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.

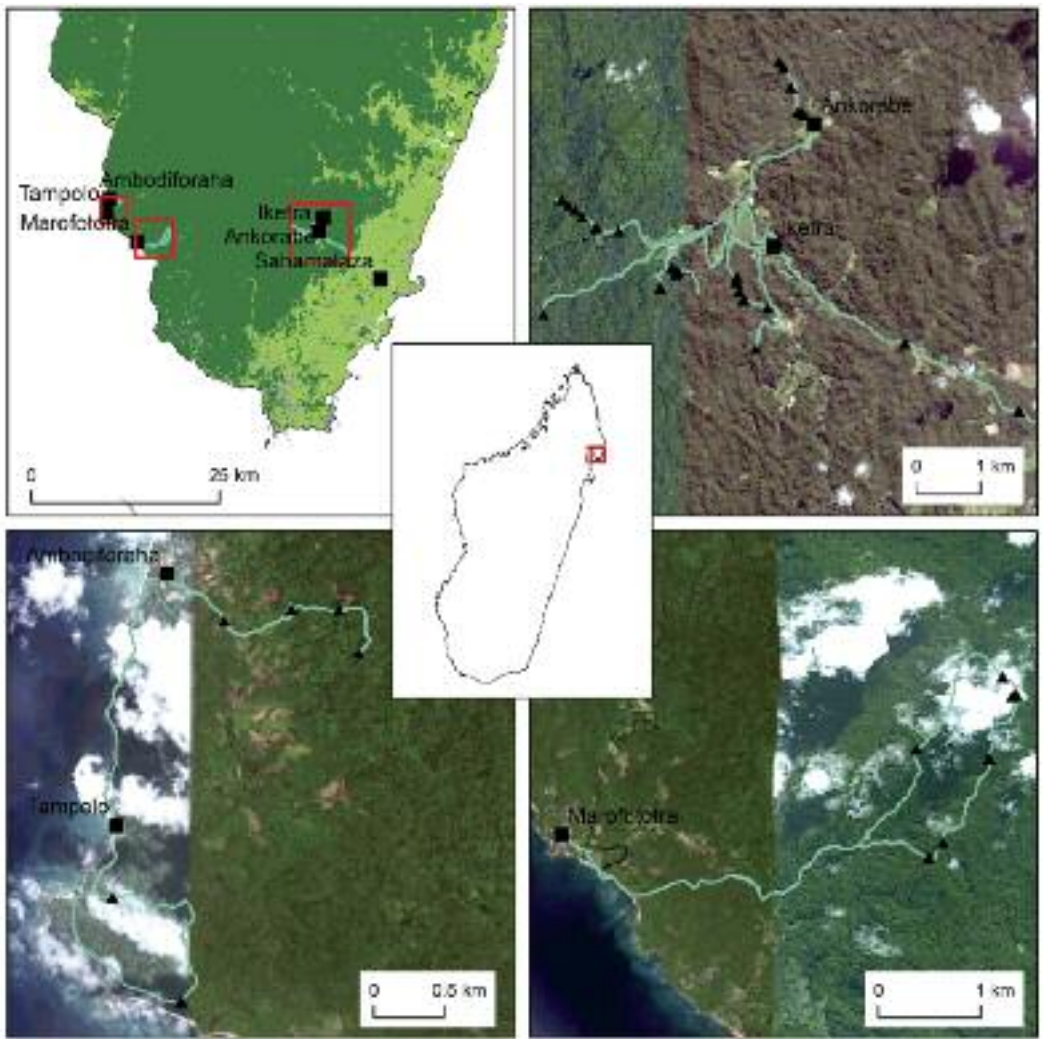
It is well established that palm diversity in Madagascar peaks in the humid forests of the island's north-east (Dransfield & Beentje 1995, Rakotoarinivo et al. 2013, 2014). Within the northeast, the Masoala Peninsula is arguably the most important palm hotspot. Palm species richness is exceptionally 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	