PRINCIPES

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PRINCIPES

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Contents for July

Cover Picture

Pseudophoenix vinifera growing near Source Matelas in the Dep. de l'Ouest, Haiti. Photo by Andrew Henderson. See pp. 134–142.

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Editorial

The Biennial Meeting of June 17–24th in Hawaii was a tremendous success, some 150 mainland and overseas members and about 40 Hawaiian members enjoying the beautiful palm collections, the good company, and the delicious food. We will have a detailed account of the meeting including new goals established for IPS in October *Principes*. One item requires mention here. By now most members of the IPS will know of Californian member Don Hodel's plans to write a book describing the species of *Chamaedorea* in cultivation. At its meeting in Hawaii, the board of IPS voted that the Society should publish the book. Don's work is nearly complete and a manuscript is ready for editing. During his research Don has discovered new species and uncovered areas of taxonomic confusion. In this issue we publish two papers by Don Hodel and Natalie Uhl describing and naming new chamaedoreas. Thus validated, the new names may be used in Don's book. As we do not wish to delay the publication of what will undoubtedly be a best-seller, we shall be including several papers on the nomenclature of *Chamaedorea* in the next few issues. Among the species treated in the present issue is *Chamaedorea stenocarpa*, long cultivated by growers, but until now, not scientifically named.

The natural vegetation of the Caribbean Island of Haiti has been almost completely destroyed. Over 20 palms belonging to 12 genera have been recorded from the island. Andrew Henderson and colleagues recently carried out field work on the island to find out whether the native palms still survive. Their paper in this issue reports on the field work and provides an insight into the conservation status of one of the most threatened palm floras in the world.

E. N. Ekpo and E. E. Ojomo report on the worrying spread of lethal coconut diseases in West Africa. It is very important that such disease outbreaks be well documented.

Palm growers know well how disfiguring spots on leaves often are. Spots can be caused by fungus and insect attack or they may be the symptoms of poor mineral nutrition. T. K. Broschat provides an account of potassium deficiency in south Florida and our back cover shows the symptoms in color.

Chapter News and Events in this issue provides evidence of the rapid growth in membership and wide range of activities pursued by the Chapters. Particularly timely is the concern that the South Florida Chapter has shown towards the problems of trade in endangered palms.

JOHN DRANSFIELD
NATALIE W. UHL

Principes, 34(3), 1990, pp. 108–119

A New Species and Synopsis of a Distinctive and Natural Subgroup of Chamaedorea

DONALD R. HODEL AND NATALIE W. UHL

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Recent work in support of a project on *Chamaedorea* in cultivation that will be published by the International Palm Society in 1991 has enabled us to gain an understanding of a distinctive and natural subgroup within the genus. This group of about five or so species is distinguished by a combination of characters including their acaulescent habit, long-pedunculate inflorescences arising from the base of the plant, the pinnae with the lower margin decurrent on the rachis, and pinnate eophylls. For lack of a better term, we have called this association of species the "pinnatifid group" but, at this time, have given it no taxonomic status. It is, however, a member of subgenus *Chamaedoropsis* Oerst. by virtue of a combination of characters including the persistent fruiting perianth and the solitary staminate flowers with apically spreading petals.

Although appearing acaulescent, members of the pinnatifid group actually possess a short, creeping stem (Fig. 1) at or near the ground and often buried in the leaf litter of the forest floor. The nodes are very prominent and densely placed, the internodes as short as 1 mm and no more than 5–7 mm long. The inter- or infrafoliar inflorescences are erect-ascending and often arcuate. Frequently they appear to be emerging from the soil or leaf litter since the stem is usually wholly below the ground or leaf litter.

The lower margins of the pinnae are decurrent along the rachis (Fig. 2). This means that the lower margin of a leaflet extends downward along the rachis, often to the next leaflet. When examined closely the rachis appears to be winged between adjacent leaflets. Although this is a constant feature within a species of this group, it varies from species to species. Some species have the leaflets with their lower margin only briefly decurrent while others have their margins decurrent all the way to the next lowest leaflet. This character is easily overlooked, especially on dried herbarium material. It is most easily seen on living material and is especially noticeable on one- and two-leaf seedlings.

Finally, the eophyll is pinnate although there may be an exception to this since, unfortunately, we did not have the opportunity to observe seedlings of the simple-leaved forms of *C. pygmaea*. The only other species of the genus with a pinnate eophyll is *C. elegans* which differs substantially from those in the pinnatifid subgroup in floral structure, inflorescence, and habit. The pinnate eophyll is an extremely attractive feature and plants are highly prized, even as small seedlings (Fig. 3).

Another interesting, yet somewhat confusing, feature of members of the pinnatifid group is that they tend to flower when very young and small, even when as little as one-fifth their eventual size. When this occurs, all parts of the plant are correspondingly small. Leaves and inflorescences are much reduced and have fewer

and/or shorter parts including pinnae, peduncles, rachillae, and bracts. Pinnae of young and old plants, both mature, of the same species are often shaped differently. Although this phenomenon occurs in species throughout *Chamaedorea*, it is very pronounced in the pinnatifid group, resulting in inconsistencies in descriptions and applications of names.

The pinnatifid group ranges from northern Colombia to Guatemala though it attains its greatest diversity and number of species on the wet Atlantic slope from western Panama to central Costa Rica.

Members of the pinnatifid group are similar ecologically. Nearly absent from warm, lowland forest, most occur in wet forest or cloud forest at middle to relatively high elevations (800–1,500 m). A notable exception to this is *C. pygmaea* which occurs as low as 100 m elevation in the Darién region of Panama. Most species of the pinnatifid group occur in forests characterized by constant, year-round, high rainfall and high humidity and moderate temperatures with little daily or seasonal fluctuation.

Here we provide a key to the species of the pinnatifid group, describe a new species and propose a name for it, and include abbreviated descriptions and discussions of previously named species; complete descriptions of these will be in Hodel's forthcoming treatment of *Chamaedorea* in cultivation. We also provide comments on cultivating these plants since they are difficult to grow well.

Key to the Species of the Pinnatifid Group Within *Chamaedorea*

1. Leaves simple and bifid. ..... *C. pygmaea*
1. Leaves pinnate. 2
2. Leaves with pinnae not decreasing in length toward the apex of the rachis. ..... *C. pygmaea*
2. Leaves with pinnae decreasing in length toward the apex of the rachis. 3
3. Margins of pinnae undulate, pistillate rachillae strongly recurved, hooklike in fruit. ..... *C. undulatifolia*
3. Margins of pinnae not undulate, pistillate rachillae ± straight or only slightly curved. 4
4. Pistillate inflorescence spicate or rarely furcate, generally smaller plants with leaves usually less than 70 cm long. ..... *C. stenocarpa*
4. Pistillate inflorescence with three or more rachillae, generally larger plants with leaves 0.7–1.5 m long. 5
5. Leaves erect-ascending, 20 or more pinnae on each side of the rachis; pistillate inflorescence with 60–100 filiform, short, ± stiff rachillae. ..... *C. brachyclada*
5. Leaves spreading, less than 20 pinnae on each side of the rachis; pistillate inflorescence with 3–15 rather thick rachillae. ..... *C. scheryi*

Chamaedorea brachyclada H. A. Wendl., Regel Gartenfl. 29: 101, 1880. Type: Cult., *H. Wendland s.n.*, unlabeled, unmounted specimen annotated as "HOLOTYPUS?" by M. H. Grayum, 23 July 1987 (Neotype, GOET).

Nunnezharia brachyclada (H. A. Wendl.) O. Kuntze, Rev. Gen. Plant. 2: 730, 1891.

Stem solitary, overall height including leaves to 1–2 m. Leaves 3 (Fig. 4), erect-ascending, pinnate, 1–2 m long; sheath to 35 cm long; petiole 40–80 cm long, erect; rachis 1–1.25 m long, petiole and rachis with a covering of minute, rough, white, glistening spots especially at rachis-petiole junction; pinnae 20–30 on each side of the rachis, dark green, linear-lanceolate, acuminate, largest to 30 × 2–3 cm, 5-nerved, fairly rough abaxially.

Inflorescences infrafoliar; peduncles to 60 cm long, green and ± rounded in flower, reddish-orange in fruit; bracts 5–9; rachis 10–12 cm long, green in flower, reddish-orange in fruit. Staminate inflorescence with 40–50 rachillae, these spreading, filiform, green, lowermost the longest, these to 10 cm long. Pistillate inflorescence bottle-brushlike; rachillae 60–100, filiform, stiffish, 3–5 cm long, green in flower, reddish-orange in fruit.

Staminate flowers greenish, oblong-ovoid; calyx cupular, 3-lobed, lobes broadly rounded; petals spreading apically and free


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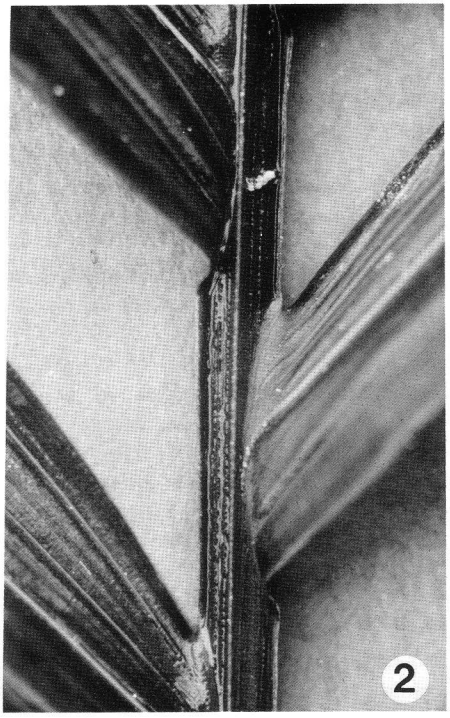
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to about the middle, green, acute and slightly recurved apically, thickened and lighter green medially on the adaxial surface; stamens with filaments and anthers yellow; pistillode equalling the stamens, columnar, yellowish. Pistillate flowers greenish; calyx very short; petals erect, convolute-imbricate. Fruits globose, black, 3–5 mm diam.

Distribution: PANAMA. Chiriquí. COSTA RICA. Puntarenas. Dense, moist or wet forest on the Pacific slope, 1,100–1,300 m elevation.

Specimens Examined: PANAMA. Chiriquí: Cerro Panda, *T. Croat 15904* (MO). COSTA RICA. Puntarenas: San Vito de Coto Brus, *M. Grayum 3351, 3352, 3365, 9280* (MO); *G. de Nevers 7763* (MO); *H. E. Moore Jr. 9995* (BH); *H. Hobbs 0583-102* (CR); *D. R. & M. A. Hodel 705A, 705B,* (BH, CR); Fila Aguabuena, Candelaria Acosta, *M. Charria Diaz 107* (CR). CULTIVATED. United States. California: Los Angeles, in greenhouse, *D. R. Hodel 865* (BH), from plants grown from seeds originally collected near San Vito de Coto Brus, Costa Rica; Huntington Beach, in the garden of F. Ketchum, *D. R. Hodel 674* (BH), from plants grown from seeds originally collected near San Vito de Coto Brus, Costa Rica. Germany. Hannover: Herrenhausen, photograph of unmounted, unlabeled specimen annotated as "Holotypus?" by. M. H. Grayum, 23 July 1987 (Neotype, GOET), presumably a plant grown from seeds introduced from Chiriquí, Panama.

Zahn collected seeds of this palm in Chiriquí in Panama and sent them to the famous plantsman Veitch in Europe prior to 1880. Wendland (1880) then described *C. brachyclada* from a cultivated pistillate plant he obtained from Veitch. It was apparently lost to cultivation until the 1960s when Robert G. Wilson established Las Cruces Tropical Botanical Garden [now Jardín Botánico Robert y Catherine Wilson (JBRCW)] at San Vito in Costa Rica near the Panamanian border. Wilson's garden included some native forest which contained populations of *C. brachyclada.* Wilson established and cultivated the species in his garden and from these plants and the wild plants in the adjacent forest he distributed seeds to fellow palm enthusiasts and botanical gardens. Through Wilson's efforts, collectors have cultivated *C. brachyclada* in California, Florida, and Hawaii since the late 1960s and early 1970s. Of all the species in the pinnatifid group, *C. brachyclada* may be the easiest to cultivate.

Although originally collected in Chiriquí, Panama, *C. brachyclada* is very rare there; in fact, we have seen only one collection of it from this area. Much of Chiriquí has been extensively deforested as have adjacent areas of Costa Rica. Grayum and de Nevers (1988) noted that this species is clearly threatened and endangered since suitable habitat is extremely scarce in this area. As recently as 1987, though, a healthy, reproducing population of this palm existed in forest remnants at JBRCW.

A very distinctive species, *C. brachyclada* is easily distinguished from other members of the pinnatifid group by its few (3–4), erect, long-pinnate leaves with numerous, straight segments and long-

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1. The staminate inflorescence of *Chamaedorea scheryi, D. R. Hodel & M. H. Grayum 697A,* Tapantí, Costa Rica, arises from near the base of the plant, a feature common in species of the pinnatifid group. 2. The decurrent pinnae form a "wing" along the rachis between two adjacent segments. *Chamaedorea scheryi, D. R. & M. A. Hodel 720A,* Río Sarapiquí, Costa Rica. 3. An attractive feature of the pinnatifid group is that usually even the youngest seedling leaves are pinnate. *Chamaedorea scheryi,* Río Sarapiquí, Costa Rica. 4. Marianne Hodel holds leaves of *Chamaedorea brachyclada, D. R. & M. A. Hodel 705A,* in forest remnants adjacent to JBRCW. Costa Rica.

pedunculate, arcuate inflorescences with numerous, short rachillae. The pistillate inflorescence somewhat resembles a bottle brush with its slender, sturdy peduncle terminating in numerous, short, densely placed, stiff rachillae.

Chamaedorea pygmaea H. A. Wendl., Otto & Dietr. Allg. Gartenzeit. 20: 217, 1852. Type: Cult., *H. Wendland s.n.* (Holotype GOET).

Stachyophorbe pygmaea (H. A. Wendl.) Oerst., Vidensk. Meddel. Kjoeb. 1858: 10, 1859.

Nunnezharia pygmaea (H. A. Wendl.) O. Kuntze, Rev. Gen. Plant. 2: 731, 1891.

Chamaedorea terryorum Standl., Field Mus. Nat. Hist. Bot. 22: 326, 1940. Type: Panama, *M. & R. Terry 1452* (Holotype MO).

Cladandra pygmaea (H. A. Wendl.) O. F. Cook, Nat. Hort. Mag. 22: 148, 1943, name of no botanical standing.

Stem solitary, overall height of the plant usually less than 60 cm. Leaves 3–8, erect-spreading; sheath short; petiole 10–25 cm long; blade 20–30 × 6–15 cm, pinnate or simple and bifid, if pinnate the pinnae usually 9–12 on each side of the rachis, falcately lanceolate, 12–15 × 1–2.5 cm, apical pinnae wider and not decreasing noticeably in length toward apex of the rachis, a prominent midrib and one intramarginal nerve conspicuous on each side of this adaxially, if simple the blade incised at the apex to ca. one-third its length, 12–14 prominent primary nerves on each of the rachises, 2 secondaries conspicuous between each pair of primaries abaxially, or the blade variously pinnate with a broad terminal pair of pinnae and several basal ones.

Inflorescences inter- or infrafoliar, arising from the base of the plant, erect, shorter than or about equalling the leaves; peduncles to 20 cm long; bracts 4–8. Staminate inflorescence with rachis to 10 cm long, greenish at anthesis; rachillae 10–25, to 6–8 cm long, widely spreading or somewhat recurved or drooping, greenish at anthesis. Pistillate inflorescence spicate or furcate; rachis or flower-bearing portion 10 cm long, curved, pale greenish at anthesis, orange and swollen in fruit. Staminate flowers green, fragrant; calyx ± cuplike; petals valvate, 3 mm long; stamens ½–¾ as long as the petals; pistillode pale or greenish. Pistillate flowers green, fragrant; petals elongate, spreading apically; staminodes 6; pistil depressed-globose, 3-lobed, stigmas recurved slightly. Fruits black, globose-oblong, 6–8 mm long.

Distribution: COLOMBIA. Socorro. PANAMA. Darién. Chiriquí. COSTA RICA. Puntarenas. Dense, wet forest; 100–2,000 m elevation.

Specimens Examined: COLOMBIA. Without a specified locality, *Funck & Schlim 1654*, annotated by H. E. Moore, Jr. as Isotype (BR). PANAMA. Darién: Chepigana, *M. & R. Terry 1452* (Holotype of *C. terryorum*, MO; Isotypes, GH, F); *1451* (F); *1453* (MO, F); Cerro Pirre, *G. de Nevers et al. 8268* (MO); *S. Mori & J. Kallunki 5388* (MO). Chiriquí: Planes de Hornito, *T. Croat 48854* (MO); Bajo Mona, *R. Woodson Jr. & R. Schery 585* (MO). COSTA RICA. Puntarenas: Río Canasta, *G. Davidse et al. 28355, 28490, 28506* (MO), *28488* (MO, CR), *28358* (CR); Las Alturas, *P. Maas & B. McAlpin 1488* (BH, U); *1489* (U); Río Burú, *L. Gómez 21419* (MO), *21407* (CR), *21683* (MO, CR). CULTIVATED. Germany. Hannover: Herrenhausen, *H. Wendland s.n.* (photograph of Holotype at GOET; Isotype, C).

Wendland (1852) described and named *C. pygmaea* from cultivated plants that Linden introduced to Europe, apparently from Diablo in Socorro Province of New Granada (Colombia) prior to 1850. Interestingly, the word "Chiapas" is written on the isotype at Copenhagen despite the fact that Wendland stated in his 1852 article that *C. pygmaea* was collected in Colombia. However, whoever wrote "Chiapas" easily could have been confused since New Granada was a term applied to both Colom-

bia and Chiapas, México by botanists of the time. *C. pygmaea* is extremely variable vegetatively with leaves being completely pinnate to simple with a bifid apex. The type has leaves with up to 12 pinnae on each side of the rachis. In addition, *C. pygmaea* has the widest altitudinal range of any species of the pinnatifid group. Although occurring mainly from 600–2,000 m elevation, a few collections from the Darién region in Panama place it as low as 100 meters.

Standley (1940) described and named *C. terryorum* from the Darién region of eastern Panama adjacent to Colombia. Standley's type (*M. & R. Terry 1452*) has leaves that are simple and bifid; however, another collection from the same population (*M. & R. Terry 1453*) has leaves that are completely pinnate and was annotated by L. H. Bailey as *C. pygmaea*. This latter collection fits *C. pygmaea* very well, substantiating the case that *C. terryorum* is a simple-leaved form of *C. pygmaea*.

Chamaedorea pygmaea is close to *C. stenocarpa* but can be distinguished by the pinnae not decreasing noticeably in length toward the apex of the rachis.

Although Guillaumin (1923) reported that *C. pygmaea* was once common in European glasshouses, it is rare in cultivation today. The only living plants that we have seen are a few cultivated in a remote location of the JBRCW, Costa Rica (Fig. 5). Bruce McAlpin collected them in 1974 in the upper valley of the Río Cotón, Puntarenas, Costa Rica.

Chamaedorea scheryi L. H. Bailey, Gentes Herb. 6: 252, Fig. 133, 1943. Type: Panama, *R. Woodson & R. Schery 680* (Holotype MO).

Stem solitary, overall height including leaves 1–1.5 m. Leaves 4–6, erect-spreading; sheath 15–30 cm long; petiole 30–45 cm long; rachis 0.8–1 m long; pinnae 16–20 on each side of the rachis, light to dark green, ± straight or only slightly sigmoid, falcately long-acuminate, linear-lanceolate, the middle and lower middle the longest, these 20–35 × 2.5–4.0 cm, a midrib and 2 marginal nerves on each side of this prominent adaxially and sometimes a less prominent secondary nerve between each of these, 5 nerves prominent abaxially.

Inflorescences inter- or infrafoliar, erect; peduncles to 50–75 cm long, greenish at anthesis, dull orange in fruit; bracts 5–10. Staminate inflorescence with a rachis to 10–20 cm long, green; rachillae 15–30 or perhaps more, lower ones the longest, these 10–15 cm long, slender, green. Pistillate inflorescence with a rachis 1–8 cm long, green at anthesis, orange in fruit; rachillae 4–15, to 10 cm long, ± stiff, erect, straight and parallel or slightly curved, green at anthesis, orange in fruit.

Staminate flowers greenish, fairly close in bud and abruptly short-pointed; calyx 3-lobed and spreading; petals valvate, free nearly to the base, spreading; stamens with the filaments white; pistillode columnar, greenish, broadly 3-lobed apically. Pistillate flowers greenish; calyx low, 3-lobed; petals pointed, fleshy, imbricate basally, free apically; pistil depressed-obovoid, green. Fruits globose, black, 5–7 mm diam.

Distribution: PANAMA. Chiriquí. Coclé. COSTA RICA. Alajuela. Heredia. San José. Cartago. Dense, wet forest, mainly on the Atlantic slope but, perhaps, elsewhere, 800–2,000 m elevation.

Specimens Examined: PANAMA. Chiriquí: Bajo Chorro, *R. Woodson & R. Schery 680* (Holotype, MO); Boquete, *D. R. & M. A. Hodel 727A, 727B* (BH, PMA); Fortuna, *H. & A. Churchill 6193, 6194* (MO); *T. Croat 50094* (MO). Coclé: El Copé, *D. R. & R. M. Hodel 738* (BH, PMA); *J. Folsom & L. Collins 6445* (MO); *B. Hammel 3522* (MO); *G. de Nevers et al. 6382* (MO). COSTA RICA. Alajuela: Río San Lorencito de San Ramón, *J. Gómez-Laurito 10294* (CR); Bajos de Jamaical de San Ramón, *I. Chacón 1767* (CR). Heredia: above San Miguel along the Río Sarapiquí, *D. R. & M. A. Hodel 720A, 720B* (BH, CR); *I. Chacón & G. Herrera*


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1176 (MO, CR), *1173* (CR); *W. Burger & T. Antonio 11150* (CR); Braulio Carrillo National Park, *R. Chazdon 179, 180* (CR); Río Sardinal, *M. Grayum 7359, 7360* (MO, CR). San José: Río Zurquí, *M. Grayum & P. Sleeper 6124* (MO); Braulio Carrillo National Park, *R. Chazdon 220* (CR). Cartago: Tapantí, *L. Gómez 18739, 19246, 19248* (MO); *T. Croat & M. Grayum 68254* (MO); *D. R. Hodel & M. Grayum 697A, 697B* (BH); *R. Lent 910* (CR); *R. Baker et al. 209* (CR).

Bailey (1943) described and named *Chamaedorea scheryi* from material that Woodson and Schery collected in Chiriquí, Panama. Apparently confined to wet forests from central Costa Rica to central Panama, it exhibits a fair amount of foliar variation over this range. Collections from the vicinity of the Río Sarapiquí in Costa Rica (Fig. 7) differ slightly from those from Tapantí, Costa Rica (Fig. 6) in the rachis being more sharply angled adaxially and the pinnae darker green with the lower margin more conspicuously decurrent along the rachis to the next lower pinna, and the nerves less pronounced. Material from near Boquete in Chiriquí, Panama (Fig. 8) differs from that from Costa Rica in the pinnae slightly broader and with the nerves even less pronounced. These differences seem insignificant when taken over the entire range.

Only recently introduced to cultivation, *C. scheryi* is rare in collections and gardens in California.

Chamaedorea stenocarpa Standl. & Steyerm., Field Mus. Nat. Hist. Bot. 23: 206, 1947. Type: Guatemala, *J. Steyermark 41893* (Holotype F).

Stem solitary, overall height including leaves 50–60 cm. Leaves 3–5 (Fig. 9), erect-spreading, pinnate, to 40–50 cm long, light forest green; sheath 3–8 cm long petiole to 5–25 cm long; rachis to 15–30 cm long; blade in outline 15–33 × 10–20 cm; pinnae 10–20 on each side of the rachis, narrowly oblong-lanceolate, to 5–18 × 2.5 cm, slightly sigmoid, falcately-acuminate, pinnae decreasing in length noticeably in a progressive manner toward the apex of the rachis, terminal pair slightly wider, a midrib and a submarginal nerve on either side of this prominent adaxially.

Inflorescences interfoliar or infrafoliar, erect, ± equalling the leaves; peduncles to 15–20 cm long, erect, greenish at anthesis, orange in fruit; bracts 5. Staminate inflorescence with a rachis to 15 cm long, green; rachillae 10–25, these 6–8 cm long, filiform, ± pendulous or flexible, green. Pistillate inflorescence spicate or rarely furcate, ± straight or slightly curved, ± stiff; rachis or flower-bearing portion 5–15 cm long, green at anthesis, thicker and reddish-orange in fruit.

Staminate flowers green; petals oblong, acute, spreading. Pistillate flowers green; calyx broadly 3-lobed, sepals imbricate; corolla with the petals tightly imbricate and open only briefly at the apex, petals oblong, acute; pistil depressed-globose, green, 3-lobed. Fruit yellow maturing black, globose, 7 mm diam.

Distribution: GUATEMALA. Izabal. COSTA RICA. Puntarenas. Alajuela. Heredia. PANAMA. Veraguas. Dense, wet forest, 300–1,000 m elevation.

Specimens Examined: GUATEMALA. Izabal: *J. Steyermark 41893* (Holotype F); *D. R. Hodel & J. J. Castillo Mont 870* (BH, AGUAT). COSTA RICA. Puntarenas: south of San Vito above the Río Claro, *R. Wilson 66-33* (BH); *H. Hobbs 0583-101* (CR). Alajuela: Los Angeles de

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5. *Chamaedorea pygmaea* cultivated in the JBRCW, Costa Rica. 6. Staminate plant of *Chamaedorea scheryi, D. R. Hodel & M. H. Grayum 697A*, Tapantí, Costa Rica. 7. Marianne Hodel and *Chamaedorea scheryi, D. R. & M. A. Hodel 720B*, Río Sarapiquí, Costa Rica. 8. *Chamaedorea scheryi, D. R. & M. A. Hodel 727B*, Chiriquí, Panama.

9. A staminate plant of *Chamaedorea stenocarpa*, *D. R. & M. A. Hodel 619A*, grows at the JBRCW, Costa Rica.

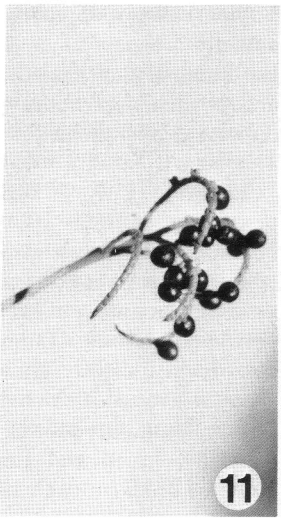
San Ramón, *S. Brenes 6111* (CR). Heredia: Varablanca, *R. Roig 12* (F, CR). PANAMA. Veraguas: Santa Fe, *S. Mori & J. Kallunki 3113* (MO), *3843* (BH, MO); *T. Croat 27694* (MO); Río Segundo, *P. Maas & R. Dressler 1656* (U). CULTIVATED. Costa Rica. Puntarenas: San Vito de Coto Brus, JBCRW, *D. R. & M. A. Hodel 619A, 619B* (BH). United States. California: La Habra, in the garden of L. Hooper, *D. R. Hodel 824A, 824B* (BH), originally received from JBRCW, Costa Rica. Hawaii: Honolulu, Ho'omaluhia Botanic Garden of the Honolulu Botanic Gardens, *D. R. Hodel 833* (BH), accessioned as *HBG 77.1331*, originally collected at JBRCW, Costa Rica.

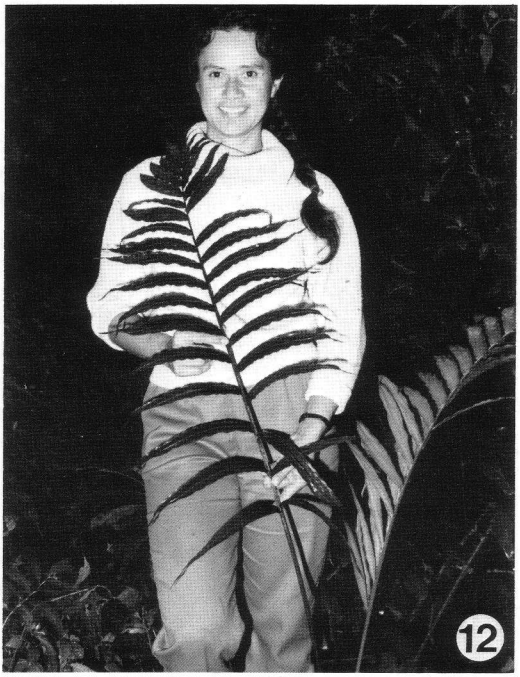
Chamaedorea stenocarpa is closest to *C. pygmaea* but can be distinguished by the greater number of pinnae that decrease markedly in length and in a progressive manner toward the apex of the rachis.

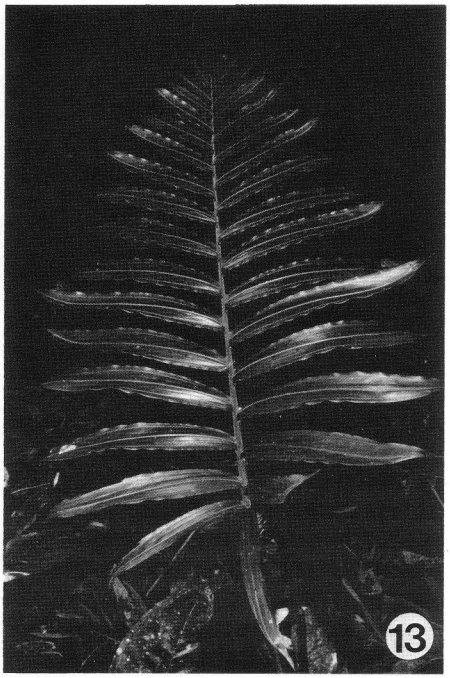
The late Robert G. Wilson of San Vito in southeastern Costa Rica is responsible for introducing this species to cultivation. In the 1960s he established fruiting populations in his garden, JBRCW. One of these plants in Wilson's garden is handsomely illustrated on the cover of *Principes* Vol. 25, No. 2, April, 1981. These plants were brought to him by local collectors or collected by Wilson in forest remnants in the mountains above San Vito, Costa Rica. Over the years, he distributed seeds and plants as the "Las Cruces elfin dwarf" or "dwarf pinnate" *Chamaedorea* to interested collectors and hobbyists. Today, *C. stenocarpa* is cultivated in Hawaii, California, Florida, Australia and, probably, elsewhere.

Chamaedorea undulatifolia D. R. Hodel & N. W. Uhl. **sp. nov.** (Figs. 10–13).

Subgeneris *Chamaedoropsis* Oerst. *C. scheryi* L. H. Bailey affinis sed segmentis marginibus undulatis, rachillis fructificantibus valde recurvatis et unciformibus differt. Typus: *H. E. Moore Jr. 10179* (Holotypus BH).







10. *Chamaedorea undulatifolia, D. R. & M. A. Hodel 695B,* in cloud forest at the type locality, Monteverde, Costa Rica. 11. Fruiting rachillae of *Chamaedorea undulatifolia* are strongly recurved and hooklike, *D. R. & M. A. Hodel 695B.* 12. Marianne Hodel holds leaf of *Chamaedorea undulatifolia, D. R. & M. A. Hodel 695A,* at the type locality. Note the undulate margins of the pinnae. 13. A close-up of a leaf of a young plant of *Chamaedorea undulatifolia* at the type locality clearly shows the undulate margins of the pinnae.

Stem solitary, appearing acaulescent but actually creeping at or slightly below the leaf litter, densely ringed, nodes prominent and swollen, internodes very short, to 5 mm long, overall height including leaves 1–1.5 m.

Leaves 3–5 (Fig. 10), erect-spreading, pinnate; sheath to 10 cm long, green, brown-margined apically, splitting deeply opposite the petiole, clasping completely in a tubular manner only near the base; petiole elongate, to 60 cm long, green and flat or very slightly channeled adaxially, green and rounded abaxially; rachis to 50–75 cm long, green and slightly angled adaxially, green and rounded abaxially; pinnae 12–18 on each side of the rachis, bright forest green, thin, lower margin decurrent along the rachis, lanceolate, slightly sigmoid, acuminate, alternate or subopposite, lower and central pinnae the largest, these to 12.5–19 × 1.6–2.7 cm, becoming progressively smaller toward the apex of the rachis, margins undulate (Figs. 12,13), midrib prominent and 1–2 lateral nerves on either side of this adaxially and abaxially, these yellowish when dry, midrib with warty-roughened surface at the base abaxially.

Inflorescences interfoliar, erect, sometimes infrafoliar in fruit, frequently appearing to arise from the ground, glabrous. Staminate inflorescence to 70 cm high but often smaller; peduncle to 47 cm long, greenish at anthesis; bracts 6, these tubular, tightly sheathing, acute-acuminate, bifid, longitudinally striate-nerved, ± papery, green but browning at anthesis; rachis 24 cm long, greenish at anthesis; rachillae 30, green, slender, lower ones the longest, these to 15 cm long, spreading, simple or once-branched, those above the middle shorter, to 5–11 cm long. Pistillate inflorescence to 55 cm long but often smaller; peduncle to 44 cm long, greenish at anthesis, orange in fruit; bracts 8, these similar to those of the staminate; rachis very short, 0.25–2.5 cm long, green at anthesis, orange in fruit; rachillae 2–6, 2.5–11 cm long, strongly recurved, hook-like (Fig. 11) and orange in fruit.

Staminate flowers green, 1.5–2 mm high; calyx membranous, shallowly 3-lobed, 0.5 mm high, flaring and drying light brown with darker margins; corolla with the petals valvate, drying dark, 1.5 mm high, ovoid, ± acute, free at anthesis; stamens with the anthers sessile, not deeply bifid at the apex; pistillode slightly shorter than anthers, 3-angled and ± angled-enlarged at the apex. Pistillate flowers with the calyx flaring, briefly 3-lobed, similar to that of the staminate; corolla 2 mm high, petals valvate but separating and recurving only at the tip at anthesis and corolla ± urceolate; pistil green. Fruits black, ellipsoid-globose, 8 × 6 mm; perianth persistent but not prominently nerved when dry.

Distribution: COSTA RICA. Puntarenas. Alajuela. Heredia. San José. Dense, wet montane forest and cloud forest on the Atlantic slope or just over the Continental Divide, 800–1,700 m elevation. Probably endemic.

Specimens Examined: COSTA RICA. Puntarenas: Monteverde, *H. E. Moore Jr. et al. 10179* (Holotype, BH), *10180* (BH); *D. R. & M. A. Hodel 695A, 695B* (BH, CR); *B. Hammel 13867* (MO, CR); *V. Dryer 149, 150B, 185, 273* (CR). Alajuela: La Peña de Zarcero, *A. Smith H-1005* (F); La Paz, NW of San Ramón, *R. Liesner et al. 15476* (MO); Balsa, NW of San Ramón, *R. Liesner & E. Judziewicz 14886* (MO, CR). Heredia: *M. Valerio 1590* (F). San José: Braulio Carrillo National Park, *R. Chazdon 225, 236* (CR). Cartago: Quebrada Casa Blanca at Tapantí, *M. Grayum & P. Sleeper 3691, 3692* (MO).

The specific epithet refers to the leaves with the pinnae having undulate margins. Chazdon (in *Brenesia* 28: 107–116, 1987) referred to *C. undulatifolia* as *Chamaedorea* sp. "elegantissima." Because of its stemless habit and decurrent pinnae with strikingly undulate margins, *C. undulatifolia* bears a remarkable resemblance,

especially when young, to certain ferns in the genus *Polypodium*. Although the undulating margins of the pinnae are quite striking and occur even on material cultivated in Costa Rica and California, they are not readily apparent on dried herbarium material.

Chamaedorea undulatifolia is similar to *C. scheryi* but can be distinguished by the undulate margins of the pinnae and the pistillate rachillae strongly recurved and hooklike, rather than straight, in fruit (Fig. 11).

Cultivation

That they are confined to a climate with such constant, exacting parameters is probably largely responsible for difficulty in cultivating members of the pinnatifid group. They are notoriously difficult to grow well and never appear as vigorous as those in the wild. They seem to do best in a moderate or slightly cool tropical climate with little variation. These conditions are difficult to duplicate in cultivation. Even in places renowned for benign climate such as wet areas of Hawaii, plants do not attain the same quality as in the wet mountain forests of Costa Rica and Panama. In places like California, they fare even worse, tending to hold very few leaves and these are marred by the pinnae with yellow and brown tips. The "tip burn" so characteristic of the pinnatifid group in cultivation is probably due to low atmospheric humidity and, to a certain extent, extremes of temperature.

Generally, in cultivation plants have crowns which are much reduced, being composed of only two–three leaves, and take on a rather poor appearance. In addition, they are susceptible to infestations of mites and thrips in cultivation, especially in areas of low humidity. Naturally slow-growing, they are even slower in cultivation and, more often than not, languish and go into a slow decline from which they seldom recover.

Growers of species in the pinnatifid group may have the best results by using a well drained medium high in organic matter and a slow release, organic type of fertilizer, situating the plants in deep shade, and, if possible, maintaining constant temperatures between 15 and 27° C (60–80° F) and relative humidities above eighty percent. These conditions are sometimes difficult to maintain. In addition, periodic leaching of the root zone with distilled or rain water would be beneficial in areas where water quality is poor and/or mineral content is high.

Acknowledgments

We express our appreciation to Richard W. Palmer, Pauleen Sullivan, Bill Gunther, and the International Palm Society for support and encouragement of Hodel's work with *Chamaedorea*. In addition, Michael H. Grayum, of the Missouri Botanical Garden and stationed in Costa Rica, shared his valuable ideas and insight and reviewed the manuscript. John Dransfield critically reviewed the manuscript also.

Literature Cited

Bailey, L. H. 1943. New palms in Panama and others. Gentes Herb. 6: 198–264.

Grayum, M. H. and G. de Nevers. 1988. New and rare understory palms from the Peninsula de Osa, Costa Rica, and adjacent regions. Principes 32(3): 101–114.

Guillaumin, M. A. 1923. Les Chamaedorea Cultivés. Jour. Soc. Nat. Hort. France, ser. 4, 24: 223–244.

Standley, P. C. 1940. Studies of Central American plants II. Field. Mus. Nat. Hist. Bot. 22: 326.

Wendland, H. 1852. Beschreibung einer neuen Chamaedorea. Otto & Dietr. Allg. Gartenzeit. 20: 217–218.

———. 1880. Beitrag zur Palmenflora Amerika's. Regel Gartenflora 29: 101–105.

Principes, 34(3), 1990, pp. 120–133

New Species of Chamaedorea from Costa Rica and Panama

DONALD R. HODEL AND NATALIE W. UHL

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Recent work in support of a project on *Chamaedorea* in cultivation that the International Palm Society will publish in 1991 has yielded several undescribed species native to Costa Rica and/or Panama. Since they are all being grown by collectors and/or botanical gardens, it is appropriate to name them at this time.

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

Subgeneris *Chamaedoropsis* Oerst. *C. pumilae* H. A. Wendl ex Dammer et *C. sullivanioris* D. R. Hodel & N. W. Uhl affinis sed laminis smaragdinis non venetis, marginibus dentatis remotioribus, inflorescentiis masculis spicatis, floribus masculis albidis, floribus femineis aureis differt; *C. pumilae* affinis sed laminis longioribus et latioribus, pluribus nervis differt; *C. sullivanioris* affinis sed laminis magis profunde bifidis differt. Typus: *D. R. & R. M. Hodel 737* (holotypus, BH; isotypus, PMA).

Stem solitary, erect apically, short, not apparent but creeping at or slightly below the leaf litter, 2.5 cm diam., green, prominently ringed, internodes 1.5 cm long, overall height including leaves less than 1 m.

Leaves 5–7, erect-spreading, simple and bifid (Fig. 1); sheath to 12 cm long, splitting deeply opposite the petiole, cylindric and clasping tightly in a tubular manner only in the basal third, green, ragged and brown-margined apically; petiole 20–25 cm long, green and flattened adaxially and slightly channeled from the lower margins of the blade extending downward to the sheath, green and rounded abaxially; rachis 20 cm long, green and angled adaxially, green and rounded abaxially; blade rich green, 40–50 × 20 cm, simple, bifid apically to nearly half its length, each lobe 20–25 cm long, acuminate, tips 18–20 cm apart, 12–16 raised and prominent primary nerves on each side of the rachis adaxially and abaxially, secondaries numerous and faint, margin conspicuously toothed.

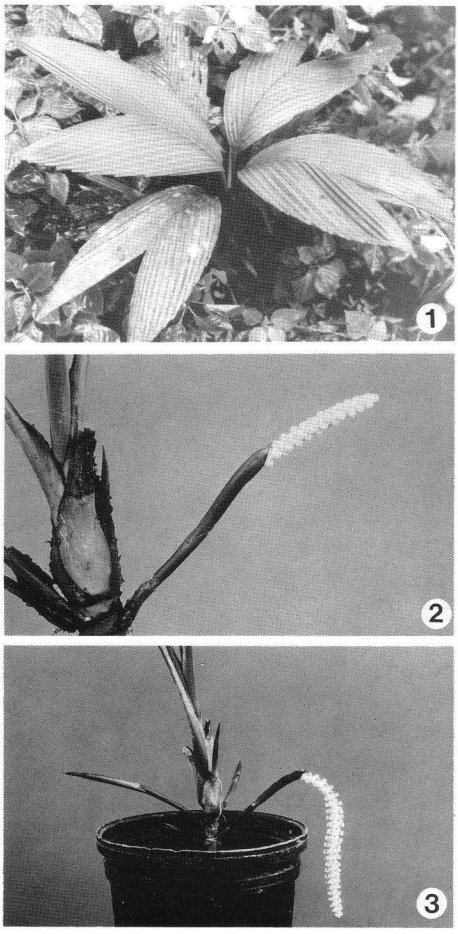
Inflorescences infrafoliar or sometimes interfoliar, often emerging from the leaf litter of the forest floor, spicate. Staminate inflorescence (Fig. 3) with a peduncle to 25 cm long, 5 mm wide at the base and there ± flattened, 4 mm wide at the apex and there rounded, erect-ascending, pale green or yellowish where exposed at anthesis; bracts 5, acute-acuminate, greenish at anthesis ageing to dark brown or nearly black, tubular, tightly sheathing basally, the upper ones inflated apically to 8 mm diam. for two-thirds their length, ± leathery, longitudinally striate-nerved, prophyll 2 cm long, 2nd bract 3–4 cm long, 3rd 5 cm long, 4th 12 cm long, 5th 15 cm long, uppermost equalling or slightly exceeding the peduncle, sometimes 5th bract very short and concealed by the 4th; rachis or flower-bearing portion to 10–15 cm long, 3–4 mm diam., pendulous, whitish, longitudinally ridged around each flower. Pistillate inflorescence (Fig. 2) ascending but often horizontal in fruit; peduncle similar to that of the staminate

but orange in fruit; bracts 5, similar to those of the staminate but burgundy in color when newly emerged, browning only slightly by anthesis, brownish in fruit; rachis to 10 cm long, ± stiff, horizontal, pale yellow or whitish at anthesis, 5 mm in diam., orange in fruit.

Staminate flowers arranged in 3 densely spiralling rows, closely placed but not contiguous, bullet-shaped, 5 × 3.5 mm, greenish-white, immersed in elliptic pits 3–4 mm long; calyx cupular, 1–1.25 × 3.5 mm, whitish tinged with green apically, shallowly 3-lobed, lobes broadly rounded, sepals imbricate, membranous; corolla with the petals erect, valvate, free more than half-way to the base, 4 × 3 mm, acute, green but with a whitish base; stamens exserted beyond the corolla, filaments columnar, 4 × 0.6 mm, clear-colored, anthers bilobed, held beyond the corolla, 1.25 mm long; pistillode columnar, 4 × 0.75 mm, clear, trifid apically. Pistillate flowers densely arranged, some contiguous but most not, 1–1.5 mm distant, very depressed-globose, 2.5 × 3.5 mm, yellow, immersed in circular depressions 4 mm across; calyx ringlike, 1 × 3.5 mm, pale yellowish or whitish, very shallowly and inconspicuously 3-lobed; corolla with the petals imbricate, spreading slightly apically, 2.5 × 4.5–5 mm, yellow, truncated and mucronate apically; pistil strongly depressed-globose, 2.5 × 3–3.5 mm, light yellowish, styles very short or lacking, stigmas pointed, erect, pale. Fruits black, globose, 7 mm diam., densely crowded.

Distribution: PANAMA. Chiriquí. Bocas del Toro. Veraguas. Coclé. COSTA RICA. Guanacaste. Alajuela. Heredia. San José. Dense, wet forest, mostly on the Atlantic slope, 650–1,500 m elevation.

Specimens Examined: PANAMA. Chiriquí: Fortuna, *G. de Nevers & G. McPherson 6854* (MO); *B. Hammel 2256* (MO); *H. Churchill 5263, 5264, 5756* (MO); *S. Knapp et al. 4055, 4057* (MO); Cerro Colorado, *S. Mori & R. Dressler 7814* (MO); *J. Folsom & L. Collins 1800* (MO). Bocas del Toro: Fortuna, *H. & A. Churchill 6191* (MO); *G. McPherson 6816* (MO); Quebrada Higueron and Quebrada Gutierrez, *J. Kirkbride Jr. & J. Duke 739* (MO, BH). Veraguas: Bajo Chitra, *G. de Nevers & G. McPherson 6765* (MO); Santa Fe, *T. Antonio 3543* (MO). Coclé: El Copé, *D. R. & R. M. Hodel 737* (holotype, BH; isotype, PMA); *J. Fol-*



1. *Chamaedorea robertii, D. R. Hodel 624,* cultivated in the JBRCW, Costa Rica. 2. Pistillate plant of *C. robertii, D. R. Hodel 828,* cultivated in Los Angeles, California. It was originally collected at the type locality in Panama. 3. Staminate plant of *C. robertii, D. R. Hodel 857,* cultivated in Los Angeles, California. It was originally collected at the type locality in Panama.

som 3243 (MO); *J. Folsom & J. Kauke 2648* (MO); *G. de Nevers et al. 6384* (MO); *B. Hammel 2421, 4094* (MO). COSTA RICA. Guanacaste: Río Negro, *W. Haber ex E. Bello C. 5874* (MO). Alajuela: Río Laurencito de San Ramón, *I. Chacón et al. 2200* (CR). Heredia: Braulio Carrillo National Park, *R. Chazdon 196* (CR). San Jose: Braulio Carrillo National Park, *D. R. Hodel et al. 971, 975, 976* (BH, CR). CULTIVATED. United States. California: Los Angeles, in greenhouse, *D. R. Hodel 828, 857* (BH), originally collected at the type locality. Costa Rica. Puntarenas: San Vito, Jardín Botánico Robert y Catherine Wilson (JBRCW), *D. R. Hodel 624* (BH), originally collected at the type locality.

The name honors Hodel's son Robert who, at age seven, made the walk from El Copé to the Continental Divide and assisted in collecting the type.

Chamaedorea robertii is an attractive and unusual species because of its simple, bifid, heavily nerved leaves, acaulescent habit, and spicate inflorescences. The flower-bearing portion of the staminate inflorescence is pendulous (Fig. 3) and densely crowded with relatively large, white-tinged-with-green flowers. The pistillate inflorescence has densely crowded, yellow flowers and the peduncle is sheathed in attractive, burgundy-colored bracts.

When it flowered for the first time in the greenhouse in Los Angeles, we originally thought this taxon was a member of subgenus *Stephanostachys* because of the densely placed staminate flowers. However, subsequent collections from this cultivated material show that the staminate flowers of *C. robertii*, while closely placed, are clearly distinct and not contiguous, thus excluding it from *Stephanostachys*. *C. robertii* is most closely related to *C. pumila* and *C. sullivaniorum*. *C. robertii* can be distinguished from both by its forest-green leaves with more remotely toothed margins, spicate staminate inflorescences with whitish flowers, and yellow pistillate flowers. It differs from *C. pumila* in the larger, broader leaf with more nerves (12–15 rather than 10) and from *C. sullivaniorum* in the leaf being more deeply bifid.

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

Subgeneris *Chamaedorea* Mart. ex H. A. Wendl. *C. amabili* H. A. Wendl. ex Dammer affinis sed laminis bifidis usque ad medi vel ultra, nervis multo paucioribus, floribus masculis angulatis differt; *C. simplici* Burret affinis sed laminis pluribus nervis, marginibus dentatis, inflorescentiis masculis non spicatis differt. Typus: *D. R. & M. A. Hodel 726A* (holotypus, BH; isotypus, PMA).

Stem solitary, erect but often creeping or procumbent and rooting along its length, to 1 m high, 7–10 mm diam., smooth, green, ringed, internodes 5–10 cm long, often with aerial roots at the base.

Leaves 7 or sometimes more, simple and bifid (Fig. 4), held horizontally; sheath 5–7 cm long, cylindric, green, minutely white-spotted, obliquely open apically, faintly longitudinally striate-nerved; petiole to 15 cm long, green and flattened adaxially, green and rounded abaxially and there with a faint pale yellow or light green band extending from the rachis to the sheath; rachis 8–12 cm long, green and angled adaxially, green and rounded abaxially;

→

4. *Chamaedorea palmeriana, D. R. & M. A. Hodel 726B*, in wet forest at the type locality in Chiriquí, Panama. 5. Staminate inflorescence of *C. palmeriana* cultivated in Los Angeles, California. The plant was originally collected at the type locality in Panama. 6. Herbarium specimen of *C. correae, R. Liesner 1001*, showing simple, bifid leaves and spicate inflorescences. 7. Herbarium specimen of *C. correae, B. Hammel 2413*, showing prostrate stem rooting at the nodes.


4


5


MISSOURI
BOTANICAL GARDEN
HERBARIUM
6


MISSOURI
BOTANICAL GARDEN
HERBARIUM
7

blade bright emerald green, ± thin, ± papery, to 25 × 25 cm, deeply bifid apically to more than one-half its length, lobes to 15 × 9 cm, corrugated with 12–14 prominent nerves at the top of each ridge adaxially, exterior margins dentate.

Inflorescences interfoliar, erect; peduncles to 20–30 cm long, slender, 5–7 mm wide at the base and there ± flattened, 2–3 mm diam. at the apex and there rounded, greenish at anthesis, orange in fruit; bracts 4–5, green at anthesis, tightly sheathing, longitudinally striate-nerved, acuminate, bifid, prophyll 5 cm long, 2nd–4th bracts 15 cm long, uppermost not exceeding the peduncle. Staminate inflorescence (Fig. 5) with a rachis 1–5 cm long, flexuous, greenish at anthesis; rachillae 2–7, ascending-spreading, to 15 cm long, 1–1.5 mm diam., longitudinally ridged, green. Pistillate inflorescence spicate or rarely with 2–3 rachillae; rachis or flower-bearing portion erect, 15–20 cm long, greenish at anthesis and 1.5–2 mm diam., orange and thickened in fruit to 2.5 mm diam.

Staminate flowers in moderately dense spirals, angular-globose, 2.5 × 2.5 mm, greenish apically, yellowish basally, slightly immersed; calyx low-cupular, 0.5 × 1.75 mm, brownish, 3-lobed, lobes broadly rounded; corolla with petals connate at their tips and there adnate to the pistillode and opening by small basal apertures, these elliptic, 0.5 mm long, corolla greenish-yellow except orange-brown around the apertures, petals 2.5 × 2–2.5 mm, rounded-triangular, acute; stamens included; pistillode columnar, 2.5 mm high. Pistillate flowers rather densely arranged, 3–4 mm apart, depressed-globose, 2 × 2 mm, pale green, slightly immersed; calyx low-cupular, very briefly imbricate or connate basally, shallowly 3-lobed, lobes broadly rounded, 0.25–0.5 mm high; corolla with the petals imbricate basally, spreading apically, greenish or yellowish, 2–2.5 mm long at anthesis, 3 mm wide at the base, acute, broadly rounded, 3 mm long in fruit, petals and sepals very lightly nerved on the inside; pistil globose-subglobose, green, rounded, acute. Fruits when immature ellipsoid, 12 × 6 mm, green, closely spaced on rachillae, black when mature, ovoid to globose, 12 × 8–10 mm.

Distribution: PANAMA. Chiriquí. Veraguas. COSTA RICA. Alajuela. Heredia. San José. Limón. Dense, wet forest, 450–1,800 m elevation on the Atlantic slope up to and just over the Continental Divide.

Specimens Examined: PANAMA. Chiriquí: Boquete, *D. R. & M. A. Hodel 726A* (holotype, BH; isotype, PMA); *726B* (BH, PMA); La Zorrea, Río Mali, *J. Kirkbride Jr. & J. Duke 735* (MO); Fortuna, *S. Knapp & M. Vodica 5535, 5064* (MO); *K. Sytsma & W. Stevens 2246* (MO); *T. Croat 49890, 49926* (MO); *R. Hampshire & C. Whitefoord 945* (BM); *B. Hammel 2312* (MO); *H. & A. Churchill 6115, 6124, 6116, 6123* (MO); *H. Churchill 5757, 5941, 5539, 5538* (MO); *T. Antonio 5065* (MO); *S. Knapp 5077* (MO). Veraguas: Santa Fe, *S. Mori & A. Bolten 7667* (BH, MO). COSTA RICA. Alajuela: near San Miguel along the Río Sarapiquí, *L. Gómez & G. Herrera 23328* (MO); *I. Chacón & G. Herrera 1204* (MO). Heredia: upper Río Sarapiquí, *H. E. Moore, Jr. 6644* (BH); Braulio Carrillo National Park, *L. Gómez 20086* (MO); *R. Chazdon 181, 193, 194* (CR); *M. Grayum & G. Herrera 7827* (CR). San Jose: Braulio Carrillo National Park, *M. Grayum & P. Sleeper 6121, 6122* (MO); *R. Chazdon 128, 140, 144, 146* (BH), *217* (CR); *L. Gómez et al. 20873* (MO, CR); *N. Zamora et al. 518* (MO); *I. Chacón & G. Herrera 1704, 1731* (MO, CR), *1742* (CR); *D. R. Hodel et al. 972* (BH, CR); Zurquí, *R. Chazdon 241* (CR); *B. Hammel et al. 17340* (CR). Cartago: Moravia, *H. E. Moore Jr. 6693* (BH). Limón: Cerro Chimu, *L. Gómez & G. Herrera 23548* (MO); Río Peje, *L. Gómez & G. Herrera 23514* (MO). CULTIVATED. United States. California: Los Angeles, in greenhouse, *D. R. Hodel 726A bis* (BH).

The name honors Richard W. Palmer of Whittier, California, who has encouraged and supported Hodel's work on palms and especially that on *Chamaedorea*. Chazdon, in a report on the palm flora of Braulio Carrillo National Park (*Brenesia* 28: 107–116, 1987), referred to *C. palmeriana* as *Chamaedorea* sp. "bifida."

Similar to *C. amabilis* in habit, *C. palmeriana* can be distinguished by its blades bifid at the apex to at least half, rather than one-fourth, their length; half the number of nerves on each side of the rachis (12–14 rather than 20–25); and the staminate flowers angular rather than globose. From *C. simplex*, it is distinguished by the thinner blades with more nerves (12–14 rather than 6–7) and dentate margins; the erect and branched, rather than spicate and pendulous, staminate inflorescences.

Chamaedorea palmeriana is relatively widespread, occurring in very wet forest from Veraguas Province in Panama westward to at least the upper reaches of the Río Sarapiquí in Costa Rica. It occurs mainly on the Atlantic slope in Costa Rica and Panama. However, in Panama where the Continental Divide is at a lower elevation, *C. palmeriana* is sometimes found just over it on the Pacific slope.

An attractive species often flowering when no more than 30 cm tall, *C. palmeriana* is noted for its simple, deeply bifid, corrugated, emerald green leaves. In the wild or when well grown, it is a very leafy plant, often holding 7–10 leaves in a handsome and compact crown. Unfortunately, like other species of the genus from wet, cool, relatively high areas, *C. palmeriana* is somewhat difficult to cultivate.

Chamaedorea correae D. R. Hodel & N. W. Uhl. **sp. nov.** (Figs. 6,7).

Subgeneris *Chamaedoropsis* Oerst. Species egregia caulibus longis gracilibus repentibus, laminis simplicibus bifidis vel raro pinnatis segmentis basalibus paucis, paribus apicalibus latioribus, inflorescentiis spicatis vel furcatis, petalis liberis viridiflavis; *C. guntherianae* D. R. Hodel & N. W. Uhl affinis sed laminis grandioribus, lobis latioribus magis divergentibus, pedunculis longioribus, floribus masculis maturescentibus simul secus axem differt. Typus: *S. Knapp & R. Dressler 3801* (holotypus, MO; isotypus, PMA).

Stem solitary, procumbent with prostrate portion longer than erect portion, to 2–3 m long, briefly erect apically to 1 m tall, rooting at the nodes where touching the ground, slender, 5–10 mm diam., ringed, nodes swollen, internodes 5–10 cm long.

Leaves 4–5, erect-spreading, dull green or gray-green, ± thick, simple and bifid or infrequently pinnate; sheath to 15 cm long, tubular, tightly clasping, obliquely open at the apex, light green, longitudinally striate-nerved; petiole to 10 cm long, gray-green and flat adaxially, rounded and gray-green abaxially with a pale yellow or light green band extending from the rachis onto the sheath; rachis 5–15 cm long, gray-green and angled adaxially, rounded and pale abaxially; rachis, petiole, and upperpart of sheath densely but minutely white-spotted; blade simple and deeply bifid apically to three-fourths its length, 15–25 cm long, lobes broadly divergent, 15–25 × 4–12 cm, lanceolate, slightly sigmoid, acuminate, 8–10 primary nerves adaxially, exterior margin toothed toward the apex, or infrequently blade pinnate with a pair of small basal pinnae, these lanceolate, sigmoid, acuminate, narrowed at the base, 8–12 × 1.5–3 cm, 2–3 prominent nerves adaxially.

Inflorescences infrafoliar, erect-ascending, slender. Staminate inflorescence with a peduncle 10–15 cm long; bracts 5–6, tubular, tightly sheathing, flaring abruptly apically, longitudinally striate-nerved, acute-acuminate, bifid, prophyll 5 mm long, 2nd bract 1 cm long, 3rd 2–3 cm long, 4th 4 cm long, 5th 6–8 cm long, 6th 8–

10 cm long, uppermost not exceeding the peduncle; rachillae 2–3 or sometimes spicate, flower-bearing portion 15–20 cm long, 1.5 mm diam., ascending, finely longitudinally striate. Pistillate inflorescence spicate or less often furcate; peduncle 15 cm long, erect-ascending, or nodding when laden with fruits; bracts similar to those of the staminate; rachis or flower-bearing portion to 15–20 cm long, 2 mm diam., finely longitudinally striate, ascending in flower, horizontal and red-orange in fruit.

Staminate flowers, rather densely arranged, subglobose in immature bud, 2 × 2.5 mm, greenish-yellow, just prior to anthesis 2.5 × 2 mm, yellowish, ± superficial; calyx low, 2.5–3 mm across, membranous, 3-lobed, lobes connate basally; corolla with the petals valvate, connate only briefly basally, spreading apically, petals rounded-triangular, 2–2.5 × 2.5 mm, acute, obscurely nerved; stamens with the filaments very short, anthers 0.75–1.25 mm long, flush against the base of the pistillode; pistillode columnar, 1.5–2 mm high, green or yellowish, broadly lobed apically, flared at the base and there adnate to the filaments. Pistillate flowers, rather densely arranged, ovoid-globose, 2 × 2 mm, greenish-yellow, ± superficial; calyx green, 2.5 mm across, 3-lobed, lobes 1–1.25 mm high, sepals connate briefly basally, ± fleshy; corolla with the petals imbricate basally, spreading apically, yellowish, 2–2.5 × 2 mm, long-triangular, acute; pistil globose, pale or greenish, 2–2.5 × 2 mm, styles short, stigmas flattened, recurved, pointed. Fruits ellipsoid-globose, black, 5–8 mm long.

Distribution: PANAMA. Veraguas. Coclé. Colón. Dense, wet forest and cloud forest mainly on the Atlantic slope at or near the Continental Divide, 800–1,000 m elevation. Probably endemic.

Specimens Examined: PANAMA. Veraguas: Santa Fe, *S. Knapp & W. Kress 4358* (MO); *S. Mori 6717, 6775* (MO); *R. Liesner 1001* (MO) (Fig. 6); *C. Hamilton & R. Dressler 3075* (MO). Coclé: El Valle, *W. H. Lewis et al. 1775* (BH, MO); *K. Sytsma 3806* (MO); *S. Knapp 5296* (MO); El Copé, *T. Croat 44680, 49190* (MO); *T. Antonio 3037* (MO); *J. Folsom 1272, 2491, 3191* (MO); *J. Folsom et al. 5735* (MO) *B. Hammel 2413* (Fig. 7), *2604, 13649* (MO); *H. E. Moore Jr. 10531* (BH); El Potroso, *K. Sytsma 1814* (MO); Los Pedregales, Cerro Tife, *S. Knapp & R. Dressler 3801* (holotype, MO; isotype, PMA); Cerro Caracoral, *J. Kirkbride 1097* (MO). Colón: Santa Rita Ridge, *H. Churchill 5547* (MO).

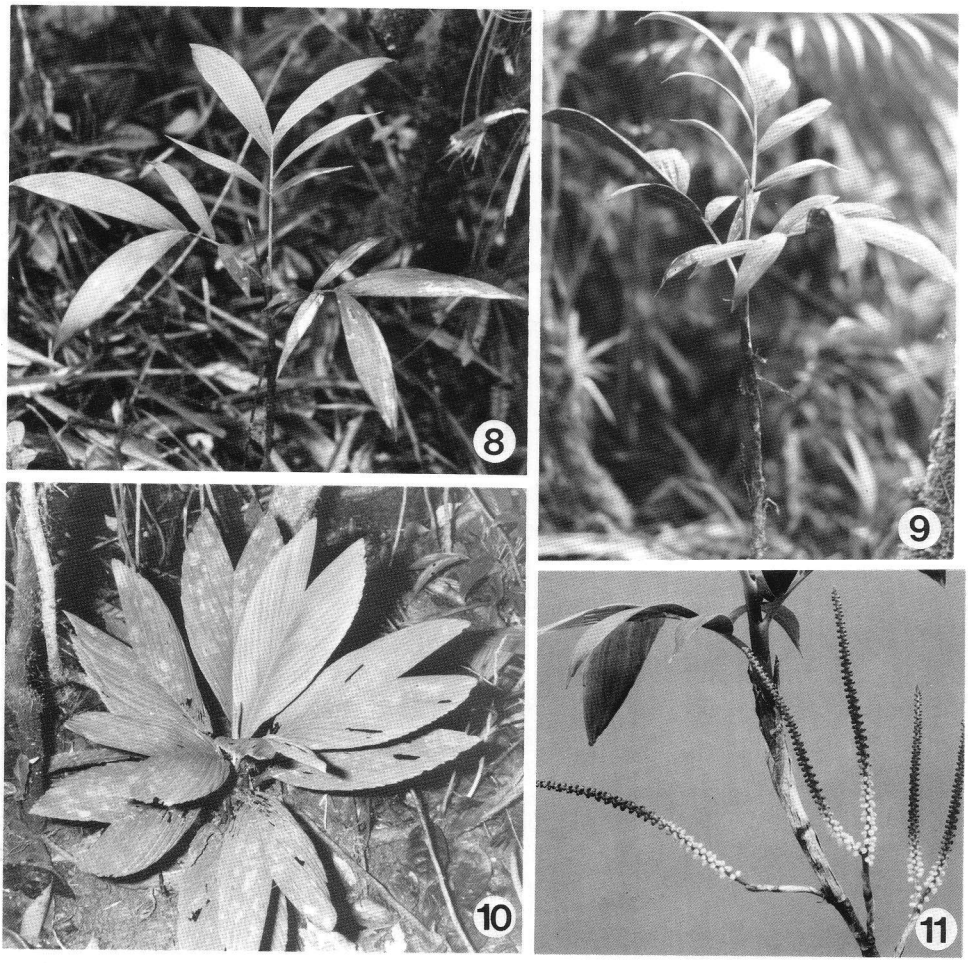
The name honors Mireya Correa, well known botanist and professor at the University of Panama. With creeping stems that root at the nodes and thickish and somewhat leathery, gray-green leaves, *C. correae* is one of the most distinctive members of the genus. It inhabits wind-swept, elfin cloud forest near or at the Continental Divide. *C. correae* is close to *C. guntheriana* but can be distinguished by its larger leaves with broader, more divergent lobes, longer peduncles, and flowers attaining anthesis at more or less the same time along the axis rather than in a conspicuously progressive, basal to apical manner.

Chamaedorea guntheriana D. R. Hodel & N. W. Uhl. **sp. nov.** (Figs. 8, 9,11).

Subgeneris *Chamaedoropsis* Oerst. Species egregia foliis parvis rigidis, laminis segmentis paucis paribus apicalibus latioribus vel raro simplicibus bifidis, inflorescentiis furcatis vel rachillis 3 raro spicatis, petalis liberis, flavis; *C. correae* D. R. Hodel & N. W. Uhl affinis sed floribus masculis maturescentibus conspicue secus axem e basi ad apicem differt. Typus: *D. R. & M. A. Hodel 746* (holotypus, BH; isotypus, PMA).

Stem solitary, erect or procumbent, to 1 m tall, 5–7 mm diam., smooth, green, ringed, conspicuously and minutely white-spotted, internodes to 2–4 cm long.

Leaves 4–5, spreading, ± stiff, ± thick,



8–9. *Chamaedorea guntheriana, D. R. & M. A. Hodel 746,* at the type locality on Cerro Jefe in Panama. 10. *Chamaedorea sullivaniorum* at the type locality near El Valle, Panama. Note the short petioles and compact crown. 11. Staminate inflorescences of *C. guntheriana, D. R. Hodel 856,* on plant cultivated in Los Angeles, California. It was originally collected at the type locality. Note the manner in which the flowers attain anthesis successively up the axis.

pinnate (Figs. 8,9) or less often simple and bifid; sheath to 9 cm long, tubular, tightly clasping, longitudinally striate-nerved, obliquely open at the apex; petiole to 9 cm long, gray-green and ± rounded or slightly flattened adaxially, rounded and gray-green abaxially with a faint yellow band extending from the rachis onto the sheath; rachis to 12 cm long, greenish and angled adaxially, rounded and greenish abaxially; petiole adaxially and abaxially and the rachis abaxially gray-green and densely white-spotted; pinnae 1–4 on each side of the rachis, basal ones to 12 × 2.5 cm, lanceolate, falcately acuminate, narrowed at the base, ± thick and coriaceous, 2–3 prominent nerves, apical pair larger (or if simple and bifid), to 19 × 3.5 cm with 5 conspicuous primary nerves, all pinnae with numerous secondary nerves, these ± faint, pinnae drying heavily striated.

Inflorescences infrafoliar, stiff and

ascending, to 15–20 cm long. Staminate inflorescence furcate, with 2 rachillae (Fig. 11), or infrequently spicate; peduncle to 5–6 cm long, 2.5–4 mm wide at the base and there ± flattened, 1.5–3.5 mm diam. at the apex and there rounded, ascending, greenish at anthesis; bracts 4, these brownish at anthesis, coriaceous, acute-acuminate, bifid, prophyll 5 mm long, 2nd bract 1 cm long, 3rd 2–3 cm long, 4th 4 cm long, tightly sheathing basally, ± inflated apically; rachis or flower-bearing portion if spicate or rachillae to 10–12 cm long, to 2 mm diam., green, ascending. Pistillate inflorescence spicate; peduncle similar to that of the staminate but brownish or dull orange in fruit; bracts similar to those of the staminate but greenish at anthesis; rachis or flower-bearing portion to 6 cm long, 2.5 cm diam., erect, greenish at anthesis, becoming thickened and dull orange in fruit.

Staminate flowers in moderately dense spirals, maturing basally first and then attaining anthesis progressively toward the apex of the axis, oblong to bullet-shaped, 2.5–3 × 2–2.5 mm, bright yellow, slightly immersed; calyx ringlike, 1 × 2.5 mm, pale green or yellowish, shallowly 3-lobed, lobes broadly rounded, sepals imbricate basally; corolla with the petals valvate, erect, spreading, free nearly to the base, 2–2.5 × 2 mm, acute, ± thick; stamens 1–1.5 mm high, filaments short, clear-colored, anthers brownish, bilobed, 0.5 mm long; pistillode columnar, 2–2.5 mm long, whitish, expanded basally and there 0.8 mm diam., apically 0.5 mm diam. and there yellow ageing to red. Pistillate flowers in moderately dense spirals, bullet-shaped, 2.5–3 × 1.5–2 mm, yellow, slightly immersed; calyx ringlike, thickened, 0.75 × 2.5–3 mm, pale green; corolla with the petals imbricate basally, spreading apically, 2 × 2.5–3 mm; pistil pale greenish, stigmas short, pale, recurved. Fruits globose, black, 6 mm diam.

Distribution: PANAMA. Panama. Windswept, moist, relatively open, dwarf cloud forest, 900–1,000 m elevation, at or near the Continental Divide. Probably endemic.

Specimens Examined: PANAMA. Panama: Cerro Jefe, *D. R. & M. A. Hodel 746* (holotype, BH; isotype, PMA); *J. & F. Witherspoon 8496* (MO); *R. Foster & H. Kennedy 1887* (MO); *J. Dwyer & S. Hayden 8090* (MO); *S. Mori & J. Kallunki 2378* (BH, MO), *3794, 6094* (MO). Pavon Road, *S. Mori & J. Kallunki 2723* (MO). CULTIVATED. United States. California: Los Angeles, in greenhouse, *D. R. Hodel 856* (BH), originally collected at the type locality in Panama.

The name honors Bill Gunther of Del Mar, California, who has encouraged and supported Hodel's work on *Chamaedorea.*

Chamaedorea guntheriana is a most unusual palm in habitat and habit. It occurs sparingly in dwarf, windswept, relatively open cloud forest at the Continental Divide in central Panama. This is not the typical, dripping-wet cloud forest festooned with epiphytes that one encounters in other parts of Panama and Costa Rica. Rather, certain elements of it seem to be of an almost sclerophyllous nature. The low, open, shrubby forest contains no tall trees. Many of the species occurring there have thick, grayish-green leaves as does *C. guntheriana.* Another aspect in which *C. guntheriana* is unusual is the manner in which the staminate flowers attain anthesis; this they do in a very pronounced, progressive manner successively from the basal end of the rachis or rachillae to the distal end (Fig. 11).

With grayish-green, thick, stiffish pinnae, *C. guntheriana* is similar to *C. correae* but can be distinguished by its slightly smaller and usually pinnate leaves and the staminate flowers attaining anthesis in a progressive manner along the axis basally to apically rather than simultaneously.

Chamaedorea sullivaniorum D. R. Hodel & N. W. Uhl. **sp. nov.** (Figs. 10,12).

12. *Chamaedorea sullivaniorum, D. R. & M. A. Hodel 740B,* in a ravine at the type locality. Note the larger leaves with longer petioles and the spicate infructescence. 13. *Chamaedorea pedunculata, D. R. & M. A. Hodel 708A,* at the type locality in forest remnants adjacent to the JBRCW, Costa Rica.

Subgeneris *Chamaedoropsis* Oerst. *C. pumilae* H. A. Wendl. ex Dammer et *C. robertii* D. R. Hodel & N. W. Uhl affinis sed laminis non profunde bifidis, stigmatibus in depressiones apicibus gynoceiorum differt; *C. pumilae* affinis sed nervis 15 utrinsecus, petalis masculis tenuibus differt; *C. robertii* affinis sed laminis venetis, marginibus serratis, inflorescentiis masculis ramosis, floribus masculis viridiflavis, floribus femineis viridibus differt. Typus: *D. R. & M. A. Hodel 740A* (holotypus, BH; isotypus, PMA).

Stem solitary, creeping, shortly erect to 25 cm tall, often subterranean or buried in leaf litter so to appear acaulescent, 1–1.5 cm diam., light green but often covered with old persistent leaf bases, prominently ringed, internodes congested, 0.7–1 cm long.

Leaves in rosettes of 10 (Fig. 10) but often as many as 15, erect-spreading, simple, bifid; sheath 3–4 cm long, open, splitting deeply opposite the petiole and clasping completely and in a circular manner only at the base, distally the margins rolled inward forming a tube; petiole 10–16 cm long, dark green, flattened adaxially and with both margins of the blade decurrent and continuing down the petiole to form a channel, rounded abaxially; rachis to 20–25 cm long, gray-green and angled adaxially, paler and rounded abaxially; blade oblong in outline, to 25–40 × 10–17 cm, incised apically to ca. one-third its length, thickened, pliable, coriaceous, dark velvety nearly iridescent mottled green, plicate, with 15 prominent primary nerves adaxially, each along the ridge of a fold resulting in a corrugated effect, nerves light green or white adaxially and abaxially, exterior margins conspicuously toothed.

Inflorescences interfoliar, emerging through the tubelike upper rolled margins of the sheath and flumelike upper surface of the petiole, erect, often appearing through the leaf litter of the forest floor. Staminate inflorescence with a peduncle to 22 cm long, 2–3 mm wide at the apex, 7–9 mm wide at the base; bracts 5, green, longitudinally striate-nerved, tightly sheathing, membranous, ± rotting away prior to flowering; rachis 2.5 cm long; rachillae 4–8, to 10 cm long, 1.5–2 mm diam., ± drooping, light green. Pistillate inflorescence spicate or rarely furcate; peduncle to 32 cm long, ascending, greenish or pale at anthesis, dull orange in fruit; bracts 5–6, similar to those of the staminate; rachis or flower-bearing portion 15–20 cm long, 3 mm diam., strongly curved, light green in flower, thickened and orange in fruit.

Staminate flowers arranged in fairly dense spirals but not contiguous, 2 mm apart, oblong, 4 × 2.5–3 mm, pale green to yellow-green, slightly immersed; calyx coroniform, low, 0.5–0.75 × 2 mm, light greenish-yellow, shallowly 3-lobed, lobes broadly rounded; corolla 3 × 2.5–2.75 mm, petals free nearly to the base, narrowly acute at the apex, 3 × 1.75 mm, light yellowish-green basally and green apically, thin and ± membranous; stamens one-half as high as the corolla; pistillode three-fourths as high as the corolla, globose basally and narrowly attenuate apically, light yellowish-green. Pistillate flowers arranged in ± dense spirals but not contiguous, 2–3 mm apart, depressed-globose, 3 × 3–3.5 mm, pale greenish-yellow, slightly immersed; calyx coroniform, 0.75–1 × 2.5–2.75 mm, light green, shallowly 3-lobed, lobes broadly rounded; corolla 3 × 3–3.5 mm, petals fleshy, imbricate nearly to the apex, there acute and flared slightly upward and outward, 3.5 × 3 mm, greenish-yellow; pistil flattened-globose, 1.5 × 2 mm, green with a depression or pit at the apex, styles lacking, stigmas pointed, slightly recurved, not exceeding the rim of the depression. Fruits black, ± globose, 6–8 mm diam.

Distribution: PANAMA. Bocas del Toro. Veraguas. Coclé. Colón. San Blas? COSTA RICA. San José. Limón. Puntarenas. Dense, wet mainly on the Atlantic slope up to and just over the Continental

Divide, 600–1,500 m elevation; infrequent in southeastern Costa Rica on the Pacific slope below 400 m elevation.

Specimens Examined: PANAMA. Bocas del Toro: Fortuna, *T. Croat & M. Grayum 60214* (MO). Veraguas: Santa Fe, *B. Hammel 4722* (MO); *G. McPherson 7156* (MO); *T. Antonio 2968.* Coclé: El Copé, *B. Hammel 2388* (MO); El Valle, *D. R. & M. A. Hodel 740A* (holotype, BH; isotype, PMA), *740B* (BH, PMA). Colón; Cerro Bruja, *B. Hammel 3121* (MO). COSTA RICA. San José: Alfombra, *W. Burger & R. Baker 10122* (CR). Limón: Río Segundo, Asuncion, *L. Gómez & G. Herrera 23486* (CR). Puntarenas: Osa Peninsula, *H. Kennedy 1927* (MO); *M. Grayum 4050, 4051* (MO). CULTIVATED. United States. California: Los Angeles, in greenhouse, *D. R. Hodel 854, 855* (BH), originally collected from the type locality. Costa Rica. Puntarenas: San Vito de Coto Brus, JBRCW, *D. R. & M. A. Hodel 626A, 626B* (BH), originally collected at the type locality.

The name honors Pauleen Sullivan and her late husband Joe who have encouraged and supported Hodel's interest and work on palms.

Chamaedorea sullivaniorum occurs in dense, wet forest, mainly on the Atlantic slope in western Panama and eastern Costa Rica. There is a report of it occurring in San Blas in eastern Panama but this has not been verified. Where the Continental Divide is low enough, as at El Valle, Panama, *C. sullivaniorum* may occur just over it on the Pacific slope. In southeastern Costa Rica, disjunct and isolated populations occur on the Osa Peninsula below 400 m elevation.

At the type locality in Panama, *C. sullivaniorum* is very localized and never widespread. There it occurs in dense, dark forest often on the sides or bottoms of steep ravines although we also found it in more open forest along rounded ridge tops. It grows with *C. amabilis* and *C. allenii* among others. During one visit to the type locality in April, 1987, the leaf litter on the forest floor was actually dusty dry. Several months later in December, the leaf litter was spongy wet.

Chamaedorea sullivaniorum is similar to *C. pumila* but can be distinguished by the blades incised at the apex only about one-third, rather than one-half, their length and with 15, rather than 10–12, nerves on each side of the rachis; the staminate flowers with thin, rather than thick and fleshy, petals; the pistillode basally globose and narrowly attenuate apically rather than ± columnar; and the pistillate flowers with the pistil having a depression at the apex in which the stigmas are situated. It can be distinguished from *C. robertii* by the branched, rather than spicate, staminate inflorescences; the greenish-yellow, rather than white, staminate flowers; the greenish, rather than yellow, pistillate flowers; and the blade with the margins serrate rather than dentate and not deeply bifid at the apex.

A striking plant to see in the wild because of its thick, leathery, heavily nerved, simple leaves only shallowly bifid at the apex, *C. sullivaniorum* is a handsome ornamental that exhibits a fairly wide range of foliar variation, especially in the length of the blade and petiole. In higher light, the crown is a rosette of 10–15 (Fig. 10), stiffish leaves with short petioles. In extremely low light, the crown contains fewer, softer, larger leaves with longer petioles (Fig. 12). It is highly sought after by collectors and hobbyists who, in some instances, have completely decimated local populations (see letter to the editor by D. R. Hodel, *Principes* 32(3): 95, 1988).

Chamaedorea pedunculata D. R. Hodel & N. W. Uhl. **sp. nov.** (Figs. 13,14).

Subgeneris *Chamaedoreae* Mart. ex H. A. Wendl. *C. macrospadici* Oerst. affinis sed segmentis late rhombicis-lanceolatis, floribus masculis rhombicis depressis dif-

14. Pistillate inflorescence (right), staminate inflorescence (left), and leaf (middle) of *Chamaedorea pedunculata, D. R. & M. A. Hodel 708A, 708B.*

fert. Typus: *D. R. & M. A. Hodel 708A* (holotypus, BH; isotypus, CR).

Stem solitary, erect or decumbent, to 2–3 m tall, 2.5 cm diam., green, ringed, internodes 7.5 cm long.

Leaves 4–6 (Fig. 13), erect-spreading, pinnate; sheath 25 cm long, splitting opposite the petiole and obliquely long-open, tubular only in the basal half; petiole 30–35 cm long, green and slightly grooved adaxially, rounded and pale-banded abaxially; rachis 1 m long, slender and attenuate toward the apex, green and sharply angled adaxially, green and rounded abaxially; pinnae 4–8 on each side of the rachis, regularly arranged, opposite or subopposite, broadly rhombic-lanceolate, slightly sigmoid, somewhat cupped downward, lower middle the largest, these to 35–37 × 12–13 cm, becoming progressively smaller toward the apex of the rachis, long-acuminate with drooping apices, narrowly contracted at the base with 8–10 nerves, these not very prominent adaxially, more prominent with an equal number of secondary nerves abaxially.

Inflorescences interfoliar, erect, becoming horizontal in fruit or flower, long-pedunculate (Fig. 13); peduncle to 1 m long or slightly more, 2–2.5 cm wide at the base, 1 cm wide at the apex, green or pale in flower, orange in fruit; bracts 7–8, tightly sheathing, obliquely open apically, drying brown at anthesis; rachis 6–10 cm long, green in flower, red-orange in fruit. Staminate inflorescence with 20 rachillae, these to 30 cm long, slender, pendulous, green. Pistillate inflorescence with 12–15 rachillae, these to 20–25 cm long, spreading, greenish-yellow at anthesis, red-orange in fruit.

Staminate flowers arranged in fairly dense spirals but not contiguous in bud, depressed-diamond-shaped, 3 × 2.5 mm, greenish-yellow; calyx low, green; corolla with petals connate at the tips and there adnate to the pistillode and opening by lateral slits, yellow-green, petals longitudinally striate-nerved. Pistillate flowers not known. Fruits black, obovoid-globose, 7–8 mm long.

Distribution: COSTA RICA. Puntarenas. Dense, wet forest on the Pacific slope, 1,000 m elevation. Probably endemic.

Specimens Examined: COSTA RICA. Puntarenas: San Vito de Coto Brus, forest remnants adjacent to JBRCW, *D. R. & M. A. Hodel 708A* (holotype, BH; isotype, CR), *708B* (BH); *H. E. Moore Jr. 10507* (BH).

The epithet refers to the long, conspicuous peduncle of this species.

Chamaedorea pedunculata is similar to *C. macrospadix* but can be distinguished by the broadly rhombic-lanceolate, rather than long-lanceolate, pinnae and the depressed-diamond-shaped, rather than ovoid, staminate flowers. Collected only at the type locality, *C. pedunculata* is uncommon in forest remnants near JBRCW where it grows with *C. warscewiczii, C. crucensis,* and *C. brachyclada.*

Acknowledgments

We express our gratitude to Richard W. Palmer, Bill Gunther, Pauleen Sullivan and the International Palm Society for encouragement and support of Hodel's field work in Costa Rica and Panama. In addition, we thank Dr. Michael H. Grayum of the Missouri Botanical Garden stationed in Costa Rica for his suggestions and thoughts and review of the manuscript. John Dransfield critically reviewed the manuscript also.

Principes, 34(3), 1990, p. 133

PALM LITERATURE

WESSELS BOER, J. G. 1988. Palmas Indigenas de Venezuela. Pittieria 17: 1–332.

Wessels Boer (1971) provided a key to the genera and species of Venezuelan palms, and wrote then that the key was based on a critical revision, which was also cited as Wessels Boer (1971). Now, 17 years later, this "critical revision" has actually been published.

The work is in Spanish and has no illustrations. It begins with an introduction, followed by a discussion of the distribution and ecology of Venezuelan palms. Numerous references are cited in the text, but a full list of literature citations is not provided. The main part of the work is taken up with taxonomy.

Wessels Boer treats 145 species under the title "Palmas Indigenas de Venezuela." By my own estimate 17 of these have not yet been collected in the country. This leaves 128 species, and I estimate that, after taking into account at least 9 synonyms, approximately 120 species actually occur in Venezuela.

We now have such a clear outline of generic concepts in palms (Uhl and Dransfield 1987) that Wessels Boer's work seems out-of-date at the generic level. Yet even 17 years ago *Lepidocaryum* and *Mauritiella* were distinct from *Mauritia*; *Jessenia* from *Oenocarpus*; *Prestoea* from *Euterpe*; *Socratea*, *Dictyocaryum*, and *Iriartella* from *Iriartea*; *Catoblastus* from *Wettinia*; *Maximiliana*, *Scheelea*, and *Orbignya* from *Attalea*; and *Barcella* from *Elaeis*. This broad generic concept means that at least 30 species have names that are not currently accepted. But even if we overlook Wessels Boer's generic concepts, at the species level the work is still very uneven.

The treatments of *Aiphanes*, *Chamaedorea*, *Ceroxylon*, and *Hyospathe* consist of an uncritical compilation of the then-available literature. *Iriartea* (sensu Wessels Boer) and *Attalea* (again sensu W. B.) are both confusing. The author even goes as far as to describe a new species, *Attalea pycnocarpa*, without having seen the staminate flowers. He suspects they may be of the "*Orbignya*-type." I suspect, with such a broad generic concept, it doesn't really matter what the flowers look like. Treatment of the largest genus, *Bactris*, is also very uneven. Take, for example, the complex of species centered around *B. major* (*B. bifida*, *B. gastoniana*, *B. cruegeriana*, *B. major*, and *B. gaviona*). *Bactris gastoniana* and *B. gaviona* have, as far as I know, never been collected in Venezuela. Inclusion of *B. bifida* is based on two sterile specimens which I had difficulty deciding were *Bactris* and not *Astrocaryum*. Inclusion of *B. cruegeriana* also rests on two specimens, one of which I considered not to represent that species.

In general, I suppose, it is better that this work has at last been published. Unfortunately it will serve to perpetuate incorrect names and unrealistic generic con-

(*Continued on p. 142*)

Principes, 34(3), 1990, pp. 134–142

Conservation Status of Haitian Palms

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ABSTRACT

The conservation status of the 13 genera and 21–24 species of palms occurring naturally in Haiti is given. Notes on distribution, uses, and common names are also given. Current conservation efforts are reported.

Résumé

L'état de conservation de 13 genres et 21–24 espèces de palmes qui grandissent naturellement en Haiti est donnée. Des notes sur leur distribution, usages et noms communs sont aussi données. Des efforts actuels de conservation sont fournis.

Rézimé

Stati sou konservasion 13 genus ak 21–24 espès palm ki pousé an Ayiti yo, bay isit. Not sou distribision yo nan peyi-a, sa yo fé avè yo ak non yo bays yo nan chak zone. Efò nou mennen pou proteksion kek palm.

Since its discovery by Columbus in 1492 the natural environment of Haiti has suffered almost complete destruction. Today approximately 2% or less of the original forest cover remains (Davis et al. 1986, Paryski and Woods 1989).

Thirteen genera and between 21 and 24 species of palms occur naturally in Haiti, and up to one quarter of these species may be endemic to the country. Because of environmental destruction many of them are rare, and the endemic species face extinction.

Two national parks exist in Haiti (Judd 1987, Paryski and Woods 1989); Parc National Pic Macaya and Parc National Morne La Visite. Unfortunately few palms occur in these parks. Many of the non-endemic Haitian palms are in cultivation in Fairchild Tropical Garden and elsewhere, but very few of these cultivated palms are of Haitian origin.

In 1988 we began a program aimed at the conservation of the rarer species of palms in Haiti. Here we report on the conservation status of all Haitian palms, as well as on our efforts to conserve the rarer species.

Methods

The following account is based on four field trips to Haiti which took place between November 1988 and December 1989. During these trips we have mapped populations of rarer palms, either on 1:50,000 or 1:100,000 scale maps. We have counted numbers of individuals in rarer populations. We have interviewed local people and collected information on uses and local names, in both French and Creole. We have made herbarium specimens of most species, and studied Haitian specimens in the herbaria in Port-au-Prince (EHH) and New York (NY), and have reviewed the relevant literature. The most recent treatment of the palms of Haiti is that of Barker and Dardeau (1930).

In order to conserve populations of rarer palms we have produced a management plan for palm conservation in Haiti, based on *Attalea crassispatha*. We have begun

to carry out some of the recommendations of the plan, particularly with *A. crassispatha* and *Pseudophoenix lediniana*. These are discussed below.

Acrocomia

This genus is now considered to consist of just two species, one of which, *Acrocomia aculeata* (Jacq.) Lodd. ex Mart., is widely distributed from Mexico to Paraguay. We have only encountered this species once in Haiti, near Beaumont (Fig. 1) on the Massif de la Hotte, but there are records and specimens to indicate that it was once widely distributed, for example on the Ile de la Tortue. Approximately 10 plants exist at the locality near Beaumont, but local people say that the palms were planted. They do not use the palms for anything, except for children who eat the seeds. The common name of this palm in Haiti is spelled "coco guinée" or "corosse" in French, and "koko ginen" or "kawos" in Creole.

Attalea

One species, *Attalea crassispatha* (Mart.) Burret, is endemic to Haiti (Henderson and Aubry 1989). A total of 26 individual trees of this species have now been located. All trees are in the southern peninsula, and most are either near Fond des Negres or Cavaillon (Fig. 2). During 1989 six trees fruited, and in August we collected approximately 500 seeds. These were distributed to two nurseries in Haiti, and the rest were distributed to various Botanical Gardens through Fairchild Tropical Garden in Florida, and to other researchers. Seeds have now germinated both in Haiti and in Florida.

The common name of this palm in Haiti is spelled "côrossié" or "petit coco" in French and "kawosie" or "ti koko" in Creole. Dransfield et al. (1988) list this species as endangered (note that Dransfield et al. list this species under *Orbignya* sp.).

Bactris

A large genus with approximately 80 species occurring throughout the neotropics. One, *Bactris plumeriana* Mart. (Fig. 3), occurs in Haiti, and throughout the Caribbean. We have seen scattered individuals throughout the country in wetter areas. This species is not used for any purpose because of its spines. Its common name in Haiti is spelled "coco macaque" in French and "koko makak" or "ti crocro" in Creole.

Calyptronoma

A genus of three species confined to the Greater Antilles. The genus is still in need of study, despite a relatively recent revision (Wessels Boer 1968). Two species are reported to occur in Hispaniola, *C. dulcis* (Wright ex Griseb.) Bailey and *C. rivalis* (Cook) Bailey. Apparently only *C. rivalis* occurs in Haiti. We have seen one very small population consisting of approximately 30 adult plants near Saut d'Eau (Fig. 4). The young, unexpanded, leaves are used for weaving and the older leaves are used for thatch. This palm occurs in very wet ground, either at the edges of streams or in marshy areas. It is known locally as "palma." Dransfield et al. (1988) list this species as vulnerable.

Coccothrinax

A very poorly known genus with up to 49 described species, 34 of them from Cuba (Uhl and Dransfield 1987). Bailey (1939*b*) reported that 6 species occurred in Haiti; *Coccothrinax argentea* (Lodd. ex Schult.) Sarg. ex Becc., *C. concolor* Burret, *C. ekmanii* Burret, *C. gracilis* Burret, *C. montana* Burret, and *C. spissa* Bailey. A seventh species, *C. scoparia* Becc. also occurs there.

Coccothrinax argentea is very variable and occurs throughout the country in a great variety of habitats, but always on calcareous soil and on mountain slopes. It

1. *Acrocomia aculeata* near Beaumont, Massif de la Hotte. 2. *Attalea crassispatha* near Cavaillon. The holes in the peduncular bracts are made by a woodpecker, *Sphyrapicus varius*. 3. *Bactris plumeriana* near Cavaillon. 4. *Calyptronoma rivalis* near Saut d'Eau.

is very common in parts of the southern peninsula (Fig. 5) up to elevations of 1,100 m where rainfall is near 2,000 mm per year. Conversely it also occurs in very arid areas, for example near Gonaïves, where rainfall is near 600 mm per year. Further study of this species may reveal that several species or sub-species actually exist. The leaves of *C. argentea* are very widely used to weave hats, saddles, and make brooms and other articles. The common name of this palm in Haiti is spelled "gouane, latanier savanne, latanier marron, latanier bourique, palme coyau" in French, and "gwenn, latanye savann, latanye maron, latanye bourik, palm koyo" in Creole.

There are two other distinct species of *Coccothrinax* in Haiti, neither of which we have seen despite searching. *Coccothrinax ekmanii* is reported by Bailey (1947) to occur in extreme southeastern Haiti, near Anse-à-Pitres, where it is called "gouane" (French) or "gwenn" (Creole). It does occur over the border in adjacent areas of the Dominican Republic. *Coccothrinax spissa* is reported by Bailey (1939b) to occur in Haiti.

The two other species listed by Bailey (1947) for Haiti (*Coccothrinax concolor* and *C. gracilis*) are probably synonyms of *C. argentea*. *Coccothrinax* cf. *montana* is reported by Judd (1987) to occur in Parc National Pic Macaya. Roger Sanders (pers. comm.) believes this palm may be *C. scoparia*. Barker and Dardeau (1930) give "latanier balai" as the common name of this species.

Copernicia

This genus contains approximately 25 species, three of which occur in South America, 20 in Cuba, and two are endemic to Hispaniola (Dahlgren and Glassman 1963).

Copernicia berteroana Becc. is quite widespread but occurs in small populations. We have seen it near Port-au-Prince, where the population was recently destroyed. Other small populations occur near Gonaïves. The greatest number of individuals we have seen occur between La Jeune and Pignon in the Dep. du Centre (Fig. 6). *Copernicia berteroana* occurs on flat land, often on saline soils, where rainfall is between 600 and 1,000 mm per year. It is locally known near La Jeune as "dyaré," and the leaves are used for thatching.

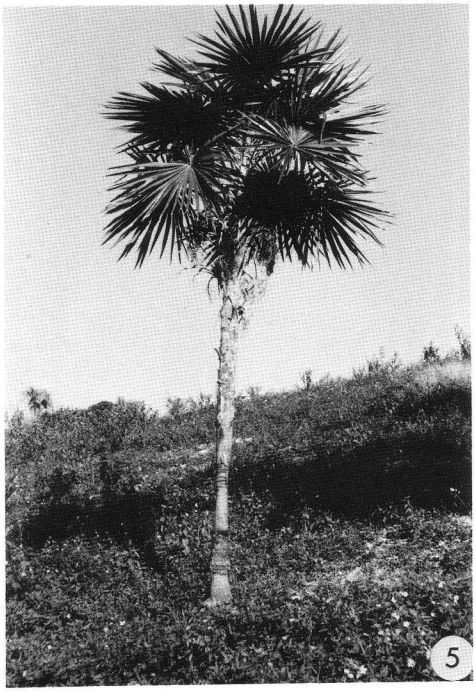
The second species, *Copernicia ekmanii* Burret is endemic to Haiti. It is very different from *C. berteronana* because of its bluish leaves which have a waxy coating. This species is reported to occur on the northern coast of Haiti, between Port-de-Paix and Môle St. Nicolas, on rocky shores near the sea. This region receives between 600 and 1,000 mm of rain per year. We have seen only one plant of this species, near Guinaudée, Dep. du Nord Ouest, and this was apparently cultivated. The palm is locally known as "homme de paille" or "jambe de paille" (French), and "om de pay" or "jamm de pay" (Creole). The leaves are reported to be a very durable and sought after thatch.

Geonoma

Another large neotropical genus, occurring throughout Central and South America. *Geonoma oxycarpa* Mart. has an unusual distribution. It occurs in Central America from Mexico to Colombia, and also in Haiti. We have seen this species only in one tiny locality at 900 m elevation where a few seedlings exist in a shady gully, in the Massif de la Hotte (Fig. 7). Locally it is called "palm." It must have had a much wider distribution in the past, because the type locality is near Port-de-Paix, in the north of the country.

Prestoea

This genus of about 12 species occurs mainly in mountainous areas in Central America and in the Andes of South America as far south as Bolivia. There is one



5. *Coccothrinax argentea* in the southern peninsula. 6. *Copernicia berteroana* near La Jeune. 7. *Geonoma oxycarpa*, Massif de la Hotte. 8. *Prestoea montana*, Massif de la Hotte.

species in the Caribbean, *Prestoea montana* (Graham) Nicholson. It is a cloud forest species, often occurring in great numbers, for example in Puerto Rico (Henderson 1984). In Haiti very few scattered individuals exist in cleared areas, especially in the Massif de la Selle (Fig. 8) and in the Massif de la Hotte, in areas between 1,000 m and 2,000 m elevation and with 2,000 mm rainfall per year. Judd (1987) reported that this species occurs in both national parks in Haiti. It is locally known as "palme à vin" (French), and the leaves are used for thatching.

A second pinnate-leafed palm occurs with *Prestoea montana* near Beaumont in the Massif de la Hotte, and its identity is unknown. Local people call it "chapelet" and insist that it is different from the *Prestoea* ("they are brothers, but they are different").

Pseudophoenix

A Caribbean genus of four species, all of which occur in Hispaniola (Read 1968). In Haiti these palms occur in very arid areas on steep hillsides, often on west-facing slopes.

Pseudophoenix lediniana Read is endemic to Haiti, and occurs in a small area in the Dep. de l'Ouest (Fig. 9). This area, the type locality, contains a small but reproductive population of about 30 trees. During 1989 we collected several hundred seeds from one tree. These seeds were planted in a nursery in Haiti, where many have germinated, and seeds were also sent to Fairchild Tropical Garden where they have also germinated. This palm is known locally as "pal" or "ti palmis maron" (Creole). It is not used to any great extent but obviously has great potential as an ornamental.

Pseudophoenix sargentii H. A. Wendl. ex Sarg. is reported from the island of La Gonave, but we have not seen it.

Pseudophoenix vinifera (Mart.) Becc. is endemic to Hispaniola. It was apparently quite widespread in Haiti, but now only two viable populations remain. One is between Poteau and Passe Reine in the Dep. de l'Artibonite, and the second is near Source Matelas (Fig. 10) in the Dep. de l'Ouest. In other areas we have observed very few juveniles in localities where adults have been cut down. Near Thomazeau it is known as "katié" (Creole), and the leaves are occasionally used for thatching and the fruits eaten. Read (1968) reported that the practice of making wine from this species has died out in Haiti.

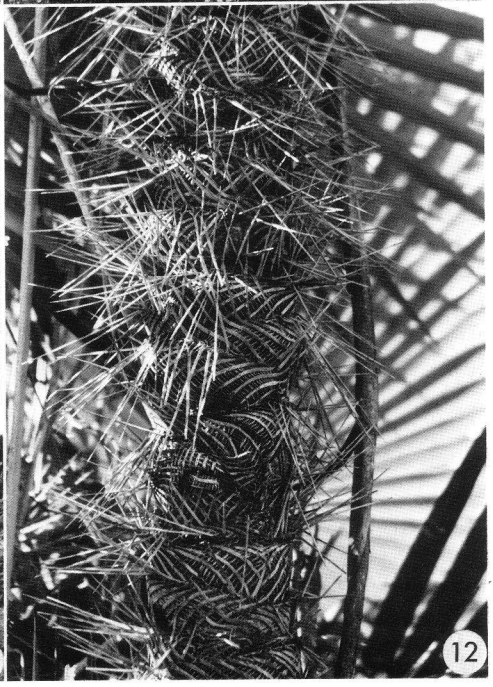
Roystonea

This Caribbean genus is much in need of revision. Bailey (1949) recognized 12 species, but there seem to be fewer. There is a very common species in Haiti which we are calling *Roystonea hispaniolana* Bailey. It is very abundant throughout the country, and seems to be one of the few palms that can regenerate well in disturbed areas. It is universally known as "palmiste" or "palmier royale" (French) or "palmis" (Creole). It is especially abundant on the Central Plateau in the Dep. du Centre. At one time there it was an important source of pig food. It is still an important tree as a source of pollen for honey bees. It is also very commonly used as a grain store. A hole is made through the swollen part of the stem several meters from the ground, and then corn is attached to either end of a stick stuck through the hole. Rodents cannot climb the palm stem to reach the corn.

Sabal

A genus of 15 species occurring throughout the Caribbean and adjacent countries (Zona 1990). Two species are apparently present in Haiti.

Sabal domingensis Becc. is endemic to Hispaniola, and is extremely abundant in the Dep. du Nord Ouest (Fig. 11). It is locally known as "paille" or "latanier chapeau" (French) and "pay" or "latanye



9. *Pseudophoenix lediniana*, Dep. de l'Ouest. 10. *Pseudophoenix vinifera* near Source Matelas. 11. *Sabal domingensis*, Dep. du Nord Ouest. 12. Stem of *Zombia antillarum*, near St. Michel du Sud.

chapo" in Creole. The leaves are heavily used for thatching and making hats, brooms, and saddles. Almost every individual *Sabal* in this region has had its leaves cut and removed. Presumably increasing pressure on the palms will eventually lead to their demise.

The second species, *Sabal causiarum* (Cook) Bailey is common in the southwestern peninsula. It is known as "latanier franc" or "latanier jaune" (French) and "latanye fran" or "latanye jone" (Creole), and again its leaves are widely used. This species also occurs in the Dominican Republic and Puerto Rico. *Sabal haitensis* Becc. is a synonym of *S. causiarum*.

Thrinax

A genus of seven species (Uhl and Dransfield 1987) occurring throughout the Caribbean. Two species are reported to occur in Haiti (Read 1975). *Thrinax morrisii* H. A. Wendl. occurs on the island of Navassa, and *T. radiata* Lodd. ex J. A. & J. H. Schult. on the island of Gonave and near Roseaux. We did not encounter the latter species on a visit to Roseaux, and both species must be considered rare in Haiti. However, the two species are widespread elsewhere in the Caribbean (Read 1975).

Zombia

This monotypic genus is endemic to Hispaniola. There are specimens and references indicating that *Zombia antillarum* (Desc. ex Jackson) Bailey had a much wider distribution formerly (see Bailey 1939*a*). We have only found two very small nonreproductive populations near St. Michel du Sud (Fig. 12). In one locality approximately 10 individuals exist, with fewer in the second locality. This palm is locally called "latanier zombi" or "latanier piquant" (French) and "latanye zombi" or "latanye pikan" in Creole. Leaves are used for weaving. This species is apparently quite common in certain areas of the Dominican Republic, where Zanoni (in Johnson 1986) considers it may be endemic to serpentine soils. This is a very ornamental palm.

Acknowledgments

Dr. Dennis Johnson initiated our study of *Attalea crassispatha*, and our first trip was funded by World Wildlife Fund–U.S. (WWF 3322). Subsequent funding was provided by US Agency for International Development through International Resources Group, Ltd. We are grateful to numerous Haitian people for their unfailing helpfulness in our search for palms. Roger Sanders and Chuck Hubbuch of Fairchild Tropical Garden and Scott Zona of Rancho Santa Ana Botanic Garden reviewed the manuscript, and Fritz Vaval and Louis Verret assisted us in the field.

Literature Cited

Bailey, L. H. 1939*a*. New Haitian genus of palms. Gentes Herb. 4: 239–246.

———. 1939*b*. *Coccothrinax* in the southern Greater Antilles. Gentes Herb. 4: 247–259.

———. 1947. The Gouane palm of Haiti. Contr. Gray Herb. 165: 5–9.

———. 1949. Palms uncertain and new. Gentes Herb. 8: 92–205.

Barker, H. D. and W. S. Dardeau. 1930. Flore d'Haïti. Port-au-Prince, Haiti.

Dahlgren, B. E. and S. F. Glassman. 1963. A revision of the genus *Copernicia*. 2. West Indian species. Gentes Herb. 9: 42–232.

Davis, S. D. et al. 1986. Plants in danger. What do we know? IUCN, Switzerland.

Dransfield, J., D. Johnson and H. Synge. 1988. The palms of the New World. A conservation status. IUCN, Switzerland.

Henderson, A. 1984. The native palms of Puerto Rico. Principes 28: 168–172.

——— and M. Aubry. 1989. *Attalea crassispatha*, an endemic and endangered Haitian palm. Principes 33: 88–90.

Johnson, D. 1986. Economic botany of the palm family in Latin America and the Caribbean. Final Report WWF 3322.

Judd, W. S. 1987. Floristic study of Morne La Visite and Pic Macaya National Parks, Haiti. Bull. Florida State Mus., Biol. Sc. 32: 1–129.

Paryski, P. and C. A. Woods. 1989. Conservation strategies and the preservation of biological diversity in Haiti. *In*: C. A. Woods (ed.).

Biogeography of the West Indies. Sandhill Crane Press, pp. 855–878.
READ, R. W. 1968. A study of *Pseudophoenix* (Palmae). Gentes Herb. 10: 169–213.
———. 1975. The genus *Thrinax* (Palmae: Coryphoideae). Smithsonian Contr. Bot. 19: 1–98.
UHL, N. W. AND J. DRANSFIELD. 1987. Genera Palmarum. L. H. Bailey Hortorium, Cornell University & The International Palm Society. Allen Press, Lawrence, Kansas.
WESSELS BOER, J. G. 1968. The geonomoid palms. Verh. Kon. Ned. Akad. Wetensch, Afd. Natuurk., Tweede Sect. ser. 2, 58: 1–202.
ZONA, S. 1990. A monograph of the *Sabal* (Arecaceae: Coryphoideae). Aliso 12: 583–666.

(*Continued from p. 133*)

PALM LITERATURE

cepts. On page 191 the author criticizes Harold Moore for taking a long time over the study of some specimens. Yet it is Wessels Boer himself who must be criticized for quick and uncritical work. In his introduction the author writes "la caótica situación de la mayoría de la relevante literatura, hace casi imposible para muchos botánicos el identificar satisfactoriamente las palmas . . . ." I couldn't have put it better myself.

LITERATURE CITED

UHL, N. W. AND J. DRANSFIELD. 1987. Genera Palmarum. L. H. Bailey Hortorium, Cornell University and The International Palm Society.
WESSELS BOER, J. G. 1971. Clave para las Palmas Venezolanas. Acta Bot. Venez. 6: 299–362.

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LETTERS

Dear Dr. Uhl,

As a new member of the International Palm Society, I read with great interest the article by Ruth Kiew in the April 1989 issue of Principes and her references to the Waterfall Gardens in Penang prompts me to update our readership about recent developments at the Waterfall Gardens, with particular reference to the palm collection.

Action has been taken by the staff over the last year to transmigrate the monkey population with the result that many of the Palm specimens have now been able to produce seeds at last, and it is hoped that the monkey over-population will soon be fully under control. The Gardens has also replanted specimens of *Johannesteijsmannia altifrons* and *J. perakensis*, and a program for propagating other Malaysian palms is underway. On joint trips with the staff of the Gardens, we have found *J. perakensis* and also possibly *J. lanceolata*—in areas not previously recorded.

There is obviously more scope for field research and surveys in Malaysia. To develop a greater national interest in the indigenous flora, there is a practical need for reliable field references to *live* plant specimens, and it would be particularly useful to have photographic information about the endangered plants listed by Kiew & Dransfield, and others.

On page 73 of the same April issue, I notice that *J. magnifica* is being offered for sale in Florida. This highlights Ruth Kiew's lament that certain overseas collectors appear to have commercialized on one of the most important endangered species in Malaysia, whereas in the country itself there is general ignorance as to what the palm actually looks like.

DATUK LIM CHONG KEAT

Principes, 34(3), 1990, pp. 143–146

The Spread of Lethal Coconut Diseases in West Africa: Incidence of Awka Disease (or Bronze Leaf Wilt) in the Ishan Area of Bendel State of Nigeria

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Abstract

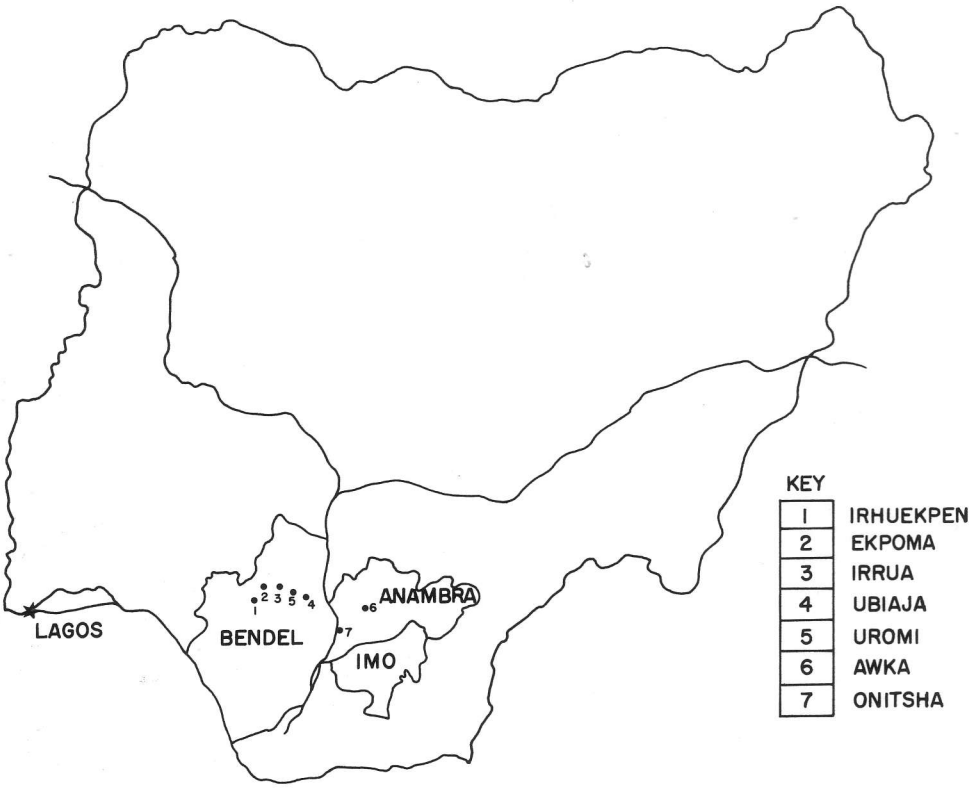
The bronze leaf wilt disease of coconuts has devastated a large number of bearing coconuts in Ishan area of Bendel State, Nigeria. The local tall variety appears to be the most susceptible to the disease. Some healthy green-fruited dwarf palms were also observed in the area. The disease was observed to affect only mature bearing palms. Information gathered from farmers revealed that affected palms invariably die within six months of onset of the disease.

The bronze leaf wilt disease of coconuts has been observed in some towns in Ishan area of Bendel State, Nigeria. Ishan area is located towards the northern part of Bendel State and is bounded to the east by Anambra State where Awka and Onitsha, the earlier areas of the disease incidence are located [see map of Nigeria (Fig. 1) showing these areas]. Imo State is located at the southern end of Anambra State with a common boundary between them (see map). The symptoms of this disease were first observed by local farmers in Ishan area about 1980 and a verbal report was made to the Nigerian Institute for Oil Palm Research (NIFOR). These symptoms appear similar to what was observed in Nigeria in 1918 in Awka area following a severe epidemic in 1917 (Bull 1955). The disease was then called bud rot and farmers had to cut more than 5,000 trees as control measures. There was however another outbreak in Awka-Onitsha area in 1951 and this time, the disease was referred to as Awka wilt or bronze leaf wilt (Bull 1955). Agwu and Okoye (1978) did some study on the distribution of the disease in Anambra and Imo States of Nigeria. Bull (1955) and Agwu and Okoye (1978) made no mention of the number of palms lost in this later occurrence of the disease. This paper presents reports on the incidence of this disease in some towns in Bendel State, the typical symptoms and stages in the disease process and reports on some microorganisms isolated from diseased leaves of the coconut.

Materials and Methods

The towns visited included Irhuekpen, Ekpoma, Irrua, Ubiaja, and Uromi. In the towns listed, observations were made on individual coconut palms in ten compounds to observe the different symptoms associated with the disease and the stages of development of the disease. Each compound had an average of five palms. Photographs of these disease stages were taken.

Some diseased leaves from affected coconut trees were collected and brought to the laboratory in polyethylene bags for isolation of associated microorganisms. In the laboratory, pieces of infected leaf material (about 3 mm) were cut, surface sterilized with 1% sodium hypochlorite (NaOCl) and plated on water agar in 9 cm petri dishes. Fungal growth observed on



1. Map of Nigeria showing areas of bronze leaf disease incidence.

these plates were then transferred to plates of potato dextrose agar (PDA) and the plates were incubated at 28° C with a photo period of 12 hours daylight and 12 hours darkness. All isolates were subcultured on fresh PDA plates and identified after observation under the microscope. Some leaf samples from diseased palms were taken to the International Institute for Tropical Agriculture, Ibadan for examination under the transmission electron microscope for viruses.

Results

The description given here is composed from the observation on affected coconuts at different stages of the disease. Similar symptoms were observed on the diseased coconuts in the five towns visited. The first observed symptom in mature coconut palms is the premature dropping of most of the nuts regardless of size. Most of the fallen nuts had brown or black watersoaked area immediately under the calyx on the stem end. Next, the leaves turn yellow usually beginning with the oldest or lowest leaves and advancing upwards through the crown. The yellow leaves ultimately turn brown, desiccate and hang down. Such leaves fall readily or are easily pulled off. As the yellowing progresses, death of the buds occurs. Finally, the top of the tree falls away, leaving a bare trunk like a telephone pole. Observations on the root showed that brown symptoms on the roots varied with the location of the roots as the disease progressed. Browning of the roots was first

observed on the outer roots while the internal central roots were not discolored. With time, more of the inner roots became discolored and necrotic. The central roots were still normal with whitish color until long after the inflorescence had fallen off. The young open inflorescence also turned yellow as the disease progressed and a gradual rot set in with time, turning the leaves brown and later leading to the rotting of the bud.

The unopened inflorescence was the last portion that turned yellow and later brown. It eventually collapsed due to the rotting of the base. Transverse section of the palms showed no abnormal discoloration and no rotting of the internal tissues was observed. Healthy palms had healthy green leaves, no root discoloration and the inflorescence and buds had no visible disease symptoms. The severity of the symptoms varied with the stage of the disease, with gradual progress inwards with time.

Infected trees usually die within six months after appearance of the first symptoms. All coconuts observed were of the African tall variety. A few of these were of medium height while others were quite tall. The level of infection was observed to be quite high, reaching 100% in some compounds. A lot of headless trunks were observed in the different areas and plants in different stages of infection were seen. Dwarf green fruited variety of coconut observed in the area had no disease symptoms. The local farmers said this particular variety does not succumb to the disease. Fungal species isolated from plated diseased segments include *Fusarium*, *Botryodiplodia theobromae*, *Aspergillus flavus* and *Aspergillus niger*. These fungi are likely to be secondary invaders as they were not found on all the examined specimens.

No viruses were observed on the leaf samples examined under the transmission electron microscope at the International Institute for Tropical Agriculture, Ibadan.

Discussion

The description of symptoms in this study is similar to that described by McCoy (1983) for lethal yellowing. He also observed in Florida that infected trees usually die within 3 to 6 months after appearance of first symptoms. From the similarity of symptoms, attempts are currently being made to find similar ways of detecting the causative organisms and to effect suitable control measures. In line with this, fresh diseased materials will be collected for electron microscope examination to see if mycoplasma-like organisms are present in the phloem tissues. There are also experiments aimed at investigating the soil in the areas of disease incidence to examine if nutrient deficiency plays a role in the disease. Along with these, a breeding program for tolerant hybrids and varieties will be set up. This will involve the use of Malayan dwarf (either yellow or green) × the West African tall coconuts to produce hybrids which will be tested along with the individual varieties. There are also proposed experiments involving trial of tetracycline for control of the disease, which is effective against lethal yellowing (McCoy 1983). It is hoped that results of these experiments will enable one to find a chemotherapeutic measure for control as well as varieties of coconuts resistant to the disease in our environment. Microscopic examination of tissues obtained from the transverse section of the stem did not reveal worms, and there was no discoloration of the transverse section so the disease is not likely to be due to infestation by flagellates or the red ring disease.

Acknowledgments

We are grateful to the Director of the Nigerian Institute for Oil Palm Research for making available facilities for this work. We are also grateful to Dr. Thotapilly of the International Institute for Tropical Agriculture who examined some of the dis-

eased leaf samples under the electron microscope for presence of viruses. We also thank members of the Plant Pathology Division of NIFOR for their assistance.

LITERATURE CITED

AGWU, S. I. AND H. C. OKOYE. 1978. The distribution of bronze leaf wilt disease of coconuts in Anambra and Imo States of Nigeria. J. NIFOR V 20: 79–85.

BULL, R. A. 1955. Bronze leaf wilt of coconut palms in Nigeria. J. W. Afri. Inst. Oil Palm Res. 1(3): 70–72.

MCCOY, R. E., *Ed.* 1983. Lethal Yellowing of Palms. Univ. of Florida, Agric. Res. Cent., Gainesville. Bull. 834:1–100.

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Principes, 34(3), 1990, pp. 147–149

CHAPTER NEWS AND EVENTS

Award to Northern Territory Group of Pacsoa

The Palm Society of the Northern Territory of Australia recently won the Keep Australia Beautiful Award for the "Most Successful Tree Planting and Landscaping Project by a Community Organization." The award was for the Society's efforts at the Freds Pass Palm Garden.

Fous de Palmiers is Growing

The French chapter of the IPS, Fous de Palmiers, recently reported 135 members, up from 58 when affiliation with IPS was initiated. The group plans a small local exhibition in September of this year on the theme of "Palmiers in Hyéres" largely based on an historical theme. They are also promoting the publication of the first book on palm culture published in French since 1910. It will be devoted to the species (65) which can be cultivated in France, mainly in the South, of course. If any members of IPS are interested in joining this group and obtaining their chapter bulletin in French, please contact Alain Herve, President of the group.

Upcoming Palm Show and Sale in Sydney, Australia

The Sydney Branch of PACSOA will be holding their Spring Palm Show and Sale for 1990 on 17–23 September, inclusive. For all you northern hemisphere readers, spring *does* come in September "down under." If anyone is interested in getting more information on venue, please contact Paul Anderson in Empire Bay, NSW. He's in the roster.

Pretorian Group in South Africa Go South American

The Pretorian group of the South African Palm Society held an Ecuadorian Evening on Saturday, March 24, 1990. The meeting was complete with Lambada music and typical Ecuadorian meal, *Arroz con Camaron y Salsa de Aqui.* Featured on the palm front was a slide show and lecture by Ron Castillo on the seed collecting expedition to Ecuador.

New Zealand Annual Meeting

The Palm and Cycad Society of New Zealand will hold their Annual General Meeting in June. For details, contact Spencer Lawes in Auckland.

Southern California Chapter 1990 Meetings

You read about the January Annual Banquet in the last issue of *Principes.* Other events planned for the year are as follows. The Southern California Chapter of the IPS met on March 17 at the South Coast Botanic Garden in Palos Verdes, California. Potluck lunch in the Patio was held with a surplus Palm Sale also on the agenda. On May 21, the group will gather at Ventura College and events will include a tour of the new Keeline-Wilcox Facility as well as several "How to" presentations. The Cold Hardiness, Germination, and Public Planting Committees will also hold meetings. Plant sales will be held before and after the meeting with a raffle and auction during the meeting. For the remainder of the year, the group plans a meeting to be announced in July, a tour of Lotusland on August 11, a Surplus Palm Sale in September and a Palm Desert meeting on November 3. If you are interested in attending any of these meetings, please contact Ralph Velez or obtain further details from the California Journal.

Houston (Texas) Area Chapter Spring Activities

The Houston (Texas) Chapter met in March at the home of Horace Hobbs for a palm slide show by Horace Hobbs and Jim Cain. The remainder of the meeting

focused on discussions of which plants did or did not survive the '89 Christmas Freeze when the temperature in Houston dropped to 7° F (−14° C) with strong northwest winds which dessicated everything. Enthusiasm wasn't killed, however, and the group went on to hold their scheduled Spring Palm Sale on April 21. Emphasis at the sale was on the more cold-tolerant species.

South Australian Branch of Pacsoa Meets

The inaugural meeting of the Palm and Cycad Society of South Australia was held at 1:00 PM on Sunday, March 4 at the East Adelaide Primary School. Members interested in future meetings should contact Randall Barry.

Pacsoa and Southern Queensland Group Hold Annual General Meeting and Sale

The Southern Queensland Group in conjunction with the Palm & Cycads Societies of Australia held their Annual Palm & Cycad Show at the Mt. Coot-tha Botanic Gardens Auditorium in Brisbane on March 10th and 11th. This is Australia's largest and most diverse display of palms and cycads, including hundreds of exotic and native species. An extensive plant sale ranging from seedlings to large specimens of rare and unusual species along with book sales, an audio-visual display, seed sales, and light refreshments were also available.

South Florida Group Helps Out at Metrozoo and USDA Station

The South Florida Chapter of the International Palm Society has scheduled workdays throughout the Spring at the Metrozoo, 12400 SW 152 Street. Starting on February 25 and continuing through late April, the workdays began with cleanup, repotting and preparation for the Spring Plantings. Lennie Goldstein has led a small group of volunteers in this community effort. The Chapter, through Bill Theobold, also organized a workday on February 10 at the USDA Station on Old Cutler Road in preparation for the USDA Station's Country Day to be held February 17. This is the only day that the facililty is open to the public.

South Florida Chapter February Meeting

On February 14, members of the South Florida Chapter of the IPS were entertained by "Impressions of Lilliput" by Lester Pancoast, featuring a presentation of slides and music from the Pancoasts' recent trip to Madagascar. Approximately 100 people attended this interesting presentation.

JIM CAIN

The South Florida Chapter Takes Steps Toward Conservation

In the past two years the South Florida Chapter of the International Palm Society has taken steps to promote palm conservation. The first and most important action was taken before the November 1988 show and sale. It is a ban at all chapter sales on endangered palm species which were collected as plants from the wild. Plants grown from wild collected seed are still accepted. The importance of this action to conservationists should be obvious, any reduction in the market for plants dug from the wild means that there will be fewer disturbances of the natural palm habitats. To palm enthusiasts in general, it means that the plants which remain in the wild may live to produce seeds at a later date. With conservative seed collecting and fewer plants being dug from the wild, palm seeds can be a renewable resource.

One of the arguments which we heard against this action is one frequently heard by conservationists, "How can a species be endangered when it is common in cultivation?" The problems include the dif-

ficulty of maintaining the natural genetic diversity of each species, because inbreeding reduces an already limited gene pool. Also, if a plant becomes extinct in the wild, the natural pollinators and seed dispersers may also disappear, which could mean that reintroduction of the species from cultivation will be impossible. So, the preservation of palms in their natural habitats is critical for their continued survival.

At the chapter sale in November, 1989, the South Florida Chapter purchased three rare specimen palms from Ken Foster for the Fairchild Tropical Garden palm collection. An endangered species, *Itaya amicorum*, has already been planted in the Rare Plant House. A species which has a vulnerable status, *Burretokentia hapala*, and one which while being rare in cultivation is frequent in its natural habitat, *Vonitra fibrosa*, will be planted in protected locations in the summer of 1990. These genera were not previously represented in the FTG collection. The results are that scientists and palm enthusiasts will be able to see and study more palm species without extensive travel. Any seeds produced in cultivation will be made available to palm enthusiasts and other scientific institutions, reducing the demand for wild collected seed. And, the existence of rare palms in scientific collections may someday prove valuable in saving those species from extinction.

The greatest problem with which the chapter has not yet dealt was approached at a recent meeting. It is the problem of palm habitat destruction. In some cases, collectors are actually saving individual palms from destruction by digging and moving them. However, wholesale plant collecting can be rationalized only in a genuine rescue operation. The sensible solution is for palm enthusiasts to take an active role in the preservation of palm habitats in forests, grasslands, and arid regions.

Recent reports from the World Wildlife Fund and the International Union for the Conservation of Nature and Natural Resources indicate that a small number of palms are already extinct and approximately one quarter of all of the palm species are considered to be threatened. This is the time to take action. As we wait, additional names will be added to the lists of threatened species—lists which are already very long.

CHARLES E. HUBBUCH

BOOKSTORE

***A GUIDE TO THE MONOCOTYLEDONS OF PAPUA NEW GUINEA, PART 3, PALMAE** (R. J. Johns and A. J. M. Hay, Eds., 1984, 124 pp.) 8.00

COCONUT PALM FROND WEAVING (Wm. H. Goodloe, 1972, 132 pp.) 4.95

CULTIVATED PALMS OF VENEZUELA (A. Braun, 1970, 94 pp. and 95 photographs.) 7.95

EL CULTIVO DE LAS PALMAS EN EL TROPICO (in Spanish, A. Braun, 1988, 65 pp., some color and line drawings). 9.95

EXOTICA (4) (A. Graf, pictorial encyclopedia, 2 vols., including 250 plant families, 16,600 illust., 405 in color, 2590 pp.) 187.00

FLORIDA PALMS, Handbook of (B. McGeachy, 1955, 62 pp.) 2.95

FLORIDA TREES AND PALMS (L. and B. Maxwell, 30 palm species, 120 pp.) 6.00

GENERA PALMARUM (N. W. Uhl and J. Dransfield, 610 pp.) 74.95

HARVEST OF THE PALM (J. J. Fox, 1977, 244 pp.) 24.00

INDEX TO PRINCIPES (Vols. 1–20, 1956–1976, H. E. Moore, Jr., 68 pp.) 4.00

MAJOR TRENDS OF EVOLUTION IN PALMS (H. E. Moore, Jr., N. W. Uhl, 1982, 69 pp.) 6.00

OIL PALMS AND OTHER OILSEEDS OF THE AMAZON (C. Pesce, 1941, translated and edited by D. Johnson, 1985, 199 pp.) 24.95

PALMAS DEL DEPARTMENTO DE ANTIOQUIA (Palms of Colombia, in Spanish; G. Galearno and R. Bernal, 1987, 207 pp.) 18.95

PALMAS PARA INTERIORES, PARQUES Y AVENIDAS (in Spanish, A. Braun, 1983, 83 pp., 39 pp. color) 8.95

PALEM INDONESIA (in Indonesian) (Sastraprdja, Mogea, Sangat, Afriastini, 1978. 52 illustrations, 120 pp. For English translation add $2.00) 5.50

PALMAS AUTOCTONAS DE VENEZUELA Y DE LOS PAISES ADYACENTES (in Spanish, A. Braun, and F. D. Chitty, 1987, 138 pp., some color) 12.95

***PALMS OF THE WORLD** (Formerly **PALMS,** A. Blombery & T. Rodd, 1982, 192 pp., 212 color photographs) 34.95

PALMS IN AUSTRALIA (David Jones, 1984, 278 pp., over 200 color photographs) 30.00

PALMS IN COLOUR (David Jones, 1985, 93 pp.) 8.95

***PALMS OF THE LESSER ANTILLES** (R. W. Read, 1979, 48 pp.) 8.00

PALMS OF THE NORTHERN TERRITORY (AUSTRALIA) (A. White, 1988, 41 pp., 21 photographs, some color) 5.95

PALMS FOR THE HOME AND GARDEN (L. Stewart, 1981, 72 pp., some color) 19.95

PALMS OF MALAYA (T. C. Whitmore, 1973, 132 pp.) 31.00

PALM SAGO (K. Ruddle, D. Johnson, P. K. Townsend, J. D. Rees, 1978, 190 pp.) 10.00

PALMS OF SUBEQUATORIAL QUEENSLAND (Robert Tucker, 1988, 91 pp., 12 pp. color, many black and white photographs and maps) 20.00

REVISIONS OF THE PALM GENUS *SYAGRUS* MART. AND OTHER SELECTED GENERA IN THE *COCOS* ALLIANCE (S. Glassman, 1987, 222 pp.) 19.95

SECRET OF THE ORIENT DWARF RHAPIS EXCELSA (L. McKamey, 1983, 51 pp.) 3.95

THE GENUS PTYCHOSPERMA LABILL. (F. B. Essig, 1978, 61 pp.) 6.50

THE INDIGENOUS PALMS OF NEW CALEDONIA (H. E. Moore, Jr., N. W. Uhl, 1984, 88 pp.) 12.00

TROPICA (A. Graf, 7000 color photos, 1138 pp.) 125.00

***TROPICALS** (G. Courtright, 1988, 153 pp., Color Pictorial sourcebook & descriptions, 12 pp. of palms) 34.95

PALM PAPERS (Postage Included)

A NEW PRITCHARDIA FROM KAUA'I, HAWAI'I (Reprint from *Principes*, R. W. Read, 1988, 4 pp.) 2.00

FURTHER INFORMATION ON HARDY PALMS (J. Popenoe, 1973, 4 pp.) 2.00

NOTES ON PRITCHARDIA IN HAWAII (D. Hodel, 1980, 16 pp.) 2.50

RARE PALMS IN ARGENTINA (reprint from *Principes*, E. J. Pingitore, 1982, 9 pp., 5 beautiful drawings) 2.75

PALMS FOR TEXAS LANDSCAPES (R. Dewers & T. Keeter, 1972, 3 pp.) 1.25

PINANGA ISSUE OF PACSOA (#16, 1987, 17 pp.) 2.50

THE HARDIEST PALMS (J. Popenoe, 1973, 4 pp.) 2.00

* New arrival

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

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Potassium Deficiency of Palms in South Florida[1]

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Potassium deficiency symptoms in palms have been documented for economically important food species such as coconut palm (*Cocos nucifera*) and African oil palm (*Elaeis guineensis*) (Broeshart et al. 1957, Bull 1961, Manciot et al. 1979) and for some ornamental palms (Broschat 1984). Yet even with this information on K deficiency symptomology available, the existence of widespread K deficiency in south Florida palms has gone undetected for decades. Marlatt (1980), Dickey (1977), and Street and Gamon (1983) point out that south Florida soils are extremely deficient in K, yet they do not report K deficiency on any ornamental plants in south Florida, much less on palms.

Palm growers have often wondered about the cause of the translucent yellow or orange flecking they observe on the oldest leaves of palms. Pathologists have never been able to isolate pathogens from these spots and unlike most biotic diseases, these symptoms are confined to the oldest leaves of the palm. Many people believed these symptoms were the result of natural leaf senescence and were therefore not preventable. However, palms growing in other parts of the world often do not show these symptoms. This fact, plus the restriction of these symptoms to the oldest leaves, suggests that the problem may be caused by a nutritional toxicity or a deficiency of a mobile element such as N, P, K, or Mg. Deficiency symptoms of N, P, and Mg are well known in palms and do not include flecking on the foliage (Broeshart et al. 1957, Broschat 1984, Bull 1958, Manciot et al. 1979). The K deficiency symptoms described by Broschat (1984) for five species of ornamental palms included necrotic spotting and streaking, but no translucent yellow flecking. Potassium deficiency symptoms of most plants consist of a marginal necrosis of the oldest leaves, although Broeshart et al. (1957), Bull (1961), and Manciot et al. (1979) have described leaf spotting symptoms similar to those described in this paper associated with potassium deficiency in *C. nucifera* and *E. guineensis*.

Close examination of palms growing under field conditions at the Fort Lauderdale Research and Education Center showed a wide range of symptoms which varied among species. For some species, only translucent yellowish flecking in varying degrees of severity was observed and marginal and tip necrosis were rarely seen (upper left, Back Cover). In other species necrotic streaks, spots, or flecks exist, but chlorotic areas were not present (upper right, Back Cover). In still other species no flecking or streaking of any kind was observed, but marginal and/or tip necrosis were the primary symptoms (lower left, Back Cover). In most species, however, translucent yellow flecking appears to be the earliest symptom of K deficiency and occurs on mildly affected leaves or towards the base of more severely affected leaves. As the deficiency progresses, the spots may

[1] Florida Agricultural Experiment Stations Journal Series No. 9893.

coalesce and marginal necrosis may appear on the leaflets. This intermediate stage appears on moderately affected leaves or on the middle leaflets of more severely affected leaves. The most severely affected leaves (the oldest on the palm) will often have entire leaflets withered and frizzled in appearance (lower right, Back Cover). These symptoms somewhat resemble those of Mn deficiency except for the lack of size reduction in affected leaves and the fact that these symptoms occur on the oldest leaves first rather than the newest. As with Mn deficiency, K deficiency is capable of killing palms if not treated. Severely affected palms of most species also tend to hold fewer leaves than healthy palms.

Potassium deficiency, like Mg deficiency, occurs on the margins of the oldest leaves of palms and from a distance the two deficiencies may sometimes be confused. However, Mg-deficient palms never show any flecking or marginal necrosis and symptoms usually appear as a distinct broad yellow band around the periphery of an otherwise green leaf. The discoloration sometimes associated with K deficiency may occur throughout the leaf, or if not, is never sharply delimited from a green leaf center as is the case with Mg deficiency. Unfortunately, both Mg and K deficiencies are widespread in south Florida and symptoms of both may occur on the same leaf, thereby making diagnosis more difficult.

Potassium deficiency was confirmed by leaf nutrient analysis for some of the species listed in this article. Comparisons of similar-aged leaves with and without symptoms for *Dictyosperma album* var. *conjugatum*, *Chrysalidocarpus lutescens*, *Howea forsteriana*, *Elaeis guineensis*, *Cocos nucifera*, and *Neodypsis decaryi* showed that leaves showing symptoms had less than half the K concentration of apparently healthy leaves. Comparison of K concentrations in leaves showing symptoms of *E. guineensis*, *C. lutescens*, *H. forsteriana*, and *Chamaedorea seifrizii* with standards established for those species showed all were deficient in K (H. Poole, pers. comm.) Established minimum K concentrations for recently matured leaves are 1.2% for *C. seifrizii*, 1.2% for *C. lutescens*, 0.59% for *H. forsteriana*, and 0.74% for *E. guineensis*. Leaf samples from palms showing symptoms averaged 0.45%, 0.88%, 0.55%, and 0.48% K, respectively for these species. Since specific symptomology varies widely among palm species, symptoms for 52 species of palms grown in south Florida are listed in the appendix.

As an element, K is highly soluble and is readily leached from the sandy soils of south Florida. Container media or soils having higher cation exchange capacities can retain K against leaching and for this reason, K deficiency is much less common in container-grown palms and in other palm growing regions of the United States. Imbalances between K and other nutrient elements such as N, Ca, and Mg can also cause K deficiency (Dickey 1977). In south Florida the problem of K deficiency is accentuated by the use of landscape fertilizers having slow release N fertilizer sources that last up to three or four months, but water-soluble K sources which can be completely leached through a sandy soil with one or two heavy irrigations or rains. At the FLREC, where such fertilizers have been used for years, the problem of K deficiency is much more severe than in landscapes which received no fertilizer at all.

Unlike Mg deficiency which is difficult to correct in palms, K-deficient palms respond rapidly to K fertilization. Addition of resin-coated controlled-release potassium sulfate to severely deficient *Hyophorbe verschafeltii* and *Chrysalidocarpus lutescens* resulted in a significant increase in the number of green leaves on the plants within four or five months. Controlled release K fertilizers are the best materials for preventing and correcting K

deficiency in south Florida since they are not readily leached by heavy rainfall or irrigation. Both sulfur-coated and resin-coated potassium sulfate are produced commercially and should be suitable for use on south Florida's sandy soils. Foliar sprays with potassium nitrate, potassium chloride, potassium sulfate, potassium acetate, and potassium citrate on severely deficient *C. lutescens* did not significantly increase leaf K concentrations over that of control plants. Thus it appears that soil application of controlled-release K fertilizers is the most effective treatment for K deficiency in south Florida palms. As with Mg deficiency, however, old affected leaves will never recover from their symptoms.

Literature Cited

Broeshart, H., J. D. Ferwerda, and W. G. Kovachich. 1957. Mineral deficiency symptoms of the oil palm. Plant Soil 8: 289–300.

Broschat, T. K. 1984. Nutrient deficiency symptoms in five species of palms grown as foliage plants. Principes 28: 6–14.

Bull, R. A. 1958. Symptoms of calcium and phosphorus deficiency in oil palm seedlings. Nature 182: 1749–1750.

Bull, R. A. 1961. Studies on the deficiency diseases of the oil palm. 2. Macronutrient deficiency symptoms in oil palm seedlings grown in sand culture. J. West African Inst. Oil Palm Res. 3: 254–264.

Dickey, R. D. 1977. Nutritional deficiencies of woody ornamental plants used in Florida landscapes. Univ. Fla. Agr. Exp. Sta. Bull. 791.

Manciot, E., M. Ollagnier, and R. Ochs. 1979. Mineral nutrition and fertilization of the coconut around the world. Oleagineaux 34: 576–580.

Marlatt, R. B. 1980. Noncontagious diseases of tropical foliage plants. Univ. Fla. Agr. Exp. Sta. Ext. Bull. 812.

Street, J. J. and N. Gamon. 1983. Plant nutrient deficiency symptoms. Univ. Fla. Coop. Ext. Serv. Circ. 435.

Appendix

Potassium deficiency symptoms for 52 species of palms. All symptoms described pertain to oldest leaves on palms. Relative susceptibility is based on observations of palms growing under similar conditions at the FLREC.

Acoelorrhaphe wrightii—oldest leaves generally off-color with raised necrotic spots feeling like pustules. Some necrotic streaking. Moderately susceptible.

Allagoptera arenaria—some orange and necrotic flecking near leaflet tips followed by tip necrosis. Slightly susceptible.

Archontophoenix alexandrae—light yellow flecking becoming generally chlorotic with necrotic spotting and marginal and tip necrosis on most severely affected leaves. Slightly susceptible.

Areca catechu—translucent whitish flecking in longitudinal bands becoming necrotic with necrotic portions often falling out of leaf leaving holes or tears in leaflets. Moderately susceptible.

Arenga australasica—some very fine translucent light green flecking and very fine necrotic flecking. Considerable tip and marginal necrosis and necrotic streaking. Moderately susceptible.

Bismarckia nobilis—tips of leaflets have chlorotic streaks or longitudinal bands with broad necrotic bands within chlorotic areas. Slightly susceptible.

Butia capitata—oldest leaves generally off-color. Some translucent orange spotting, necrotic flecking, and marginal and tip necrosis. Moderately susceptible.

Carpentaria acuminata—oldest leaves generally off-color. Extensive yellow spotting and necrotic spotting with extensive tip necrosis giving frizzled appearance. Moderately susceptible.

Caryota mitis—foliage slightly off-color. Necrotic spotting with some marginal and tip necrosis. Moderately susceptible.

C. rumphiana—oldest leaves off-color with tip necrosis and some necrotic flecking. Slightly susceptible.

Chamaedorea elegans—slight discoloration of leaves, some minor chlorotic and necrotic flecking. Tip and marginal necrosis. Slightly susceptible.

C. seifrizii—slight mottling of leaflets, but generally just tip necrosis. Slightly susceptible.

Chamaerops humilis—fine translucent flecking coalescing to encompass entire leaf. Chlorotic areas have necrotic flecking within. Most severely affected leaves have marginal and tip necrosis. Moderately susceptible.

Chelyocarpus sp.—Extensive marginal and tip necrosis surrounded by slight chlorotic halo. No spotting present. Moderately susceptible.

Chrysalidocarpus cabadae—translucent yellow flecking interspersed with necrotic flecking. Extensive marginal and tip necrosis giving frizzled appearance to older leaves. Very susceptible.

C. lutescens—leaves becoming off-colored to orange. Translucent orange flecking and necrotic spotting with extensive marginal and tip necrosis. Very susceptible.

Coccothrinax miraguama—yellow to orange flecks or elongated streaks. Streaks becoming necrotic. Marginal and tip necrosis. Moderately susceptible.

Cocos nucifera—translucent orange flecking becoming interspersed with necrotic spotting as severity increases. Extensive marginal and tip necrosis giving withered appearance to leaf tip. Very susceptible.

Corypha elata—very fine translucent yellow flecking followed by marginal and tip necrosis. Moderately susceptible.

Dictyosperma album—uniform translucent yellow flecking throughout leaves. No necrosis observed. Moderately susceptible.

Elaeis guineensis—translucent orange and light green flecking near leaflet tips with marginal and tip necrosis resulting in frizzled appearance. Moderately susceptible.

Gaussia maya—older leaves light yellowish-green. Some light green translucent flecking and necrotic spotting. Some marginal and tip necrosis. Slightly susceptible.

Heterospathe elata—leaves becoming off-color. Necrotic flecking and tip necrosis with some necrotic streaking evident. Slightly susceptible.

Howea forsteriana—leaflets becoming slightly discolored with necrotic tips. Occasional orange flecking near leaflet tips. Slightly susceptible.

Hyophorbe verschaffeltii—bright orange translucent flecking with entire leaf eventually becoming orange. Extensive marginal and tip necrosis giving oldest leaf frizzled appearance. Extremely susceptible.

Hyphaene sp.—fine necrotic flecks coalescing to form large necrotic blotches. Some tip necrosis. Moderately susceptible.

Latania lontaroides—general discoloration with extensive chlorotic and necrotic streaking, followed by marginal and tip necrosis of leaflets. Moderately susceptible.

Licuala grandis—translucent yellow flecking with some tip necrosis around the margin of the leaf. Moderately susceptible.

Livistona australis—Extensive necrotic streaking and marginal and tip necrosis giving leaves a tattered appearance. No flecking or discoloration evident. Extremely susceptible.

L. chinensis—Necrotic flecking with narrow orange halos surrounding flecks concentrated in the center of the leaflets. Leaflet centers becoming necrotic rather than marginal or tip necrosis as in other species. Moderately susceptible.

L. mariae—very fine translucent yellow flecking with some necrotic streaking and tip necrosis. Moderately susceptible.

L. rotundifolia—older leaves off-color. No flecking, but extensive marginal and tip necrosis and necrotic streaking. Moderately susceptible.

Neodypsis decaryi—yellow translucent flecks coalescing to form larger chlorotic spots. Extensive marginal and tip necrosis giving oldest leaves a frizzled appearance. Moderately susceptible.

Phoenix dactylifera—some discoloration towards the tips of leaflets with very fine translucent flecking followed by marginal and tip necrosis. Moderately susceptible.

P. reclinata—tips of leaves off-color. Some translucent yellow and necrotic flecks followed by extensive marginal and tip necrosis. Moderately susceptible.

P. roebelenii—tips of leaflets becoming off-color and then orange followed by tip necrosis. Moderately susceptible.

Pritchardia beccariana—translucent yellow flecking, off-color foliage and extensive tip necrosis. Moderately susceptible.

Ptychosperma elegans—older leaves off-color. Coalescing orange spots with extensive necrotic spotting interspersed. Some tip necrosis. Moderately susceptible.

P. macarthurii—necrotic spots with narrow yellow halos. Some necrotic streaking and marginal necrosis. Slightly susceptible.

P. nicolai—older leaves off-color with slight mottling of foliage. Extensive tip necrosis. Moderately susceptible.

Ravenea rivularis—older leaves slightly off-color. Fine necrotic flecking becoming necrotic streaks with some tip and marginal necrosis. Severely affected leaves have only necrotic veins remaining on leaves. Moderately susceptible.

Rhapis excelsa—older leaves off-color with very fine necrotic flecking and extensive marginal and tip necrosis. Moderately susceptible.

Roystonea regia—Some translucent yellow flecking, but extensive marginal and tip necrosis giving older leaves a frizzled appearance. Moderately susceptible.

Sabal mauritiiformis—translucent yellow spotting, leaves off-color towards tips with marginal and tip necrosis. Slightly susceptible.

S. palmetto—translucent yellow-orange flecking followed by marginal and tip necrosis. Slightly susceptible.
Scheelea rostrata—translucent fine light green streaking, necrotic spotting, truncation of leaf tip, and extensive marginal necrosis. Moderately susceptible.
Syagrus amara—translucent yellow-orange flecking and necrotic flecking surrounded by chlorotic halo. Marginal and tip necrosis. Slightly susceptible.
S. pseudococos—Highly resistant.
S. romanzoffiana—clusters of translucent yellow flecks near leaflet tips with some marginal and tip necrosis. Severely affected leaves appear frizzled and orange in color. Moderately susceptible.
S. schizophylla—general discoloration of older leaves with light green translucent flecks coalescing into spots up to 3 mm in diameter. Moderately susceptible.
Thrinax radiata—translucent yellow and necrotic flecking. No significant marginal or tip necrosis. Moderately susceptible.
Trachycarpus martianus—minor yellow flecking on slightly off-color leaves. Some tip necrosis. Fairly resistant.
Trithrinax acanthocoma—translucent light green flecks usually appearing in longitudinal bands along the leaflets. Some tip necrosis and necrotic streaking. Fairly resistant.
Veitchia macdanielsii—slight tip necrosis. Very resistant.
Wodyetia bifurcata—interveinal chlorotic streaking with necrotic spots surrounded by narrow yellow halo. Some marginal and tip necrosis. Moderately susceptible.

NOTICE

"Palms in tropical rain forests." A symposium in IQUITOS, PERU, 18–24 September 1991—to include a field trip in the Lower Ucayali River Basin. For information write: FRANCIS KAHN, ORSTOM, Apartado 18–1209, LIMA, PERU.

Back Cover

Potassium deficiency in palms of south Florida. Upper left, old leaflets of potassium deficient *Dictyosperma album* held up to the light to show translucent yellow flecking. Upper right, *Caryota mitis* showing the necrotic flecking characteristic of potassium deficiency in this species. Lower left, old leaf of *Roystonea regia* showing marginal and tip necrosis caused by potassium deficiency in the species. Lower right, *Hyophorbe verschaffeltii* with reduced leaf number and characteristic frizzling of the oldest most severely affected leaf. Less severely affected leaves have extensive orange translucent flecking, not apparent in this photograph. See pp. 151–155.