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PALM NEWS

La Société Palmophile Francophone, the French Palm Society that publishes the journal *Princeps*, has announced that its forum, www.forum-palmiers-spf.org, is now accessible via a free app for smartphones and tablets. **The French Palm Society's forum is now available on the Topic'it platform for mobile devices**. The Topic'it app is available for free on the Play Store and the App Store. The forum allows users to take part in on-line discussions, post photos and videos and communicate via private messages.

We are saddened by the recent passing of two IPS members. Ralph Velez was a long-time member of the IPS and the Palm Society of Southern California. He passed away on April 24th after a long illness. His boundless passion for palms and his species-rich garden will be long remembered by all of us who knew him. Lucinda McCartney passed away unexpectedly on April 25th. Lucinda was an active participant on recent IPS Biennials, and her warm spirit and kind nature will be greatly missed.

The beautiful botanic gardens at Gothenburg, Sweden, played host to the **annual meeting of EUNOPS** 12–13 May 2018. The European Network of Palm Scientists this year drew participation from throughout Europe, as well as North America, with a wide range of informal talks and discussions touching on palm taxonomy, phylogeny, ecology, conservation and pollination. Next year's meeting will, it is hoped, be held in Paris, France. Watch the EUNOPS website (www.eunops.org) for further details.

Blanca Martinez, María José Sanín, Luiz Santiago Castillo, René López and Rodrigo Bernal, working in Colombia, have documented **sex change occurring in the dioecious palm, *Ceroxylon quindiuense***. Sex changes have rarely been seen in dioecious palms (but see M. Dahme's note on *Kerriodoxa elegans*, *PALMS* 61: 135–137. 2017). The researchers reported that, at one site, females outnumber males two to one and that two individuals had produced male inflorescences before producing female inflorescences. It is not known if these two individuals underwent a one-time change, or if they may switch back to male in the future. The report appears as a short note in the journal *Ecology* (https://doi.org/10.1002/ecy.2171).

Botanical exploration of Vietnam continues to yield palms new to science. Dr. Andrew Henderson and Nguyen Quoc Dung recently published **six new taxa of *Calamus* from Vietnam** in the e-journal *Phytotaxa* (347: 251–262. 2018. http://dx.doi.org/10.11646/phytotaxa.347.4.1). The five species and one subspecies are described and illustrated. These remarkable discoveries were made possible, in part, by support to Dr. Henderson from the IPS Endowment Fund. Pictured is the aply named *Calamus cinereus*.


Andrew Henderson

Notes on *Borassus aethiopum* Mart., a Multi-Purpose Palm in Togo and Benin

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Borassus aethiopum Mart., known in many African countries as _rônier_ or _cocker_, represents one of the most important palm resources in western parts of the continent. The present notes aim to provide updated information on the species, in particular presenting new data on its morphology and ecology gathered between 2014 and 2015 during an inventory of the native palms of Togo and Benin. The main uses recorded for this palm are described here, emphasizing the trade and human consumption of the cotyledonary petiole, a relatively unknown use of a morphologically complex organ emerging from the seed. Although ranking among the most important palms in West African countries, the species faces significant threats of overexploitation and destruction of natural habitats.

The West African countries of Togo (8°N, 1.1°E) and Benin (9.3°N, 2.15°E) occupy an important part of the widely known Dahomey Gap, an unusually dry region of West Africa extending from the Accra plains in Ghana to south-western Nigeria. The forested zone of West Africa is there interrupted and divided into two blocks, the Upper Guinean Forests extending west of the gap and the Lower Guinean forests extending east of the gap. The region is characterized by extensive coastal and inland savannas, as well as dry forests sustaining a characteristic palm flora. The first author undertook a project aiming to study floristics, structural botany, ethnobotany and phytogeography of the native palms from Togo and Benin, countries that beside few exceptions (i.e. Profizi 1983, 1986a, 1986b) had been poorly studied with respect to their palm flora. As a result of our two field missions, almost 100 herbarium samples were gathered in the two countries, representing one of the most important palm sampling efforts ever undertaken in West Africa; ten species distributed in eight genera and three subfamilies were recorded for the two countries. The palm inventory revealed that most palms were fundamental for local human populations in rural areas, but *Borassus aethiopum* was identified among the most abundant and economically important species in Togo and Benin.

The palm inventory that the Conservatory and Botanic Gardens of Geneva is currently undertaking in West Africa (Da Giau 2014, Ouattara et al. 2015, Michon 2017, Stauffer et al. 2017) has confirmed that *Borassus aethiopum*, together with the oil palm (*Elaeis guineensis*) and several species of *Raphia* and rattans (*Eremospatha*, *Laccosperma*), provide abundant food and construction material for local populations. Several authors (e.g. Mollet 1999, Bayton 2007) have reported that this palm is used for wine production, and this activity may severely threaten wild populations of this species in some West African countries (Sambou et al. 2002). The fruits are reported to be eaten in Guinea-Bissau (Diniz & Martins 2002) and the same has been observed by us in countries such as Senegal, Ivory Coast, Ghana, Togo and Benin. A comprehensive description of the uses of this palm in Africa was provided by Giffard (1967) and Burkill (1997). The second species of *Borassus* identified in continental Africa (*Borassus akeassii* Bayton, Ouédr. & Guinko) has been reported by Bayton (2007) as used in Burkina Faso for wine production, the unripe endosperm consumed and the leaves used for thatch and weaving. Non-palm experts are rarely aware of the slight morphological differences between the two species, and misidentification of these palms in several published papers is very possible.

This paper compiles recent studies and offers updated information on the morphology and socio-economic importance of *Borassus aethiopum* in Togo and Benin. It also discusses some concerns with respect to the conservation of wild populations due to overharvesting and destruction of natural habitats.

Morphology of *Borassus aethiopum*

During our field work in Togo and Benin, we found only *Borassus aethiopum*. *Borassus akeassii* was not spotted in the northern regions of these countries, despite having been reported in Benin by some authors (Aké Assi & Guinko 1996, Govaerts et al. 2017) and having been observed by Ross Bayton (pers. comm.) in Arly National Park, Burkina Faso, just over the border from northern Benin. Our study of the morphological diversity of the palm based on extensive sampling of male and female individuals confirms that the species is rather homogeneous. A general description of this palm collected in Togo and Benin is provided here and aims to complement the description published by Bayton (2007), in particular with respect to the reproductive organs.

Borassus aethiopum is a solitary, robust, tall, pleonanthic, dioecious and armed palm (Fig. 1A). The stems are gray to pale gray, 15–25 m in height, up to 60 cm in diameter at one meter in height, hard, bearing leaf sheath scars forming rings; a swollen part is present at approximately 2/3 of its height then shrinking below the leaf crown; the stem is sometimes covered by remnant old leaf sheaths (especially on young individuals) (Fig. 1B), then falling off when aged and leaving on the stem 2–4 cm thick scars.

The leaves of this palm are costapalmate, and plication is induplicate; the leaf sheaths are robust, gray to dark-brown, stiff, sometimes fibrous at the base, splitting longitudinally from juvenile stages and producing a wide triangular cleft, with fibrous edges and armed margins (Fig. 1C); the petioles are brown-gray at the base to yellow-green towards the top, smooth, abaxially rounded, adaxially

1. Vegetative morphology of *Borassus aethiopum*. **A**. Massive growth habit of the palm in the coastal savanna of Benin (beyond Fidjrossè, west of Cotonou); **B**. Juvenile individual with stem entirely covered by leaf sheaths; **C**. Lower view of the crown showing the characteristic longitudinal cleft of the leaf sheaths; **D**. Loïc Michon holding a large leaf blade supported by a long petiole.

channeled, margins brown to dark, strongly armed with 1.5–2 cm long, irregular brown-black, flat, forward-facing spines; the hastula is well differentiated, abaxially rounded and adaxially pointed; the leaf blade is up to 3.5 m long and 2.5 m in width, divided towards the middle into up to 100 regular segments, reaching ca. 80 cm long, 10–12 cm in width, slightly bifid at the apex, prominent midrib abaxially, secondary transverse veinlets are often visible, interfold filaments dark brown, up to 60 cm long (Fig. 1D).

The inflorescences are interfoliar and unisexual; the staminate inflorescences are shorter than the leaves, cylindrical, 45–55 cm

long, branched to 2 orders (Fig. 2A); first order branches are flattened and the prophyll is 2-keeled and with a long tubular base; the peduncle is very short, similar to the rachis; the latter subtended at different levels by tubular rachis bracts; the rachillae are 1–3 in number, elongate, spike-like, 30–35 cm long, 1.5–2.5 cm in width, tightly covered with spirally imbricate and fused bracts; each bract subtending numerous flowers. The male flowers emerge from pits, several buds at different stages are arranged in a cincinnus; the staminate flowers are yellow to brown at the apex; the calyx is composed of 3 sepals that are elongate, membranous, asymmetrical and stiff; the corolla is 3-lobed; the 6 stamens present short and triangular filaments, the anther is medifixed, elongate, with lateral dehiscence; a small and conical pistillode is present in the center of the flower. The pistillate inflorescence is spicate or rarely 1-branched and with a short peduncle; the prophyll is tubular, 2-keeled and pointed; the peduncular bracts are 2 or more, often longer than the peduncle itself; the rachillae are massive; the pistillate flowers are in turn

2. Reproductive morphology of *Borassus aethiopum*. **A**. Detail of male rachillae at full anthesis; **B**. Infructescence at maturity; **C**. Ripe fruit ready to be opened by one of our field guides in Dapaong (northern Togo); **D**. The edible jelly endosperm is highly appreciated by local inhabitants in Benin.

subtended by 2 small bracteoles; the calyx is composed of 3 imbricate, thick and rounded sepals; the corolla is composed of 3 imbricate, thick and rounded petals; triangular staminodes may be present, sometimes developing a sterile anther; the gynoecium is 3-carpellate, syncarpous; each carpel contains a single basal ovule.

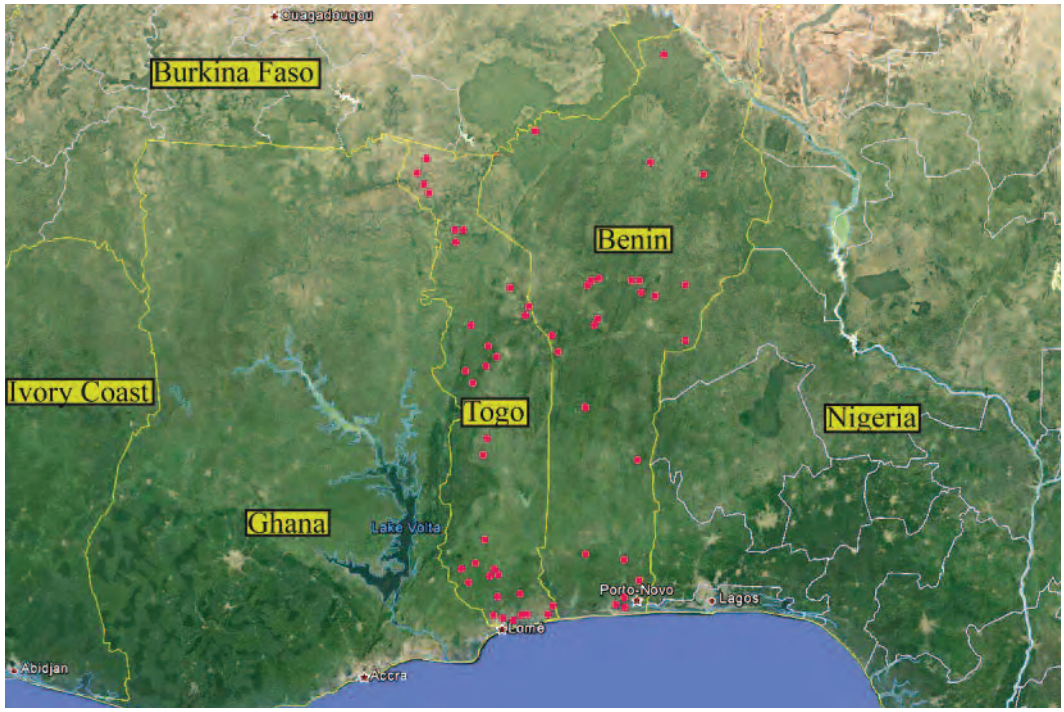
The fruits of this palm are large, yellow to orange in development, orange with brown areas when ripe, up to 20 cm long and 15 cm in width, sometimes larger, rounded to oblong; the well-developed perianth is persistent at the base of the fruit; the epicarp is smooth, the mesocarp fibrous and fragrant, and the endocarp is hard (Figs. 2B & C). The pyrenes are 1–3 in number, ovoid, 11 cm long and 9 cm in width, slightly flattened and covered by brown, stiff fibers, with a fleshy endosperm (Fig. 2D) becoming hard when ripe. The eophyll is entire and linear, and the cotyledonary petiole is 45–52 cm long, subterranean, emerging from the pyrene at the distalmost region; the main root emerges at the base of the cotyledonary petiole.

Distribution and ecology of *Borassus aethiopum* in Togo and Benin

In Togo and Benin the species has a wide distribution and can be found from the coastal areas in the south to the very dry savannas and gallery forests of the north, where its abundance largely increases (Fig. 3). Human populations interviewed claim that this palm is not cultivated; however, our observations confirm that it is at least encouraged in its growing as the juveniles of this species present in crop fields are normally not removed because of the diversity of uses reported for the palm. In Togo, the species was observed forming dense stands near the village of Agové in the south of the country (Fig. 3) and a true plantation of this palm was observed on both sides of the road RN1 between Mango and Dapaong, beyond the Barkoassi forest. According to our observations this man-made plantation formed a true palm grove and appeared to be actively exploited (Fig. 4). In the village of Tileka on the road to Mango we observed a very young population, apparently planted by a local farmer for the valuable edible fruits. The palm is so important economically for locals in Togo that a district of the Togolese capital of Lomé is called Ago and a village near the capital is called Agové, making in both cases reference to the name of the palm in Ewé dialect.

The distribution of the species in Benin is now known in great detail as result of an in-depth inventory of the populations undertaken by

3. Distribution of *Borassus aethiopum* in Togo and Benin. Red dots indicate the localities where the palm was collected or observed. Additional data was extracted from the study of Salako et al. (2015).



4. Plantation of *Borassus aethiopum* in Togo. A. Large plantation of the palm associated with bean, tomato and yam crops (region between Mango and Dapaong, northern Togo).

Gbesso et al. (2014) and Salako et al. (2015). The presence of the palm in most areas of the country was confirmed by us using geo-referencing methods (Fig. 3). Our observations in central Benin showed that the species is well represented near Savè and Glazoué and clearly more abundant in the south-central region of the country. The species is rare but can be observed in the coastal areas, and according to the observations of Salako et al. (2015), the highest densities can be observed more to the north. The same authors identified *Borassus aethiopum* as the best indicator of natural habitats in Benin (Fig. 3). The wide distribution of this palm in the northern part of the country could be partially explained by the fact that fruits are known to be consumed by elephants (*Loxodonta africana*) (Arbonnier 2002, Azihou et al. 2013), which are relatively common in the region.

In the framework of our study, we could not identify any specific pollinators for the palm; however, Thione (2000) identified insects such as *Chrysomya* sp. and *Rhinia apicalis* (Diptera) and *Apis mellifera* and *Nomia* sp. (Hymenoptera) as potential pollinators of the palm. The same author pointed out that 73% of pollination in this palm may be associated with entomophily, whereas anemophily would be responsible for only 23% of pollination (4% was unknown). In dry savannas *B. aethiopum* was often observed associated with the presence of Little Weaver birds (*Ploceus luteolus,* Ploceidae), which use leaflet fibers to make their hanging nests on the crown of the palm.

Main uses

Borassus aethiopum is widely used and highly important for populations in rural areas throughout Togo and Benin. Here we present the most common uses of this palm recorded during our field missions and we complement these data with recent publications. Uses of the palm can be clearly classified as construction and handicraft manufacture, human consumption and medicinal uses.

Construction and handicraft manufacture

The palm stem is used locally for house construction, usually once processed into planks, boards or beams. Most people consulted confirmed that the wood from this palm was of very high quality and resists attacks by fungi and termites; however, the swollen part of the stem is typically not used as it is believed to be of lesser quality. Construction material obtained from adult male individuals is reputed to be more resistant than that obtained from female individuals (Cabannes et al. 1987, Jatau 2008). The leaf segments are woven and transformed into mats and used in basketry; fans made of leaf

5. Harvest of the cotyledonary petiole in a field neighboring road RNIE5 Glazoué-Savè (Benin). **A**. The cotyledonary petiole is deeply buried in sandy areas, from where it is extracted by A. Kifouli (left) and E. Eben-Ezer (right); **B**. The long subterranean seed appendix is deeply sunken and permanently hidden from sunlight; **C**. Example of cotyledonary petioles at different stages of development; the one at the right is already too old and hence not suitable for sale.

segments of this palm are used to rekindle cooking fires. The petiole is occasionally carved as a large spoon to mix sorghum beer. In southern Togo, we also observed the production of hats and sieves using leaves from *B. aethiopum*.

Human consumption

In Togo and Benin, the cotyledonary petiole of *B. aethiopum* is highly appreciated and of great economic importance in rural markets. As in other related genera, this organ consists

6. Preparation and trade of the cotyledonary petiole (town of Savè on the road RNIE5, Benin). **A**. Women are in charge of peeling and boiling the cotyledonary petioles in water; **B**. Large amounts of this product are prepared in order to satisfy local demand; **C**. Cotyledonary petioles ready to be packed and sold in the town of Savè; these products are also transported to the street markets of Cotonou.

of an extension of the cotyledon emerging directly from the seed and presenting positive geotropism as typically shown by roots. As cotyledonary petioles are deeply buried on well-aerated sandy soils, their harvesting is carried out by men (Figs. 5A–C), whereas women are in charge of the preparation and sale of the product (Figs. 6A–C). The cotyledonary petiole becomes tender and edible once it has been peeled and boiled; afterwards, it is sectioned in pieces of 10–15 cm long (Fig. 6C). The slightly bitter taste of this product is very much appreciated by local inhabitants. In Benin, this organ is the main product commercialized from the palm and it is an important contribution to family incomes in rural areas. Indeed, we were told that some families were able to send their children to

school thanks to the money obtained from this harvest. Trade of small packs of this product in local street markets in Benin ranges between 50–150 West African francs or CFA francs (0.07–0.25 €), depending whether it is sold cooked or raw. A standard pack sold on the street contains 3 or 4 slices of boiled cotyledonary petiole intermixed with some pieces of coconut flesh; according to locals, the latter is added to reduce the bitterness of the cotyledonary petioles. In some areas of Benin (Savè and Glazoué), the trade in this product was estimated to represent 90% of the income of women, with relatively good margins for the producers. According to our informants the income for producers may range between 34,500–54,660 CFA francs/month (52–83 €/month) and between 25,000–120,000 CFA francs/month (38–182 €/month) for local sellers. Also in Benin, the cotyledonary petiole is ground to a powder and transformed into local couscous, or mixed with maize flour to prepare local food. According to Gbesso et al. (2013) and our own observations, the commercialization of this product includes three main activities: 1) fruit harvesting (from early January), 2) seed planting (from March), and 3) harvesting of the cotyledonary petiole (six to seven months after plantation). Despite the fact that locals in the Savè and Glazoué areas (Central-East Benin) attribute great economic importance to the trade of the cotyledonary petiole for food purposes, no real efforts were observed towards its promotion or cultivation on a commercial scale. The packs of cotyledonary petioles are mainly sold along the roads near production sites, though one can find some resellers in bigger market places in the city of Cotonou. The same was observed in Togo, where fruits and seedlings of *B. aethiopum* are brought to the markets in Lomé from the countryside in the northern part of the country.

The fruits of this palm are prepared in many different ways and offer abundant benefits to local inhabitants of the two countries. In Togo, fruits are eaten raw, boiled in salty water or peeled and then cooked on fire or embers. In Benin the endosperm of unripe fruits is eaten mainly by children, the latter considering it as a kind of candy. Its taste is very sweet and refreshing, closely resembling the flesh of a young coconut (Fig. 2D).

From the fibrous mesocarp of the ripe and unripe fruits is obtained a refreshing juice drink. The flavor is rather bitter and closely resembles carrot juice. Indeed, locals claim that the juice obtained from the mesocarp is rich in vitamin C and potassium. The liquid endosperm from unripe seeds is drunk and called "eau de coco" (coconut water); meanwhile the sweet jelly endosperm from partially ripe seeds is consumed like coconut. In local markets, the seeds are sold for planting or human consumption; around 1,500 CFA francs (approx. 2.30 €) for two big bags of seed, representing 20–25 kg each. Surprisingly, unlike in other West African countries, palm wine consumption was not recorded in either Togo or Benin. However, the study of De Souza (2008) and our records of common names associated with palm wine extraction in Benin (*ekiko*, *ogoro* or *oguro*, meaning "palm wine" in Yoruba and Nago) may suggest that this practice is still employed in some areas of the country. The entire fresh ripe fruits are placed in houses to repel shrews, which according to locals do not like the strong fragrance emanating from the fleshy mesocarp.

Medicinal uses

We were able to record a diversity of medicinal uses in the region of Savè (Benin). The petiole is mixed with oil palm seeds in "fermented water." This mixture is then crushed, filtered and finally drunk as treatment for malaria. According to some of our informants, the roots of the palm are mixed with roots of the lemon tree to accelerate teeth growth in babies. Also in Benin and according to Gbesso et al. (2016) the young cotyledonary petioles are dried, sliced and pickled in alcohol to be used as aphrodisiac. In Togo, the seeds are ground to powder and used to treat asthma and dementia. In the Maritime Region of this country, the leaves of this palm are used in a decoction against malaria (Koudouvo et al. 2011).

Conservation notes on *Borassus aethiopum* in Togo and Benin

Our observations during the field trip to Benin and Togo showed that there is an important ageing of the population, a phenomenon Neuenschwander (2011) attributed to excessive fruit collection. Although this palm appears to be somehow adapted to fire at early stages of development, our observations in Benin suggest that the survival of young individuals was severely hindered due to frequent human-induced fires associated with land clearance for crop production (Fig. 7).

7. Threats to *Borassus aethiopum* in Togo and Benin. One of the main threats to this palm is human-induced fires, expanding the agricultural areas surrounding villages, as well as the slash-and-burn farming system.

Only in the Savè area (Benin), where the trade in cotyledonary petioles has become an important commercial activity, traditional cropping systems are progressively abandoned by local farmers to allow the germination of *B. aethiopum* seeds. Seeds that are not sold are left in the field and germinate successfully, guaranteeing the re-establishment of natural populations. In northern Togo, our observations of extensive plantations on both sides of the road RN1, between Mango and Dapaong and beyond the Barkoassi forest, suggest that conservation of the palm in this area is of lower concern. According to locals and the chief of the village of Agové, wild populations in Togo were supposed to occur and form much denser palm stands in areas near the village of Agové (Maritime Department). From these palm stands, almost nothing has been left and only a few individuals were observed during our study.

Final remarks

Our preliminary observations in the field confirm that *Borassus aethiopum* is an important, multi-purpose resource for rural populations in Togo and Benin, its natural regeneration in the region also playing a major role increasing biological diversity given its importance in the ecosystem (Gbesso et al. 2014). Our studies in several West African countries show that the species is morphologically homogeneous. However, population diversity needs to be assessed at a fine scale in order better to understand inter-population variability and the effects of domestication, as reported in Senegal and Burkina Faso, on the morphological diversity of the palm. Locals in West Africa seem readily able to distinguish *B. aethiopum* from *B. akeassii* (Sambou, pers. comm.). From our point of view this should be further explored with the aid of population genetic tools. Such studies could potentially demonstrate that *B. akeassii* is embedded within a more widely interpreted *B. aethiopum*. Alternatively, if studies support their recognition as separate species, then it would be interesting to explore whether or not they form hybrids in overlapping regions.

Several authors have pointed out the great economic potential of *B. aethiopum* for the human populations of the Sudano-Guinean zone of Benin; however, the implementation of management plans aiming to guarantee the sustainable exploitation of the palm have not been proposed here. Research undertaken in Burkina Faso has played a leading role in West Africa, as it has provided critical data on the

food, economic value and some methods of preservation of the species (Yaméogo 2007, Kansolé 2010). Production of palm wine from *B. aethiopum* is currently not or only marginally practiced in Benin and Togo and this has preserved some native populations from massive destruction. Indeed, the methods employed so far in other countries (i.e. Ivory Coast, Ghana, Senegal and Burkina Faso) have been identified as highly destructive, leading to the palm's death because the apical meristem is severely damaged. Promising new methods tested in Burkina Faso and Senegal (i.e., Niang 1976, Maydell & Götz 1985, Mollet et al. 2000) appear to indicate that the survival of wild populations *of B. aethiopum* is possible through the implementation of sustainable methods of exploitation. The active exploitation of the cotyledonary petiole for commercial purposes in Togo and Benin, although clearly interesting from an economic perspective and representing an important contribution for the family income in some regions, remains a potentially threatening activity for wild populations, in particular if all seeds from a population are extracted for commercial purposes. The impact of this activity on the survival of the populations should be quantified and specific measures proposed to guaranty a sustainable extraction of material for sexual reproduction.

Although the conservation status assessment of *B. aethiopum* in Togo and Benin is a challenging task given its wide distribution, local populations may already be regarded as vulnerable or threatened and some of the economically useful genetic diversity could be at risk if no governmental efforts are undertaken in the short term. Indeed, the Benin Red List of threatened species (Adomou et al. 2011) considered this palm as vulnerable as a result of excessive fruit harvest for human consumption; Neuenschwander (2011) pointed out that the species was already threatened due to the overexploitation of the fruits and the seeds. A well-document species-level conservation assessment of this palm is urgent and highly necessary for the implementation of conservation policy at the national level. Human populations, in particular those inhabiting the harsh conditions in the Sahel region, have always relied on *B. aethiopum*. Domestication efforts, characterization of the genetic diversity of wild populations and reconstruction of past and current uses for the palm represent key elements for the establishment of management plans that will guarantee the survival of this important resource for the future generations.

Acknowledgments

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Literature Cited

Adomou, A.C., O.P. Agbani and B. Sinsin. 2011. Plantes. Pp. 21–46, in Neuenschwander, P., B. Sinsin and G. Georgen (Eds.). Protection de la Nature en Afrique de l'Ouest: Une Liste Rouge pour le Bénin. International Institute of Tropical Agriculture, Ibadan, Nigeria.

Aké Assi, L. and S. Guinko. 1996. Confusion de deux taxons spécifiques ou subspécifiques au sein du genre *Borassus* en Afrique de l'Ouest. Pp. 773–779, in van der Maesen, L.J.G.X., M. van der Burgt and R. van de Medenbach (Eds.). The Biodiversity of African Plants: Proceedings of the 14th AETFAT Congress.

Arbonnier, M. 2002. Arbres, Arbustes et Lianes des Zones Sèches d'Afrique de l'Ouest. CIRAD; MNHN; UICN; 2ème édition, Artecom (89, Pont-sur-moyenne), France, 573 pp.

Azihou, A.F., R. Glèlè Kakaï, R. Bellefontaine and B. Sinsin. 2013. Distribution of tree species along a gallery forest–savanna gradient: patterns, overlaps and ecological thresholds. Journal of Tropical Ecology 29: 25–37.

Bayton, R.P. 2007. A revision of *Borassus* L. (Arecaceae). Kew Bulletin 62: 561–586.

Burkill, H.M. 1997. The Useful Plants of West Tropical Africa (Families M–R). Kew: Royal Botanic Gardens.

Cabannes, Y., G. Chantry and V. Willemin 1987. Le Rônier et le Palmier à Sucre: Production et Mise en Oeuvre dans l'Habitat. Dossier Technologie et Développement, Ministère de la Coopération, Paris. 92 p.

Da Giau, S. 2014. Studies on the Ethnobotany and Structural Biology of Palms (Arecaceae) in Ivory Coast. University of Geneva, Switzerland.

De Souza, S. 2008. Flore du Bénin, tome 3. Noms des Plantes dans les Langues Nationales Béninoises. Imprimerie Tundé. Cotonou. 2ème édition.

Diniz, M.A. and E.S. Martins. 2002. Palms of Guinea-Bissau: their utilization. Garcia de Orta. Série de Botânica 16: 39–49.

Gbesso, F., G. Akouehou, B. Tent and A. Akoegninou. 2013. Aspects technico-économiques de la transformation de *Borassus aethiopum* Mart (Arecaceae) au Centre Bénin. Afrique Science 9: 159–173.

Gbesso, F., H. Yedomonhan, B. Tent and A. Akoegninou. 2014. Distribution géographique des populations de rôniers (*Borassus aethiopum* Mart, Arecaceae) et caractérisation phytoécologique de leurs habitats dans la zone soudano-guinéenne du Benin. Journal of Applied Biosciences 74: 6099–6111.

Gbesso, F., A. Adjatin, A. Dansi and A. Akoegninou. 2016. Aphrodisiac properties of hypocotyls extracts of *Borassus aethiopum* Mart. (Arecaceae) collected in Central of Benin Republic. International Journal of Current Microbiology and Applied Sciences 5: 802–814.

Giffard, P.L. 1967. Le palmier rônier *Borassus aethiopum* Mart. Bois et Forêts des Tropiques 116: 3–12.

Govaerts, R., J. Dransfield, S. Zona, D.R. Hodel and A. Henderson. 2017. World Checklist of Arecaceae. Facilitated by the Royal Botanic Gardens, Kew. Published on the Internet; http://wcsp.science.kew.org Retrieved 25 September 2017.

Jatau, D.F. 2008. Profitability assessment of *Borassus aethiopum* Mart. marketing in Adamawa State, Nigeria. Journal of Agriculture & Social Sciences 4: 159–164.

Koudouvo, K., D.S. Karoua, K. Kokou, K. Essien, K. Aklikokou, I.A. Glitho, J. Simpore, R. Sanogo, C. De Souza and M. Gbeassor. 2011. An ethnobotanical study of antimalarial plants in Togo Maritime Region. Journal of Ethnopharmacology 134: 183–190.

Maydell, H.J. and E. Goetz. 1985. Palmen in agroforstlichen Landnutzungsystemen, Beitrag zur Weltforstwirtschaft 5, World Forest Miscellanea 5: 41–143.

Michon, L. 2017. Contribution to the study of West African palms (Benin, Togo) and structural studies in *Hyphaene* (Coryphoideae, Borasseae). Master's thesis, Université de Genève, Conservatoire et Jardin botaniques de la Ville de Genève Pp. 1–214.

Mollet, M. 1999. L'Utilisation Durable des Palmiers *Borassus aethiopum*, *Elaeis guineensis* et *Raphia hookeri* pour l'Extraction de Vin de Palme en Côte d'Ivoire: Tropenökologisches Begleitprogram – TÖB, FTWF- 12f: 1–69.

Mollet, M., F. Herzog and Y. Behi. 2000. Sustainable exploitation of *Borassus aethiopum*, *Elaeis guineensis* and *Raphia hookeri* for the extraction of palm wine in Côte d'Ivoire. Environment, Development and Sustainability 2: 45.

Neuenschwander, P., B. Sinsin and G. Goergen (Eds.) 2011. Protection de la Nature en Afrique de l'Ouest: Une Liste Rouge pour le Bénin. Nature Conservation in West Africa: Red List for Benin. International Institute of Tropical Agriculture, Ibadan, Nigeria. 365 p.

Niang, M. 1976. The ronier-palm (*Borassus flabellifer*) in the Thies (Senegal) region: geographical study. Notes Africaines 147: 77–82.

Ouattara, D., P. Ekpe, A. Bakayoko and F.W. Stauffer. 2015. Ethnobotany and conservation of palms from Ghana. Palms 59: 85–103.

Profizi, J.P. 1983. Contribution à l'étude des palmiers *Raphia* du sud-Bénin. Botanique, écologie et ethnobotanique. Thèse de troisième Cycle d'Écologie. Université de Montpellier, France.

Profizi, J.P. 1986a. Notes on West African rattans. RIC-Bulletin 5: 1–3.

Profizi, J.P. 1986b. Biologie et modes de gestion des marécages à *Raphia hookeri* Mann & Wendl. au Sud-Est du Bénin. Journal d'Agriculture Traditionnelle et de Botanique Appliquée 33: 49–58.

Salako, V.K., A.E. Assogbadjo, A.C. Adomou, C. Agbangla, and L.R. Glèlè Kakaï. 2015. Latitudinal distribution, co-occurring tree

species and structural diversity of the threatened palm *Borassus aethiopum* (Arecaceae) in Benin, West Africa. Plant Ecology and Evolution 148: 335–349.

SAMBOU, B., A. GOUDIABY, F. ERVIK, D. DIALLO AND M.C. CAMARA. 2002. Palm wine harvesting by Bassari threatens *Borassus aethiopum* populations in north-western Guinea. Biodiversity & Conservation 11: 1149–1161.

THIONE, L.A. 2000. Biologie de la reproduction et étude de l'impact de l'exploitation des feuilles et des fruits sur la productivité de *Borassus aethiopum* Mart. PhD dissertation, Cheikh Anta Diop University, Dakar.

PALM LITERATURE

PALMS OF CUBA – Raúl Verdecia Pérez, Florida Keys TREE Institute. 2017. Softcover booklet, in English and Spanish. Price: $10 plus $2.95 shipping and handling. 24 pages. Contact info@treeinstitute.org.

Cuba has an extremely rich palm flora for the size of the country, with 98 taxa in 15 genera currently recognized. Eighty-five of these taxa are endemic to Cuba. With such diversity occurring in an area roughly the size of Guatemala or Pennsylvania, it does not take much roaming to come across several palm species in a relatively short time.

Palms of Cuba, by Raúl Verdecia Pérez, is intended as a reference guide for visitors traversing Cuba so they may be able to determine the various palms they encounter. Raúl is the top palm researcher in Cuba, and funding for his travels throughout Cuba to gather information and take photos for this work was partially paid through an IPS grant. Additional funding was provided by the Florida Keys TREE Institute. This booklet treats four taxa per 8.5×11-inch (21.6×28 cm) page. There are generally three photos of each palm showing an overall view, with additional detail photos of its infructescence, leaf base fiber, leaf close-up or some other identifying detail. Common local names and/or English names, distribution, habitat and a very brief description accompany each taxon in both English and Spanish. The photos are quite small but are adequate for the scope of this booklet.

Taxonomic work has increased in Cuba in the last two or three years, and there are three recently described taxa not included. They are *Coccothrinax spirituana, Coccothrinax* x *angelae* and *Copernicia* x *dahlgreniana*. There are also a couple of name changes that have occurred. *Coccothrinax miraguama* subsp. *arenicola* has just very recently been changed to *Coccothrinax acuminata*, which would not have been known at the time this booklet was written. The other

is *Bactris cubensis*, which was split out from *Bactris plumeriana* a few years back after being lumped together for a short time. While it is surprising a couple of these taxonomic changes were not incorporated in this work, it is likely only a handful of people will ever notice. These omissions do not detract from the usefulness of *Palms of Cuba*. I know this booklet would have been very useful in my travels throughout Cuba, and I believe anyone wanting to explore palms in Cuba would find it an extremely useful guide as well as to help increase his/her general knowledge of Cuban palms. *Palms of Cuba* is a welcome addition to our knowledge of these diverse and beautiful Cuban species. It was designed to be a quick reference guide, and it achieves its goal admirably.

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Lemurophoenix laevis

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A second species of the endemic Madagascar palm genus, *Lemurophoenix*, is described from cultivation in Hawai'i.

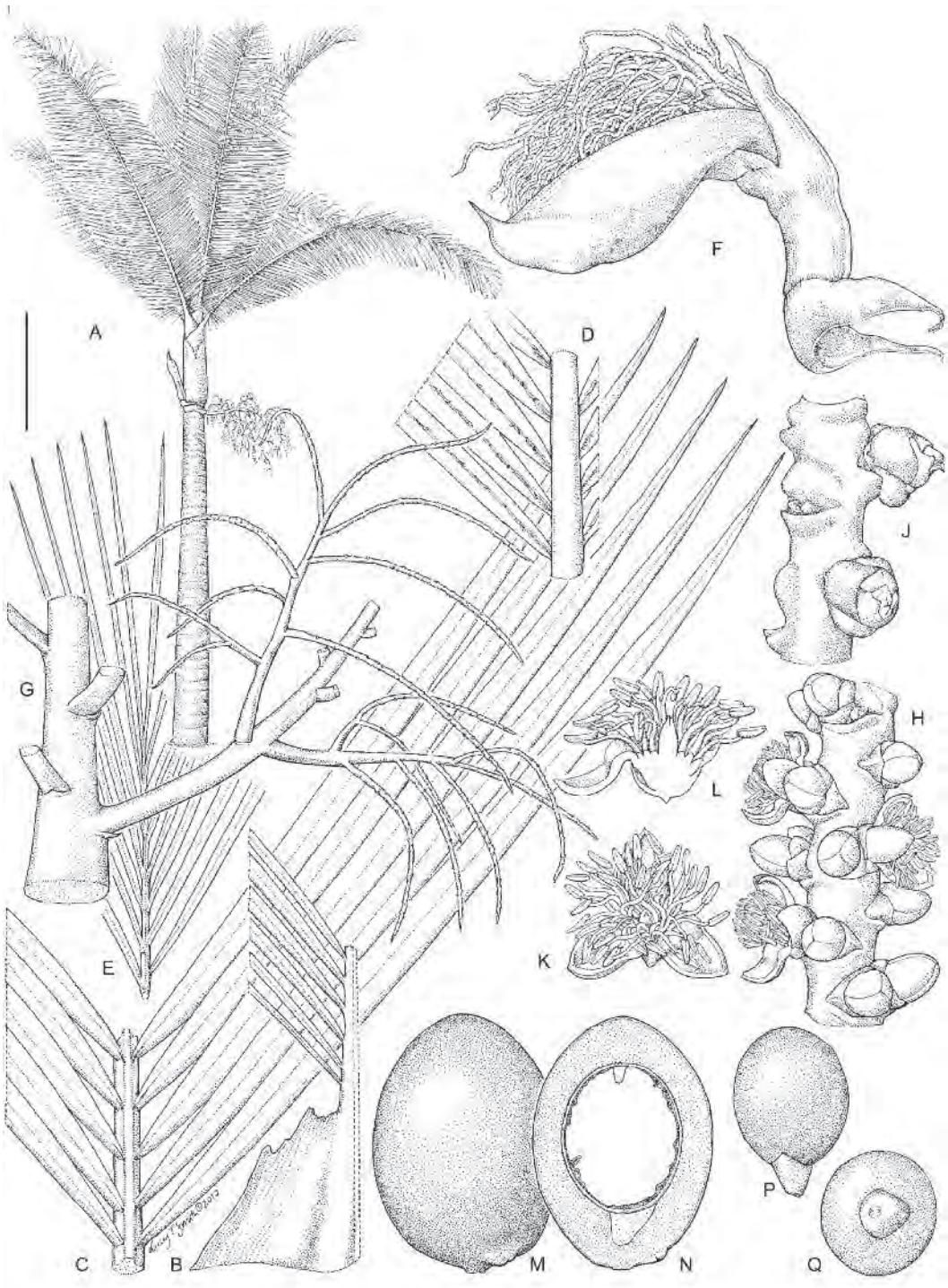
In the second edition of Genera Palmarum (Dransfield et al. 2008) mention was made in the account of *Lemurophoenix* that seeds imported from Madagascar by seed merchants suggested the presence of a second species of this then monotypic genus. The seeds in question were imported and distributed by Clayton York of Utopia Palms in Australia. Unlike *Lemurophoenix halleuxii*, the fruits of this possible second species are ovoid and smooth, rather than spherical and corky-warted, and furthermore are smaller than the known species. However, with but a single fruit sent to JD and now preserved in the Herbarium at Kew, the palm has remained a tantalizing mystery. No locality data were available and despite continuing intensive field study of palms in Madagascar, nothing was discovered that remotely matched the material from Clayton York.

JM obtained some seeds from this batch and one individual has survived to maturity and has begun to flower (Fig. 2). There is no doubt at all that the palm belongs to *Lemurophoenix*. Everything agrees with the genus apart from the fact that the epicarp of the fruit from which the cultivated plant has developed does not crack into the low corky-warts that are such a feature of *Lemurophoenix halleuxii*. In other details, also, the palm differs from *L. halleuxii* and thus requires a name.

It is, of course, unsatisfactory to describe a new taxon based on such limited material, but now that the cultivated specimen is reproductive, the differences are apparent and confirm Clayton York's hunch, based on the imported batch of fruit, that there is a second species of the genus. The palm in cultivation in JM's garden has begun to produce fertile fruits that although not yet mature match the single fruit sent originally by Clayton York. We propose the epithet "*laevis*" to reflect the smooth pericarp of the new species.

Lemurophoenix laevis J.Dransf. & J.Marcus, new species, differing from *L. halleuxii* in the staminate flowers with 33–41 stamens rather than 52–59, the pistillode pyramidal rather than columnar and the ovoid fruit with smooth epicarp rather than the globose fruit covered in corky warts. Type: HAWAII, cultivated, Mountain View, Floribunda Palms, November 2016, *Marcus s.n.* (Holotype K) (Figs 1–7).

Massive solitary palm. **Stem** to 3 m tall at first flowering in cultivation, ca. 45 cm diam. near the base; internodes ca. 20 cm long with nodal scars ca. 1 cm wide, surface in newly exposed stem pale green, covered with a very dense layer of white wax. **Leaves** 8–10 in crown; crownshaft elongate, 143 cm long, 32 cm diam.; leaf sheath strictly tubular, tinged



1. *Lemurophoenix laevis*. **A** habit; **B** part of leaf sheath and petiole base; **C** adaxial view of mid part of leaf; **D** abaxial view of mid part of leaf; **E** leaf tip: **F** young inflorescence; **G** part of inflorescence; **H** part of rachilla with male flowers in bud and at anthesis; **J** part of rachilla with open female flowers; **K** open male flower; **L** male flower in cross section; **M** whole fruit; **N** fruit in section; **P** endocarp with basal button from side; **Q** end view of endocarp basal button. **A**–**L** from *Marcus s.n.* (cultivated Floribunda Palms), **M**–**Q** from *C. York s.n.*, drawn by Lucy T. Smith. Scale bar: **A** = 2 m, **B**–**E** = 12 cm, **F** = 20 cm, **G** = 9 cm, **H**, **J** = 15 mm, **K**, **L** = 1 cm, **M**–**Q** = 2 cm.

2. *Lemurophoenix laevis*. Tree in flower at Floribunda Palms, Hawai'i. Photo by Mike Knell.

3 (top). *Lemurophoenix laevis*. View into crown with inflorescences and infructescence. Photo by Mike Knell. 4 (bottom). *Lemurophoenix laevis*. View of emerging inflorescence and fully expanded inflorescence. Note the striping on the leaf sheath, which is sometimes conspicuous. Photo by Suchin Marcus.

5 (top). *Lemurophoenix laevis*. Expanding inflorescence emerging from prophyll and peduncular bract. Photo by Mike Knell. 6 (bottom). *Lemurophoenix laevis*. Close-up of rachillae with staminate buds and open staminate flowers. Photo by Suchin Marcus.

yellowish or slightly pink in places, covered in dense white wax, sometimes the sheath distinctively marked with parallel diagonal stripes corresponding to major fibres; petiole very short (ca. 5 cm long) or absent, densely covered with white indumentum; rachis 5.8 m

7. *Lemurophoenix laevis*. Maturing fruit (November 2018). Photo by Mike Knell.

long, rounded abaxially, channelled adaxially near the base, becoming ridged distally, abaxially densely covered with white indumentum; leaflets 130–131 on each side of the rachis, very regularly arranged, held rather stiffly; median leaflets to 90–105 × 4.5–9 cm, adaxially glabrous, abaxially with scattered pale brown ramenta near the base and brown punctiform scales on veins. **Inflorescence** infrafoliar, branching to 3 orders, protandrous, held more or less erect at anthesis and then spreading, 115 × 130 cm; peduncle base swollen; prophyll 2-keeled, flattened, 43 cm long, 16 cm wide, with a beak 2 cm long, bright crimson on first emergence, drying mid brown and striate, with sparse brown scales; peduncular bract 1, similar to prophyll, but about twice its length, not keeled; first order branches 15; rachillae ± 212, 20–30 cm long at anthesis, 7 mm diam. at the base, tapering to 4 mm diam. towards the tip, tips lacking flowers to 5 cm long, 2.5 mm diam., rachilla surface glabrous but minutely papillate; triads 7–10 mm distant, partially sunken in shallow pits. **Staminate flower** buds just pre anthesis 8 × 5 mm; at anthesis, sepals 3, 4 × 4 mm, free, imbricate, rounded, irregularly keeled, gibbous, the margins minutely ciliate, otherwise glabrous; petals 3, valvate, 8 × 4 mm, free throughout their length apart from the very base where adnate to the receptacle for 2 mm, glabrous; stamens 33–41, crowded on the receptacle, to 6 mm at anthesis, filaments free or basally connate in 2s and 3s, to 5 mm long, 0.5 mm diam., contorted in bud and remaining somewhat contorted at anthesis, anthers 2 0.75 mm, medifixed; pistillode 2 1 mm, pyramidal, irregularly trifid. **Pistillate flower** spherical, 8 mm diam.; sepals 3, imbricate, slightly emarginate, 3 × 6 mm; petals 3, similar to sepals, 5 × 4 mm, with short broadly triangular valvate tips; staminodes 4, irregular, triangular, laterally joined and inserted at one side of the gynoecium, 0.5 mm high; ovary irregularly ovoid, 3 mm diam., stigmas closely adpressed in bud. **Fruit** broadly ovoid, 4.3 × 3.8 cm, stigmatic remains basal; pericarp ca. 6 mm thick at the fruit equator; epicarp smooth, obscurely striate and somewhat pebbled but not corky-warted; mesocarp ca. 6 mm thick with abundant longitudinal fibres in the innermost layer; endocarp ovoid, 2.5 × 2.1 cm, smooth, with a pronounced basal somewhat heart-shaped button 7 × 7 mm, tapering basally. **Seed** ovoid, 2.4 × 2.0 cm; endosperm irregularly sparsely ruminate, embryo apical.

SPECIMENS EXAMINED. HAWAII, cultivated, Mountain View, Floribunda Palms, November

2016, *Marcus s.n.* (Holotype K). MADAGASCAR. Without locality, single fruit, 2003, *local collector working for Clayton York* (K).

Clearly, finding this in the wild should be a high priority. *Lemurophoenix halleuxii* itself is critically endangered, and it may well be that the new taxon is equally restricted in its distribution and threatened. We have attempted several times to obtain more information about where the seeds were originally collected, but as with many batches of seed imported by the horticultural trade, this information is just not available. Almost all the Madagascar palms that have been described from cultivated material over the last few years have now been found in the wild; this gives us hope that *L. laevis* will at some point be discovered serendipitously somewhere in Madagascar.

JM has received photographs from Dr. Arden Dearden in Whyanbeel, Queensland, Australia, of two individuals of *L. laevis* in his garden; they are not yet at maturity but appear to be growing well. Perhaps this beautiful palm will eventually become more widespread in cultivation.

Acknowledgments

We are grateful to Clayton York for sending the fruit that first made us aware of a potential second species. Lucy Smith prepared the analytical plate.

Literature Cited

Dransfield, J., N.W. Uhl, C.B. Asmussen, W.J. Baker, M.M. Harley & C.E. Lewis. 2008. Genera Palmarum: The Evolution and Classification of Palms. 732 pp. Kew Books, Royal Botanic Gardens, Kew

Syagrus guaratingensis: a New Species from Bahia, Brazil

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This new species is restricted to rocky sites in relatively inaccessible areas in Guaratinga, Bahia (Fig. 1), where granitic inselbergs are common. The palm has rarely been collected because of the difficulty in accessing the top and slopes of these steep-sided, granitic outcrops arising abruptly from the landscape.

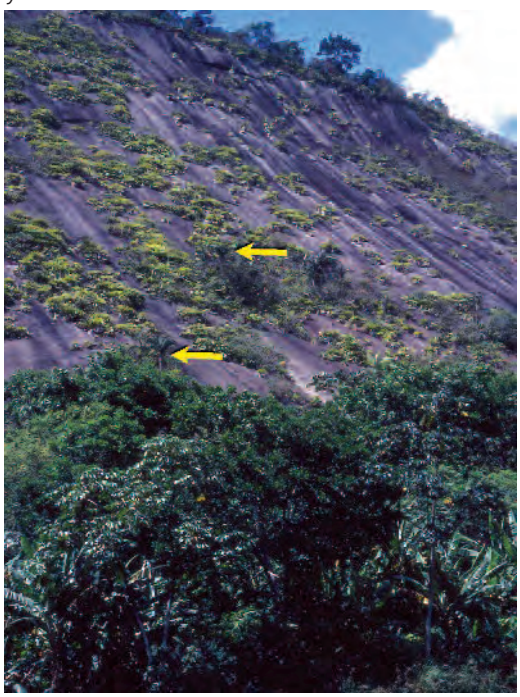
It was in early 1989, as I explored the state of Bahia for my research project on a palm flora for the Brazilian state of Bahia as part of my doctorate studies (Noblick 1991), that I first collected this species. Being new and still insecure in my study of Arecaceae, and especially *Syagrus*, I initially did not know enough to recognize it as anything unique. It was a beautiful day, and as I hiked along a trail surrounded by Atlantic rain forest vegetation and cocoa plantations, the trail suddenly ended at a steep granitic rock face (Fig. 2). High on the rock face I spied a few dark green palms. The weather was dry, so I courageously or perhaps foolishly climbed up the steep crystalline granite rock face to the trees. When I reached the palms, my precarious perch made it difficult to photograph the palm, as with one hand I clung onto cracks in the rock or whatever was available to keep from falling or rather sliding back down the granite rock face, while taking the picture with my other hand (Fig. 3). I would never have attempted the climb on a wet day, when scaling the rain-slick granite would have been impossible. Equally challenging was getting back down the rock face with the palm collections without damaging the camera. My first impressions were that the palm's large pistillate flowers were like *S. flexuosa* or *S. oleracea*, but the rachillae were spirally rather than unilaterally arranged, which ruled out *S. flexuosa,* and the palm's stem was too slender and the leaves were too short to be *S. oleracea*. As I had not expected to find a new species, I tried to match the palm to existing species. The images of *S. picrophylla* (Barbosa Rodrigues 1903) and habitat description provided by Bondar (1964) seemed to fit my palm, so initially, I identified it as *S. picrophylla* (Noblick 1991). In 2010, just south the city of Rio de Janeiro, in the state of Rio de Janeiro, I saw *S. picrophylla* for the first time in the Parque da Cidade, which convinced me that my Bahia palm was not that species. *Syagrus picrophylla* is a much more robust palm than anything I had seen in Bahia. In the state of Espirito Santo, Harri Lorenzi and I saw a slender-stemmed palm similar to the Bahian one, and after identifying and describing it as a new species, *Syagrus*

1. A lone *Syagrus guaratingensis* stands in the background in a field of bromeliads atop a granite inselberg near Guaratinga, Bahia, Brazil in 1989.

lorenzoniorum (Noblick & Lorenzi 2010), I was sure that my Bahian palm had to be the same. The habit and habitat of *S. lorenzoniorum* were almost identical to the Bahian one. However, I was wrong again.

In September, 2017, I had the opportunity to revisit Guaratinga with colleagues from the Universidade Federal da Bahia and some Brazilian friends. We found *Syagrus pseudococos*, which had never been recorded for Bahia. In fact, we found *Syagrus pseudococos* to be quite common in this region of Bahia. However, we had a difficult time finding the palm I had seen and collected in 1989. At the end of the final day, we found it just west of the small town of Buranhém, within the municipio of Guaratinga. Our two guides blazed a trail to the palms. We followed, struggling up the steep slope through the dense vegetation to reach the palms. During the whole climb, I kept thinking that I was finally going to be able to confirm the existence of *Syagrus lorenzoniorum* for Bahia. However, as soon as I arrived at the palms, one of our guides, João Santos (the discoverer of *S. itapebiensis* and *S. santosii*), handed me some fruits and old endocarps of the palm, and I was stunned to see that they were nothing like the *Syagrus lorenzoniorum* I knew from Espirito Santo. My colleagues kept repeating that it was *S. lorenzoniorum,* but I quietly suspected that it was not. Not only were the fruits the wrong color, orange-brown rather than yellow, but the fruits and especially

2. A few *Syagrus guaratingensis* on a steep granitic rock face near Guaratinga, Bahia, Brazil indicated by yellow arrows.



3. **A.** First image of *Syagrus guaratingensis* (*Noblick 4765*) near Guaratinga, Bahia, Brazil. **B.** Infructescence of *Syagrus guaratingensis* cultivated at Inhotim in Brumadinho, Minas Gerais, Brazil (photo by Kelen Soares).

the endocarps were more conically shaped, with the endocarps displaying a very distinctive tapering beak often with three obvious ridges. I also noticed the slender, unswollen, columnar stems, shorter, narrower leaves, and larger pistillate flowers. We made our collection from what little reproductive material was available and hiked back to the vehicles. After returning to the Montgomery Botanical Center in Miami, I sectioned and examined a portion of the leaflet margin of this specimen and compared it with other known samples of *Syagrus lorenzoniorum* and other similar *Syagrus* species. The leaflet anatomy confirmed my suspicions. This was indeed a new and previously unrecognized species.

Syagrus guaratingensis Noblick **sp. nov.**

Small to medium palm with an aerial, columnar stem 2–4 m × 9–15 cm, similar to *Syagrus lorenzoniorum* in habit and in habitat, but differs in having a columnar stem instead of a slightly ventricose stem, larger pyramidal-shaped pistillate flowers rather than conically shaped pistillate flowers, up to 3.3 cm vs. 1.3 cm long, larger fruits 3.0–4.5 cm long vs. 2.5–3.0 cm and endocarps to 4 cm long vs. 2.8 cm long, which are more conically to ovoid shaped, rather than nearly globose. Anatomically the leaflet margins have several mesophyll minor veins located in the mid to lower portion of the mesophyll instead of abaxial minor veins attached to the abaxial hypodermis. (Figs. 3–6, 7A)

Type: BRAZIL. Bahia, Guaratinga, 5 km W of Guaratinga, 300–350 m, 16°34'S, 39°34'W, 22 January 1989, *L.R. Noblick 4765* (holotype CEPEC!, isotypes F!, K!)

Small to moderately-sized, solitary palm. **Stem** 2–4 m (to 6–7 m in better soils) × 9–15 cm, caulescent, erect, with a columnar, ringed stem, self-cleaning with no or few persistent leaf bases. **Leaves** spirally arranged and spreading, slightly arched, 7–15 in the crown; sheath ca. 50 cm long, with fibrous margins or a fabric matting of the same fibers; pseudopetiole ca. 50 cm long; petiole absent or nearly so; rachis 175–240 cm long; leaflets linear, rigid, medium green to slightly paler on the lower surface, with obtuse or unequal tip, sometimes almost appearing bifid or emarginate, 105–123 leaflets along each side of the rachis, distributed irregularly in clusters of 2–4, inserted in various planes, ramenta or

4. **A.** A small population of *Syagrus guaratingensis* atop a granitic ridge with cacti near Buranhém, Guaratinga, Bahia, Brazil; **B. & C.** *Syagrus guaratingensis* and closeup of crown near Buranhém, Guaratinga, Bahia, Brazil.

5. **A.** Holotype of *Syagrus guaratingensis* (*Noblick 4765*) deposited at the Centro de Pesquisa de Cacao (CEPEC), Itabuna, Bahia, Brazil; **B. & C.** Endocarps of *Syagrus guaratingensis* from Buranhém, Guaratinga, Bahia, Brazil.

tomentum present where the leaflets are inserted on the rachis and also along the abaxial midvein; basal leaflets 45–50 × 0.5–1.5 cm, middle leaflets 30–37 × 3.4–4.0 cm, apical leaflets 14–19 × 0.5–1.0 cm. **Inflorescence** spirally branched; prophyll 50 × 4.5 cm; peduncular bract 74–116 cm long, expanded part 35–56 × 3.5–8 cm in width, 14.5 cm perimeter and 1–2 mm thick, sulcate, with a 1 cm long beak; peduncle 46–61 cm long, laterally compressed; *inflorescence axis* 74–108 cm long; rachis 21–51 cm long; rachillae 21–41, apex 7–13 cm long, middle 14–18 cm long, and base 20–40 cm long. **Staminate flowers** arranged spirally on the rachilla, cream-white, 8–11 mm long at the tip and

Table 1. Comparison of *Syagrus guaratingensis* with other closely related *Syagrus* species.

Character	*S. guaratingensis*	*S. lorenzoniorum*	*S. picrophylla*	*S. kellyana*	*S. cearensis*	*S. oleracea*
stem	columnar	ventricose	columnar	columnar	columnar	columnar
stem diameter (cm)	9–15	9–16	12–20	16–18	10–18	14–30
petiole length (cm)	0–1	0–2	2–13	0–11	0–2	4–16
leaf rachis (cm)	175–240	160–270	190–270	240–400	230–320	185–380
number of leaflets	105–123	55–123	133–160	104–131	100–130	96–161
raphides along midrib	yes	yes	no	no	no	often
apical leaflets (cm)	14–19	10–19	6–12	24–26	13–33	19–56
middle leaflet length (cm)	30–37	30–56	43–76	57–72	68–100	50–100
peduncular bract (cm)	74–116	80–160	93–131	110–160	102–115	84–172
peduncular bract perimeter (cm)	13–14.5	4–10	12–29	15–25	14–26	12–29
peduncle length (cm)	46–61	60–110	36–78	56–82	40–80	16–64
number of rachillae	21–41	25–47	40–70	47–69	35–45	40–87
Pistillate flowers (mm)	20–33	8–15	10–15	16–21	17–25	13–27
Fruit length (cm)	3.0–4.5	2.5–3.0	3.0–4.0	3.5–4.0	3.5–5.0	4.0–7.0
Endocarp length (cm)	3.0–4.0	2.4–2.8	2.7–3.8	3.3–3.5	ca. 4.0	4.5–6.0
Fruit shape	ovoid to conical	globose	ovoid	ovoid	globose, but with flat apex	ovoid to ellipsoid
Mature fruit color	orange-brown	yellow-green	yellow-green	yellow-green	brown	yellow-green
endocarp shape	conical to ovoid	globose	ovoid	ellipsoid	ellipsoid	ellipsoid
Mesophyll minor veins	yes	no	no	yes	yes	yes

11–15 mm long at the base and 2.5–3.0 mm wide, sepals 2 × 0.5 mm, glabrous with no distinct venation, petals valvate 8–12 × 2.0–2.5 mm with attenuate tips, stamens 5–7.5 mm long, anthers 4–6 mm long, filaments 1–1.5 mm long, pistillode trifid, 0.3–0.5 mm. **Pistillate flowers** elongate pyramidal, cream-white, ca. 20–33 × 6–8 mm, glabrous, sepals 15–33 × 6–8 mm, distinctly keeled, obscurely veined only at the tip, petals 12–15 × 4–5 mm, glabrous with no visible venation, valvate tips 1/3–1/2 the length of the petal, ca. 7–8 mm long, pistil 10–15 × 3.5–5.0 mm, glabrous or with a thin indument, stigmas 4–6 mm long, glabrous, staminodal ring 1–2 mm with undulate or occasional shallow dentate margin. **Fruit** conical to ovoid, 3.0–4.5 × 2.0–2.8 cm, cinnamon to orange brown when mature, epicarp less than 0.5 mm thick, covered with brownish fibers, mesocarp thickness not measured, fibrous and not particularly succulent; endocarp conical to ovoid, 3.0–4.0 × 2.2–2.5 cm, 3–5 mm thick and often with a tri-ridged beak. **Seed** nearly globose, 18–20 mm in diameter, endosperm homogeneous. **Germination** remote-tubular.

Common Name: *licuri*.

Etymology: This palm is named for the municipality of Guaratinga, Bahia, where it appears to be endemic as there are no collections of it outside of Guaratinga.

Distribution and Habitat: This species occurs in southern Bahia in the western portion of the municipio of Guaratinga. It appears to be endemic to Guaratinga, but it may be found in Minas Gerais, as *Noblick 5708* was collected less than 5.5 km from the Minas Gerais border. In Bahia, populations of this palm have been seen west of Guaratinga growing with bromeliads and other rock-loving plants in thin soils (Fig. 1) and in some places in association with cacti (Fig. 4). The palm grows on the top and on the steep sides of inselbergs or monoliths in thin soils (Figs. 1–4). These outcrops characterize the Serra do Mar geological formation. Soil on these geological formations is very thin and almost non-existent in places, but the species has not been found in deeper soils. It is not commonly collected because of its relative inaccessibility. *Syagrus lorenzoniorum, S. kellyana* and *S. guaratingensis* grow in a habitat that might well be considered *campo rupestre* but located within the Atlantic coastal rain forest of eastern Brazil. In Guaratinga, the lower slopes of these mountains used to be used to cultivate cacao but have slowly transformed into pasture for cattle.

Conservation: This species grows only on inaccessible rock outcrops with little soil in areas of no agricultural value. It is not threatened by agriculture. Its most serious threat would most likely be fire, as fire is a primary means used to renew pastures and may inadvertently reach some of these isolated areas. However, for now I am classifying this palm as least concern, LC.

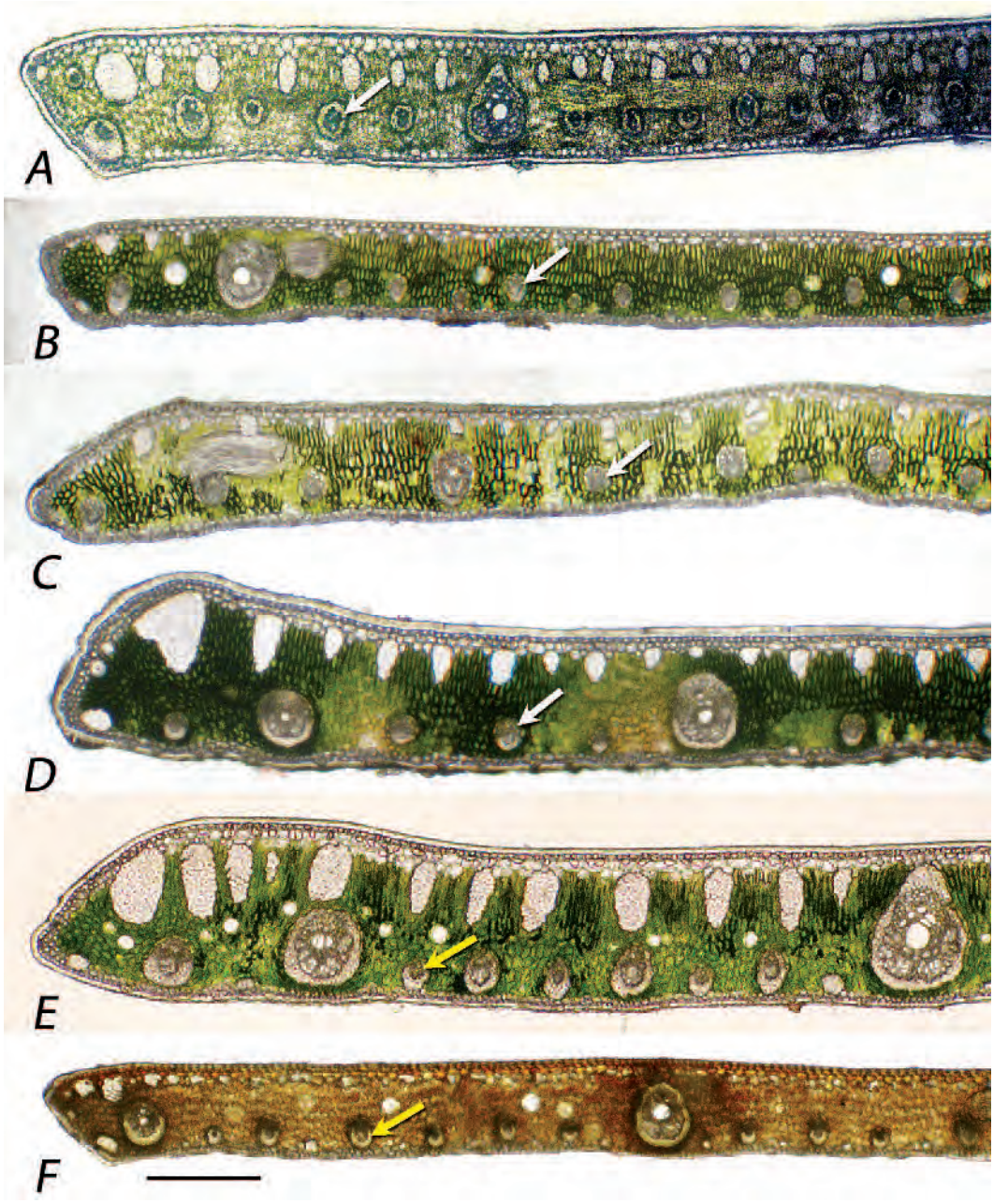
Phenology: This palm likely flowers and fruits year around.

Uses: The palm has some notable ornamental attributes. With its medium size, its dark green coriaceous leaves, self-cleaning, attractively ringed stem and possible drought resistance, it is a good candidate for the landscaping industry.

Notes: *Syagrus guaratingensis* has a slender stem, a leaf with no or very little petiole, and ramenta on the underside of the leaflet veins. This species has been confused with *S. picrophylla* and *S. lorenzoniorum* in the past (Noblick 1991, Noblick 2017a) because of their similar habit and habitat, but there are clear differences among them. *Syagrus lorenzoniorum* has a slightly swollen trunk and a long pendulous inflorescence, smaller pistillate flowers, smaller, globose fruits and also a narrower peduncular bract. *Syagrus guaratingensis* lacks the ventricose trunk, it has larger pistillate flowers, its fruits are a different color and shape and its inflorescence is not as long and pendulous as that of *S. lorenzoniorum*. *Syagrus lorenzoniorum* fruit and endocarp are nearly globose vs. ellipsoid in *S. picrophylla* and conical or ovoid and beaked in *S. guaratingensis* (see Table 1 for further comparison).

The marginal leaflet anatomy suggests that the new palm species is more closely related to *S. cearensis, S. kellyana* and *S. oleracea* than it is to *S. lorenzoniorum* and *S. picrophylla* (Fig. 7). Mesophyll minor veins, which are unattached minor veins that appear to be floating freely within the mesophyll of the leaf, are seen in four species: *S. guaratingensis, S. oleracea, S. cearensis* and *S. kellyana* (Fig. 7A, 7B, 7C, 7D) indicated by the white arrows. There are no mesophyll minor veins in *S. lorenzoniorum* and *S. picrophylla*. They both have only abaxial minor veins that are attached to the lower or abaxial surface of the leaf (Fig. 7E, 7F) and indicated by the yellow arrows.

6. *Syagrus guaratingensis*: **A.** Leaf base; **B.** Leaf middle; **C.** Leaf apex; **D.** Peduncular bract; **E.** Staminate portion of rachilla with staminate flowers; **F.** Staminate flower, petal and stamens; **G.** Inflorescence, basal and apical portion; **H.** Pistillate portion of inflorescence; **I.** Pistillate flower sepals; **J.** Pistillate flower petals, note narrow valvate tips; **K.** Pistil; L. Portion of infructescence; **M.** Fruits; **N.** Endocarp, note apical ridges. A–H, L and M, *Noblick 4765* (F). Images taken by Daniel Le (F). I–K, N. *Noblick 5708* (FTG). Long scales are 10 cm. Short scales are 10 mm.



7. *Syagrus* leaflet margin cross-sections: **A**. *S. guaratingensis*; **B**. *S. oleracea*; **C**. *S. cearensis*; **D**. *S. kellyana*; **E**. *S. lorenzoniorum*; **F**. *S. picrophylla*. Scale = 0.25 mm. White arrows indicate unattached mesophyll minor veins and yellow arrows indicate abaxial minor veins, which are attached to the lower leaf surface.

Additional Specimen: BRAZIL. Bahia, Guaratinga, Buranhém, ca. 1.5 km W of Buranhém on the road to Monte Azul, Minas Gerais. Growing on a large granite ridge N of the road, in semi-open areas on and along the ridge, elevation 351 m, 16°34′35.8″S, 40°6′29.9″W, 22 September 2017, *L.R. Noblick, C. Sacramento, G.A.L. Guimarães, J.E. Santos & L. de J. Santana 5708* (ALBC!, FTG!, HUEFS!).

Identification Key modifications

Morphological Key: The new species keys out under the following section of the published morphological key (Noblick 2017a): SOLITARY PALM SPECIES WITH ERECT ABOVE-GROUND STEMS.

Under this section were included only those species that primarily or commonly have

solitary stems, but many species with caespitose or clustering stems rarely or occasionally have solitary stems, including: *Syagrus ruschiana, S. flexuosa, S. campestris*, *S. cataphracta* and *S. deflexa*. This must be considered when using the published key. The published key can be modified by correcting and adding the following couplets:

25. Pistillate flower petals terminating in a long tapering valvate tip . . . . . 26.

– Pistillate flowers abruptly terminating in a short valvate tip . . . . . 27.

26. Petiole absent, middle leaflets less than 40 cm long, fruit orange-brown, 3.0–4.5 cm long, covered with short lepidote fibers often from the apex to the base . . . . . ***Syagrus guaratingensis***

– Petiole 4–16 cm, middle leaflets usually greater than 50 cm long, fruit yellow-green, 4–7 cm long, mostly glabrous, scale or short indument present only at the tip . . . . . *Syagrus oleracea*

27. Stems in twos, fours or clustered, but also solitary, fruit nearly globose, broadly flatted at tip . . . . . *Syagrus cearensis*

– Stems always solitary, fruit ovoid, rounded to tapered at tip . . . . . *Syagrus kellyana*

Anatomical Key: The following couplets should replace those in the published version of the anatomical key (Noblick 2017b):

44. Cuticle layer, very thick, first adaxial fiber bundle the largest . . . . . 45.

– Cuticle layer, very thin, not obvious, first adaxial fiber bundle not always the largest . . . . . .46.

45. Mesophyll minor veins surrounded by a sheath composed of a one-celled layer of sclerenchymous cells. . . ***S. guaratingensis***

– Mesophyll minor veins with sclerenchymous cells only on the abaxial side of the minor veins forming a shallow U-shape . *S. kellyana*

46. Large primary vein near the margin . . . . . *S. oleracea*

– Only secondary or minor veins near the margins . . . . . *S. cearensis*

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Literature Cited

Barbosa Rodrigues, J. 1903. Sertum Palmarum Brasiliensium, ou Relation des Palmiers Noveaux du Bresil, Decouverts, Descrits et Dessines d'apres Nature. 1: 1–140, 91 plates; 2: 1–114, 83 plates. Bruxelles. Both volumes reprinted as one book in 1989. Publicação do Jardim Botânico de Rio de Janeiro, Brazil. ISBN 85-208-0119-6. 254 pp. and 174 color plates originally painted by Barbosa Rodrigues.

Bondar, G. 1964. Palmeiras do Brasil. Boletim do Instituto de Botânica. São Paulo 2: 1–158.

Noblick, L.R. 1991. The indigenous palms of the state of Bahia, Brazil. PhD Dissertation. University of Illinois at Chicago. 523 pp.

Noblick, L.R. and H. Lorenzi. 2010. New *Syagrus* Species from Brazil. Palms 54:18–42.

Noblick, L.R. 2017a. A revision of the genus *Syagrus* (Arecaceae). Phytotaxa 294: 1–262.

Noblick, L.R. 2017b. Key to *Syagrus* identification using leaflet margin anatomy: Supplement to "A revision of *Syagrus* (Arecaceae)." Phytokeys 81: 19–43.

The Palms from the Southwestern Congolese Central Basin (Democratic Republic of Congo)

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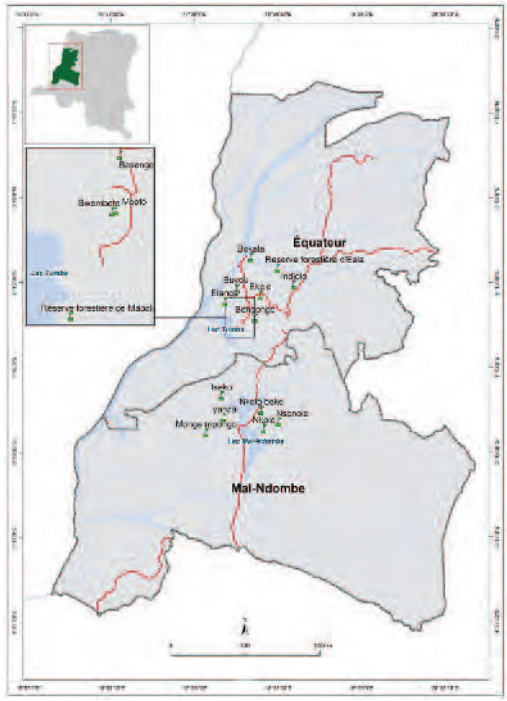
Generous support from the International Palm Society enabled us to undertake the first inventory of native palms from the southwestern Congolese Central Basin in the Democratic Republic of the Congo (DRC). Our study includes taxonomic notes for all palms reported for the area and descriptions of traditional uses, and local names are presented for the 18 species observed. Visits to several villages confirmed the critical economic importance of the palm family for the local ethnic groups and the main threats faced by some of the most useful species.

In spite of the great economic importance reported for many palm species in the Democratic Republic of Congo (i.e. food, beverage, handicraft and building material), a thorough inventory of the palm flora native in this country is still lacking. Some publications (i.e. Stauffer et al. 2014, 2017) have already highlighted the rich palm flora represented in the country and current figures indicate that with 36 palm species, belonging to 8 genera (Table 1), the DRC ranks after Cameroon as the richest country in continental Africa for palms. As the available scientific data on the palms in this country remain scattered and not at all up to date, our project aims to provide new information based on the study of wild populations and the collection of informative herbarium samples, also including DNA material for molecular phylogenetic analyses (i.e. *Raphia* project of T. Couvreur and co-workers), as well as leaf and flower samples for structural studies. The present contribution describes the palms of the little explored southwestern Congolese Central Basin, a fascinating area hosting many interesting palm taxa, some of them (i.e. *Raphia* spp., rattans) challenging to identify. This is the second of a series of contributions (Mbandu Luzolawo et al., submitted) in the framework of the preparation of the Palm Flora of RDC, a scientific collaboration between the University of Kinshasa and the Conservatory and Botanic Gardens of Geneva, under the editorial coordination of the Botanical Garden of Meise (Belgium).



1. Localities visited in the regions of Mbandaka and Inongo (southwestern Congolese Central Basin). Green flags: localities visited; red lines: main roads.

Area of study

Sampling efforts were concentrated in the regions of Inongo and Mbandaka, in the Congolese Central Basin (Fig. 1). This is an extensive depression of 750,000 km², with a mean altitude relatively low ranging between 340 m in the Tumba and Maindombe Lakes and 700 m in the Uelé Hills. The Congolese Central Basin is bordered by the Oubangui and Chari's sharing waters in the north, the montane ridge lining the African Rift in the east, the plateaus of Kasai and Katanga in the south and southeast and by the Mayombe province in the west (Laclavere, 1978). The Inongo and Mbandaka regions are mostly represented by an equatorial climate, with an annual mean temperature of 24–25°C and the highest values reported between March and April (Belesi 2009). In the north of the Maindombe Lake the mean annual precipitation reaches 1800 mm (Anonymous 1987). Rainfall in the surrounding regions of the Tumba Lake reach 2000 mm, and the mean value of atmospheric humidity has been reported to be 90%; the temperature reaches a mean value of 25.8°C (Deuse 1960). Our field missions in the region of Mbandaka, including extensive palm collecting and ethnobotanic survey of palm uses, covered the localities of Bengongo, Buya, Bwembete, Indjolo, Elanga, Ekele, Mooto, along the road towards Bikoro, Bokala along the road towards Bamania and the palm-rich Forest Reserve of Mabali around the Tumba Lake. In Inongo, we collected along the Inongo-Nkolobeke and the Inongo-Ngongiyembe axes. Southwest of the Inongo region and on the road towards Lukolela, we visited the villages of Monge Mpongo, Menkiri, Isoko and Iyanza, which are respectively 45, 50, 60 and 70 km away from the locality of Selenge (Fig. 1).

General vegetation features

A large diversity of forest types characterizes the area visited in the framework of our palm inventory. The evergreen forest is largely dominated by *Gilbertiodendron dewevrei* (De Wild.) J. Léonard (Fabaceae) and also characterized by the presence of *Prioria balsamifera* (Vermoesen) Breteler (Fabaceae), *Staudtia stipitata* Warb. (Myristicaceae) and

2. *Eremospatha cabrae* with inflorescences in a clearing at the locality of Bokala (Region of Mbandaka).

Table 1. Taxonomic classification of the palms present in the southwestern Congolese Central Basin.

Subfamily	Tribe	Subtribe	Genus	Species
Arecoideae	Cocoseae	Elaeidinae	*Elaeis*	*E. guineensis*
	Sclerospermae		*Sclerosperma*	*S. mannii*
				S. profizianum
				S. walkeri
Calamoideae	Calameae	Calaminae	*Calamus*	*C. deerratus*
	Lepidocaryeae	Ancistrophyllinae	*Eremospatha*	*E. cabrae*
				E. haullevilleana
				E. laurentii
				E. sp.
			Laccosperma	*L. acutiflorum*
				L. opacum
				L. robustum
				L. secundiflorum
			Oncocalamus	*O.* (undetermined species)
		Raphiinae	*Raphia*	*R. gentiliana*
				R. laurentii
				R. sese
Coryphoideae	Borasseae	Lantaniinae	*Borassus*	*B. aethiopum*

Entandrophragma angolense (Welw.) C. DC. (Meliaceae). In the region of Inongo, clearings have been reported, locally known as "*esobe*," in the center of these evergreen rainforests (Evrard 1968). Mixed rainforests with a dominance of *Scorodophloeus zenkeri* Harms (Fabaceae) develop on the plateau soils. Forests of *Guibourtia demeusei* (Harms) J. Léonard (Fabaceae) and *Cleistanthus mildbraedii* Jabl. (Euphorbiaceae) are present in those swampy areas, which are periodically subject to flooding; extensive raphia stands of *Raphia sese* De Wild. and *R. laurentii* De Wild. have also been observed in this region. The mature secondary forest is another type of vegetation that results from sufficiently evolved and aged forest fallows (Belesi 2009). Swampy and seasonally flooded forests develop along the Maindombe and the Tumba Lakes on the banks of which abundant populations of *Raphia sese*. are widespread. In these areas *Sclerosperma mannii* (Mann & Wendl.) H. Wendl. is very abundant in the understory but can also be observed in seasonally flooded areas of contact between the forest and the savannahs.

Materials and Methods

Our inventory focused on the collection of informative botanical samples (including vegetative and reproductive organs) and was carried out between August 2015 and July 2016. Specialized African palm literature (i.e. Tuley 1995, Otedoh 1982, Sunderland 2007, 2012, Van Valkenburg et al 2008) was consulted for species identification. In our field work in 2016, we were joined by the PhD candidate Suzanne Mogue (University of Yaoundé-IRD), and contributed to our knowledge of the native *Raphia* species from RDC. All the specimens collected were deposited in the Herbarium of the University of Kinshasa, and duplicates will soon be distributed to other large herbaria with specific interest on African palms (i.e. BR, G, K, L, P). In all the regions visited, local guides were interviewed in order to gather information on the vernacular names and the traditional uses of the collected palm species.

Results and Discussion

General taxonomic diversity

Our inventory and the relatively few studies carried out on the RDC palms point out the presence of 18 native palm species in the southwestern Congolese Central Basin. Concerning the genera, 8 out of the 12 genera represented in RDC were recorded in our studied region, with most species belonging

3. *Eremospatha laurentii* growth habit (Boloko River, Region of Mbandaka).

4. Tall individuals of *Laccosperma secundiflorum* showing inflorescences (Forest of Iyanza, Region of Inongo).

to the rattan genera *Eremospatha* and *Laccosperma* but also a number representing *Raphia* and *Sclerosperma*. The subfamily Calamoideae largely dominates the taxonomic diversity of the area with 13 of the 18 inventoried species. In particular, the forests of the Inongo and Mbandaka regions have an important representation of this subfamily confirming previous reports suggesting that these regions may correspond to refuge areas little affected by the overall arid climatic events partially explaining the low palm diversity displayed elsewhere in the continent. The subfamily Arecoideae is represented by 4 species whereas *Borassus aethiopum* Mart. is the single representative of the subfamily Coryphoideae.

Tribe Lepidocaryeae

Subtribes Ancistrophyllinae and Raphiinae are present in the studied regions, the former consisting of *Eremospatha*, *Laccosperma* and *Oncocalamus*. *Eremospatha* is represented by *E. cabrae* De Wild. (Fig. 2) and *E. haullevilleana* De Wild., which are frequent in the understory of high forests or in secondary, more disturbed forests. *Eremospatha laurentii* (Fig. 3), locally known as "*bendjale*" or "*kekele ya mayi*," is abundant in swamp areas and along the banks of the Ruki and Boloko streams. These species are characterized by their linear-lanceolate leaflets and the presence of spines on the petiole margins and the rachis, but almost absent or only scantily present on the leaf sheath. *Laccosperma* is represented by *L. acutiflorum* Becc., *L. opacum* Drude, *L. robustum* (Burret) J. Dransf. and *L. secundiflorum* (P. Beauv.) Kuntze (Fig. 4). These palms were mostly observed in swampy forests and clearings and are characterized by the presence of spines on the leaf sheath, the petiole, the rachis and the leaflet veins. They display a hapaxanthic type of reproduction, as the stems only produce one group of inflorescences during their lifetime. In particular, *L. robustum* and *L. secundiflorum* have a large distribution area in the studied region. The genus *Oncocalamus* was only rarely observed as a single, unknown species in the studied area. Indeed, only a few individuals of this palm were found in the region of Nsonole and on the road towards Ngongiyembe. We were not able to establish the taxonomic identity of this palm, and we are making every effort to propose an accurate name for it.

Subtribe Raphiinae remains poorly understood and the identification of the species present in the studied area represented an important challenge. *Raphia* consists of arborescent to

5. Reproductive individual of *Raphia gentiliana* showing hanging inflorescences (Forest Reserve of Mabali, Tumba Lake).

almost stemless palms, with 2–18 m long, pinnate leaves; abundant spines are present on the leaf rachis and on the leaflets; the fruits contain 1–3 seeds and are densely covered by imbricate scales. Stems of *Raphia* palms flower only once and die after fructification. The most widespread species in the studied regions were *R. gentiliana* De Wild. (Fig. 5), *R. laurentii* and *R. sese* (Fig. 6). *Raphia gentiliana* is a solitary, 4–9 m high palm, with fibers densely covering the stem; the latter and the petiole are yellow-orange and the leaves are up to 10 m long; the 2 m long inflorescence are pendant; the fruits range from globular to ellipsoid-ovoid and they are 4 cm long and 3–4 cm in diameter, covered with 11–12 ranks of imbricate scales; this species appears highly adapted to different soil conditions. *Raphia laurentii* is a clustering, sometimes solitary, 2–5 m high palm, with long leaves sometimes reaching about 15 m long; the stems are covered by linear leaf sheath fibers and the more or less erect inflorescences, usually 2–4 observed on one individual, present flat second-order branches. The fruits of this species are oblong to ellipsoid, 5–10 cm long and 4–7 cm diameter, orange to yellow when ripe and displaying 11–12 ranks of imbricate scales; the infructescences are 1–2 m long. This species is locally known as "*likali*" and forms locally dense, yet relatively small populations in seasonally flooded forests. It is abundant along the road joining Mbandaka to Bikoro, in the villages of Bengongo, Besenge, Buya, Bwembete, Elanga and Indjolo. *Raphia laurentii* is also present around the Tumba Lake, and in the southwest region of Inongo, the species has been observed in Iyanza, Isoko and Monge Mpongo. *Raphia sese* is a solitary palm with a slender stem that reaches up to 10 m, and is densely covered by curled fibers; the usually two pendant inflorescences are conspicuously violet at early stages of development; the infructescence is about 1–1.5 m long and the fruits are ovoid, 5–7 cm long and 2.8–3.5 cm diameter, yellow-orange when mature, and covered by 12 ranks of imbricate scales. This species is abundant and in our studied area observed along the Boloko and the Ruki rivers, forming marginal belts in the riverine forests. Populations of *R. sese* were also observed in the surroundings of the Maindombe and the Tumba lakes, as well as along the road between Inongo and Nkolobeke.

Tribe Calameae

This tribe is represented by only one species, *Calamus deerratus* Mann & Wendl., the only *Calamus* represented in Africa. In our studied area, this palm was observed in sunny, exposed, often disturbed areas. This rattan palm reaches more than 30 m long and bears

6. Population of *Raphia sese* growing in swamp forest at Nsonole (Region of Inongo).

7. Young individuals of *Sclerosperma walkeri* (Forest of Nkolobeke, Region of Inongo).

leaves up to 1–1.5 m. The long flagella developing from the leaf axil allow the palm to climb on surrounding vegetation.

Tribe Borasseae

In the DRC, the tribe Borasseae is represented by the subtribes Hyphaeninae and Lantaniinae. In the studied area, the latter is represented by the genus *Borassus,* with *B. aethiopum* as the only species reported. This is a tall, erect palm that may reach up to 25 m; the stem displays a characteristic swelling towards the upper third and the large costapalmate leaves are regularly divided in lanceolate-ensiform segments to nearly half of their length. *Borassus aethiopum* was observed in shrubby to grassland savannahs in the regions of Kutu and Mushie, although some populations have been also reported in the surroundings of the villages of Menkiri and Isoko on the road towards Lukolela. In the region of Nioki an estimation of 18 individuals/ha of *B. aethiopum* was reported by C. Lubini (pers. comm.).

8. House thatched with leaves of *Raphia laurentii* (Region of Inongo).

Tribe Sclerospermeae

Sclerospermeae is well represented in the southwestern Congolese Central Basin. In our field missions we sampled *Sclerosperma mannii*, *S. profizianum* Valk. & Sunder. and *S. walkeri* A. Chev (Fig. 7). All these palms present short, usually clustered arial stems or appear stemless; they are unarmed, with leaf blades either almost entire-bifid (*S. profizianum*) or divided in more or less regular segments (*S. mannii*, *S. walkeri*). *Sclerosperma mannii* is widely distributed in the studied area.

Tribe Cocoseae

In our study area, the Cocoseae are represented by the economically important oil palm *Elaeis guineensis* Jacq. This palm forms natural, subspontaneous populations, generally in swampy areas. In villages such as Nkole, Ikalata, Ngongo and Menkiri this palm is frequently cultivated for the production of palm oil.

Palm uses in the southwestern Congolese Central Basin

Most palm species inventoried present several important uses for the local populations (Table 2); however, our ethnobotanical data clearly highlight that those uses concentrate in building and handicraft activities (Figs. 8–12). With respect to building construction it was evident that the leaves from *Raphia laurentii, Sclerosperma mannii*, *S. profizianum* and *S. walkeri* represent the most common raw material. In particular, the petioles and rachis of *Raphia laurentii* are intensively used in the building of frameworks, either as timber roof or fences, as well as for the palisade of front walls (Fig. 8). Due to its large and entire-bifid leaves and being the most common species observed within *Sclerosperma, S. profizianum* is largely preferred as thatching material by local populations in the region of Bikoro.

Palm wine tapping is a common practice in the region. To extract *Raphia* wine local people climb up the palm in order to tap the uppermost part of the stems; in most cases the palm dies after the wine has been collected as the apical meristem is permanently damaged. In the case of the oil palm (*Elaeis guineensis*) the sap is obtained by two different methods, either directly tapping under the male

9. Baskets and shelves made from *Eremospatha haullevilleana* for sale in a specialized market of Kinshasa.

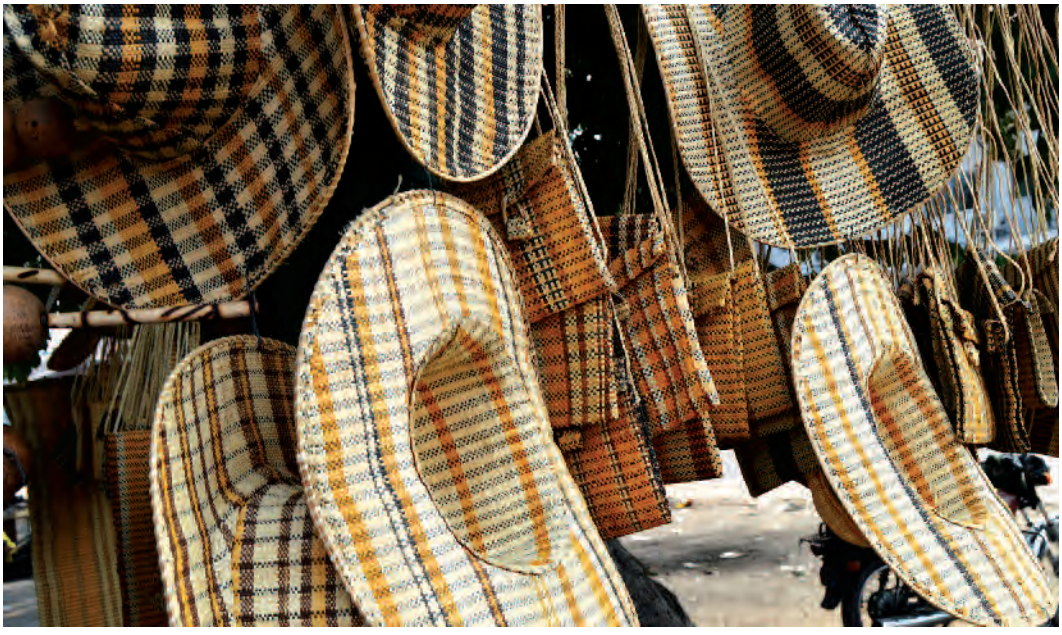
inflorescences while the plant remains standing or by the more destructive method of cutting down the palm and extracting the wine from the apicalmost region of the stem. The palm wine resource is diversely exploited by the local communities (i.e. Ekonda, Kundo, Mongo, Ntomba and Sengele tribes, as well as the Pygmies) which identify themselves by their different techniques of exploiting palm wine.

10. Young girls carrying baskets made from petiole and rachis of *Eremospatha haullevilleana* (Forest Reserve of Mabali, Tumba Lake)

11. Chairs made from stems of *Eremospatha cabrae* for sale in a market of Mbandaka.

The high pressure observed on the most useful palm species in the region (i.e. *Raphia laurentii*, *R. gentiliana*, *R. sese*, *Sclerosperma mannii*, *S. profizianum* and *S. walkeri*) leads to a reduction of their natural populations and therefore has strong consequences on their current distribution in the prospected regions. The urgent need to regulate these activities is thus evident for a sustainable exploitation of the palm wine resource and a better management of the protected areas of the Tumba Lake and the Salonga National Park. Domestication efforts of these species, including their introduction in local botanic gardens, should

12. Hats and handbags made from *Raphia sese* or *Raphia gentiliana* in a specialized market of Kinshasa.



be addressed in order to protect these threatened palms.

Conclusion

With 18 native palm species representing 69% of the palms reported for the whole country and about 30% of the palms currently estimated for continental Africa, the south-western Congolese Central Basin is extremely rich from a floristic and taxonomic perspective. Our sampling effort contributed to a better understanding of the poorly known genus *Raphia*, which requires further studies in order to clarify the taxonomic identity of the central African species. The multiple uses of palms reported in our inventory highlight the importance of some species for the local economy; however, overexploitation of many populations may in a relatively short period may threaten the survival of many species. On the other hand, destruction of natural habitats, mainly due to the increase of agricultural frontiers, is a major concern, and the creation of new protected areas, or the expansion of the ones already present, becomes a major issue in order to promote the conservation of palm populations. Besides the case observed of *Raphia gentiliana*, no domestication efforts have been carried out on any other native palm species.

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Literature Cited

Anonymous. 1987. Aménagement de l'espace rural de la région du Bandundu. Potentialités naturelles, projet ZAI/86/007, PNUD-IGZ et BEAU. Kinshasa-Zaïre.

Belesi, H. 2009. Etude floristique, phytogéographique et phytosociologique de la végétation du Bas-Kasai en République Démocratique du Congo. Thèse de doctorat, Université de Kinshasa, 565 p.

Deuse P. 1960. Etude écologique et phytosociologique de la végétation des Esôbe de la région Est du Lac Tumba (Congo). ARSOM, Bruxelles, 115 p.

Evrard, C. 1968. Recherches écologiques sur le peuplement forestier des sols hydromorphes de la Cuvette centrale congolaise. Série Scient. no. 110, INEAC, 295 p.

Laclavere, G. 1978. Atlas de la République du Zaïre. Editions Jeune Afrique, 72 p.

Mbandu Luzolawo, P., C. Lubini Ayingweu, H. Belesi Katula and F.W. Stauffer. Notes floristiques, écologiques et ethno-botaniques sur les palmiers (Arecaceae) en République Démocratique du Congo. I. Le Kongo central. Princeps. submitted.

Otedoh, M.O. 1982. A revision of the genus *Raphia* Beauv. Journal of the Nigerian Institute for Oil Palm Research 6: 145–189.

Stauffer, F.W., D. Ouattara and A.I. Stork. 2014. *Palmae,* Pp. 326–354. In Lebrun, J.-P. and A.I. Stork (Eds.). Tropical African Flowering Plants: Monocotyledons 2, vol. 8. Conservatoire et Jardin Botaniques de la Ville de Genève, Switzerland.

Stauffer, F.W., D.N. Ouattara, D. Roguet, S. Da Giau, L. Michon, A. Bakayoko and P. Ekpe. 2017. An update to the African palms (Arecaceae) floristic and taxonomic knowledge, with emphasis to the West African region. Webbia. Available from http://w.w.w.tandfonline.com/loi/tweb20

Sunderland, T.C.H. 2007. Field Guide to the Rattans of Africa. Royal Botanic Gardens, Kew Publishing, Kew. 66 p.

Sunderland, T.C.H. 2012. A taxonomic revision of the rattans of Africa (*Arecaceae*: *Calamoideae*). Phytotaxa 51: 1–76.

Tuley, P. 1995. The Palms of Africa. The Trendrine Press, UK. 189 p.

Van Valkenburg, J., T.C.H. Sunderland and T.L.P. Couvreur. 2008. A revision of the genus *Sclerosperma* (*Arecaceae*). Kew Bulletin 63: 75–86.

Table 2. Traditional palm uses in the southwestern Congolese Central Basin.

Scientific name (local name: linguistic group)	Reported uses in the region
Borassus aethiopum (*ilebo*: sengele)	Cutting of terminal bud for palm wine extraction; Leaves for making hats; Seeds used either in mourning ceremonials to mourn their dead relatives (i.e. Sengele groups) or in bells to be attached at the necks of hunting dogs; Stem for the building of WC.
Calamus deerratus	Canes for building and basket manufacture.
Elaeis guineensis (*libila*: lingala)	Terminal bud eaten as vegetable (known as cabbage tree); Mesocarp oil as ingredient in local dishes; Palm nuts boiled in salted water and eaten as dessert; Peduncle of the young male inflorescence and stem apex tapped for palm wine (fermentable sweet sap); Palm wine used in ritual ceremonials and in traditional medicine as a medium of dissolution or maceration; Palm oil for the preparation of the coatings used as baby ointments; Seed oil used for traditional soap manufacture.
Eremospatha cabrae (*bobangu*: sengele)	Leaf base as a stick to clean teeth; Cane to make chair backs, armchairs or baskets; Strips from the cane used as rope for hunting bows; Cane for building houses and bridges and making wardrobes or cupboards and stools.
E. haullevilleana (*mbobi*: lokonda and lokundu; *nkeko*: mongo; *nkoli*: lontomba)	Same uses as reported for *E. cabrae*.
E. laurentii (*bendjale*: lontomba and lokonda; *ngodji*: mongo)	Cirrus employed as fish-hook; Leaf rachis as a handle for arrows for hunting but also used in fish traps; Canes used for the construction of houses and bridges and making wardrobes, cupboards, stools and baskets for the transport of smoked fish.
Laccosperma acutiflorum (same name recorded for *L. robustum*) (*botende*: sengele)	Split canes used for making baskets, fish-traps, chair backs and bottoms and armchairs or the whole cane

	itself used for chair construction;
	Canes used for house building;
	Cirrus used as an indigenous hook;
	Young stems eaten as a vegetable.
L. robustum (*benkau, bokau*: lokonda, mongo, lontomba and sengele)	The same uses as reported for *L. acutiflorum*.
L. secundiflorum (*isapa*: lokonda and sengele; *lokake*: lontomba)	The same uses as for *L. acutifolium*; After being cleared of its thorns the cane is used as a domestic tool to smash cassava leaves.
Raphia gentiliana (same name recorded for *R. gilletti)* (*impeke*: lokonda, mongo, lokundu, lontomba and sengele)	The epidermis of young leaves is split in ribbons to be used in the making of ropes or textile fibers for the making of handbags, hats, purses, and traditional clothes;
	Petiole and leaf rachis used for making of traditional beds (litters), tables, mats, fish-traps, stools, doors and windows;
	Petiole and leaf rachis used as building material for frameworks, palisades of front walls, roof timber and, wall cross-bars;
	Leaves used as plant tiles;
	Innermost part of leaf rachis used for making child toys;
	Fruit mesocarp used for the traditional treatment of rate and liver pains;
	Dead stipe as a reproduction medium for the edible grub of *Rhyncophorus phoenicis*, locally known as *mpose*;
	Fibers of petiole and leaf rachis used for making tissues for the clothes of traditional chiefs;
	Sticky decoction of leaves used as a drug against asthenia;
	Leaf main veins used for making brooms (i.e. used by traditional chiefs of the Ntomba tribe).
Raphia laurenti (*ikali*: lokonda, lokundu, mongo, lontomba and sengele)	Dead stems used as a reproduction medium for the edible larvae of *Rhyncophorus phoenicis,* locally known as *mpose*;
	Sap extracted for palm wine production;
	Petiole and leaf rachis used for making traditional beds (litters), tables, mats, fish-traps, stools, doors and windows;
	Petiole and leaf rachis used as building material of frameworks, palisades

	of front walls, roof timber, and wall cross-bars; Extraction of petiole sap to treat snake bites; Leaves used as plant tiles locally known as *ndelé* for house roofing; Leaves used for broom making; Fruits edible and used as decorative objects; Fruit mesocarp used for the extraction of edible oil, and also to regulate blood pressure; Mesocarp oil used for the healing of wounds after the circumcision.
Raphia sese (*bodjilo*: mongo; *molilo*: lonkundu, lokonda and lontomba; *mabondo*: sengele)	Dead used as a reproduction medium for the edible larvae of *Rhyncophorus phoenicis*, locally known as *mpose*; Sap extraction for palm wine production (known as *masanga ya nsesé*); Fruits, called *mpandé*, edible after cooking, used for the traditional treatment of diabetes and high blood pressure; Fresh fruits smashed and put in stream for fishing; Fruits used for the making of traditional collars and as decorative objects; Petiole and rachis fibers used for the making of hats, umbrellas, bags and Turkish slippers.
Sclerosperma mannii (same names recorded for *S. profizianum* and *S. walkeri*) (*igaa*: sakata; *mpete*: lonkundu, lokonda and mongo; *mansole*: sengele; *maluwa*: lontomba)	Leaves used as building material: hut roofing and wall palisades, making of garrets for the conservation of seeds and the storage of crop harvests: Also used for WC building; Petioles and main veins used as weaving material for mats and also used for the peaking of huts; Leaves used for the treatment of throat diseases; Stem fibers and leaves for broom making; Ashes of leaves used for the treatment of burns; Fruits edible; Mesocarp oil used for the treatment of abscess.

Photo Feature

Pritchardia thurstonii in the Wild

In my monograph of *Pritchardia* (Hodel 2007), I noted that *P. thurstonii* was known to occur on the tops of small, coral limestone islets in two lagoons in the Southern Lau Group, Fiji. Since seeing the cover of Dick Watling's book on Fijian palms (Watling 2005), reproducing a painting of *P. thurstonii* on one of these islets, I have always wanted to see the islets myself. Finally, in June 2017, I was able to make arrangements for a helicopter trip from Suva, Fiji, to Fulaga Lagoon, 325 km east-southeast of the capital. While I had seen *Pritchardia thurstonii* in Tonga, where it occurs on steep limestone slopes and jumbled rocks on Eua, and I knew it was found in similar habitats on Vanua Balavu in the Northern Lau Group in Fiji, nothing could have prepared me for the breathtaking sight of this palm in Fulaga Lagoon. In the cerulean and turquoise waters, *P. thurstonii* was conspicuous, sometimes especially so, on small to moderate, profoundly undercut, mushroom-shaped, coral limestone islets where the "mushroom dome" can be only about 10 m tall and 10 m wide and held on a "stem" sometimes as slender as 5 m in diameter. Some of the islets had only a few palms while others had mostly palms and little other vegetation. All, especially on their perimeters, had bare, exposed areas marking the wave splash zone, where the palms must be subjected to tremendous amounts of salt spray and even inundation of their roots with salt water during high tides and stormy conditions. The coral

limestone was rough, uneven, fissured and sharply angled and ridged. All age and size classes of palms were visible, from young seedlings 30 cm tall to mature trees 8 m tall or slightly more, indicating that successful regeneration was occurring and that rats had not yet gained access to the islets.

Read the full, copiously illustrated account in *PalmArbor* at *http://ucanr.edu/sites/HodelPalmsTrees/files/268034.pdf*

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Literature Cited

Hodel, D.R. 2007. A review of the genus *Pritchardia*. Palms 51 (Special Supplement): 1–53.

Watling, D. 2005. Palms of the Fiji Islands. Environmental Consultants, Suva, Fiji.

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