. Mardy Darian. Illustrated previews of some of these and of some additional attractions of the 1986 Biennial will appear in coming issues of *Principes*.

Make your plans now to be in San Diego from June 23rd through June 29, 1986. We expect that more people will attend the 1986 Biennial than any former meeting of The International Palm Society. And if your schedule permits a few extra days, you will have a choice either of a post-Biennial trip to Hawaii or of a post-Biennial tour of palm attractions from Los Angeles to Santa Barbara. Details will follow.

AL BREDESON
PRESIDENT

Wanted—A New Logo for The International Palm Society

During recent years, several different "runs" of stationery and envelopes for "The Palm Society" have been produced, each with a different "logo" design. Now that our name has been changed to "The International Palm Society," some people are reluctant to use stationery which bears our old name; others have been worrying about which is the right "logo" to use. Let's use up the stock which is on hand. Yes, it is OK to use an envelope with one logo to enclose a letter with a different logo!

Our Seed Bank Chairman, Lois Rossten, 6561 Melbourne Drive, Huntington Beach, CA 92647, has a considerable supply of stationery, and volunteers to be the temporary "stationery headquarters" for The Society. If you need letterhead stationery and/or logo envelopes, please submit your written request to Lois, indicating your specific needs for six months. Conversely, if you now have more of The Palm Society stationery and/or envelopes than you will need for the next half-year, PLEASE send your excess supply to Lois Rossten now. You will be reimbursed for postage.

A new run of stationery for "The International Palm Society" is needed. Toward that end, The Society hereby announced an open competition for the new logo. Entries should be in black (either bold pen, felt-tip pen, or black paint but NOT pencil) on a white sheet of paper 8½ × 11″, or smaller but NOT larger. Entries must be received by Lois Rossten before the next Board Meeting of The Society (the date and locale of that meeting will be announced soon). The Board will select the winning entry. The prize for the winner will be one copy of the new book "Genera Palmarum." The new stationery and envelopes will be printed promptly after the next Board Meeting, at which times all then-unused stationery and envelopes of "The Palm Society" should be discarded.

AL BREDESON
PRESIDENT

Announcement

The International Society of Oil Palm Breeders (ISOPB)

The International Society of Oil Palm Breeders was established in August 1983. Its aim is to promote the availability of improved planting materials of the oil palm. The Society plans to organize symposia, establish working groups, promote exchange of genetic material, and publish a newsletter. Inquiries should be addressed to its secretary, Dr. N. Rajanaidu, % PORIM, P.O. Box 10620, Kuala Lumpur, Malaysia.

PALM LITERATURE

MURAKAMI, PAUL AND FRED D. RAUCH. An Annotated Palm Bibliography. University of Hawaii, College of Tropical Agriculture and Human Resources Research Extension Series 040. 1983. 41 pages.

This publication contains annotated reference listings for palms on the subjects of botany and classification, propagation, culture, pests and their control, use, miscellaneous, and books. The idea of a palm bibliography is an excellent concept and it would be a useful tool for all students of palms. The major shortcoming of this work is that it is very incomplete and much material has not been included especially in the area of botany and classification, but the authors admit this. It can be obtained for $1.25 plus postage from Agricultural Publications and Information Office, College of Tropical Agriculture and Human Resources, University of Hawaii, 2500 Dole Street, Krauss Hall Room 6, Honolulu, HI 96822.

DONALD R. HODEL

PALM CONSERVATION

The International Union for Conservation of Nature and Natural Resources (IUCN) is an independent organization dedicated to the conservation and sustainable use of living plants and animals. Within IUCN there exists a Species Survival Commission which is served by Specialist Groups providing the necessary technical expertise for sound conservation action. The Palm Specialist Group was formed in 1984. It currently consists of John Dransfield, Chairman; Dennis Johnson, Deputy Chairman; Robert W. Read and Michael J. Balick, USA; Rodrigo Bernal-G., Colombia; J. Tadeu de Medeiros-Costa, Brazil; Maurice Schmid, France; Voara Randrianostolo, Madagascar; S. K. Basu, India; Wong Khoon Meng, Malaysia; Domingo Madulid, Philippines; Johanis P. Mogea, Indonesia; and A. K. Irvine, Australia.

Closely allied with IUCN is World Wildlife Fund (WWF), a group of affiliated private international conservation organizations including 24 WWFs in various countries and coordinated by WWF-International. Both IUCN and WWF-I operate from the World Conservation Centre, Gland, Switzerland.

World Wildlife Fund-U.S. has made a grant of $25,000 for 1985 in support of a project entitled "Economic Botany and Threatened Species of the Palm Family in Latin America and the Caribbean." This represents the first major activity of the Palm Specialist Group and has as its objectives the study of palm economic botany with special attention to the utilization of palms by local peoples and palm species which are threatened in the wild as a result of forest clearing or overexploitation for their economic products. The project is being led by Dennis Johnson in collaboration with Robert W. Read, Smithsonian Institution and Michael J. Balick, The New York Botanical Garden.

Palm Society members are invited to contribute their personal knowledge on either of these subjects by writing to: Dennis Johnson, % Linda McMahan, World Wildlife Fund-U.S., 1601 Connecticut Ave., N.W., Washington, D.C. 20009.

DENNIS JOHNSON

Principes, 29(2), 1985, p. 95

PALM RESEARCH

Pejibaye

During the last few years the rhythm of research on Pejibaye (*Bactris gasipass* H.B.K.) has increased markedly. Germplasm collections are now extensive and continuing. However, the development of adequate field and germplasm bank descriptor lists, used for characterizing the plants morphologically and genetically, has lagged somewhat. At present the University of Costa Rica has several students working on different aspects of the problem.

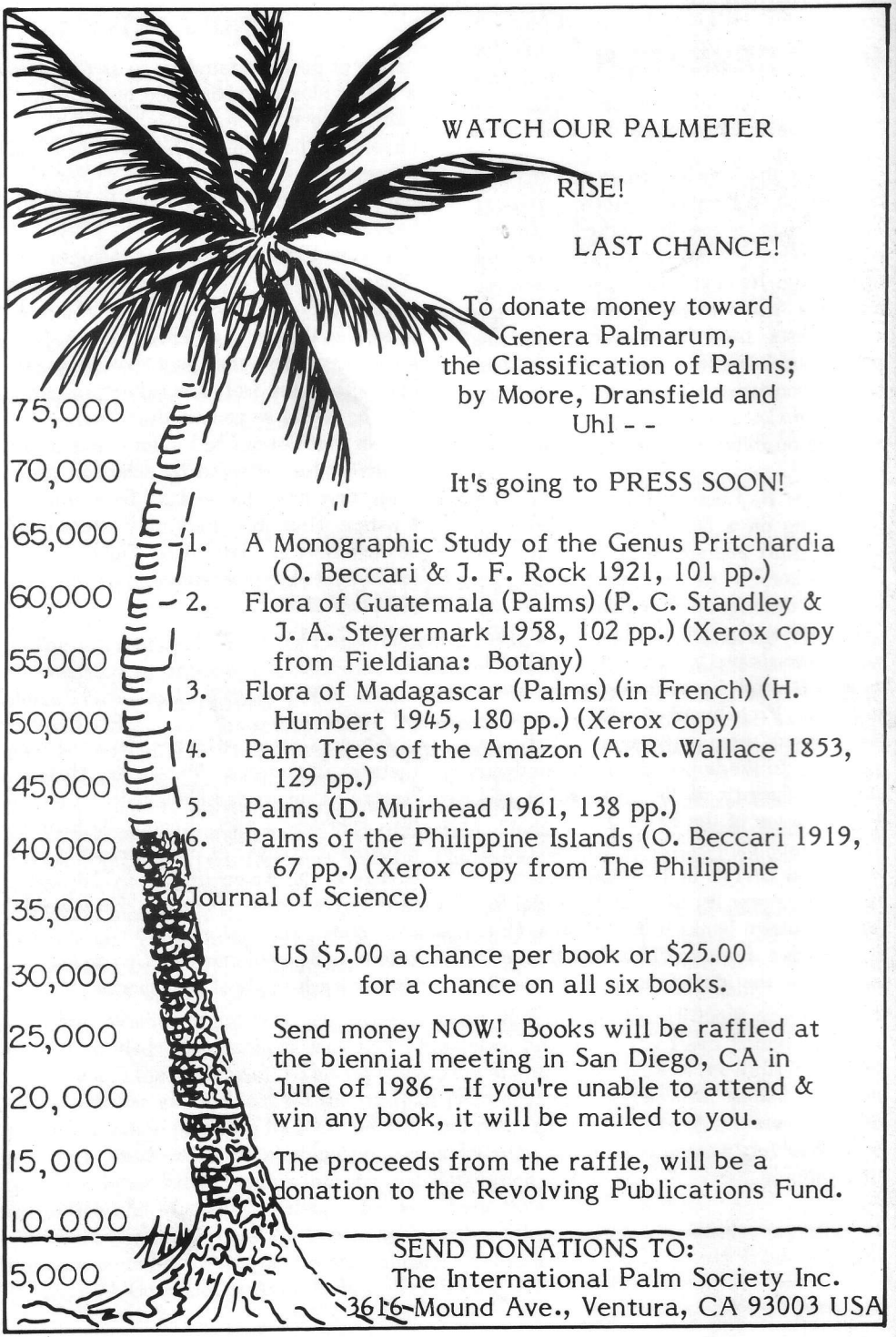
Charles R. Clement (M.Sc. candidate) is working on a field descriptor list that will be short enough to be attractive to field workers, as well as complete enough to insure description of populations. When developed and tested the list will be used to describe about 15 populations, for which data exist, from Costa Rica and the Amazon basin. Probable phylogenetic relationships among these populations will also be proposed, in the hopes of helping to decipher the history of the distribution and domestication of the Pejibaye.

Clemente Zamora (M.Sc. candidate) is working at CATIE in Turrialba on a minimum descriptor list that will be useful for the germplasm banks in Costa Rica, Brazil, Colombia, Peru and Ecuador. His work focuses on the identification and classification of progeny families, so as to obtain a better idea of inheritance of agronomically important characters of the Pejibaye. Relationships within and between progeny families will also help explain the patterns of variation observed in the Pejibaye.

Maria Elena Valverde (candidate for "Licenciatura") is working on defining descriptors for the Pejibaye inflorescences, in the hopes of determining a short list of descriptors that may show less variability than the fruit descriptors and may thus be useful as genetic descriptors. It is known that flowers and inflorescences are relatively less affected by selection pressures that have focused on fruit characteristics. Thus this study may affect both of the others at a later date. Further studies on fruit characteristics and on the seed are planned.

Ceroxylon

Gloria Galeano-Garcés, Instituto de Ciencias Naturales, Museo de Historia Natural, Universidad Nacional de Colombia, apartado 7495, Bogotá, Colombia, is planning a study of the systematics and biology of the American ceroxyloid palms (*Ceroxylon* and *Juania*). She would appreciate any information on poorly known wild populations of *Ceroxylon*, as well as fresh seeds of any species.


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To donate money toward
Genera Palmarum,
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It's going to PRESS SOON!
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2. Flora of Guatemala (Palms) (P. C. Standley & J. A. Steyermark 1958, 102 pp.) (Xerox copy from Fieldiana: Botany)
3. Flora of Madagascar (Palms) (in French) (H. Humbert 1945, 180 pp.) (Xerox copy)
4. Palm Trees of the Amazon (A. R. Wallace 1853, 129 pp.)
5. Palms (D. Muirhead 1961, 138 pp.)
6. Palms of the Philippine Islands (O. Beccari 1919, 67 pp.) (Xerox copy from The Philippine Journal of Science)
US $5.00 a chance per book or $25.00 for a chance on all six books.
Send money NOW! Books will be raffled at the biennial meeting in San Diego, CA in June of 1986 - If you're unable to attend & win any book, it will be mailed to you.
The proceeds from the raffle, will be a donation to the Revolving Publications Fund.
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