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FRONT COVER

The seldom-seen *Mauritiella pumila*, newly resurrected from taxonomic obscurity. See article by Rodrigo Bernal and Gloria Galeano, p. 119. Photo by R. Bernal.

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BACK COVER

Parajubaea cocoides in the village of Tabaconas. Wild populations of this species represent a new generic record for Peru. See article by F. Roca p. 133.

PALM NEWS

Two recent publications **shed light on Hartrot, a lethal disease of coconuts** (and perhaps other palms) that threatens the coconut industry in the Latin America. The disease is caused by a parasitic microbe that colonizes the phloem of coconut stems. In "Fine structure of phloematic trypanosomatid-coconut tree interaction" (J. Gen. Plant Pathol. 76: 74–83. 2010.), M. da Cunha et al. studied the process by which the microbes "clogged" the phloem sieve cells in coconut tissues. They found the organism in shoot apex, leaves, stems and inflorescence in diseased plants, but not in the roots. In their work "*In vitro* cultivation and morphological characterization of phloemic trypanosomatids isolated from coconut trees" (J. Eukaryot. Microbiol. 57: 87–93. 2010.), D.G. Keller and F.C. Miguens cracked the problem of culturing the organism that causes Hartrot. Growing the organism in the laboratory will allow researchers to study the organism more easily and investigate possible control measures.


A. Popovkin

Once again, researchers have demonstrated the **importance of mycorrhizae in wild palms**. In "Contribution of mycorrhizae to early growth and phosphorus uptake by a neotropical palm" (J. Plant Nutr. 32: 855–866. 2009.), J. Ramos-Zapata et al. have show that mycorrhizae associated with the roots of *Desmoncus othacanthos* function like an extension of the palm's root system, soaking up nutrients, especially phosphorous, that would otherwise be unavailable to the palm. Their results showed that mycorrhizae play an important role in early growth and phosphorous uptake by *D. orthacanthos* seedlings but that the absence of mycorrhizae is easily and readily compensated for by the application of fertilizer. While mycorrhizae may not be relevant to palms growing in nurseries or gardens, the interaction is important in establishing plantations of palms on infertile soil, or in using palms in forest restoration projects.


Nobu Tamura

New fossils from Big Bend National Park suggest that **dinosaurs may have eaten *Sabal* palm fruits**. In their paper "Fossil palms (Arecaceae, Coryphoideae) associated with juvenile herbivorous dinosaurs in the Upper Cretaceous Aguja Formation, Big Bend National Park, Texas" (Internat. J. Plant Sciences 171: 679–689. 2010.), S. Manchester and coauthors described two new species of extinct *Sabal* from fossilized seeds that look remarkably similar to those of modern species. More surprisingly, they showed how the seeds were associated with the bones of juvenile dinosaurs (hadrosaurs and ceratopsians). They surmised that palms similar to modern *Sabal* species may have been food sources for young herbivorous dinosaurs.


M. Gibbons

The latest issue of *The Palm Journal* (No 194), the journal of our affiliate in Southern California, is devoted to ***Trachycarpus* and *Guihaia***; in it you will find a most useful illustrated account of the species of *Trachycarpus*, written for the grower. The paper by Chris Stevens is a comprehensive summary of what is known about this popular genus. The article concludes with a table that allows for a side-by-side comparison of the species. Tobias Spanner provided a key, which should allow growers to identify mystery *Trachycarpus* species in cultivation. *Guihaia*, which is less common in Southern California gardens, gets a less expansive treatment, but the information and the photos will surely spark an interest in this intriguing genus.

Major Jenkins' Fan Palm in Thailand

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1. Habit of *Livistona jenkinsiana*. Phu Soi Dao. (Photo: Katja Anker)

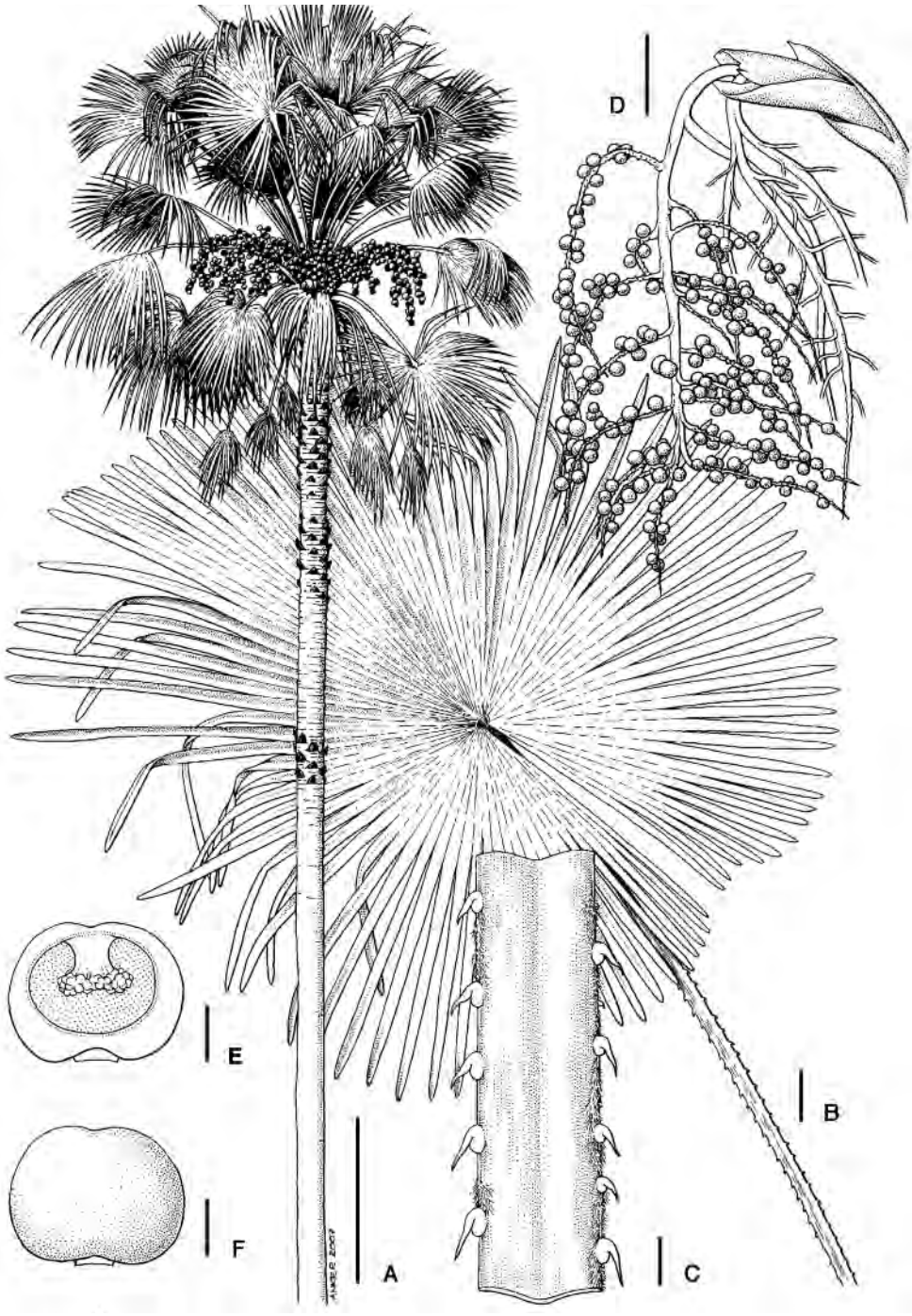
Major Jenkins' Fan Palm, *Livistona jenkinsiana*, is currently under threat in northern Thailand from habitat destruction caused by unsustainable agricultural practices. Based on recent field work and other research, we discuss the historical background and the taxonomic delimitation of the species.

Livistona jenkinsiana Griff. (Figs. 1 & 2) was first described by William Griffith (1845), based on his field observations and a collection made in 1842 from Assam by Major Francis Jenkins, and named in his honor (Box 1). The type specimen, conserved in the herbarium of the National Botanic Garden of Belgium, consists of an inflorescence and remnants of flowers and a few fruits (Fig. 3). The protologue clearly described the fruit and seed as: "Drupe *reniform, round, slightly attenuate at the base, the size of a musket ball, of a leaden blue colour, marked on one side with a depressed white line.* Seed *erect, presenting on the side corresponding with the above line on the fruit a broad raphe-like line. Albumen horny, opposite the centre of the above line deeply excavated; cavity as usual filled with a spongy substance. Embryo opposite the excavation or in the centre of the dorsal face.*" Griffith (1850) subsequently provided two illustrations to accompany his account of *L. jenkinsiana* in his *Palms of British East India*. One plate included a full leaf, whilst the second plate included an inflorescence, and flower and fruit dissections (Fig. 4). Some descriptive elaboration of the fruit was provided by Blatter (1926), who noted the dimensions as *" ¾–1 inch in diameter"* but otherwise quoted verbatim the description in the protologue. More thoroughly, Beccari (1931) described the fruit from "*very good specimens*" collected from Naga Hills by Gustav Mann as: "*globular, 22–28 mm in diam. often slightly broader than high and somewhat asymmetrical,*" as well as providing a diagnostic illustration of fruit "*from Assam,*" but still without significant variation from the protologue. More recently, Rao and Joseph (1962) provided a diagnostic illustration of the fruit, which conformed to the previous descriptions for the species. In summary, the fruit of *L. jenkinsiana* is rather similar in all the descriptions noted above, and does not display any significant variation across its natural distribution.

Taxonomic status relative to *Livistona speciosa*

Twenty-nine years after Major Jenkins' Fan Palm was described from Assam, another species of fan palm was published by the German botanist Wilhelm Sulpiz Kurz, who at the time was curator of the herbarium in Calcutta. The new species was named *Livistona speciosa*, which means the showy or splendid one. Kurz (1874) described the new species based on a collection he had made in the mountains of Pegu Yoma of central Burma (*Kurz 3330/3331*). That collection, conserved in the Natural History Museum London and Kew Herbarium, has been accepted as the type specimen (Dowe 2009). Kurz noted in the protologue of *L. speciosa* the similarity of *L. speciosa* and *L. jenkinsiana*, and he distinguished the species as "*differing chiefly by the smooth (not scurvy) spathes and in shape of fruits.*" He furthermore described the fruits of *L. speciosa* as: "*Drupes elliptically obovoid, to nearly an inch long, dark blue, smooth, 1-seeded, seated on the short thick indurated perianth jointed with the nipple- or disk-shaped very short peduncle.*" The illustration accompanying Kurz's protologue conformed to his description. Beccari and Hooker (1894) provided a brief and similar description, whilst Beccari (1931) provided a very detailed description based on the type and other Kurz specimens, as: "Fruit *obovate obpyriform, exactly rounded above, distinctly narrowed to a rather acute base, 2.5 cm long, 18 mm through, carried by a pedicel 4–5 mm long and 2.5 mm thick, formed by the hardened and somewhat thickened perianth and by the also somewhat increased flower bearing tubercle…..* Seed *oblong-elliptical,*

Livistona jenkinsiana was named for Major Francis Jenkins (b. St Clement, Cornwall, U.K., 4 Aug., 1793; d. Guwahati, Assam, 28 Aug., 1866), collector of the type specimen in 1842 at Nowgong, Assam. He was Captain in the Mercantile Marine when given the task of assessing the resources of Assam (Bhuyan 2006). In the company of Indian Army Officers Lieutenant R.B. Pemberton and Captain G.T. Gordon he explored a route for communication between Assam and Manipur in January 1832, thus initiating the annexation of Assam and placing it under British colonial jurisdiction (Kanungo 2006). Subsequently, Jenkins was appointed as the British Commissioner of Assam and Agent to the Governor-General for the Northeastern Frontier of India, serving in that role from 1834 to 1861 (Bhuyan 2006). The development and establishment of the tea industry in Assam, and the formation of the Assam Tea Company in 1839, was facilitated by Jenkins (Royle 1840; Sharma 2006). Apart from being a capable and diplomatic administrator (Zou 2005), Jenkins had interests in natural history and botany (Griffith 1847), and Assamese history, culture and art (Robinson 1841), upon which he wrote a number of published articles (Bhuyan 2006).



2. *Livistona jenkinsiana*. **A**. Habit. **B**. Leaf petiole and blade. **C**. Detail of petiole. **D**. Infructescence. **E**. Fruit, longitudinal section. **F**. Fruit, lateral view. Scale bars A = 1 m; B = 10 cm; C = 1 cm; D = 10 cm; E = 1 cm; F = 1 cm. All from Barfod et al. 714. Drawn by Katja Anker.

rounded at both ends, 17 mm long, 12 mm through." Beccari's accompanying diagnostic illustration conformed precisely to his description. Furthermore, Beccari (1931) noted that "L. speciosa *is related to* L. jenkinsiana *and as to the leaves and the spinescence of the petioles it is hardly distinguishable from it: it is however, recognizable by its smaller flowers, but especially by the quite different form of the fruit and the thickness of its pericarp*."

3 (above). Type specimen of *Livistona jenkinsiana*, collected by Major Francis Jenkins, in 1842 from Nowgong, Assam, and conserved in the Herbarium, National Botanic Garden of Belgium (BR) (reproduced with permission). 4 (below). Illustration of *Livistona jenkinsiana*, from Griffith, W., Palms of British East India, plate 226B (1850).

Although both *L. jenkinsiana* and *L. speciosa* can be readily distinguished in literature descriptions by fruit characteristics, it is the variability of *L. speciosa* as met with in the field that has caused botanists to query the taxonomic status of the two species. Dowe (2001, 2003) concluded that the two taxa were indistinguishable and represented variation within a single species, and placed *L. speciosa* as a synonym of *L. jenkinsiana*, as the latter had nomenclatural priority in such an action. This assessment was followed by Dransfield et al. (2004) and Govaerts and Dransfield (2005). Although the fruit of *L. speciosa* was unambiguously described by Kurz and subsequent botanists, it has been found to be variable in both size and color across its distributional range. It must be noted that fruit shape and size are generally conservative for *Livistona* species, i.e., fruit characters and dimensions usually fall within a narrow range for a particular species, and that the broad range, particularly in dimensions, for *L. speciosa* is unusual for the genus.

Field work to investigate *Livistona* in Thailand

In 2006, a joint team of Danish and Thai researchers visited the Phu Soi Dao National Park in connection with the Flora of Thailand project. The Park, which extends across Pittsanulok and Uttaradit provinces in northern Thailand, was established to conserve forest ecosystems that are in danger of being converted into agricultural land. The landscape within the national park is mountainous with altitudinal range of 500–2000 m.

Outside Phu Soi Dao National Park, solitary trees of *L. speciosa* are found scattered throughout the landscape. While we were preparing specimens of that species for pressing, a local farmer told us about another fan palm of a similar stature but with larger, blue fruits that ripened earlier than *L. speciosa* and was in season at that time. Arriving at our final destination, the Rom Klao Botanical Garden, we learned that the head of the Garden, Mr. Danai Sabbhasri, wrote his Master's thesis on this very palm with special emphasis on its uses. Locally it is called *Kho*, and the mesocarp is considered a delicacy. The palm was reported to grow in populations some hours away near the border with the Lao People's Democratic Republic (Laos).

On the morning of March 4th, a group consisting of A.S. Barfod, P. Suksathan, D. Sabbhasri, illustrator Katja Anker from the

5. Young fruits of *Livistona speciosa*. The fruits grow in size but retain their overall shape and green metallic luster until maturity. Phu Soi Dao. (Photo: Anders S. Barfod)

Botanical Museum in Copenhagen and assistants from the Phu Soi Dao Botanical Garden set out to hunt for the mysterious blue-fruited fan palm. At mid-day, after an arduous journey consisting of various types of tractor transport and eventual hiking, we arrived at undisturbed forest with several rattan species in the understorey, and the mysterious fan palm in all its beauty and splendor at the peak of fruiting (Figs. 1, 6 & 7). An appropriate individual for sampling was identified, and the tree climber carefully climbed the tree to cut down material for pressing – carefully, because the petioles were heavily armed. The tree was about 9 m tall and relatively easy to climb because the stem was stepped by old leaf bases. The crown was composed of 35–40 leaves with a "skirt" of 10–15 old, dead leaves. The leaf bases were 50–60 cm long, split to the base, eventually breaking up in brown fibrous mesh. The petioles were 240–260 cm long, with up to 2 cm long, basally swollen, slightly recurved, green to blackish spines, which decreased in size towards the blade. The blades were circular in outline and 280 cm across. The tree sampled carried five infructescences, which were branched to the third order. The peduncles were about 25 cm long and the rachis about 1 m long with 5–6 first order branches. The fruits were about 3 cm wide and 2.6 cm long and matched Griffith's 164 year old description almost exactly: *"Drupe reniform, round, slightly attenuate at the base, the size of a musket ball, of a leaden blue color, marked on one side with a depressed white line"* (Griffith 1845). After having carefully noted down the key measurements and thoroughly photographed all the different parts of the palm we managed to prepare a beautiful collection in four duplicates, which are stored in herbaria in Thailand, the UK and Denmark. While we were sweating away making the collections, Katja Anker managed to produce a number of sketches. It is these sketches upon which the line drawing shown in Fig. 6 is based. The drawing will eventually appear in the palm treatment for Flora of Thailand.

Our conclusion

Based on the original descriptions by Griffith and Kurz, the observations in the field described above and further research by Dowe (2009), the authors had somewhat independently arrived at the conclusion that *Livistona jenkinsiana* and *L. speciosa* should be considered as taxonomically distinct entities, with *L. jenkinsiana* readily distinguished by fruit that is globose to reniform, 19–28 mm long, 20–30 mm wide, leaden blue to dark bluish-purple and with subapical stigmatic

remains, whilst the fruit of *L. speciosa* is much more variable, obovoid, obpyriform, to ovoid, rounded apically, narrowed basally, 25–35 mm long, 18–25 mm wide, greenish-blue to light-blue at maturity; and with apical stigmatic remains (Fig. 5). Perhaps the simplest way to distinguish the fruit is that in *L. jenkinsiana* it is wider than long, whereas in *L. speciosa* it is longer than wide. Characters used to recognize *L. jenkinsiana* and *L. speciosa* in the field are presented in Table 1.

Distribution and conservation status of *Livistona jenkinsiana*

The range of *Livistona jenkinsiana* is from northern India, through Sikkim, Bangladesh, Myanmar, southern China to Thailand (Fig. 8). Because of the lack of precise distribution data and with no documentation of population numbers, the conservation status of *L. jenkinsiana* cannot presently be determined with acceptable precision, but there is reason to suspect that it is regionally threatened, if not endangered. A rare and/or endangered status has been applied to the population in India (Basu 1991, Behera et al. 2002, Aumeeruddy-Thomas & Pei 2003). Dowe (2009) applied the IUCN- World Conservation Union rating as "near threatened," based on the known distribution data. The definition of "near threatened" is:

> *A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future* (IUCN 2007).

In Thailand, *L. jenkinsiana*, unlike the more gregarious *L. speciosa*, is locally rare, and therefore threatened by unmanaged fire, forest clearing, agriculture and urban development. The populations in Phu Soi Dao are under immediate pressure from expanding agriculture associated with ginger cultivation (Fig. 9). The unsustainable agricultural practice most often used in connection with this type of semi-subsistence agriculture is a contentious issue, which is closely linked to the on-going debate on ethnicity and opium eradication programs.

Uses of *Livistona jenkinsiana* in Thailand

As is often the case with palms, *Livistona jenkinsiana* is used for multiple purposes based on its structural and nutritional properties.

Table 1. Diagnostic differences between *Livistona jenkinsiana* and *L. speciosa* in Phu Soi Dao National Park.

	L. jenkinsiana	*L. speciosa*
LEAVES		
Blade size across (cm)	270–290	200–210
Petiole length (cm)	240–260	190–200
INFRUCTESCENCE		
peduncle length (cm)	50	25
branching	to the 3rd order	to the 4th order
FRUIT		
shape	wider than long, kidney-shaped	longer than wide, obovoid
color	leaden blue	turquoise, iridescent
position	solitary	solitary or in pairs
PHENOLOGY		
flowering season	December–January	February–March
Fruiting season	25–26 months after	November–January*

*Since the fruits are not consumed, our informants were not aware whether it takes one or two years for them to mature.

6. *Livistona jenkinsiana*, leaf. Phu Soi Dao National Park, Thailand. (Photo: Katja Anker)

The leaves are used for thatching houses in the Phu Soi Dao area. After harvest 5 or 6 leaves in the center of the crown are left on the palm to prevent it from dying. The palm heart is edible. The fleshy mesocarps of the boiled fruits are considered a delicacy. It takes almost two years for the fruits to reach maturity. Seeds from the boiled fruits do not only survive the heat treatment but allegedly germinate faster. The fruits are also boiled to extract oil used for skin moisturizers. In India, Aumeeruddy-Thomas and Pei (2003) recorded that the leaves are used for thatching and hat-making and that the mesocarp is edible.

7. *Livistona jenkinsiana*, infructescence. Phu Soi Dao National Park, Thailand. (Photo: Piyakaset Suksathan)

Acknowledgments

We thank the Head of the Rom Klao Botanical Garden, Mr. Danai Sabbhasri for sharing his knowledge of livistonas in the Phu Soi Dao area with us and for pleasant company in the field. We are grateful to Katja Anker who produced the line drawing of *Livistona jenkinsiana* based partially on sketches rendered in the field. This study was supported by the Carlsberg foundation (grant no. 04-0427/10 to Anders S. Barfod) and the Queen Sirikit Botanic Garden. We are grateful for the challenges imposed on us by an anonymous reviewer.

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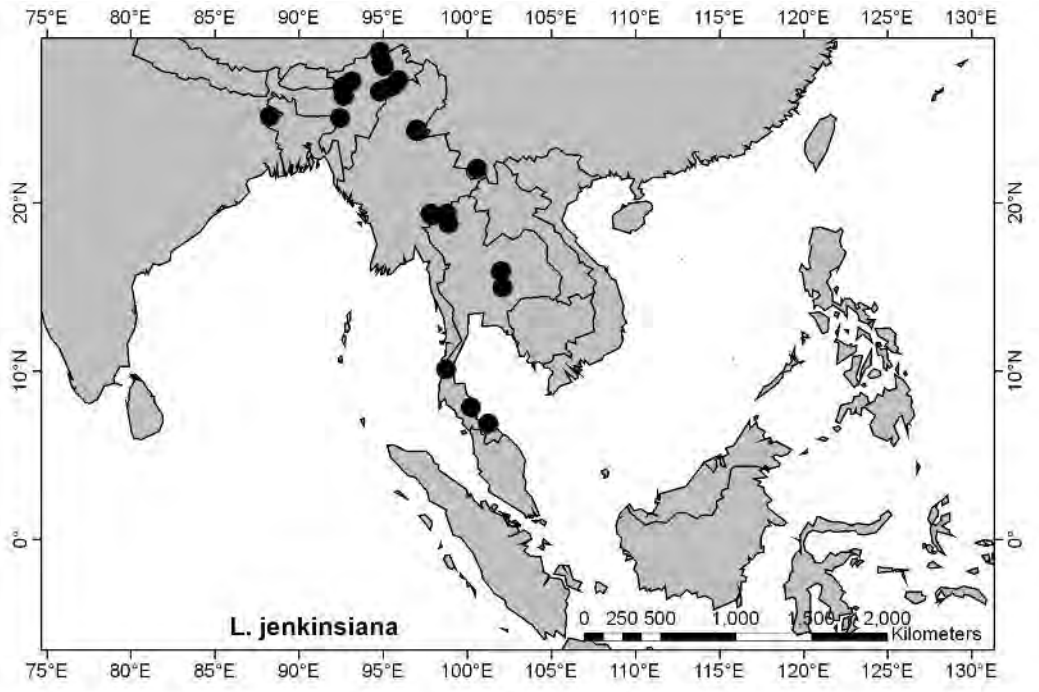

8. Distribution map of *Livistona jenkinsiana*, prepared by Mirjam Maughan, ACTFR.

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Notes on *Mauritiella*, *Manicaria* and *Leopoldinia*

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A study of palms in the upper Río Negro area, in northern South America, reveals two previously misinterpreted species, *Mauritiella pumila* and *Manicaria martiana,* and shows that the enigmatic *Leopoldinia major* is actually not different from the better-known *Leopoldinia pulchra*.

The small South American genera *Mauritiella*, *Manicaria* and *Leopoldinia* include some of the most conspicuous palms growing in the white-sand forests and savannas of the upper Río Negro and the black-water tributaries of the upper Orinoco, in the bordering area of Colombia, Brazil and Venezuela. This region is the center of diversity for them, and all of their species but one are found in this area.

In spite of their small size (eight species in total), no modern revision of any of these genera is available. The most recent accounts were made by Henderson (1995) and Henderson et al. (1995), and, although not intended as formal revisions, they have been taken as a standard reference by further authors (e.g. Stauffer 2000, Govaerts & Dransfield 2005, Dransfield et al. 2008, Pintaud et al. 2008).

Recent field work in the upper Río Negro area and along the Río Atabapo, a black-water tributary of the Orinoco, and the study of herbarium specimens at several herbaria, have shown that some changes in the taxonomy of these genera must be made, awaiting their badly needed revisions.

Mauritiella

The genus *Mauritiella* was established by Burret (1935) to include several species of palms related to the large and widespread, *moriche* or *buritĺ* palm, *Mauritia flexuosa*, from South America, but differing from it in their usually caespitose habit, spiny stems and their waxy, grayish green leaf undersurface. One of the names transferred to *Mauritiella* was *Mauritia pumila*, a binomial applied by Wallace (1853) to a small palm from the upper Río Negro area. This palm has been scarcely mentioned after its original description and its further transfer to *Mauritiella*. Although no formal revision of the genus has been made, Wessels Boer (1988) considered *Mauritiella pumila* as a depauperate form of the widespread *Mauritiella armata* (treated by him as *M. martiana*), resulting from growing in the poor soils of savannas. Wessels Boer's treatment has been followed by Henderson (1995), Henderson et al. (1995) and Stauffer (2000). Henderson et al. (1995), however, suggested that the small palms from white sand savannas did appear to represent a distinct species, apparently *M. pumila*. In the last years we used this name for some determinations, and it has recently been used

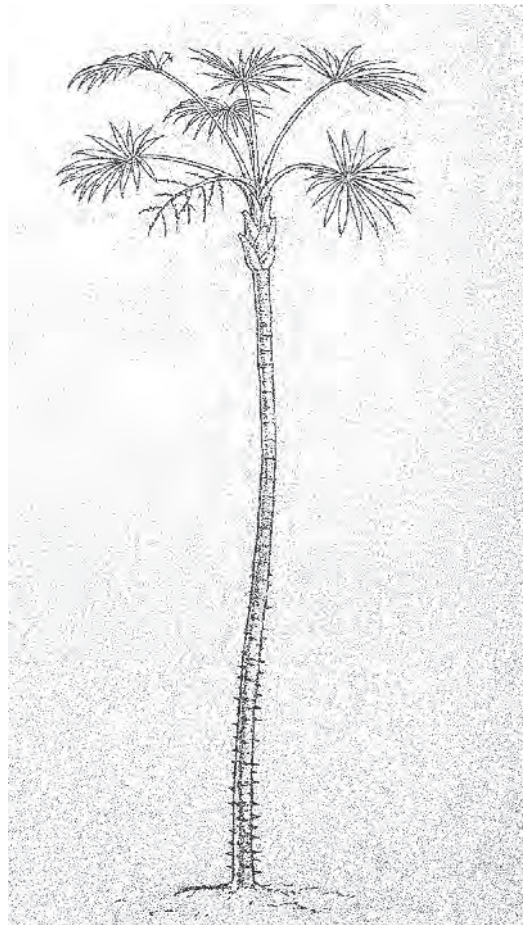
by Cárdenas López (2007). A formal reinstatement seems therefore appropriate.

The name *Mauritia pumila* is not associated with a specimen; Wessels Boer (1988) designated as a lectotype the illustration accompanying the protologue (Wallace 1853, pl. 21) (Fig. 1) in spite of its rather crude nature. However, Wallace's description is good enough to identify the species among the palm flora of the Upper Río Negro area. We have collected this small palm in the savannas of the Orinoco basin in eastern Colombia and have studied several collections from neighboring areas in Colombia and Venezuela, as well as many specimens of the other species of *Mauritiella*. We conclude that it differs from *M. armata* in many respects, and it is not just a reduced form of that species. Therefore, here we reinstate *Mauritiella pumila* as a distinct species and include *Mauritiella subinermis* (Spruce) Burret in its synonymy. Table 1 compares the three species of *Mauritiella* occurring in the Río Negro area.

Mauritiella pumila (Wallace) Burret, Notizbl. Bot. Gart. Berlin-Dahlem 12: 611. 1935. *Mauritia pumila* Wallace, Palm Trees of the Amazon 59. 1853. Lectotype (Wessels Boer 1988). Wallace, Palm Trees of the Amazon, t. 21. 1853. *Lepidococcus pumilus* (Wallace) H. Wendl. & Drude in Kerch., Palmiers. 249. 1878. Figs. 1–5 & Front Cover.

Mauritiella subinermis (Spruce) Burret, Notizbl. Bot. Gart. Berlin-Dahlem 12: 611. 1935. *Mauritia subinermis* Spruce, J. Linn. Soc., Bot. 11: 171. 1871. *Orophoma subinermis* (Spruce) Drude in Martius, Fl. bras.: Cyclanthaceae et Palmae I, fasc. 85, vol. 3(2): 296. 1881. *Lepidococcus subinermis* (Spruce) A.D. Hawkes, Arq. Bot. Est. Sao Paulo, n.s. 2: 174. 1952. Type. Venezuela. Amazonas: confluence of Casiquiare and Río Guainía, n.d., *R. Spruce 39* (holotype K, n.v.).

Caespitose, with 1–5 developed stems and several shoots. Stem 1–3 m tall, 4.5–5 cm diam., gray to brown, with a few conical spines to 1 cm long, the upper part of the stem covered with persistent leaf bases. Leaves 5–7, forming a hemispherical crown, with 2–3 persistent dead leaves; sheath 20–29 cm long; petiole 59–80 cm long, 1–1.5 cm diam., cylindrical, in young leaves completely covered with whitish wax; costa 1–1.5 cm long; blade divided into 16–26(–38) rigid segments, middle ones 38–45(–57) cm long, 2–3.8 cm wide, pointing upwards and arched at the tip, the lower surface with a thick layer of wax, and completely lacking scales, the margin lacking spines. Inflorescence interfoliar; staminate inflorescence with peduncle 29 cm long; rachis 60–68 cm long, with 20–23 branches arranged in one plane, the longest ones 22–24 cm long, with 26–34 rachillae ca. 1 cm long; flowers not seen; pistillate inflorescence with peduncle 31–48 cm long; rachis 30–47 cm long, with 6–11 branches 12–23 cm long, each bearing 13–31 rachillae up to 1.6 cm long, arranged in one plane; flowers not seen. Fruits obovoid, 1.8–3 cm long, 1.7–2.4 cm diam., with dark yellowish brown scales arranged in 24–30 rows, individual scales 2–3 mm long, 2.5–5 mm wide, with the margin usually slightly scarious.



1. Lectotype of *Mauritia pumila* (Wallace 1853, pl. 21).

Distribution and habitat. White sand savannas and rocky outcrops in the Upper Río Negro and adjacent areas in Colombia and Venezuela, between 90 and 250 m elevation. Grows on well drained soils or occasionally in areas with a high water table.

Common names: *cahuayo*, *caguaya*, *morichito*

(Spanish); *cadanaripi* (the palm) *cadanarite* (the fruit) (Curripaco); *cadanari* (Baniwa); *caranaí, mirichimiri* (Geral).

Selected specimens: **COLOMBIA**. **Guainía**: Río Inírida, 0–6 km on rd. from Huesito to El Pato, ca. 150 m, 23 May 1994, *Bernal 2111* (COL); Huesito, 3°26′23′′N, 67°54′00′′W, 100–120 m, 3 Aug 2004, *Cárdenas 15211* (COAH); Caño Nabuquén, 3°02′86.5′′N, 68°20′52.7′′W, 3 Jan 2007, *Cárdenas 20384* (COAH); 1–2 km W of Río Guainía, 5 km N of Boca de Casiquiare, 1°57′N, 67°08′W, 120 m, 5 Feb 1980, *Liesner 9134* (COL, MO); Corregimiento de Cacahual, caño Garza, ca. 500 m upstream from its confluence with Río Atabapo, 3°28′20.5′′N, 67°25′18.3′′W, 91 m alt., 8 Mar 2009, *Bernal 4373* (COAH, COL), *4374* (COAH, COL). **Vaupés**: municipio de Mitú, Río Vaupés, comunidad de Los Cerros, Jul 1993, *Martínez 318, 509* (COL); Serranía de Taraira, 10 km NW from Raudal de La Libertad,

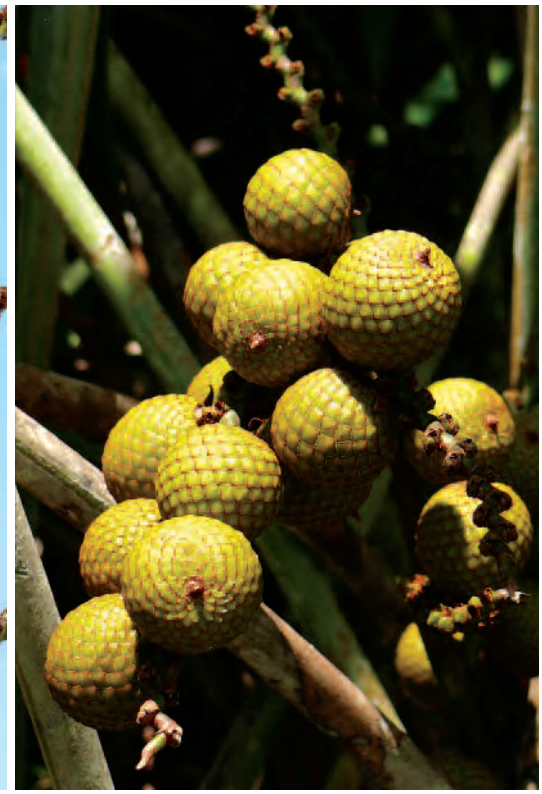
Table 1. Comparison among the species of *Mauritiella* growing east of the Andes.

Character	*Mauritiella pumila*	*Mauritiella armata*	*Mauritiella aculeata*
Habitat	Savannas or rocky outcrops	Forest swamps	River banks
Stems per mature individual	1–5	1–7	(5–)10–50
Stem height	1–3	(2.5–)3–18	5–12(–20)
Stem diameter	4.5–5	7.5–12(–20)	(5–)7.5–15
Persistence of leaves	Persistent	Cleanly abscising	Cleanly abscising
Wax on petiole	Present	Absent	Absent
Primary leaf folds	16–26(–38)	(54–)86–104	61–80
Leaf base	Not peltate	Peltate, funnel-shaped	Peltate, funnel-shaped
Costa length (cm)	1–1.5	(1–)3–20	2–3.5(–13)
Scales on the main veins leaf underside	Absent	Usually with long, narrow, purplish brown ramenta	Usually with long, narrow, purplish brown ramenta
Mid-segment length (cm)	38–45(–57)	(60–)70–133	62–87
Mid-segment width (cm)	2–3.8	1.5–3.7	1–2
Segment margins	Smooth	Sometimes spiny	Usually spiny
Segment orientation	Straight	Straight	Pendant
Number of female inflorescence branches	6–11	12–32	9–18
Length of female branches	12–23	16–50	11–45
Number of rachillae per branch	13–31	(21–)26–63	(15–)21–48
Fruit length × width (cm)	1.8–3 × 1.7–2.4	2.5–3.5 × 2–3	4–5 × 3–4.5
Rows of scales	24–30	21–32	32–55

2 (above). *Mauritiella pumila*, habit. 3 (below). leaf.

0°58′S, 69°45′W, 250 m, 26 Jul 1993, *Cortés 597* (COL). **VENEZUELA. Amazonas**, Dept. Atabapo, Caño Yagua at Cucurital de Yagua, 3°36′N, 66°34′W, 120 m, 8 May 1979, *Davidse 17386* (MO); Dept. Atabapo, Caño Caname. nearly opposite Cucurital de Caname, 3°40′N, 67°22′W, 95m, 2 May 1979, *Davidse 17039* (MO); N side of Laja Suiza, Río Guasacaví, 3.5 km SSW of Santa Cruz, 3°14′N, 67°24′W, 100 m, 4 Mar 1996, *Berry 5966* (MO); Dept. Atures, 2 km upstream of San Juan de Utaca on the Caño Utaca, a black water affluent of the Orinoco, 4°20′25″N, 67°44′12″W, 120–150 m, 15 Jun 1992, *Berry 5101* (MO); Dept. Casiquiare, Caño San Miguel, 2°40′N, 66°50′W, 160 m, 21 Apr 1991, *Aymard 9097* (MO); Dept. Río Negro, carretera near San Carlos, 75–120 m, *Hoffmann 90-3-40* (MO).

As currently understood, the three species of *Mauritiella* growing east of the Andes have different distribution and habitat: *M. armata* is widespread in northern and central South America, from Venezuela and Colombia to Bolivia, where it grows on poorly drained, soils, sometimes derived from white sands; *M. aculeata* grows on sandy soils along the margins of black-water rivers in the upper Río Negro area and neighboring black-water tributaries of the Orinoco and the Amazon,



4 (left). *Mauritiella pumila*, staminate inflorescence after anthesis. 5 (right). fruits.

where it forms large clumps; *M. pumila* is known only from sandy soils or rocky outcrops on open savannas, in the upper Río Negro and adjacent areas of the Orinoco basin in eastern Colombia and western Venezuela. Where the three species converge, they are sometimes found in close proximity, although each in its particular habitat.

Mauritiella pumila is indeed closely related to *M. armata*, from which it differs in the shorter and thinner stems covered with persistent leaf bases, the smaller leaves with a thick cover of wax on the petiole, the lower number of leaf segments (and of veins), the absence of ramenta on the main veins below, the shorter inflorescence branches with fewer rachillae, and the smaller fruits (Table 1). Although some of these characters overlap, particularly with small individuals of *M. armata* from Bolivia, leaf characters are absolutely contrasting; thus, for example, not even the smallest individuals of *M. armata* have fewer than 54 leaf segments, whereas no plant of *M. pumila* is known to have more than 38 leaf segments.

Manicaria

The genus *Manicaria* was established by Gaertner (1791), with one species, *Manicaria saccifera*, from the coasts of northern South America and adjacent Curaçao. This species was later recorded from the mouth of the Amazon by Martius (1823) and Wallace (1853). A new species, *Manicaria pluckenetii* Griseb. & H. Wendl., was later described from Trinidad (Grisebach 1864), but it was afterwards treated by Drude (1881) as a variety of *M. saccifera*.

The first botanist to record *Manicaria* in inland Amazonia was Trail (1876), who described *Manicaria saccifera* var. *mediterranea* Trail from sandy soils near Manaus, on the Río Negro. A second Amazonian record was introduced by Burret (1928), who described *Manicaria martiana* Burret from near Manaus, Brazil. He separated this new species from *M. saccifera* by its shorter bracteoles, sharper fruit projections, and brown trichomes on the leaf undersurface. He considered that *M. martiana* was identical to Trail's *M. saccifera* var. *mediterranea*, which he included in synonymy. Shortly thereafter, he (Burret 1930) added a third species, *Manicaria atricha* Burret, from the Río Vaupés, on the border between Brazil and Colombia. No attempts to revise the genus have been made since Burret's appraisal, and the only modern treatments are those of Wessels Boer (1988), Henderson (1995) and Henderson et al. (1995).

Wessels Boer (1988) recognized three species from Venezuela, *M. pluckenetii*, *M. atricha* and *M. martiana* but suggested that they could all represent one single species, *Manicaria saccifera*. Henderson (1995) and Henderson et al. (1995) recognized only one species, *Manicaria saccifera*, a treatment followed by subsequent authors (e.g. Borchsenius et al. 1998, Stauffer 2000, Govaerts & Dransfield 2005, Dransfield et al. 2008, Pintaud et al. 2008).

Recent field work along the Río Vaupés, a tributary of the Río Negro, and the study of specimens at COAH, COL, MO and US has shown that there are two different species of *Manicaria* in northwestern Amazonia, where they are scarce, and they are therefore poorly represented in herbaria. One of them is the one called by Burret *Manicaria martiana,* which we now reinstate. It is a slender palm with clean stems, smaller, deciduous leaves divided into narrow segments composed of one to a few folds, the undersurface provided with conspicuous, brown, scale-like trichomes, and small inflorescences with shorter branches, simple or divided into 2–4 rachillae that have small bracteoles, and bear only a few fruits (Fig. 6), with sharp woody projections.

The other species, in contrast, is a massive palm with thick stems covered, at least in the upper part, with persistent leaf bases that accumulate debris, with large leaves that persist for a long time after drying, most often divided into segments composed of many folds, glabrous underneath, large inflorescences with longer rachillae that are unbranched or forked, have conspicuous bracteoles, and bear numerous fruits with pyramidal, blunt projections (Fig. 7). From the specimens available to our study, we cannot separate this large species from the typical *Manicaria saccifera* that grows along the coasts of northern South America and in Central America as far north as Belize; they do seem to differ in habit, though – Amazonian

Table 2. Comparison of *Manicaria saccifera* and *Manicaria martiana*.

Character	*Manicaria martiana*	*Manicaria saccifera*
Stem diameter (cm)	5–11	13–35
Covering of stem	Naked throughout; leaves deciduous	Covered, at least in the upper half, with leaf bases
Leaf rachis length (cm)	154–171(–265)	(330–)470–740(–800)
Number of primary leaf folds	58–70	(92–)100–130
Division of leaf blade	Almost regularly pinnatisect, most segments narrow, with few folds	Irregularly pinnatisect, most segments broad, with many folds
Largest number of folds in leaf segments	6	55
Length of middle pinnae (cm)	72–150	135–186
Distance between folds at the center of the lamina (cm)	1.0–1.8	1.8–2.5
Trichomes on leaf undersurface	Abundant, persistent, crustose, reddish brown	Absent
Length of inflorescence rachis (cm)	16–28	(21–)45–81
Branching of basal rachillae	Unbranched or divided into 2–4 rachillae	Unbranched or occasionally forked
Length of basal rachillae (cm)	7–15	27–30(–62)
Bracts below staminate flowers	Almost as long as calyx, inconspicuous	Usually longer than flowers, conspicuous
Fruit diameter (cm)	3–4.5	4.5–5.5
Fruit projections	Usually long and sharp	Usually short and blunt

6. *Manicaria martiana*, infructescence.

populations comprise solitary, unbranched palms, whereas coastal populations often have multiple stems, as a result of basal, dichotomous branching (Fisher & Zona 2006).

Until differences between coastal and Amazonian populations are well established, we continue to keep *M. pluckenetii* and *M. atricha* in synonymy of *M. saccifera*, and we include also in its synonymy Trail's var. *mediterranea*, which Burret considered as conspecific with *M. martiana*. Trail's description corresponds to a palm with stem 15 cm in diameter and leaves 3.2–3.6 m long, which is beyond the range of *M. martiana*, and agrees with some of the smaller individuals of *M. saccifera*.

7. *Manicaria saccifera*, infructescence.

Some of the differences between the two species (Table 2) are not easily detected in herbarium material, and since field notes are usually as poor as the specimens themselves, the two species can be easily confused in the herbarium.

Manicaria martiana Burret, Notizbl. Bot. Gart. Berlin-Dahlem 10: 392. 1928. Type. Brazil. Amazonas: Manaus, n.d., *G. Hübner 2* [holotype, B, destroyed; neotype (here designated): COLOMBIA, Vaupés, Río Vaupés, Naná, 01° 00'N, 69° 55' W, 175 m, 24 Nov 2004, *Bernal 3615* (COL)]. Fig. 6.

Solitary or cespitose with a few stems 2.5–4 (–6) m tall, 5–11 cm diam., naked, dark brown, with conspicuous leaf scars, with internodes ca. 2 cm long. Leaves 6–20, suberect to horizontally spreading; sheath together with petiole 102–150 cm long, ca. 1 cm wide at apex; rachis 1.5–2.6 cm long; pinnae 13–26 on each side, mostly composed of 1–6 folds, and the leaf thus appearing as almost regularly pinnatisect, multi-fold pinnae deeply dentate at apex, in total 58–70 primary folds on each side, 1–1.8 cm apart; basal pinnae 80–122 cm long, middle pinnae 72–150 cm long, apical pinnae 22–40 cm long, all glabrous above, covered below with abundant, persistent, crustose, reddish brown trichomes, easily seen with the naked eye. Inflorescence interfoliar, 2–4 simultaneous in different stages; prophyll bicarinate, ca. 15 cm long, 2.5 cm wide,

reddish brown; peduncular bract ca. 50 cm long, seamless, made of interwoven reddish brown fibers, disintegrating in fruit; peduncle 30–60 cm long, 1.5–2 cm wide, provided toward apex with 1–2 bracts less than 5 cm long; rachis 16–28 cm long; flowering branches (8–)14–25(–56) simple or the basal ones divided in up to 4 rachillae; rachillae 7–15 cm long. Staminate flowers subtended by 5–7 mm long bracts, inconspicuous and scarcely projecting among the flowers; sepals ovate, imbricate, 2.5–3.5 mm long; petals lanceolate, valvate, thick, 4.5–6 mm long. Pistillate flowers with sepals 3–3.5 mm long; petals lanceolate, valvate, 6–7 mm long; ovary ca. 3 mm long, obovoid, minutely verrucose. Fruits usually less than 6 per infructescence, with 1–3 seeds, subglobose or 2–3-lobed, and then each lobe subglobose, 3–4.5 cm diam.; exocarp brown, formed by woody pyramidal projections that are conspicuously pointed at apex; seed subglobose, 2.5–3 cm diam.

Distribution and habitat. Northwestern Amazonia in the bordering area between Colombia and Brazil, and extending as far south as Manaus (where known only from the type). Probably found also in adjacent areas of Peru. Extremely rare and local, growing on sandy soils.

Common names. *Coco* (Amazonas, Colombia); *ubí* (Río Vaupés, Colombia); *wachi* (Cubeo), *taahiye* (Miraña), *bohsomuh* (Siriano), *ampiapúne* (Tariano), *hubi*, *ngumaku* (Tikuna), *bohsomuh* (Tukano), *bohsom* (Tuyuca). Some of these names are probably applied also to *M. saccifera*.

Uses. Leaves are used for thatching; immature endosperm is edible. Ripe fruits are said to be eaten by tapirs (*Tapirus terrestris*) and wild boars (*Tayassu tajacu*).

Selected specimens. COLOMBIA. Amazonas: Río Loretoyacu, near San Agustín 18 Jan 1973, *Glenboski C-233* (COL, US); Río Cahuinarí, between lake Carijona and lake Pescado, tertiary hills, ca. 300 m, 10 Sep 1988, *Galeano 1677* (COL, COAH); La Pedrera, Río Caquetá, near the airstrip, 13 Jun 1996, *Tuberquia 454* (COAH, COL, HUA); Corregimiento Tarapacá, 2°34′32.8″S, 70°05′34.6″W, 6 Mar 1999, *López 4917* (COAH); between Alegría and Porvenir Grande rivers, 2°35′44.8″S, 70°04′45.2″W, 110 m, 24 Aug 2004, *López 8472* (COAH). **Vaupés**: Cerro de Circasia, 300–500 m, 10 Oct 1939, *Cuatrecasas 7181-A* (COL, US); Río Apaporis, between the confluence of Ríos Pacoa and Cananarí, Soratama, 19–23 Mar 1952, *Mora APA-357* (COL); Río Apaporis, Caño Peritomé, left tributary of Piraparaná river, 18–20 Feb 1952, *Schultes 15517* (MO); Río Vaupés, Naná, 01°00′N, 69°55′W, 175 m, 24 Nov 2004, *Bernal 3615* (COL); Mun. Mitú, vereda Makayuka, 1°10′51.2″N, 70°08′20.8″W, 26 Nov 2001, *López 7250* (COAH); Pacoa, Río Kananarí, caño Malla, Buenos Aires, camino hacia el cerro Totuma, 0°0.1′S, 70°58′W, 517 m, 19 Mar 2009, *Betancur 3594* (COL); Pacoa, raudal Jirijirimo, Río Apaporis, pathway between Jirijirimo and Piraparaná, 0°0′19″S, 70°56′00″W, *Cárdenas 22177* (COAH).

Leopoldinia

The genus *Leopoldinia* was established by Martius (1824), who described two species from the lower Río Negro – *Leopoldinia puchra* Mart., and *L. insignis* Mart. Two additional species were added by Wallace (1853) – *Leopoldinia piassaba* Wallace and *Leopoldinia major* Wallace. The former is a remarkably distinct species, and its identity poses no problem. The latter, however, was separated by Wallace only on account of its taller and thicker stem, with a larger bare portion, larger infructescences with bigger fruits, and on the information of the natives, who used it to obtain salt by burning the fruits and filtering the ashes, a use for which *L. pulchra* was purportedly not appropriate.

Spruce (1869) stated that both species grow together over a large area on the Río Negro and along the black-water tributaries of the

8. *Leopoldinia pulchra*, variation in fruit size and shape among fruits from two neighboring individuals. Fruits were arranged according to size.

9. *Leopoldinia pulchra,* habit. Note some leaves with somewhat hanging pinnae.

Casiquiare and the Orinoco. He provided a detailed description of *L. major* and separated it from *L. puchra* on account of its caespitose habit, taller stem, frailer leaf sheaths, more numerous and pendulous pinnae, more closely spaced flower pits and different shape of the bracteoles. Spruce himself, however, was unable to assign to either species some of his own specimens, which he suspected might correspond to *L. pulchra*.

The identity of *L. major* has remained obscure since the time of Wallace and Spruce, and later authors have not been able to separate it

10 (left). *Leopoldinia pulchra*, detail of stem. 11 (right). *Leopoldinia pulchra*, infructescence.

properly from *L. pulchra* (Wessels Boer 1988, Henderson 1995, Guánchez & Romero 1995), as specimen labels seldom mention number of stems or arrangement of pinnae, and there is much variation in the other characters pointed by Spruce. Wessels Boer (1988) doubted that any difference existed between them but followed Spruce in keeping them separate. Guánchez and Romero (1995) were unable to find any plant referable to this species, although they visited localities cited by Spruce and examined numerous specimens in several herbaria. Henderson (1995) separated *L. major* from *L. pulchra* on account of habit, width of leaf sheath fibers, arrangement of pinnae, fruit size and shape, and several minor floral characters. However, he recognized that differences between both species were still not well established.

Our own field work in the upper Río Negro area and along black-water tributaries of the Río Orinoco, in the bordering area of Venezuela, Colombia, and Brazil, and the study of 83 herbarium specimens kept at COAH, COL, MO and NY, have shown that the differences established by Wallace (1853), Spruce (1869) and Henderson (1995) do not actually exist. In some cases, variation covering most of the range for a particular character is found in a single population or even in a single individual, as is the case with fruit shape and size (Fig. 8); in other cases, as with caespitose vs. solitary habit, the difference is due to a misinterpretation, as the clumps are often loose, and are easily mistaken for separate, solitary individuals. In many cases, only after digging out the connecting rhizome is it possible to determine that two separate stems belong to the same genetic individual. This situation is further complicated by the fact that the palms remain submerged up to a considerable height every year, during the months of the rainy season.

As to the arrangement of the pinnae, horizontally spreading vs. pendulous, this is a mistake introduced by Spruce, who stated that *L. major* has pinnae completely pendulous "as in the Assai palm" (*Euterpe oleracea*). During our own field work along more than 350 km on the Rio Atabapo, Rio Negro and some of their small tributaries, we searched for *Leopoldinia* palms with pendulous pinnae, and did not find a single individual agreeing with Spruce's description. Most individuals that we

saw had pinnae horizontally spreading, and only occasional palms had them slightly pendulous (Fig. 9), but never as strongly pendulous as described by Spruce. These individuals were identical in every respect to those with horizontal pinnae. Palms with pendulous pinnae reminding Spruce's description are probably occasional, however, as one has been illustrated by Dransfield et al. (2008).

As to variation in the density of flowers, Guánchez and Romero (1995) have documented that there is a wide range of variation in the number of staminate and pistillate flowers and in their arrangement on the rachillae. Our conclusion is that besides the fiber-yielding *piassaba* or *chiquichiqui* palm, *Leopoldinia piassaba*, there is only one other species of *Leopoldinia*, for which the oldest name is *Leopoldinia pulchra*.

The fourth species in the genus, *L. insignis*, was not recognized by Martius in the field as distinct, and was only separated on the base of the herbarium specimen. A study of digital images of this specimen, however, reveals that it is a mixture of two different species, including leaf fragments of *Oenocarpus bataua*, and fruits and inflorescence of *L. pulchra*. Martius himself expressed his doubt that the inflorescence actually belonged to the specimen. We, therefore, include *L. insignis* as a partial synonym of *L. pulchra*.

Leopoldinia pulchra Mart., Hist. nat. palm. 2: 59. 1824. Type: Brazil. Amazonas: Barra do Rio Negro (Manaus), s. f., *Martius s. n.* (holotype, M). Figures 8–12.

Leopoldinia insignis Mart. Hist. nat. palm. 2: 60. 1824. Type. Brazil. Amazonas: Canumá, s. f., *Martius s. n.* (holotype, M) (*pro parte*, inflorescence only).

Leopoldinia major Wallace, Palm Trees of the Amazon 15. 1853. Lectotype (Wessels Boer 1988): Wallace, Palm Trees of the Amazon t. 5. 1853.

Caespitose, with several adult stems and sometimes with basal shoots, occasionally up to 20 stems or more, but usually in loose clumps, and then the stems appearing as if they were solitary. Stem 2.5–8 m tall, 4–7 cm diameter, covered with persistent leaf bases, which make up a dense network of gray fibers, so that the covered stem appears to be ca. 10 cm in diameter, sometimes the stem naked near base, but always covered in fibers towards apex. Leaves 5–14, plus 3–4 dead leaves hanging down on the crown, usually 1–2 of the dead leaves conspicuously colored yellow or orange, and easily recognized from a distance; sheath 18–35 cm long, formed by a network of reddish brown fibers 1–4 mm wide, which turn gray with age; petiole 31–63 cm long, ca. 1 cm wide at apex with brown, fimbriate scales; rachis 48–70(–136) cm long, with indumentum like that of the petiole; pinnae (14–)17–29(–37) on each side, regularly arranged, horizontally spreading or occasionally somewhat pendulous, sometimes 2–3 basal pinnae slightly closer to each other than the remaining pinnae; basal pinnae 29–36 cm long, 1.2–2.0 cm wide; middle pinnae (28–)43–72 cm long, 2.2–4 cm wide; apical pinnae 15–22 cm long, 1–1.3 cm wide, all pinnae glabrous on both sides, with conspicuous transverse veins. Inflorescence interfoliar, ca. 1 m long, branched to 3rd order in predominantly pistillate inflorescences or to 4th order in predominantly staminate inflorescences, covered with a short and dense, reddish brown, persistent tomentum, velvety in appearance, sometimes falling off in some areas of the peduncle; peduncle 25–38 cm long; peduncular bract 20–38.5 cm long, 4 cm wide, flat, bicarinate, reddish-brown, inserted ca. 20 cm above the base of the peduncle, with dense, velvety indumentum of short, white, penicillate hairs; rachis 20–35 (–66) cm long; branches 19–28, the last-order rachillae 0.6–1.5(–5) cm long, 1(–2) mm diam. in staminate inflorescences, 5–6(–12) cm long, 1.5–2 mm diam. in pistillate inflorescences. Staminate flowers 0.8–1 mm long; sepals broadly ovate, imbricate, scarious, 0.3–0.4 mm long; petals ovate, obtuse, and slightly cuccullate at apex, 0.6–0.8 mm long; stamens 6; filaments broad and flattened; anthers ca. 0.2 × 0.2 mm; pistillode minute. Pistillate flowers similar in shape to the staminate ones but slightly broader; sepals broadly ovate to reniform, 0.8–1 mm long; petals ovate, 0.8–1 mm long. Fruit laterally compressed, variable in shape, even in one infructescence, circular in profile (and then lenticular), or irregularly circular, kidney-shaped, comma-shaped, ovoid or almost squarish, 2.5–3.8(–4.4) cm long or diam., to 1.5 cm thick, passing from yellowish to wine red, and finally dark purple when falling onto the ground; mesocarp fleshy, whitish, covering a network of thick fibers that surround the seed.

12. *Leopoldinia pulchra*, habitat on riverine white sands.

Distribution. Sandy soils near black water tributaries of the Amazon and the Orinoco in western Venezuela (Amazonas), Colombia (Vichada, Guainía) and Brazil (Amazonas, Pará), between 6°48′N and 7°58′S latitude, and between 55°00′ and 68°52′W longitude, at 25–200 m elevation.

Common names. *Palmito*, *palmalito*, *palmarito*, *palmiche* (Colombia); *chiquichiquito*, *morichito*, *palmiche* (Venezuela); *jará* (Brazil); *manicoli*, *manicore* (Curripaco); *jará*, *yará* (Geral).

Uses. Stems are used today for fencing, in the same way described by Wallace (1853); they are also used for house walls (Fig. 13) and courts. The palm heart is edible. A beverage is obtained by kneading the ripe fruits in water.

Selected specimens. BRAZIL, **Amazonas**, Alto Rio Negro, ca. 10 km N of Barcelos, 00°52′28″S, 62°58′13″W, 100 m, 6 Aug 1996, *Acevedo 8026, 8027* (NY); Borba, Rio Madeira, 3 km south of town, 4°23′20″S, 59°35′37″W, 29 m, 29 Dec 1990, *Henderson 1504* (NY); Manaus, Taruma, 6 Aug 1986, *Henderson 650* (NY); Munic. Careiro, Manaus-Porto Velho highway, km 22, 2 km on rd. to Purupuru, 3°30′N, 60°00′W, 1 Apr 1985, *Henderson 179* (NY); Munic. Humaitá, BR 230, Estrada Transamazónica, km 126, on Rio Marmelos, 7°58′S, 62°02′W, 17 Apr

1985, *Henderson 255* (NY); Río Paporí, 12 Sep 1928, *von Luetzelburg 23047* (NY); **Pará**. Munic. Santarem, Vila de Alter do Chao, 2°31′S, 55°00′W, 27 Dec 1991, *Ferreira 56* (NY). **COLOMBIA**, **Guainía**. Near Coitara, ca. 7 km S of San Fernando de Atabapo (Venezuela), 3°55′N, 67°43′W, 95 m, 28 Apr 1979, *Davidse 16846* (MO, NY); road Puerto Inírida to Caño Vitina, 4–11 km from Puerto Inírida, 3°50′N, 67°52′W, 200 m, 21 May 1994, *Bernal 2105* (COL); Mun. Inírida, Resguardo indígena Almidón-La Ceiba, comunidad La Ceiba, near caño Agujón, 3°32′N, 67°51′W, 80 m, 21 Mar 1998, *Rudas 7165* (COL); Comunidad Guamal, 3°52′32.4″N, 67°51′51.2″W, 13 Dec 2005, *Arias 2010* (COAH); Río Atabapo, between Maviso and Comunidad Chaquita, 4°2′15.38″N, 67°42′43.11″W, 9 May 2007, *Cárdenas et al. 20531* (COAH); Corregimiento Cacahual, Caño Garza, ca. 500 m above the confluence with Río Atabapo, 3°28′20.5″N, 67°25′18.3″W, 91 m, 8 Mar 2009, *Bernal 4372* (COAH, COL); Corregimiento La Guadalupe, Caño Macacuní, south branch, ca. 7 km upstream from confluence with Río Negro, 1°17′37″N, 66°55′0.8″W, 73 m, 11 Mar 2009, *Bernal 4407* (COAH, COL). **Vichada**: Puerto Carreño, 14 Jul 1997, *Acero 13* (COL); Mun. Cumaribo, selva de Matavén, Caño Matavén, 4°30′28″N, 68°03′32″W, 190 m, 28 Mar 2007, *Prieto 6118* (COAH); Inspección de Policía Amanavén, Caño Jota, 4°4′ 8.4″N, 67°54′10.1″W, 7 Jul 2008, *Cárdenas et al. 21562* (COAH). **VENEZUELA**, **Amazonas**, 3–5 km NE and E of San Carlos de Río Negro, 1°51′N, 67°03′W, 120 m, 22 Jan 1980, *Liesner 8608* (MO); Cerro Arauicaua, Rio Yatua, 1°35′N, 66°10′W, 125–150 m, 11 Apr 1970, *Steyermark 102653* (COL, NY); Cerro Yapacana, Caño Catua (Caño Yapacana), 19 Nov 1953, *Maguire 36558* (NY); Depto. Atures, 47 km N of alcabala of Puerto Ayacucho, 6°00′N, 67°20′W, 80 m, 8 Sep 1985, *Steyermark 131605* (MO, NY); Depto. Río Negro, lower part of the Río Baria, 1°27′–1°10′N, 66°32′–66°25′W, 80 m, 22, 23 Jul 1984, *Davidse 27714* (MO, NY); Dpto. Atabapo, Alto Orinoco, San José del Orinoco, 10 km al SW de La Esmeralda, 3°5′N, 65°35′W, 150 m, 27 Feb 1990, *Aymard 8327* (NY); Dpto. Atabapo, Macabana, Río Ventuari, 4°15′N, 66°20′W, 90 m, Sep 1989, *Delgado 692* (NY); Dpto. Río Negro, Río Pasimoni, between its mouth and its junction with the Río Baria and the Río Yatua, 1°53′–1°27′N, 66°35′–66°32′W, 80 m, 23–25 Jul 1984, *Davidse 27845* (NY); **Apure**, Distrito Pedro Camejo, E of the southern tip of the Galeras de Cinaruco, 6°35′N, 67°15′W, 50 m, 23 Feb 1979, *Davidse 15646* (MO); Atures, Bosque de rebalse al pie de la Serranía de San Borja, 6°48′N, 67°22′W, 24 Jan 1989, *Cuello 566* (NY); **Bolívar**, Along rd. from Puerto Ayacucho to Puerto Páez, 5°50′N, 67°30′W, 2 Aug 1967, *Wessels Boer 1943* (NY).

13. A house made with stems of *Leopoldinia pulchra*, and thatched with leaves of *Leopoldinia piassaba*, on the Venezuelan margin of Río Guainía.

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Parajubaea cocoides, a New Record for Peru

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1. Crowns of *Parajubaea cocoides*.

Parajubaea cocoides **(Fig. 1) is recorded for the first time in the wild, in Peru.**

The Cordillera of the Andes in Peru, rising from the Pacific coast in the west and dipping down into the Amazon River basin in the east, ranges from 1000 to 3500 meters above sea level. The Cordillera carries remnants of very humid rainforest frequently covered in clouds. This forest is loosely termed by villagers, high forest (*selva alta*), *rupa rupa*, *yungas* or "eyebrow

forest" (*ceja de selva*). This way of characterizing the forest is more common on the eastern flank that slopes down toward the Amazon River basin.

However, on the western slope that fronts the Pacific Ocean, mainly along Peru's northern coast (in the departments of Piura, Lambayeque and La Libertad) one can still find patches of tropical cloud forest that formerly extended from Ecuador almost to the twelfth parallel in the south, in what is now the department of Lima, along Peru's central coast. These ecosystems of cloud forest are characterized by a very high biodiversity and intense rainfall, which is accentuated along the Pacific Ocean when the phenomenon of "El Niño" occurs.

Within the great biodiversity of these ecosystems, it is quite common to find palms at different altitudes in these *yungas* or cloud forests, particularly *Ceroxylon* accompanied by *Syagrus*, *Wettinia* and *Iriartea*. These palm

2. *Parajubaea cocoides* in the village of Tabaconas, Province of San Ignacio (Cajamarca), Peru.

3. One of the comon, but unidentified species of *Bactris* in the region of Tabaconas.

genera were recorded for Peru three centuries ago, when the first expeditions of European naturalists began to cross these lands conducting inventories of the local flora and fauna, and describing geographic features and towns.

It was odd that one particular genus of high-altitude Andean palms, *Parajubaea*, had been recorded only in Ecuador, Colombia and Bolivia did not appear to occur in Peru (Pintaud et al. 2008). This is more surprising if we realize that the northern Andes within Peruvian territory and the southern Andes within Ecuadorian territory form a great region with many common ecosystems. In this northern region of Peru, a wild population of *Parajubaea cocoides*, also called Quito palms, was recently discovered. Until now this species had been recorded only as being cultivated in Ecuador (Quito) and Colombia (Pasto) and was not known with certainty from the wild. The newly discovered population in Peru may be the only wild population existing in South America.

The discovery was made when Nicole Bernex, of the Center of Research and Applied Geography at the Catholic University of Peru, and Fernando Roca, SJ, from the Institute of

Environmental Sciences at the same university (IDEA-PUCP), went to the Tabaconas River valley in order to give a series of workshops on the environment to the area's peasants at the invitation of the bishop of Jaén, Santiago García de la Rasilla, SJ.

The palms identified as *Parajubaea cocoides* are found in the Peruvian Andean region, in the district of Tabaconas (1900 m above sea level), located in the province of San Ignacio, in the northern part of the department of Cajamarca. In spite of great deforestation this zone has excellent potential for sustainable development due to the variety of ecosystems and its great biodiversity. The National Sanctuary of Tabaconas-Namballe is located in this region. The small town of Tabaconas, the district capital, was built between these palms, and there are still some palms about 3–5 km away from the center of the town (Fig. 2 & Back Cover), in the outlying neighborhoods. According to the settlers, "to build the town we destroyed the forest but we left many of the palms…" In a meeting with the Dr. Andrew Henderson, a specialist in Latin American palms at the New York Botanical Garden, we were informed that these palms were probably a hundred years old.

The inhabitants of Tabaconas do not exceed 1000. They have begun to develop crafts using fruits from *Parajubaea cocoides*. This use of the fruits will endanger the natural regeneration of this rare palm. There are no major traditional uses attributed to these palms, unlike *Ceroxylon*, the wood of which is commonly used, or *Bactris* (very common in the zone), the fruit of which is much in demand and commercialized by companies that have sprung up along the northern Peruvian Pacific coast. There are at least two species of *Bactris* (Fig. 3) with abundant populations in the valley, but they remain unidentified, although the villagers claim that they can classify up to four species. It is surprising to learn that they only consume the fruit but not the *palmito* (the heart-of-palm).

The Tabaconas-Namballe National Sanctuary (in the departments of Piura and Cajamarca) is a protected natural zone in the department of Cajamarca, in the province of San Ignacio, in northern Peru. It consists principally of the Tabaconas River basin and has at least four different ecosystems: Amazonian tropical dry forest, humid forest (*bosque premontano*), Amazonian cloud forest and paramo. The altitudes range from 1000 to 3600 meters about sea level. The Tabaconas-Namballe National Sanctuary is the habitat of the spectacled or Andean bear (*Tremarctos ornatus*) and of the great tapir of Latin America, *tapir pinchaque* or great beast (*Tapirus pinchaque*). We also found many unusual birds such as the Andean Cock of the Rocks (*Rupicola peruviana*), the national bird of Peru, and different trogon species, relatives of the Central American quetzal. Also, three years ago, in the Ocol forest, in the department of Amazonas, at least two new *Ceroxylon* species were discovered. This new record of *Parajubaea cocoides* represents an important addition to the palms of Peru, a country where we still "have many things to discover in nature."

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Toxicity of Turfgrass Postemergence Herbicides to *Wodyetia bifurcata*

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Selective postemergence herbicides are an effective means of managing weeds in turfgrass. However, since palms have extensive root systems that typically extend well beyond the dripline of their canopies, their roots could be exposed to herbicides applied to nearby turfgrass in a landscape. While preemergence herbicides have been shown to be toxic to container-grown palms under certain environmental conditions (Donselman & Broschat 1986; Meerow & Broschat 1991; Broschat 2000), non-selective herbicides such as diquat, glufosinate-ammonium, glyphosate and paraquat can be safely applied as directed sprays around the trunks of mature palms (Broschat 2004). Applications of glyphosate directly to the foliage of seedling palms caused no damage to *Cocos nucifera*, but injured one or two leaves when applied to eight other species (Donselman & Broschat 1986). Only two of the 45 palm seedlings treated with glyphosate died.

Relatively little is known about the safety to palms of selective post-emergence herbicides used on warm-season turf-grasses. Romney (1964, 1965) found that young *Cocos nucifera* were injured by foliar applications of phenoxy herbicides such as 2,4-D, 2,4,5-T and MCPB, especially when volatile ester forms were used. The purpose of this study was to determine the phytotoxicity of 8 turf-grass herbicides when applied to the soil and leaf bases of juvenile palms.

Materials and Methods

Juvenile *Wodyetia bifurcata* palms approximately 1.5 m tall growing in 13.8-liter plastic containers were measured for initial height to the tip of the longest fully extended leaf. Any blemishes on the foliage (usually necrotic spotting caused by potassium deficiency) were noted, and the youngest fully expanded leaf was tagged as a reference point. The 8 herbicides evaluated (Table 1) are registered

Table 1. Trade names and active ingredients of herbicides applied to the soil of container-grown *Wodyetia bifurcata* with label rates used (1X).

Trade name	Manufacturer	Active ingredient(s)	Rate (kg a.i./ha)
Atrazine 4L	SipCam Agro,USA, Roswell, GA	atrazine	2.240
Clarity	BASF, Research Triangle Pk, NC	dicamba	0.087
Image	BASF	imazaquin	0.280
Manor	Nufarm Americas, Burr Ridge, IL	metsulfuron	0.042
Certainty	Monsanto, St. Louis, MO	sulfosulfuron	0.066
Amine 400	PBI Gordon, Kansas, City, MO	2,4-D amine	0.420
Trimec Southern	PBI Gordon	*	
Mecomec 4	PBI Gordon	mecoprop	0.387

*Trimec Southern is 1.44, 1.32 and 0.30 lb/gal acid equivalent of 2,4,D, mecoprop and dicamba, respectively. Applied rates for the individual active ingredients in Trimec Southern (0.403, 0.370 and 0.084 kg/ha acid equivalent) were similar to the active ingredients applied separately. All mecoprop acid equivalents are based on the biologically active (R)-isomer. All synthetic auxin herbicides (2,4-D, mecoprop and dicamba) were in the dimethylamine salt formulation except Mecomec 4 which was the potassium salt.

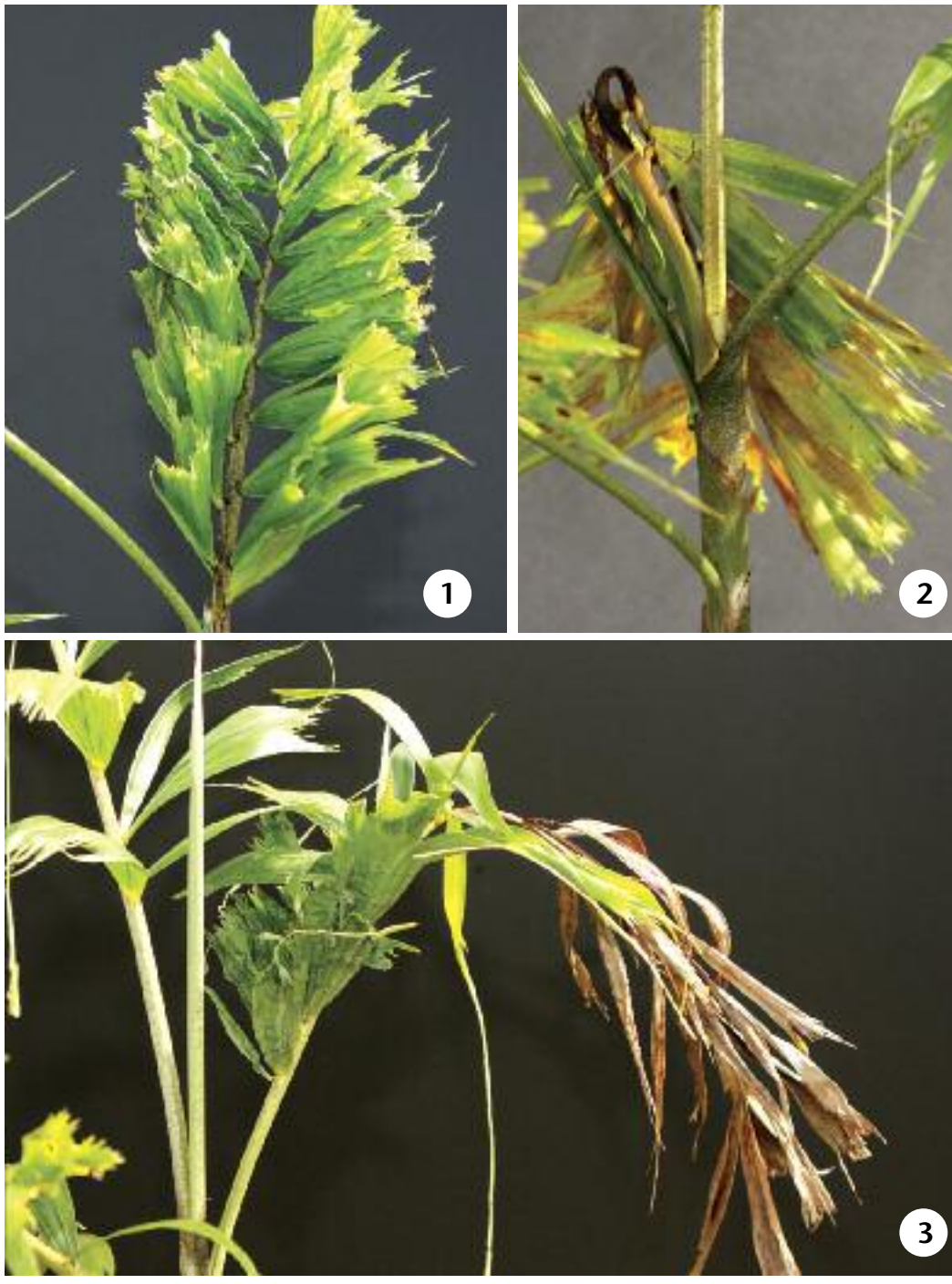
for use on bermuda-grass and/or St. Augustine-grass lawns and were applied at 1, 2 and 3 × their label rates. The higher rates were applied to determine the margin of safety for each product. Six replicate palms were randomly assigned to each of the 24 herbicide treatments. Control palms were sprayed with water only. For application purposes, all palms receiving a given treatment were arranged in a row and the soil surfaces of each container and the palm leaf bases were sprayed to a height of approximately 15 cm above the soil surface using a CO_2-pressurized backpack sprayer (Weed Systems, Inc., Hawthorne, FL) equipped with flat fan spray tip nozzles (TeeJet 11002, Spraying Systems Co., Wheaton, IL) at 401 L/ha. Applications were made on 14 November 2007 under overcast skies and a temperature of 27ºC.

Following treatment, all palms were moved into a greenhouse for 24 h to prevent rainfall from washing off the applied chemicals. Palms were then moved into a shade-house with 50% light exclusion for growing and observations. There they were arranged in a completely randomized design. The palms received ~2 cm of water from overhead irrigation daily. Palms were monitored monthly and any abnormal appearances recorded.

Results and Discussion

None of the palms exhibited any symptoms of herbicide injury during the first 6 months following application. On 10 June 2008, 16 of the 18 palms receiving metsulfuron treatments showed unusual deformations on the first or second leaf produced after treatment. Typical symptoms on the affected leaf included a kink or necrotic lesion on the rachis with the distal portion of the leaf having normal-shaped, but sometimes withered or completely necrotic tissue. The basal portions of the affected leaves were unusually dark green and often crumpled in appearance or in a few cases, the entire affected leaf was crumpled (Figs. 1–3). The spear leaf was crumpled and stunted (one palm) or slightly wavy (two palms) but normal in appearance in the remaining 15 palms receiving this chemical. Application rate of metsulfuron had no significant effect on the severity of these symptoms although two of the 1× rate palms showed no symptoms. None of the control palms or those receiving any other herbicide treatment exhibited any unusual symptoms. Growth rate was not noticeably affected by any treatment.

The unusual pattern of symptoms for metsulfuron injury suggests that this herbicide



1. *Wodyetia bifurcata* showing crumpled leaflets caused by metsulfuron. 2. Necrotic lesion and kink in metsulfuron-treated *Wodyetia bifurcata*. 3. Typical metsulfuron damage on *Wodyetia bifurcata* showing leaf withering distally and dark green crumpled leaflets proximally. Note that younger leaf is normal in appearance.

affected only the oldest unexposed leaf within the palm crown. The spear leaf at the time of application, plus all the exposed leaves were unaffected by this herbicide. The kink or necrotic lesion on the affected leaf represents a critical (susceptible) stage of development at the time of herbicide uptake. If the necrotic lesion or kink was severe enough, the older distal portion of the leaf eventually withered or even dropped off in a few cases. The

younger, more proximal portion of the affected leaf showed crumpling of the leaflets, a symptom associated with excess auxin within palms (Broschat 2007). Since metsulfuron affected only a single leaf on treated palms and subsequent growth was normal for all replicates, this product had no lasting effects on *Wodyetia bifurcata* health.

In this experiment we observed no effects from the 3 phenoxy herbicides tested (2,4-D amine, mecoprop and the two in combination with dicamba) when applied to the soil and leaf bases of juvenile *Wodyetia bifurcata*. None was applied in an ester formulation. In contrast, Romney (1964,1965) found that direct foliar applications of ester forms of 2,4-D, 2,4,5-T and MCPB either killed young *Cocos nucifera* or caused the palms to grow at 5–10º angles from the vertical, a symptom of excess auxin (Broschat, 2007). However, he noted that direct foliar applications of atrazine did not damage these palms in any way (Romney 1965). As might be expected, he found that direct applications of diquat and paraquat caused substantial foliar necrosis but did not affect growth rate or survival rate (Romney 1964). Hoyle (1969) observed no effects on 3-year old *Cocos nucifera* from soil applications of 2,4-D amine, bromacil, linuron, diuron, atrazine, simazine or paraquat.

The delayed response to herbicides has been noted previously by Meerow and Broschat (1991), where palm responses to the pre-emergence herbicide metolachlor were not visible for 7–9 months. Donselman and Broschat (1986) noted that phytotoxic effects of oxyfluorfen-containing granular herbicides did not become apparent until new leaves emerged 4–6 weeks following application. Thus, it is important to keep in mind that injurious effects of some herbicides may not be apparent for some time after application.

In conclusion, this experiment demonstrated that application of most commonly used selective post-emergence turf herbicides to the soil and leaf bases of juvenile *Wodyetia bifurcata* palms, even at high rates, had no apparent effect on the health of these palms. Metsulfuron, when applied at label or higher rates, caused temporary injury to a single leaf, but had no significant long-term effects on these palms. It is not known what effects, if any, these chemicals would have on other palm species. Also, it is not known how this or other palms would respond to direct foliar applications of any of these products, an unlikely event in the landscape, we would hope.

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Analalava – a Palm Conservation Hotspot in Eastern Madagascar

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At the present day, only a few small fragments of original rainforest remain along the east coast of Madagascar. One such forest fragment is Analalava, about 7 km west of Mahavelona, to the north of Toamasina. An inventory of this forest recorded 25 palm species. This paper emphasizes the richness of the palm flora and the conservation efforts necessary for their survival.

The high diversity of palms in the eastern part of Madagascar is well known. Approximately 90% of the 188 indigenous palms species on the island occur in rainforest (Dransfield & Beentje 1995; Rakotoarinivo & Dransfield, submitted), the primary vegetation of the eastern part of Madagascar. In the past, the rainforest is thought to have been contiguous from Sambava to Taolagnaro (Humbert & Cours-Darne 1965), but now primary forest is scarce along the eastern escarpment and extremely rare on the coastal plain. Only 48 km sq. of coastal vegetation remains (Moat & Smith 2007), and the area continues to decrease since annual deforestation rate is estimated to be around 0.20% between 2000–2005 (MEFT 2009). On the Indian Ocean coastal plain, where the human population is dense and the land is more accessible, the rainforests have been most seriously degraded. Thus, our understanding of the original palm diversity in Madagascar is limited because good forest is rare and located mainly in remote areas. Some species are possibly extinct and many palms are recorded only from single locations in tiny fragments of primary forest.

The forest of Analalava, north of Toamasina, is a rare example of a coastal plain rainforest remnant. Analalava is located 7 km west of Mahavelona (or Foulpointe) and has a climate classified as perhumid with ca. 3000 mm of rainfall in a year, ca. 24°C mean temperature and lacking a dry season (Cornet 1974). The forest fragment consists of ca. 2 km sq. of remnant lowland vegetation ranging between 40 and 80 m elevation and growing mainly on laterites, but with some parts on alluvial and white sands. The forest is evergreen and has a closed subcanopy. Following the former exploitation of the forest, only a few trees from the original canopy remain and now appear as emergents (C. Birkinshaw, pers. comm.). Despite this state of degradation and its limited size, the forest has a diverse flora, with 317 plant species recorded by Missouri Botanical Gardens (2007). The principal human activity in the vicinity of Analalava is agriculture, but the expansion of tourism at Mahavelona has resulted in an increase in the demand for construction wood. In recent decades, one third of the forest has been burnt or otherwise destroyed to provide agricultural land. The latest census states that 23,000 people dwell in the Mahavelona area, with one quarter of them living in close proximity to the forest .

The Palm flora of Analalava

As part of the taxonomic and ecological study of Madagascar palms at the Royal Botanic Gardens, Kew, an inventory of the species in Analalava was made during three visits to the forest between 1999 and 2008. This inventory has been complimented by surveys conducted by the Missouri Botanical Garden. Twenty-five palm species are now known to occur in Analalava. Analalava is thus the sixth most important hotspot for palm diversity in Madagascar. Comparable areas richer than Analalava include Antanambe (Mananara Avaratra), Ambinanitelo (Makira), Tampolo (Masoala), Marojejy and Sahamalaza (Masoala) (Rakotoarinivo 2008). Moreover, most of the species in Analalava are rare. Some are known only to occur in the region; others have a larger distribution range, but their distributions are severely fragmented. Here we list the palm species of Analalava, giving details of their occurrence in Madagascar and distribution within Analalava.

1. ***Dypsis angustifolia*** (H. Perrier) Beentje & J. Dransf. (Figs. 1, 2)

This is a clustering undergrowth palm found only in Toamasina region. Apart from

1. *Dypsis angustifolia* growing beside a small stream. (Photo: J. Dransfield)

Analalava, the other known site for this species is in the Betampona reserve at an elevation between 400–500 m (Dransfield & Beentje 1995). This is a rare species, collected only six times since it was discovered in Betampona in 1925 by H. Perrier de la Bâthie. Each of these two sites is located on the watercourses of the Onibe River, suggesting that other populations may still occur in remaining forest along this river. In all localities, clumps of the palm are sparse.

2. ***Dypsis bejofo*** Beentje (Fig. 3)

This is a solitary canopy palm that is known from disjunct sites between Betampona and areas to the north of Maroantsetra (Rakotoarinivo 2008). *Dypsis bejofo* is known from eight locations and only three of them are not around the Bay of Antongil (Ambatovaky, Analalava and Betampona). This palm is frequently recorded from submontane forests around 400 m, but its elevational gradient ranges from sea level up to 800 m. In Analalava forest, it is rare. Only two mature individuals were found; they are both located on the crest of a steep slope where the canopy is slightly open. In 2008, abundant seedlings were observed around the mature individuals.

3. ***Dypsis bosseri*** J. Dransf.

This slender undergrowth palm was described in 1995 from a single herbarium specimen collected in the Mahavelona area by French botanist Jean M. Bosser in 1962 (Dransfield & Beentje 1995). As primary forest was mostly destroyed in this zone and no newer collections were made since its first collection, *Dypsis bosseri* was presumed to be extinct until its rediscovery in 1999 in Analalava forest. The palm is quite common in Analalava but it has never been recorded outside this locality. Individuals are found in swampy or periodically inundated sites.

4. ***Dypsis carlsmithii*** J. Dransf. & Marcus (Figs. 4, 5)

This is a robust palm that was initially described from a garden plant in Hawaii (Dransfield & Marcus 2002). Its occurrence in Analalava is the second record of the species in Madagascar after that in Tampolo, in the western part of the Masoala Peninsula. In both known sites, the palm grows on flat partially inundated land in valley bottoms. Only two individuals have been observed in Analalava.

5. ***Dypsis confusa*** Beentje

This slender shrubby palm is relatively common in the undergrowth in lowland forest of the northeast part of Madagascar. With 17 locations known between Antalaha and Ranomafana, from sea level up to 1200 m elevation, this species is one of the most

2 (left). *Dypsis angustifolia*: close up of crown. 3 (right). *Dypsis bejofo*: mature tree with inflorescences. (Photos: J. Dransfield)

4 (left). *Dypsis carlsmithii*: the whole magnificent palm. 5 (right). *Dypsis carlsmithii*: view of the crown. (Photos: W.J. Baker)

widespread palms of Madagascar. In its occurrence sites, individuals are mostly found on shallow soils where the forest canopy is slightly open.

6. ***Dypsis faneva*** Beentje

This is a slender palm of the undergrowth in humid forest up to 300 m and known from four separate areas between Maroantsetra and Analalava. This is a rare species in the forest.

7. ***Dypsis fibrosa*** (Wright) Beentje & J. Dransf.

Dypsis fibrosa is a branched shrubby palm, characterized by its disintegrating leaf sheath, which produces a fibrous skirt (piassava) in the upper part of the trunk. This palm is one of the most widespread in Madagascar as it is represented by 54 herbarium specimens collected from 17 localities between Daraina and Taolagnaro, and from humid lowland forest to mountain forest on the Eastern escarpment. In all of its occurrence sites, individuals are most frequent on hill slopes.

8. ***Dypsis forficifolia*** Mart.

This slender, undergrowth palm is especially abundant around the Bay of Antongil from the western part of Masoala Peninsula to Soanierana Ivongo region. The occurrence of this palm in the Analalava forest represents an outlier.

9. ***Dypsis hovomantsina*** Beentje

This canopy palm can be distinguished from other species by its crownshaft that is densely waxy in the lower part and with golden fur in its upper parts. This species is known to occur discontinuously from five localities in lowland areas below 300 m from Analalava towards Masoala. Individuals are frequently found in forest with a relatively open canopy, on steep slopes and rocky sites.

10. ***Dypsis lastelliana*** (Baill.) Beentje & J. Dransf.

This palm is one of the most typical species to be found in the lowland humid forest of north-eastern Madagascar. This species is also found in the Sambirano region and has apparently a continuous occurrence from Daraina to Mahanoro, and from sea level up to 900 m elevation. *Dypsis lastelliana* is a canopy tree palm characterized by its red furry crownshaft. In the forest, individuals are usually quite numerous and generally occupy slopes.

6. *Dypsis poivreana*, in flower. (Photo: J. Dransfield)

Unusually among Madagascar's palms, this species is able to survive in disturbed areas, possibly because the "cabbage" is not eaten.

11. ***Dypsis nodifera***
This is a slender undergrowth palm of the humid forest along the eastern escarpment of

7. *Dypsis poivreana*, in fruit. (Photo: W.J. Baker)

Madagascar, from sea level to 1500 m elevation. With 62 different herbarium samples, this species is one of the palms in Madagascar best represented in herbaria. *Dypsis nodifera* is widespread as the occurrence sites extend from 23 locations between Antsiranana and Taolagnaro. Abundance of this species is rather variable in these locations. In Analalava, *Dypsis nodifera* is quite common.

12. ***Dypsis paludosa*** J. Dransf.

This is a clustering undergrowth palm, growing in swamps or in flat valley bottoms that are frequently flooded. *Dypsis paludosa* may have either entire bifid or pinnate leaves, like many other slender or dwarf palm in Madagascar. The species has been recorded from seven localities between Masoala to Ampasimanolotra. This palm is very frequent in the coastal zone within this region, with an elevational range up to 400 m.

13. ***Dypsis pinnatifrons*** Mart.

This is a moderately robust palm of the forest undergrowth. *Dypsis pinnatifrons* is superficially similar to *D. nodifera* in general habit and their identification may be also difficult as they have more or less the same extent in distribution range. However, *D. pinnatifrons* has three stamens and homogenous endosperm while there are six stamens and ruminate endosperms for *D. nodifera*. This palm is widespread. At the moment, there are about 90 herbarium samples collected from 42 locations

across the humid forest, from Sambirano area to Taolagnaro and from sea level up to 1200 m elevation.

14. ***Dypsis poivreana*** (Baill.) Beentje & J. Dransf. (Figs. 6, 7)

This dwarf palm of the understory is relatively common throughout the forest of Analalava. It is endemic to a small area to the north of Toamasina, with the only other known site, lying approximately 30 km north from Analalava, in Tampolo forest (Fenoarivo Atsinanana – not Tampolo, Masoala). In both sites, clumps of this palm are found mostly on flat and occasionally flooded terrain.

15. ***Dypsis psammophila*** Beentje

This is a slender clustering palm known especially from swampy and dune areas behind the shoreline of the Indian Ocean from five extremely fragmented locations between Taolagnaro and Ambohitralanana, east Masoala. *Dypsis psammophila* is a rare species in geographical point of view but it may occur in abundance, especially in the coastal bush. The occurrence of this species in Analalava, growing along a stream, is the first record for this palm in humid forest.

16. ***Dypsis tokoravina*** Beentje

This is one of the most robust solitary palms of the canopy in the rainforest. Only juvenile individuals with their characteristic leaflets, large and arranged in different planes, have been recorded in the Analalava forest. This species has for a long time been thought to be an endemic of the forests surrounding the Bay of Antongil, but recent expeditions have shown that its range extends into Daraina to the north and into Ampasimanolotra area, its southern limit.

17. Dypsis spp.

Three palms belonging to the genus *Dypsis* have not been identified properly. Two of them are slender palms of the undergrowth (Fig. 8); the other is arborescent with conspicuous leaves arranged in three ranks in the crownshaft (Fig. 9). It is possible that they represent undescribed taxa. At the moment, new fertile herbarium specimens are needed in order to establish their identity.

18. ***Marojejya*** sp. (Figs. 10, 11)

This is a rare squat palm of the undergrowth in Analalava, recorded from lower slopes and in swampy areas. Its habit seems to be intermediate between *M. insignis* and *M. darianii*. The upper part of the leaves is neatly pinnate (*M. insignis* character) while the blade of the half lower part is entire (*M. darianii* character). The two species within the genus *Marojejya* are rare: *Marojejya insignis* has a wide distribution range (Marojejy to Andohahela) but no where is it common. *M. darianii* is known only from four locations between Betampona and the Masoala Peninsula; all populations of this species are known from swampy areas. To identify this palm of Analalava correctly, further material is needed, in particular ripe fruit.

8. An unidentified *Dypsis* sp. (Photo: J. Dransfield)

19. ***Masoala madagascariensis*** Jum.

This is a squat palm of the understory with its trunk covered with dead leaf sheath remains. The species is known from nine locations between Marojejy and Analalava. Abundance of this species may vary, depending on the quality of the forest. However, it is a rare palm and in Analalava, only a few mature individuals have been seen.

20. ***Orania longisquama*** (Jum.) J. Dransf. & N.W. Uhl

This is a relatively common canopy palm of the lowland north-eastern rainforest; the

9. An unidentified species of *Dypsis* with unusually swollen sheaths. (Photo: J. Dransfield)

global distribution range extends between Toamasina region and Masoala Peninsula, with outliers in Farafangana and Manakara regions. Individuals are numerous in Analalava forest.

10. *Marojejya* sp., growing in a swampy valley bottom. (Photo: W.J. Baker)

21. ***Orania trispatha*** (J. Dransf. & N.W. Uhl) Beentje & J. Dransf.

This is a canopy palm distinguished by its distichous habit. Its distribution range is quite similar to those of *O. longisquama* (Masoala to Farafangana). This is one of the commonest and most abundant palms in Analalava.

22. ***Ravenea julietiae*** Beentje

This is a rare subcanopy palm known from eight scattered sites between Mananara Avaratra and Farafangana, from sea level to 600 m high. *Ravenea julietiae* is instantly recognised in the forest if it is a female plant. The female inflorescence has a very long peduncle, exceeding the crown. This character is unique within the genus *Ravenea*. As in all other known sites, only a few individuals have been seen in the forest of Analalava.

23. ***Ravenea robustior*** Jum. & H. Perrier

This is a robust canopy palm, present in almost all humid forests between Daraina and Taolagnaro region, from sea level up to 1200 m. Abundance of this species may vary with locality; in Analalava forest it is relatively rare.

24. ***Ravenea sambiranensis*** Jum. & H. Perrier

This sub-canopy palm is one of the commonest and most frequent palms of the

11. Detail of the crown of *Marojejya* sp. (Photo: W.J. Baker)

rainforest in Madagascar. It has been collected 57 times from 28 locations. *Ravenea sambiranensis* has approximately the same distribution range as *R. robustior* in the east of Madagascar but it is also present in Bemaraha and Bongolava mountains, areas bordering the Western region.

25. ***Ravenea*** sp.

A canopy palm looking similar to *Ravenea lakatra* has been found in the forest of Analalava. Since trunked individuals were all sterile during our visit, we have not been able to identify it.

Palms, Conservation and Tourism

Ananalava forest is of great interest for its palms. Not only does this site have high palm species diversity, but many rare palms are also present (e.g., *Dypsis carlsmithii*, *D. hovomantsina*). Palm-lovers and tourists may easily see these species in their natural habitat in Analalava, because the site lies just 7 km from Mahavelona, one of the most visited touristic villages in Madagascar. As a charismatic plant group, palms may help in promoting the conservation of species and landscapes. Furthermore, it is known that ecotourism has the potential to make a substantial contribution to regional development (Boo 1990). Analalava could thus be a model for integrated conservation, tourism and sustainable development.

Analalava site has been managed by the Missouri Botanical Garden since 2005. The Garden aims to find ways to reconcile the imperatives of biodiversity conservation and sustainable local economic development (MBG 2007). MBG together with a local NGO, *Velonala*, and other stake-holders are now developing strategies to achieve this objective. The preparation of all documents needed for the designation of the site as a new protected area is now in progress. MBG intervention in this forest includes research on decision-making for conservation actions, promotion of fuel wood and timber alternatives, restoration of the degraded part of the forest, raising public awareness on fire control and the importance of the biodiversity of the site, as well as the promotion of local economic development by means of the ecotourism. Local people are encouraged to use the forest sustainably by demonstrating that it provides critical ecosystem services, such as ground water, essential for aquaculture and agriculture, and natural resources for daily life. Local people have also been taught to build plant nurseries and propagate native plants. Such activities are recommended by the Convention on Biological Diversity (UNEP 2000) and mentioned as a primary means of achieving conservation. Promoting the use of biodiversity will be of growing importance for maintaining biodiversity in the future decades as human development depends on it (Given 1994). Thus, encouraging people to understand the importance of diversity is essential to balance economic growth and conservation.

Palm conservation in this site thus requires the involvement of the local population, as like everywhere on the east coast palms constitute a vital part of village-level economies in Madagascar (Dransfield & Beentje 1995). Species such as *Dypsis fibrosa, Masoala madagascariensis* and *Ravenea robustior* may be used in thatching in Analalava, seeds of *Dypsis bejofo, D. carlsmithii, Ravenea julietiae* and some others may be collected for generating seedlings or directly selling into horticulture for the national and international markets. This will ensure that palms are protected and local people take advantage of their presence in the forest.

The conservation of palms at this site may also require the conservation of the small population of the white-fronted brown lemur (*Eulemur albifrons*) that survives here. Species of *Eulemur* are known to be excellent seed dispersers of many Malagasy plants with succulent fruits, including palms. It is highly desirable to maintain this service to allow palms to regenerate at new locations away from the parent plants.

Despite such initiatives the Analalava Forest and the palms that it contains will remain threatened by wildfires, selective exploitation of timber and cyclones for the foreseeable future. Several of Analalava's palm species are very rare and localised at this site and could easily be extirpated by such events. It is therefore recommended that the populations of these species should be reinforced by the collection of small quantities of seeds for ex-situ propagation and then planting the resultant seedlings in zones of reforestation. Some seedlings of each species propagated in this way should also be planted in the ex-situ conservation collection for palms at the nearby Parc Ivoloina.

Conclusions

Analalava forest is richer in palm species than any of the other four significant rainforest fragments on the eastern coastal plain (Ambila-Lemaitso, Betampona, Manombo, Tampolo), and, despite an area of just 200 ha, is among the top six palm hotspots in Madagascar. Thus, this tiny, degraded forest fragment is of conservation significance at the national and international level, providing insight into the diversity of palms that formerly occupied this large coastal area. This high diversity is very likely to be reflected in other groups of plants. In drawing attention to Analalava and its palms, we aim to provide additional impetus to the case for its conservation and further promote opportunities, such as ecotourism, that could ensure a sustainable future for the forest.

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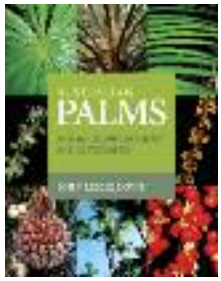
PALM LITERATURE



AUSTRALIAN PALMS: BIOGEOGRAPHY, ECOLOGY AND SYSTEMATICS. John Leslie Dowe. CSIRO Publishing, Collingwood, Victoria, Australia. 2010. ISBN 9780643096158. Price AU$140.00. Soft cover. Pp. 290.

Australia with its offshore territories has 21 genera and 60 species of palm – not a large flora in relation to its size, but one of great scientific interest. Furthermore, Australian palms include some of the most important cultivated ornamental species. John Leslie Dowe has written a book that deals with many aspects of the palms of Australia, and this work will be of lasting value to our knowledge of the flora. It is also a beautiful book, lavishly and consistently illustrated with color photographs and maps throughout. No one knows the palms of Australia better than John Dowe, and so it is excellent that he has synthesized what he knows into this single 290 page volume. All you need to know about Australian palms? – well perhaps not everything, but there is an immense amount of useful information in the book.

The book is divided into two main sections. The first provides a general introduction and a discussion of the history of Australian palm botany, historical biogeography and distribution and ecology. This is followed by the second part, devoted to the systematics of Australian palms, arranged according to the latest generic monograph, *Genera Palmarum Ed. 2*. Finally there is a field key, a checklist, a glossary, bibliography and index.

The chief glory of the book is the thorough illustration of the species. Almost every species is illustrated with high-quality, color photographs illustrating details of habit (and sometimes habitat too), leaves and/or crown, inflorescences, flowers of both sexes and fruit, and a photograph of the type specimen. This is wonderfully valuable in genera such as *Linospadix* and *Archontophoenix* where there are several rather similar species – in fact, these are easily distinguished in the superb photographs.

For each genus and species there is a complete nomenclatural citation, properly typified, a full description, a discussion of distribution and ecology, including conservation status, highly detailed etymology and notes. Genera, and in some instances species too, are placed in a phylogenetic framework, in the case of genera, largely derived from *Genera Palmarum Ed. 2*.

Dowe clearly relishes delving into the minutiae of the etymology of each genus and species. In some places, I feel a simple single phrase would have sufficed. For example, it takes five lines of text to explain the origin of *maxima* under *Archontophoenix maxima*. In one case, *Linospadix* the etymology seems just perverse to me – instead of being derived, as generally accepted, from Greek *Linon*, flax or a thread, and Greek *spadix*, from the slender thread-like inflorescences, Dowe suggests it is from the Latin "*line*," a twelfth of an inch (which in any case should be *linea*) and *spadix*. Wendland, the author of the genus, would have been unlikely to use a macaronic generic name, mixing Latin and Greek roots, and what has a twelfth of an inch to do with the threadlike inflorescence?

Although the text of the systematic part if the book is extremely thorough, there are some loose ends. One is in *Livistona*. An unusual feature of the genus in Australia is the fact that there is variation in sexuality. The author describes two species, *L. concinna* and *L. humilis*, as being dioecious with male inflorescences of a form different from that of the female, and borne on separate trees. No differences in flowers are described or discussed, although close-up photographs of male and female flowers of *L. humilis* are included and do not seem to show any differences. All other species are described as being "functionally dioecious." "Functionally" is superfluous – if a palm is dioecious then it is dioecious – that is its function. Unfortunately, nowhere does John Dowe explain what he means by this. The flowers of all these *Livistona* spp. seem to be hermaphroditic so where does the dioecy enter the story? Could it be that although the inflorescences and flowers appear similar, only certain trees bear fruit, and are hence female, while the others never fruit and are thus male? Is there really no difference in appearance between the flowers? This seems to me to be such an interesting aspect of *Livistona* that I find it surprising and disappointing that there is no discussion at all of sexuality in this genus.

For *Lepidorrhachis*, although John Dowe cites the paper of Baker and Hutton (*Lepidorrhachis*.

Palms 50: 33–38. 2006), he still describes the inflorescences as bearing triads of male and female flowers, and makes no mention of the observations in the Baker and Hutton paper that *Lepidorrhachis* produces unisexual inflorescences (also reported in *Genera Palmarum Ed. 2*), completely missing a very unusual and important character of the genus. This is bizarre when he also uses illustrations taken from the Baker and Hutton paper to illustrate male and female flowers, close-ups that provide strong evidence for the unisexuality of the inflorescences.

I have a few minor quibbles. The flange on the upper surface of the leaf rachis in *Oraniopsis* is certainly not unique – it's also present in *Ceroxylon*, *Nypa* occasionally has a ruminate endosperm (not mentioned) and given the fact that we have a recent monograph of the whole family at the generic level (*Genera Palmarum Ed. 2*), that accepts with good justification 183 genera, it seems rather contrary on page 54 of *Australian Palms* to use a total of ca. 190 genera.

I feel that the field key could have been constructed in a more friendly way that relies less on characters of flowers and fruit. However, even though there is a field key, the format of this book is not designed for it to be taken in the field. The book at 21 × 27 cm and 290 pages means that the covers (paper) are really too thin to support the book, and I doubt it would withstand much fieldwork.

So, for whom has this book been written? It is clearly not a field guide (but, incidentally would provide the perfect basic material for developing a user friendly, pocket-sized field guide in the future, for which, I feel, there would be a real market). The amount of detail in the descriptions suggests that it is aimed at an academic audience, and it will be an invaluable reference. At $140 Australian dollars this is not a cheap book, which is a shame – it is so beautiful and contains so much useful material that it deserves a wide readership among palm lovers, not just academics.

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BRAZILIAN FLORA LORENZI ARECACEAE (PALMS). Harri Lorenzi, Larry Noblick, Francis Kahn and Evandro Ferreira. Instituto Plantarum de Estudos da Flora, Nova Odessa, Brazil. [www.plantarum.com.br]. 2010. 85-86714-35-1. Price $60.00. Hardcover. Pp. 384.

Brazil is the largest country in South America, with a correspondingly large number of different natural habitats, from ever-wet Amazonian rainforest to seasonally flooded plains, cloud forest, dry scrub and grasslands. The palm flora of Brazil is, not surprisingly, just as diverse and is the largest in South America. With the publication of this new book, the number of palm species in Brazil just grew even larger. The new species described in this work (adding to the many that were described earlier this year in anticipation of the book) are *Acrocomia glaucescens*, *Butia catarinensis*, *B. lepidotispatha*, *B. pubispatha*, *Geonoma bondariana*, *G. conduruensis*, *G. littoralis*, *G. meridionalis* and *G. telesana*. New combinations published for the first time are *Acrocomia emensis* and *Butia odorata*. The authors' species concepts are considerably narrower than that used by Henderson et al. in their *Field Guide to the Palms of the Americas* (1995. Princeton University Press). All told, Lorenzi and co-authors recognize 300 species, nearly all of which get a full page treatment in this lavish, large-format (31 × 21 cm) volume.

Too large for a field guide, the book is intended as an identification manual, although there are brief sections on general palm morphology and propagation from seed. A key to the genera of Brazilian palms takes up only two pages of text. The genera and species are then treated alphabetically and make up the bulk of the book. Lorenzi is the author for most treatments, but other genera are treated by Noblick (*Butia*, *Lytocaryum* and *Syagrus*), Kahn (*Astrocaryum*) and Ferreira (*Bactris*).

The glossy photographs that illustrate the species treatments are generally outstanding. Four poorly known *Astrocaryum* species are illustrated by drawings, but each of the remaining 296 species is illustrated by at least one photo of the palm's habit, along with a photo of flowers or fruits and a small but useful distribution map. Readers familiar with Lorenzi's work will recognize his blue grid

background for the photos of flowers and fruits. What these compositions lack in artistry they make up for in utility. The habits and parts of small palms, such as many understory *Geonoma* species, were photographed with a black backdrop that shows off the palms to good advantage.

As an identification manual, the book is largely successful. The keys to the species, coupled with the photos, locality data and descriptions of major features, should facilitate naming an unknown palm. The "major features" section for each species could be more succinct and thereby more user-friendly. For example, is it necessary to describe every species of *Attalea* as having pinnate leaves? Surely that information is in the genus description and does not need to be repeated for every species. The species treatments also provide common names, information on uses and notes on propagation (including for many species, the number of seeds per kilogram – without doubt useful information for the commercial nurseryman). On the other hand, the treatments also include more technical details than one expects in a book of this sort, e.g. citation of original publication, synonymy and at least one voucher specimen. These extras do not detract from the book, but one wonders if they are necessary in pages that are already crowded with text and illustrations.

Overall, I can recommend this book to anyone wishing for an accessible account of the palms of Brazil. It is good value for money. The treatments of the large genera, such as *Geonoma*, *Bactris* and *Astrocaryum* – genera that are not often seen in gardens – are especially fascinating, as are the seldom-seen *Barcella odora* and *Dictyocaryum ptarianum*. I found the photos of the grass-mimicking *Butia* and *Syagrus* species to be especially interesting, and now that grasses are no longer fashionable among arbiters of garden design, I mused on creating a "prairie" of palms. For those of us not privileged to see these palms in the wild, this book will fuel the desire to see them enter the trade and become available to growers throughout the world. The palms of Brazil, as this book amply illustrates, are too beautiful to ignore.

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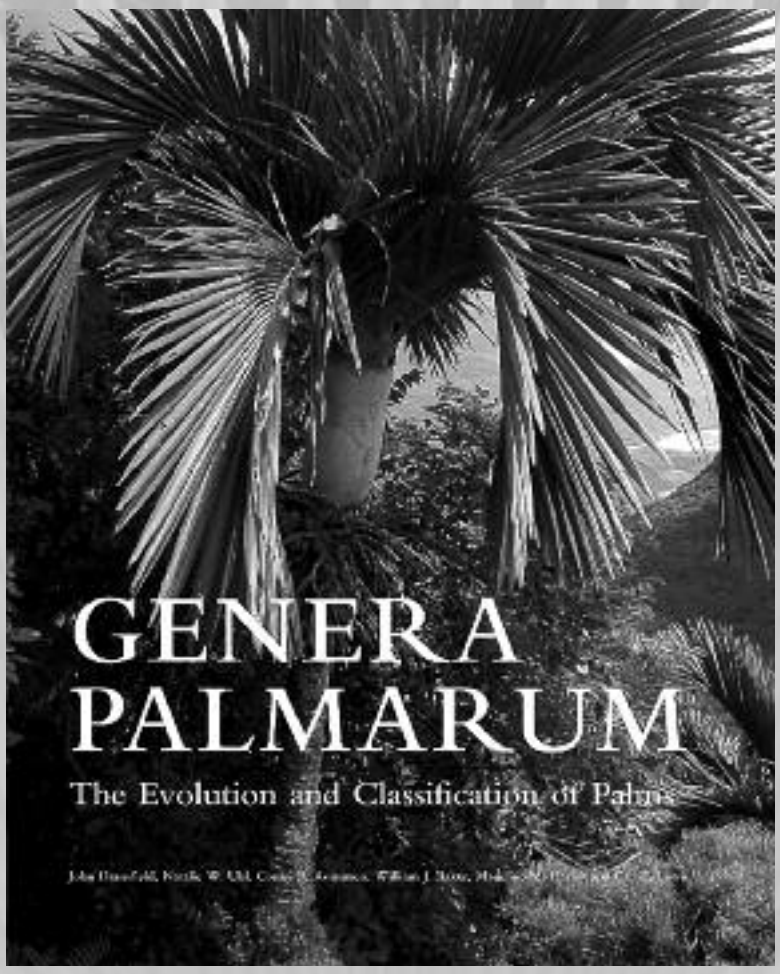

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