Palms

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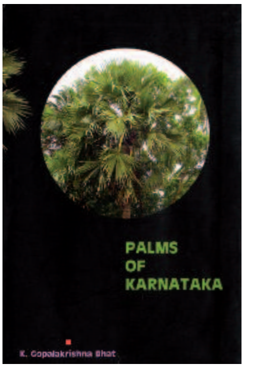
IPS INTERNATIONAL Palm Society

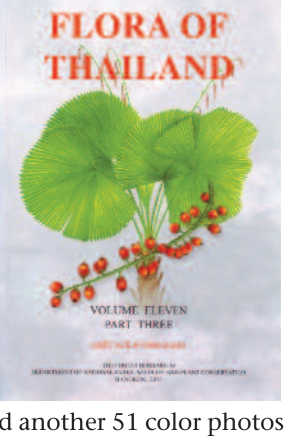
PALM NEWS

A trio of books of possible iinterest to IPS members have reciently come to the attention of the editors, who offer the following “mini-reviews”:



PALMS OF KARNATAKA – K. Gopalakrishna Bhat. Published by K. Gopalakrishna Bhat, Taxonomy Research Centre, Department of Botany, Poornaprajna College, Udupi, India, 2011. Pp.93, many color photographs. This nicely produced, slim paperback is a guide to the palms, native and introduced, in the state of Karnataka, India. Forty-two genera are treated, arranged according to the second edition of *Genera Palmarum*. Nomenclature is not absolutely up to date, and a few of the illustrations are suspect (e.g. the illustration of *Rhopaloblaste augusta* is surely *Dictyosperma album*, and that of *Heterospathe elata* looks suspiciously like an odd form of *Dypsis madagascariensis*). However, the overall effect is pleasing – color printing and general format make this an attractive publication. – JD

***COCOS WEDDELLIANA* H. WENDL. 1871 – Pal Meir. Privately published, 2012. Pp. 116. Numerous illustrations.** This small-format (14.5 × 14.5 cm), ring-bound book contains a collation of all sorts of aspects of the palm currently known as *Syagrus weddelliana*. Written in German, the text covers the history of the name of the palm, its description, natural distribution and cultivation, including a discussion of common problems with cultivation of this beautiful palm. Throughout there is a wealth of color photographs. Altogether it is a most attractive booklet. It can be obtained from the author (pal.meir@gmx.de) for Euros €10.50 plus €2.25 for postage and handling in Germany or €4.25 elsewhere. – JD



FLORA OF THAILAND. VO. 11, PT. 3. ARECACEAE (PALMAE). – A.S. Barfod & J. Dransfield. Forest Herbarium, Dept. of National Parks, Wildlife and Plant Conservation, Bangkok, 2013. Pp. 176, color plates. The scholarly work is the definitive account of the palms of Thailand and is the culmination of many years’ research by A.S. Barfod and J. Dransfield, with contributions from R. Pongsattayapipat, A. Henderson and D.R. Hodel. Thailand is located at the intersection of three floristically rich regions (India, China and the Indo-Malesian region), so its palm flora is abundant and varied. The palm volume covers 33 genera and 164 native taxa, more than half of which are rattans and their relatives. There are keys to the genera and species, and for each species, there is a brief description, along with notes on distribution, common name, use, ecology and conservation status. The scientific names are cross referenced with Hodel’s *Palms and Cycads of Thailand* and Henderson’s *Palms of Southern Asia*. Twenty-six species are illustrated with line drawings, and another 51 color photos appear at the end of the volume. This is a must-have book for the serious student of SE Asian palms. As well as being a superb account of the Thai palms, it will also prove useful in understanding the palms in neighboring countries, such as Cambodia and Myanmar, where modern floristic studies are lacking. – SZ

Adaptations of an Understory *Geonoma*

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1. Rare, well-developed aerial sucker on *yanga* stem, 1.47 m above ground.

The peculiar morphology of *Yanga* (*Geonoma pinnatifrons* var. *martinicensis*) is uniquely adapted to life in the forest understory.

Yanga is the common name on Dominica for *Geonoma pinnatifrons* Willd. var. *martinicensis* (Mart.) Henderson, which until recently was known as *Geonoma interrupta* (Ruiz & Pavon) Mart. var. *interrupta* (Henderson 2011). The latter species is now believed to be confined to South America, whereas *G. pinnatifrons* var. *martinicensis* is known from Guadeloupe, Martinique, Dominica and St. Lucia (Henderson 2011). *Yanga* is Dominica's only native species of clustering palm, as well as the island's smallest native species of palm in terms of its stem-diameter.

The stem of the *yanga* bears prominent leaf scars, and while young, is tan-colored, very smooth to the touch and resembles a piece of sugar-cane. However, as the palm grows older and taller, its stem roughens somewhat, providing a substrate for the establishment and growth of a variety of epiphytes including lichens, mosses, vanilla and a few other orchids, ferns, bromeliads, and bird's nest anthurium, among other species of *Anthurium*. Climbers such as *Asplundia rigida,* gesneriads, philodendrons, non-woody vines and even lianas, sometimes grow up the stem of adult *yanga* palms.

Between 2007 and 2012 the author, then a Forest Officer with the Forestry, Wildlife & Parks Division in Dominica, and a team of assistants conducted some basic research on the *yanga* on the island (James 2012). The team collected data on some of the palm's physical characteristics (stem height, stem size and number of leaves in crown), the reproductive status of each palm at the time of observation and cluster information, i.e. number of stems in each cluster and the number of basal suckers. Additional information was gathered for individual palms in terms of the shape of the stem, the presence of above-ground roots and the types of plants hosted by the *yanga* palms. The team gathered data from 426 clusters of palms in six sites, which were distributed in the Morne Trois Pitons and Morne Diablotin National Parks and the Northern and Central Forest Reserves. The research was supported in part by a grant from the South Florida Palm Society.

The tallest *yanga* that we measured had a stem height of approximately 8.76 m (28.7 ft), but the mean height was 2.99 m. Stem diameter ranged between 2.7 cm and 6.7 cm at or near breast-height; mean stem diameter was 4.3 cm. We found that clusters contained between 1 and 8 palms with defined stems, along with 0 to 27 basal suckers. A few of the smaller clusters had no basal suckers.

Yanga occasionally has suckers that are produced some distance up the stem. We call these aerial suckers, to differentiate them from suckers produced at the base of the cluster (basal suckers). The production of aerial suckers by the *yanga* is rather rare. Our team encountered only 18 palms with aerial suckers among the 1,063 palms in our survey (<2%). Among the palms that we documented with aerial suckers, the largest number of such suckers found on a single stem was six. Only one stem in a cluster produces aerial suckers; the team never observed two or more stems in a cluster with aerial suckers.

2. Small, tightly-packed adventitious roots on *yanga* stem, well above ground.

These aerial suckers are sometimes produced over 1 m above the ground, and initially at least, they have no direct connection with the ground. They may even be referred to as semi-parasitic, dependent upon the mother for water and mineral salts but relying on their own photosynthesis for at least some of their nutrients.

Only one of the aerial suckers that the team encountered had a well-defined, measurable stem. That sucker, located at 1.47 m up the stem from the base of the mother (the highest such sucker documented), had a stem that was 0.65 m long (Fig. 1). The other aerial suckers encountered had virtually no defined stem.

In addition to basal and aerial suckers, *yanga* also produces basal adventitious roots, and

3. Bulge and short prop roots on stem of *yanga*, resembling a giant spider.

when they reach the ground, they are referred to as prop roots. Occasionally, one encounters *yanga* palms with adventitious roots over a meter above ground, emerging in the air and growing downward toward the ground (Fig. 2). The palms do not have to be reproductively mature to begin producing adventitious roots.

Aerial roots and suckers are not unique to *yanga*. *Hyospathe* species produce aerial shoots from dormant axillary buds (Skov & Balslev 1989). Another palm that produces aerial branches is *Pinanga rivularis*, although the branches arise from the internodal position (Dransfield 1992). A greater number of palms produce aerial roots. In addition to the taxa just mentioned, a large number of *Chamaedorea* species produces aerial roots (Hodel 1992). Examples include *C. stolonifera*, *C. metallica*, *C. serpens* and *C. ernesti-augusti*. The ability of some *Chamaedorea* species to produce aerial roots, especially in response to the stem's contact with a moist substrate, is the basis for the horticultural technique of air-layering. Many *Chamaedorea* palms can be air-layered in order to produce smaller, shorter plants (Hodel 1992). The rattans *Calamus javensis*, *C. heteroideus* and *C. reinwardtii* can root whenever their stems touch the ground (Watanabe et al. 2006).

These palms, along with *yanga*, have in common an unstable habitat. Many are palms of wet forests on slopes, where they are at risk of erosion and landslides. They are also palms of the understory, where lush life in the cool shade can suddenly be cut short by a falling limb or tree. Indeed, falling debris or falling trees are a major cause of death for understory plants, and palms are no exception (De Steven & Putz 1985). *Pinanga rivularis* is a rheophyte, a plant growing on the banks of fast-moving rivers and streams, where erosion frequently uproots plants and deposition can bury plants. The rattan palms are lianas, which fall from the canopy when they become too heavy for their supporting trees and branches.

As a relatively small-diameter, flexible-stem palm living in the understory, *yanga* is well adapted to the perils of the rain forest environment by virtue of the peculiarities of its stem. Its ability to produce adventitious roots insures that a palm stem, once knocked down, does not perish. It shares this survival strategy with other understory palms such as *Geonoma congesta* (Chazdon 1992) and *Geonoma brevispatha* (Souza et al. 2003). The clustering growth habit insures that the plant survives, even if individual stems are killed. Its ability to produce suckers some distance from the base of the stem means that fallen stems can regenerate and survive.

One *yanga* palm, which had most likely been pinned to the ground by a fallen tree or large tree branch for several years, was observed in 2012 growing in an L-shape, and had produced a set of prop roots on the underside of its stem where it contacted the soil, giving that part of the stem the resemblance of a giant spider (Fig. 3).

Falling tree limbs, heavy lianas, toppling trees and shifting substrates can take down an understory plant such as *yanga*. *Yanga* must be able to survive under those conditions, which it can as long as some the palm's roots remain in the soil. Equipped with its ability to produce basal and aerial suckers and adventitious roots, *yanga* seems well prepared to survive in the rain forest environment.

Acknowledgments

The author is indebted to the Forestry, Wildlife & Parks Division of Dominica for maintaining Native Palm Research on its work program for at least a decade. I also acknowledge the South Florida Palm Society, whose assistance aided in defraying some of the costs of conducting the field work for the *yanga* documentation and report preparation. I also acknowledge the members of the Ti-Palm Association (Guadeloupe, Martinique and French Guiana chapter of the International Palm Society) for their collaboration. And most importantly, many thanks to my colleagues and some of the past interns at the Forestry, Wildlife & Parks Division, who assisted in collecting the field data and information. Scott Zona assisted me with the relevant literature.

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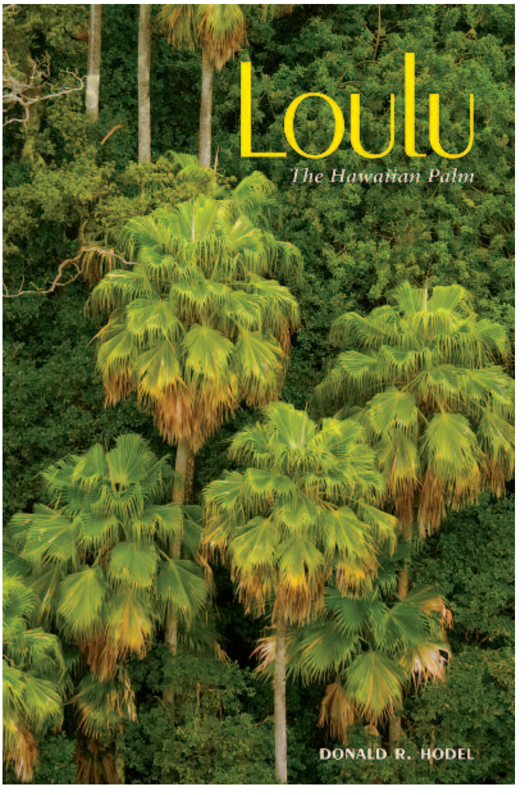
LOULU: THE HAWAIIAN PALM – Donald R. Hodel, University of Hawai'i Press, 2012. ISBN 978-0-8248-3567-5. US$48. Hardback. 190 pages.



Pritchardia palms are renowned as elegant ornamentals in many countries, and Hawai'i's native *Pritchardia* have steadily increased in popularity over the past two decades. There has long been a need for a field guide to the Hawaiian *Pritchardia*, called *loulu* in Hawaiian (pronounced "loh-loo"). This much anticipated work is the first complete reference of its kind, a definitive treatment covering all aspects of loulu palms. Long a respected authority on palms, Donald R. Hodel draws on his 34 years of abiding passion for loulu and their study. Bolstered by the grassroots desire and the fund-raising efforts of members of the Hawaii Island Palm Society and the Palm Society of Southern California, he carried out extensive fieldwork and herbarium research over a number of years in order to produce this authoritative yet approachable source of valuable information on all 27 *Pritchardia* species.

With an eloquent foreword by *loulo* enthusiast and Pulitzer-Prize-winning US Poet Laureate William S. Merwin, the book explores the human history behind the palms from their importance to ancient Hawaiians to the intriguing lives and work of botanists and conservationists who have been honored with species that now bear their names. The Hawaiian archipelago is of course famous for its highly varied terrain and remarkable array climates of that occur within close proximity that have given rise to extremely high numbers of endemic species. It is particularly interesting to read about how scientists have used molecular research to determine that the ancestors of *Pritchardia* originated from the Americas before speciating into two dozen Hawaiian species. With great detail and adeptness Hodel explains *loulu* distribution and ecology from island to island, covering climate types from sea shore to mountain top and detailing how hosts of unique factors form niches in which each different species is found. It should be noted that a type of Hawaiian forest called *'ōhi'a* forest that is frequently referred to in the book is consistently misspelled as *'ōhia*. There are excellent color-coded distribution maps with elevation shading of each island on which natural *loulu* populations occur; these visuals are powerful in demonstrating just how extremely limited the ranges of some species are. There is also an important telling of how distribution patterns and populations of *Pritchardia* have changed since 400CE when humans first settled in Hawai'i, specifically how man drastically reduced their numbers by altering the ecosystem with the introduction invasive flora and fauna. The conservation status and hurdles to survival of each species are discussed in detail, and the author also provides the data in tabular format so that the reader can compare the conservation status of all Hawaiian *Pritchardia*; it is striking to see the figures laid out and to see just how endangered some species are. The book is a call to action as it makes clear that all native "loulu will not survive in the wild without new and continued management" and that ex situ cultivation alone is not sufficient: "The only viable strategy to ensure survival of a species, including a sufficient amount of genetic diversity, is to preserve and manage its habitat so that it can produce and maintain healthy, regenerating populations." A very hopeful example of the positive change that can come for imperiled populations when concerted strategies are implemented is given in the recent success of the 'Ōhikilolo Ridge population of *P. kaalae*, which is now rebounding with greater vigor than expected after goat- and pig-proof fencing encircled the palms, invasive plant species were removed and bait stations installed to suppress rats.

It is worth owning a copy of this book for its superb photos alone. Even though I had seen an image of it before, I gasped audibly upon first seeing a series of new images of the famous Huelo Islet, a dramatic sea stack whose top is covered with an improbable number of glaucous-leaved *P. hillebrandii*, a striking visual example of how *loulu* used to dominate lowland dry forest on main islands before humans changed the ecosystem. The book is filled with 240 color photos, many full-page showing glorious *loulu* in stunning vistas. Hodel is a skilled photographer with a great sense of light; those with experience photographing palms *in situ* know how difficult it can be to capture images of mature palms in wild places. Paul Weissich related in his foreword that some of Hodel's images were taken while hanging out the doors of helicopters! Other highlights include a gorgeous photo of *P. lowreyana* growing on dramatic sea cliff Moloka'i and vintage photos of *loulu* in habitat by University of Hawai'i's first botanist, Joseph Rock.

While today the two most widely cultivated species, *P. pacifica* and *P. thurstonii* (both non-Hawaiian), are well known and easily identified, the process of identifying Hawaiian species has often been confusing and frustrating for both botanists and horticulturists alike for as long as Hawaiian species have been known to science. In his research Hodel has sought to improve identification process by placing more emphasis on character weighing as taxonomic strategy, that is to say, less importance is given to the shapes and features of individual flowers while precedence is given to a combination of characters including leaves, fruits, and flowering structures. This new approach was first published in his *Review of the Genus Pritchardia* (a 2007 IPS journal supplement) using technical language familiar to botanists. His new book has a newly expanded key that includes all 27 *loulu* species and seven other non-native, naturalized palms, so that anyone in the wild places of Hawai'i can identify any palms. Both in his new key and throughout the book he has employed simplified terminology (e.g., "fruit stalk" instead of infructescence), making the identification process accessible to laypeople. Also near the beginning of the book is a useful introduction to palm morphology with which one can become familiar with the botanical characteristics of *loulu* palms. Unfortunately no metric measurements are provided alongside inches in the key. While I greatly admire the care and effort put into developing his species concepts, I am disappointed that modern molecular taxonomic tools were not implemented before this great book was published, as they would have shed significant additional light on *Pritchardia* species relationships.

Each of the Hawaiian species is described individually with great attention, discussing its natural and human history, distribution, ecology and conservation status accompanied by maps and illustrated with numerous color photos showing mature individuals in their habitats as well as closer views of distinctive characteristics such as fruits and inflorescences. Notably absent are close-up photos or scale drawings of individual flowers, though this omission may reflect Hodel's approach in their identification. The most salient physical features and identifying characters are italicized to aid one in finding them quickly within the text, and some species' entries have interesting human histories attached. There is a strong emphasis in referring to each species by common names. Each entry is headed by a scientific binomial after which only its common name is used, so *Pritchardia kaalae* becomes *Ka'ala Loulu* and *P. gordonii* is Gordon's *Loulu*. Pukui and Elbert's Hawaiian Dictionary lists *Loulu Hiwa* as the name for *P. martii* and *Loulu Lelo* for *P. hillebrandii*. It is not clear why Hodel chose to call them Martius' *Loulu* and Hillebrand's *Loulu* when Hawaiian names already existed for these species before they were named by western science.

A handy seven-page comparative table of all 24 Hawaiian species is found at the back of the book, a quick reference comparison for each species, listing synonyms, common names, distribution, habitat type, ID characters and conservation status. Also included is a useful guide to *loulu* propagation that includes instructions on sowing, germination, potting on, planting out, watering, and soil types.

This book deserves a place in the library of any lover of palms and native Hawaiian plants.

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Palm Stem Shape Correlates with Hurricane Tolerance, in a Manner Consistent with Natural Selection

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Palms have been characterized as tolerant of high winds, but that may be a simplified view. The effects of hurricanes on palm collections at Montgomery Botanical Center offered the opportunity to investigate aspects of natural selection for wind tolerance. A major finding is that wind tolerance is correlated with geography – Caribbean palms are more resistant than South American palms. This finding prompted further investigation of palm habit – basic morphology – in relation to wind resistance. Here, we present data on basic stem shape (height and diameter), root habit characters and their relationship to wind tolerance, using examples from *Coccothrinax* and *Syagrus*. We find that stem shape correlates with hurricane tolerance in *Syagrus*, but not in *Coccothrinax*; this is consistent with natural selection of Caribbean palms for high winds.

Growing palms is a rewarding pursuit most days. Even so, from time to time, pests, accidents, or lightning can bring disappointment or even heartache. Probably the worst palm tragedies come from cyclones, severe tropical windstorms, which are called hurricanes in the Atlantic. This journal reported on one such disaster 20 years ago (Klein 1992).

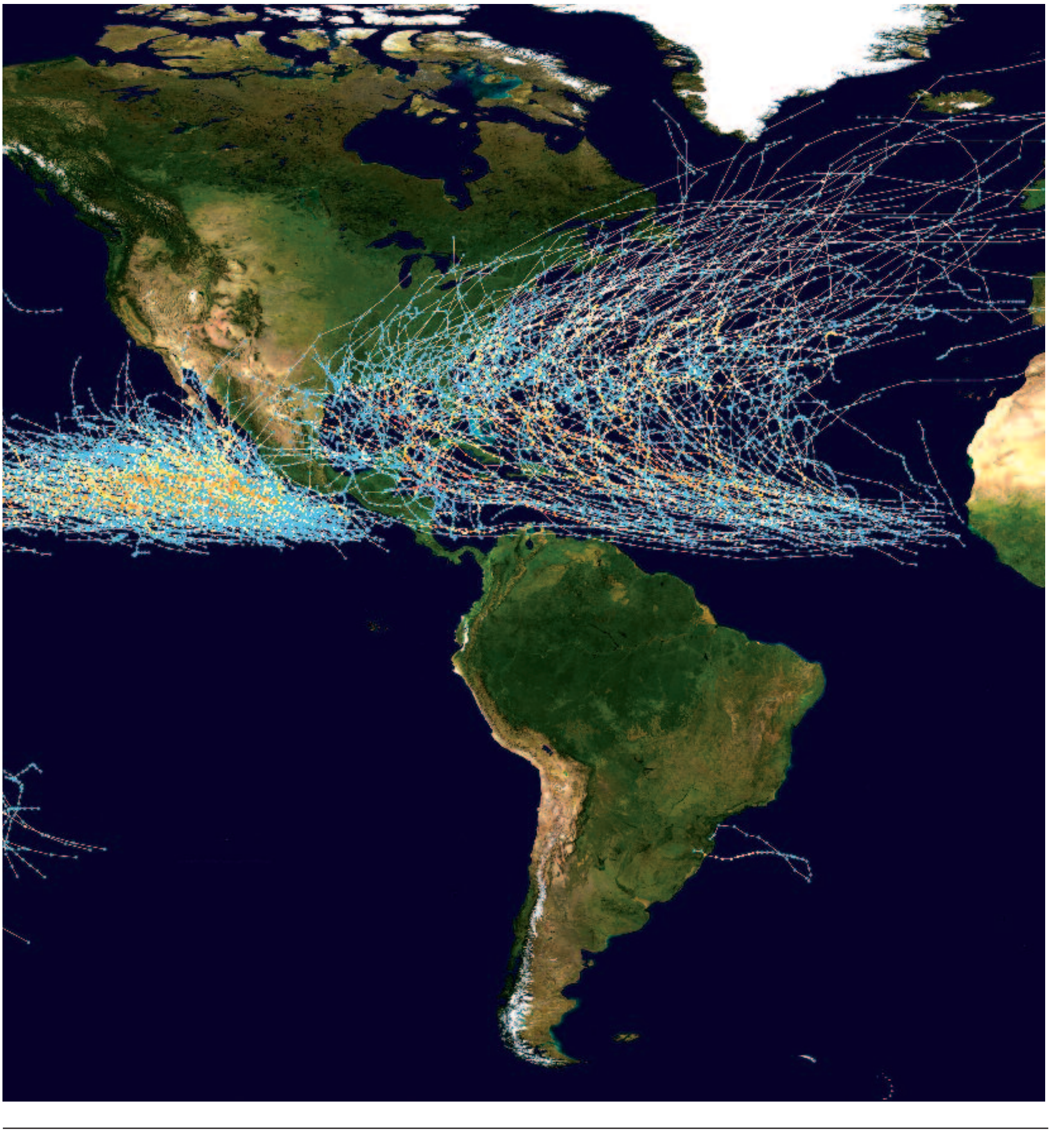
Even that report highlighted one potential benefit of such bad days. Klein (1992) noted the potential for scientific study on the plants lost to Hurricane Andrew – calling them "grist for the scientific mill." Fisher et al. (1996) made use of that 'windfall' to gain an understanding of ventricose palm trunk anatomy, using cultivated *Acrocomia*. Dowe (2009) similarly studied how wild

Archontophoenix palms are affected by major cyclones in the Southern Hemisphere. This work with palms fits into a context of other new findings that come from hurricanes (e.g. Horvitz & Koop 2001, Holt 2006).

At Montgomery, Hurricane Wilma in 2005 offered an opportunity to learn about palms and how they tolerate very high winds. These studies found that Caribbean palm species have evolved greater tolerance for high winds than South American palms (Griffith et al. 2008). This was fairly straightforward; we had assembled palms from throughout the New World in one location, and after the hurricane, we simply counted how many were lost as a result. Since we knew where these garden palms were collected, and could make estimates of how they were related (based on Asmussen et al. 2006 and others), we could compare hurricane tolerance with biogeography and phylogeny.

Our opinion was that palms offer an excellent model system to investigate evolution of hurricane tolerance (Griffith et al. 2008) because the single growing point on many palm species meant that severe wind damage

1. Extent of cyclone geography in the New World (Public domain image adapted from US National Oceanic and Atmospheric Administration data). This composite of all cyclone tracks from 1985-2005 demonstrates the near-discrete boundaries of the 'hurricane-prone' Caribbean and 'hurricane-free' South America, at more or less 10 degrees north latitude. *Coccothrinax* is native to the hurricane-prone area, and *Syagrus* is native to the hurricane-free area (with one exception).



would be a strong force of natural selection; if the single trunk fails, that palm will not reproduce again. The other fact that made this study possible is the near-binary geographic distribution of hurricanes in the Western Hemisphere (Fig. 1).What these conditions allowed was a technical insight on natural selection in this group. In the strict sense, natural selection works to reduce variation in a given trait. We found that South American palms were quite variable with regard to surviving high winds, but Caribbean palms were uniformly resistant, demonstrating natural selection through frequent hurricanes. The hurricane tolerance of Caribbean palms was also shown to be correlated with geography alone, and independent of phylogeny (Griffith et al. 2008).

When that insight – that Caribbean palms evolved to survive high winds – comes up in conversation, it prompts a natural question: "how?" Our study simply discovered the correlation of biogeography and hurricane tolerance. We included some basic comparisons (e.g. *Pseudophoenix*, *Coccothrinax* and *Syagrus*) to show that there appears to be no correlation with palmate vs. pinnate leaves, crownshaft vs. no crownshaft habit, or swollen vs. cylindrical trunks.

A Hypothesis

This paper continues the study of palms and hurricanes, by presenting a more detailed comparison of *Coccothrinax* and *Syagrus*, looking at data on very basic stem allometry and its relationship to mortality from hurricane damage. It is clear that for equal amounts of wind load, such as from a hurricane, and equal stem diameter and mechanical properties, a taller palm will have greater risk of mechanical failure (i.e. death), due to increased leverage. Thus, stem morphology may show patterns consistent with natural selection to resist high winds. Here, we explore this hypothesis – stem shape correlates to hurricane tolerance – using palms from hurricane-prone and hurricane-free areas.

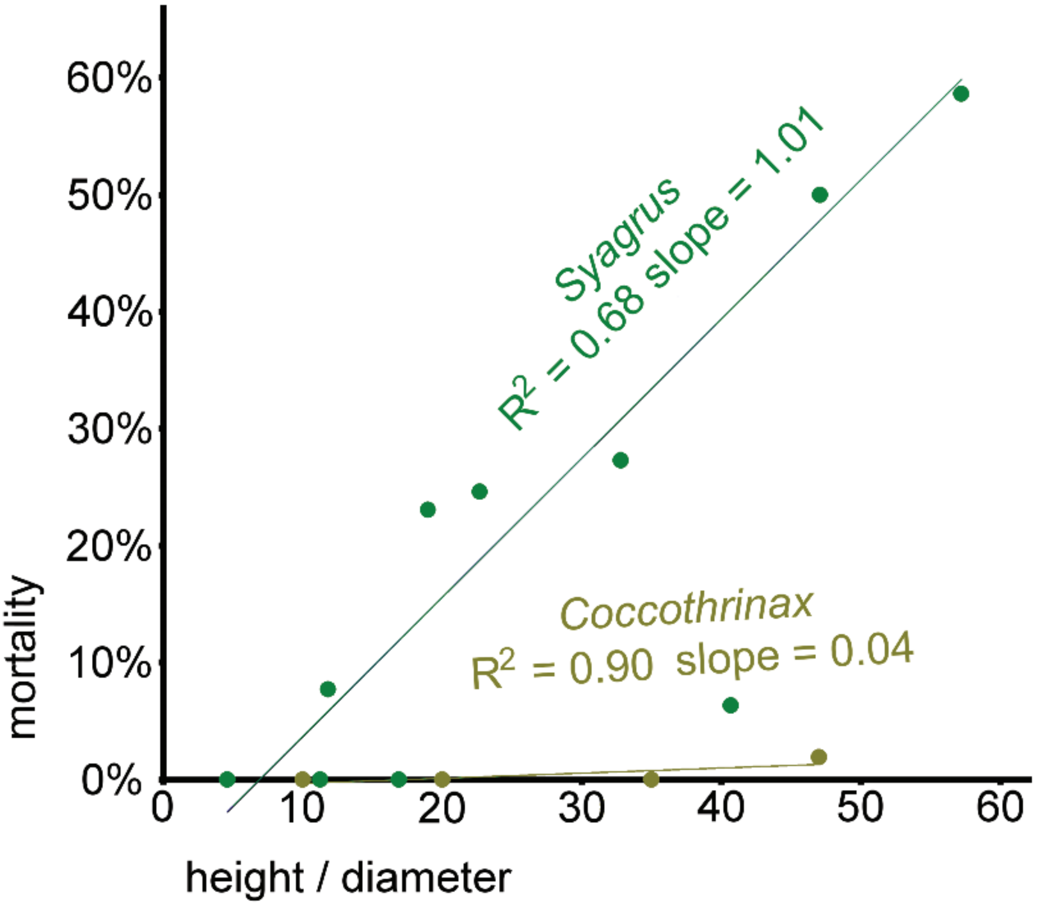
Methods

Palms studied: This study used collections of *Coccothrinax* and *Syagrus* at Montgomery Botanical Center. Specimens examined are detailed in Table 1. We chose to focus on these two genera for the following reasons: (1) adequate sample sizes of palms available, (2) availability of many species with single, self-supporting trunk habit (excluding rattans, branching, and clumping palms), and (3) the

Table 1. Species and number of plants examined, percent mortality, height / diameter ratio, and root diameter (in cm). Percent mortality data are from Griffith et al. (2008).

Species	n[1]	% mortality	Mean H / D	Mean root diameter (cm)
Coccothrinax argentata	13/7	0.00%	7.8±3.4	0.175±0.05
Coccothrinax barbadensis	106/10	1.90%	58.2±26.2	0.367±0.05
Coccothrinax scoparia	34/5	0.00%	23.7±3.3	0.3±0.1
Coccothrinax spissa	27/6	0.00%	10.3±0.8	0.2±0.1
Syagrus amara	13/5	0.00%	16.9±4.3	0.85±0.1
Syagrus botryophora	29/8	58.60%	57.2±6.0	0.325±0.08
Syagrus coronata	33/27	0.00%	4.6±5.5	$0.767 \pm 1.4\text{x}10^{-16}$
Syagrus kellyana	11/17	0.00%	11.2±5.2	0.55±0.15
Syagrus oleracea	13/8	27.30%	32.8±5.5	0.475±0.2
Syagrus orinocensis	17/8	23.10%	19±5.3	0.65±0.1
Syagrus romanzoffiana	61/34	24.60%	22.7±6.7	0.367±0.11
Syagrus sancona	2/1	50.00%	47.1	0.45±0.13
Syagrus vermicularis	16/14	6.30%	41±11.6	0.425±0.05
Syagrus × costae	13/12	7.70%	11.8±2.54	0.7±0

[1] First n is for mortality data, second n is for morphology data.



2. Percent mortality as a function of height / diameter for each species in the study (Table 1). Green points are *Syagrus*, and tan points are *Coccothrinax*. Taller and thinner *Coccothrinax* are almost imperceptibly more likely to fail (slope = 1/25), while *Syagrus* failure is correlated with trunk shape (slope = 1/1).

geographic distribution of these two groups. *Coccothrinax* is essentially a Caribbean Basin genus (Henderson et al. 1995), and *Syagrus* is essentially a South American genus (Noblick et al. in press) — with one important exception, *Syagrus amara*. Finally, it was decided that the plants needed to be 10 years old or older, to exclude plants not yet mature enough.

Wind event: Specimens were examined for the effects of Hurricane Wilma, which crossed the study site on 24 October 2005. Wind speeds of up to 49–55 m/sec (95–105 knots) were recorded near the study site (Pasch et al. 2006).

Data collection: Data on plants killed as a result of the hurricane were compiled in the weeks after the wind event (as in Griffith et al. 2008). For this study, we also gathered measurements of height and diameter on living specimens of the study species at Montgomery. Height was determined by measuring from the ground at the base of the plant to the point where the petiole of the lowest green leaf crossed the vertical line of the trunk, this being the only consistently obtainable standard for height on these palms due to the presence of adherent leaf bases. On smaller palms (1–2 m), a retractable 10 m steel tape measure was used. On larger palms (2–5 m), an extendable fiberglass measuring pole was used, with the hook placed on the base of the lowest green petiole. On the tallest palms (≥ 5 m), a hypsometer was used, sighting from the point where the lowest green leaf attached to the trunk, and to the ground at the base of the plant. Three measurements were taken with the hypsometer and the average recorded. Diameter was measured at 1 m from ground level along the trunk for greater efficiency and consistency in the field, rather than at the traditional "DBH" of 4.5 feet. A 50 cm caliper was placed on top of the meter stick to measure the diameter of the trunk. When diameter exceeded 50cm, a measuring tape was used.

3 (left). *Syagrus amara* (MBC 96165*C) collected from Guadeloupe in 1996. This Caribbean species, in an otherwise South American genus, is exceptionally wind resistant. Note the prominent basal trunk swelling (see also Figure 6). 4 (right). An exceptionally tall (6.9 m to crown, 21 cm diameter) *Coccothrinax spissa,* MBC 60814*A. This individual (H/D = 32.8) is known as the Florida State Champion of its species. The seed was collected in 1960 in the Dominican Republic. At Montgomery, it has survived decades of high winds and several major hurricanes.

Preliminary survey of primary root diameters was also performed on a random subset of the palms studied.

Analysis: Height and Diameter were both standardized to m, and then divided to give the H/D ratio (Height divided by diameter), to provide a standard, dimensionless comparative measure of how stout each palm is relative to its height. H/D was averaged to give a mean H/D value for each species. Root diameters were also averaged for each species. The metrics were graphed against % mortality data (Griffith et al. 2008) using Excel (Microsoft Corporation 2010), and simple linear least-squares regressions and R^2 values were calculated.

Results

Percent mortality for each species is compared to its H/D ratio in Table 1. Percent mortality varied from no loss (e.g. *Coccothrinax argentata*) to nearly 60% (*Syagrus botryophora*). Figure 2 plots these points, and shows an immediately obvious difference between the two genera studied. Linear regression on these data gives R^2 values of 0.37 for the total data, 0.68 for *Syagrus* taken alone and 0.90 for *Coccothrinax* taken alone, further establishing that the genera have divergent trends. The regression slopes for each genus were 1.01 for *Syagrus* and 0.04 for *Coccothrinax*. A test of the coefficient of an interaction term in a multiple regression model for the complete data shows that the difference in these regression slopes is statistically significant ($p = 0.0212$), and each regression is significant (*Coccothrinax*, $p=0.0463$; *Syagrus,* $p = 0.0032$).

Considering the hypothesis

Thus, our hypothesis – palms show patterns of hurricane mortality that correspond with stem

5. *Syagrus botryophora* collections at MBC the day after Hurricane Wilma (October 25, 2005). These were grown from seed collected in 1994, in Bahia, Brazil, and were thus 11 years old in this photo. These are relatively tall and thin *Syagrus* (Average H/D = 57.2). See also Figure 7.

shape – is confirmed for *Syagrus*, and rejected for *Coccothrinax*. *Coccothrinax* is invariably windproof in this analysis, regardless of its trunk shape. Although the regression slope for *Coccothrinax* was significantly greater than 0, the magnitude is so small (4%) as to be effectively negligible, and certainly far lower than for *Syagrus,* which as a genus has an essentially 1:1 relationship between H/D and % mortality.

Since *Coccothrinax* is mainly distributed in the Caribbean Basin, we expect it has been selected for high winds, due to the ongoing presence of hurricanes there over millennia (Griffith et al. 2008). The very low range of % mortality (0–1.9%), regardless of stem shape, is consistent with natural selection for hurricane tolerance. On the other hand, *Syagrus* shows much greater variation (0–58.6% mortality) in its tolerance for high winds. As a South American genus, *Syagrus* has evolved in a hurricane-free environment, and thus continues to possess variation in wind tolerance, as this trait has not been under the same selective forces as Caribbean palms.

One exceptional *Syagrus* is *S. amara* (Fig. 3), the only *Syagrus* not native to South America, but found in the Lesser Antilles. Since these islands are exposed to hurricanes, we expect reduced mortality in *S. amara*, consistent with natural selection. We see exactly that; *S. amara* showed no mortality, despite H/D of 16.9. The only other *Syagrus* with no mortality are *S. kellyana* and *S. coronata*, which have the lowest and second-lowest H/D in the group.

At the other end of this trend is *S. botryophora* (Fig. 5), native to the Atlantic Coastal Forest of Brazil (Lorenzi et al. 2010). Montgomery lost well over half of its collection of *S. botryophora* to storms in 2005, and it has the highest H/D of the group, at 57.2. *Syagrus botryophora* evolved in a hurricane-free environment, and this tall, thin, fast-growing palm saw exceptional damage. Thus, the ability of *Syagrus* to survive high winds appears related to stem dimensions, where these palm trunks function as levers; with longer trunks, a given wind load can exert greater force at ground level, thus requiring greater trunk strength, perhaps obtained through greater diameter (cf. Sterken 2008).

Is there a 'hurricane habit' for palms?

So, although trunk shape can help explain hurricane mortality in *Syagrus*, it does little to explain how *Coccothrinax* tolerates high winds. *Coccothrinax* shows much variation in trunk

6 (left). *Syagrus amara* (MBC 20030597*A); see also Figure 3. Roots of this species are exceptionally robust within the genus, with diameter often reaching over 1cm. 7 (right). *Syagrus botryophora* (MBC 941217*F); see also Figure 4. Roots of *S. botryophora* are much thinner (Table 1) compared to *S. amara* (Figure 6).

shape, from very stout palms (e.g. *C. spissa*, Fig. 4), to very tall, slender plants (e.g. *C. barbadensis*), yet all are consistently windproof. So we return to that previous question of "how?"

Future investigations of trunk anatomy (cf. Fisher et al. 1996; Tomlinson 2006) could offer insight on how palms become windproof. One approach to this stem anatomy research would be to compare *Syagrus amara* to other *Syagrus* species. Another potential approach would be to quantify and survey the often swollen trunk bases of these palms. *Syagrus amara* collections at Montgomery show prominent basal swellings (Fig. 3). Since other Caribbean palms are quite divergent in habit and shape, perhaps a heretofore unexamined aspect such as root habit may influence wind tolerance. The above-mentioned basal trunk swellings in *S. amara* may enable greater numbers of roots. Individual roots may also play a role; initial survey shows that within *Syagrus*, *S. amara* has exceptionally robust root diameter (Fig. 6), while *S. botryophora* has very slender roots (Fig. 7). Preliminary survey of these primary root diameters shows some correlation between increasing root diameter and decreased wind mortality in *Syagrus* (slope = -0.81, R^2 = 0.47; data from Table 1). So, perhaps further examination of root morphology and structure will reveal a key adaptation for palms in high wind environments.

Differences in mode of failure can also be considered (Griffith et al. 2008). For example, Fig. 5 shows *Syagrus botryophora* specimens that are either uprooted or broken at mid-trunk.

Table 2. Relative proximate cause of mortality of *Syagrus* at MBC due to hurricanes.

Cause	Percentage of losses
Unspecified mechanical damage	40%
Uprooted/toppled	36%
Trunk snapped	20%
Crushed by falling debris	4%

Mechanical failure of the crown was also observed. Review of all *Syagrus* lost to storm damage at Montgomery shows no clear majority of failure mode (Table 2). Further investigation of failure mode as compared to morphology will certainly provide additional insight.

Everyone involved with this palm collection hopes for no further hurricanes. However, given current knowledge in the biology of wind tolerance in palms, the next storm will present further opportunity for research.

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The Bequest of Richard Douglas

Richard Douglas took great pride in developing his garden and donating his time to the Northern California local chapter of the Palm Society and served as IPS President during 1983 and 1984. Richard's generosity extended far beyond family, friends and acquaintances and was truly reflective of his love for palms. Richard left wonderful memories with all of us, but more than that, left us with a gift of life. The IPS has been given a generous bequest of $15,000 from his estate trust. We gratefully acknowledge this bequest to the IPS' endowment fund, which supports research and education.

Leland Lai
President, IPS

Palms of Southern Cameroon

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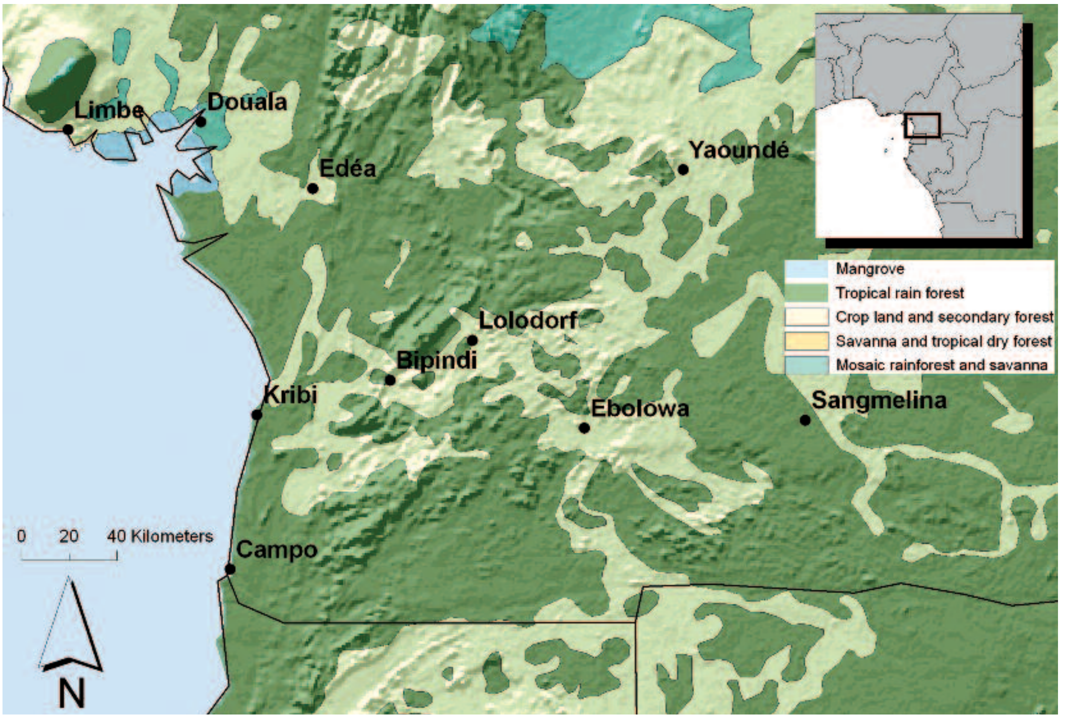
Africa is generally associated with a poor palm flora. Although this might be true in terms of numbers, with only 65 species recorded in contrast to the ca. 730 for South America, palms are omnipresent in African rain forests. This is especially true for rattans.

Several hypotheses have been advanced to explain the paucity of the African palm flora. The main hypothesis stipulates that palms underwent high extinction rates linked to an increase in aridity of the climate since the Miocene (Moore 1973; Morley 2000) leading to fewer species than in other tropical regions. This was supported to some extent by the fossil record (Pan et al. 2005) and by a worldwide ecological study of palms (Kissling et al. 2012). In contrast, a study of global diversification rates at the family level did not detect a significant decrease in rates for African palms (Baker & Couvreur 2012), suggesting that African palms might not have been affected by the change in climate as previously suggested. However, to date, detailed knowledge of palm species evolutionary dynamics are lacking hampering any solid understanding of palm history in Africa. To this end, we shall reconstruct the phylogeny in order to understand the evolutionary dynamics of the African rattan clade, Ancistrophyllineae. This clade comprises three genera representing 21



1. Map centered on Southern Cameroon. Notice the mountain range of Ngovanyang between Bipindi and Lolodorf.

species and has recently been revised (Sunderland 2012). They are mostly distributed across the rain forests of West and Central Africa. Moreover, rattans are used for a multitude of purposes across tropical Africa, mainly for the construction of furniture, which represents a large international market for cane exportation (Sunderland et al. 2008). Seventeen species of this clade are found in Cameroon, and thus a field trip was undertaken there (Fig. 1) in order to collect herbarium and DNA material for phylogenetic studies.

We first visited the Campo Ma'an National Park, in the south-west of the country. This park is well known for its high biodiversity with numerous endemic species. Part of the park is suggested to have been a potential refuge forest during the Pleisotcene climatic fluctuations (Tchouto et al. 2006a, Tchouto et al. 2006b), underlining its biological and conservation importance.

The first day we drove to the seaside town of Kribi (Fig. 1), one of the favorite holiday spots for Cameroonians and tourists. From there we drove to the small village of Campo. The coastline between these two villages has been the site of numerous botanical collections in the past, so we did not stop that much as our main goal was to collect within the park boundaries. We did, however, come across a sad sight. Part of the large economical reforms of the country, a new deep-sea port is being constructed 30 kilometers south of Kribi. The construction started by massive deforestation leaving once lush tropical and mangrove vegetation to a bare ground of white sand that extends for over 4 kilometers.

After an interesting discussion with Campo Ma'an manager we headed out to our camping site at the edge of the park. From there we undertook daily trips around the park and collected all palm species we encountered. Rattans grow in a wide range of different habitats. Some species are light demanding and grow along roads and in gap vegetation while others grow in the understory vegetation (Sunderland 2007).

The first species we encountered were the widespread abundant ones growing along the roads, such as *Laccosperma robustum* (Burret) J. Dransf. (Fig. 2) or *Oncocalamus mannii* (H. Wendl.) H. Wendl. (Fig. 3). The former is the most common species we saw and is largely widespread in Central and Western Africa. It is also a good source for cane production (Sunderland 2007). The latter species has a strong leaf dimorphism, with juvenile leaves initially bifid then becoming pinnate, a change that can lead to some confusion (see Fig. 2). We also collected *Laccosperma secundiflorum* (P. Beauv.) Kuntze, a species closely resembling *L. robustum*.

Further into the national park, along the main road to Nyabyssan we came across a population of the wonderfully beautiful *Eremospatha wendlandiana* Dammer ex Becc.. This species is characterized by its leaves with ca. 40 fish-tail leaflets (Fig. 4). Its presence along the walls of vegetation that surround the roads provides a lovely contrast to the other shapes commonly encountered in the forest.

Finally, in the understory of the forest we also collected *Podococcus barteri* Mann & H. Wendl., a small understory palm easily recognizable by its jagged leaflet margins. This is one of the two species known from the genus, the other, *P. acaulis* Hua, being located farther south, in Gabon (van Valkenburg & Sunderland 2008). The populations around Campo Ma'an represent the limit of its distribution to the north. It is found again locally in southern Nigeria. One of our projects is to understand better the genetic structure of populations of these two species of *Podococcus* in order to draw a model response from undergrowth species to climate change since the last glaciation in the rainforests of Africa.

The next stop of our trip was located in the small mountain range of Ngovanyang, situated between the town of Bipindi (famous as the home to the botanist George Zenker 1855–1922) and the old town of Lolodorf. This region has been the focus of a recent vegetation study, but unfortunately palms were not inventoried (Gonmadje et al. 2011). The idea was to try and collect a few understory rattan species, in contrast to Campo where most species we encountered were light demanding.

We camped near the village of Mbikiliki (midway between Bipindi and Lolodorf), at 500 m altitude in an abandoned Baka tribe camp. The roofs of the small huts were made with *Raphia* leaves. The first interesting collection we made was *Laccosperma korupensis* Sunderaland. This species was recently described by Sunderland (2002) and this represents the tenth collection of this species, and the first for the mountain range. *Laccosperma korupensis* is characterized by a lack of acanthophylls on the cirrus (Fig. 4). Unfortunately, the flowers and fruits of this species remain unknown, as our collection was also sterile. A few meters farther we made yet

2. Vegetation at Campo Ma'an National Park. On the left *Laccosperma robustum* and on the right *Oncocalamus mannii*, juvenile form (notice the bifid leaves).

3. *Oncocalamus mannii*. Top: Habit, along the road. Lower left: Infructescence. Lower right: detail of scaly fruits.

another interesting collection. *Eremospatha haullevilleana* De Wildeman is distributed mainly in the Congo basin and is very rare in Cameroon but was found growing in Ngovoyang (Fig. 5). This is the second collection of this species for the country and

4. Top: *Eremospatha wendlandiana*: detail of leaflets. Lower left: *Laccosperma korupensis*, notice lack of acantophylls on the cirrus. Lower right: inflorescence of *Eremospatha laurentii*.

the first for the region. This collection nicely fills in the small gap between the other Cameroonian collection (southwestern Cameroon, near the border with Nigeria) and the rest of its distribution (Sunderland 2012). Another rattan species, *Eremospatha laurentii*

5. *Eremospatha haullevilleana* growing in understory vegetation of Ngovoyang mountain range.

De Wildeman was also found growing in the understory (Fig. 4). The flowers of this species turn a bright pink at anthesis and emit a sweet scent of jasmine – just what one needs after a long day in the field!

A bit higher up, we collected an unidentified species of *Eremospatha*, which had leaves lacking leaflets on the rachis. It was a clustering individual and all the stems we brought down had this characteristic, even those at the end of the stem, closer to the canopy. This condition has been documented in *Eremospatha* and *Oncocalamus* but it remains unclear as to what the function of such leaves is (Sunderland 2001). Up to now it is unclear to what species this form belongs.

Besides rattans we also collected material of potentially two *Raphia* species. The first one was growing along a small stream and had a stem of ca. 2–5 m. It was an impressive sight, with numerous individuals scattered across a marshy type of vegetation (Fig. 6). The inflorescences had one thick rachis with numerous pendulous rachillae and the fruits had yellowish scales, suggesting that we had come across *R. hookeri* G. Mann & H. Wendl. The other species of *Raphia* was found higher up the mountain, and was on *tierra firme* (Fig. 7). All individuals seen were stemless. The young immature inflorescences were hidden between the large petioles of the upright leaves. The rachis was also robust with numerous pendulous rachillae. It could be that this form corresponds to the species *R. regalis* Becc., although more detailed study of the material is still needed at this point.

The last part of our trip was supposed to be the hardest, but the most exciting. We wanted to recollect *Eremospatha barendii* Sund., known only by a single collection. In 1996, the forester Barend van Gemerden, who incidentally did his PhD with the same supervisor as the first author, collected this new species near a river south of Lolodorf. Little was known about this species as the collector was in a great hurry that day (pers. comm.). Some of our colleagues had little hope we would recollect this species 15 years later especially because of its proximity to Lolodorf.

We drove off in the morning, and came to the river as indicated by Barend, which we later learned was called Melange. We walked a bit in the secondary vegetation and within a few minutes we came across a species of

6: *Raphia* cf. *hookeri*. Adama Faye using a collecting pole to saw down a leaf and a bunch of fruits.

7. *Raphia* cf. *regalis* found on *tierra firme* a few meters higher than *R. hookeri*.

Eremospatha that appeared to have the morphological characteristics of *E. barendii* – an elongate-linear knee and linear leaflets. We were pleased and excited as this was going to be only the second collection of this species (Fig. 8), which was later confirmed by Sunderland (pers. comm.). We were able to make some extra observations on the ecology of this species. *Eremospatha barendii* appears to be restricted to rivers, and interestingly it grows on sand banks. Indeed, we were able to locate up to six individuals all growing on sand, which was not suspected up to now. In addition it would appear to be a shade tolerant species. A few 100 meters on both sides of the river, the vegetation became seriously degraded (slash-and-burn), and we failed to find this species anywhere else including along two other rivers further up the road. Unfortunately, none of the individuals we found was fertile. The flowers of this species thus remain unknown. We did however come across a snake that was sleeping in one of the low reaching leaves of *E. barendii*, and we were lucky not to have tried to grab it while searching for some fertile material. Given these observations, this species deserves the highest conservation status of "critically endangered" especially because its ecology is so specialized. One idea would be to continue down the Melange River in search of other potential sand banks and verify its presence at other localities.

In total we made 26 palm collections in two weeks, representing eleven rattan species, one *Podococcus* and two *Raphia*. We have now started reconstructing the phylogenetic relationships within the Ancistrophyllineae, which will provide a better understanding of palm evolution in Africa since the Miocene.

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8: The second collection of *Eremospatha barendii* growing along a river bank on sandy soil.

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The Useful Palms of Sainte Luce: Implications for Local Resource Availability and Conservation

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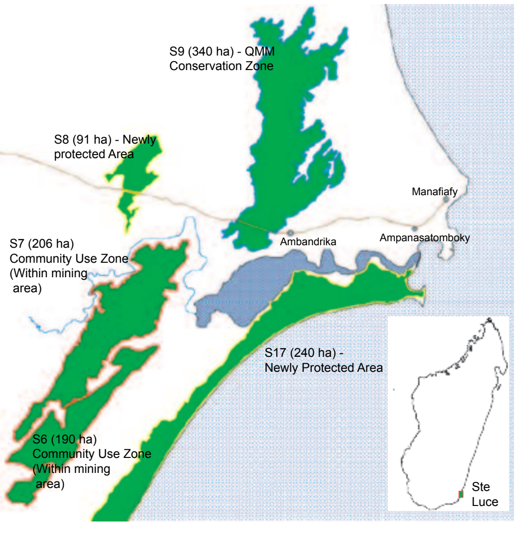
The community of Sainte Luce, southeast Madagascar, has traditionally relied on palms for a wide range of applications that underpin local livelihoods, but unsustainable extraction and forest cover loss are reducing palm numbers and habitat extent in the area. Six of the ten native palm species found within the littoral forest of Sainte Luce are threatened with extinction (IUCN 2012). This investigation reveals that local dependence on these palms remains high, raising concerns both for resource availability and conservation. The potential onset of large-scale mining operations in the area intensifies the need to address these concerns.

Palms (Arecaceae) are essential to subsistence and small-scale commercial livelihood strategies across Madagascar (Dransfield & Beentje 1995, Byg & Baslev 2001); however, documentation of the uses of palm species in many ecologically significant regions remains limited. Understanding utilization is an important prerequisite for planning *in situ* species conservation initiatives (Johnson 1996, Heywood & Dulloo 2005) and for informing community-based natural resource management plans.

The littoral forest of Sainte Luce is one of three remaining stands of intact littoral forest within the Tolagnaro region (as defined by Vincelette et al. 2007). These fragmented forests are home to exceptional plant diversity and endemism; over 25% of the 1535 plant species found are endemic to the littoral forest habitat (Consiglio et al. 2006). In comparison to the region's other littoral forests, Mandena and Petriky, the palm family is best represented at Sainte Luce, where ten native species are found, six of which are threatened with extinction (IUCN 2012). Other impressive areas for palms can be found in the southeast too, most notably amidst the large, pristine tract of humid evergreen forest, known as Tsitongambarika, which cloaks the Vohimena mountain range just to the west of Sainte Luce and the lowland coastal plain (see Dransfield & Rakotoarinivo, 2012).

Along with *tavy* (slash-and-burn agriculture) and persistent logging, mining is a significant threat to the littoral forest of Sainte Luce. QIT Madagascar and Minerals (QMM), a subsidiary of Rio Tinto, has targeted 57% of Sainte Luce's littoral forest to be cleared for the extraction of ilmenite (Vincelette et al. 2007), a titanium-iron oxide mineral that is eventually used as a whitening agent. In 2008, mineral extraction at the pilot site Mandena began, and by 2012, prefeasibility studies in Sainte Luce were underway, but due to weaker market conditions for their products these operations have been recently suspended (1 Feb 2013). Given the environmental context, QMM is committed to achieving a net positive impact (NPI) on the region's biodiversity (see Temple et al. 2012).

1. The study area at Sainte Luce: forest fragments S6 & S7 (community use zones), S8 & S17 (Newly Protected Areas formed in 2003) and S9 (QMM conservation zone), note that S17 extends further south than shown; the three hamlets; the river & road. S6 and S7 are situated within the mining area.



Azafady, a local non-governmental organization, has been working in Sainte Luce for over a decade and has been focusing research efforts towards the *in situ* conservation of threatened palm species alongside other initiatives including biodiversity monitoring, local capacity building and environmental education. Azafady has a team of staff and volunteers working permanently in Sainte Luce who are able to record the local uses of the palm flora while also collecting information on palm morphology, ecology and harvesting practices. The ultimate goal of this paper is to draw attention to issues regarding palm conservation and resource availability in relation to five of the largest littoral forest fragments in Sainte Luce - S6, S7, S8, S9 and S17 (Fig. 1).

METHODS

Study Area

Sainte Luce (24°45'S, 47°11'E) is situated along the southeastern coastline of Madagascar approximately 45 km north of Tolagnaro, the urban center of the Anosy region, and comprises three hamlets with a total human population of around 2000 inhabitants (Chef de Fokontany, personal communication, 1 June 2012). Sainte Luce is part of the humid bioclimatic zone, as defined by Cornet (1974) and Schatz (2000), with relatively constant and high temperatures throughout the year, high annual rainfall and no well-defined dry season. The littoral forest stands over poor, sandy soils, in extreme proximity to the coast and at a low altitude of 0–20 m. All three hamlets in Sainte Luce – Ambandrika, Ampanasantomboky and Manafiafy – are within a 30-minute walk to the nearest forest fragment. Fifteen littoral forest fragments remain in Sainte Luce, in varying degrees of degradation, ranging from 1 to 340 hectares with a total littoral forest cover area of approximately 1500 hectares (Ramanamanjato 2007, Vincelette et al. 2007).

Study Species

Nine of the ten palm species native to Sainte Luce were included in the survey (see Table 1). The large trichistous arboreal palm *Dypsis mananjarensis* was excluded from the survey, as

Table 1. The palms of Sainte Luce: the conservation status and distribution according to the IUCN (2012); species highlighted in bold are thought to be introduced to the Sainte Luce area; **Dypsis mananjarensis* excluded from survey.

Species	Distribution
Beccariophoenix madagascariensis (VU)	E Madagascar; between Tolagnaro and Mantadia
Dypsis brevicaulis (CR)	SE Madagascar; Tolagnaro region
Dypsis fibrosa (LC)	E & NW Madagascar; widespread
Dypsis lutescens (NT)	E Madagascar; widespread
Dypsis nodifera (LC)	E & NW Madagascar; widespread
Dypsis mananjarensis (NT)*	E Madagascar; between Tolagnaro and Ampasimanolotra
Dypsis prestoniana (VU)	SE Madagascar; between Mahanoro and Tolagnaro
Dypsis psammophila (EN)	SE & NE Madagascar; littoral forests and lowland humid evergreen forests (e.g. Tsitongambarika)
Dypsis saintelucei (EN)	E Madagascar; SE littoral forests, Vondrozo, Vatovavy, south of Toamasina
Dypsis scottiana (VU)	SE Madagascar; between Tolagnaro and Farafangana
Raphia farinifera	Tropical Africa, N & E Madagascar
Ravenea sambiranensis (LC)	E, W & NW Madagascar
Cocos nucifera	Pantropical

only three individuals have ever been located in the area according to local reports and extensive explorations by Azafady researchers. However, some observations of *D. mananjarensis* are provided. In addition, the pantropical coconut (*Cocos nucifera*), *Dypsis lutescens* and *Raphia farinifera* are not included, as they are found outside the littoral forest and are considered introduced to the area.

Survey

Between April and May 2012, 54 semi-structured interviews (six for each species) were conducted with 21 different interviewees. All interviewees were male (age range 25–67) and were resident in Sainte Luce. Two survey approaches were adopted; pre-arranged interviews with local people and opportunistic interviews carried out with local people encountered in the forest. For both approaches, an adult and a juvenile of the palm species was visited in S7, S8 or S9 with the interviewee, the primary researcher, a Malagasy translator and a local guide. Depending on time availability, one to four species were visited with each interviewee. The species are presented in alphabetical order according to their scientific name with the vernacular name(s) provided in brackets.

Preliminary interviews found that it was difficult to discern whether the interviewee's answers referred to common uses or personal use. Therefore, it was decided that the investigation would focus on common village uses rather than person specific uses. Indeed, distinguishing between knowledge of common uses and actual uses in the community is important – some applications that are common knowledge may be historical and no longer applied today. To address this, observations of palm harvest and use by households were recorded between February 2011 and July 2012 to confirm which applications were current and to gauge the frequency of use by the community.

Previous studies have shown that local knowledge of resource availability can reveal changes in actual resource abundance (Gadgil et al. 1993, Duffield et al. 1998). The survey therefore asked interviewees whether they had perceived any changes in the availability of the species in question over the last 20 years. For some of the younger interviewees, the question was rephrased to account for changes over the last ten years.

Ecology and Conservation

Information on local distribution, habitat preference, morphology and life history were recorded between February 2011 and July 2012 in forest fragments S6, S7, S8, S9 and S17, and are presented in the Results section in correlation with the survey findings. Concerns for conservation of palm species in Sainte Luce are briefly touched upon in the Results section but are examined in greater detail, along with observations of palm harvest and use, in the Discussion section.

RESULTS

Beccariophoenix madagacascariensis (Boaka-mainty or *Lafa)*

Beccariophoenix madagascariensis has fewer than 50 known adults and fewer than 300 juveniles remaining in the area, with the largest subpopulations located in S6/S7 and S8. Several adults have survived *tavy* practices and now stand outside the forest edge (Fig. 2).

2. *Beccariophoenix madagascariensis* standing in a *tavy* field near to the southern edge of forest fragment S8 (Photograph by David Meyer).

However, seedlings require forest interiors and well-drained soils with generous canopy cover for survival.

Uses: At present, the local community does not frequently use *B. madagascariensis*: however, applications remain diverse. The fibrous leaf rachis of juveniles and sub-adult trees are harvested at the base, stripped longitudinally and woven into lobster traps. However, the durability of the lobster trap is poor and a possible reason as to why other species (e.g. *D. scottiana, D. saintelucei* and *D. prestoniana*) are selected more regularly for this purpose. The long majestic leaves, typical of individuals during sub-adult stages of development, are sometimes cultural ornaments during ceremonies. The strong, dead leaf rachises are cut from the adult tree prior to abscission for a carrying implement, known locally as *bao*. Several interviewees also mentioned historical uses such as making beehives and flooring from trunk sections.

Availability: Decrease (3 respondants out of 6), No change (2/6), Increase (1/6)

Life History: Beetles have been observed predating young fruit.

Conservation Concerns: The need to protect this species appears to be common local knowledge, in all likelihood due to educational programs by local NGOs and independent researchers raising awareness. Harvesting and use is very rare. QMM and Azafady are cultivating seedlings in Sainte Luce.

Dypsis brevicaulis

This incredibly rare dwarf palm is restricted to the littoral forests of Sainte Luce, the lowland humid evergreen forests of Tsitongambarika and an area just south of Manantenina (J. Dransfield, personal communication, 10 Nov. 2011). Unexpectedly, preliminary census efforts in a 10-hectare section of forest fragment S8 have revealed high densities (more than 400 adults) and interesting morphological details (see below). *Dypsis brevicaulis* is known from two major forest fragments in Sainte Luce; S8 (protected area) and S7 (within the mining area) and occupies well-drained soils and tolerates low canopy cover. Its distribution could possibly extend to other fragments too.

Uses: No local names or uses for this species were mentioned during the surveys.

Life History/Morphology: Eggs of *Phelsuma* spp., possibly *Phelsuma quadriocellata,* were found nestled within the crown (Fig. 3). *Habit:* both solitary and clustering (<6 stems). *Trunk:* either hidden underground or exposed and up to 2 m in length. *Fruit* 1-seeded, ovoid, ca. 12 × 7 mm, red at maturity (Fig. 4). *Seed* elongate, ca. 11 × 5 mm, endosperm homogeneous. Morphological details recorded from individuals at S8.

Conservation Concerns: No immediate threats at Sainte Luce, although further explorations are needed to determine its exact local distribution.

***Dypsis fibrosa* (*Boakandambo* or *Palima*)**

In Sainte Luce, *Dypsis fibrosa* commonly inhabits riparian zones with well-saturated soils, and is found across all major fragments (S6, S7, S8 and S9) except for the coastal S17 forest. Local knowledge on this species appears to be limited.

Uses: Over half the interviewees were unable to name the species, and no interviewees gave any local uses. At other locations along the east coast, *Dypsis fibrosa* is an important forest resource for weaving products such as basketry and thatch (Byg & Baslev 2001). However in Sainte Luce, like most villages across Anosy, the community uses *mahampy* reeds *Lepironia mucronata* (Cyperaceae) for basketry and the leaves of *ravinala*, *Ravenala madagascariensis* (Strelitziaceae), for roofing.

Availability: No change (6/6).

Life History: None available.

Conservation Concerns: No immediate threats at Sainte Luce.

Dypsis nodifera (Raobe)

Dypsis nodifera seems to have similar habitat preferences to *D. fibros*a – alongside riparian habitats and preferring good shading. This slender palm is found in all major forest fragments (S6, S7, S8, S9 and S17) in Sainte Luce. Juveniles can be confused for *raotry* (*D. scottiana*) however the larger stature (DBH 5–7 cm) of sub-adults/adults is unmistakable. Some local people differentiate these two species more accurately by examining the leaves; *D. nodifera* possesses more strongly grouped and arcuate leaflets than *D. scottiana*.

Uses: The local uses of *D. nodifera* are diverse. The fruit (ellipsoid, green ripening to yellow) is consumed as a snack. Stems of more supple juveniles are stripped length ways to weave lobster traps. The stiffer stems of adults are cloven in two and sharpened to pierce together

3 (top). Eggs of *Phelsuma* sp. found in the crown of *Dypsis brevicaulis* in S8. 4 (bottom) Fruit of *Dypsis brevicaulis.* (Photographs by David Meyer)

the petioles of *Ravenala madagascariensis* in wall construction (known as *manohy falafa*) for local housing. Fishermen use the mature stems to increase the wall-height of sea-bearing pirogues (dug-out canoes); these stems are long-lasting and do not often need replacing. The leaflets of juveniles and sub-adults are foraged and brewed into tea by local healers for treating *tonporaza*, a disease with similar symptoms to epilepsy.

Availability: No change (5/6), Decrease (1/6)

Life History: None available.

Conservation Concerns: *Dypsis nodifera* is still fairly abundant across Sainte Luce; however, the recent increase in targeted extraction may be a cause for concern in the future.

Dypsis mananjarensis

One sub-adult can be found in a *tavy* field to the southwest of S8 and two adults can be seen in the western sub-fragments of S8 with limited signs of regeneration apparent. Recent observations by Azafady have confirmed that *D. mananjarensis* is also found in higher numbers at Farafara-Vatambe, a village located near to Tsitongambarika forest (approximately 25 km west of Sainte Luce).

Dypsis prestoniana (Boakabe - adults, ***Boaka*** - juveniles*)*

Dypsis prestoniana is distributed across all major fragments (S6, S7, S8, S9 and S17) with the largest population lying in the northern parts of S9 and possibly southern S7. Habitat preferences vary, although well-drained interior soils and generous canopy cover appear most advantageous.

The Uses: The leaf rachises of all age cohorts (2–3 m juveniles most frequently) are used to fashion lobster traps. The trunk is sectioned, cloven and the soft core left to decompose before flattening into flooring for construction (very rare). Similarly to *B. madagascariensis*, the majestic leaves of large sub-adults are sometimes used as cultural ornaments at ceremonies and festivities. Dead abscised leaf sheaths of large adults are used as shoulder padding by lumberjacks when carrying planked timber.

Availability: No change (4/6), Decrease (2/6)

Life History: Massive infructescences bear an important food source for the red-collared brown lemurs (*Eulemur collaris*) during the lean season.

Conservation Concerns: As mentioned previously, the largest population of adults is located to the north of S9, a QMM conservation zone, which provides some security for the species at Sainte Luce. However, non-timber forest products, like the leaf rachis of juvenile *D. prestoniana*, are regularly harvested at S9.

Dypsis psammophila (Hanjo)

Currently absent from the species list for the area (see Rabenantoandro et al. 2007a), *D. psammophila* is abundant across the northern reaches of S9 and throughout S8, S7 and possibly S6. As suggested by its etymology (sand-loving), this palm prefers sandy, well-drained soils and tolerates high sun exposure.

Uses: Its most common use is to combine petioles of *Ravenala madagascariensis* together in wall construction for housing. As with *D. nodifera*, the more mature, stiffer stems are selected, split and sharpened to a point, which are then pierced through multiple *R. madagascariensis* petioles to create a wall panel. Observations suggest that *D. psammophila* is becoming more frequently used for this purpose, as adult *D. nodifera* and *D. scottiana* stems are becoming increasingly difficult to find.

Life History: The locally endemic and Critically Endangered day gecko, *Phelsuma antanosy*, has been observed frequently on this palm, which appears to be an important foraging microhabitat for this gecko species (Azafady, unpublished data). Local people have observed flying foxes, *Pteropus rufus*, feeding on the fruit.

Availability: No change (5/6), Decrease (1/6)

Conservation Concern: No immediate threats at Sainte Luce.

Dypsis saintelucei (Telopoloambilany)

Dypsis saintelucei is locally named *telopoloambilany,* 'thirty trees to fill a cooking pot,' presumably because of its edible palm heart. Previously thought to be restricted to the littoral forests of Sainte Luce, *D. saintelucei* has since been found in other areas further up the east coast (J. Dransfield, personal communication, 10 Nov. 2011). Today, the largest populations of *D. saintelucei* in Sainte Luce are found in S7, followed by S8, and although juveniles are relatively abundant in S9, only one mature individual is known. This palm prefers medium soil saturation and generous canopy cover, especially for younger individuals. Older individuals occupying drier, more exposed areas are often stunted and display poor vigor in the crown.

5. Lobster traps (at right) made of *Dypsis scottiana* (Photograph by Naidi McDonnell).

Uses: Palm hearts, *tavolo*, were more commonly harvested in the past (before ca. 1985) when the adult trees were more abundant and during times of food insecurity. Several interviewees recalled that only a few households possessed the skills for harvesting the bitter palm heart, and the study revealed that this practice has been discontinued by the younger generation. In terms of current usages, the leaf rachises of juveniles (most commonly), sub-adults and adults are harvested and woven into lobster traps. Other applications include the use of trunks for flooring but this seems to be very uncommon.

Life History: No observations of any seed dispersers. Seeds commonly land and germinate at the base of the parent tree. Bees have been seen frequenting inflorescences of trees in forest fragment S7.

Availability: Decrease (6/6)

Conservation Concerns: Adults are being lost to habitat destruction from *tavy* and occasionally for lobster trap or construction materials. There is widespread evidence of rachis harvesting of juveniles despite reports of low frequency of use, which may be impacting the growth and development of this younger age cohort. Trunk axe marks (for testing maturity) may be correlated with the prevalence of a soft rot. The potential loss of S6 and S7 to mining is of major concern the future of this emblematic species at Sainte Luce. Azafady and QMM cultivate this species at tree nurseries based in Sainte Luce.

***Dypsis scottiana* (*Raotry/Raotsy* - adults, *Amboza* – juveniles)**

Dypsis scottiana is located in all major forest fragments occupying a range of habitat types, including dry forest edges and moist interior patches. Of all the palms, immature *D. scottiana*, locally known as *amboza*, is possibly the most frequently utilized in Sainte Luce.

The Uses: The stems of this threatened clustering palm are cut at ground level and just below the oldest petiole, stripped longitudinally and woven into lobster traps (Fig. 5). Adult stems are used in a similar fashion to those of *D. nodifera* and *D. psammophila* – to pierce and combine *R. madagascariensis* stems for wall construction (the panels are known locally as *manohy falafa*) (Fig. 6), the slight difference being that the stems of *D. scottiana* are thin enough (<4 cm DBH) to be used whole rather than split in two. According to the survey, *D. scottiana* is the first choice material for this common wall-building technique, although scarcity has prompted diversification to other slender palms for this purpose (*D. nodifera* and *D. psammophila*). As with *D. nodifera*, timber panels are bound to the side of the pirogues with adult *D. scottiana* (*raotry*) stems to increase the height of pirogue sidewalls to reduce seawater spilling over during rough conditions.

Availability. Decrease (6/6)

Life History: None available.

Conservation Concerns: The combination of extraction for *manohy falafa* and lobster traps has critically reduced numbers in Sainte Luce. Sexually mature individuals are increasingly hard to find, making seed collection challenging. Cultivation research and a species recovery plan are needed.

***Ravenea sambiranensis* (*Vakapasy*)**

This medium to large dioecious palm is relatively low in abundance throughout forest fragments S6, S7, S8 and S9. It has not been reported from or observed in S17. It occupies a range of habitat types from swamp areas to dry, well drained soils. As inferred by the interviews, it is highly likely that a large proportion of the local community are unable to identify it as a separate species from other large palms, especially *B. madagascariensis*.

Uses: Leaf rachises of juvenile *R. sambiranensis* are harvested for lobster trap weaving materials, but used infrequently in comparison to other palm species. Two older interviewees mentioned the use of the trunk to make sharpened spears for protection when travelling; indeed, the trunk is remarkably strong and resistant to axe damage. A large population of *R. sambiranensis* is situated 29 km southwest, near the village of Mahialambo.

Availability: Decrease (3/6), No Change (3/6)

Life History: None available.

Conservation Concerns: Low density, increasing fragmentation/habitat destruction and the recent extraction of juveniles for lobster traps may be compounded by its dioecious habit.

DISCUSSION

Vernacular-Scientific Name Correspondence

Indigenous Malagasy criteria for naming are often based on appearance, physical properties and applications of the plant (Randriatafika & Rabenantoandro 2007). Interestingly, immature *D. scottiana* is differentiated from mature individuals by name (*amboza* and *raotry* respectively), presumably due to the differences in their applications (*amboza* – lobster traps, *raotry* – construction material). The survey did not reveal local names for either *D. brevicaulis* or *D. fibrosa*. Local names for palm species may be different between neighboring communities, for example, people from the mountain village Volobe, 20 km to the west of Sainte Luce, refer to *R. sambiranensis* as *anivo*. It is therefore important to note that the vernacular-scientific name correspondence outlined in this paper is only relevant within the community of Sainte Luce, and should be verified by scientific identification whenever possible.

6. *Dypsis scottiana* stems being used to make wall panels (Photograph by Naidi McDonnell).

Palm Harvest and Application

Diversification of Material Use for Lobster Traps

Palms are an essential part of the economics of the lobster trade as they provide the materials for trap construction. At present, the fishermen are able to use seven species of palm to weave traps – the most economically significant application of palms by people in Sainte Luce.

Lobster is a top commercial export for the Anosy region and productive fishing centers such as Sainte Luce have attracted a growing migrant population to join the cottage industry. This population increase, combined with the average regional population growth, places enormous pressure on high preference lobster trap materials. Prior to ca. 1990, the liana *Flagellaria indica* (Flagellariaceae), known locally as *vahipiky*, was the most frequently used material for constructing lobster traps and is now at the brink of extirpation in Sainte Luce. In an effort to resolve this problem, cultivation trials by Rabenantoandro et al. (2007b) found that the liana is easily propagated from seed (rather than cuttings) but found that its slow growth rate would hinder its effectiveness as a long-term solution. Other natural materials have been tested in the area, including a Bamboo species, *Bambusa multiplex* (Poaceae), but traps proved to be very weak when woven from dried materials and according to the fishermen sharp edges damaged the lobsters (Rabenantoandro et al. 2007b).

Although traders continue to bring a declining reserve of *Flagellaria indica* from the Tsitongambarika forests (25 km to the west), the community of Sainte Luce have diversified their material usage to other forest resources. Palms, primarily *D. scottiana*, now constitute the majority of traps woven in Sainte Luce; however, it must be noted that *Ravenala madagascariensis* is a regular alternative material too (Shrum et al., in review). To make one trap, which lasts a maximum of three weeks in good sea conditions, twenty stems of *D. scottiana* (*amboza*) are required (Shrum et al. in review). Hundreds of fishermen using up to ten traps each at any one time, throughout the ten-month fishing season, constituting a huge annual demand (Shrum et al. in review). This coupled with the use of adult *D. scottiana* (*raotry*) for the common wall construction technique, *manohy falafa*, is rapidly exhausting the Sainte Luce population. When asked about changes in resource availability over time, all interviewees had noticed a decrease in the availability of *D. scottiana*. This is a priority species for both conservation and natural resource management at Sainte Luce.

The Juvenilization of Palm Populations

The juvenilization of populations through intensive rachis pruning has been observed in useful palm species (Dransfield & Beentje 1995). At Sainte Luce, *D. saintelucei* may be one palm subject to this process. Typically, of juveniles, the youngest developing leaf shoot is left untouched during rachis harvesting for making lobster traps. It can be assumed that in some cases the youngest is left intact because its small size is unsuitable for the purpose; however, some interviewees stated that this was a practice to maintain resource availability. Indeed, rachis harvesting is not fatal to the individual but may be preserving the population in a quasi-juvenile state, possibly explaining the demographic imbalance of *D. saintelucei* in Sainte Luce (Azafady unpublished data).

Other arboreal and solitary palm species (*D. prestoniana, R. sambiranensis*) have been subjected to an increased frequency of rachis harvesting of juvenile individuals for lobster traps over the last seven to ten years. Some interviewees did comment on this diversification in material use, stating that the depletion of *D. scottiana* and the absence of *F. indica* the main contributing factors. Assessing optimal rachis harvesting has been done with other useful palms in Madagascar, such as *Dypsis decaryi* (Ratsirarson et al. 1996), and could be considered with *D. saintelucei*.

At present, the harvest of mature adult arboreal palms (*B. madagascariensis, D. prestoniana, D. saintelucei* and *R. sambiranensis*) is very uncommon; however, the felling of several adult *D. prestoniana* (in S9) and *D. saintelucei* (in S7) for house construction was observed between the period of February 2011 and July 2012. Adult *D. saintelucei* have also been cut down to access the crown for weaving lobster traps in S7. These people were probably from villages outside Sainte Luce (Ebakika, Tsiharoa or Mahatalaky) highlighting the need to encompass outlying resource-dependent communities in conservation, resource management and awareness raising initiatives.

Stem Collection of Clustering Palms

Stems of the more slender clustering palms *D. scottiana* and *D. psammophila* (and *D. nodifera* which sometimes exhibits a clustering habit) are used in the common wall construction technique, *manohy falafa,* and for other purposes such as pirogue modification. According to field observations and survey findings, two harvesting practices are followed; only some of the stems are taken to promote stem regeneration, or every stem is cut, often leading to plant death. Indeed, some stems may be left if they are unsuitable for the purpose required, but there is evidence to suggest that some fishermen adjust their harvesting practices in an attempt to manage valued natural resources. The exact socio-economic parameters that influence which groups of people follow which practice are unknown. However, immigrants to Sainte Luce are perceived by the native people to be less sensitive to the traditional set of rules (the *dina*), which aim to promote the sustainable and fair use of both forest and marine resources.

Potential Impacts of Mining on Palm Populations and Resource Availability

QMM is committed to achieving a net positive impact on biodiversity (NPI) whilst taking into account the needs and rights of the local Anosy communities bordering the project zone, Sainte Luce. However, the expected loss of several large community use zones to mining, primarily S6 and S7, will directly impact immediate local resource availability and palm population biology at Sainte Luce.

Forest fragment S8 has been a protected area since 2003 and lies outside the designated mining area. This fragment is an important location for the palm flora of Sainte Luce, with all ten species present. However, despite falling under the responsibility of the "*Communauté de Base*" (CoBa, or local forest management committee), areas of S8 continue to be degraded and lost to prohibited activities. In recent years, the Sainte Luce CoBa has been largely non-functional, non-representative and lacked the support of the local community. This may change following recent elections and ongoing institutional capacity building by QMM; however, capacity and transparency issues with CoBas seem to be persistent and island-wide (see Hockley & Andriamarovololona 2007).

The main community use zones, forest fragments S6 and S7, represent a significant proportion of Sainte Luce's palm flora but are within the mining area. These fragments are home to the largest population of *D. saintelucei* (with over 100 adults recorded), the second largest population of *B. madagacariensis,* the Critically Endangered *D. brevicaulis* and the Endangered *D. psammophila* (IUCN 2012, Azafady, unpublished data). In addition, S7 is an important collection site for *D. scottiana* and other species used for lobster traps. The loss of S6 and S7 will place massive pressure on S8 to continue contributing palm resources to local livelihoods whilst maintaining viable populations for the area as a whole. S9 (QMM conservation zone) and S17 (Protected Area) are largely lacking in palm diversity and density but may be important locations to consider for *in situ* conservation measures.

Recommendations

Further research is needed to determine the exact palm distribution and population sizes/trends of all threatened palm species across the different forest fragments at Sainte Luce. The likely inclusion of S6 and S7 in the mining path strongly necessitates the sustainable (community-based) management of S8's natural resources and habitat, with effective population (participatory) monitoring and possible population reinforcements. The QMM conservation zone, S9, will offer the best protection for all flora and fauna in Sainte Luce, and could play an important role in species recovery plans. As a priority, the investigation and application of alternative materials for lobster traps is essential for both palm and overall habitat conservation in Sainte Luce.

CONCLUSIONS

Palms are among the most widely utilized plants in Sainte Luce. Their applications are diverse: fishing tackle, medicine, house and pirogue construction, food, utensils and cultural ornaments. Fabricating lobster traps is currently the most frequent and economically important local application of palms, employing seven of the ten species native to Sainte Luce. However, unsustainable extraction is depleting palm populations. Most urgently, *Dypsis scottiana* appears to be facing a similar path to extirpation as the previously utilized *Flagellaria indica*. Intensive rachis harvesting of juvenile *D. saintelucei*, and potentially other solitary arboreal palms, may be causing the juvenilization of the population.

Rapid human population increase is placing further pressure on the littoral forest to contribute natural resources, like palms, to local livelihoods at Sainte Luce. Mining at locations known to support high palm densities, reducing palm population size and extent, may compound this issue. Nursery-reared or alternative resources for fabricating lobster traps should be investigated further, involving the meaningful participation of local fishermen at every stage of the process. A functional community-based institution (CoBa or other) must be in place to manage existing forest resources, support sustainable extraction of resources at the conservation zone (S9) and protected areas (S8, S17), and monitor overall habitat protection. We hope that this report contributes in some way to the conservation of these beautiful plants in their natural habitat.

Acknowledgments

We would like to thank the interviewees, Aimé and Rivo, all Azafady's ACP volunteers involved, local guides (Solo, Babaly, Altere and Ranjiva), Vayah and Eva, Sosony at the Azafady community tree nursery, Foara (Chef de Fokontany) and the community of Sainte Luce. We are very grateful to John Dransfield for sharing so much expertise on Malagasy palms, Mark Jacobs, Laura Robson, Gemma Holloway and Jo Coxall for reviewing the paper, and David Meyer and Naidi McDonnell for their wonderful photography work. We would also like to extend our gratitude to the QMM Biodiversity team and their vital work across the Tolagnaro region.

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Twin Remembrances of Ed Moore (1917–2012)

Ed Moore, The Cookie Man

As a youngster, I especially looked forward to Ed Moore's visits at my grandparents' nursery and garden, because he would usually bring some cookies from the Sunshine Biscuit Company, where he worked. When I was sixteen, I would visit his garden twice a week to pollinate his many philodendrons and later in the summer collect the seeds. During those visits, Ed would take the time to introduce me to the beautiful begonias, epiphytes (mostly from Mexico) growing on his trees and other unusual plants. He would teach me to identify the many mature palms and cycads crowded into his garden but always beautifully displayed around the water features and pathways. Ed's garden is world famous and has inspired many people in Southern California to convert their lawns into beautiful gardens.

During those visits, Ed would describe his trips to Baja California and the many localities at which he would obtain seeds from different *Brahea* species and other plants of Baja. He would always make the point that *Brahea brandegeei* should be the most cultivated palm street tree in Southern California due to its grace and good growth behavior.

My last visit with Ed included a discussion the dramatic *Encephalartos tegulaneus* that was in his garden. He was 95 years old at the time! I mentioned I had no idea where the three specimens in my grandparents garden came from. He promptly told me that he, Loren Whitlock and my grandfather had obtained these in a shipment that they shared from South Africa before CITES but just after South Africa passed rules restricting the export of *Encephalartos* without special permits. Soon after they acquired those cycads, CITES restricted the nursery trade in South African cycads.

Ed's horticultural contributions to San Diego are important and often overlooked, as he worked quietly (and very hard) out of the limelight. After he retired, Ed spent many hours at the San Diego Zoo and Balboa Park as a volunteer making an impact on the palm and cycad collections. I am sure that I am not alone in having Ed as one of the main inspirations for my passion for plants…and a certain weakness for cookies.

Eric Anderson
San Diego, California, USA

Ed Moore, The Plant Lover

The IPS Biennial in 1978 was held in San Diego, California. As a new nurseryman specializing in palms in Australia, I joined the IPS that year in order to attend the conference and learn about palms, their cultivations and sources of good, fresh seeds. One of the many private gardens we visited with great collections of palms and other plants was Ed Moore's garden in San Diego. I was astonished what this man had managed to cram into a relative small area. It was not just a dense jungle of greenery but rather a well structured and thoughtfully organized display that, with the twisting and turning of the path, made the visitor constantly discover new botanical delights. It was also here that I discovered cycads, which up to that time were only vaguely recognized by me. When I asked Ed what they were, he was astonished at my ignorance and told me that we had so many of these plants in Australia. Upon my return to my nursery I decided I had to learn whatever there was to learn about cycads, and Ed was, for all the years to come, my inspiration and my reliable source of information. I have never met another plant lover so free with information gathered over long periods. Ed was also very generous with his excess plants, which he would only ever give away. He said he did not want to be commercial about his love for plants. About 20 years ago his garden needed a major thinning out since many plants had become far too big. He gave all of these large plants taken out to the park surrounding a new resort development in San Diego. He wanted nothing in return except some soil to fill the holes where the palms had been growing.

Whenever I was in the USA, I would visit him and his wife Priscilla and stay in a room overlooking their unique garden. We often talked about doing a trip across the southern part of the States, and this we finally undertook in 1982. That year, the IPS Biennial was held in Florida, and Ed and I drove 6800 km from San Diego to Miami to attend it. We drove through deserts and scrubby, thinly populated country whilst Ed told me his life story, about the things he loved and those he hated. He was stuck during WWII in the Pacific for many years without ever having had a break until the war was over. In San Diego he bought a barren building plot where he built his house and where soon afterwards the magic transformation from bare soil into showpiece garden began. I have seen many beautiful gardens throughout the world but Ed's garden on an ordinary home plot is without a doubt the finest I have ever enjoyed anywhere in the world.

Ed had a soft tender heart, was kind and considered in spite of sometimes giving off a first impression to the contrary. He was loyal, honest and reliable, a man from the times "when men were men and women appreciated it," as he liked to say. I shall miss his advice, his knowledge and his experience he passed on so readily. May he rest in peace.

ROLF KYBURZ
Queensland, Australia

Richard (Dick) Douglas (1938–2013) IPS President 1983–1984

Born on the banks of The Great Okefenokee Swamp in Georgia on November 14,1938, son of Mildred Richey and R. G. Douglas, Richard grew up in Waycross, Nicholls and Montezuma, Georgia. Following graduation from Nicholls High School in 1956, he attended the University of Georgia's Landscape Architecture program (BLA). Anxious to experience a cosmopolitan setting, Richard moved to Miami, Florida, where he worked at the Surf Club and Burdine's department store. Whilst in Miami, Richard developed an interest in flying, eventually obtaining his pilot's license. Richard then joined the US Army, serving two years at the Pentagon in Washington, D.C. Subsequent to his discharge from service, he returned to Miami where in 1966, he was hired by United Airlines. In 1967, Richard successfully bid for a first officer position in the San Francisco Bay Area where he remained domiciled until his retirement from United Airlines in 1998.

Fascinated by palm trees from an early age, Richard moved in 1972 from San Francisco to the East Bay community of Walnut Creek, California, where he started his impressive, if not unique palm garden. Richard rapidly gained a reputation for his exceptional knowledge of palms and hybridization techniques. A founding member of the Northern California Palm Society and President Emeritus of the International Palm Society, Richard welcomed many visitors from around the world with whom he graciously and enthusiastically shared his remarkable garden. Through the years, Richard has left a legacy of palms dispersed across California and beyond, his passion and exuberance having influenced many to appreciate, if not create, palm gardens.

A talented artist, an accomplished pilot, a gentle being, Richard was a generous and kindly man with a sharp wit and a great sense of humor who lived his life to the fullest, cherishing not only every day that was bestowed upon him, but his family, his friends, and of course, his garden. Richard will be deeply missed by the many people whose lives he touched, but none more than by those who loved him.

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Syagrus stenopetala, a Good Species

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1. Clustering stems of *Syagrus stenopetala*.

The distinctness of *Syagrus stenopetala* is confirmed.

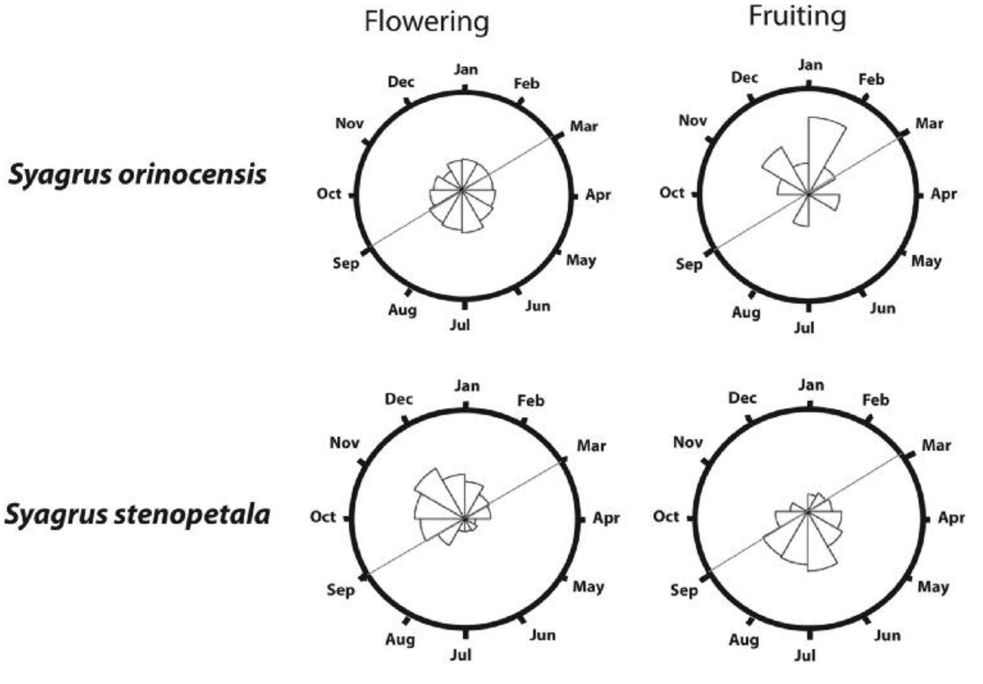
In 1969, Dr Sidney Glassman placed *Syagrus stenopetala* Burret in synonomy with *S. orinocensis* (Spruce) Burret (Glassman 1969) and continued to propose this in his 1987 revision of *Syagrus* (Glassman 1987), even though H.E. Moore had suggested to him that the populations near Carababo, Venezuela (a locality of *S. stenopetala*), may represent a distinct taxon. Glassman (1969) originally sank the species because "The types resemble each

2. Solitary stem of *Syagrus orinocensis* showing a prominently swollen base both on this tree and on the one just behind and to the right.

other in the pinnae being arranged in loose clusters of 2–3 and 2.0–2.4 cm wide." He wrote that the fruits of *S. stenopetala* appeared rather long (3.4–3.7 cm) and relatively narrow (1.3–1.5 cm in diameter). Then he commented that the fruit was probably immature, while failing to notice that these immature fruits were longer than the normal upper limits (3.4 cm) of the mature *S. orinocensis* fruits that he described. Nevertheless, other palm taxonomists initially accepted Glassman's change (Henderson et al. 1995, Govaerts & Dransfield 2005).

In 1991, as I worked on a morphological and anatomical analysis of *Syagrus* (Noblick et al. in press), I noted that the dried inflorescences, flowers and fruit of *S. stenopetala* appeared to be more robust than those of *S. orinocensis* suggesting again that the two might be distinct and so I separated them. After personally observing and collecting both in the wild in 1994, I became convinced that they were different. Fred Stauffer independently came to the same conclusion and defended the distinctiveness of *S. stenopetala* (Stauffer 1996). He justified the two species with a detailed table comparing and contrasting some 28 differences that he found. Among some of the differences that Stauffer found separating *S. stenopetala* from *S. orinocensis* are clustering (Fig. 1) vs. solitary stems (Fig. 2), stem hardly thickened at the base vs. prominently thickened at the base, 13–17 leaves in the crown vs. 10–12 leaves, longer peduncular bract (140–150 cm vs. 87–90 cm), longer

3. Flowering and fruiting events for *Syagrus orinocensis* and *S. stenopetala* showing their nearly opposite flowering and fruiting times. Gray line divides spring-summer from fall-winter seasons.



rachillae (38–40 cm vs. 24–30 cm) and a larger number of rachillae (65–70 vs. 40–50). The two also grow in very different habitats, with *S. stenopetala* growing near the northern, dry, coastal mountains of Venezuela in semi-deciduous forests or dry spiny savannas, while *S. orinocensis* grows in the southern, wet, Amazonian region of Venezuela near the Orinoco River, growing on rocky granitic outcrops. Today, the name has gradually regained acceptance (Hokche et al. 2008, Govaerts et al. 2012).

In the wild the differences in size and habit are distinctive, but in cultivation sometimes these differences blur with *S. orinocensis* occasionally clustering (under stress) and *S. stenopetala* not growing as robustly and even occasionally growing with a single stem.

Recently, I became aware of still another difference between the two species. Montgomery Botanical Center has been collecting phenological data (flowering and fruiting cycles) on these two species since 1999. While working on another paper, I discovered that these two species have nearly opposite phenologies. More specifically, *S. stenopetala* flowers mostly in the fall and winter and fruits in the spring and summer, while *S. orinocensis* fruits mostly in the fall and winter and flowers slight more in the spring and summer (Fig. 3). Reinstating *S. stenopetala* was the right thing to do and has now been further verified by a decade-worth of phenological data.

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A New Species of *Korthalsia* (Palmae) from Laos and Vietnam

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A new species of *Korthalsia* from Laos and Vietnam is described and illustrated, and compared with similar species.

Korthalsia contains 27 species (Govaerts & Dransfield 2005), widely distributed throughout the Asian tropics from Myanmar in the west to New Guinea in the east. The most widely distributed species is *Korthalsia laciniosa* (Griff.) Mart., which occurs in Myanmar, the Andaman and Nicobar Islands, Thailand, Cambodia, Laos, Vietnam, Malaysia, Sumatra, Java, and the Philippines (Henderson 2009).

During our field work in Vietnam we have noticed that there is great variation in size of pinnae within *Korthalsia laciniosa*, and in herbaria there appear to be two groups of specimens present from the country, one with larger-sized (24–33 cm long and 11–18 cm wide) and the other with smaller-sized (13.5–20 cm long and 6–11 cm wide) pinnae. Evans et al. (2002) also noted this difference in Laos, and referred to the smaller-sized specimens as *Korthalsia sp. A.* to distinguish them from *K. laciniosa*.

Larger-sized specimens from Laos and Vietnam correspond to *Korthalsia laciniosa* as represented by the type (which we have seen in the Brussels herbarium) and many specimens in other herbaria. One possible name for the smaller-sized specimens is *K. bejaudii* Gagnepain, a little known species from Cambodia. We have now examined the type of this in the Paris herbarium. There are two sheets. The leaf and ocreas on one sheet appear to be from an apical leaf and this would account for their small size. The second sheet has more typical *K. laciniosa* size pinnae. Although young fruits were described by Gagnepain (1937) and illustrated by Gagnepain and Conrard (1937, fig. 96), they

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are not present on either of the two Paris sheets. On one sheet there is a drawing of a fruit (repeated in Gagnepain & Conrard 1937), but there is no indication of the nature of the endosperm. However, the drawing clearly shows the laciniate fruit scales typical of *K. laciniosa*. We conclude that *K. bejaudii* is a synonym of *K. laciniosa*.

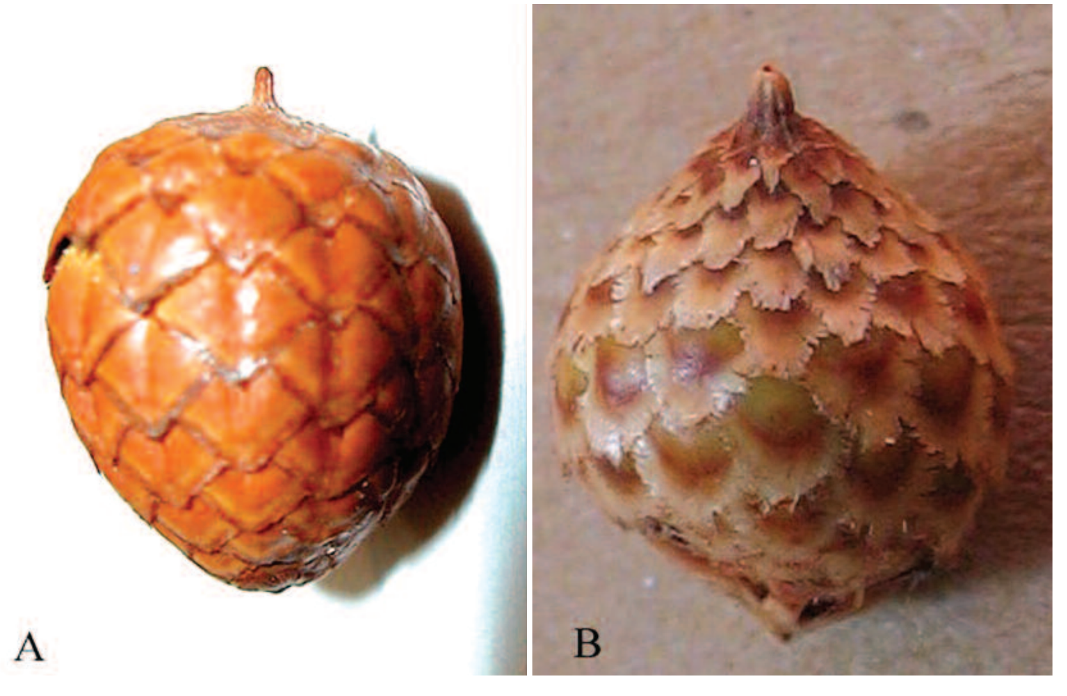
Most of the smaller-sized specimens are sterile, but we now have three fertile specimens. Comparison of the fruits of smaller-sized specimens with those of *K. laciniosa* shows clear differences. The smaller-sized specimens have fruits to 1.2 cm long with evenly brown, non-laciniate scales (Fig. 1A) and seeds with homogeneous endosperm; while *K. laciniosa* has fruits to 2 cm long with laciniate, bi-colored scales (Fig. 1B) and seeds with ruminate endosperm. Here we describe the smaller-sized specimens as a new species.

Korthalsia minor Henderson & N. Q. Dung, **sp. nov.**, it differs from *Korthalsia laciniosa* in its smaller pinnae, fruits with evenly brown, non-laciniate scales, and seeds with homogeneous endosperm. Type. Vietnam. Dong Nai: Cat Tien National Park, road to north of park headquarters, 11°26'N, 107°23'E, 150 m, 25 May 2007, A. *Henderson & Bui Van Thanh 3390* (Holotype: HN! Isotype: NY!) (Fig. 2).

Stems clustered, branching in the canopy or more often near ground level, to 50 m long, 0.8-2 cm diameter with leaf sheaths, 0.6–1.2 cm diameter without leaf sheaths; sheaths green with brown tomentum, with scattered, black, triangular spines to 1 cm long, often without spines; ocreas 4–13 cm long, fibrous, truncate, becoming loose and net-like in older leaves, seldom spiny; petioles 4–15 cm long, 0.3–0.5 mm wide, brown tomentose initially; rachis 40–50 cm long, tomentose as the petiole, with scattered, recurved spines abaxially; pinnae 4–8 pinnae per side of rachis, rhomboid, regularly arranged, with a distinct proximal stalk, 13.5–20 cm long, 6–11 cm wide at widest point, silvery-gray abaxially; cirri 30–65 cm long, spiny abaxially as the rachis. Compound inflorescences 25–40 cm long; individual inflorescences 8–10 cm long; rachillae to 10 cm long, 0.5 cm diameter, densely reddish-brown tomentose; only old flowers seen; sepals 2 mm long, split almost to the base into 3 lobes; petals to 4 mm long, free, valvate; fruits obovoid, 0.8–1.2 cm long, 0.7–1.5 cm diameter; scales brown, non-laciniate; seeds with homogeneous endosperm; embryo lateral.

Local names and uses: Laos: *wai nga, wai nyeng, wai neng, detlhe*; Vietnam: *may dung dinh, may ra nho, may ra, phuon nho*. In Laos the

1. A. Fruit of *Korthalsia minor* (from *Khamphone KP 451*); B. Fruit of *K. laciniosa* (from a specimen photographed by Khou Eang Hourt in Kirirom, Cambodia).



2. *Korthalsia minor*. A. Apical part of flowering stem. B. Pinnae. C. Ocrea. D. Infructescence with immature fruits (all from *Henderson & Bui Van Thanh 3390*).

shoots are reported to be edible, and the stems are used for tying. Like other species of *Korthalsia*, the stems are generally of too poor a quality for furniture making.

Distribution and habitat: Laos (Bolikhamsay) and central and southern Vietnam (Bien Hoa, Binh Thuan, Dong Nai, Quang Tri and Thua Thien-Hue), in lowland or montane forest, or drier forest or disturbed areas, at 100–892 m elevation.

Notes: A single, sterile specimen from Mondulikiri, Cambodia (*Evans TDE 91*), may be *Korthalsia minor*, but there is some doubt. On the specimen label it says, "None has the neatly truncate zoned short ocrea of *K.* sp. *A* from Laos." Khou Eanghourt (2008) placed all Cambodian specimens in *K. laciniosa* and described the endosperm as ruminate.

Korthalsia minor may be confused with *K. laciniosa*, especially if sterile. As pointed out by Dransfield (1981), *K. laciniosa* is a variable species. We have seen some specimens with similar pinnae dimensions to those of *K. minor* from Peninsular Malaysia and Thailand, but in all cases, when fertile, they have fruits typical of *K. laciniosa*. Plants vary not just geographically but also developmentally. Younger leaves from *K. laciniosa* are likely to approach those of *K. minor* in size, and because species of *Korthalsia* are hapaxanthic (semelparous) (Henderson 2009), leaves from near the apices of fertile stems are likely to be smaller than others.

Apart from *K. laciniosa*, specimens of *K. minor* of unknown origin could be confused with several species with similar dimensions (Dransfield 1981). *Korthalsia debilis* from Sumatra and Borneo has gray rachillae tomentum (versus reddish-brown rachillae tomentum in *K. minor*); *K. tenuissima* from the Malay Peninsula has compound inflorescences with 1–3 rachillae only (versus inflorescences with numerous rachillae in *K. minor*); *K. concolor* from Borneo has concolorous pinnae (versus pinnae silvery-gray abaxially in *K. minor*); *K. rogersii* from the Andamans has seeds with ruminate endosperm (Mathew et al. 2007) (versus seeds with homogeneous endosperm in *K. minor*); *K. paucijuga* from Sumatra and Borneo lacks a petiole (versus petioles 4–15 cm long in *K. minor*); *K. celebica* from the Celebes has seeds with ruminate endosperm (versus seeds with homogeneous endosperm in *K. minor*); *K. rigida* from southern Thailand and the Malay Peninsula, Sumatra, Borneo and Palawan has 2.5–5.0(–8.0) cm long ocreas which scarcely split (Hodel 1998) (versus 4–13 cm long ocreas, which become loose and net-like in *K. minor*).

Additional specimens examined. VIETNAM. Bien Hoa: "Song Lu(?), austro Cochinchina," Feb 1877, *Pierre 1878* (A, K, NY, P). Binh Thuan: Tanh Linh District, Nui Ong Nature Reserve, 11.02°N, 107.71°E, 158 m, 21 Oct 2009, *Henderson et al 3632* (HN, NY). Dong Nai: Cat Tien National Park, road to north of park headquarters, 11°26′N, 107°23′E, 150 m, 25 May 2007, *Henderson et al. 3390* (HN, NY); Cat Tien District, Doi Dat Do, National Cat Tien Park, 11°26′N, 107°24′E, 110 m, 15 Nov 2006, *Le Dong Tan et al. 754* (NY). Quang Tri: Da Krong District, Da Krong Nature Reserve, near Ba Long Commune, 16.651°N, 107.037°E, ca. 500 m, 28 Feb 2009, *Henderson et al. 3497* (HN, NY). Thua Thien-Hue: Bach Ma National Park, steep forested slopes, 16°14′N, 107°52′E, ca. 100 m, 12 Apr 2007, *Henderson et al. 3265* (HN, NY); Phong Dien District, Phong Dien Nature Reserve, 16.577°N, 107.232°E, ca. 300 m, 5 Mar 2009, *Henderson et al. 3520* (HN, NY); Phong Dien District, Phong Dien NR 16°30.923′N, 107°12.649′E, 783ft., 9, Feb 2012, *Bui Van Thanh et al. PD 10* (HN, NY); A Luoi District, Sao La Nature Reserve, 16.077°N, 107.488°E, 892 m, 7 Mar 2009, *Henderson et al. 3536* (HN, NY); A Luoi District, Sao La Nature Reserve, 16.115°N, 107.426°E, 666 m, 9 Mar 2009, *Henderson et al. 3553* (HN, NY); A Luoi District, Sao La NR, 16°04.691′N, 107°29.178′E, 2294 ft., 15 Feb 2012, *Bui Van Thanh et al. SL 04* (HN, NY). **LAOS**. Bolikhamsay: Khamkheut, Ban Namuang (map name Ban Nasao), Houay Tin, 14 Mar 1999, *Khamphone KP 388* (FRCL, K); Pakkading, Ban Naphong, headwater of Houay Nyanyoung, 12 Mar 2000, *Viengkham 238* (K); Phou Tat Thone, Ban Naphong, 8 Feb 1999, *Evans 30* (FRCL, K); Thaphabat, headwaters of Houay Say (H. Kay on map), 15 Dec 1998, *Khamphone KP 311* (FRCL, K); Pak Kading, no date, *Khamphone KP 451* (FRCL, K); Ban Nakhua, 10 Feb 1993, *Southone 39* (K).

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