Analalava – a Palm Conservation Hotspot in Eastern Madagascar

MIJORO RAKOTOARINIVO
Royal Botanic Gardens, Kew, Madagascar Office, Lot II J 131 B, Ambodivoanjo Ivandry, Antananarivo 101, Madagascar
mrakotoarinivo.rbgkew@moov.mg

JEREMIE L. RAZAFITSALAMA
Missouri Botanical Garden, BP 268, Antsiranana 201, Madagascar
jeremie.razafitsalama@mobot-mg.org

WILLIAM J. BAKER
AND
JOHN DRANSFIELD
Royal Botanic Gardens, Kew, Richmond, Surrey, TW9 3AB, United Kingdom
w.baker@kew.org, j.dransfield@kew.org

At the present day, only a few small fragments of original rainforest remain along the east coast of Madagascar. One such forest fragment is Analalava, about 7 km west of Mahavelona, to the north of Toamasina. An inventory of this forest recorded 25 palm species. This paper emphasizes the richness of the palm flora and the conservation efforts necessary for their survival.

The high diversity of palms in the eastern part of Madagascar is well known. Approximately 90% of the 188 indigenous palms species on the island occur in rainforest (Dransfield & Beentje 1995; Rakotoarinivo & Dransfield, submitted), the primary vegetation of the eastern part of Madagascar. In the past, the rainforest is thought to have been contiguous from Sambava to Taolagnaro (Humbert & Cours-Darne 1965) but now, primary forest is scarce along the eastern escarpment and extremely rare on the coastal plain. Only 47.737 km sq. of this vegetation type remains (Moat & Smith 2007) and the area continues to decrease since annual deforestation rate is estimated to be around 0.20% between 2000–2005 (MEFT 2009). On the Indian Ocean coastal plain, where the human population is dense and the land is more accessible, the rainforests have been most seriously degraded. Thus, our understanding of the original palm diversity in Madagascar is limited because good forest is rare and located mainly in remote areas. Some species are possibly extinct and many palms are recorded only from single locations in tiny fragments of primary forest.

The forest of Analalava, north of Toamasina, is a rare example of a coastal plain rainforest remnant. Analalava is located 7 km west of Mahavelona (or Foulpointe) and has a climate classified as perhumid with ca. 3000 mm of rainfall in a year, ca. 24°C mean temperature and lacking a dry season (Cornet 1974). The forest fragment consists of ca. 200 hectares of remnant lowland vegetation ranging between 40 and 80 m elevation and growing mainly on laterites, but with some parts on alluvial and white sands. The forest is evergreen and has a closed subcanopy. Following the former exploitation of the forest, only a few trees from the original canopy remain and now appear as emergents (C. Birkinshaw, pers. comm.). Despite this state of degradation and its limited size, the forest has a diverse flora, with 317 plant species recorded by Missouri Botanical Gardens (2007). The principal human activity in the vicinity of Analalava is agriculture, but the expansion of tourism at Mahavelona has resulted in an increase in the demand for construction wood. In recent decades, one third of the forest has been burnt or otherwise destroyed to provide agricultural land, and the remainder now lacks large trees due to timber extraction. The latest census states that 23,000 people dwell in the Mahavelona area, with one quarter of them living in close proximity to the forest .

The Palm flora of Analalava

As part of the taxonomic and ecological study of Madagascar palms at the Royal Botanic Gardens, Kew, an inventory of the species in Analalava was made during three visits to the forest between 1999 and 2008. This inventory has been complimented by surveys conducted by the Missouri Botanical Garden. Twenty-five palm species are now known to occur in Analalava. Analalava is thus the sixth most important hotspot for palm diversity in Madagascar. Comparable areas richer than Analalava include Antanambe (Mananara Avaratra), Ambinanitelo (Makira), Tampolo (Masoala), Marojejy and Sahamalaza (Masoala) (Rakotoarinivo 2008). Moreover, most of the species in Analalava are rare. Some are known only to occur in the region; others have a larger distribution range, but their distributions are severely fragmented. Here we list the palm species of Analalava, giving details of their occurrence in Madagascar and distribution within Analalava.

1. ***Dypsis angustifolia*** (H. Perrier) Beentje & J. Dransf. (Figs 1, 2)

This is a clustering undergrowth palm found only in Toamasina region. Apart from Analalava, the other known site for this species is in the Betampona reserve at an elevation between 400–500 m (Dransfield & Beentje

1. *Dypsis angustifolia* growing beside a small stream.

1995). This is a rare species, collected only six times since it was discovered in Betampona in 1925 by H. Perrier de la Bâthie. Each of these two sites is located on the watercourses of the Onibe River, suggesting that other populations may still occur in remaining forest along this river. In all localities, clumps of the palm are sparse.

2. ***Dypsis bejofo*** Beentje (Fig. 3)

This is a solitary canopy palm that is known from disjunct sites between Betampona and areas to the north of Maroantsetra (Rakotoarinivo 2008). *Dypsis bejofo* is known from eight locations and only three of them are not around the Bay of Antongil (Ambatovaky, Analalava and Betampona). This palm is frequently recorded from submontane forests around 400 m, but its elevational gradient ranges from sea level up to 800 m. In Analalava forest, it is rare. Only two mature individuals were found; they are both located on the crest of a steep slope where the canopy is slightly open. In 2008, abundant seedlings were observed around the mature individuals.

3. ***Dypsis bosseri*** J. Dransf.

This slender undergrowth palm was described in 1995 from a single herbarium specimen collected in the Mahavelona area by French botanist Jean M. Bosser in 1962 (Dransfield & Beentje 1995). As primary forest was mostly destroyed in this zone and no newer collections were made since its first collection, *Dypsis bosseri* was presumed to be extinct until its rediscovery in 1999 in Analalava forest. The palm is quite common in Analalava but it has never been recorded outside this locality. Individuals are found in swampy or periodically inundated sites.

4. ***Dypsis carlsmithii*** J. Dransf. & Marcus (Figs 4, 5)

This is a robust palm that was initially described from a garden plant in Hawaii (Dransfield & Marcus 2002). Its occurrence in Analalava is the second record of the species in Madagascar after that in Tampolo, in the western part of the Masoala Peninsula. In both known sites, the palm grows on flat partially inundated land in valley bottoms. Only two individuals have been observed in Analalava.

5. ***Dypsis confusa*** Beentje

This slender shrubby palm is relatively common in the undergrowth in lowland forest of the northeast part of Madagascar. With 17 locations known between Antalaha and

2 (left). *Dypsis angustifolia*: close up of crown. 3 (right). *Dypsis bejofo*: mature tree with inflorescences.

4 (left). *Dypsis carlsmithii*: the whole magnificent palm. 5 (right). *Dypsis carlsmithis*: view of the crown.

Ranomafana, from sea level up to 1200 m elevation, this species is one of the most widespread palms of Madagascar. In its occurrence sites, individuals are mostly found on shallow soils where the forest canopy is slightly open.

6. ***Dypsis faneva*** Beentje

This is a slender palm of the undergrowth in humid forest up to 300 m and known from four separate areas between Maroantsetra and Analalava. This is a rare species in the forest.

7. ***Dypsis fibrosa*** (Wright) Beentje & J. Dransf.

Dypsis fibrosa is a branched shrubby palm, characterized by its disintegrating leaf sheath, which produces a fibrous skirt (piassava) in the upper part of the trunk. This palm is one of the most widespread in Madagascar as it is represented by 54 herbarium specimens collected from 17 localities between Daraina and Taolagnaro, and from humid lowland forest to mountain forest on the Eastern escarpment. In all of its occurrence sites, individuals are most frequent on hill slopes.

8. ***Dypsis forficifolia*** Mart.

This slender, undergrowth palm is especially abundant around the Bay of Antongil from the western part of Masoala Peninsula to Soanierana Ivongo region. The occurrence of this palm in the Analalava forest represents an outlier.

9. ***Dypsis hovomantsina*** Beentje

This canopy palm can be distinguished from other species by its crownshaft that is densely waxy in the lower part and with golden fur in its upper parts. This species is known to occur discontinuously from five localities in lowland areas below 300 m from Analalava towards Masoala. Individuals are frequently found in forest with a relatively open canopy, on steep slopes and rocky sites.

10. ***Dypsis lastelliana*** (Baill.) Beentje & J. Dransf.

This palm is one of the most typical species to be found in the lowland humid forest of north-eastern Madagascar. This species is also found in the Sambirano region and has apparently a continuous occurrence from Daraina to Mahanoro, and from sea level up to 900 m elevation. *Dypsis lastelliana* is a canopy tree palm characterized by its red furry crownshaft. In the forest, individuals are usually quite numerous and generally occupy slopes.

6. *Dypsis poivreana*, in flower.

Unusually among Madagascar's palms, this species is able to survive in disturbed areas, possibly because the "cabbage" is not eaten.

11. ***Dypsis nodifera*** Mart.

This is a slender undergrowth palm of the humid forest along the eastern escarpment of

7. *Dypsis poivreana*, in fruit.

Madagascar, from sea level to 1500 m elevation. With 62 different herbarium samples, this species is one of the palms in Madagascar best represented in herbaria. *Dypsis nodifera* is widespread as the occurrence sites extend from 23 locations between Antsiranana and Taolagnaro. Abundance of this species is rather variable in these locations. In Analalava, *Dypsis nodifera* is quite common.

12. ***Dypsis paludosa*** J. Dransf.

This is a clustering undergrowth palm, growing in swamps or in flat valley bottoms that are frequently flooded. *Dypsis paludosa* may have either entire bifid or pinnate leaves, like many other slender or dwarf palm in Madagascar. The species has been recorded from seven localities between Masoala to Ampasimanolotra. This palm is very frequent in the coastal zone within this region, with an elevational range up to 400 m.

13. ***Dypsis pinnatifrons*** Mart.

This is a moderately robust palm of the forest undergrowth. *Dypsis pinnatifrons* is superficially similar to *D. nodifera* in general habit and their identification may be also difficult as they have more or less the same extent in distribution range. However, *D. pinnatifrons* has three stamens and homogenous endosperm while there are six stamens and ruminate endosperms for *D. nodifera*. This palm is widespread. At the moment, there are about 90 herbarium samples collected from 42 locations

across the humid forest, from Sambirano area to Taolagnaro and from sea level up to 1200 m elevation.

14. ***Dypsis poivreana*** (Baill.) Beentje & J. Dransf. (Figs. 6, 7)

This dwarf palm of the understory is relatively common throughout the forest of Analalava. It is endemic to a small area to the north of Toamasina, with the only other known site, lying approximately 30 km north from Analalava, in Tampolo forest (Fenoarivo Atsinanana – not Tampolo, Masoala). In both sites, clumps of this palm are found mostly on flat and occasionally flooded terrain.

15. ***Dypsis psammophila*** Beentje

This is a slender clustering palm known especially from swampy and dune areas behind the shoreline of the Indian Ocean from five extremely fragmented locations between Taolagnaro and Ambohitralanana, east Masoala. *Dypsis psammophila* is a rare species in geographical point of view but it may occur in abundance, especially in the coastal bush. The occurrence of this species in Analalava, growing along a stream, is the first record for this palm in humid forest.

16. ***Dypsis tokoravina*** Beentje

This is one of the most robust solitary palms of the canopy in the rainforest. Only juvenile individuals with their characteristic leaflets, large and arranged in different planes, have been recorded in the Analalava forest. This species has for a long time been thought to be an endemic of the forests surrounding the Bay of Antongil, but recent expeditions have shown that its range extends into Daraina to the north and into Ampasimanolotra area, its southern limit.

17. Dypsis spp.

Three palms belonging to the genus *Dypsis* have not been identified properly. Two of them are slender palms of the undergrowth (Fig. 8); the other is arborescent with conspicuous leaves arranged in three ranks in the crownshaft (Fig. 9). It is possible that they represent undescribed taxa. At the moment, new fertile herbarium specimens are needed in order to establish their identity.

18. ***Marojejya*** sp. (Figs. 10, 11)

This is a rare squat palm of the undergrowth in Analalava, recorded from lower slopes and in swampy areas. Its habit seems to be intermediate between *M. insignis* and *M. darianii*. The upper part of the leaves is neatly pinnate (*M. insignis* character) while the blade of the half lower part is entire (*M. darianii* character). The two species within the genus *Marojejya* are rare: *Marojejya insignis* has a wide distribution range (Marojejy to Andohahela) but no where is it common. *M. darianii* is known only from four locations between Betampona and the Masoala Peninsula; all populations of this species are known from swampy areas. To identify this palm of Analalava correctly, further material is needed, in particular ripe fruit.

8. A slender unidentified *Dypsis* sp.

19. ***Masoala madagascariensis*** Jum.

This is a squat palm of the understory with its trunk covered with dead leaf sheath remains. The species is known from nine locations between Marojejy and Analalava. Abundance of this species may vary, depending on the quality of the forest. However, it is a rare palm and in Analalava, only a few mature individuals have been seen.

20. ***Orania longisquama*** (Jum.) J. Dransf. & N.W. Uhl

This is a relatively common canopy palm of the lowland north-eastern rainforest; the

9. An unidentified species of *Dypsis* with unusually swollen sheaths.

global distribution range extends between Toamasina region and Masoala Peninsula, with outliers in Farafangana and Manakara regions. Individuals are numerous in Analalava forest.

10. *Marojejya* sp., growing in a swampy valley bottom.

21. ***Orania trispatha*** (J. Dransf. & N.W. Uhl) Beentje & J. Dransf.

This is a canopy palm distinguished by its distichous habit. Its distribution range is quite similar to those of *O. longisquama* (Masoala to Farafangana). This is one of the commonest and most abundant palms in Analalava.

22. ***Ravenea julietiae*** Beentje

This is a rare subcanopy palm known from eight scattered sites between Mananara Avaratra and Farafangana, from sea level to 600 m high. *Ravenea julietiae* is instantly recognised in the forest if it is a female plant. The female inflorescence has a very long peduncle, exceeding the crown. This character is unique within the genus *Ravenea*. As in all other known sites, only a few individuals have been seen in the forest of Analalava.

23. ***Ravenea robustior*** Jum. & H. Perrier

This is a robust canopy palm, present in almost all humid forests between Daraina and Taolagnaro region, from sea level up to 1200 m. Abundance of this species may vary with locality; in Analalava forest it is relatively rare.

24. ***Ravenea sambiranensis*** Jum. & H. Perrier

This sub-canopy palm is one of the commonest and most frequent palms of the

11. Detail of the crown of *Marojejya* sp.

rainforest in Madagascar. It has been collected 57 times from 28 locations. *Ravenea sambiranensis* has approximately the same distribution range as *R. robustior* in the east of Madagascar but it is also present in Bemaraha and Bongolava mountains, areas bordering the Western region.

25. ***Ravenea*** sp.

A canopy palm looking similar to *Ravenea lakatra* has been found in the forest of Analalava. Since trunked individuals were all sterile during our visit, we have not been able to identify it.

Palms, Conservation and Tourism

Ananalava forest is of great interest for its palms. Not only does this site have high palm species diversity, but many rare palms are also present (e.g. *Dypsis carlsmithii*, *D. hovomantsina*). Palm-lovers and tourists may easily see these species in their natural habitat in Analalava, because the site lies just 7 km from Mahavelona, one of the most visited touristic villages in Madagascar. As a charismatic plant group, palms may help in promoting the conservation of species and landscapes. Furthermore, it is known that ecotourism has the potential to make a substantial contribution to regional development (Boo 1990). Analalava could thus be a model for integrated conservation, tourism and sustainable development.

Analalava site has been managed by the Missouri Botanical Garden since 2005. The Garden aims to find ways to reconcile the imperatives of biodiversity conservation and sustainable local economic development (MBG 2007). MBG together with a local NGO, *Velonala*, and other stake-holders are now developing strategies to achieve this objective. The preparation of all documents needed for the designation of the site as a new protected area is now in progress. MBG intervention in this forest includes research on decision-making for conservation actions, promotion of fuel wood and timber alternatives, restoration of the degraded part of the forest, raising public awareness on fire control and the importance of the biodiversity of the site, as well as the promotion of local economic development by means of the ecotourism. Local people are encouraged to use the forest sustainably by demonstrating that it provides critical ecosystem services, such as ground water, essential for aquaculture and agriculture, and natural resources for daily life. Local people have also been taught to build plant nurseries and propagate native plants. Such activities are recommended by the Convention on Biological Diversity (UNEP 2000) and mentioned as a primary means of achieving conservation. Promoting the use of biodiversity will be of growing importance for maintaining biodiversity in the future decades as human development depends on it (Given 1994). Thus, encouraging people to understand the importance of diversity is essential to balance economic growth and conservation.

Palm conservation in this site thus requires the involvement of the local population, as like everywhere on the east coast palms constitute a vital part of village-level economies in Madagascar (Dransfield & Beentje 1995). Species such as *Dypsis fibrosa, Masoala madagascariensis* and *Ravenea robustior* may be used in thatching in Analalava, seeds of *Dypsis bejofo, D. carlsmithii, Ravenea julietiae* and some others may be collected for generating seedlings or directly selling into horticulture for the national and international markets. This will ensure that palms are protected and local people take advantage of their presence in the forest.

The conservation of palms at this site may also require the conservation of the small population of the white-fronted brown lemur (*Eulemur albifrons*) that survives here. Species of *Eulemur* are known to be excellent seed dispersers of many Malagasy plants with succulent fruits, including palms. It is highly desirable to maintain this service to allow palms to regenerate at new locations away from the parent plants.

Despite such initiatives the Analalava Forest and the palms that it contains will remain threatened by wildfires, selective exploitation of timber and cyclones for the foreseeable future. Several of Analalava's palm species are very rare and localised at this site and could easily be extirpated by such events. It is therefore recommended that the populations of these species should be reinforced by the collection of small quantities of seeds for ex-situ propagation and then planting the resultant seedlings in zones of reforestation. Some seedlings of each species propagated in this way should also be planted in the ex-situ conservation collection for palms at the nearby Parc Ivoloina.

Conclusions

Analalava forest is richer in palm species than any of the other four significant rainforest fragments on the eastern coastal plain (Ambila-Lemaitso, Betampona, Manombo, Tampolo), and, despite an area of just 200 ha, is among the top six palm hotspots in Madagascar. Thus, this tiny, degraded forest fragment is of conservation significance at the national and international level, providing insight into the diversity of palms that formerly occupied this large coastal area. This high diversity is very likely to be reflected in other groups of plants. In drawing attention to Analalava and its palms, we aim to provide additional impetus to the case for its conservation and further promote opportunities, such as ecotourism, that could ensure a sustainable future for the forest.

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