Troy Doedens, 2017

Possible new species of *Ravenea* from the Antsiranana region, Madagascar

Species of *Ravenea* in the Montagne D'Ambre rainforest, Antsiranana region, Madagascar

Madagascar is an island located in the Indian ocean off the coast of southeast Africa. Madagascar is the fourth largest island in the world. With almost 600.000 square km it is larger than France, Belgium and the Netherlands combined. Madagascar got separated from the Indian peninsula about 88 million years ago and is likely to be isolated since then. This, and the addition of a tropical climate, mountains and diverse climate zones give Madagascar an enormous biodiversity. About 90% of the biodiversity occurs nowhere else in the world. Madagascar is also one of the poorest countries of the world with 90% of the inhabitants living of less than 2 USD per day. Because of the low living standards, many people have to live of what nature provides. Enormous amounts of rainforests have already disappeared because of slash and burn agricultural practices and charcoal collecting *(Hooper, 2015; The guardian, 2011)*.

The island is home to at least 195 species of palm (2014) in 17 genera of which 192 occur nowhere else. From 1995 to 2014, 28 new species were discovered including the spectacular new genus of the self-destructing palm *Tahina* in 2007 *(Dransfield, 2008)*. It is estimated that 83% of Madagascar palms are threatened, this proportion of threatened species exceeds all other plant groups in Madagascar for which comprehensive evaluations are available. The genus *Dypsis* is by far the largest genus with at least 145 species, followed by the genus *Ravenea (Rakotoarinivo et al., 2014).*

The genus *Ravenea* currently contains 21 species and is indigenous in Madagascar and 1 to the Comoros islands. *Ravenea* is placed in the *Ceroxyleae* tribe together with *Ceroxilon*, *Juania* and *Oraniopsis (Dransfield, 2008)*. *Ravenea* is a very diverse genus containing very small undergrowth palms, short and squat palms, slender middle size trees and canopy giants. The habitat ranges from lowland to montagne rainforest, dry areas to river banks and even one species called *R. musicalis* that lives permanenty in water *(Hogg et al., 2014)*. Formally *Ravenea* was separated in two genera, namely *Ravenea* and *Louvelia*, however a review by Beentje and Dransfield in 1994 concluded that they should be placed in one genus. One of the main difficulties in this review was the distinction of taxa that were quite close together like that of *R. madagascariensis, R. latisecta*, and *R. sambiranensis (Beentje, 1994).*

National park (NP) Montagne D'Ambre (Figure 2) is located in the Antsiranana region in the extreme north of Madagascar. NP Montagne D'Ambre lies just 30km south of the city of Antsiranana (Often called Diego Suarez). It is easiest accessed from a tiny town called Joffreville. NP Montagne D'Ambre was established in 1958 and protects a total surface of 185 square kilometres. The massif rises from the surrounding dry region forming an isolated stretch of montane rainforest. There is a great variation in climate zones in the park ranging from very hot lowland zones to cool mountain tops to an altitude of 1470m and very humid misty crater lakes. The massif has a great biodiversity and contains over 1000 known species of plants *(Madagascar national parcs, 2016)*. It is very likely NP Montagne D'Ambre contains lots of undescribed plant species, there was even the discovery of a completely undescribed species of primate in 2015 *(Sci-news, 2015)*.

Figure 2: NP Montagne D'Ambre (Arrow) from above. A: Total map of Madagascar. B: The Antsiranana region. C: NP Montagne D'Ambre

No species of *Ravenea* are known in literature to be present in NP Montagne D'Ambre. However, *Ravenea robustior* and *Ravenea sambiranensis* are described in the north of Madagascar. During an expedition to Madagascar in 2012, a palm that looked like a species of *Ravenea* was photographed in NP Montagne D'Ambre and seemed quite distinct from *Ravenea robustior* and *Ravenea sambiranensis*. Therefor a new expedition was conducted to collect data and measurements from this palm in 2016.

NP Montagne D'Ambre was visited for two days, during these days as much data as possible was collected. The local name of the palm is 'Kindro' in Malagasy, a name that is used to describe at least 9 different species including this species *(Dransfield, 1995)*. The palm grows in plentiful numbers in the area north west of lake Mahamasina from 950 – 1150m altitude (Figure 3).

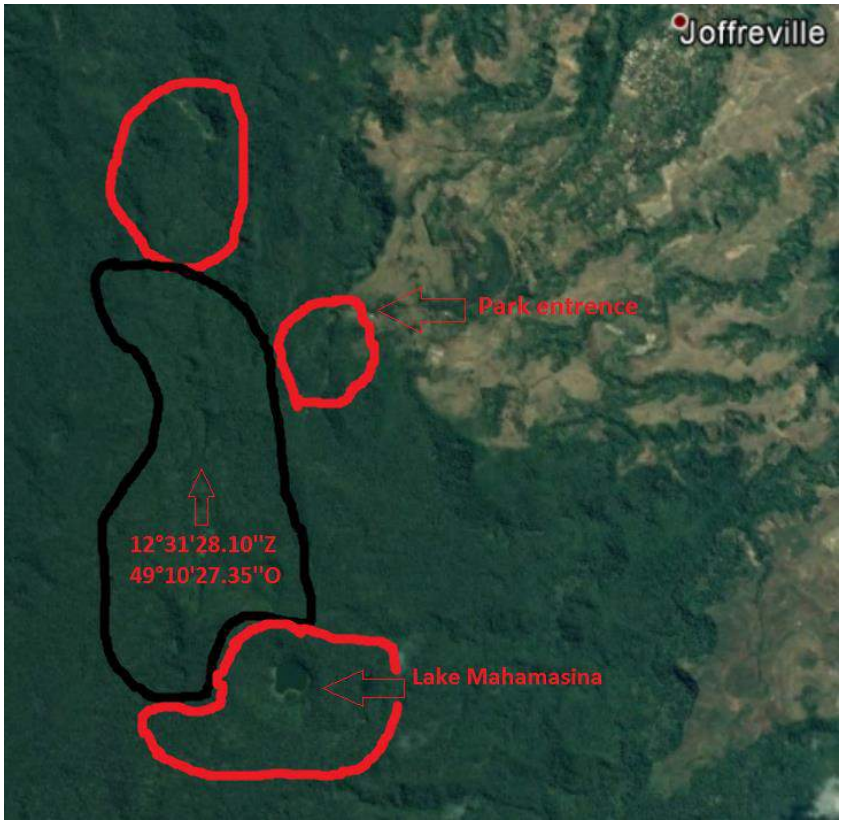

Figure 3: Both areas in red and black were visited, the palm was only observed in the black area.

The palms showed very clear self-cleaning trunks and almost no necrosis on lower leaves, indicating the palm sheds its leaves when they are still green (Figure 4) and pistillate inflorescence is growing interfoliar (Figure 5). Many of the palms have longitudinal holes in the trunks where mouse lemurs house (Figure 6). The palms have straight porrect leaves when growing under canopy (Figure 7), however one individual was found growing in full sun that showed porrect to slightly arching leaves (Figure 8). The palms grow in small groups of 3-10 palms, usually where there are slight openings in the forest canopy (Figure 9). Fallen leaves found under adult trees still showed green regular leaflets, contributing to the self-cleaning habit of the trunk (Figure 10). Multiple pistillate inflorescence was found under multiple adult trees (Figure 11). The old female inflorescence showed a 1 order division, and 40-70 rachillae (Figure 12). Multiple seedlings were found growing under these female trees, the seedling leaves were bifid (Figure 13). One individual was found having pistillate inflorescence with some young unripe fruits. It was impossible to reach this palm to take measurements however, it was showing a obovoid to oblong shape (Figure 14). One palm observed in 2012 was found again, indicating the growth rate (Figure 15). No mature fruit, seeds, pistillate flowers, staminate inflorescence nor any staminate flowers were found.

Figure 4: Adult palm showing clear self-cleaning trunk without old leaf remnants and shiny green lower leaves.

Figure 5: Old pistillate inflorescence growing interfoliar, juvenile tree.

Figure 6: One of many longitudinal holes in the trunk where mouse lemurs house.

Figure 7: Left: Juvenile palm growing under canopy showing straight porrect leaves. Right: Adult tree growing under canopy also showing porrect leaves.

Figure 8: Individual adult palm growing in full sun showing slightly arching leaves.

Figure 9: Small group of 3 palms, growing under an open part of the forest canopy.

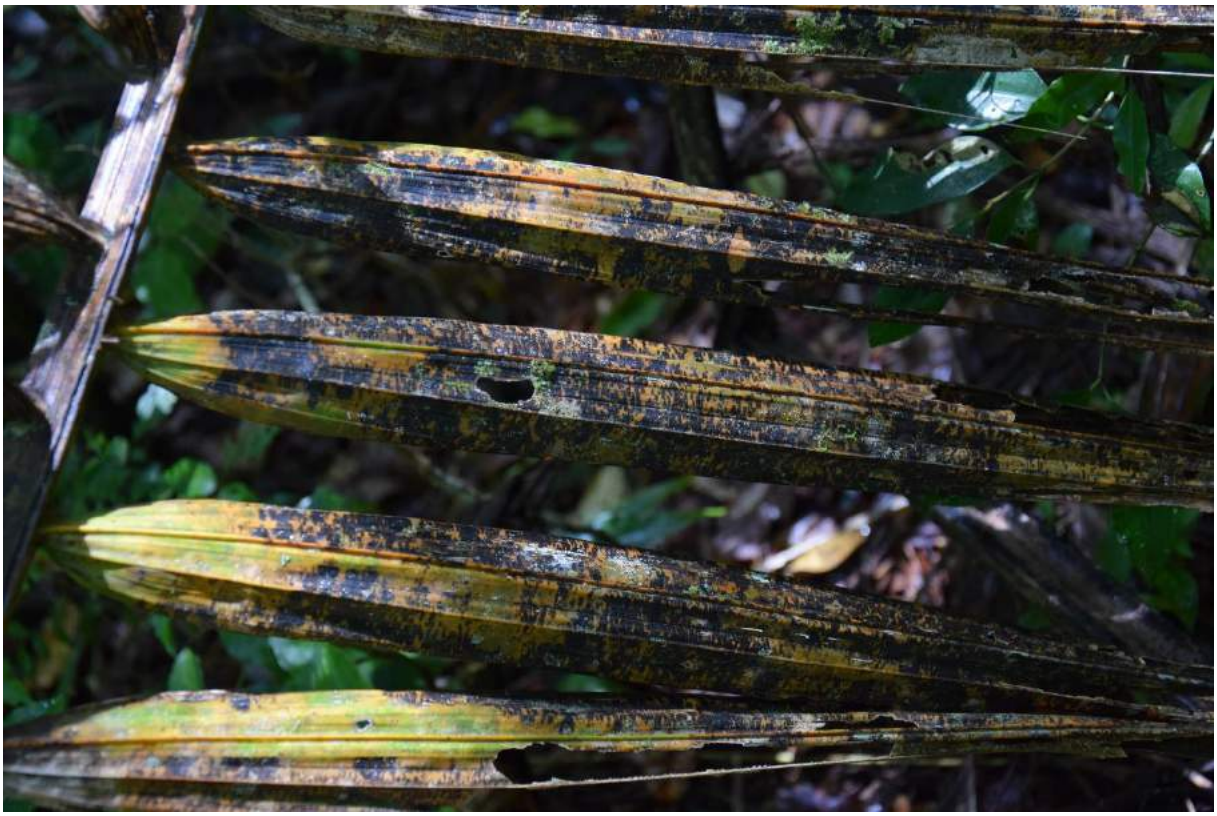

Figure 10: A freshly fallen leave still showing green regular leaflets.

Figure 11: Old pistillate inflorescence found under adult trees.

Figure 12: Close up on the 1 order, old pistillate inflorescence

Figure 13: Bifid seedling growing under adult palms.

Figure 14: Unripe green fruit showing the obovoid to oblong shape

Figure 15: Two photos of the same tree. Left: May 2012. Right November 2016

A comparison was made between the measurements and descriptions of the NP Montagne D'Ambre *Ravenea* and all other species in the genus and it was very clear that *R. robustior* and *R. Sambiranensis* were indeed the most similar, therefor these two species were compared in detail (Figure 16; Table 1).

Description *Ravenea Montagne D'Ambre*

NP Montagne D'Ambre, Antsiranana region, plentiful from entrance near Joffreville to cascade Antomboka up to Lake Maharasika from 800 to 1150m altitude. Growing in small groups of 3-10 adult trees. Local names 'Kindro' or Palmier royale. Wood used to make houses, fruit eaten by lemurs and parrots. Mouse lemurs are housed in longitudinal holes in the trunk. Flowering time according to local people is June – July.

An majestic moderate to large solitary unarmed tree palm. TRUNK up to 20m, 31cm diam. (Near crown 18cm); Base sometimes bulbous; Nodal scars faint, nodes 1cm, internodes 3-5cm, sometimes longitudinal holes where mouse lemurs sleep, usually no remnants of sheaths. LEAVES 18-32 in the crown, porrect to slightly arching when positioned in sun; Sheath, Open, length 50cm, wide 35cm, brown-tomentose externally; Petiole, length 30-40cm wide 4-8cm, convex with sharp edges; Rachis length 2,9m, mid leave convex and white-, green, to brown tomentose; Leaflets regular, rigid, lanceolate, oblique, straight, acute, dark green, 49 on each side of the rachis, leaflet length 55cm near the petiole to 80cm near the middle and end. PISTILLATE INFLORECENCE interfoliar, solitary, grey brown tomentose, total length 130cm, branched to 1 order, peduncle length 60cm, rachis length 54cm, rachillae 40 – 70, lower rachillae length 33cm highest rachillae length 16cm, FRUIT obovoid to oblong. EOPHYLL bifid

Figure 16: Comparison between *R. sambiranensis* (Left)(Cindy Adair, Satranala reserve), *R. Robustior* (Middle)(Olivier Reilhes, Andasibe) and the NP Montagne D'Ambre *Ravenea* (Right)

Table 1: Comparison of the NP Montagne D'Ambre *Ravenea* measurements and descriptions to *R. robustior* and *R. Sambiranensis*

	R. robustior	*R. sambiranensis*	***R. Montagne D'Ambre***
Trunk			
Height (max) (m)	30	30	20
Circumference 1m (cm)	20 - 75	5-29	29-33
Circumference under crown (cm)	16-40	5-10	18
Node height (cm)	3-7	2-4	1
Internode height (cm)	7-25	-	3-5
Base bulbous	Sometimes	Sometimes	Sometimes
Old leaf remnants	Remnants	Clean	Clean
Leaves			
Amount of leaves in the crown	11-25	10-28	18-32
Leaf curve	Porrect	Strongly curved	Porrect, slightly curved in full sun

Leaf structure	Regular	Regular	Regular
Sheath	Open	Open	Open
Sheath height (cm)	38-112	12-70	50
Sheath with (cm)	16-45	10-20	35
Leaflet tips	Entire	Entire	Entire
Reduplicate	Yes	Yes	Yes
Orientation leaflets	Horizontal, slightly arching	Horizontal	Horizontal
Petiole	Slightly convex	Convex	Convex
Petiole length (cm)	17-134	13.5-76	30x40
Petiole with (cm)	8-17	1.3-7 x 0.6-4	4x8
Rachis length (m)	2.2-4	0.6-2.5	2.8-3
Amount of leaflets per size of the ranchis	50-105	35-67	49
Pistillate inflorescence			
Inflorescence	Interfoliar	Interfoliar	Interfoliar
Number of orders	1-2	1	1
Peduncle (cm)	45-100	29-93	50-70
Rachis (cm)	55-80	14-60	54
Amount of rachillae	45-100	28-77	40-70
Rachillae length	9-81	5-50	16-33
Pedicels (mm)	1-28	0.3-6 x 1.3	
Pistillate flowers			
Petal wide (mm)		2.2-5	
Petal length (mm)	4-4.2 x 1.8-2.4	1.5-2.3	
Staminodes (mm)	0.8	1,3	
Ovary (mm)	3.5	2.2-3.2	
Staminate inflorescence			
Inflorescence	Interfoliar	Interfoliar	
Number of orders	2-3	1-2	
Peduncle (cm)	50-60	25-74	
Rachis	84-131	20-54	
Rachillae	39-140	19-104 (order 1) - 3-6	
Pedicels	0.2-3	0-1	
Staminate flowers			
Petals wide (mm)		2-3	
Petal length (mm)	1.4-5 x 1.2-2.2	1.8-5	
Number of stamens	6		
Stamen length (mm)	0.5-1		
Anthers (mm)	1.5-2.8 x 0.7-1.3	1-3.7 x 0.8-1.6	
Fruit			
Colour	Orange	Orange to coral-red	
Shape	Obovoid to ovoid-globose	Ovoid to oblong, rounded at the apex	Obovoid to oblong
Size (mm)	10-18 x 8-15	10-12 x 9-10	
Amount of seeds	One-seeded, occasionally 2-3-seeded	One-seeded, occasionally 2-3-seeded	
Seed			
Colour	Red-brown	Brown	
Size (mm)	9-16 x 6-13	7-8 x 5-7.5	
Seedcoat thick (mm)	0.2		
Eophyll			
First leaves	Bifid	Bifid	Bifid

Summary of the differences found in the NP Montagne D'Ambre *Ravenea* (in red)

Ravenea robustior

- Has slightly convex petioles (Convex)
- Has broader petioles (8-17cm) (4-8cm)
- Has larger leaf node scars and internodes (Node 3-7cm; internodes 7-25cm) (>1cm; 3-5cm)
- Distal part of trunk usually with remnants of sheaths (Clean trunk)
- Less leaves in the crown (11-25) (18-32)
- Has larger rachis in the pistillate inflorescence (55-80cm) (54)
- More leaflets on each side of the rachis (50-105) (>49)
- Has obovoid to ovoid-globose fruit (Obovoid to oblong)

Ravenea sambiranensis
- Has a smaller trunk diameter (5-29cm; near crown 5-10cm) (<31; 18cm)
- Larger nodal scars (2-4cm) (>1cm)
- Leaves often strongly arching (Straight – slightly arching)
- Has smaller leaf rachis length (0,6-2,5m) (2,8-3m)
- Has wider leaf sheaths (10-20) (35)

Conservation

The Montagne D'Ambre *Ravenea* grows plentiful in the area and does not seem to be in any danger, protected by the national park borders. It is unknown if the palm spreads further south-west into the forest, however local people that live inside of the national park borders cut down the palms for their wood. The palms are important for multiple species of mouse lemurs that sleep inside the holes in the trunk, and for other lemur species and parrots that eat the fruit. The lower area surrounding the national park is getting drier, and since the palm grows in the lower parts of the forest (800-1150m) this could potentially become a future problem as dry areas are spreading up the mountain.

Conclusion

The palm found in NP Montagne D'Ambre was until this study unknown in this area and is most similar to *Ravenea sambiranensis* and *Ravenea robustior* but has some distinctive morphological characteristics. The obtained results are not enough evidence to name it a new species yet, because it lacks the description of male inflorescences, flowers and seeds. Therefore, for now, the palm has to be regarded as *Ravenea robustior*. A problematic species that probably includes at least 4 species, including the Montagne D'Ambre *Ravenea*, that needs a future review to complete the full taxonomic description.

References

Beentje, H, Ravenea in Madagascar, 1994

Dransfield, J., Tahina, a new palm genus from Madagascar, 2008

Dransfield, J., Beentje, H., Britt, A., Ranarivelo, T., Razafitsalama, J., Field guide to the palms of Madagascar, 1995

Dransfield J., N. Uhl, C. Asmussen, W.J. Baker, M. Harley, C. Lewis, Genera Palmarum. The evolution and classification of palms. 2008)

Hogg, F., Henshall, J, In search of Madagascar elusive river palm, Ravenea musicalis, 2014

Hooper, J, Oxford bibliographies, Madagascar, 2015

Madagascar national parcs, Parc national Montagne D'Ambre, 2016, http://www.parcs-madagascar.com/aire-prot%C3%A9g%C3%A9e/parc-national-montagne-dambre, Last accessed on December 7, 2016

Mcneil, J., et al., International code of nomenclature for algea, fungi and plants (Melborne code), 2012

Palmweb.org, Ravenea sambiranensis & Ravenea robustior, 2016, http://palmweb.org/cdm_dataportal/taxon/0813bdf6-1fa3-4dc0-a1e3-3df43bd1b927, Last accessed on November 22, 2016

Rakotoarinivo, M., Dransfield, J., Bachman, S.P., Moat, J. & Baker, W.J, Comprehensive Red List assessment reveals exceptionally high extinction risk to Madagascar palms, 2014

Sci-news, Montagne d'ambre dwarf lemur: New species found, 2015, http://www.sci-news.com/biology/science-montagne-dambre-dwarf-lemur-cheirogaleus-andysabini-03328.html

The guardian, Madagascar's record of biodiversity: 600 species discovered in a decade, 2011

Troy Doedens, 2017