Palms

Journal of the International Palm Society Vol. 53(3) Sep. 2009

THE INTERNATIONAL PALM SOCIETY, INC.

The International Palm Society

Founder: Dent Smith

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Chapters: See listing in the Supplement.

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FRONT COVER

×*Butyagrus nabonnandii* at Villeneuve-Loubet, in the former property of Clément Nabonnand (Photo: Patricia Cavallo). See article p. 119.

Palms (formerly PRINCIPES)

Journal of The International Palm Society

An illustrated, peer-reviewed quarterly devoted to information about palms and published in March, June, September and December by The International Palm Society, 810 East 10th St., P.O. Box 1897, Lawrence, Kansas 66044-8897, USA.

Guidelines for authors are available on request from the Editors.

Annual membership dues are US$45.00 for Individuals (or US$120 for three years) and include a subscription to the Journal. Donor memberships are US$500 per year. Individual Lifetime memberships are available for a one-time fee of US$1000. Benefactor memberships require a one-time payment of US$2500. Subscription price is US$45.00 per year for libraries and institutions. Dues include mailing of the Journal by airlift service to addresses outside the USA. Dues may be paid on-line at www.palms.org.

Change of Address: Send change of address, phone number or e-mail to The International Palm Society Inc., 6913 Poncha Pass, Austin, TX 78749-4371 USA, or by e-mail to info@palms.org.

Claims for Missing Issues: Claims for issues not received in the USA should be made within three months of the mailing date; claims for issues outside the USA should be made within six months of the mailing date.

Periodical postage paid at Lawrence, KS, USA. Postmaster: Send address changes to The International Palm Society Inc., 6913 Poncha Pass, Austin, TX 78749-4371 USA.

PALMS (ISSN 1523-4495)

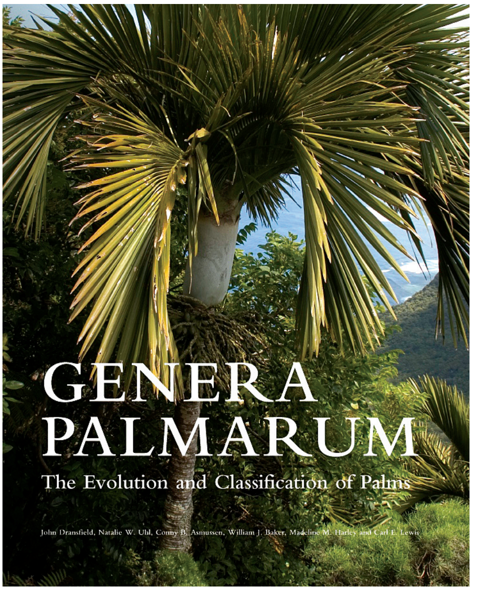
Mailed at Lawrence, Kansas Sep. 15, 2009

The full text of PALMS is available on EBSCO Publishing's database.

This publication is printed on acid-free paper.

CONTENTS

Features

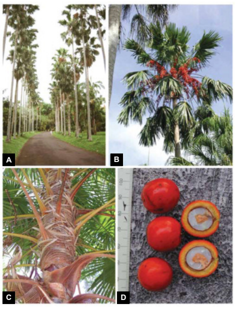


The second edition of *Genera Palmarum*, known to its fans as *GP2*, is still available through the IPS website, www.palms.org. This book, published jointly by the IPS, the Royal Botanic Garden Kew and the L.H. Bailey Hortorium, was recently recognized by the Council on Botanical and Horticultural Libraries as the best botanical book published in 2009. Don't miss out on this landmark book! *GP2* will be the authoratative word on palm taxonomy at the genus level for many years to come.

BACK COVER

Dypsis makirae, a new species from Ankirindro, Madagascar, described in this issue. See article by Rakotoarinivo et al., p. 125.

PALM NEWS



A new taxonomic account of the genus *Livistona* by John Dowe appeared recently in the Gardens' Bulletin of Singapore (60: 185–344. 2009). The work is comprehensive assessment of all of the known taxa and includes a key to the species, conservation assessments, habitat descriptions, distribution maps and 25 color plates. Thirty-six species are recognized, and users of Kew's Word Checklist of Palms (Govaerts & Dransfield 2005) will want to note that changes are made to few names: *Livistona robinsoniana* is treated as a synonym of *L. rotundifolia*, *L. fengkaiensis* is placed under *L. speciosa* and *L. kimberleyana* is synonymized under *L. lorophylla*. Anyone can download a copy of this work (along with many of Dr. John Dowe's other palm publications) at www.actfr.jcu.edu.au/staff/JCUDEV_014558.html.

We note with deep sadness **the passing of Mrs. Doris Smith, the widow of IPS founder, Dent Smith**. Mrs. Smith passed away on 10 May 2009, and a memorial service was held on 30 June at St. Mary's Church, in Daytona Beach, Florida. Mrs. Smith regularly opened her garden to visitors, and Dent's palm collection was recently profiled in PALMS (50: 27–32. 2006). She also recognized the significance of her husband's work with palms and recently donated his papers to the special collections of the library at Fairchild Tropical Botanic Garden, Miami, Florida (PALMS 50: 193–195. 2006). We do not know at this time if the Smith family has any plans for the garden and its palms.

FOUS
DE
PALMIERS

This year sees **the twentieth anniversary of the founding of the French chapter of the IPS, Fous de Palmiers**. To celebrate, the Fous held a weekend-long meeting based in Menton on the French Riviera. Approximately 150 members attended the packed program of lectures, banquets and garden visits, both in France and in neighboring parts of Italy. Our congratulations go to the Fous de Palmiers on reaching this anniversary – clearly the society is in excellent shape and growing in membership.

Another publication of note is a **new taxonomic revision of *Cyrtostachys* by Charlie Heatubun et al.**, published in Kew Bulletin (64: 67–94. 2009). The genus *Cyrtostachys* includes the popular Sealing-wax Palm, *C. renda*. The new treatment recognizes seven species, with five species synonymized under *C. loriae*, but three species newly described. The authors used morphological data and pollen anatomy to propose a hypothesis of relationships among the species. A pdf download is available at www.kew.org/publications/kewbulletin.html.

twitter You can now **follow the IPS on Twitter** at www.twitter.com/IPS_PalmSociety.

GROWING PALMS

Horticultural and practical advice for the enthusiast

by Randal J. Moore

Product Review: Termador for Control of Argentine Ants

Argentine ants [*Linepithema humile* (Mayr), Figs. 1 & 2] are found throughout the southern United States, having been accidentally introduced from Brazil into Louisiana in 1890. These pests are a common and persistent problem in Southern California where my garden is located. The ants thrive in a warm Mediterranean climate and like the moist soil next to buildings or near sidewalks and plants. They are aggressive and have mostly displaced our native ants.

Since Argentine ants prefer sweet foods, they are often found tending scale or aphids on palms using them as a source of sugar-rich honeydew. A subsidiary problem is a sooty mold fungus that will grow on the honeydew. The ants usually inhabit the outdoors. However, they will also come inside buildings when foraging for food. The Argentine ant can be a serious pest of honey bee hives.

Unlike most other ants, an Argentine ant colony can have many productive queens. Large colonies can contain hundreds of queens. When the colony gets crowded, or is stressed, some of the queens may leave the nest with some of the workers forming a new colony. During the summer months, new satellite nests are usually established close to food sources. This trait of the Argentine ant can make control especially difficult.

The use of insecticidal sprays or dusts can create stress in the colony and cause it to fracture into sub-colonies. For this reason, quick killing sprays and dusts can make the infestation worse. Only the foraging ants will be killed. The remaining ants are extremely mobile and will move colonies frequently. As they move, Argentine ants create strong pheromone trails that are easy to spot.

Slow-acting baits allows the foraging ants to carry the poison back to the nest and feed the queen, workers and brood. Some types of bait are more attractive to Argentine ants. Several different types may need to be tried until one or more is found acceptable to the ants. The main types of bait are sugar-carbohydrate based, grease-fat based, and a protein-based bait. Queens eat the protein/grease baits exclusively. Workers eat the sugar-based baits.

1. Argentine ant. Photo courtesy of Joyce Gross.

Termidor SC Termiticide/Insecticide is a highly effective product that can be used for outdoor control of carpenter ants, Argentine ants, big-headed ants, odorous house ants and pavement ants (as well as termites and some other social insects) around structures and on plants. It is manufactured by BASF Corporation, Agricultural Products Group, Research Triangle Park, North Carolina USA (919-547-2000). For ant control, it should not be applied more than twice a year. It will give excellent results on both termites and ants. Often, 100% control of the colony is obtained.

Exterminators throughout the world have been using this product for many years. Only recently has it been available without a license or permit.

The active ingredient in Termidor SC is fipronil (9.1%) in the phenyl pyrazole family of chemicals. It is not a repellent, which is formulated to drive ants away from a treated area but not kill them. Ants cannot see, smell or taste fipronil. They unknowingly contact and share the insecticide with the rest of the colony. The "SC" in the name stands for "Suspension Concentrate" and is the delivery formulation. A suspension concentrate is made of finely divided solid particles in a liquid carrier. It is similar to a flowable formulation and designed to be mixed with water at the time of application.


2. Argentine ants can tend aphids, scale and other plant pests Photo courtesy of Gary McDonald.

Fipronil is a broad spectrum that disrupts the insect's central nervous system. Fipronil is used as the active ingredient in Frontline, a topical flea control commonly used on dogs and cats. It kills adult fleas before they lay eggs. It is also the active ingredient in Over-N-Out fire ant control product. In the US, ant fipronil-containing gels are sold under the brand (manufactured by Bayer), and under the Combat brand (manufactured by Dial Corp). Both brands carry 0.001% Fipronil by weight as the active ingredient. Agricultural products include Chipco Choice for use against pests of field corn, golf courses and commercial turf.

Some exterminators claim that fipronil can stay active in the soil (or other treated surfaces) for up to 8–10 years. Because it is a non-repellent, Termidor SC can be coupled with a control program that also includes bait stations. The disadvantage of bait stations is the waiting period while ants find and ingest the bait. Fipronil becomes effective immediately upon application.

Treatments of Termidor SC can be accomplished in two ways. Ants foraging on treated surfaces can ingest Termidor. Alternatively, ants can be sprayed directly with a pump sprayer. The ants sprayed directly or the ones that ingest it are killed, but not before spreading the active ingredient through contact within the colony. The product contains a patented "transfer effect" surfactant that easily adheres to the ant. Because it is slow-acting, there is plenty of time to spread the insecticide through transfer and contact within the entire colony. Exposed ants are killed within three days.

Termidor SC carries a National Fire Protection Association health hazard code of 2 (0=minimal hazard, 4=severe hazard). This means that "Intense or continued but not chronic exposure could cause temporary incapacitation or possible residual injury." Termador SC carries the signal word "Caution" on its label, meaning it has the lowest hazard level and is unlikely to cause acute effects in humans within 24 hours of exposure. It is, however, a toxic chemical and handling instructions should be followed to the letter. When applying Termidor SC, applicators should use an approved respirator, chemical goggles for eye protection, a chemically resistant suit, neoprene gloves and have adequate ventilation. Termidor is toxic to birds, fish and aquatic invertebrates.

Termidor SC is packaged in a 20-ounce bottle. The correct measurement of concentrate is easily and safely dispensed with a clearly-marked, tip-and-pour bottle. A single highly-concentrated bottle makes between 12 gallons (0.125% solution, the maximum application rate) to 24 gallons (0.06% solution, the minimum application rate) of properly diluted spray. When mixed at a dilution rate to yield 12-gallons, the cost per gallon is about US$5.00.

A severe infestation of Argentine ants was one of my main pest problems on my large 2-1/2 acre garden in northern San Diego County, California. Not only were they a pest outside, each summer they would come inside foraging for food and water. Over the years I had attempted to control them with contact killers, sticky guards on tree trunks and bait stations. Although the persistent use of bait stations would have provided control after several weeks, I found it difficult and expensive to maintain such a large number of stations.

Two years ago, I was made aware of Termidor SC and tested it in my garden. It took a diligent effort at first to knock down all sightings of ant trails and nests. I also performed a preventative spraying around the perimeter of my house, palm conservatory and shadehouse. I have used the insecticide on my tender tropical palms without any damage to the foliage. After a few weeks, there was a nearly-complete elimination of the ant population and no further incursions into my house. A single bottle lasted the entire gardening season.

Unfortunately, the properties that surround my garden do not practice ant control. Therefore, each year as the weather warms the ants test the boundaries of my perimeter. I keep 1 gallon pump sprayer ready with Termidor SC mix in case I encounter a trail or nest. This is possible since the mix seems to stays viable for very long time, does not separate, and is easy to remix. One of my most perplexing pest problems is now a thing of the past.

Termidor SC is not readily available for purchase. One on-line source is Do-It-Yourself Pest Control (or 800-476-3368). The retail price of a bottle from this source is US$58.95 which includes free 1–3 day shipping within the lower 48 U.S. states. It is not available in all U.S. states.

Unusual Fruiting of *Chamaedorea tenella*

Chamaedorea tenella (Fig. 1) is a highly ornamental, diminutive understory palm that is prized by many palm enthusiasts. The palm attains a height of only 2 meters, with a slender stem of 4 or 5 mm in diameter and 5–7 attractive, bifid leaves. It is found in two geographically distinct populations in Chiapas, Mexico and in Puntarenas, Costa Rica. Some growers distinguish between the two populations, recognizing that plants from Chiapas have leaves that are stiffer and narrower. Several palm enthusiasts have observed a strange phenomenon in the fruiting of *Chamaedorea tenella*: the fruits on the same infructescence will develop and mature in two or more flushes. The fruiting period is unusually lengthy, and a single infructescence can produce fruits for two or more years.

1. A mature female specimen of *Chamaedorea tenella* cultivated in the garden of Jim Wright in San Diego, California.

2. A one-year old infructescence on a *Chamaedorea* tenella exhibiting fruits in different stages of development.

The youngest inflorescences are green, becoming yellowish by the time the flowers open. As the fruits develop, the infructescence axis becomes red-orange. Immature fruits are green. Mature ripe fruits are black. Immature fruits of different ages can seen on a single infructescence (Fig. 2), illustrating the different flushes of fruit maturation.

Loran Whitelock and Jim Wright have been cultivating *C. tenella* in their gardens in southern California since the early 1990s. Both have observed this long and unusual fruiting period. Their plants were producing multiple batches of fruits on the same inflorescence. Mr. Whitelock alerted Donald Hodel, an authority on *Chamaedorea* and author of a book on the genus (*Chamaedorea* Palms: The Species and Their Cultivation. 1992. International Palm Society). He postulated that this may be a survival adaptation. *Chamaedorea tenella* has a very long period during which ripe fruits are present. Such a strategy could make the ripe fruits available for dispersal over a longer period of time, helping to increase the chances that fruits are dispersed, presumably by birds. Such a strategy would be especially effective if encounters between the palm and its agent(s) of dispersal were uncommon.

Chamaedorea tenella is not the only palm to exhibit this phenomenon. According to Don Hodel, it occurs in a few other *Chamaedorea*, including *C. geonomiformis* and *C. frondosa*.

NB. Some taxonomists treat *C. tenella* as a synonym of *C. geonomiformis*.

The assistance of Don Hodel (Environmental Horticulturalist, University of California Cooperative Extension, Los Angeles, CA), Jim Wright (San Diego, CA), Scott Zona (Florida International University, Miami, FL) and Loran Whitelock (Eagle Rock, CA) is gratefully acknowledged.

Syagrus evansiana, a New Palm from Minas Gerais, Brazil

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1. *Syagrus evansiana* in habitat with its blue to gray-green foliage.

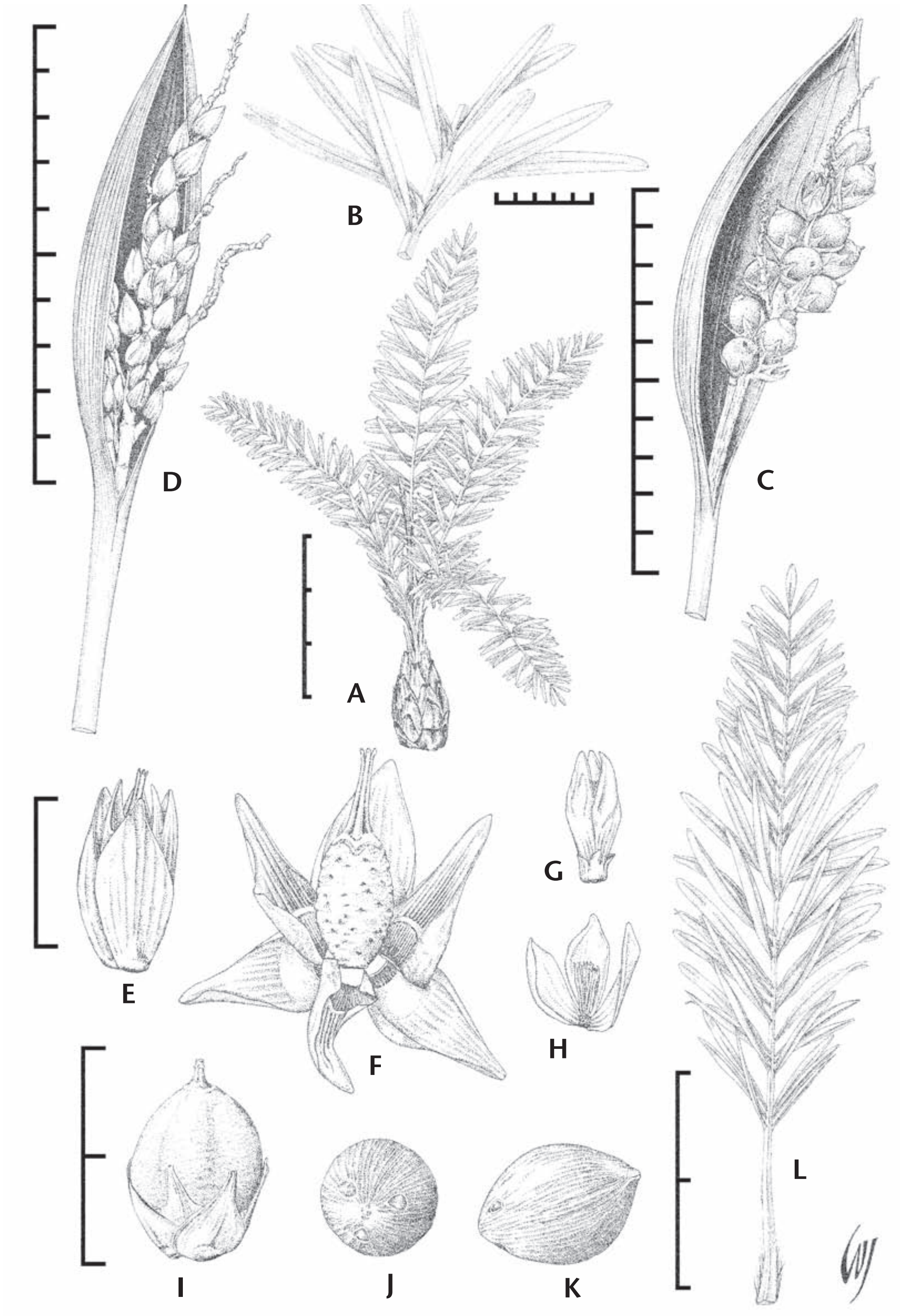
A new, nearly stemless species of *Syagrus* (Figs. 1 & 2) has been discovered in the campo rupestre regions of Minas Gerais, Brazil and is named here *S. evansiana*.

Don Evans, Fairchild Tropical Botanic Garden's retired Director of Grounds Management, placed on my desk the dried leaf and spicate inflorescence of a nearly stemless palm that he had collected and photographed on a 1992 expedition with Roberto Burle Marx in the state of Minas Gerais. Even though the leaves had an uncanny resemblance to *Syagrus duartei* Glassman (Serra do Cipó) and *S.glaucescens* Glaz. ex Becc. (Serra da Diamantina), the inflorescence was far too small for either of these species and it was north of their normal distribution ranges. *Syagrus duartei* and *S. glaucescens* are separated by size differences (Glassman 1987). Since I did not have enough information on this palm, I waited for the opportunity to investigate its habitat in Minas Gerais in person. Years passed, when Harri Lorenzi wrote that he was going to the Diamantina region of Minas Gerais to photograph *S. mendanhensis* and asked me if there were any other palms in that region that were in need of checking. I immediately asked him to investigate the palm Don had discovered. So it was with a great deal of excitement that he e-mailed me a few weeks later with photos and a conviction that it was a new species. He even put it into his revised palm book as *Syagrus* sp. nov. 1 (Lorenzi 2004). Finally, in June of 2008 we visited this region together and learned that it had a larger distributional range than we had anticipated. The description of the new species follows.

Syagrus evansiana Noblick **sp. nov.**, a *S. glaucescens* et *S. duartei* statura breviore, plerumque acaule, inflorescentia plerumque spicata, bractea peduncularis breviore 7–22 cm, inflorescentiis brevioribus 4.5–10 cm, staminibus brevioribus 4–5 mm, fructibus brevioribus 2.0–2.3 cm × 1.3–1.5 cm, et endocarpio cum 3–5 poris differt. Typus. Brazil, Minas Gerias, Montes Claros, N side of BR 365 (Pirapora\Montes Claros) at km 70.5, S17°04'05.9" W044°20'19.0" 960 m, 20 Jun 2008, *Rodrigo Tsuji, H. Lorenzi, L.A. Ventura, L.R. Noblick 2703* (Holotypus: HPL! Isotypi: R! BHCB! FTG! K! NY!). (Fig. 3.)

Palm, solitary and acaulescent or nearly so with a very short to subterranean trunk, whole plant usually less than 60 cm in height, but varying from 40–100 cm in height. Leaves gray-green, 3–11 in number; leaf sheath plus the petiole ca. 10–40 cm long, sheathing leaf base ca. 10–20 cm long, fibrous with papery membrane between the fine principal warp fibers, tending to disintegrate along the margins of the pseudo-petiole; true petiole absent to nearly 18 (–26.5) cm long and 0.6–1.5 cm wide by 0.3–0.8 cm thick, channeled adaxially and rounded abaxially, pseudopetiole (true petiole plus part of the sheath) to 10–33 cm long; rachis 21–92 cm long; leaflets medium to dark gray green becoming lighter when dried, discolorous, adaxial surface waxy, but abaxial surface with a thicker white waxy coating, leaflets 18–48 along one side, irregularly distributed in clusters of 2–4 (–5) along the rachis and inserted in divergent planes, ramenta or tomentum absent at leaflet insertion and along the abaxial midvein of the leaflets; basal leaflets 4–27 cm long by 0.2–0.8 cm wide, middle leaflets 12–30 cm long and 1.5–3 cm wide, apical leaflets 3–12 cm long and 0.1–0.9 cm wide, both lobes of the asymmetric tip rounded. Inflorescence androgynous, interfoliar, commonly spicate, with a total length of 4.5–17 cm from the first flowers or basal primary branch to the apex; prophyll 6–16 cm × 1.5–2.5 cm; peduncular bract woody, sulcate,

2. Spike inflorescence of *Syagrus evansiana* with mature male flowers.



3. Diagnostic Plate of *Syagrus evansiana*: **A**. Habit; **B**. Leaflets; **C**. Infructescence; **D**. Inflorescence; **E**. Receptive pistillate flower; **F**. Pistillate flower opened to see ovary; **G**. Staminate flower; **H**. Staminate flower opened to see stamens; **I**. Fruit; **J**. Endocarp end view showing pores; **K**. Endocarp side view; **L**. Leaf. Habit, leaf and leaflets drawn from images supplied by Harri Lorenzi. Reproductive parts drawn from *Lorenzi 4276*. All scales are in 1 cm units except **A** and **L** which are in 1 dm units.

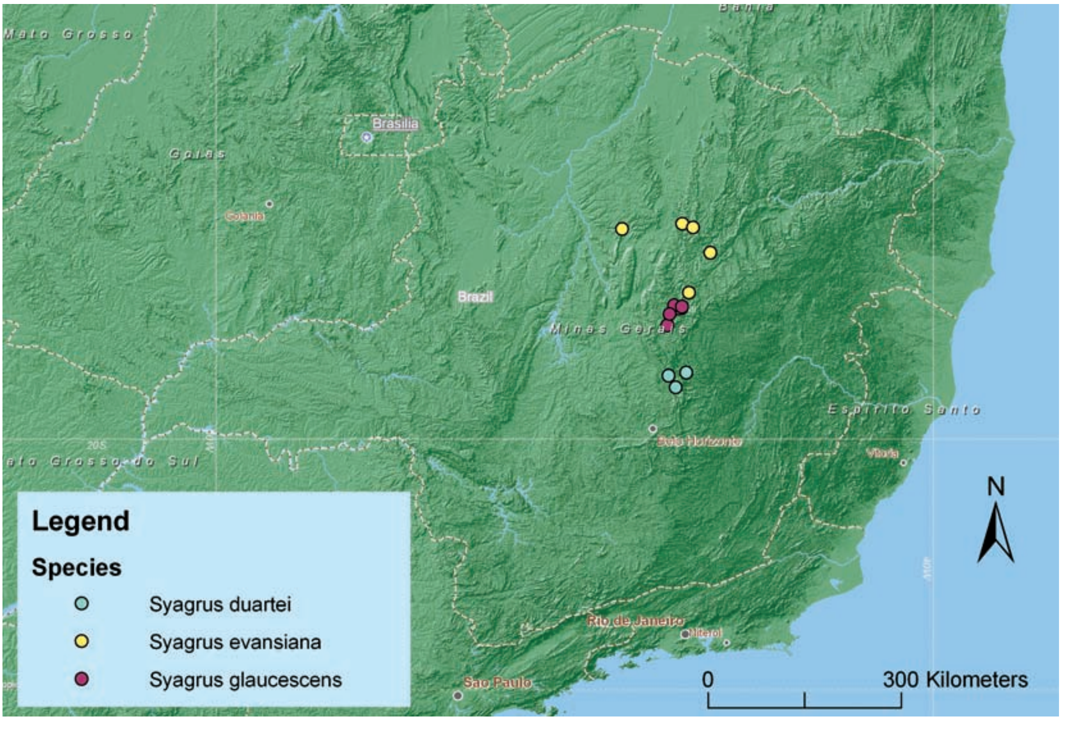
4. The "campo rupestre" or rocky fields habitat of *Syagrus evansiana* in Minas Gerais near Itacambira.

exterior with scattered thin indument becoming increasingly dense near the base, total length ca. 12–48 cm including a beak of 0–1.5 cm, expanded or inflated portion 7–22 cm long, with 1.5–7 cm diam. and 3–11 cm perimeter and 1–2 mm thickness; peduncle glabrous, ca. 8–27 cm long, somewhat flattened in cross-section, 0.3–0.7 × 0.3–0.5 cm diam., rachis 0–6 cm long measured between the lowest and upper branches, primary branches glabrous, numbering 1–8, 4.5–10 cm long at the apex, (2–) 5–8 cm at the base, 4–5 mm diam. at the base and 1–2 mm diam. at its tip, pistillate portion 2–5 cm long with 3–12 pistillate flowers or fruits per primary branch, staminate portion 2–7 cm long; staminate flowers yellow, arranged in triads on the lower portion or in staminate dyads or singly on the upper portion of the primary branch, 8–10 mm long and 4–5 mm wide, sepals and petals 3, sepals 1.5–2 mm long and 1.5–2 mm wide, usually keeled and connate at the base, petals valvate, 7 mm long and 4–5 mm wide with acute tips, nerves indistinct, stamens 6, 4–5 mm long, anthers 3.5–4.0 mm long, filaments 1 mm long, pistillode trifid and less than 1 mm long; basal pistillate flowers elongate pyramidal, glabrous, 11–19 mm long and 5–10 mm wide (apical flowers 8–10 mm × 4–7 mm), sepals and petals 3, sepals imbricate 11–19 mm long and 4–5 mm wide, petals unnerved, imbricate at the base but (upper 4–5 mm) valvate at the tips, 10–11 mm long and 3.5–4.0 mm wide, pistil, with lepidote indument from base to nearly the base of the stigmas, 10–11 mm long and 3.5–4.0 mm in diam., stigmas 3–5, and 3 mm long, glabrous, staminodial ring about 1–3 mm high and 6-dentate; fruit yellowish brown when mature, obscured by a thick brown indument or lepidote tomentum, globose, about as long as wide 2–2.3, 1.4–1.5 cm in diam. with a 1–2 mm thick fleshy-fibrous (pulpy) mesocarp and ca. 1 mm thick endocarp, endocarp ca. 1.4–1.6 cm long × 1.1–1.3 cm diam. with 3–5 visible endocarp pores on the basal end and seed nearly globose ca. 8 mm in diam.

Common Name: *palmerinha*.

Etomology: The specific epithet honors Don Evans, retired Director of Grounds Management at Fairchild Tropical Botanic Garden, Miami, Florida, USA.

Distribution and Ecology: Brazil, locally common in the well-drained, rocky soils and high grassy plains (900–1300 m) of the "campo rupestre" regions (Fig. 4) northwest and north of Diamantina, Minas Gerais, with its *S. glaucescens* populations (Fig. 5), but also in



5 (top). Map showing the state of Minas Gerais, Brazil and the known distribution of *Syagrus evansiana*, *S. glaucescens* and *S. duartei*. 6 (bottom). The type locality of *Syagrus evansiana*, a cerrado between Pirapora and Montes Claros, Minas Gerais.

high altitude cerrado (west of Montes Claros). (Fig. 6) It is not a rare plant; in fact, it is common on the Cadeia do Espinhaço, Minas Gerais (MG). There are areas where it is a dominant plant, i.e. on the high flat grassy plateaus near Itacambira.

Table 1. A comparison between *Syagrus evansiana* and two other closely related species, *S. duartei* and *S. glaucescens*.

	S. duartei	*S. glaucescens*	*S. evansiana*
Peduncular Bract length (cm)	33–73	37–83	12–48
Peduncular Bract length Inflated portion (cm)	20–45	25–40	7–22
Peduncle length (cm)	26–50	21–64	8–27
Inflorescence length (cm)	15–36	16–29	4.5–17
Rachis length (cm)	7–23	5–16	0–8
Stamen length (mm)	8–10.5	6–8.5	4–5
Anther length (mm)	6–9.5	5–7.5	3.5–4
Pistillate flower length (mm)	20–22	8–14	10–19
Pistillate flower width (mm)	4.5–6	4–6	5–10
Fruit length (cm)	3–3.8	2.5–3	2–2.3
Fruit width (cm)	2.5–3.2	1.6–2.5	1.3–1.5
Number of Endocarp pores	3	3	3–5

Phenology: Flowering in June–August and also December and with mature fruits in December.

Additional Specimens Examined: BRAZIL, Minas Gerais, Municipio de Juramento, SE of the city of Juramento on Rd. to Itacambira (Itacambira\Montes Claros), Serra Catuni, border between Juramento and Itacambira. 17°00'S, 43°30'W, Aug 1992. *Don Evans s.n* (FTG); Municipio de Itacambira, 17 Dec 2003, *H.Lorenzi 4269* (HPL), na estrada de terra para Caçaratiba, 17 Dec 2003, *H.* Lorenzi 4276 (FTG, HPL).

Uses: This palm has ornamental potential. It is petite with attractive foliage.

Notes: *Syagrus glaucescens* and *Syagrus duartei* are the two most similar looking palms to *S. evansiana* in terms of foliage. However, *S. evansiana* is smaller overall in relation to the other two (Table 1). The inflated or expanded portion of the peduncular bract is smaller in *S. evansiana* (7–22 cm vs. 20–40 cm). It has a smaller inflorescence, often a spike (4.5–17 cm vs. 15–36 cm long), and smaller rachis (0–8 cm vs. 5–23 cm). *Syagrus evansiana* fruits are less than 2.5 cm long (2.3 cm), while *S. duartei* have the largest fruits at nearly 4 cm (3.8 cm) in length. One unusual character of this new *Syagrus* species is the variable number of pores in its endocarp, with most having three, but several having as many as four and five pores. The overall size of the plants increase (from less than 40 cm to more than a meter) from the western side of its distribution (west of Montes Claros) to the eastern side of its distribution (north of Diamantina), from rocky soils to deep clay soils.

Acknowledgments

Thanks to my friend and former Fairchild Tropical Botanical Garden (FTBG) colleague, Don Evans, for bringing this palm to my attention and for his additional remembrances on the matter. A special thanks to Harri Lorenzi, for his excellent fieldwork, photos and collections. Sincere thanks to FTBG, where I am a research associate, and especially to their volunteer, Wes Jurgens, who furnished the diagnostic plate. The impetus for publishing this species was provided by the National Science Foundation Grant #0212779.

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The Nabonnand Family and Palms

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1. *Washingtonia filifera*, *Livistona chinensis* in the nursery of Paul and Clément Nabonnand around 1900.

The French nurseryman, Gilbert Nabonnand, and his two sons, Paul and Clément, introduced and acclimatized a multitude of exotic plants in the gardens of the Côte d'Azur, in the south of France. In less than a century they also created more than 300 varieties of roses. Paul Nabonnand chose to specialize in the hybridization of palms and produced two notable hybrids.

Gilbert Nabonnand (1828–1903) was born in Grézolles, in the department of La Loire, France. After having trained with nurserymen in his native region he set up his own nurseries in Sorgues and later in Avignon. In 1855 an event changed the course of his career: the Englishman Henry Peter Brougham, 1st Baron Brougham and Vaux (1778–1868), hired him to design and plant the garden surrounding the Villa Eleanor Louise, the splendid property he had built in Cannes. In the ten years that followed, Gilbert Nabonnand planted an incomparable collection of exotic plants; *Araucaria*, *Eucalyptus*, *Ficus*, *Phoenix* and *Syagrus* were planted throughout the grounds. Having built the first villa in Cannes, Brougham was followed by other wealthy English aristocrats who also called upon Nabonnand to design and plant their gardens.

In 1864 Gilbert Nabonnand transferred his nursery operations to Golfe-Juan, bringing him closer to his clientele. The nurseries overflowed with rare plants, to the point that J. Benjamin Chabaud (1833–1915), another figure in the acclimatization of palms to France and director of the Marine Botanical Garden in Toulon, wrote in 1882, "It would be difficult to give the names of all the plants cultivated here; suffice it to say that the palms, whether in pots or in the ground, are grown here by the thousands and all the other most desirable plants for our southern gardens are found here as well." (Chabaud 1882).

Renowned creators of exquisite varieties of roses, Gilbert and his two sons, Paul (1860–1937) and Clément (1864–1949), utilized their knowledge of the techniques of hybridization to improve other plants. While roses were their specialty, they worked with palms, in particular, seeking to create a variety of date palm capable of ripening its fruit on the northern Mediterranean coast. Following the death of their father, the two sons took over the family business (Figs. 1 & 2) until it was sold in 1908. At that time they each chose different directions: Clément set up business in Villeneuve-Loubet and continued the work with roses, while Paul stayed in Golfe-Juan where he acclimatized more and more exotic plants. He also continued the hybridization of palms and created two remarkable hybrids: ×*Butyagrus nabonnandii* and *Phoenix* × *nabonnandii*.

×*Butyagrus nabonnandii* (Prosch.) Vorster

Butia capitata (Mart.) Becc. × *Syagrus romanzoffiana* (Chamisso) Becc.

Around 1890, Paul Nabonnand (Fig. 3) fertilized the flowers of a *Butia capitata* var. *pulposa,* a variety with bigger fruit no longer distinguished from the type, with pollen harvested from *Syagrus romanzoffiana* var. *australis*. This southern variety of queen palm, described by Odoardo Beccari in 1916, has narrow seeds pointed at the extremities but is today included within the typical variety. The hybrids obtained from this cross were heterogeneous and exceptionally beautiful. Visiting the Nabonnand nurseries in order to survey the damage following the hard frosts of December 16 and 17, 1920, Axel Robertson Proschowsky (1857–1944) was stunned when

2. *Syagrus romanzoffiana* and *Brahea edulis* at the same time in the nursery.

he came upon a specimen growing in Paul's garden. This eccentric Danish doctor owned a fantastic garden called "Les Tropiques" on the hillsides of Mont Fabron in Nice and was one of the most extensive collections of exotic plants on the Côte d'Azur. Planted starting in 1895 it included, at its peak, before the brutal winters of 1920 and 1929, one hundred and twenty five species of palms in the ground. It was, according to many, the widest collection ever assembled in Europe. In the French magazine, La Revue Horticole, Axel Robertson Proschowsky proposed to name Nabonnand's hybrid "*Butiarecastrum Nabonnandi*" creating a nothogenus, joining together the names of the two parents of the hybrid and dedicating the specific epithet to its breeder (Proschowsky 1921). As the genus *Arecastrum* has disappeared, being replaced by *Syagrus*, the new name *Butyagrus* was made by the South African botanist Piet Vorster in 1990.

The Nabonnand nurseries sold the hybrid in the early twentieth century after which it was more or less forgotten. It was in the United-States that, by chance, Paul Nabonnand's creation was rediscovered. In 1949 some strange palms, which turned out later to be ×*Butyagrus*, showed up in a nursery in Leesburg, Florida. Three of these crosses were planted in Fairchild Tropical Botanic Garden in Miami and caught the eye of biologist Sidney F. Glassman who named them *Syagrus* × *fairchildensis* (Glassman 1971). Since, at that time, the genus *Butia* was included within *Syagrus*, Glassman thought that he was in the presence of an interspecific hybrid that had not been previously described. He no doubt was unaware of the article written by Axel Robertson Proschowsky forty years earlier. Afterward, Harold E. Moore brought Proschowsky's publication to the attention of the palm community, clarifying that the hybrid must be named ×*Butiarecastrum nabonnandii* according to the International Code of Botanical Nomenclature (Moore 1982).

3. Paul Nabonnand (1860–1937). Photograph illustrating his obituary published in the journal *Les amis des roses*.

At the same time, in France, no other nurseryman sought to reproduce the cross, making ×*Butyagrus* particularly rare in gardens. Today fewer than ten adult specimens are still growing on the French Riviera. Four of them were rediscovered in 1997 in Villeneuve-Loubet by Pierre-Olivier Albano, former vice-president of "Fous de Palmiers," the French palm society and founder of the new sister society, "Ti Palm," which serves members on the French islands of the Caribbean as well as French Guyana. The Villeneuve-Loubet palms are quite different from each other: "One is quite airy, close to a *Syagrus* in appearance without being plumose while the stockiest specimen more closely resembles a *Butia*." (Albano 2001). These palms are growing in the garden of a modern apartment building, on the grounds of the former property of Clément Nabonnand, known as "Lou Mas di Roso" (Front Cover).

Phoenix × *nabonnandii* P. Nabonnand

(*Phoenix canariensis* Chab. × *Phoenix reclinata* Jacq.) × *Phoenix roebelenii* O'Brien

At the end of the nineteenth century Paul Nabonnand experimented with *Phoenix* hybridization. An un-named hybrid was born of a cross between *Phoenix canariensis* and *P. reclinata*. This one, with "longer and more graceful fronds" (Nabonnand 1933) grew vigorously, to a height of between 5 and 6 m in just 35 years. Around 1915, Paul Nabonnand succeeded, with great difficulty, in fertilizing the female flowers of the un-named hybrid with pollen of *P. roebelenii.* Since the two palms do not flower at the same time,

4. *Phoenix* × *nabonnandii* in the royal greenhouses of Laeken (Photo: Frédéric Calmant).

the pollen had to be preserved from one year to the next, and two attempts were necessary. Nabonnand named the hybrid *Phoenix nabonnandii* and presented it, in 1933, at the International Floralies Exposition in Gand, Belgium. He received first prize for this new palm. He gave the palm to Elisabeth of Bavaria, the queen consort of Albert I of Belgium, when she visited the exposition on April 28. It was planted in the royal greenhouses of Laeken, in the location recommended by Nabonnand himself and it is there to this day, growing in the winter garden. This *Phoenix × nabonnandii*, the only one of its kind in Europe, has a curved trunk 25 cm in diameter and 5 m tall; it is supported to prevent its collapse (Fig. 4). Infloresences regularly emerge from the crown of leaves. From an historic point of view, Nabonnand's *Phoenix* hybrid is also outstanding because it is the first instance of a palm hybrid involving three species.

Gilbert Nabonnand owned a garden called "Le Cottage," next to his nursery. Located in Golfe-Juan, on the road to Cannes, it had a particularly protected microclimate. Tree ferns, cycads and palms such as *Brahea edulis*, *Phoenix sylvestris*, *P. reclinata*, *L. decora* and *Washingtonia filifera* flourished here. Unfortunately, in the second half of the twentieth century, after the deaths of Paul and Clément, their properties, nurseries and plantings disappeared, victims of the urbanization of the Mediterranean coastline.

Today forty varieties of roses and these two palms are all that remains of the prestigious work carried out by these two generations of nurserymen.

Acknowledgments

I thank Steve Swinscoe for the English translation, Patricia Cavallo (www.roses-nabonnand.com) for the information about the Nabonnand family and Frédéric Calmant, who supplied the picture of *Phoenix × nabonnandii*.

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Photo Feature

Dypsis bejofo, one of the most majestic of all palms in Madagascar, photographed at Analalafa near Mahavelona, a degraded forest fragment that is nevertheless full of extraordinary palms. When this individual was photographed in October 2008 it represented a new and the most southerly record for a species mostly confined to the forests around the Bay of Antongil. (Photo: John Dransfield)

The Palms of the Makira Protected Area, Madagascar

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The island of Madagascar is widely recognized as a global biodiversity hotspot with high levels of species richness and endemism. The Bay of Antongil region in the northeast is thought to contain the most species-rich habitats in Madagascar (Meyers 2001, Holmes 2007). Over 50% of the island's floral diversity occurs in this area, which also includes some of the world's most important sites for palm conservation.

The largest remnant of almost continuous rain forest in Madagascar stretches from the Masoala Peninsula on the eastern side of the Bay of Antongil to the Makira region, a chain of mountain ranges to the west of Maroantsetra (Moat & Smith 2007; Fig. 1). Despite its biological importance, the area remains incompletely explored with scientific data coming mainly from the edge of the mountains bordering the bay. Difficult access, the large area and the challenging climate (high rainfall and frequent cyclones) are among the factors that have inhibited research in this region. Nevertheless, this region has long been recognized as a top priority for conservation with just over 240,000 ha of rain forest already protected within the Masoala National Park (Kremen et al. 1999) and a further 371,000 ha (Holmes 2007, WCS 2008) in the process of designation as a protected area in the Makira region. These reserves are the two largest protected areas in Madagascar. However, despite their official status, threats such as deforestation and hunting persist within these reserves, resulting in habitat degradation and the decline of various local species (Kremen 2003).

The Bay of Antongil

The high levels of biodiversity observed in the Antongil region can be explained by a combination of geographic and climatic factors, which promote the co-occurrence of different species on a very fine scale. Topography varies dramatically with relatively large gradients in elevation occurring over small distances. In most cases a littoral plain is absent. Mountain slopes often start from the shoreline and the terrain is usually rugged and steep. The geology is mainly based on Antongil granites, but some metamorphic (gneiss, quartzite), ultramafic and alluvial substrates also occur. From the climatic perspective, the highest humidity in Madagascar is recorded in the vicinity of Maroantsetra. There is no dry season in this area. With mean annual precipitation estimated to exceed 3500 mm and occasionally reaching 5900 mm (Jury 2003), humidity remains at 85% throughout the year (Chaperon et al. 2005). This high degree of diversity in the landscape coupled with the permanent moisture appears to provide ideal conditions for high rain forest species richness.

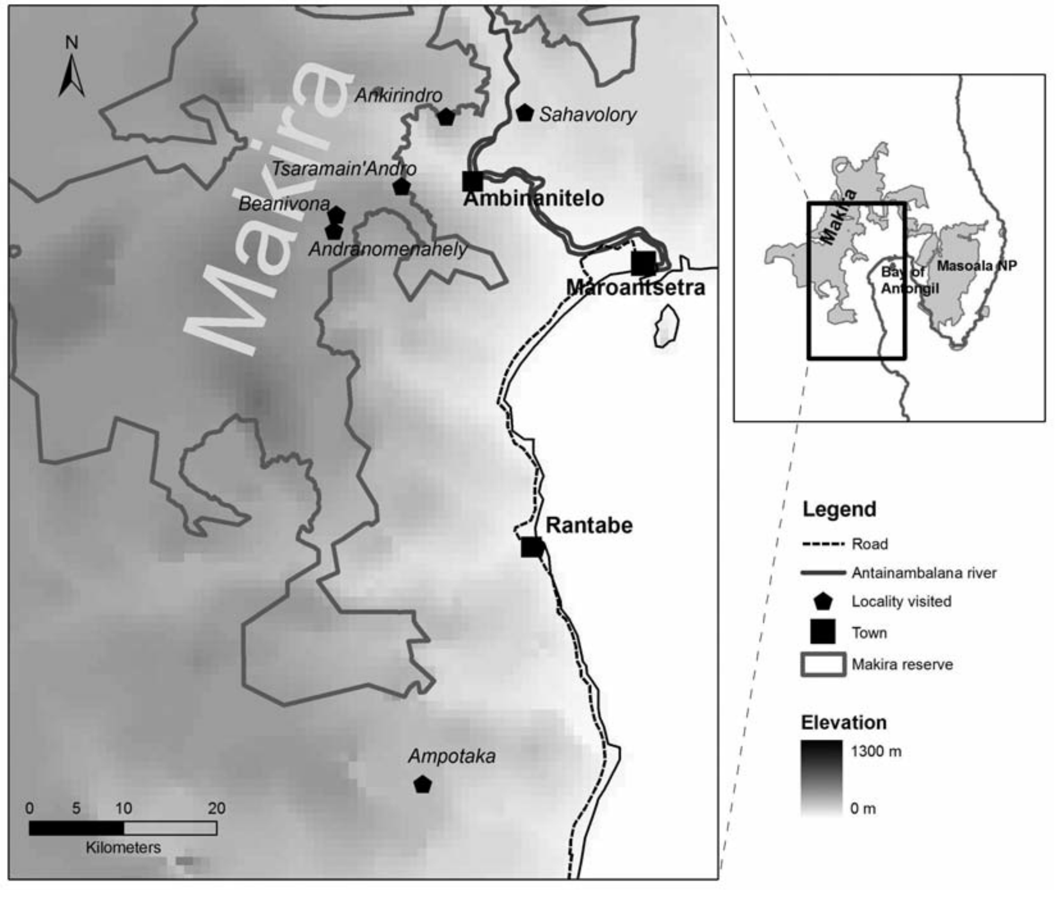
The palm flora of the Masoala Peninsula is relatively well known in some areas. Sixty species of palms have been recorded from Masoala, which equates to 34% of the total Madagascar palm flora occurring within less than 1% of the island's surface (Kremen et al. 1999). In comparison, the palm flora of the Makira chain is scarcely explored with only three species (*Ravenea albicans*, *Dypsis lucens*, *D. monostachya*) confirmed from the general area by Dransfield and Beentje (1995). The shortage of data has left two key questions unanswered. Firstly, is the Makira area as significant a palm diversity hotspot as the adjacent Masoala Peninsula? Secondly, how does the species composition of Makira compare to that of Masoala and other parts of Madagascar?

To address these questions, three expeditions to the Makira chain were conducted in 2005 and 2007 by scientists from the Royal Botanic Gardens, Kew (RBG Kew) and Parc Botanique et Zoologique de Tsimbazaza (PBZT). Although our findings do not give a complete assessment of palm diversity throughout the Makira chain, some surprising results were obtained that indicate the considerable importance of the Makira protected area to the conservation of Madagascar's threatened palms.

Palm flora of the eastern central Makira

Two of the three expeditions focused on the eastern part of the central section of the Makira protected area. Both gained access from

1. Map showing location of field sites in the Makira protected area. Inset map illustrates the location of the Makira protected area and Masoala National Park in northeast Madagascar.



2. *Dypsis thiryana* near the Andranomenahely camp

Ambinanitelo, a small town on the Antainambalana river ca. 20 km west-northwest of Maroantsetra (Fig. 1). The first trip was a short, preliminary excursion carried out by Adam Britt (RBG Kew) and Franck Rakotonasolo (PBZT) in March 2005 to Tsaramain'Andro, a mountainous locality that reaches ca. 700m just inside the protected area due east of Ambinanitelo. The second expedition was accomplished over two weeks in May 2007 and involved palm researchers from RBG Kew (Mijoro Rakotoarinivo, Bill Baker and Melinda Trudgen), as well as Rubiaceae (coffee family) specialists Aaron Davis, Marie Briggs and Tiana Ranarivelo (RBG Kew) and Franck Rakotonasolo (PBZT). Three field sites were selected for this second expedition based on their relative accessibility and reported variation in vegetation, and are the primary focus of discussion below. Table 1 lists the species recorded and collected in each site. Five new species discovered on these expeditions are described formally below.

Prior to the 2007 expedition, we made a prediction of the potential palm flora of the region using the software Maxent (Maximum Entropy Species Modelling) based on random point localities generated within the region that we planned to visit. Surprisingly, the species included in the potential list were mostly typical of habitats at elevations exceeding 1200 m whereas the range in elevation of our field sites would largely be classified as lowland. These results confirmed a trend detected by the collections made by Britt and Rakotonasolo in Tsaramain'Andro where montane species such *Dypsis spicata* and *D. oreophila* were collected at around 700 m; elsewhere these species are known to occur frequently above 1100 m in the Marojejy mountains. Thus, Makira became even more interesting for palm research because the predictions suggested that we would find a diverse flora quite unlike that of the Masoala Peninsula, containing many montane palm species at unusually low elevations.

The first site visited during the 2007 fieldwork was located in the vicinity of the small river Andranomenahely that drains from the mountain plateau of Beanivona. We worked from a base camp on the banks of the Andranomenahely at 700 m, collecting up to the Beanivona plateau at ca. 950 m; we observed quartzite geology throughout. The camp-site was reached by walking for two days from Ambinanitelo via Ambalamahogo, spending the first night at Anjiahely.

The vegetation in this area comprises tall rain forest that is largely lowland in character, but with montane elements increasing with elevation. The composition of the palm flora

Table 1. Inventory of palms recorded in Makira. The occurrence in a locality is indicated by a collector's number where herbarium specimens were collected or with a symbol (+) where a sight record was made. Abbreviations correspond to collectors: AB (Adam Britt), MST (Melinda Trudgen), RMJ (Mijoro Rakotoarinivo) and WB (William Baker). Specimens are deposited at the herbaria at K and TAN, with duplicates of many collections also in P and MO.

	Eastern Central Makira					Southern Makira
Species	Tsaramain' Andro 750–850 m	Andrano-menahely to Beanivona 700–900 m	Summit of Beanivona 950 m	Sahavalory 100–200 m	Ankirindro 400–650 m	Ampotaka 300-600 m
1. *Dypsis ankirindro*			RMJ340		WB1329	
2. *Dypsis baronii*	+	+	+		+	
3. *Dypsis bejofo*		MST72				+
4. *Dypsis bonsai*		WB1323				
5. *Dypsis brittiana*	AB211					
6. *Dypsis ceracea*		RMJ342				
7. *Dypsis concinna*			+			
8. *Dypsis confusa*				+		
9. *Dypsis coriacea*					MST77	
10. *Dypsis coursii*		+	WB1322			
11. *Dypsis crinita*+						
12. *Dypsis fasciculata*		RMJ343		+	+	
13. *Dypsis fibrosa*		+				+
14. *Dypsis forficifolia*	AB204, AB205, AB233	MST73	WB1324	+	MST78	
15. *Dypsis humilis*				MST74, MST75		
16. *Dypsis lantzeana*				WB1327	+	
17. *Dypsis lastelliana*		+		+		+
18. *Dypsis makirae*	AB195, AB207	+			RMJ346	
19. *Dypsis mocquerysiana*				RMJ345	+	
20. *Dypsis nodifera*		+		+	+	
21. *Dypsis oreophila*	AB199	MST68		+	+	

Table 1 (continued).

Species	Eastern Central Makira					Southern Makira
	Tsaramain' Andro 750–850 m	Andrano-menahely to Beanivona 700–900 m	Summit of Beanivona 950 m	Sahavalory 100–200 m	Ankirindro 400–650 m	Ampotaka 300-600 m
22. *Dypsis paludosa*				+		
23. *Dypsis perrieri*		+			WB1328	+
24. *Dypsis pinnatifrons*	AB231	+		+	+	
25. *Dypsis procera*		WB1321			+	
26. *Dypsis procumbens*	AB206, AB210		+			
27.*Dypsis rakotonasoloi*	AB209					
28. *Dypsis* aff. *serpentina*	AB198	RMJ339				RMJ 178
29. *Dypsis spicata*	AB201, AB202	WB1320, MST67			MST76	
30. *Dypsis thiryana*	AB208, AB232	MST69				
31. *Dypsis tsaravoasira*		+				
32. *Lemurophoenix halleuxii*						RMJ 177
33. *Marojejya insignis*		MST71				
34. *Masoala madagascariensis*						+
35. *Orania ravaka*		RMJ338			+	+
36. *Ravenea albicans*		WB1325				
37. *Ravenea dransfieldii*					MST79	+
38. *Ravenea julietiae*		+				
39. *Ravenea lakatra*					+	
40. *Ravenea robustior*						+
41. *Ravenea sambiranensis*		MST70		+	+	+
42. *Satranala decussilvae*						+
43. *Voanioala gerardii*						RMJ 176

3. The Andranomenahely catchment viewed from the mountain thicket at the edge of the Beanivona plateau.

in this area is very similar to that found at Tsaramain'Andro (see Table 1 for summary). The canopy of the lower rain forest in the vicinity of the Andranomenahely camp contains hundreds of individuals of *Dypsis bejofo* and some *Orania ravaka*. In its undergrowth occur many small palm species including *D. oreophila, D. spicata, D.* aff. *serpentina, D. thiryana* (Fig. 2) and numerous individuals of *D. makirae*, a new species first collected in Tsaramain'Andro in 2005 and described here (Back Cover). The habit of this new species is close to *D. procumbens*, but the inflorescence structure is completely different and the leaflets are strongly hooded. Other notable species in this area include *Dypsis perrieri*, *Ravenea albicans* and *R. julietiae*.

Even though the altitudinal difference between the camp area and the Beanivona plateau is not very great, vegetation types differ significantly (Fig. 3). Above the Andranomenahely camp, tall submontane forest persists with a similar palm flora, but with notable additions, such as *Dypsis ceracea*, *D. tsaravoasira* and *Marojejya insignis*. At the foot of the plateau itself, the transition between typical rain forest and the summit vegetation is abrupt due to the sudden steepness of the slopes and increased exposure of the vegetation. The last steep slope before the plateau itself is highly distinctive. The vegetation here is stunted as wind sweeps it permanently, with cloud masking the upper part of the plateau at the time of our visit. This mountain thicket vegetation becomes somewhat taller, but no less dense as the plateau flattens out ahead. Here, *D. coursii* (Figs. 4 & 5) occurs frequently, along with species such as *D. bonsai*, *D. baronii*, *D. concinna* and *D. procumbens*. A further new species similar to *D. andrianatonga*, described here as *D. ankirindro* (Figs. 6, 7 & 15), was discovered here. This dramatic change in vegetation results in a rapid turnover in the palm flora; out of the 28 species found between Andranomenahely and Beanivona, only *Dypsis oreophila* and *Ravenea sambiranensis* occur throughout.

Our second field site, Ankirindro, is a mountain located ca. 8 km northwest of Ambinanitelo. After about four hours walking from Ambinanitelo across cultivated land and then up very steep slopes, we made a camp in a clearing just inside the boundary of the protected area at about 400 m. Above this elevation, Ankirindro is still covered by relatively intact rain forest, although there is evidence of human activity. Most of the lower

4 (left). *Dypsis coursii* in the mountain thicket vegetation of Beanivona. 5 (right). Infructescences of *Dypsis coursii*. The fruit flesh splits to reveal the delicately grooved seed.

6 (left). *Dypsis ankirindro* on the summit plateau of Beanivona. 7 (right). *Dypsis ankirindro* on the summit plateau of Beanivona.

slopes are deforested. Canopy palms are rare here; only two species, *Orania ravaka* and *Ravenea sambiranensis*, are relatively frequent. *Ravenea dransfieldii* (Figs. 8 & 9) and *R. lakatra* are also found but only locally. In contrast, palms found in the undergrowth are diverse and, in some cases, common. For example, species such *Dypsis forficifolia, D. lantzeana, D. mocquerysiana* (Figs. 10 & 11)*, D. fasciculata, D. spicata* and *D. coriacea* are abundant.

The summit of Ankirindro consists of a rather level, crescent-shaped ridge some 1.5 km in length, ranging from around 600 m to the summit at over 650 m. An extraordinary elfin forest occurs here, strongly montane in appearance despite the low elevation, growing over compacted fine quartzite sands. The palm flora here contains many elements that were observed at higher elevations around Beanivona, such as *Dypsis baronii, D. ceracea* and *D. spicata*. In the shallow slopes behind the ridge, we found *D. perrieri* and *D. makirae* (Back Cover; Figs. 12 & 18). *Dypsis baronii* and *D. ankirindro* were abundant on the ridge itself.

Our third field site, Sahavalory, is a granite hill (ca. 300 m) above the Antainambalana river opposite the village of Ambodivohangy. We reached the site by travelling north by pirogue from Ambinanitelo. Just before the village of Ambodivohangy, clumps of *Dypsis lutescens* occur infrequently along the riverside. Sahavalory falls outside the boundary of the Makira protected area and is extensively damaged, but some parts are managed by the local community. The species found in the forested areas visited by us reflected the expected palm flora of lowland, northeastern Madagascar (e.g. *Dypsis lastelliana, D. confusa, D. lantzeana, D. mocquerysiana*, *D. crinita, D. forficifolia*). Our visit lasted only one half-day, and in this time the region could not be surveyed in full. Nevertheless, in addition to the widespread species found here, we discovered a new acaulescent *Dypsis* species, described here as *D. humilis* (Figs. 13, 14 & 17), that is quite distinct from the two remaining acaulescent species in Madagascar, *D. acaulis* and *D. aquatilis*. In addition, we found juveniles of a *Dypsis* species with plumose

8 (left). *Ravenea dransfieldii* on Ankirindro. 9 (right). Infructescences of *Ravenea dransfieldii.*

leaflets. Correct identification of the species was not possible as no mature trees were seen, but the huge size of these young individuals and their more or less open, glabrous leaf sheaths suggest that they may be identified as *D. tokoravina*.

Notably, two new species discovered by our colleagues Adam Britt and Franck Rakotonasolo, *Dypsis brittiana* and *D. rakotonasoloi*, were not re-discovered by us in any of the localities visited in 2007. This suggests that these species may be restricted in distribution.

Palm flora of southern Makira

The remaining expedition focused on the Ampotaka area between Rantabe and Mananara Avaratra, in the southern part of Makira chain but outside the protected area, and was conducted by Mijoro Rakotoarinivo in 2005 with the help of local guides. The Ampotaka area is located at around 300–600 m and is reached by walking for two days from Rantabe via Maromahitsy, crossing the mountain chains to the west. The rain forest on the steep mountain slopes of this area is more or less intact. Forest clearance is controlled here as this area is part of the buffer zone of the Makira protected area, although some disturbance was observed.

The primary aim of visiting Ampotaka was to investigate rumors concerning the occurrence of endangered taxa such as *Voanioala gerardii* and *Lemurophoenix halleuxii* that were previously known only from the Masoala Peninsula. A thorough palm survey could not be conducted due to time limitations. However, general observations indicate that the palm flora of this area is rather different to that of eastern central Makira and is more similar to that of western Masoala or Mananara Avaratra. The humid forest of Ampotaka is mainly inhabited by palms such as *Dypsis bejofo, D. fibrosa, D. lastelliana, D. perrieri, D.* aff. *serpentina, Masoala madagascariensis, Orania ravaka, Ravenea dransfieldii, R. robustior* and *Satranala decussilvae* (Table 1). Most significantly, the occurrence of both *Voanioala* and *Lemurophoenix* was confirmed. About 10 mature individuals and many juveniles of *V.*

gerardii were observed, substantially more than the Masoala population at Antalavia where only a single reproductive individual was observed in 2005. Four fruiting individuals of *L. halleuxii* were located at Ampotaka.

Composition of the Makira palm flora

In total, 38 species of palms were recorded on the two expeditions to eastern central Makira. This area can thus be considered to have a diverse palm flora compared to other sites in Madagascar. Higher species richness in similar-sized areas is known only from Mananara Avaratra and the west coast of Masoala between Tampolo and Antalavia with 43 and 39 species respectively. Our preliminary observations in southern Makira located some rare species of exceptional conservation significance, bringing the total for the Makira area to 43 species. However, the survey in the south cannot be considered in any sense to be complete and did not re-locate two species reported from the general vicinity by Dransfield and Beentje (1995; *Dypsis lucens* and *D. monostachya*). If a more thorough census of the Makira palm flora is completed with all the varied geologies and elevations sampled effectively, it is possible that this region possesses the richest palm diversity in Madagascar.

As suggested by our predictive modelling, the list of species found in eastern central Makira is indicative of montane forests and yet the altitudinal range of almost all the locations visited are technically classified as lowland (0–800 m; Humbert & Cours-Darne 1965). The palm species composition shows a close affinity with that of the upper part of Marojejy, rather than the closer, topographically similar Masoala Peninsula and Mananara Avaratra. Species such *Dypsis baronii, D. bonsai, D. ceracea, D. oreophila, D. procumbens* and *D. spicata* are frequent at 1000–1300 m in the Marojejy mountains (Dransfield & Beentje 1995). Moreover, the rarity of certain species such as *Dypsis lastelliana* and *D. tsaravoasira*, which are abundant in Masoala and any other east coast lowland rain forest between Ampasimanolotra (Brickaville) and Antalaha, suggests that environmental conditions in Makira are significantly different despite its low elevation.

10 (left). *Dypsis mocquerysiana.* 11 (right). *Dypsis mocquerysiana* inflorescences.

The montane character of central Makira, as evidenced by the palm flora and the occurrence of stunted forest, may be explained by a reverse "Massenerhebung effect" or "mass elevation effect" (Van Steenis 1961). This effect brings about dramatic variation in vegetation zonation through the proximity of mountains to the coast, which increases atmospheric humidity and lowers the cloud ceiling. Grubb and Whitmore (1966) stated that the frequency of cloud or fog (or both) is the most important factor determining the stature of montane forest. The persistent cloud cover in the mountains of central Makira appears to create a suitable climate for taxa adapted to higher elevations and eliminates some lowland species that are intolerant of such conditions despite the fact that the elevation is still within their normal range.

Nevertheless, the mountain mass effect is not enough to explain the astonishing dissimilarity and turnover between the palm flora of Makira and adjacent Masoala or the striking difference between the central and the southern parts of Makira, which receive comparable annual precipitation and share similar topography. The reason may come from patterns of atmospheric circulation around the Bay of Antongil. The southeastern trade wind (Alizé) is concentrated after entering the bay, promoting the high rainfall in this part of Madagascar (Donque 1972), but its influence on temperature varies dramatically around the bay. Mountain chains to the north of Maroantsetra (central and northern parts of Makira) are perpendicular to the direction of the trade wind. Their slopes force the wind currents to ascend, destabilizing the air and decreasing the temperature through persistent drizzle or fog. In contrast, the mountains either side of the Bay of Antongil (i.e. Masoala, southern Makira chain, Mananara Avaratra) run parallel to the direction of the wind. While heavy rain and cloud is characteristic of these areas, the air current remains stable and temperatures high. To summarize, the effect of the trade wind creates lower temperatures at equivalent elevations in central/northern Makira than in Masoala or southern Makira. This may explain the occurrence of taxa favoring warm and perhumid conditions such as *Lemurophoenix halleuxii, Voanioala gerardii, Marojejya darianii* and *Satranala decussilvae* on either side of the Bay of Antongil and their apparent absence northwest of Maroantsetra. Conversely, it may also permit the occurrence of high mountain taxa at lower elevations northwest of Maroantsetra that do not occur either side of the bay. This montane trend in the northern part of Makira should become more accentuated further north towards Marojejy or Anjanaharibe-sud.

12. A juvenile plant of *Dypsis makirae* showing distinctive simple bifid leaf form.

Conclusions

Although the three expeditions described here have covered only a fraction of the Makira area, they have already provided answers to the questions posed in our introduction. Clearly the palm diversity of Makira is similar to Masoala and perhaps even richer. In composition, the montane bias in the palm flora of central Makira north of the Bay of Antongil is in stark contrast to that found on either side of the bay and in other comparable low elevation areas of Madagascar, and is most likely driven by local effects of topography on climate. This compositional variation further accentuates the global significance of the Bay of Antongil region as a palm hotspot.

The high diversity of palms found during our expeditions mirrors the findings of other

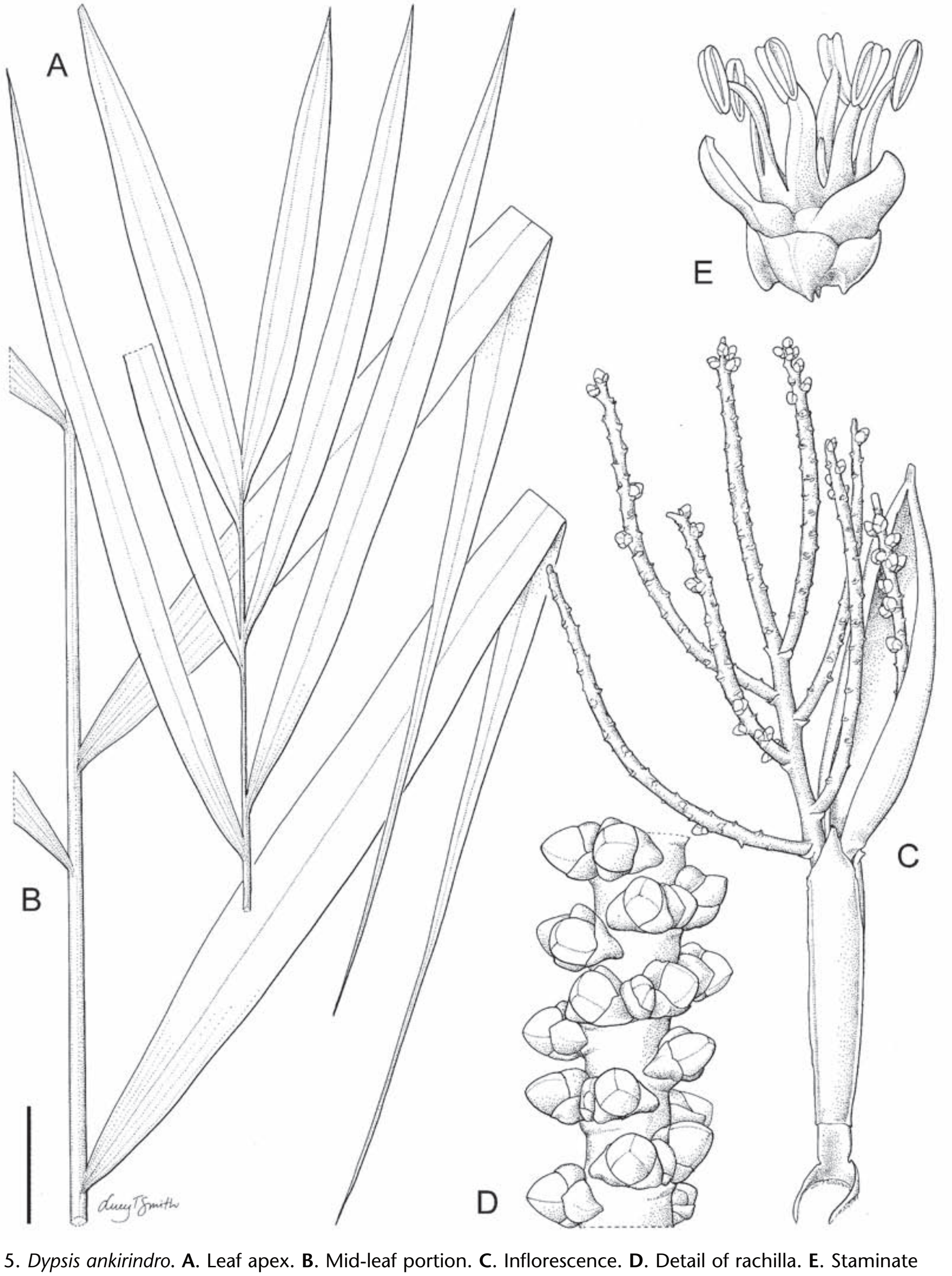
13. The type plant of *Dypsis humilis* on Sahavalory. 14. Inflorescences of *Dypsis humilis*.

fieldworkers in Makira who have also recorded high levels of species richness, turnover and endemism (including undescribed species) in other plant groups, birds, insects and freshwater fish (e.g. Missouri Botanical Garden 2003, Meyers 2001). These observations highlight the importance of Makira for biodiversity conservation in Madagascar and the need for a full biological inventory of the area. The proposed protection of Makira, the largest rain forest remnant and single largest protected area on the island, is thus a truly significant and timely step in the protection of Madagascar's extraordinary yet beleaguered biota.

Taxonomic treatments of new species

1. Dypsis ankirindro W.J.Baker, Rakotoarin. & M.S.Trudgen **sp. nov.**, a *D. andrianatonga* caule non ramificanti inflorescentiis infrafoliaribus differt Typus: Madagascar, Toamasina, Maroantsetra, Makira protected area, just below summit of Ankirindro, May 2007, *Baker et al. 1329* (holotypus K, isotypus TAN).

Clustering palm. **Stem** to ca. 5 m high, erect, ca. 2–3 cm diam., internodes 2–3.6 cm, green with corky warts. **Leaves** 5–7 in the crown, spiral, erect, crown shuttlecock-like; sheath 25–32 cm, ca. 3.5 cm diam., closed, forming well-defined crownshaft to 50 cm long, green with scattered dark scales and black indumentum towards apex and grey bloom when young; petiole ca. 30 cm long, 6–7 mm wide, sparsely to densely black/brown scaly, sometimes with thin grey indumentum, adaxially channeled; leaf rachis ca. 60 cm long, 4–6 mm wide at mid point, triangular in section, indumentum/scales as rachis; leaflets narrowly to broadly lanceolate, leathery, single-fold, sometimes narrowly tapering, 10–20 on each side of the rachis, regularly arranged, ascending slightly then tips drooping, inserted 8–14 cm apart, proximal leaflets 35–72 × 0.5–2.5 cm, median leaflets 37–56 × 2.6–3.5 cm, distal leaflets 6–18 × 0.6–1.5 cm, sparsely to quite densely dark scaly on both surfaces, scales more abundant towards base and on abaxial surface, few medifixed ramenta on abaxial surface of midrib. **Inflorescence** infrafoliar, branched to 1 order; peduncle 9–12 cm long, ca. 0.8 cm wide, glabrous or with scattered scales;



15. *Dypsis ankirindro*. **A**. Leaf apex. **B**. Mid-leaf portion. **C**. Inflorescence. **D**. Detail of rachilla. **E**. Staminate flower. Scale bar: **A**, **B**, **C** = 4 cm; **D** = 1 cm; **E** = 6 mm. **A–C**, **E** from *Baker et al. 1329*, **D** from *Rakotoarinivo 340*. Drawn by Lucy T. Smith.

prophyll 9.5–10.5 cm long, 2–2.5 cm wide, borne 1–2 cm above the base of peduncle, 2-keeled, opening apically, persistent; peduncular bract 20–26 cm × ca. 4 cm, cucullate, opening longitudinally, persistent, inserted at ca. 4 cm from the base of the peduncle; rachis 3.5–7.5 cm long, with scattered scales, with ca. 9 rachillae; rachillae 10–17 cm long, up to 8 mm diam. at widest point, indumentum as rachis, rachilla bracts conspicuous, triads quite closely spaced. **Staminate flowers** 8–9 × 11–13 mm at anthesis, sepals 3, 4 × 4–4.5 mm, imbricate, cucullate, thick, with angular abaxial ridge, petals 3, 3.5–4.5 × 4–4.5 mm, valvate, triangular, stamens 6, erect, recurving, filament 6–7 × ca. 1.5 mm, flattened, briefly united basally, anthers medifixed ca. 3 × 1.5 mm; pistillode 2–3 × 1–1.5 mm, pyramidal; **Pistillate flowers** immature, bud ca. 4 × 6 mm, ovoid, perianth imbricate, staminodes 6, to 2 mm long, gynoecium 5 × 3 mm, ellipsoid. **Fruits** not seen. **Seeds** not seen.

Specimens examined: Madagascar, Toamasina, Maroantsetra, Makira protected area, Ambinanitelo: just below summit of Ankirindro, May 2007, *Baker et al. 1329* (holotype K, isotype TAN); summit of Beanivona, May 2007, *Rakotoarinivo et al.* 340 (K, TAN, MO).

Distribution: Northeast Madagascar, known from two mountains in the eastern central part of the Makira protected area.

Habitat: Mountain summit vegetation, elfin forest and mountain thicket on quartzite, 650–950 m.

Vernacular name: Not recorded.

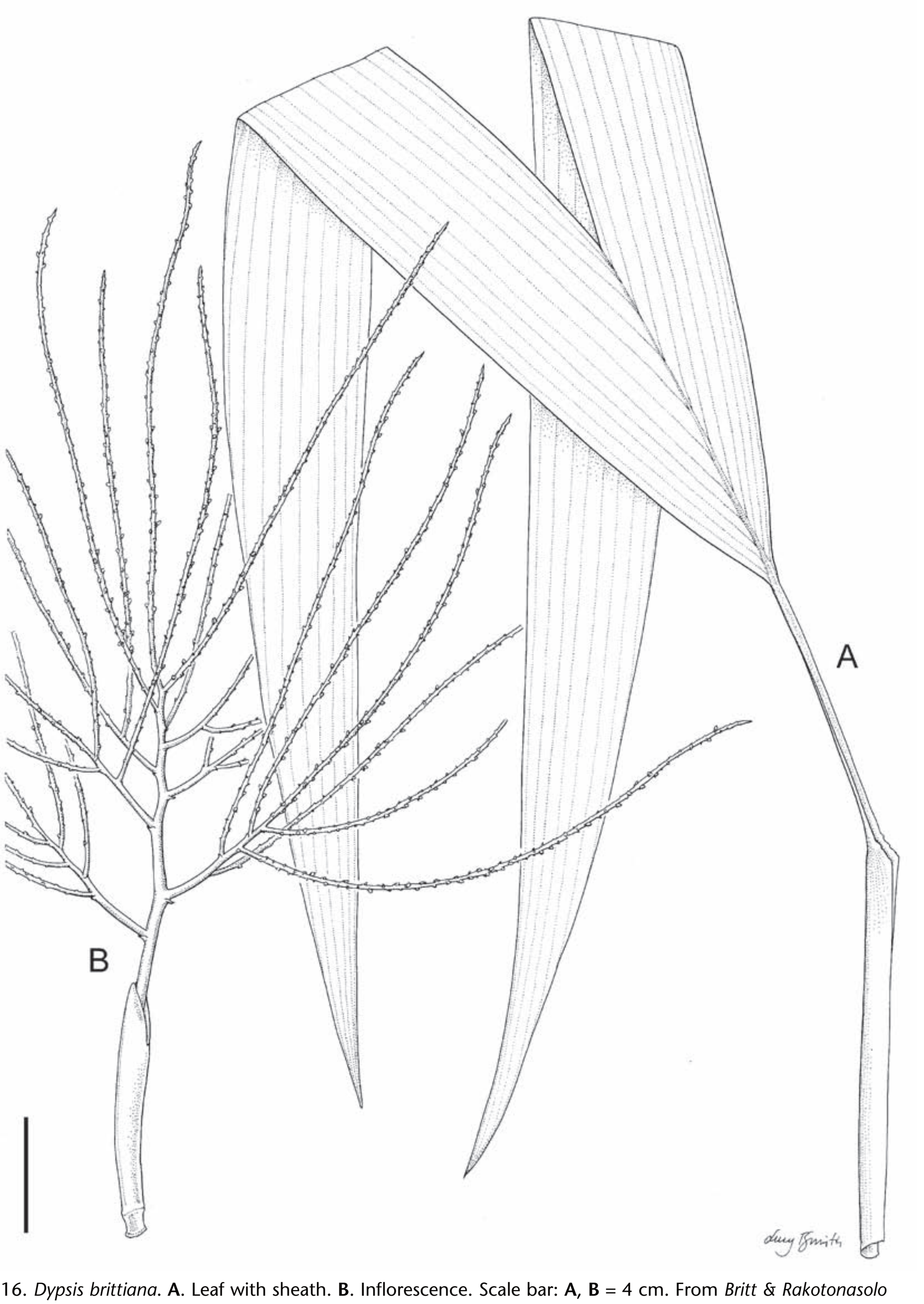
Conservation status: Vulnerable [VU (D2)] (provisional assessment). Populations restricted to the summit of mountains in the central eastern part of Makira (Ankirindro and Beanivona), numbers of individuals are low and the area of occupancy is small. Nevertheless, isolation, difficult access and protection of its habitat decrease the risk of extinction of this species currently.

Notes: This new taxon (Figs. 6, 7 & 15) falls into *Dypsis* Group 3 (Dransfield & Beentje 1995). Other species from this group that occur in the same area include *D. baronii*, *D. oreophila* and *D.* aff. *serpentina*. Of these, *D. ankirindro* is most similar to *D. serpentina*, but it more closely resembles *D. andrianatonga*, which is not yet recorded from Makira. However, both of these species have somewhat floppy, snaking stems that branch aerially, in contrast to the erect, unbranched habit of *D. ankirindro*. The new species also has somewhat broader elliptic leaflets, compared to the rather narrowly elliptic or linear leaflets of the other two species, as well as inflorescences that appear somewhat more robust. In addition, *Dypsis serpentina* has irregular or grouped leaflets, while *D. ankirindro* has regular leaflets, and *D. andrianatonga* has interfoliar inflorescences compared to the infrafoliar inflorescences of *D. ankirindro*. We have observed a degree of variability in *D. ankirindro* in leaf morphology that may correspond with altitude. We acknowledge that distinguishing species in this group can be problematic and it is possible that species limits may be reconsidered when further new material becomes available. As a practical solution, however, we formally recognize this entity here to account for the new morphological dimensions that we have observed in the field.

2. Dypsis brittiana Rakotoarin. **sp. nov.**, habitu et foliis *D. procerae* et *D. paludosae* similis sed floribus staminatis 6 staminibus didymis vice 3 staminibus sagittatis differt. Typus: Madagascar, Toamasina, Maroantsetra, Makira protected area: Tsaramain'Andro, March 2005, *Britt & Rakotonasolo 211* (holotypus K, isotypus TAN).

Slender palm. **Stem** to 3 m tall, ca. 1.5 cm diam. **Leaves** 4–8 in the crown; sheath ca. 13–18 cm × 2.8 cm, forming a crownshaft, densely covered with red-brown stellate scales, open apically; petiole ca. 10 cm long, 4–5 mm wide, shallowly channeled to adaxially flat, abaxial surface covered of red brown scales; rachis ca. 14 cm, densely pubescent-scaly in the abaxial surface; blade entire-bifid, 54–60 × ca. 13 cm, lobe ca. 45 cm long, ca. 12 cm wide, main veins prominent, 10–12 in each side of the rachis, abaxial surface glabrous except for scattered ramenta 2.5–3 mm long, apex toothed. **Inflorescence** infrafoliar, erect to pendulous, branched to 2 orders; peduncle ca. 10 × 0.4 cm, densely puberulous; prophyll ca. 8.5 × 0.8 cm, keeled, borne at 0.8 cm above the base of peduncle, minutely scaly, opened in the ca. 2.3 cm of the distal; peduncular bract not seen, deciduous, borne at ca. 2 cm above the base of peduncle; rachis ca. 7.5 cm long, puberulous, with ca. 6 branched and 4 unbranched first order branches, the proximal with a rachis to 5.5 cm, slightly flattened, with 3–7 rachillae; rachillae 20–22 cm long, ca. 1 mm diam., red-brown, covered with trichomes, triads 0.8–1.2 mm apart. **Staminate flowers** sepals 1.1–1.2 × 1.1–1.4 mm, imbricate, asymmetric, keeled, minutely puberulous; petals 1.5–1.6 × 1–1.2 mm, valvate, striate, elliptic, coriaceous; stamens 6, didymous, filaments ca. 0.2 mm, anthers 0.3–0.5 × 0.5–0.6 mm, locules divergent, pistillode minute. **Pistillate flowers** measures from young bud: sepals 1.4 × 1.1–1.4 mm, imbricate, asymmetric, petals ca. 1.3 × 0.7, valvate, fleshy; staminodes 6, ca. 0.5 mm high; pistil ca. 0.7 mm high. **Fruits** not seen.

Specimens examined: Madagascar, Toamasina, Maroantsetra, Makira protected



16. *Dypsis brittiana*. **A**. Leaf with sheath. **B**. Inflorescence. Scale bar: **A, B** = 4 cm. From *Britt & Rakotonasolo 211*. Drawn by Lucy T. Smith.

area, Ambinanitelo: Tsaramain'Andro, March 2005, *Britt & Rakotonasolo 211* (holotype K, isotype TAN).

Distribution: Northeast Madagascar, known from a single locality in the eastern central part of the Makira protected area.

Habitat: Primary rain forest, on ridge tops, ca. 900 m.

Vernacular name: Not recorded.

Conservation status: Critically endangered [CR (B1a)] (provisional assessment). This palm is known only from a single specimen collected at Tsaramain'Andro on the 2005 Makira expedition. This locality is just on the eastern boundary of the Makira protected area. It was not recorded again from any of the localities visited on the 2007 expedition. We infer from these limited data that *D. brittiana* is likely to be narrowly restricted in distribution and the provisional rating provided here is thus appropriate.

Notes: Unfortunately, there is just one herbarium collection of this species (Fig. 16). Nevertheless, it has been impossible to match it with any described species of *Dypsis*. In order to draw attention to it, we are describing it as new in the hope that more material will be collected. It is superficially similar to *Dypsis procera* and *D. paludosa*, but differs in its androecium. In *D. brittiana*, there are six didymous stamens whereas in *D. procera* and *D. paludosa* (*Dypsis* Group 13 of Dransfield and Beentje 1995) the androecium comprises three antesepalous stamens.

Dypsis brittiana is named for Adam Britt, former colleague at Kew, who conducted the first palm exploration of Makira with Franck Rakotonasolo, during which this new species was discovered.

3. Dypsis humilis M.S.Trudgen, Rakotoarin. & W.J.Baker **sp. nov.**, a *D. acauli* inflorescentia in 1 ordinem ramificanti et floribus staminatis 6 staminibus differt. Typus: Madagascar, Toamasina, Maroantsetra, Sahavalory forest near Ambodivoahangy, May 2007, *Trudgen et al. 74* (holotypus K, isotypi TAN, MO, P).

Clustering, acaulescent palm. **Leaves** 8 in the crown; petiole ca. 40 cm long, 3–4 mm wide, densely black/brown scaly, adaxially flat; leaf rachis ca. 40 cm long, in mid-leaf 1.2–2 mm wide, pubescent/scaly; leaflets sigmoid, 8 on each side of the rachis, borne regularly, inserted 1–5 cm apart, proximal leaflets 22–27 × 2–3 cm, with 2-3 folds, median leaflets 20–23 × ca. 2 cm, single fold, distal leaflets 10–14 × 2–3.5 cm, with 3-5 folds, abaxial surface sparsely brown scaly, distal margins of leaflets densely scaly, medifixed ramenta on abaxial surface of mid-veins in proximal half of leaflets, 0.1–0.4 mm long. **Inflorescence** 22–35cm long, interfoliar, branched to 1 order, erect; peduncle 10–15 cm long, 0.5–2 mm wide, pubescent; prophyll 6–7 cm long, 0.5–1 cm wide, 2-keeled, opening apically; Peduncular bracts 2; first peduncular bract similar to prophyll, 11–13 cm long, 0.5–1 cm wide, borne 4 cm above the insertion of the prophyll, opening apically; second peduncular bract triangular, not enclosing the peduncle, 0.2-0.4 cm long; rachis ca. 15 cm long, pubescent, with 4–6 rachillae; rachillae to 14 cm long, 0.8–1.4 mm diam., 0.5–1 cm apart; sparsely pubescent, triads 2-4 mm apart, arranged spirally. **Staminate flowers** 1.5 × 1.1 mm, sepals 3, 0.7 mm long, petals 3, valvate, 1.5 × 0.9 mm, stamens 6, filament 0.5–0.7 × 0.2–0.3 mm, flattened, anthers 0.3 × 0.2 mm; pistillode 0.3 × 0.2 mm. **Pistillate flowers** 2.5 × 1.5 mm, sepals 3, petals 3, valvate, triangular, 2.1 × 1.3 mm, gynoecium gibbous, 1.3 × 1.2 mm, stigmas 3. **Fruits** immature, green, sickle shaped, 1.8 × 0.3 mm. **Seeds** immature, ca. 3 × 11 mm, endosperm homogeneous.

Specimens examined: Madagascar, Toamasina, Maroantsetra, Ambinanitelo: Sahavalory forest near Ambodivoahangy, May 2007, *Trudgen et al. 74* (holotype K, isotypes TAN, MO, P), *Trudgen et al. 75* (K, TAN).

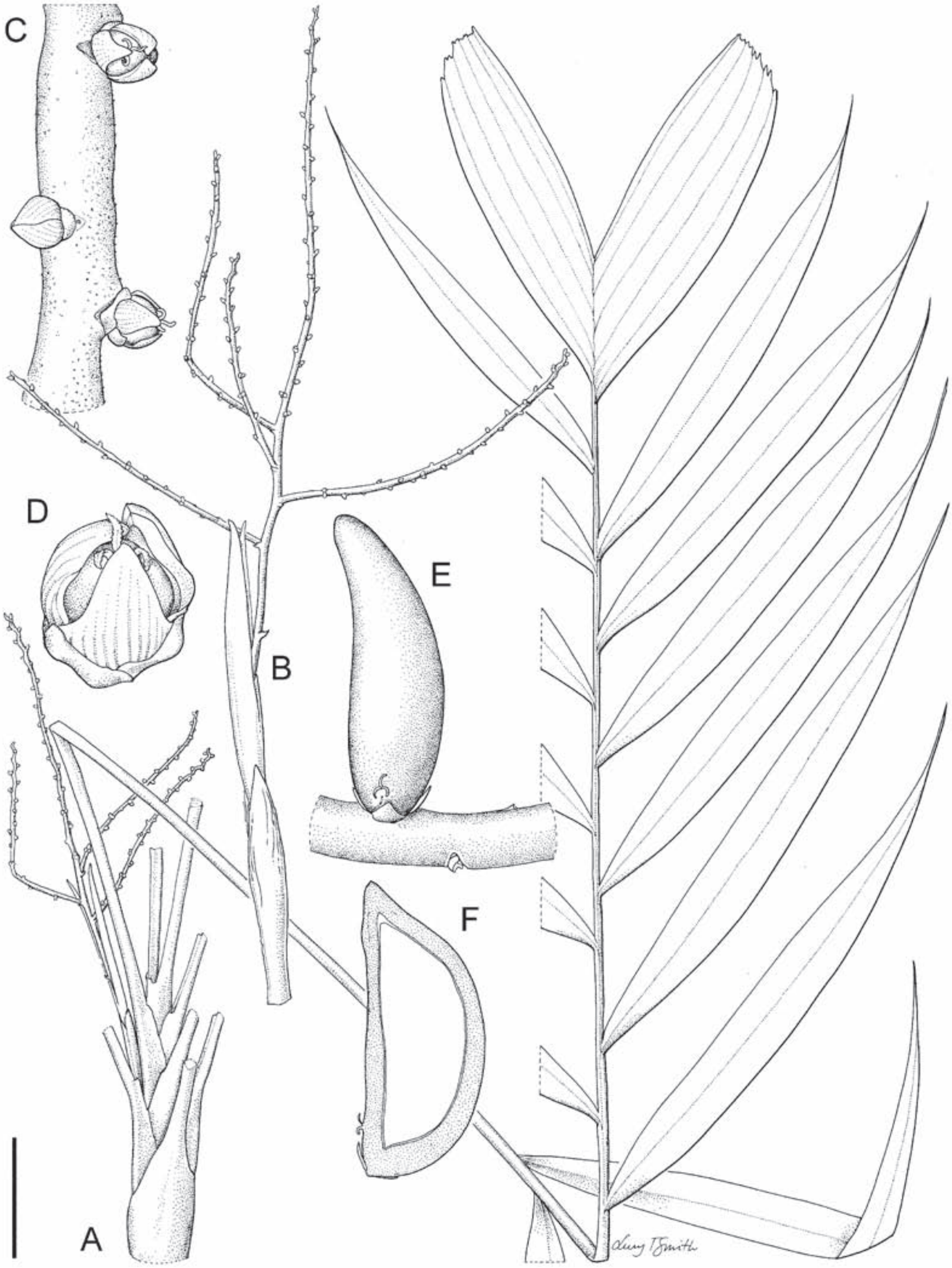
Distribution: Northeast Madagascar, known from a single site above the Antainambalana River near the village of Ambodivoahangy west-northwest of Maroantsetra.

Habitat: Disturbed rain forest on granitic ridge top, 100-200 m.

Vernacular name: Not recorded.

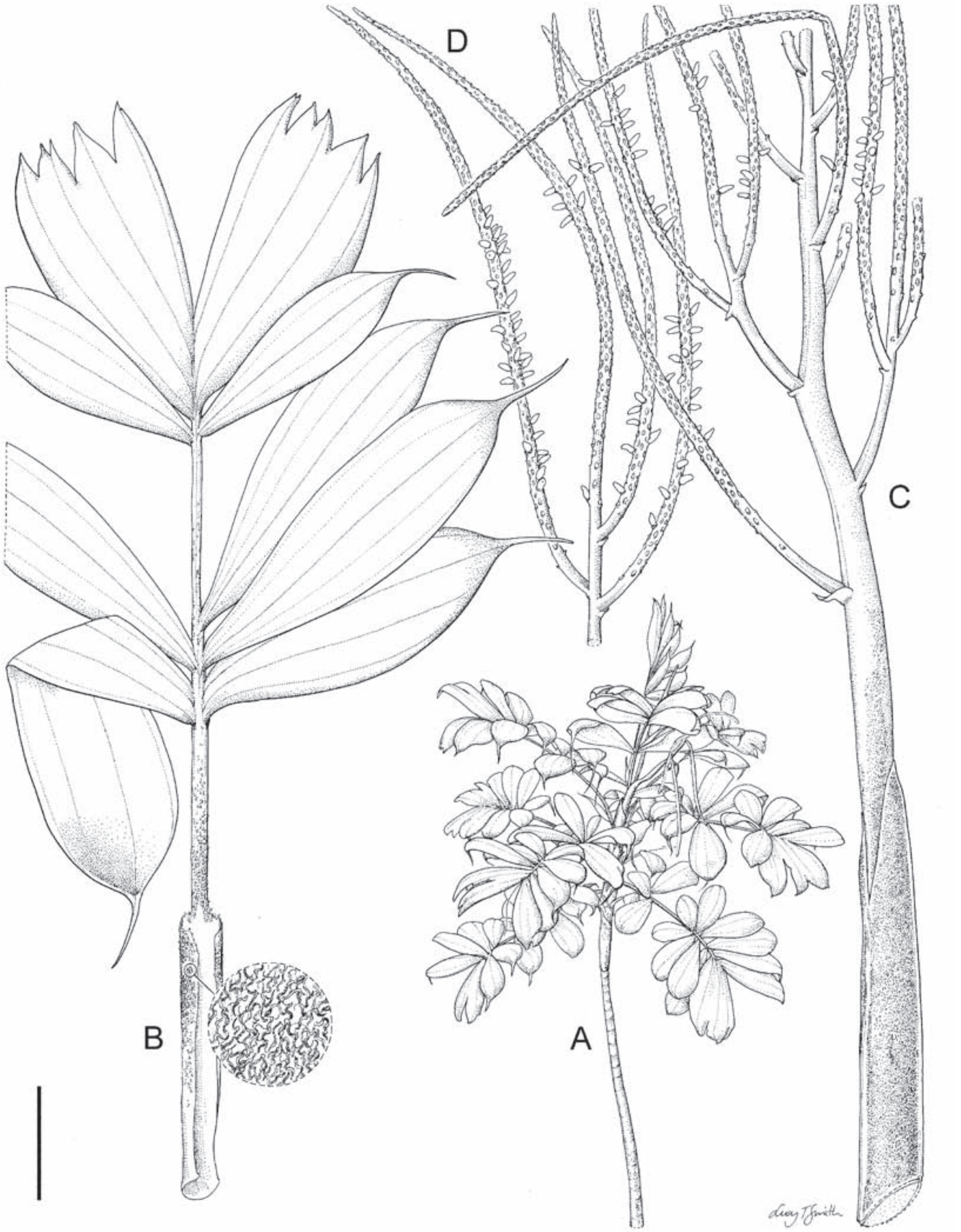
Conservation status: Critically endangered [CR (A1 + D)] (provisional assessment). Known only from one locality where fewer than ten individuals were observed. The site is outside the boundary of the Makira protected area and the forest is degraded.

Notes: In reproductive morphology, this new species (Figs. 13, 14 & 17.) appears most similar to taxa in *Dypsis* Group 8 (e.g. *D. concinna*, *D. corniculata*, *D. thiryana*) of Dransfield and Beentje (1995) or perhaps Group 5 (*D. procumbens*). However, neither of these groups contains acaulescent species. In fact, only two other species of acaulescent *Dypsis* have been recorded from Madagascar. They were poorly known when *The Palms of Madagascar* (Dransfield & Beentje 1995) was published, but both have since been rediscovered (Dransfield et al. 2006). Neither can be



18. *Dypsis humilis*. **A**. Crown with leaf and inflorescence. **B**. Inflorescence. **C**. Detail of rachilla. **D**. Pistillate flower. **E**. Fruit attached to rachilla. **F**. Fruit in longitudinal section (embryo not located). Scale bar: **A** = 4 cm; **B** = 3 cm; **C** = 4 mm; **D** = 1.5 mm; **E**, **F** = 7 mm. **A–B** from *Trudgen et al. 74*, **C–F** from *Trudgen 75*. Drawn by Lucy T. Smith.

confused with *D. humilis*. *Dypsis acaulis* (Group 18) from Masoala is a stemless or very short palm with bifid leaves that are chalky white on the undersurface, spicate inflorescences and staminate flowers with three antepetalous stamens. *Dypsis aquatilis* (Group 16), known from one locality in Manantenina in south-east Madagascar, is truly acaulescent and grows in water. It is more robust than *D. humilis* with very different leaf characteristics and has inflorescences branched to two orders. *Dypsis humilis* is thus a very distinct and easily



18. *Dypsis makirae*. **A**. Habit. **B**. Leaf with indumentum detail. **C**. Inflorescence. **D**. Inflorescence apex. Scale bar: **A** = 25 cm; **B** = 6 cm, **C**, **D** = 5 mm. **A** from *Rakotoarinivo et al. 346*, **B–D** from *Britt & Rakotonasolo 207*. Drawn by Lucy T. Smith.

recognized new species. The species epithet refers to the low-growing habit of the palm.

4. Dypsis makirae Rakotoarin. & Britt **sp. nov.**, habitu *D. bonsai* et *D. procumbenti* similis sed ramis inflorescentiae longioribus crassioribus foveolatis differt. Typus: Madagascar, Toamasina, Maroantsetra, Makira protected area: Tsaramain'Andro, March 2005, *Britt & Rakotonasolo 195* (holotypus K, isotypus TAN).

Solitary palm. **Stem** 4–5 m high, ca. 6 cm diam. **Leaves** 10–13 in the crown, spiral; sheath 14–16 cm, 1.8–2.2 cm diam., closed, forming well-defined crownshaft, brown with dense red pubescence in the upper part, triangular auricles up to 8mm; petiole 4–15 cm long, 3–6 mm wide, slightly or densely pubescent/scaly, adaxially flattened; leaf rachis 20.5–25 cm long, 3–6 mm wide in mid-leaf, triangular in section, pubescent/scaly; leaflets lanceolate, strongly cucullate, 4–8 on each side of the rachis, in groups of 2–4 leaflets, groups 11–12.5 cm apart, the proximal leaflets 12–17 × 2.4–5.2 cm, median leaflets 20.5–24 × 2.7–5.5 cm, distal leaflets 14–17 × 3–7.5 cm, width of leaflet base at insertion on rachis 0.5–3 cm, distal leaflet pair often multifold, acumen 0.8–4 cm, abaxial surface with scattered to abundant scales in proximal part and occasionally bands of minute punctiform scales on the margin and along the blade. **Inflorescence** interfoliar, branched to 2 orders, erect; peduncle 38–40 cm long, 0.8–1.7 cm wide, densely pubescent; prophyll 28–34 cm long, 2–3 cm wide, borne 7 cm above the base of peduncle, with sparse to dense reddish tomentum, 2-keeled, opening distally 5.5–9 cm; peduncular bract not seen, deciduous, inserted at 23–25 cm from the base of peduncle; rachis 23–37 cm long including terminal rachilla, slightly to densely pubescent, with 2–4 branched and 7–10 unbranched first order branches, the proximal with a secondary rachis up to 7.5 cm, with up to 3 rachillae; rachillae 16–32 cm long, 2–5 mm diam., densely puberulous, triads rather closely packed in shallow pits. **Flowers** not seen. **Fruits** yellowish, ellipsoid, slightly curved 9–12 × 3–4 mm, mesocarp fleshy, endocarp fibrous. **Seeds** ca. 9 × 2 mm, pointed at the apex, homogeneous endosperm.

Specimens examined: Madagascar, Toamasina, Maroantsetra, Makira protected area, Ambinanitelo: Tsaramain'Andro, March 2005, *Britt & Rakotonasolo 195* (holotype K, isotype TAN), *Britt & Rakotonasolo 207* (K, TAN); Ankirindro, May 2007, *Rakotoarinivo et al.* 346 (K, TAN).

Distribution: Northeast Madagascar, known from several localities in the eastern central part of the Makira protected area.

Habitat: Primary rain forest, on steep slopes near ridge tops, 600–900 m.

Vernacular name: Tsingovatra (Betsimisaraka).

Conservation status: Vulnerable [VU (D1+2)], (provisional assessment). A common palm along the eastern edge of the central part of Makira. The population is estimated to exceed one thousand indviduals, many occurring within the protected area.

Notes: Vegetatively, this palm (Back Cover; Figs. 12 & 18) superficially resembles *Dypsis bonsai* or some forms of *D. procumbens*. However, the inflorescence is composed of long, thick rachillae with flowers and fruits borne in shallow pits, suggesting a relationship with the species of *Dypsis* Group 7 (e.g. *D. boiviniana, D. sanctaemariae*, *D. mangorensis*) defined by Dransfield and Beentje (1995). It is easily distinguished by the almost disproportionately robust, erect inflorescences.

5. Dypsis rakotonasoloi Rakotoarin., **sp. nov.**, *D. fasciculatae* similis sed habitu minore inflorescentia in 1 ordinem ramificanti differt. Typus: Madagascar, Toamasina, Maroantsetra, Makira protected area: Tsaramain'Andro, March 2005, *Britt & Rakotonasolo 209* (holotypus K, isotypus TAN).

Slender palm. **Stems** to 2 m, 6–10 mm diam., internodes pale green, more than 1 cm long, scattered black punctiform scales near the crown, nodal scars ca. 1 mm wide. **Leaves** 5 in the crown, porrect, pinnate; sheath 9–11.5 cm long, open in distal 2.5–3 cm, pale green, densely to sparsely covered with black punctiform scales, auricles ca. 1 mm long; petiole 8–11 cm long, ca. 2 mm wide, scaly, deeply channeled in the adaxial surface; rachis 30–34 cm long, minutely to densely scaly on all surfaces; leaflets 10–14 in each side of the rachis, in group of 2–5 but distal leaflets regular, groups 3–7 cm apart, proximal leaflets 9–11 × 0.5–1.3 cm, median leaflets 11–16 × 1.4–2 cm, distal leaflets 15–17 × 2.8–3.3 cm and multifold, apices unequally acuminate to 3 cm long, main veins 3–5, minute black punctiform on the abaxial surface near the insertion. **Inflorescence** interfoliar, branched to 1 order; peduncle ca. 30 cm long, distally 1.5–2 mm diam., scaly; prophyll not seen (hidden among the leaf sheath); peduncular bract inserted at ca. 9 cm from the base of the peduncle, ca. 16 × 0.6 cm, pale brown, with few scattered punctiform scales, open in distal 1.7 cm; rachis ca. 6 cm, densely scaly, with ca. 7 branches; rachillae 20–23 cm long, ca. 0.8 mm wide, scaly, triads 0.2–0.5 mm apart. **Staminate flowers** not seen. **Pistillate flowers** sepals 0.8–0.9 × 1.1–1.2 mm, triangular, margins ragged, imbricate, minutely scaly; petals ellipsoid, 1.9–2 × 1.6–1.7 mm, striate, valvate; pistil ca. 1.2 × 1.6 mm, stigma ca. 0.3 mm high. **Fruit** not seen.

19. *Dypsis rakotonasoloi*. Habit with inflorescence. Scale bar = 4 cm. From *Britt & Rakotonasolo 209*. Drawn by Lucy T. Smith.

Specimens examined: Madagascar, Toamasina, Maroantsetra, Makira protected area, Ambinanitelo: Tsaramain'Andro, March 2005, *Britt & Rakotonasolo 209* (holotype K, isotype TAN).

Distribution: Northeast Madagascar, known from a single locality in the eastern central part of the Makira protected area.

Habitat: Primary rain forest, on ridge tops, ca. 900 m.

Vernacular name: Not recorded.

Conservation status: Critically Endangered [CR (B1a)] (provisional assessment). The justification for this threat category is the same as for *D. brittiana* (see above).

Notes: As with *D. brittiana,*, we have only one collection of this species (Fig. 19) and certain key features such as the nature of the stamens are not known. Nevertheless, it clearly matches no known species and so is here described as new. The species that it most closely resembles appears to be *D. fasciculata*, but it is an altogether smaller plant and the inflorescence is branched to one order only. We suggest that it belongs to *Dypsis* Group 15 of Dransfield and Beentje (1995).

Dypsis rakotonasoloi is named for Franck Rakotonasolo, botanist at PBZT, who has collaborated with Kew botanists on many adventurous botanical expeditions in Madagascar, providing invaluable logistical support as well as great scientific expertise. Franck discovered this new species with Kew Adam Britt during their 2005 expedition to Makira.

Acknowledgments

We are extremely grateful to Christopher Holmes and Rina Ralison of the Wildlife Conservation Society for encouraging our fieldwork and providing logistical support. We were expertly guided around the forests of Makira by Sasidy Venant and Naivoson Razafindra Jules, with the assistance of numerous willing porters. David Lees (Natural History Museum, London) generously shared his knowledge of Makira with us and advised on our routes. John Dransfield helped with both expedition planning and specimen identification. Henk Beentje advised extensively on the recognition of *Dypsis ankirindro*. All expeditions were funded through the Threatened Plants Appeal of the Friends of RBG Kew, which also supported the doctoral research of MR. Finally, we are indebted to our colleagues from Kew (Aaron Davis, Marie Briggs, Tianjanahary Randriamboavonjy, Hélène Ralimanana, Adam Britt) and PBZT (Franck Rakotonasolo) for their many contributions to the success of our expedition and the results presented here.

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The Uses of *Johannesteijsmannia* by Indigenous Communities and the Current Ornamental Trade in the Genus

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1. *Johannesteijsmannia perakensis*

There are four species in the genus *Johannesteijsmannia* – *J. altifrons*, *J. magnifica*, *J. lanceolata* and *J. perakensis* (Fig. 1), with the last three species rare and endemic to Peninsular Malaysia.

Many palm species have economic or ornamental value. Johnson (1996) reported 39 species (or 45%) out of the 86 listed major ornamental palms are threatened. In Malaysia, *Johannesteijsmannia* palms (*J. magnifica* and *J. lanceolata*) have been reported to be threatened by illegal poaching and seed collection, because these beautiful palms are commercialized as ornamental plants (Kiew & Pearce 1991, Lim & Whitmore 2000). Other threats include conversion of large tracts of forest to oil palm plantations and rubber estates (in Kledang-Saiong), building of dams (in Semenyih), highway construction (in Jelebu and Kuala Pilah) and logging (in Johor), which have drastically reduced the number of *Johannesteijsmannia* populations (pers. obs.).

The distributions of *Johannesteijsmannia magnifica, J. lanceolata* and *J. perakensis* are rather limited to a small range, compared to *J. altifrons* which is widespread from Malay Peninsula, Sumatra to Borneo (Dransfield 1972). *Johannesteijsmannia perakensis* is restricted to the Bintang Range (Kedah and Perak), *J. magnifica* (Fig. 2) to Perak, Selangor and Negeri Sembilan, and *J. lanceolata* (Fig 3) to Pahang, Selangor and Negeri Sembilan. The indigenous people use the broad leaves of *Johannesteijsmannia* as roof thatch (*atap*) (Dransfield 1972), while the Chinese in Kelantan use the fruits of *J. altifrons* (Fig. 4) as herbal medicine (Kiew 1991).

This paper highlights the uses and current collection of *Johannesteijsmannia* among the indigenous people (*orang asli*), and the current ornamental trade of the palm. We conducted surveys among the indigenous people and nurseries aim to answer these main questions:

What are the uses of the palm and its economic importance to the indigenous people, and how do they harvest it?

What is the scale of trade and market price of the palm?

Where does the source of palms come from and to what extent is the trade threatening the palms?

Additional information on the trading of the palms through the Internet was also investigated.

Methods

Survey among the indigenous people

Localities known to have *Johannesteijsmannia* palms were sourced from herbarium records and literature, and only selected localities were targeted for the study. A total of seven villages in four states were surveyed (Tab. 1)

The heads (Tok Batins) or representatives of the villages were interviewed and shown pictures of the four species of *Johannesteijsmannia* as in Figs. 1–4.

Survey of nurseries

The availability and market price of the *Johannesteijsmannia* palms were surveyed in 10 selected nurseries in Sungai Buloh, Selangor, followed by interviews with the owners or

2 (left). *Johannesteijsmannia magnifica.* 3 (right). *J. lanceolata.*

caretakers of another eight big nurseries in Bakri and Parit Sulong, Johor.

The World Wide Web was searched through the Google and Yahoo search engines for the trade of *Johannesteijsmannia* palms, using the keyword 'Johannesteijsmannia.' The first author also e-mailed an additional contact in Brunei, asking for the price of the palms.

Results

Survey among the indigenous people

a) Species identified

Local names for the palms differ among the communities, except in Selangor and Negeri Sembilan, where *J. lanceolata* and *J. magnifica* share the same local names (Table 1). Commonly, *J. lanceolata* is known as *chica*, *J. magnifica* as *segalok*, *J. altifrons* as *segalok* or *payung* and *J. perakensis* as *sang*. In Johor, however, all the four species are called *payung*.

Some Tok Batins mistook *J. lanceolata* as the sapling of *J. altifrons*, or *J. magnifica* as the sapling of *J. altifrons*. Tok Batin from Kampung Peta claimed to have seen the four species, but at different localities in the Johor State Park.

b) Traditional uses

All the indigenous communities (except Kampung Serendah) used the leaves of the palm as '*atap*' or roof thatch, but since their rooftops have been replaced by zinc roofs, they rarely used the leaves. The palms had no usage to Kg. Serendah villagers, as the palms were too remote for the villagers to collect. If they come across the palm when it rains in the forest, they will use the leaves as umbrellas.

No medicinal value of the palm was recorded except from Kampung Selai and Kampung Peta in Johor. Petioles are burnt and the ashes, with some water added, are applied topically to the body, usually of children who have respiratory problems. The ashes are also used for small wounds. Three or four seeds are boiled with water and the concoction is taken orally to reduce fever among children. Seeds are also grated into powder and applied to the face, chest or tongue for curing sore throat, cough and asthma.

c) Leaves and seeds harvesting

The *orang asli* collect the leaves and fruits occasionally for their own use. About 5–10 mature leaves are collected from each adult palm, and up to 15 leaves may be collected if the palm has 20–30 good leaves. Young leaves are not harvested, as they are not strong enough for making thatch and easily shrink upon drying. Thatch for one medium-sized house usually requires 1000–2000 leaves. Smaller hut uses about 300 leaves. The leaves of all the four species are used, but *J. lanceolata* is used less commonly, as the leaves are much

4. *Johannesteijsmannia altifrons.*

Table 1. Species of *Johannesteijsmannia* identified and their uses to the indigenous people in four different states.

	Selangor	**Perak**	**Negeri Sembilan**	**Johor**
Villages	Sg. Lalang Baru, Donglai & Serendah	Ulu Bekor	Ulu Kelaka	Selai & Peta
Species recorded*	*J. magnifica*, *J. lanceolata*	*J. perakensis*	*J. lanceolata*, *J. magnifica*	*J. altifrons*
Local name	*J. lanceolata* = chica; *J. magnifica* = segalok, selibar, daun lebar, daun serdang; *J. altifrons* = segalok	sang	*J. lanceolata* = chica, *J. magnifica* = segalok	daun payung, daun sabun
Collection locality	Sg. Lalang FR & Serendah FR	Kledang-Saiong FR	Jeram Toi, Gebang Angsi & Angsi FR	Johor State Park, Labis FR & G. Tiong
Plant parts collected	leaves, fruits	leaves	leaves	leaves, fruits
Collection frequency	once in 6 or more months	once in 1 or 2 years	rarely, only during 'kenduri'	occasionally for 'kenduri' and small shelter
Plant usage	roof thatch	roof thatch	roof thatch	roof thatch, medicine
Medicinal value	nil	nil	nil	cures respiratory problems and small wounds

* Species recorded in the literature and KEP herbarium records.

Abbreviations: Sg – sungai; FR – forest reserve; Kenduri – a feast usually for religious or celebration purposes.

smaller and narrower. People collect leaves annually or less frequenty, to replace old ones, depending on the durability of the existing leaves, which usually last from 1–4 years.

Villagers in Semenyih sometimes sell the leaves for US$0.50 per leaf to other people for making roofs. One villager also collects and germinates the seeds, and sells the juveniles to private collectors. The seeds of *J. lanceolata* are harder to find than those of *J. magnifica*. In the past, seeds were collected and sold to outsiders for US$0.15 to US$0.60 each. However, the demand for seeds has dropped drastically nowadays. The villagers collect fruits for their own use as medicine and do not sell them, although there are demands from outsiders for the seeds as medicine.

Whole palms or seedlings, however, are not collected from the forest, although there are demands for seedlings. In the past, villagers of Kampung Peta used to sell one seedling for US$31, which was directly collected from the forests. Trading has ceased since they were aware that *Johannesteijsmannia* species are prohibited for sale and protected in the Johor State Park.

Survey of nurseries

a) The ornamental trade

From the survey, *Johannesteijsmannia* palms were sold in 8 out of the 10 nurseries in Sg. Buloh, and in all the eight nurseries in Bakri and Parit Sulong. In Johor, seven of the interviewees were plant suppliers or middlemen, and one was the major supplier who supplies seedlings to the middlemen.

Seedlings were rare in Sungai Buloh nurseries (only *J. magnifica* and *J. altifrons* were available) with limited stocks, 10 palms at the most, usually 0.5–1 m tall. They sourced their palms from wholesalers, from whom stock arrived within a few days.

Most nurseries in Bakri and Parit Sulong have small stocks of 30–100 palms (0.3–1 m tall), and have reduced taking in large stocks because sales were lukewarm, due to difficult handling of *Johannesteijsmannia* in cultivation; they will grow only under proper shade and will die if exposed to direct sunlight. Also, there were many other alternatives to choose from in the market. Some of the nurseries used to export the palms to Singapore, but since the Department of Agriculture Malaysia has banned the palms for export, they supply only to local demands.

The major supplier monopolized the seedlings in Bakri and Parit Sulong, with stocks of about 4000–5000, mainly *J. perakensis* (2000–3000), followed by *J. lanceolata* and *J. magnifica* (ca. 1000 each), and the least was *J. altifrons* (ca. 500). The supplier also had palms of about 1.5 m tall, but only a few of them left, as they sold fast to buyers. The supplier secured the seeds from *orang asli* or Malay villagers in Selangor, Seremban, Perak and areas bordering Malaysia and Thailand (and he was reluctant to reveal any further specifics).

b) Market prices

The palms sold from US$6 to US$40, depending on species and height of the palms (from 0.3–1 m). The seedlings sold by the major supplier priced from US$2 (*J. magnifica*) to US$2.70 (*J. lanceolata, J. altifrons* and *J. perakensis*). No seed was sold by any of the nurseries.

Generally, the prices for *J. magnifica* were lower than those of other species, as it was the most commonly available species in the nurseries. There was, however, one nursery willing to sell a half meter tall *J. altifrons* (old stock) for US$6–9, compared to some other nurseries selling at US$34–40. Prices were determined by the height or age of the palm. A 30 cm tall palm would cost about US$19, a 1.5 m tall *J. perakensis* about US$156 while a 15-year old *J. lanceolata* could go up to US$312. The prices of the palms were not very stable as they varied among nurseries.

Table 2. The prices of *Johannesteijsmannia* palms based on different criteria (sourced from the websites).

Criteria	Price	
	J. altifrons	*J. magnifica*
Pot diameter		
100	-	AS$ 25
140	AS$ 30	-
200	AS$ 39.50	AS$ 29.50
250	AS$ 49.50	-
300	AS$ 88	-
400	AS$ 165	-
Palm height (inches)		
7	US$ 50	US$ 50
8–10	US$ 44.95	-
seedling	US$ 28	US$ 19.50
juvenile	US$ 65	-
No. of seeds		
10	US$ 14	US$ 22
100	US$ 85	US$ 200
1000	US$ 590	-

Internet trading

Twelve websites (accessed on 24 May 2007) were found to be trading *Johannesteijsmannia* palms online. *Johannesteijsmannia altifrons* (Green or Diamond Joey Palm) was traded in 10 out of the 12 websites, and *J. magnifica* (Silver Joey) was traded in seven. The nurseries were mostly from the United States of America (n = 4) and Australia (n = 3), with others from Canada, Singapore and Borneo (n = 1 for each country). Another two websites were a discussion lounge and an item-bidding site. Two of the nurseries listed *J. altifrons* and *J. magnifica* for sale, but the palms were temporarily out of stock. Another nursery (in Canada) listed all the four species but also had no stock. Overall, only *J. altifrons* and *J. magnifica* were available for sale.

A person living in Thailand offered seeds of *J. altifrons* and *J. magnifica* for sale on the discussion lounge on 3 November 2005, in batches of 10, 100 and 1000 seeds (Table 2). Meanwhile, the bidding website offered *J. altifrons* (seedling with 2–4 leaves) at the bidding price of US$24.99. The nurseries in Australia quoted the prices based on pot diameter while those in America based on palm height. An enterprise in Brunei (contacted by e-mail) offered *J. magnifica* and *J. lanceolata* of 1 m tall for US$37.50 and US$18.8 respectively, while *J. perakensis* of 45 cm tall for US$14. Another nursery in Borneo (based in Kuching) claimed that their seeds were harvested from cultivated palms and were certified by the Sarawak Forestry Department, but the nursery also had no stock available at that time.

Discussion

From all the surveys carried out on *orang asli* and nurseries, the information gathered seems to contradict each other. The *orang asli* have ceased collecting seeds or palms for sale, but major nurseries in Johor have produced thousands of *Johannesteijsmannia* seedlings for sale, possibly from cultivated sources. It is possible that villagers (who may or may not be *orang asli*) still collect seeds for sale, but we are not certain, because we did not capture information on all the sources in the surveys. Despite that, the trade market was lukewarm, the prices were not stable and most local nurseries have reduced taking on stock.

Although the genus is not listed in the Convention on International Trade of Endangered Species (CITES), it is prohibited for export from Malaysia under the Customs (Prohibition of Export) Order 1998 (Ho, H.L., Department of Agriculture Malaysia, pers. comm.). The ban may explain the scarcity of some species like *J. lanceolata* and *J. perakensis* in the overseas market, but not *J. altifrons* and *J. magnifica*. Perhaps *J. altifrons* can be easily sourced from other countries like Thailand and Indonesia, or both *J. altifrons* and *J. magnifica* have been sourced from cultivated palms (since the palms were collected long ago by foreigners for propagation).

Conclusion

In our opinion, seeds collected from the wild for cultivation is justifiable provided the resource is not depleted, or is harvested sustainably to allow some regeneration in the wild. With much of our forests under the threat of logging or deforestation, the cultivation of palms in nurseries or *ex situ* helps to preserve the genetic pool of the species, if the palms go extinct in the wild. However, we strongly advocate *in situ* protection of *Johannesteijsmannia* and its habitat as the main conservation priority. At the same time, domestication of the palms is highly recommended to relieve pressures of wild seed collection.

On the other hand, the *orang asli*, if properly informed and educated, can play a major role in protecting and guarding our valuable forest resources from overexploitation, especially the rare and endangered species. Furthermore, sustainable collection of forest goods by the *orang asli* helps to ensure continuous availability of the resources in the long run, as most of them still depend on forest goods to support their livelihood. The general public should also be informed of the consequences of buying such endangered species.

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Dr. Sidney Fredrick Glassman (1919–2008)

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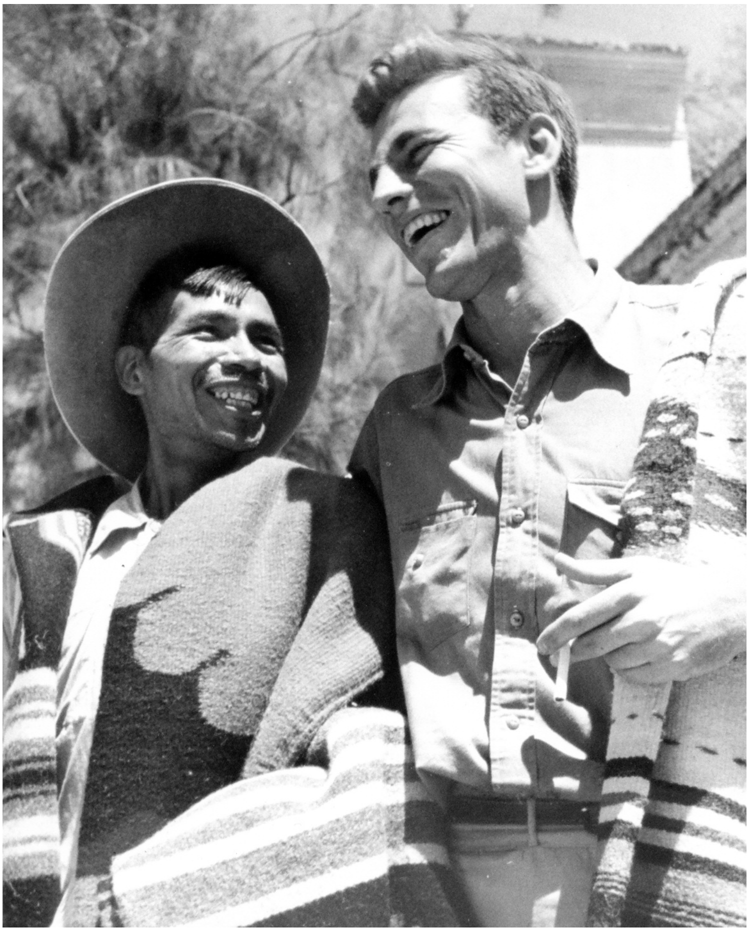

Dr. Sidney F. Glassman (right), 1948 in Mexico.

Dr. Sidney F. Glassman passed away quietly on December 9, 2008 at the age of 89. He spent the greater part of his life studying and writing about palms. His principal contributions were to our knowledge of the genus *Syagrus*, *Butia*, *Attalea* and related Cocoseae and Attaleinae.

Glassman was my dissertation advisor at the University of Illinois at Chicago (UIC). He retired at the age of 70 in 1989. As an emeritus professor, he was able to remain an important member of my graduate committee and continued to offer valuable advice. Besides being my advisor, he was my friend.

Sidney Glassman was born in Chicago on 30 July 1919; his father was a union organizer in the clothing industry. Glassman got his degree in biology in 1941. He served in WWII as part of a Navy Medical Research Unit that worked on schistosomiasis (NAMRU-2) in the South Pacific. He became enamored by the vegetation of the South Pacific islands and while stationed on Guam collected plants from 1944 to 1946, sending his collections to Dr. E.D. Merrill at the Arnold Arboretum. Fortunately all of his work on Guam counted in part towards his Master's degree (Glassman 1948). After leaving the service in 1946, he continued working on the island floras of the South Pacific. However, sometime around 1948, he also received a grant to do a collecting trip in Honduras. He had a friend who was doing photography to promote tourism for the Mexican government, and the two of them traveled together through Mexico as part of that Honduran trip. He next collected the flora of Ponape in 1949 as a part of his Ph.D., married his wife, Ida, and submitted his Ph.D. thesis in 1950, graduated with his doctorate from the University of Oklahoma in 1951 and published *The Flora of Ponape* the following year (Glassman 1952a, 1952b). He did post-graduate work at the University of Chicago followed by a teaching assistantship at the University of Wyoming in Laramie. Finally in 1952, he started teaching at the University of Illinois, Navy Pier (now University of Illinois at Chicago or UIC), and he also became a research associate at the Field Museum of Natural History.

Glassman's interest was at first drawn to the monocots, especially the grasses, but one of his colleagues at the Museum, B.E. Dahlgren, recruited his help to work on the palm genus *Copernicia*, especially in Cuba (Dahlgren & Glassman 1961, 1963). Dahlgren was also revising his famous Index of American Palms, but when he saw that he would not be able to finish it due to old age and failing health, he begged Glassman to finish the work (Glassman 1972). It is a work that most palm biologists, including myself, have found to be very useful even today. Only the recent online palm checklist based at Kew comes close (http://apps.kew.org/wcsp/qsearch.do). *Copernicia* was only the beginning of a life long passion for palms. He then accepted the challenge to straighten out the confusion found in the genus *Syagrus* and its allied genera (i.e. *Butia*). He visited many herbaria in the US and in Europe and made several trips to Brazil, almost getting killed on one of those trips (Glassman 1967b), when he was thrown out as his vehicle rolled down the side of a mountain. After working on *Syagrus* for a number of years, he began working on an even more difficult group, *Attalea* (including the former genera of *Maxmiliana*, *Orbignya* and *Scheelea*).

Glassman was a taxonomist and a prolific writer, and sometimes the things he published were not always popular. However, they did spark controversy and force many of us to reexamine these particular palm groups from a different perspective. Some of his earlier concepts on the palm family are being validated today by the newer molecular techniques, although at the time they were met with a lot of resistance, forcing him to reverse his position. Much of the research that I have done with palms, especially with *Syagrus*, is just a continuation of his work.

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