Celebrating 60 Years

Palms

Journal of the International Palm Society Vol. 60(4) Dec. 2016

THE INTERNATIONAL PALM SOCIETY, INC.

The International Palm Society

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Palms (formerly PRINCIPES)

Journal of The International Palm Society

An illustrated, peer-reviewed quarterly devoted to information about palms and published in March, June, September and December by The International Palm Society Inc., 9300 Sandstone St., Austin, TX 78737-1135 USA.

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

Change of Address: Send change of address, phone number or e-mail to The International Palm Society Inc., 9300 Sandstone St., Austin, TX 78737-1135 USA, or by e-mail to info@palms.org.

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

Periodical postage paid at Austin, TX, USA and additional mailing offices. Postmaster: Send address changes to The International Palm Society Inc., 9300 Sandstone St., Austin, TX 78737-1135 USA.

PALMS (ISSN 1523-4495)

Mailed at Lawrence, Kansas 15 Dec. 2016

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

This publication is printed on acid-free paper.

CONTENTS

Features

The red new leaf of *Dypsis vonitrandambo*. See article by Baker et al., p. 169. Photo by W.J. Baker.

FRONT COVER

Dypsis metallica is one of the understory treasures of the Masoala Peninsula of Madagascar. See article by Baker et al., p. 169. Photo by W.L. Eiserhardt.

BACK COVERS

The magnificent leaves of *Marojejya darianii*, another fabulous palm from the Masoala Peninsula. See article by Baker et al., p. 169. Photo by W.J. Baker.

PALM NEWS

A recent thesis submitted by M.I. Ojeda García of the Pontificia Universidad Católica del Ecuador, **examines the seed dispersal of two common Amazonian palms, *Oenocarpus bataua* and *Mauritia flexuosa***. She examined both primary and secondary seed dispersal using direct observations and camera traps and found 52 animal species associated with *O. bataua*, 22 of which were seed dispersers. For *M. flexuosa*, she found 49 species of animals, of which 18 were dispersers. The White Capuchin Monkey (*Cebus albifrons*) was the most common primary disperser of *O. bataua*, while the Red Bellied Macaw (*Orthopsittaca manilata*) was the most common for *M. flexuosa*. The most common secondary dispersers were Green Acouchi (*Myoprocta pratti*) for *O. bataua* and the Black Agouti (*Dasyprocta fuliginosa*) and Lowland Paca (*Cuniculus paca*) for *M. flexuosa*. Most surprisingly, there is only 18% overall similarity between the dispersers of the two palms. These findings reinforce the critical importance of palms in the ecosystems in which they occur.

We are saddened to learn of **the deaths of two major researchers in the field of diseases of coconuts and other palms**. In October 2015 the coconut specialist Dave Romney died, aged 86. He played a crucial role, particularly in Jamaica, in the establishment of strategies to combat lethal yellowing disease of coconuts and in the redevelopment of coconut plantations after the devastation caused by the disease. In May 2016, the plant pathologist Karl Maramorosch died, aged 101. He was an early investigator into coconut lethal yellowing as well as *cadang cadang* and the diseases of palms generally. He was the author or coauthor of more than 800 research papers with major interests in comparative virology, invertebrate cell culture, parasitology, diseases caused by spirochetes, viroids, phytoplasmas and spiroplasmas.

The city of Phoenix, Arizona, has found an **innovative way of dealing with the tens of thousands of palm leaves that are disposed of every year** by residents. The leaves of *Phoenix* species are too fibrous and spiny to mulch with other green waste, and they take decades to biodegrade in the desert climate of Phoenix. About 34,000 tons go into the local landfill each year. The city has contracted with Palm Silage Inc., of Thermal, California, a company that uses palm leaves to make a pelletized feed for cows, horses, chickens and pigs. The feed, which also incorporates dates as a sweetener, is as nutritious as medium-grade hay.

A New Species of *Attalea* from the Bolivian Lowlands

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1. Palm stands in cattle pastures dominated by *Attalea princeps*, the *motacú* palm, on the alluvial plain of Bolivia.

***Attalea pacensis* from the lowlands of Bolivia is described as new.**

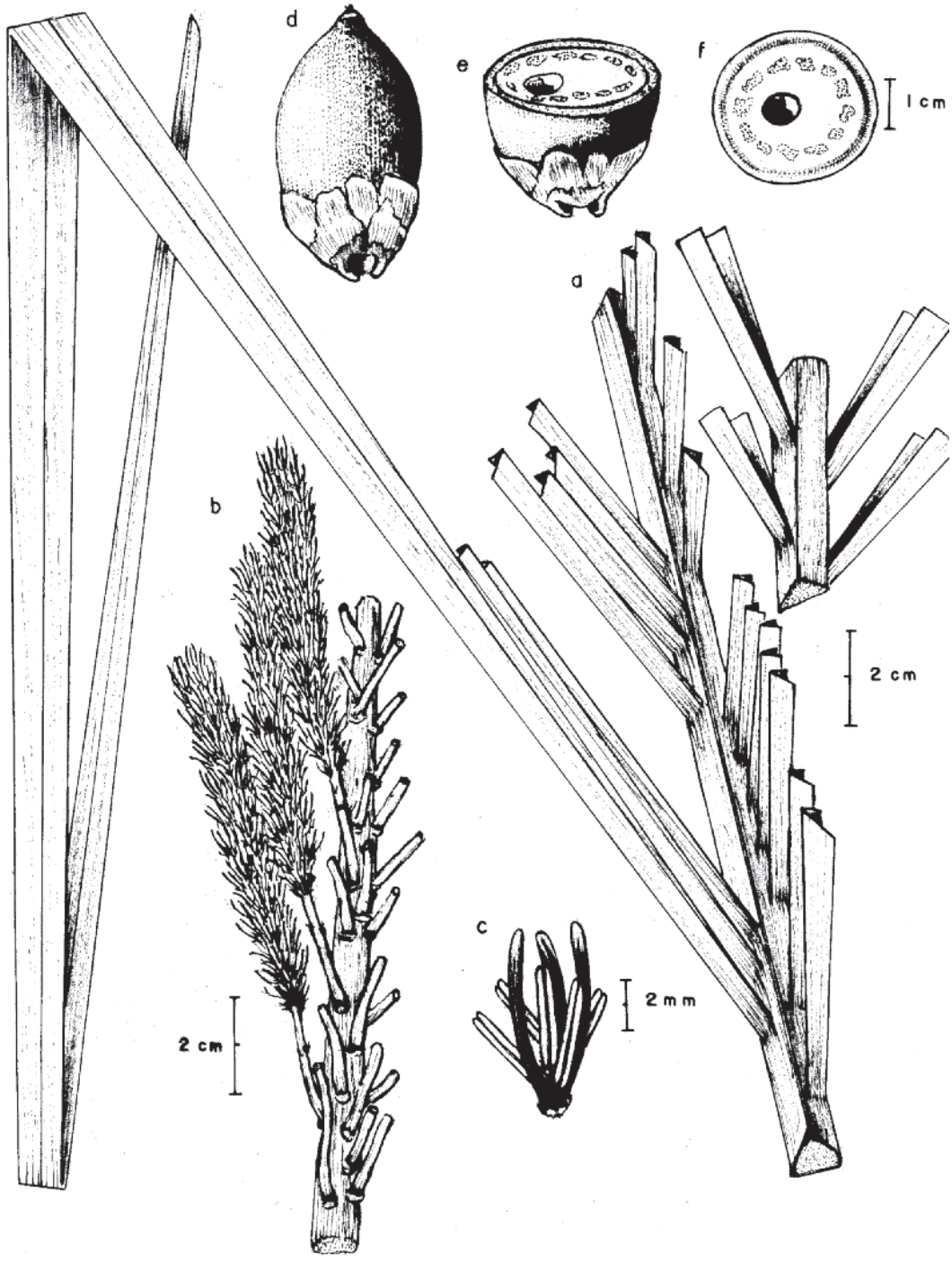
According to Pintaud (2008), the taxonomy of the genus *Attalea* has been poorly understood due to the conflicting generic and species concepts published in the last 20 years. Among the reasons that have affected and biased our taxonomic understanding of the genus are: few scientific collections (considering that these are species of large size),

2 (left). Palms whose identity was thought to be *Attalea princeps* and here are described as new, *A. pacensis*. 3 (right). *A. pacensis* with typical erect leaves and a cylindrical trunk. Both show habit of *A. pacensis.*

loss of many type specimens, and difficulties in interpreting hybrids (Pintaud 2008). Being a large palm, this new taxon was not formerly separated from the common *Attalea princeps,* because they share similar habitats. However, it is much less frequent in the northwestern plains of Bolivia. This new species occurs mixed with *A. princeps* in cattle pastures, where both are left to shade the cattle in a landscape free of other trees (Fig. 1).

In Bolivia, the *motacú* palm (*Attalea princeps*, which was formerly mistakenly identified as *A. phalerata*) is a common species, widely known to local people and occupying an important geographical area in the country. It is represented in more than five vegetation types of Bolivia, e.g. island forests in savannas, humid well-drained forests of both mountains and lowlands, riparian and flooded forests, and secondary forests (Moraes 2007, Moraes et al. 2014). Locally, people use the leaves temporarily to thatch their roofs (which last 3–6 years), and they also extract the edible fruit oil for hair cosmetics and medicinal purposes (Moraes et al. 1996). The dense groves of *A. princeps* might be considered a consequence of the reproductive success of this species and its heliophilous adaptation that allows it to colonize aggressively sites that are not used by other tree species. Such sites include the edges of forest islands or successional stages of riparian forests in the alluvial region of Bolivia. With livestock, this species is very successful in ensuring its dispersal and seedling establishment with a high density. Even though 81% of the endocarps are destroyed by the beetle *Pachymerus palmarum,* its impact depends on the number of seeds per fruit as part of the population control dynamics of this species (Rios & Loayza 2000, Rios & Pacheco 2006). We had thought that these palm stands in livestock pastures were monotypic and shaped by old adult individuals of *A. princeps*. Even though seedling establishment may be successful, livestock do not allow seedlings and small juveniles to grow because they browse them. So, if livestock are not excluded, no *in situ* regeneration will take place (pers. obs).

During fieldwork in western Amazon sites, especially in southeastern Peru and western Brazil over the last two years, we have taken photos of the habit of *Attalea* species that occur both in forest formations and also close to local homes. Among these images, we recorded certain palms with a different habit that



4. *Attalea pacensis*. **a**. Section of leaf, **b**. portion of staminate inflorescence, **c**. staminate flower, **d**. fruit, **e**. and **f**. views of cross-section of fruit.

showed stiff and erect leaves that were densely arranged in the crown (Figs. 2 & 3). First, we thought they were very old individuals with a cylindrical trunk densely covered by woody leaf bases. According to Pintaud et al. (2016), from a distance, the most distinctive character is its erect leaves. We thought the presence of erect leaves was more representative of Acre in western Brazil. Therefore, we first named it *Attalea* sp. "Acre" and compared its features with other species under the *A. phalerata* complex (Pintaud et al. 2016). However, during recent fieldwork and records gathered from 2014 to 2015 in northwestern Bolivia, it

5 (left). Leaf with irregularly arranged groups of 2–8 lanceolate pinnae. 6 (right) The fibrous sheath with a very short petiole less than 7 cm long.

became clear that this new species is rather more characteristic of the lowlands in the department of northeastern and northern La Paz at an elevation of 250–400 m.

Attalea pacensis *M. Moraes et J.-C. Pintaud*, **sp. nov.** Palm with erect leaves, petiole to 7 cm long, inflorescence interfoliar, mesocarp cream and fleshy, endocarp with loosely 13–18 grouped fibers. Type: Bolivia: Dept. La Paz, Prov. Abel Iturralde, San Buenaventura, 19.11.2015, *M. Moraes & T. Cartagena MMR2531* (Holotype LPB, isotype K).

Robust, solitary, unarmed, pleonanthic, monoecious, tree palm 8–10 m tall. *Stem* erect, to 5.5–7 m tall, 60–90 cm diam. at breast height, cylindric from base to crown, beige, densely covered by elongated leaf bases. *Leaves* 36–48 densely packed in crown, pinnate, straight, sheath open to 90 cm long and 60 cm wide at the base, thick fibrous along the margins; petiole very short up to 7 cm long; rachis 130–160 cm long, densely covered with a brown tomentum; leaflets 80–105 on each side of the rachis, irregularly arranged in groups of 2–8 pinnae, densely inserted in two planes, stiff and expanded (not folded), 69–74 × 1.7–2.1 cm at the base of the leaf, 55–70(100) × 3.1–4.6 cm in mid leaf, 3–12 × 0.5 cm at the tip, asymmetric at the tip, adaxially green, abaxially grayish, glabrous, with obscure transverse veinlets. *Inflorescences* solitary, interfoliar, branching to 1 order, only staminate inflorescences and infructescence seen; peduncle moderate, ca. 90 cm long, elliptical in cross-section; prophyll not seen, presumably inserted at the base of the peduncle; peduncular bract woody, to 1.2 cm thick, deeply sulcate, with a solid beak 19–25 cm long; initiating inflorescences (87–99 cm long) with a deltate shape in cross-section due to the compression of the inflorescence between the leaves in the crown; rachis ca. 50 cm long; rachillae 150–190, 10–12 cm long, 3–4 mm in diameter, glabrous, cream, with spiral insertion of staminate flowers, proximally with a bare portion 5–7 cm long and 2 mm wide, then bearing paired staminate flowers. *Staminate flowers* narrow elongate, 9–10 mm long; sepals to 1 mm long, joined basally, then free and imbricate, glabrous; petals to 9 mm long, coriaceous, free, glabrous; stamens 6; filaments to 1 mm, anthers elongate 2.5 mm long, erect; pistillode not seen. *Pistillate flowers* not seen, but perianths persistent and enlarging in fruit, 3–5 pistillate flowers per rachillae. *Fruit* 1–3-seeded, obovoid, 6–8 × 3–3.5 cm, with a triangular beak 5–7

7 (left). Pinnae inserted in two planes. 8 (right). Each leaflet has an asymetrically tip.

mm long, orange-yellow at maturity, smooth, surface glabrous; mesocarp cream, fibrous, 2 mm thick with longitudinal fibers, endocarp 8–15 mm thick, with 13–18 strongly clustered fiber bundles close to the outer surface. *Seed* elongate, 4 cm × 8 mm (Figs. 2–11).

SPECIMENS EXAMINED: BOLIVIA: Dept. La Paz, Prov. Abel Iturralde, San Isidro, on road from San Buenaventura to Alto Madidi, 14°23'41.93"S, 67°38'16.6"W, 400 m alt., 21–31.03.2005, *Balslev et al. HB6761* (AAU, LPB). San Buenaventura, 14°26'11.9"S, 67°32'20.2"W, humid tropical forest, 230 m alt, 19.11.2015, *M. Moraes R. & T. Cartagena MMR2531* (Holotype LPB, Isotype K). 7 km north from Buenaventura to Tumupasa, Casto Sosa ranch, 14°24'07.7"S, 67°35'27.6"W, cattle field, 250 m alt, 19.11.2015, *M. Moraes R. & T. Cartagena MMR2532* (LPB). 3 km before Tumupasa, Mamuque river, tropical forest, 14°09'39.3"W, 67°51'31.7"W, 362 m alt, 19.11.2015, *M. Moraes R. & T. Cartagena MMR2533* (LPB). 2 km south of Ixiamas, Chumi, paddock, 13°47'16.8"S, 68°07'0.32"W, 278 m alt, 20.11.2015, *M. Moraes & T. Cartagena MMR2538* (LPB).

The character that separates this species from the *Attalea phalerata* complex is the presence of erect and stiff leaves, which is unique to *A. pacensis*. Since it shares a part of the whole geographical area of *A. princeps,* at first glance both seem the same. However, they differ in several characters, such as stem shape, the length of the pinnae and their texture and color, mesocarp taste and the number of fiber bundles in the endocarp (Table 1).

Attalea pacensis grows in the tropical forests of alluvial plains in the Andean foothills from Bolivia northwards to Acre (Brazil) and SE Peru. Thanks to a field trip made in 2014 to SE Peru (Puerto Maldonado) and near the border of Acre in Brazil, we made photographs of this species, although it was not possible to make botanical collections. In Bolivia, where the largest geographic area of its distribution is located, its distribution is similar to *A. princeps*; in fact, they are sympatric. This species might be favored by its coexistence with *A. princeps*. It seems to have adapted a mimicry in several respects, not only vegetatively, but reproductively. They share similarities, such as height, pistillate flower morphology, and type of fruits, although it is unknown to what extent they could also share pollinators and dispersers. However, definitely their population density is much lower than that of *A. princeps*; in one hectare the ratio is 10:1.

9 (upper left). Staminate inflorescence bud is dorsiventrally compressed with an elongated beak. 10 (upper right). The infructescence with obovoid fruits. 11 (bottom). A cross-section of endocarps that shows clustered fiber bundles.

Table 1. Distinctive morphological characters to compare *A. pacensis* and *A. princeps*.

Characters	*Attalea pacensis*	*Attalea princeps*
Stem shape towards crown	Cylindrical	Inverted cone
Petiole length	<7 cm	75-90 cm
Leaf rachis orientation	Straight	Arching
Medial pinnae length & width	55–70(100) × 3.1–4.6 cm, stiff	55-100 x 2.4-3 cm, pendulous
Pinnae fold to central nerve	Open, extended	Folded
Pinnae texture	Crisp	Flexible
Pinnae insertion	2 planes	3 planes
Pinnae color adaxially	Green	Green
Pinnae color abaxially	Grayish	Green
Inflorescence x-section	Dorsiventral	Circular
Mesocarp taste	Bitter, not edible	Sweet, edible
Mesocarp color and texture	Cream and fibrous	Orange and fleshy
Endocarp fiber bundles	13–18	7–9
Seed number per fruit	2–5	1–3

The description of this new species conforms to the proposed comparative table of species that make up the group *Attalea phalerata* and has been detailed in Pintaud et al. (2016). It is clearly distinguished from all other species of the genus *Attalea* by the straight orientation of its leaf rachis. However, it is necessary to highlight other characters between *A. princeps* and *A. pacensis* because their populations occur in the same types of rainforests in the NW of Bolivia, not only in the natural state, but also when they are transformed into pastures for livestock. The adults of both species are kept for the purposes of shade and livestock feed.

Finally, this paper is a contribution towards a better understanding of the species of this genus for Bolivia. Over 10 years ago, only five species were known (Moraes, 2004). Today that figure has risen to 11 through the increased support of photographic records and scientific collections (Moraes, 2015). Whereas many regions of the country are not under a high human pressure derived from urbanization, massive populations of palm trees can still be studied even with limited logistical conditions.

Acknowledgments

We appreciate the review of Larry Noblick from the Montgomery Botanical Center, who helped us in improving the original version, as well as the English language.

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The Palms of the Masoala Peninsula

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The Masoala Peninsula is arguably the most celebrated destination for palms in Madagascar, and yet much of the region is inaccessible and remains unexplored. Here, we report the findings of an expedition in November 2015, during which we visited both the west side of the peninsula and the scarcely known east, encountering extraordinary palm diversity and several species new to science.

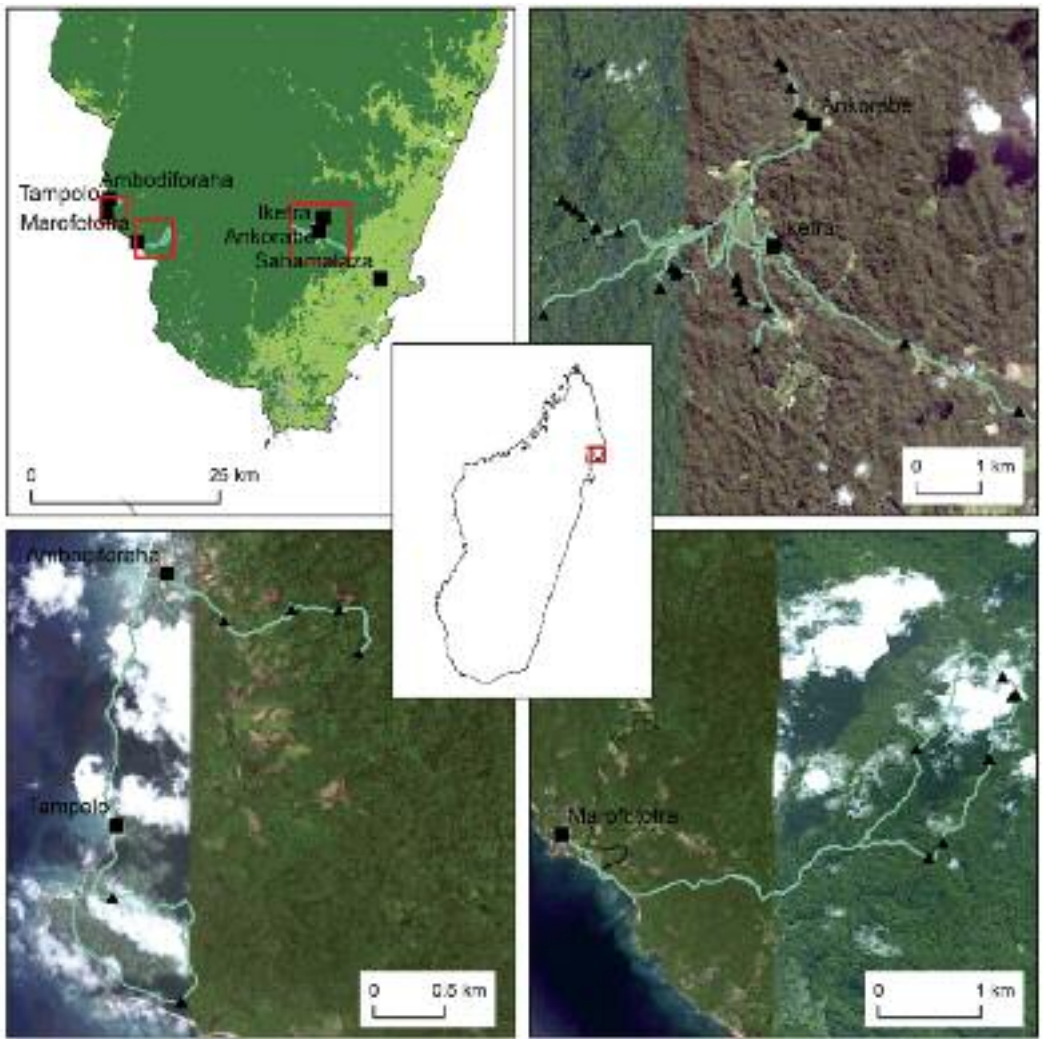
It is well established that palm diversity in Madagascar peaks in the humid forests of the island's north-east (Dransfield & Beentje 1995, Rakotoarinivo et al. 2013, 2014). Within the northeast, the Masoala Peninsula is arguably the most important palm hotspot. Palm species richness is exceptionally high there with as many as 60 species having been recorded (Rakotoarinivo et al. 2009). While other areas, such as the adjacent Makira Protected Area, may rival Masoala in species diversity (Rakotoarinivo et al. 2009), Masoala is particularly diverse at the genus level – all the "big game" rarities of the Madagascar palm

flora, such as *Lemurophoenix*, *Satranala* and *Voanioala*, are found there.

The richness of the Masoala Peninsula may arise from a combination of factors (Rakotoarinivo et al. 2013). Firstly, rainfall in this area is extremely high and has been so even during the last glacial maximum (>20,000 years ago), when climates globally were cooler and drier. High rainfall is an established driver of palm species richness worldwide (Kissling et al. 2012). Secondly, despite its modest size (80 km long, 60 km wide at widest point), the peninsula is topographically varied, with high mountains to more than 1100 m rising sharply on the west side in contrast to the more gentle landscapes of the east side. Masoala is rather homogeneous geologically, consisting largely of granitic basement rocks. However, small-scale variations in substrate that do not appear on geological maps may contribute to the peninsula's palm richness.

A significant proportion of Madagascar's remaining humid forest is found in the Masoala Peninsula and around 240,000 ha of the peninsula is now protected within the Masoala National Park. Important areas of the peninsula remain threatened, however, especially on the east side where deforestation is greatest and significant areas of forest fall outside the park boundary. Even within the park, risks to biodiversity remain high due to illegal logging, for example for ebony and rosewood, and hunting for bushmeat. In the case of palms, the larger species are targeted for

1. Map of the study area. Centre: location of the Masoala peninsula in Madagascar. Upper left: overview of the Masoala peninsula with fieldwork areas indicated in red, and GPS track logs indicated in light blue. Track logs and collections (triangles) in Iketra (upper right), Tampolo (lower left) and Antalavia (lower right) areas.



2 (left). *Dypsis acaulis*. 3 (right). *Dypsis pachyramea*. Photos: W.J. Baker.

palm heart extraction, a common practice throughout Madagascar, which is of particular concern for critically endangered species with low population sizes, such as *Voanioala*.

The goal of our expedition in November 2015 was to explore for the widest diversity of Masoala palms, collecting herbarium specimens of all species encountered and leaf tissue for DNA-based research on the evolution of the Madagascar palm flora. As most previous palm research effort has focused on sites in West Masoala, we gave most of our attention to inland sites in East Masoala, reached via the Anaovandrano River valley (Fig. 1). This area was explored during a short reconnaissance expedition in 1996 by Dr. John Dransfield and colleagues (Dransfield 1996), resulting in the discovery of remarkable novelties, such as *Dypsis metallica*, *D. reflexa* and *D. vonitrandambo* (Rakotoarinivo & Dransfield 2010), and sightings of several more that could not be collected at the time. Our expedition concluded with a short stay in better known sites in West Masoala in the vicinity of Tampolo and Antalavia.

Voyage to Masoala

On 11 November, the expedition team arrived in Maroantsetra, the gateway to the Masoala Peninsula. Our departure from Antananarivo had been fraught with anxiety as Air Madagascar had threatened not to carry all of our copious baggage until the very last minute. But the sedate pace of life in Maroantsetra is irresistible, and having set up base (with all our luggage) at the sleepy Coco Beach Hotel, we soon regained our composure. Over the following day and a half, we made final arrangements for our fieldwork, visiting the offices of Madagascar National Parks (to hire our MNP guide, Donné, and cook, Angèle), chartering a boat and sourcing provisions in the market and shops around town.

At 8 a.m. on 13 November, our boat departed for the 120 km journey around to the east side of the peninsula. The weather was perfect, giving us glorious views of the island of Nosy Mangabe across the oily calm waters at the head of the Bay of Antongil. We sped out of the estuary into a sublime scene, with the high mountains of Masoala rearing up to one side,

4. View of East Masoala from the trail to Iketra. Photo: W.J. Baker.

fish leaping from the water with fishermen in pirogues in hot pursuit and the bay opening up in front of us. The experience would have been very different, no doubt, had the weather been less kind to us or our boat less sturdy.

After rounding the tip of the peninsula at Cap Masoala into the choppier waters of the Indian Ocean, we stopped briefly on a spectacular white sand beach at Ambodilaitry to seek advice on local guides. We then continued northwards along the east coast for the final 20 km of the voyage before turning inland into the mouth of the Anaovandrano River. Near the coast, the river runs through patches of littoral forest and large clumps of *Dypsis lutescens* sway precariously over the banks. Finally, at around 2 p.m., we reached our destination, Sahamalaza, a village that flanks an important track running north-south along the east of Masoala that is accessible at least to motorbikes. It was far too late in the day to start trekking into the interior, and so we made camp in the village and went on a search for local knowledge of the route into the interior. By nightfall, we had been joined by two guides, Emmanuel and Donat, and a team of excellent pirogue men who offered to punt our luggage up river by boat, which relieved us of the inevitable challenges that come with managing a large group of porters. So far, so good, we thought. Our careful planning had delivered us safely to a place that, for the past two years, had existed only in our imaginations. But the following day, the real work would begin in earnest.

Hike from Sahamalaza to Iketra

We broke camp early next morning and, fueled with a typical breakfast of rice and beans, hauled our luggage to the river where our pirogues were loaded to the gunnels. At 8 a.m., the pirogue men cast off, while the rest of us were ferried across the river to begin our hike into the forest on foot to an area known as Iketra, some 14 km inland to the east where Dransfield and colleagues had camped in 1996. We followed a path that lay to the north of the Anaovandrano. The first two hours of the hike passed through a landscape of fields and degraded vegetation, crossing many streams and swampy hollows. The sky was perfectly blue, but this turned out to be a mixed blessing as the heat bore down on us. Finally the path entered fragmented forest, bringing welcome shade and, almost immediately, interesting palms.

One of the first palms we encountered, *Dypsis acaulis* (Fig. 2), was seen at no other time during the expedition. Dransfield too recorded this species in the same area in 1996, the first

record since the type collection by Perrier de la Bâthie in 1912 (Dransfield 1997). This dwarf, stemless palm occurred in small colonies, sometimes mixed with another understory palmlet, *Dypsis pachyramea* (Fig. 3), in a wet valley bottom and on stream banks. Its bifid leaves are highly distinctive being leathery and almost eophyll-like, with dense gray-white indumentum on the undersurface. Inconspicuous, spicate inflorescences emerge from between the leaves. Other more widespread palms encountered along the path included *Dypsis dransfieldii*, *D. forficifolia*, *D. fibrosa* and *D. pinnatifrons*.

The forest now became contiguous, though the path connected several open areas cleared for farming, often with a small settlement in each site accommodating a small, extended family (Fig. 4). Near lunchtime, we stopped at one such settlement, a cluster of small houses with a dramatic forest backdrop, where we gorged on coconuts and jackfruit. The path now threaded along the forest edge, making it easy to spot the bigger tree palms, such as *Dypsis lastelliana*, *Orania longisquama*, *O. trispatha*, *Ravenea julietiae* and *R. dransfieldii*. We saw also one scruffy individual of an undescribed *Dypsis* with the local name *sira*, discussed in more detail below. As we neared Iketra, we were excited to see a hut part-thatched with fan leaves, and shortly after came upon the source, *Satranala decussilvae,* the first of the "big game" palms of the trip, albeit an underwhelming specimen of it.

Finally, after fording the chest-deep waters of the Anaovandrano River, we reached Iketra around 4 p.m., where we set up camp on the edge of the village football pitch, the site of spirited, mixed soccer matches every evening. Iketra consists of an area of cleared farmland flanking a 2.5 km section of the river, much of it uncultivated and only lightly grazed by zebu cattle. A large area of forest had been freshly cleared across the river, opposite our camp. Iketra village itself comprises just a few clusters of tiny houses sparsely inhabited by a small population subsisting on slash-and-burn agriculture. Life for the people of Iketra is undoubtedly isolated and tough.

The core palm flora of Iketra

Despite new clearances, spectacular primary forest surrounds Iketra. Having walked from the east side of Iketra, we decided to use the six fieldwork days that followed to explore in the remaining directions to the north, south and west. The landscape throughout the area is characterized by low rolling hills and ridges under 100 m elevation, with many small stream valleys draining towards the Anaovandrano River. The palm flora was rich, with at least 40 species observed in total, but local species richness was patchy and tended to be most concentrated in wetter valley sides and floors.

5. *Dypsis vonitrandambo.* Photo: W.J. Baker.

A core palm flora comprising eleven species, mostly understory palms, was encountered in almost every site around Iketra. The smallest of these, *Dypsis pachyramea*, is the commonest understory palmlet in Masoala. This species was extremely abundant especially in valley bottoms, growing gregariously in large numbers. The remaining species of understory palm were taller in stature. On slopes, *D. fasciculata* and *D. forficifolia* were frequently observed, the former displaying a bewildering diversity of leaf forms. Less common in the same habitat but still widespread were *D. confusa* and *D. pinnatifrons*. Perhaps the most spectacular of the taller undergrowth palms was *Dypsis procera*, which formed large clumps in and around valley bottoms. Although forms with divided leaves were present, the

6. *Orania longisquama*. Photo: W.J. Baker.

7. *Orania trispatha*. Photo: W.J. Baker.

8. Hills south of Iketra. Photo: W.J. Baker.

spectacular entire-leaved form was most prevalent.

Arguably the most remarkable of the widespread understory palms was *D. vonitrandambo* (Fig. 5), a *Vonitra*-type *Dypsis* discovered by John Dransfield on the 1996 expedition to Iketra and described in 2010 (Rakotoarinivo & Dransfield 2010). This squat palm has erect or leaning stems typically up to 1.5 m tall that are covered in persistent leaf sheath fiber and produce abundant, thin stilt roots at the base. The leaves are unique among *Vonitra*-type *Dypsis* in bearing few, broad, hooded leaflets (around 10 each side of the rachis), rather than numerous, narrow, linear leaflets. The emerging young leaves are deep purple-red and the inflorescences are erect and brush-like, with rather few rachillae. More striking is the fact that *D. vonitrandambo* was locally very common in wet valley sides and bottoms throughout the Iketra area and yet has never been recorded from any other site in Masoala. It appears to replace a similar species, *D. pusilla*, which is widespread in West Masoala, but is unrecorded in the East.

Four larger palms featured among the eleven core species. Another *Vonitra*-type species, *Dypsis dransfieldii*, was common throughout the area. This moderate, clustering, under- to midstory species has distinctive inflorescences that project from the crown. The handsome emergent *D. lastelliana* was also scattered across every site though never in large numbers. Finally, two species of *Orania*, *O. trispatha* and *O. longisquama* (Figs. 6 & 7), were abundant, though not in the same habitats. The spectacular, distichous *O. trispatha* occurred mainly in wetter areas, especially around streams and on the banks of the Anaovandrano River. In contrast, *O. longisquama* was found only on drier slopes. The Iketra form had a compact crown of erect, shuttlecock leaves, in contrast to other forms elsewhere on the east coast with looser crowns of recurved leaves.

South of Iketra

We spent two days exploring the ridges and valleys south of Iketra (Fig. 8). Several settled clearings lie around this area and as a result people are actively exploiting the forest, for timber extraction and some clearing for farmland. Nevertheless, the forest was largely in good condition, supporting primarily the typical palm flora of the area. Our first day focused on a search for another of the "big game" species of Masoala, *Marojejya darianii* or *velatra* as it is known locally. John Dransfield had recorded it in two sites around Iketra in 1996, and we were anxious to see it ourselves. Our guide Emmanuel assured us that he knew a site in a southwesterly direction from our camp, but after some hours walk, wading in and out of streams, and looping back on ourselves, we began to doubt that we would ever find it. Our luck held, however, when we came into a flat and swampy valley bottom with a rather broken canopy, through which around 30 massive, stemless individuals of *M. darianii* were scattered with their largely undivided leaves reaching to 6 m in length (Fig. 9). Encountering this almost mythical palm in so wild and remote a place was incredibly exciting. Curiously, none of the individuals formed visible stems or showed signs of flowering. Perhaps this was an establishing colony, or alternatively stemmed adults may have been targeted for palm heart extraction. Evidence of human activity in the site suggests that felling for palm heart or other materials could be a significant risk to the population.

9. *Marojejya darianii*. Photo: W.J. Baker.

Our second foray into this general area took us due south of camp in search of more "big game." John Dransfield had reported sighting three juveniles of *Voanioala gerardii*, but Emmanuel was hopeful that he could locate adult palms for us. Sadly, he did not succeed, although we did find three juveniles widely scattered across the landscape. It seems entirely likely that adults must exist in this area, given the rather young age of the juveniles that we observed, but they may occur at extremely low densities. Emmanuel reported that he knew of one that grew close to Iketra, but that it had been felled for palm heart. On our quest for *Voanioala*, we made other interesting finds, including a few juveniles of *Satranala decussilvae* and occasional individuals of *Ravenea julietiae*, which is distinctive in the female inflorescence protruding from the crown. We also found a few individuals of *Dypsis metallica*, discussed further below.

West of Iketra

In principle, the Anaovandrano River provided ready access to the forests west of Iketra by pirogue. However, the river is shallow and fast-flowing, with numerous rapids, making paddling or punting the pirogue a slow and tiring business. On our first attempt, we took almost two hours to travel only 3 km, repeatedly wading upriver while the pirogues were dragged over the rapids. The slow journey gave us plenty of time to admire the forest, its

10. *Dypsis crinita*. Photo: W.J. Baker.

11. *Dypsis reflexa*. Photo: W.J. Baker.

wildlife and palms, especially *Orania trispatha*, *Dypsis crinita* (Fig. 10) and *D. lastelliana*.

Finally, we abandoned the pirogue to explore the hills above the river. Among the ever-present *Dypsis pachyramea* in the undergrowth, occasional individuals of the superficially similar *D. mocquerysiana* were concealed. In a swampy stream valley, we found the elegant, slender understory *Dypsis reflexa* (Fig. 11), discovered by John Dransfield in 1996, with inflorescences arching from the center of the crown with reflexed inflorescence branches that account for the species name. Non-descript *D. hiarakae* grew nearby. As the path became steeper, palm diversity declined, but brought new finds, such as *D. perrieri* and an unknown species with affinities to *D. baronii*.

We returned to the west of Iketra later in the expedition to follow up reports of a giant *Ravenea* known locally as *kona*. Returning up river by pirogue again, we turned up a narrow tributary some 1.5 km west of our camp. We then walked in a westerly direction for 2.5 km, mostly wading up streams through exquisitely beautiful valley bottom forest (Fig. 12). We turned repeatedly as one stream met another, but our guides knew the area well, having spent time there recently hunting for crabs. Finally, we came upon a small colony of monumental palms. This immense species of *Ravenea* (Fig. 13) is known from several sites along the east coast of Madagascar and has been confused with *R. robustior* whereas it appears to be an undescribed species (J. Dransfield, pers. comm.). The specimens that we observed towered 30 m above the forest floor, with 80 cm wide stems at the base that tapered to about half the diameter towards the apex. As we marveled at these forest giants, a troop of endemic red-ruffed lemurs passed by, barking noisily to one another but remaining frustratingly out-of-sight.

North of Iketra

John Dransfield's 1996 expedition yielded especially rich pickings in a site around 2 km north of Iketra known as Ankorabe or Tanany Rabe Pierre, meaning Rabe Pierre's land (Dransfield 1996). We too found this area so exciting for palms that we spent two consecutive days collecting there, in the company of Monsieur Rabe Pierre himself, the patriarch of the area who, though now advanced in years, clearly remembered collecting palms with Dransfield and co. in

12 (left). Fieldwork west of Iketra. 13 (right). *Ravenea* sp. "*kona*." Photos: W.J. Baker.

14. *Dypsis metallica*. Photo: W.J. Baker.

1996. Tanany Rabe Pierre is an intensively farmed forest clearing of perhaps a third of a square kilometer, sustaining an extended family living in a handful of small houses.

The trail from Iketra to Tanany Rabe Pierre passed through hilly forest, somewhat disturbed in places, typical of the area adjacent to Iketra itself, yielding nothing that we had not seen elsewhere. However, M. Rabe Pierre guided us to a quite different forest area north of his home. The path led first down into a swampy hollow where we found clumps of *Dypsis metallica* (Figs. 14 & 15), another species discovered by John Dransfield during his 1996 visit. This is an intensely beautiful, slender, clustering species, somewhat *Chamaedorea*-like with its short entire leaves and erect orange-yellow inflorescences. The leaves are very dark, glossy green with a yellow midrib and are very leathery. Nearby grew *D. lantzeana* and large clumps of *D. procera*.

The path then led up on to a level terrace with white sand soils so rich in interesting palms that we had no time to explore beyond it. We first came upon a colony of juvenile *Marojejya* plants with the local name *sira siribe* (Fig. 16), all sporting entire, somewhat hooded juvenile leaves, but regularly pinnate leaves at later stages. This was clearly not *M. darianii*, but this leaf character does not correspond with the other species, *M. insignis,* either. We saw no adults, but Dransfield reported one which possessed a stepped trunk, which is also inconsistent with *M. insignis*. This palm underscores the need for a reappraisal of the taxonomy of *Marojejya* now that more is known about its morphological diversity.

15. *Dypsis metallica*. Photo: W.J. Baker.

16. *Marojejya* sp. "*sira siribe.*" Photo: W.J. Baker.

17. *Dypsis* sp. "*lafaza maitso.*" Photo: W.J. Baker.

Perhaps as a result of the nutrient-poor substrates on which it grew, the forest here was made up of slender, even spindly trees with a rather light canopy. It was, however, rich in tree palms, including *Dypsis hovomantsina*, *D. lastelliana*, *D. perrieri*, *Orania longisquama*, *Ravenea sambiranensis* and *Ravenea* sp. "*kona*." We also found more individuals of the *Dypsis* species with affinities to *D. baronii* that we had seen west of Iketra (Figs. 17 & 18). This palm, known locally as *lafaza maitso*, appears to be an undescribed species, a suspicion that needs to be confirmed by carefully comparing its characters with other *Chrysalidocarpus*-type *Dypsis* species.

Then came arguably the most exciting palm hotspot of the entire expedition. We walked into a pock-marked landscape, characterized by pot-holes in the ground, perhaps 2 m wide and half a meter deep. M. Rabe Pierre attributed these to fallen *Ravenala* trees, though this seemed hard to believe as we observed few live *Ravenala* individuals. We found huge shuttlecock juveniles named *hovodrakidraky*, which we later confirmed as *Masoala madagascariensis* (Fig. 19), when we located a majestic flowering adult. *Satranala decussilvae* was scattered across the site, including some impressive groups of adults.

18. *Dypsis* sp. "*lafaza maitso*." Photo: W.J. Baker.

Most exciting however, was the presence of three undescribed solitary, canopy *Dypsis* species. The first of these, locally named *sira* (Fig. 20), was a robust, plumose-leaved species, with pronounced rusty red-brown and gray indumentum on its leaf sheaths, which formed an ill-defined crownshaft. The inflorescences are erect, highly branched and borne between the leaves. This species was not restricted to this site – we had seen occasional individuals elsewhere around Iketra – but was rather common at this site.

The second new species, known as *ovojavavy* (Fig. 21), grew among *Dypsis* sp. "*sira*" and was of similar stature but was characterized by its neat, recurved leaves with ascending leaflets, gray-green, rather open leaf-sheaths and its highly branched, pendulous inflorescence that emerged between the leaves. The fourth species, known as *angolafa*, remains something of a mystery. John Dransfield reported seeing only juveniles on his 1996 trip and added only a sighting of a short-trunked, non-flowering individual. We encountered the exact same situation: thanks to the large, red scales on the petiole of this palm, we readily identified some juveniles as *angolafa*, but like Dransfield, we failed to find fertile individuals that would allow us to describe this exciting palm as a new species.

Iketra to Tampolo

After six concentrated field days, we had exhausted the palms of Iketra. We broke camp and made the 12 km trek back to Sahamalaza, where we were met by our boat the following morning. The boat took us back around Cap Masoala, stopping half way up the west side of the peninsula at Tampolo, where we would have a further three days' fieldwork. Tampolo is a rather well-known location for palms. West Masoala is much more mountainous than the east, with steep slopes rising directly from the shore. The undulating coastal flatlands that surround Tampolo are unusual in this respect (Fig. 22). We stayed at the rustic, but very comfortable Tampolodge, which sits at the back of a painfully beautiful beach, a steep arc of golden sand, backed by glorious littoral forest and with granite crags at either end. It was an ideal location to recuperate from our exertions in East Masoala while having further productive experiences in the field.

19. *Masoala madagascariensis*. Photo: W.J. Baker.

20. *Dypsis* sp. "*sira*." Photo: W.J. Baker.

21. *Dypsis* sp. "*ovojavavy*." Photo: W.J. Baker.

From our base in Tampolo, we took the opportunity to explore for more of the "big game" palms of Madagascar. We had heard of a site for *Lemurophoenix halleuxii* above the nearby village of Ambodiforaha and made that the target of our first foray from Tampolo. Ambodiforaha lies about 2 km walk along the coastal path running north from Tampolo. There we met a local guide, Marco, on whose land the *Lemurophoenix* palms grow. It transpired that he had guided many other palm enthusiasts to this locality. The path to the site wound inland through local farmland, eventually climbing steeply into the mountains behind the low coastal plain. The forest was rather disturbed but yielded many palm species, including *Dypsis confusa*, *D. dransfieldii*, *D. faneva*, *D. fibrosa*, *D. forficifolia*, *D. hovomantsina*, *D. lastelliana*, *D. mocqueryssiana*, *D. pachyramea*, *D. pinnatifrons*, *D. procera* and *Ravenea dransfieldii*.

About 1 km inland from Ambodiforaha, on the edge of a recently opened forest clearing we came to the *Lemurophoenix* site (Fig. 23). The population comprised five extremely impressive adult palms with stems to around 20 m high and 50 cm in diameter. We found many yellow-brown ripe fruit on the forest floor, displaying the typical corky warts and heart-shaped button on the spherical seed. Seedlings were numerous, but survival seemed to be low, as we observed no individuals of an age class between seedling and adult. The adjacent forest clearing had been opened only recently, which clearly concerned Marco, who recognized the value of the palm stand as an attraction for tourists. We could not resent the

22. West Masoala view from Tampolodge. Photo: W.J. Baker.

23. *Lemurophoenix halleuxii*. Photo: W.J. Baker.

rather high guide fee that Marco charged if it helped to protect this spectacular stand of this endangered palm.

Hiking beyond the *Lemurophoenix* site, we came into high, pristine rain forest. With no clear path to follow, we bashed our way through the vegetation hoping to find more *Lemurophoenix* but without success. The forest was full of other large tree palms, however, elegant, tristichous *Dypsis tsaravoasira*, plumose-leaved *D. hovomantsina* with its white, waxy crownshaft and the immense *D. tokoravina*, with its massive crown of open leaf sheaths and feathery leaves.

Antalavia

The temptation of the legendary palm location of Antalavia, some 8 km south of Tampolo proved too much to bear. Antalavia is the type locality of the forest coconut, *Voanioala gerardii*, one of the most exciting finds in the entire exploration of the Madagascar palm flora, and perhaps the ultimate "big game" palm on the island. The discovery of *Voanioala* by Gerard Jean, John Dransfield and David Cooke in 1986 is an adventure story more than worthy of the annals of palm exploration (Dransfield 1989), and all the more impressive for the challenges of getting around Madagascar at that time. In contrast, we hopped on our chartered speed boat at Tampolo and were disembarking just half an hour later.

In the Antalavia area, *Voanioala* occurs at around 500 m elevation in the mountains that rise steeply from the shore. To reach this site, Dransfield and co. followed a treacherous, boulder-strewn river, whereas our route avoided this by starting at Marofototra, a sizeable village a little to the north. At first, our path passed through low-lying coastal forest, swampy in places and thick with understory species such as *Dypsis confusa* and *D. procera*. The route then climbed gently before crossing an idyllic, rocky stream, lined with *D. crinita*, tree ferns and dracaenas. Beyond the stream crossing, the ascent began in earnest, becoming increasingly extreme. The palm sightings on the climb are a bit of a blur, as we concentrated more on staying upright and catching our breath, but we still managed to spot and impressive diversity of species, including *D. dransfieldii*, *D. faneva*, *D. fanjana*, *D. fibrosa*, *D. hovomantsina*, *D. lastelliana*, *D. minuta*, *D. mocquerysiana*, *D. pachyramea*, *D. pinnatifrons*, *D. pusilla*, *D. tsaravoasira*, *Orania longisquama*, *Ravenea dransfieldii* and *R. julietiae*. Eventually the route leveled out on to broad, flat ridge covered in tall forest. Our guide from Marofototra assured us that we were nearly at the *Voanioala* site, but as we slogged on for a further hour, we all began to doubt that we would ever make it. We passed impressive specimens of *Dypsis tokoravina* and *Ravenea lakatra*, which kept our spirits up. Finally, the guide announced that we had arrived, but *Voanioala* was nowhere to be seen. A large *Masoala madagascariensis* stood nearby and we briefly wondered if we had been taken on a wild goose chase to see this, rather than *Voanioala*, but then we found mini-coconut endocarps on the forest floor. Scattered in the dense vegetation around us stood three adult *Voanioala* individuals with their classic stepped trunks and open-sheathed crowns with *Attalea*-like inflorescences protruding from between the leaves. A number of juveniles were spotted in the undergrowth, but the species was far from abundant. Our GPS indicated that we were perhaps less than 1 km from the type locality itself, which suggests that *Voanioala* may be widely but sparsely distributed in the local area. The inadequate understanding of the distribution of this critically endangered palm is a significant obstacle to its conservation. A systematic survey of the Masoala Peninsula would be extremely useful in this respect but would be very difficult to achieve.

The descent from *Voanioala* was as tough as the ascent, but by the late afternoon, we reached the shore, exhausted, but extremely satisfied after a formative palm hunting experience.

Tampolo

Our final day in the Masoala Peninsula was spent exploring the littoral forest directly south of Tampolodge. We entered the forest via a disused railway line, which had once been used to facilitate the harvest of timber during colonial times. All that remains of the line today is a straight and level path, and a few timber railway sleepers. Littoral forest of the quality found at Tampolo is very rare now in Madagascar. Many of Madagascar's botanical wonders could be seen there, such as *Cycas thouarsii* growing near the shore and large plants of Darwin's Comet Orchid, *Angraecum sesquipedale*, clinging to rocks. The golden flowers of *Sarcolaena multiflora*, a member of the woody plant family Sarcolaenaceae, which is entirely endemic to Madagascar, were found, and the curious leafless Iridaceae saprophyte, *Geosiris aphylla* lurked on the forest floor.

24. *Satranala decussilvae*. Photo: W.J. Baker.

Though the forest was beautiful, it was relatively poor in palms. The commonly observed species included *Dypsis confusa*, *D. dransfieldii*, *D. fibrosa*, *D. forficifolia*, *D. procera*, *D. pusilla*, *D. tsaravoasira*, *Ravenea dransfieldii* and *R. sambiranensis*. Stands of *Satranala*

decussilvae (Figs. 24 & 25), including some reproductive adults, were distributed along the loop trail that we followed, although they had been badly damaged by local people collecting leaves for thatch. A curious unidentified *Vonitra*-type *Dypsis* was also common, which produced long, slender entire leaves at younger stages, becoming pinnate at later stages, but mature individuals of this species could not be found. This palm was first seen by Dransfield in 1997 and despite many visits to the area has never been seen fertile. Scattered individuals of *D. carlsmithii*, a species described from cultivation as recently as 2002, towered in the canopy, looking like giant *D. lutescens*.

We regretted having insufficient time to explore the flatlands behind Tampolo in more detail. This area is still densely forested and must be relatively accessibly from Tampolodge, and yet, to date, most formal botanical records in this area come from the coastal areas between Ambanizana and Tampolo, and Antalavia. Who knows what lies undiscovered in the stunning forests of West Masoala?

Conclusions

Our expedition to eastern and western Masoala was incredibly productive and easily the most fruitful in a series of four field trips to different parts of eastern Madagascar recently organized by the Royal Botanic Gardens, Kew. In total, we found 46 palm species, including perhaps as many as seven undescribed species (five *Dypsis*, one *Ravenea*, and one *Marojejya*). We were able to obtain sufficient material to describe four of those new species, including three massive canopy palms that are either locally abundant (*Dypsis* sp. "*sira*" and *Dypsis* sp. "*ovojavavy*") or widespread in north-eastern Madagascar (*Ravenea* sp. "*kona*"). These finds illustrate that the palm flora of Madagascar, in spite of decades of intensive exploration and taxonomic treatment (Dransfield & Beentje 1995), is still far from being completely known. In fact, it is this foundational research on Madagascar palm diversity that makes it possible to explore this extraordinary palm flora still further and paves the way for broader studies in other disciplines.

Despite our considerable efforts, our expedition only scratched the surface of this vast, underexplored tract of humid forest. Though we penetrated some way into the peninsula from the East, we were unable to push deeper due to the tough terrain, difficulties of moving supplies and equipment, and unpredictable local taboos (*fady*). Even the West, which is better known, has only been

25. The endocarps of *Satranala decussilvae* are ridged and lobed. Photo: W.J. Baker.

explored for palms near to the coast. A more thorough exploration of Masoala, e.g. by means of transects crossing the peninsula east-west, would be highly worthwhile, but would require a much larger effort than the expedition described here. More than 80% of Madagascan palm species are threatened with extinction (Rakotoarinivo et al. 2014), and any yet-unknown species is highly likely to be at risk also. The chance that species could disappear before we have had a chance to explore them scientifically and horticulturally is high. The systematic exploration of Masoala's magnificent forests and its palms must be treated as an urgent priority.

Acknowledgments

We are extremely grateful to our colleagues at the Kew Madagascar Conservation Centre, especially Franck Rakotonasolo and Helene Ralimanana, without whose support this expedition would have been entirely impossible. John Dransfield and Stuart Cable provided guidance tirelessly, ensuring that the trip was as productive as possible. Madagascar National Parks and numerous local guides also provided essential logistical support. Madagascar National Parks and the Madagascan Ministry of the Environment kindly granted permission to collect (permit No. 259/14/MEEF/SG/DGF/DCB.SAP/SCB) and export plant specimens. This fieldwork was made possible thanks to generous funding from the International Palm Society, the Royal Horticultural Society (RHS Coke Trust Bursary Fund), the National Geographic Society (Global Exploration Fund – Northern Europe), the Bentham-Moxon Trust, Pam Le Couteur and the Royal Botanic Gardens, Kew. WLE was supported financially by the European Union FP7-PEOPLE program (grant # 327259).

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Appendix 1: Palm species seen and collected, by date in November, 2015. X = species seen. Collection numbers (e.g. WLE124) are given where collections have been made.

		Iketra							
	Trek in/out	**West**	**South**	**North**	**South**	**West**	**Ambodi-foraha**	**Antalavia**	**Tampolo**
Day	**14&21.11**	**15.11**	**16.11**	**17&18.11.**	**19.11**	**20.11**	**23.11**	**24.11**	**25.11**
Dypsis acaulis	WLE124								
Dypsis carlsmithii									X
Dypsis confusa			WB1416	X	X	X	X	X	
Dypsis crinita		X				X		X	
Dypsis dransfieldii	X	X	WLE131	X	X	X	X	X	X
Dypsis faneva							WB1426	X	
Dypsis fanjana								WLE149	
Dypsis fasciculata		WB1411 WB1412	X		X	X			
Dypsis fibrosa	X			X			X	X	X
Dypsis forficifolia	X	WLE125	X		X	X	X	X	X
Dypsis hiarakae		WLE127		X					
Dypsis hovomantsina				X?			WLE145	X	
Dypsis lantzeana				WB1418A	WLE142				
Dypsis lastelliana	X	X	X	X	WLE143	X	X	X	
Dypsis metallica	X			WB1420, WLE132	WB1424				
Dypsis minuta								WLE147, WLE148, WLE152	
Dypsis mocquerysiana	WLE129,	WLE130				X	X		
Dypsis nodifera				X					
Dypsis pachyramea	X	WB1413	X	X	X	X	X	X	
Dypsis perrieri		WB1414		X					
Dypsis pinnatifrons	X	X	X	X	X		X	X	
Dypsis procera		X	X	WLE133 WLE134	X	X	X	X	

Dypsis pusilla								WB1428	X
Dypsis reflexa		WLE126							
Dypsis tokoravina							WLE146	X	
Dypsis tsaravoasira			X				X	X	X
Dypsis vonitrandambo		WB1415		X	X				
Dypsis sp. entire-leaved *Vonitra*									WLE153
Dypsis sp. "angolafa"			X						
Dypsis sp. "ovojavavy"			WB1419						
Dypsis sp. aff. *baronii* "lafaza maitso"	X	WLE128		WLE137, WLE138, WLE139					
Dypsis sp. aff. *lastelliana* "sira"	X			WB1418B, WLE135					
Lemurophoenix halleuxii							WB1425		
Marojejya darianii			WB1417						
Marojejya sp. "sira siribe"				WLE136					
Masoala madagascariensis				WLE140				X	
Orania longisquama	X	X	X	X	X			X	
Orania trispatha	X	X	X	X	X	X			
Ravenea dransfieldii	X						X	X	X
Ravenea julietiae	X				WB1423			X	
Ravenea lakatra		X						X	
Ravenea sambiranensis				X					X
Ravenea sp. "kona"				X		WLE144			
Satranala decussilvae	WB1427			WB1422					X
Voanioala gerardii					WLE141			WLE150, WLE151	

Natural History of *Phoenix andamanensis* from the Andaman Islands

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Phoenix andamanensis **is an insular endemic described by Sasha C. Barrow in 1998 based on the specimens collected in 1990 by Jamueal Leopold Ellis from the Saddle Peak. This species is known only from a few herbarium collections, mostly collected during the earlier part of 20th century. The ecology, populations, natural regeneration and conservation status of this species are poorly known. During recent fieldwork in the Andaman-Nicobar Archipelago, two populations of** ***Phoenix andamanensis*** **were located in dense evergreen forests near Kalpong Hydroelectric Project catchment area and Saddle Peak. The natural history of** ***Phoenix andamanensis*** **is detailed and illustrated here.**

Phoenix L., is an Old World genus having a wide distribution from the northwestern Coast of Africa (Canary Islands and Cape Verde Islands) to subtropical and tropical Africa, and from the Arabian Peninsula through the Mediterranean to the Indian Subcontinent, Indochina to Hong Kong and Malesia. Barrow (1998), in her revisionary studies, distinguished 13 species and two varieties in the genus. In the Andaman-Nicobar Islands, the genus is represented by three species viz. *Phoenix andamanensis* S. Barrow, *P. paludosa* Roxb. and *P. sylvestris* (L.) Roxb. A fourth species, *P. rupicola* T. Anderson, was included in a checklist of the Andaman flora by Pande and Diwakar (2008), but it is likely that the authors confused the taxon with *Phoenix andamanensis,* with which it is very closely allied morphologically. *Phoenix andamanensis* (Fig. 1) is a little-known species described by

Barrow in 1998 from specimens collected by Jamueal Leopold Ellis in 1990 from the Saddle Peak, the highest point in the Bay of Bengal.

According to Barrow (1998), "…The biogeographical basis of the close relationship between these two species of limited distribution, *P. rupicola* from Bhutan and Northeastern India, and *P. andamanensis* from the Andaman Islands, has not been thoroughly investigated and needs further study…. *Phoenix andamanensis* has been recorded from one locality each in both North Andaman and Little Andaman, and from Cinque and Rutland Islands (Brandis 1906, Parkinson 1923). The modern distribution of the species is unknown." Barrow had only secondary information on this taxon, collected from herbarium sheets and literature by Brandis (1906) and Parkinson (1923). Parkinson (1923) referred to the frequent occurrence of a lesser known *Phoenix* species from the Cinque Island and Mount Ford (Rutland Island) of the South Andaman group in his *Forest Flora of the Andaman Islands*. It seems that Parkinson relied upon the account of Brandis (1906) for the entry of *P. andamanensis* in his flora. Parkinson did not refer to his own sighting of the taxon.

Charles Edward Parkinson (1890–1945) was an Extra Assistant Conservator of the Andaman Forest Department and worked as Forest Botanist in Burma during the British regime. He undertook the major task of compiling a tree flora of the Andaman Islands for the first time in the floristic history of Andaman Islands. Parkinson undertook several intensive and extensive explorations, especially amongst the South and Middle Andaman group of islands during his tenure in Andamans and made remarkable herbarium collections. His specimens were deposited primarily at the Forest Research Institute, Dehra Dun (DD) and otherwise at the Botanical Survey of India of Howrah (CAL) and Port Blair (PBL). Dietrich Brandis also mentioned *P. andamanensis* in his *Indian Trees* (1906) based on information from Rogers. Charles Gilbert Rogers, who was an Assistant Conservator of Forests in Andaman Islands, also carried out extensive studies on Andaman forest types in relation with soil types and formation. According to Rogers, a single stemmed palm with dark brown-colored petiole bases and orange-colored fruits and inflorescences occurred in Cinque Island and Northeast corner of the Rutland Island (Fig. 2) (Brandis 1906). He considered that it may be the same *Phoenix* species mentioned by Kurz (1870) in his *Report on the Andaman Islands*. Interestingly, Kurz did not cite this taxon in his monumental work, *Forest Flora of British Burma*

1. A population of *Phoenix andamanensis* at Kalpong, North Andamans.

2. Rutland Island, another habitat of *Phoenix andamanensis*. Rogers located the taxon and collected specimens in 1904 from Rutland Is. (*Rogers 132* & *285*, K).

(1877), although he had included other insular taxa from the Andaman-Nicobar Islands, making this lesser known species more curious.

In this context, it is relevant to mention the compendium titled *A Preliminary List of Plants of the Andaman Islands* by J.S. Gamble (1903). Gamble prepared this checklist of Andaman plants mostly through compilation of taxa listed in the separate floras of Hooker and Kurz and also from data gathered by Rogers and Heinig. Robert Lawrence Heinig was the Conservator of Forests contemporary with Rogers in the Andaman Forest Department. Interestingly, Gamble (1903) did not include *P. andamanensis* in his compendium.

According to available data at the Royal Botanic Gardens, Kew (K) and the Botanical Survey of India (CAL & PBL), the earlier herbarium collections of this species from the Little Andaman Island and South Andaman group of Islands were mostly collected by Rogers. Rogers made extensive plant explorations during his tenure in Andaman Islands, and his specimens were deposited at CAL, K and PBL. Rogers collected this species for the first time from Little Andaman Island in January 1903 (*Rogers s.n.*, K). Rogers recorded the species again from Rutland Island (South Andaman) near Port Blair in 1904 (*Rogers 132*, K). During 1905, the species was recorded from Saddle Peak (North Andaman) at an altitude of 459 m by Osmaston (CAL). Later in 1911, Rogers again collected specimens from Cinque Island (*Rogers s.n.*, CAL) and Rutland Island (*Rogers s.n.*, K). Thereafter, for a remarkable period of about 65 years, this taxon was not recorded or collected until 1976 by Balakrishnan and Nair from the Saddle Peak at an altitude of 500 m (*Balakrishnan & Nair 4771*, CAL & PBL). Later, in 1990, Ellis collected this species again from Saddle Peak at an altitude of 700 m (*Ellis 14189*, K & PBL). The Ellis specimen is the type for the species.

The Andaman-Nicobar Islands

The Andaman and Nicobar Islands, with their enchanting seascapes bordering lush green rain forests, are located in the Bay of Bengal over 650 nautical miles away from the Coromandel Coast of Peninsular India. This archipelago lying in north-south direction consists of 306 islands and 206 rocks and rock outcrops (islets) in the tropical belt from latitudes 6°45′ to 13°41′N and longitudes 92°12′ to 93°57′E. The flora of Andaman-Nicobar Archipelago is significantly rich, with a diverse and pristine composition of tropical plant species. According to an official estimate carried out by the author in 2014, there are 2463 Angiosperm

3. *Phoenix andamanensis*. Individual ca. 15 m tall projecting out the crown over the canopy at Kalpong forest, North Andamans.

species comprising up to 182 families and 1018 genera, within this small, fragmented geographical region of 8249 km^2, thus indicating a high degree of plant diversity and fragile ecological equilibrium. Geologically, the Andaman-Nicobar Islands are regarded as the exposed peaks of a submerged mountain range in continuation with the Arakan–Yoma Mountains of the Myanmar towards Moluccas Island of the Indonesia (Renvoize 1979); hence the insular flora of Andaman-Nicobar Islands is obviously "continental" in origin and evolved to the present status from a totally balanced continental bio-system through evolution over millions of years. Therefore, the present insular bio-system may be referred to as a "sub continental bio-system" coupled with multi-dimensional phytogeographical affinities towards nearer and distant regions such as Northeast India, Southeast Asia, Sri Lanka and Peninsular India (Western Ghats). The geographical isolation of this floristic zone from the major land masses of South and Southeast Asia over millions of years has resulted in variation of its insular taxa from their ancestrally-allied taxa found in continently South and South East Asia. The flora of the Andaman-Nicobar Islands is rather unusual in phytogeography, characterizing transit zone vegetation between the Indian Subcontinent and the Malesian region.

Phoenix andamanensis in Andaman Islands

The Andaman-Nicobar Archipelago present difficult conditions for fieldwork. Many of the islands are inaccessible and remain uninhabited. Barrow (1998) referred to the occurrence of *Phoenix andamanensis* in

4 (top). Saddle Peak, viewed from Kalipur beach. Saddle Peak is the type locality of *Phoenix andamanensis*.
5 (bottom). Kalpong River at North Andamans.

undisturbed "scrub jungle" along the eastern side of Rutland Island and northern end of Cinque Island from a personal communication by Balachandran, one of the Conservators of Andaman Forest Department during the period of her studies. During the year 1992, the author conducted a survey of palms of Andaman and Nicobar Islands among selected islands significantly rich in palm species (Mathew & Abraham 1994). The fieldwork on Rutland Island at this time was hampered by a cyclonic storm and heavy rain, making it

6. A seedling of *Phoenix andamanensis* from JNTBGRI Field Gene Bank nursery.

difficult to explore all regions of Mount Ford (on Rutland Island), thus perhaps explaining the absence of *P. andamanensis* from the survey.

Recently, the author recorded two populations of this taxon as evergreen forest components at two localities in North Andaman, viz. Saddle Peak and Kalpong (Fig. 3). Saddle Peak (732 m) is the highest point in the Andaman-Nicobar Archipelago, recognized as a National Park in 1979, covering an area of 3254 hectares. The locality at Saddle Peak (Fig. 4), where this taxon occurred at an altitude of about 710 m, may be the same place that Ellis had made his type collection. The Andaman Islands are almost devoid of fresh water sources, with the exception of the Kalpong River in North Andamans (Fig. 5). The Kalpong River originates from the Saddle Peak and flows across the island in a northward direction about 35 km before joining the Aerial Bay Creek of the eastern coast at Diligpur. The first hydroelectric project of the Andaman-Nicobar Administration was constructed on this river. The author located only a few individuals of this taxon at Saddle Peak. One population, comprising around 50 individuals, was located about 500 m above the Kalpong river bank, occurring on rather undulating terrain. The author did not locate the taxon during exploration, over a five-day period in 2012, of the evergreen forests of Little Andaman Island at Krishna Nalla, Rabidranagar and Vishu Nalla Dam. Rogers located this taxon at Bumila creek in the southwest region of the island, but the present status of the taxon there is unknown.

Phoenix andamanensis is a tall palm growing up to 15 m in natural habitats, its crown projecting over the top of the canopy at Saddle Peak and Kalpong forests. The fruits are orange in color and up to 24 × 12 mm in size. The rest of the details are more or less same as the taxonomic description in the revisionary work (Barrow 1998). Barrow (pers. comm.) noted that the distinguishing character between *P. andamanensis* and its allied taxon, *P. rupicola*, is the nature of the endosperm. *Phoenix andamanensis* has a ruminate endosperm, and *P. rupicola* has a homogenous endosperm. The author found fruiting specimens of *P. andamanensis* at the Kalpong River location; however, the nature of the endosperm of the seeds is still to be clarified.

Conservation

Plant diversity management for successful conservation, especially in the insular habitats of Andaman-Nicobar Islands, requires a strategic framework of action in order to

overcome diverse pressures, such as catastrophic events, inaccessibility of several uninhabited islands, disjunct geographical distribution of endemic taxa, and anthropogenic interventions among inhabited islands. Therefore, conservation of insular germplasm outside the island is highly recommended for safeguarding insular plant species. Jawaharlal Nehru Tropical Botanic Garden and Research Institute (JNTBGRI), located at the foothills of the southern Western Ghats, has a concern for insular germplasm conservation of the Andaman-Nicobar plant species. It is one of the mandates of the field gene bank, established in 1994 in JNTBGRI, to be a center of conservation of Andaman plant species outside the islands. The climatological features and the latitudes of the Andaman Islands and the southern Western Ghats are broadly similar, the latter lending themselves well for successful growth of Andaman species on the slopes of the Western Ghats. To date, 125 species from Andaman-Nicobar Islands have been established at the field gene bank of JNTBGRI. It is considered to be the largest collection of Andaman- Nicobar plant species outside the islands.

Phoenix andamanensis is evidently rare in the Andaman Islands. The present population located at Kalpong is within the protected forests region, and the other population at Saddle Peak is in the National Park area. It would appear that the species has a small gene pool comprising a very few populations in isolated pockets of three or four islands, and thus the possibility for out-breeding is limited. The conservation status is very likely to be fragile and possibly endangered. The regeneration of the species in natural habitats would appear very limited; however, seed germination was successfully carried out by the North Andaman Forest Division of the Andaman-Nicobar Administration. The growth rate of the seedlings is rather slow when compared with other insular palm species. As regards to the conservation of the species outside the islands, JNTBGRI has taken the initiative, and a few seedlings have been introduced at the field conservatory for Andaman-Nicobar plants established in JNTBGRI (Fig. 6).

Acknowledgments

The author is thankful to Dr. P.G. Latha, Director, JNTBGRI for encouragements. Dr. C. Murugan, BSI, Port Blair and forest officials of Andaman-Nicobar Forest Department for facilities rendered for the explorations. The author also wish to record his sincere thanks to Dr. John Drandfield, Royal Botanic Garden, Kew and Dr. Sasha C. Barrow for their valuable help during the the preparation of the manuscript.

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Photo Feature

Eugeissona brachystachys is a local palm of ridge tops in northeastern Peninsular Malaysia. Unlike the weedy, widespread *Eugeissona tristis*, *E. brachystachys* has less heavily spiny petioles, broader leaflets and emerald green, rather than brown, petals. Male flower buds are shown here; after the male flowers have finished flowering, they will be pushed out of their subtending bracts by the hermaphroditic flowers, which look very similar apart from an obliquely flattened side to the petal tips, formed as they pressed against the male flowers.

John Dransfield & Scott Zona

Index to Volume 60

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Palms	7 8 2 – 7 2 0	
4. Issue Frequency	5. Number of Issues Published Annually	6. Annual Subscription Price
Quarterly	4	$45.00

7. Complete Mailing Address of Known Office of Publication *(Not printer) (Street, city, county, state, and ZIP+4®)*
International Palm Society, 9300 Sandstone St., Austin, Travis Co., TX 78737-1135
Contact Person: Lisa Mayhew
Telephone *(Include area code)*: 785-843-1234

8. Complete Mailing Address of Headquarters or General Business Office of Publisher *(Not printer)*
International Palm Society, 9300 Sandstone St., Austin, TX 78737-1135

9. Full Names and Complete Mailing Addresses of Publisher, Editor, and Managing Editor *(Do not leave blank)*

Publisher *(Name and complete mailing address)*
International Palm Society, 9300 Sandstone St., Austin, TX 78737-1135

Editor *(Name and complete mailing address)*
John Dransfield, Herbarium, Royal Botanic Gardens, Kew, Richmond, Surrey, TW9 3AE, United Kingdom

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☐ Has Changed During Preceding 12 Months *(Publisher must submit explanation of change with this statement)*

13. Publication Title: Palms

14. Issue Date for Circulation Data Below: September - 2016

15. **Extent and Nature of Circulation**

			Average No. Copies Each Issue During Preceding 12 Months	No. Copies of Single Issue Published Nearest to Filing Date
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