



Diversity and Conservation of Comoro Island Palms: Mission Report 2023 & 2024

William J. Baker, Thomas Pickering, William Spoelstra
Royal Botanic Gardens, Kew

Andilyat Mohamed
Herbier National des Comores, Université des Comores

Yahaya Ibrahim
Centre National de Documentation et de Recherche Scientifique

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Background

The Comoro Islands is an archipelago of four main oceanic islands, volcanic in origin, lying in the Mozambique Channel of the Indian Ocean between the northern tip of Madagascar and the east coast of Africa (Plate 1). The plant diversity of the Comoros, which total just over 2,000 km² in surface area across four main islands, is extraordinarily rich with around 1,000 native species, 30% of which occur nowhere else. The fauna is equally remarkable, including 17 endemic bird species, nine endemic reptiles and two endemic fruit bats (such as the charismatic Livingstone's fruit bat). The fauna is largely dependent on the forest. However, limited intact forest remains on Anjouan and Mayotte, while the forests of Mohéli and Ngazidja (Grande Comore) are badly degraded, except at higher elevations. The major drivers of vegetation transformation are land clearance for agriculture and construction, and invasive exotic plant species, the impacts of which are exacerbated by cyclones that are frequent in the region and likely to intensify due to climate change.

Palms are keystone species in tropical forests, acting as “ecosystem engineers” and providing numerous services to other wildlife. Four species of palm are endemic to the Comoro Islands. Three are already known to be threatened with extinction according to the IUCN Red List of Threatened Species: *Ravenea moorei* (Critically Endangered), *Ravenea hildebrandtii* (Endangered) and *Chrysalidocarpus lanceolatus* (Vulnerable). The fourth, *C. cabadae*, was discovered in cultivation, having been described from material growing in a garden in Cuba (Moore 1962), but reports have emerged of its presence in the wild in Mayotte (Barthelat & Viscardi 2012). A further species name exists, *C. humblotianus*, but it has not been reported in the wild since 1884. A further species known in cultivation as *Chrysalidocarpus* “Mayotte” has also been reported, but confirmed field observations are lacking. To better understand this important group of plants, a concerted field campaign with associated taxonomic research is required. The inadequate taxonomic foundations of the Comoro palms represent an existential threat to their long-term survival.

Uniquely among botanic gardens, all three of the better-known species of Comoro palm are cultivated in the Palm House at the Royal Botanic Gardens, Kew. However, a forthcoming renovation of the Palm House will result in the removal of all plants from the building. This raises concerns about the long-term survival of these important collections. Of intense concern is *Ravenea moorei*, which is unknown from cultivation in any other botanic or private garden. Moreover, prior to the missions described in this report, little was known of the state of wild populations (Keith *et al.* 2006). *Ravenea moorei* is a majestic, coconut-like palm with stems reaching 20 m tall and 11-35 cm diameter, and leaves up to 3 m in length. The first specimens of *R. moorei* were made in Ngazidja in the 1960s, although these were at first confused with *R. hildebrandtii* (Moore 1965, Dransfield & Uhl 1986). It is known only from forest on basalt at 600-1000 m on the western flanks of Mt. Karthala, an active volcano. The extent and current state of the population is unknown, raising concerns that it may be on the brink of extinction. Although seeds of *R. moorei* from the type collection were distributed to multiple gardens, the Kew palm is the last authenticated survivor in cultivation. The palm is dioecious, the Kew specimen being male, and therefore cannot be propagated. Given its size and maturity, it is unlikely that this palm can be moved successfully. It was the potential global significance of this cultivated palm, which will likely be lost during the preparation for the Palm House renovation, that was the initial driver for the work described in this report.

Purpose of missions

Through two missions to the Comoro Islands in November 2023 and November 2024, we aimed to establish an integrated, collaborative programme on the diversity and conservation of Comoro palms to:

1. Address the major knowledge gaps in our understanding of the diversity and taxonomy of Comoro palms and identify new species, if any exist, drawing on Kew's >30-year research experience on Indian Ocean palms.
2. Document the distribution, population status and threats to all Comoro palm species as a fundamental baseline for updated IUCN extinction risk assessment.
3. Undertake training in the Comoro Islands, targeted at key stakeholders, in palm biology, including taxonomy, field skills and cultivation, to build in-country capacity for palm conservation.
4. Establish *ex situ* collections of palms on the Comoro Islands, and potentially elsewhere, developing in-country horticultural skills and infrastructure to ensure long-term sustainability of conservation collections.
5. Use *Ravenea moorei* and the Comoro palms as a case study for public engagement on extinction and conservation of tropical palms and the forest that they inhabit in the renovated Palm House and via appropriate mechanism in the Comoro Islands.

Partnerships

Having identified the need for field research on palms, the Royal Botanic Gardens, Kew reached out to potential partners with similar interests with whom to develop collaborations. Following an introduction via Hugh Doulton of Anjouan-based NGO Dahari, the Kew team made contact with Yahaya Ibrahim at the National Center for Documentation and Scientific Research (Centre National de Documentation et de Recherche Scientifique [CNDRS]), a recognised expert on the flora of the Comoros with a long history of collaborating with overseas partners. CNDRS formally invited the Kew team to visit Comoros (mission 1), facilitating a “visa de service”. Following arrival, Yahaya Ibrahim introduced the team to many other potential stakeholders, namely Karthala National Park (Parc National du Karthala), the National Herbarium (Herbier National des Comores, Université des Comoros) and the National School of Horticulture. Fieldwork for mission 1 was primarily conducted in collaboration with CNDRS, supported by ecoguards from Karthala National Park, with Dr. Andilyat Mohamed of the National Herbarium joining for some field days.

Mission 2 took place under a formal invitation from the University of the Comoros in collaboration with Dr. Andilyat Mohamed. Yahaya Ibrahim supported the organisation of the trip, but was unable to participate directly. As mission 2 involved fieldwork on all three islands, links were built with Ntringui National Parc in Anjouan (Parc National de Ntringui) and Mohéli National Park (Parc National de Mohéli). The training course in the third week of mission 2, conducted in Ngazidja, involved representatives from the National Herbarium, the University, Karthala National Park and CNDRS. In light of experiences gained during the two missions, it emerged that the most appropriate “core” partnership would likely be tripartite, between RBG Kew, the National Herbarium and Karthala National Park.

Personnel

Principle Investigators

Royal Botanic Gardens, Kew

Prof. William (Bill) Baker

Tom Pickering

Will Spoelstra

Herbier National des Comores (Université des Comores)

Dr. Andilyat Mohamed

Centre National de Documentation et de Recherche Scientifique (CNDRS)

Yahaya Ibrahim

Collaborating partners

Université des Comoros

Dr. Ibouroi Ali Toibibou

Ramadhoini Ali Islam

Mamie Matoire

Parc National du Karthala

Rahamata Ahamada

Said Moussa

Ali Mohamed

Parc National de Ntringui

Zalahat Bacar

Abdou Mohamed

Ecogardes: Kiboutia Boura, Anlaoudine Nouridine, Daniel Ben Soumdou, Mouzouma, Mohamed Ahmadi (Sabena).

Parc National de Mohéli

Chekidine Said

Fahade Said Manini

Ecogardes: Jean-Ahmed Saïd Madi, Ibrahim Mourdassi, Saidina-Omar, Lyssam, Ben Salim

Documentary film makers

During the palm training course, the team were joined by a film crew from the Antananarivo office of DDC International. Cameraman Nantenaina Rakotondranivo and his colleague Tojo Patrick Ratsimbazafy filmed the activities of the training course 25-29 November, including interviews with the Kew team as well as collaborators from l'Herbier National and Parc National Karthala. The footage will be used to make a documentary representing the activities of the trip for promotion through communication channels in Kew and Comorian institutions.

Itineraries

Mission 1: November 2023

Date	Activities
07/11/2023	Kew team departs London
08/11/2023	Kew team arrives Moroni. Preliminary meetings with Andilyat Mohamed (National Herbarium) and Yahaya Ibrahim (CNDRS).
09/11/2023	Meetings with Karthala National Park (Rahamata Ahamada, Said Moussa, Ali Mohamed), National Herbarium (Andilyat Mohamed, Ouledi Ahmed, Ramadha Oin, Mamie Matoir) and National School of Horticulture. All accompanied by Yahaya Ibrahim and Zakaria Cheha Mkatibo.
10/11/2023	Fieldwork day 1, starting from Mvouni to above Boboni.
11/12/2023	Fieldwork day 2, starting from Mdjoiezi.
12/12/2023	Fieldwork day 3, starting from Djoumouchongo, hiking to Nyumbadjou (Humblot residence).
13/12/2023	Fieldwork day 4 at La Grille.
14/12/2023	Fieldwork day 5 above Tsinimouapanga.
15/12/2023	Fieldwork day 6 on Mt Karthala road from Mvouni.
16/12/2023	Fieldwork day 7 in lowland littoral forest fragments near Moroni and lowland forest fragments near Mdjoiezi road. Visit to 1977 lava flow.
17/12/2023	Specimen preparation at CNDRS.
18/12/2023	Synthesis meeting at CNDRS. Meeting at Mitsiamouli with CNDRS director.
19/12/2023	Visit to north of island (Dos du Dragon, Lac Salé, Trou du Prophète, Maloudja).
20/12/2023	Press conference. Follow-up visit to <i>Ravenia moorei</i> sites on Mt Karthala road.
21/12/2023	Kew team departs Moroni
22/12/2023	Kew team arrives London

Mission 2: November-December 2024

Date	Activities
10/11/2024	Kew team departs London.
11/11/2024	Kew team arrives Moroni. Evening reception with University Rector (Dr Ibouroi Ali Toibibou) and team at Itsandra Beach Hotel.
12/11/2024	Meetings with Karthala National Park (Rahamata Ahamada, Said Moussa, Ali Mohamed), National Herbarium (Andilyat Mohamed) and CNDRS (Yahaya Ibrahim). Visit to herbarium to meet undergraduate students studying palms.
13/11/2024	Flight to Fomboni (Mohéli), accommodation at Motel Faradel. Meeting with Chekidine Said and Fahade Said Manini (Mohéli National Park).
14/11/2024	Fieldwork hiking from Ouallah 1.
15/11/2024	Fieldwork in dry forest on north-east coast near Wanani.
16/11/2024	Fieldwork in the Fomboni Forest.
17/11/2024	Wrap-up meeting with Mohéli National Park staff at Nioumachoua. Visit to islands at Nioumachoua, returning along south coast to look for <i>Hyphaene coriacea</i> in two sites.
18/11/2024	Flight to Moroni, then on to Mutsamudu (Anjouan). Meeting with Ntringui National Park (Abdou Mohamed) and Dahari (Hugh Doulton).
19/11/2024	Meeting with Governor of Anjouan (Dr. Zaidou Youssof) and Regional Director of Environment (Kiwamidine Chibaco). Meeting with Ntringui National Park staff at Lingoni office (Abdou Mohamed with ca. 15 ecogardes). Fieldwork plans aborted due to vehicle problems.
20/11/2024	Fieldwork at Dindri (Ntringui). Demonstration of iNaturalist.
21/11/2024	Fieldwork at Ouzini.
22/11/2024	Work at hotel, preparation for upcoming palm training in Moroni.
23/11/2024	Visit to dry forest at Bimbini.

24/11/2024	Flight to Moroni. Visit to palm nursery in garden of Andilyat Mohamed. Arrival of DDC film crew.
25/11/2024	Palm training course day 1 at Karthala National Park offices at Bahani. DDC interviews with Said Moussa and Rahamata Ahamada.
26/11/2024	Palm training course day 2 on Mt Karthala. DDC interview with Andilyat Mohamed.
27/11/2024	Palm training course day 3 on Mt Karthala. DDC interviews with Will Spoelstra and Tom Pickering.
28/11/2024	Palm training course day 4 at University. DDC interviews with Bill Baker.
29/11/2024	Final meeting with Karthala National Park (Said Moussa). Palm planting (<i>Ravenea moorei</i> , <i>R. hildebrandtii</i> , <i>Chrysalidocarpus lanceolatus</i>) at Dr. Ouledi Ahmed's garden and the grounds of the University administration. Meeting with Université des Comoros Rector (Dr Ibouroi Ali Toibibou). DDC film crew departs.
30/11/2024	Report-writing at hotel. Meeting with CNDRS (Yahaya Ibrahim). Final dinner with Andilyat Mohamed, Dr Ibouroi Ali Toibibou, and Damier Ben Ali (first President of Université des Comoros Rector and founder of CNDRS).
01/12/2024	Visit to dry forest in south of Ngazidja.
02/12/2024	Kew team depart Moroni.
03/12/2024	Kew team arrive London.

Fieldwork reports

See Plate 1 for maps of fieldwork locations.

Ngazidja

Fieldwork in Ngazidja was largely undertaken during mission 1. As mission 1 was focused on the status of *Ravenea moorei*, fieldwork took place mainly on the western side of Karthala, which receives the highest rainfall on the island (>4000 mm per annum) and retains important stands of rainforest, which are relatively intact from around 700 m upwards. The type locality of *R. moorei* was visited near Boboni, as well as two other sites (Karthala summit road and above Mdjoiezi). A fourth day, commencing at Djoumouachongo and hiking to Nyumbadjou (Humboldt's residence), was less successful due to a lack of a guide with knowledge of access to the forest. Two days were spent in lower rainfall areas, one in the La Grille massif in the north of Ngazidja, although this was cut short by bad weather, and another above Tsinimouapanga on the eastern side of Karthala. Rainforest occurs in both of these areas, although it is significantly degraded. A final day was spent in drier coastal areas to the west of Karthala, exploring fragments of forest vegetation; very little humid coastal forest remains making this vegetation type one of the most threatened in the Comoros. In the forest on the western side of Karthala above 700 m, *Ravenea moorei*, *R. hildebrandtii* and *C. lanceolatus* were observed and collected, whereas only *R. hildebrandtii* was noted at La Grille and *C. lanceolatus* at Tsinimouapanga. In the western coastal forest remnants, we found *C. cabadae*, the first formal documentation of this species in Ngazidja (it has previously been reported from Mayotte). Thus, Ngazidja is the only island in the Comoros on which all four endemic species occur. A fifth, non-endemic species, *Phoenix reclinata*, was also observed in dry vegetation in the south of the island.

Mohéli

Six days were spent in Mohéli during mission 2. Two field days were focused on rainforest sites in the central west of the island, the first reached by walking north from Ouallah 1 and the second reached by walking south from Fomboni into the Fomboni Forest. Dry vegetation was also visited on the north-east coast near Wanani and in the islands south of Nioumachoua. Of the endemic species, only *Chrysalidocarpus lanceolatus* and *Ravenea hildebrandtii* were observed. *Phoenix reclinata* occurred throughout the island, including in the islands south of Nioumachoua, but never in closed forest vegetation. A lone individual of *Hyphaene coriacea* was observed on the south coast.

Anjouan

Six days were also spent in Anjouan during mission 2. Two field days were focused on rainforest sites. The first of these focused on degraded forest in Mount Ntringui National Park, around Dindri and Lake Dzilandzé. The second was reached by hiking west of Ouzini towards the Moya Forest. A third field day was used to explore dry forest west of Bimbini, although almost all intact forest in this area is now lost. Like Mohéli, only two of the endemic species were observed (only *Chrysalidocarpus lanceolatus*, *Ravenea hildebrandtii*). *Phoenix reclinata* was also observed west of Bimbini.

Palm Inventory

Palms are conspicuous throughout the landscapes of the Comoro Islands. However, the palms that are most often encountered are introduced and cultivated, not native. The coconut (*Cocos nucifera*) is especially abundant and extensively used by humans. Other useful, introduced species (Plate 2) that are conspicuous include the betel nut palm (*Areca catechu*) and the raffia palm (*Raphia farinifera*). A small number of cultivated ornamental species are also found (e.g. *Bismarckia nobilis*, *Phoenix dactylifera*, *Roystonea oleracea*). *Chrysalidocarpus lutescens*, which is so common in the horticultural flora throughout the tropics, is not widely known in Comoros, although it was observed semi-naturalised in secondary vegetation in Nyumbadjou, Ngazidja. It has potential to be invasive, though the population observed did not appear to be in good health.

Following our survey, we believe that the native palm flora of the Comoro Islands comprises seven species (Plates 2–8), including the four endemics list above. The species are unevenly distributed across the islands as described in Table 1 below.

Table 1. Native palms of the Comoro Islands. Occurrence of native palm species across the four Comoro Islands. Records for Mayotte were derived from literature (Ludwig 1999, Pibot & Soumille 2000, Reilhes 2010). For all remaining islands, records have been ground-truthed during the fieldwork described in this report.

	Ngazidja	Anjouan	Mohéli	Mayotte
Non-endemics				
<i>Hyphaene coriacea</i>			x	x
<i>Phoenix reclinata</i>	x	x	x	x
<i>Borassus aethiopum</i>				x
Endemics				
<i>Chrysalidocarpus cabadae</i>	x			x
<i>Chrysalidocarpus lanceolatus</i>	x	x	x	x
<i>Ravenea hildebrandtii</i>	x	x	x	x
<i>Ravenea moorei</i>	x			

Non-endemics

The non-endemic native palm species (Plate 2) of the Comoro Islands (*Borassus aethiopum*, *Hyphaene coriacea*, *Phoenix reclinata*) are widespread species that are also found in Madagascar and continental Africa. All are palms of seasonal environments, rather than rainforests, and all are useful to humans. Although there is no reason to doubt their native existence in the Comoros, it is conceivable that humans have had a hand in their distribution.

Of the non-endemic native species, *Phoenix reclinata* is the most common and is especially abundant on Mohéli. The authors of this report did not observe *Borassus aethiopum*, which is reported for Mayotte in the literature and from photographs posted online¹.

On Mohéli, a single individual of *Hyphaene coriacea* was found on the strandline of a south coast beach. It seems likely that this plant established through the arrival of a viable drift seed.

Endemics

Ravenea hildebrandtii

(Plates 3 & 5)

This dwarf palm is readily distinguished by its relatively short stem (usually up to 3 m, but sometimes up to 9 m), stem diameter less than 10 cm and leaves with 30–45 leaflets each side

¹ <https://www.flickr.com/photos/88672295@N02/albums/72157640377936023/>

of the rachis. Like all species of *Ravenea*, it lacks a crownshaft and is dioecious. The females often produce inflorescences that are as long as (or longer than) the leaves when in fruit. Sometimes, the base of the stem is grossly swollen, but this is not a consistent feature within the species and it is also observed in *R. moorei*.

Ravenea hildebrandtii is more abundant than any other palm species in the Comoro Islands, sometimes growing gregariously. During our missions we observed it in montane rainforest (including degraded forest) from 800 m to over 1300 m on Mount Karthala, but on Mohéli, it is found from 300 m elevation. On Mayotte, it is also reported to occur at lower elevations of ca. 500–600 m (Pibot & Soumille 2000). Most forest at low elevations is destroyed in the Comoros, making reliable observations of the lower elevational limits of mountain species difficult. We estimate that populations on each island likely amount to ca. 1000 individuals, although a formal survey is required to obtain more exact figures. Populations on Mayotte are reported to contain only ca. 200 individuals (Pibot & Soumille 2000). There is evidence of recruitment at most sites, although at the time of our missions (November) fruit were observed on only one individual at La Grille. However, many flowering individuals were noted.

Ravenea moorei (Plates 4 & 5)

This species is very closely related to *R. hildebrandtii* but is much larger, with stems rising to around 20 m and attaining approximately 20–35 cm in diameter. The leaves are more robust than those of *R. hildebrandtii*, with 55–70 leaflets on each side of the rachis. Like *R. hildebrandtii*, the female inflorescences can be elongated, but we have only observed them being shorter than the leaves. As stated above, the base of the stem is sometimes grossly swollen, as in some but not all individuals of *R. hildebrandtii*.

Ravenea moorei has the most restricted distribution of any palm in the Comoros. It is known only with certainty from high-rainfall, montane rainforest on the western side of Mount Karthala in Ngazidja. We recorded it between 750 and 1200 m elevation in three sites: in the vicinity of the type locality above Boboni, in forest above Mdjoiezi and adjacent to the Mount Karthala summit road reached from Mvouni. An unsubstantiated report of the species at 500 m elevation above Mitsamiouli could not be verified (Dransfield & Beentje 1995). We did not observe the species in the La Grille massif, which is the nearest rainforest to this town, but more thorough exploration of the remaining forest is needed there. During our missions we recorded 50 individuals, of which 12 were of adult reproductive age. However, we recognise that rainforest persists between these locations and a systematic survey of the forests will very likely reveal more individuals. We estimate that the total population in Ngazidja likely numbers a few hundred. We observed three fruiting females, as well as at least one other female with signs of old inflorescences. Male inflorescences are short and can be obscured by leaf bases, making them difficult to observe in tall individuals. Seedlings and juveniles were also observed, suggesting that successful recruitment is taking place.

Ravenea moorei and *R. hildebrandtii* are known to be sister species, i.e. they are each other's closest relative. We observed the two species co-occurring at two sites (Plate 5). Under these circumstances, some introgression (hybridisation) is likely to occur. We observed some individuals of *R. moorei* on Mt Karthala that appeared to show intermediate morphology (more slender habit, elongated female inflorescences), which may be evidence of hybridisation. In view of the significant conservation value of both species, but especially *R. moorei*, genetic studies are now required to understand better the impact and implications of gene flow among the species.

Chrysalidocarpus lanceolatus

(Plates 6 & 7)

The two species of *Chrysalidocarpus* are easily distinguished from *Ravenea* because they are generally clustering palms (forming clumps of multiple stems) and each stem is topped with a crownshaft, a tubular structure consisting of cylindrical leaf sheaths. *Chrysalidocarpus lanceolatus* (formerly known as *Dypsis lanceolata*) is distinguished easily from the other species, *C. cabadae*, by its broad leaflets. It is also distinct in its ecology, occurring only in montane rainforest at 670–1100 m elevation (*C. cabadae* is a palm of coastal forests). *Chrysalidocarpus lanceolatus* is, however, rather variable. It can range from a few metres in height to at least 16m. Some forms appear solitary stemmed (although usually suckers can be observed at the base), whereas others produce as many as 20 stems. The leaflets are generally arranged in either a regular or subregular fashion and may be held in somewhat multiple planes. We noticed that individuals from Anjouan and Mohéli tend to have more regularly arranged leaflets that are slightly ascending and drooping at the tips, while individuals in Ngazidja have leaflets arranged in a slightly plumose fashion (Plate 7). The variation with *C. lanceolatus* may be indicative of local ecotypic variation or speciation in action. This merits further investigation using genetic analyses that draw in its closest relatives, notably *C. cabadae* (see below) and *C. pembanus* from Pemba island.

Chrysalidocarpus lanceolatus is generally observed scattered through the forest. Occasionally it is a dominant element of the forest (e.g. Fomboni Forest, Tsinimouapanga), but it is not gregarious to the same extent as *Ravenea hildebrandtii*. We would estimate that the total population across all four islands amounts to a few thousand individuals.

Chrysalidocarpus cabadae

(Plates 8)

This species is similar to its close relative of *Chrysalidocarpus lanceolatus*, but can be readily distinguished by its strongly arching leaves with ascending, narrow and closely spaced leaflets. It is also distinct in its ecology, being found only in littoral vegetation – we recorded individuals up to about 100 m elevation. It was originally described from a palm thought to be of Comoro origin cultivated in a garden in Cuba {Moore, 1962 #2634}, but has since been recorded from Sohoa in Mayotte (Barthelat & Viscardi 2012). We are aware of no formal records of *C. cabadae* from Ngazidja prior to our mission, but the palm is well known to local botanists. The Mayotte form appears to differ a little in that the ascending leaflets droop a little at their apices.

On Ngazidja, the coastal forest in which this species originally occurred is severely degraded. We found *Chrysalidocarpus cabadae* persisting in three sites, one on the outskirts of Moroni, a second west of Séléa, and a third west of Mdjoiezi-Hambou. The third site still contains some relatively high canopy forest trees and the palms there are rather tall. However, only scrub remains at the other two sites and the individuals there have shorter stems. *Chrysalidocarpus cabadae* can also be seen planted in the urban setting of Moroni, many specimens having been rescued from wild sites under threat. We estimate that around 100 individuals remain on Ngazidja. This appears to be the most threatened palm species in the Comoro Islands.

Incompletely known species: Dypsis humblotiana and Chrysalidocarpus “Mayotte”

No species if *Dypsis* was observed during the missions. Type material of *D. humblotiana* is held in the Kew herbarium. Close examination of this material suggest that it may in fact be conspecific with *C. cabadae*. Further evaluation, ideally accompanied by genetic evidence, is required to reach a final conclusion.

Chrysalidocarpus “Mayotte” is a palm known from cultivation. Sources in Hawaii describe it as a tall, solitary palm reaching 15 m tall. Photographs reveal a palm that is similar to a robust form of

C. cabadae as observed during our missions in coastal Ngazidja. These photographs are also consistent with the images found online². It is however possible that some cultivated plants referred to as *C. “Mayotte”* are also identifiable as *C. lanceolatus* (see for example³).

Status of palms in Comoros

The current IUCN Red List assessments for Comoro Island palms date from 1998 and need to be revised. Based on the new information gathered during our missions, we anticipate that new evaluations would result in all species being assessed as Endangered or Critically Endangered.

The threats that endemic palm species face in the Comoro Islands are severe (Plate 9). Natural vegetation has already been lost from the vast majority of the land surface of the islands and while all of the species were observed persisting in degraded vegetation, their ongoing survival in such habitats is questionable due to diminished recruitment, altered light and water regimes and competition with secondary forest plants and invasive, alien species. More concerning, however, is the ongoing degradation of important palm habitat in protected areas. For example, the threats to the largest population of *Ravenea moorei* observed on mission 1 have substantially by mission 2, only one year later. This site is adjacent to the Mount Karthala summit road and falls within the ZNP (zone de non prélèvement) of the national park. We observed 33 individuals, including 8 adults, some actively reproducing. In November 2023, some evidence of agriculture existed at this site – a field of bananas and some more bananas planted along the path – but the forest remained largely closed. In November 2024, many more bananas were present and the forest canopy had been substantially cleared. Near the largest and most productive female palm, a large *Weinmannia* tree had been felled in a manner that imperilled the largest *R. moorei* and damaged the area around it in which many establishing seedlings had previously been observed. Illegal forest degradation for agriculture and timber extraction is the primary risk to protected areas across the islands, although the approach taken by individual park authorities to address this varies from park to park. Vegetation clearance is also progressing rapidly for construction at lower elevations (a particular risk for *Chrysalidocarpus cabadae*) and some areas are also quarried for stone and aggregates for construction activities.

Forest disturbance promotes the establishment of invasive plants, which are highly prevalent in the Comoro Islands. *Psidium cattleianum* and *Clidemia hirta* (= *Miconia crenata*) are among the most noxious of the weed species, forming dense communities that compete with other plants and prevent their regeneration. These species are now beyond control throughout the Comoros and their prevalence is intensified by the fact that some are useful; *P. cattleianum*, for example, is used for producing charcoal.

The core threats to Comoro Islands and species are compounded further by poorly understood impacts of climate change. Islands are especially vulnerable to climatic shifts that might alter rainfall and temperature patterns. The distribution of *Ravenea moorei*, for example, appears to closely correspond to the zone of highest rainfall on Ngazidja. Should this high rainfall area become drier, there may be a consequent impact on the habitat of *R. moorei* and the survival of the palm itself. Climate change may also increase the frequency and intensity of extreme weather events; less than two weeks after our return from mission 2, Mayotte was devastated by Cyclone Chido on 16 December 2024. In addition to destroying countless towns and buildings, trees and forests were devastated. The impacts on Mayotte’s fragile remaining biodiversity is yet to be understood, but will take many years and will be seriously impacted by aggressive non-native invasive plants. The same risks exists for all Comoro Islands.

² <https://www.flickr.com/photos/88672295@N02/albums/72157640377936023/>

³ https://www.palmpedia.net/wiki/Dypsis_sp._%27Mayotte%27

Palm training course

To develop capacity in the study and conservation of palm diversity in the Comoro Islands, a four-day palm training course was held involving 22 participants from Karthala National Park, the National Herbarium and CNDRS (Plate 10). The training was led by the RBG Kew team, with substantial logistical support from Parc National du Karthala and the herbar national. The objectives of the course were as follows:

1. To instruct participants on the diversity and distribution of Comoro palms.
2. To share skills knowledge and experience on the propagation of palms from seed.
3. To develop skills in field identification of Comoro palms.
4. To learn how to apply new tools to the recording and mapping of wild biodiversity.
5. To co-develop a conservation action plan for Comoro endemic palms.

Course outline

25/11/2024	Palm training course day 1 – presentations by Kew team at Karthala National Park offices at Bahani. Subjects covered – palm diversity, Comorian palms, iNaturalist, palm cultivation. Also, practical work on palm seed germination and potting on.
26/11/2024	Palm training course day 2 – fieldwork on Karthala to observe <i>Ravenea moorei</i> , <i>R. hildebrandtii</i> and <i>Chrysalidocarpus lanceolatus</i> in the wild. In the afternoon, relocated to littoral forest fragments on outskirts of Moroni to see <i>Chrysalidocarpus cabadae</i> population.
27/11/2024	Palm training course day 3 – BioBlitz Karthala! Rapid inventory of plants on the Karthala road using iNaturalist smartphone application.
28/11/2024	Palm training course day 4 – résumé and discussion, including group exercise on theme "Three concrete action for palm conservation in Comoros". Lecture to undergraduate students by Bill Baker.

Participants in palm training course (25-28 November 2024)

Name	Organisation
Hachimia Salim	CNDRS
Mohamed Zair Abderemane	CNDRS
Nasma Hamidou	CNDRS
Nassourdine Ahamada	CNDRS
Alhousseine Ibnou Anli	Herbier National des Comores
Andilyat Mohamed	Herbier National des Comores
Chamsia Ibrahim	Herbier National des Comores
Nadjim Soule Mohamed	Herbier National des Comores
Youssef Nadjim	Herbier National des Comores
Djibaba Ibrahim	Parc National du Karthala
Hainia Ibrahim	Parc National du Karthala
Insoime Mohamed	Parc National du Karthala
Mohamed Ali Andoihona	Parc National du Karthala
Mohamed Ali Mmadi Boina	Parc National du Karthala
Mondoha Assoumani Mselam	Parc National du Karthala
Moussa Mmadi	Parc National du Karthala
Nassabia Mohamed	Parc National du Karthala
Nazilati Said Ali	Parc National du Karthala
Rahamata Ahamada	Parc National du Karthala
Rouchdati Rafiou Yahaya	Parc National du Karthala
Said Moindju	Parc National du Karthala
Said Moussa	Parc National du Karthala

Outline action plan

The two missions have led to an increase in awareness of Comorian palms. During the missions, a range of necessary actions became apparent and were discussed with local counterparts. On the final day of the palm training course, a workshop was held during the palm training course from which an outline action plan for conserving the endemic palms of the Comoro Islands developed. The participants were divided into three groups and asked to identify “three concrete actions for palm conservation in Comoros”. Each group presented their ideas back to the whole group and supplied summary notes. These were then shared with the RBG Kew team, who have condensed them into the outline action plan below, augmenting the proposals with some additional ideas.

1. Fundamental scientific research involving key institutions:

1.1 Taxonomy and Identification. Effective conservation action is dependent on robust taxonomy. The four endemic species of the Comoro Islands are relatively well delimited and identified. However, the potential for hybridization (suspected in *Ravenea*) and significant variation observed in *Chrysalidocarpus* require further investigation. Further research is required to clarify these issues. It is proposed that a revision of the Comoro palm flora is undertaken at RBG Kew. Genomic data collection is already in process to establish the genetic basis of the species.

1.2 Distribution and population studies. Although the two missions visited all islands, more work is needed to establish precisely the distribution of all species. The accurate mapping of the distribution of the most threatened species, *R. moorei* and *C. cabadae*, is urgently needed, including thorough population censuses, prioritizing western slopes of Karthala, coastal forest remnants and La Grille massif.

1.3 Ecological research (e.g. phenology, pollination, dispersal, interactions, demography, etc.) Little is known about the ecology of Comorian endemic palms. Deeper insights into the biology of these species may shed light on the differences in abundance and endangerment across the four species. It will also be critical to reintroduction and reforestation initiatives. Numerous projects could be conceived for students at the University that would further inform conservation decision-making.

1.4 Propagation and cultivation. Conservation horticulture is already playing a key role in the preservation of Comorian palms. Palm rescue missions to relocate threatened specimens of *C. cabadae* have been undertaken on multiple occasions (led by Andilyat Mohammed), with many rescued palms now growing in the urban landscape in Moroni. Dr. Mohammed has also established a palm nursery in her own home garden, with support of key students, and is starting experimental plantings in Moroni. Further development of palm horticultural knowledge and capacity will be required to generate plants for palm restoration as well as for urban planting and raising awareness.

1.5 Revision of IUCN Red List assessments. Extinction risk assessments for three of the endemic palms of Comoros are published on the IUCN Red List. However, these date from 1998 and require reassessment. *Chrysalidocarpus cabadae* is yet to be assessed. The recent missions provide abundant information for the completion of up-to-date assessments.

2. Conservation of wild palm trees through habitat conservation and restoration

2.1 Protection of known populations. All species except for *C. cabadae* are found within protected areas. Nevertheless, habitat degradation continues even within national parks, as has taken place in a key *R. moorei* population observed during the missions. The challenges here are considerable and multi-layered. In the case of *C. cabadae*, all sites for this species are highly degraded and under substantial pressure. Action to protect the best remaining populations is urgently needed.

2.2 Establishment of special palm reserves within the Comoros National Parks. To address the difficulties of ongoing habitat destruction within the park, it is proposed that key palm strongholds are prioritized for enforcement (e.g. by ecogardes) and for public awareness activities. There is potential for involving the local community, provided there are means to create motivation and incentives.

2.3 Monitoring of known populations and restoration areas. An active monitoring programme is essential to track changes to natural populations and to measure success of conservation interventions.

2.4 Establishment of infrastructure for native plant propagation. Some plant propagation facilities already exist (e.g. Karthala National Park headquarters, National Herbarium palm nursery). However, some further investment would allow palm plants to be produced at scale for reintroduction and for use in public horticulture. Comorian palms are relatively straightforward to grow from seed with simple and readily accessible materials. Building capacity for palm production in Comoros is entirely achievable.

2.5 Restoration of forest ecosystems and palms in the wild. The reintroduction of palms into the wild in locations where they have been lost or depleted and their inclusion in reforestation programmes is of obvious importance and will be essential to ensure that some species are not lost altogether (e.g. *C. cabadae*). It is important to take into account the provenance of accessions for reintroduction – reintroduced material should originate from seed sourced from near to the reintroduction location.

3. Conservation of palm trees ex situ

3.1 Planting of palms in public spaces and gardens in Comoros. Ex situ horticulture is an essential conservation approach. Palms have particular landscape value and the inclusion of endemic palms in the urban landscape and gardens of the Comoros is a significant opportunity for both conserving palm germplasm and for raising public awareness of natural patrimony. Given their handsome appearance and that they are readily cultivated, palms could become the icons of conservation in the Comoros.

3.2 Cultivation of palms in botanic gardens around the world. Three of the four Comorian endemic palms are already conspicuous in botanic gardens around the world: especially *C. cabadae*, but also *C. lanceolatus* and *R. hildebrandtii*. The provenance of the introductions to gardens are however poorly documented. Moreover, *R. moorei* is only cultivated at Kew. Concerted efforts should be made to introduce known provenance, wild source material to gardens, including germplasm obtained from throughout the ranges of the species. During the first mission, seeds (and some seedlings) of all four species were obtained and were germinated at Kew, from where seedlings are now being distributed to relevant botanic gardens, where possible. Ideally, all leading palm gardens would hold living material of these species.

3.3 Official distribution of wild-collected seed for purchase by palm growers (with income flowing back to Comoros). Following the discovery in 2007 of the Critically Endangered *Tahina spectabilis*, a massive fan palm from Madagascar, legal collections and export of seed was organized by Kew and its partners in Madagascar. This seed was then sold by a trusted seed merchant, with all profits being returned to the local community in which *Tahina* grows. A similar model could be established in Comoros, and could be especially impactful in the case of *R. moorei*, as it would ensure that a distributed conservation “metacollection” would exist, benefiting from the abundant skills of palm enthusiasts around the world.

4. Knowledge sharing and public awareness

4.1 Sharing knowledge with decision-makers and authorities. The two missions have helped to build awareness of Comorian endemic palms and their potential as flagship species for

conservation. However, this knowledge primarily resides with expert individuals and should be shared with those in power to influence resourcing and decision-making.

4.2 Raising awareness among the Comorian communities through environmental education. The majority of the pressure on the natural environment in the Comoros arises from activities of local people, e.g. through agriculture, logging, land clearance for construction. Without information about the environmental impacts of these activities, people cannot be empowered to make decisions with positive biodiversity impacts. The exact nature of awareness raising activities is yet to be decided, but it has been suggested that focusing on younger age groups, such as school children is especially important, to ignite passions and to encourage them to influence the actions of older people.

4.3 Creation of an association for the conservation of Comoro palms. One means of promoting awareness would be to create a Comorian Palm Association, which would deploy “citizen scientists” to raise capacity for education, horticulture and monitoring activities. Such an association could be a powerful instrument that could be replicated for other biodiversity priorities.

4.5 Communicating the story of Comorian palms and forests inside and outside Comores. The two missions represent a strong example of collaboration and conservation activism in Comoros. They present an excellent opportunity to share the outcomes and challenges of conservation action in Comoros. The documentary film now in preparation will be made publicly available (e.g. YouTube) and will tell the story of the project in a compelling and accessible way, using voices from key partners. The Comoro palm story will also be communicated through new interpretation to be installed in Kew’s renovated palm house. A popular article will also be written for the International Palm Society journal *Palms*. Further communication opportunities will be sought, especially inside Comoros.

Next steps

Having established a baseline understanding of the status of the endemic palms of the Comoros, we aim to prioritise and further develop the action plan outlined above. Many of the actions listed require detailed development and the designation of responsible owners (individuals or partner institutions) to take the actions forward. Further discussions will be held with between the partners to put the plan into practice.

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References

- Barthelat, F. & Viscardi, G. (2012) Flore menacée de l'île de Mayotte: importance patrimoniale et enjeux de conservation *Revue d'Ecologie (La Terre et la Vie)* 67: 15-27.
- Dransfield, J. & Uhl, N. (1986) *Ravenea* in the Comores. *Principes* 30: 156-160.
- Dransfield, J. & Beentje, H. (1995) *The Palms of Madagascar*. Royal Botanic Gardens, Kew and the International Palm Society.
- Keith, P., Abdou, A. & Labat, J.-N. (2006) Inventaire Faunistique des rivières des Comores et Inventaire botanique. Museum National d'Histoire Naturelle, Paris.
- Ludwig, N. (1999) Notes of the palms of Mayotte, Comoro Islands, Indian Ocean. *Palms* 43: 149-151.
- Moore, H.E. (1965) Palm Hunting Around the World. *Principes* 9: 13-29.
- Moore, H.E., Jr. (1962) Two New Species of *Chrysalidocarpus*. *Principes* 6: 106-110.
- Pibot, A. & Soumille, O. (2000) *Ravenea hildebrandtii* in Mayotte. *Palms* 44: 127-131.
- Reilhes, O. (2010) *Mayotte*. Available at: <https://www.flickr.com/photos/88672295@N02/albums/72157640377936023/> (accessed

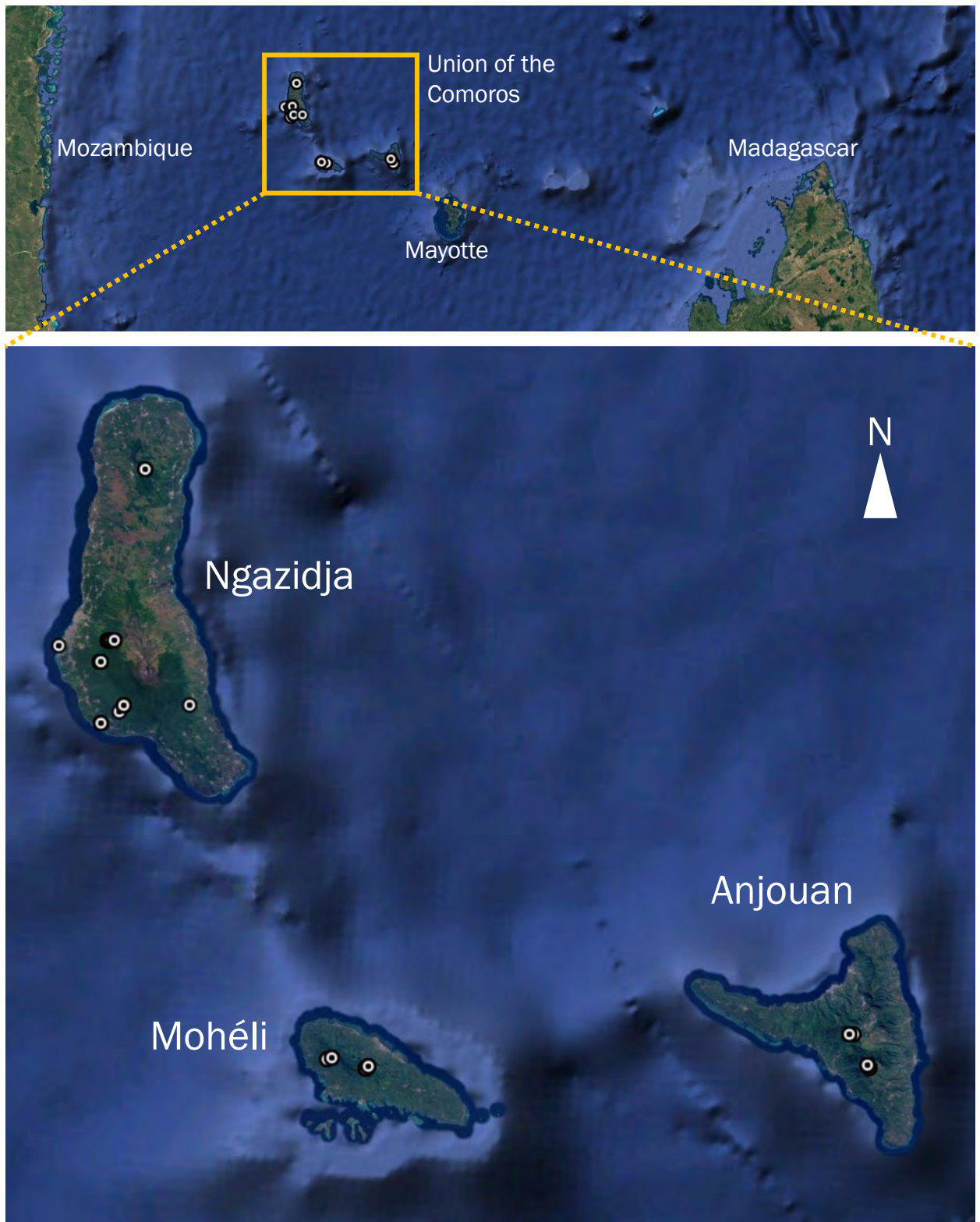


Plate 1. Maps of the Comoro Islands. Upper panel shows the Comoro Islands (comprising the Union of the Comoros and Mayotte) in their location between Mozambique and Madagascar. Lower panel focuses on the Union of the Comoros with dots indicating fieldwork localities during the two missions.



Plate 2. Non-endemic and non-native palms of the Comoro Islands. A. *Phoenix reclinata* (native, non-endemic). B. *Hyphaene coriacea* (native, non-endemic). C. *Raphia farinifera* (non-native, cultivated). D. *Areca catechu* (non-native, cultivated)..



Plate 3. *Ravenea hildebrandtii*. A. Habit, Karthala summit road (Ngazidja). B. Male inflorescence, Ouzini (Anjouan). C. Female inflorescence, which extends beyond the leaves, Karthala summit road (Ngazidja).



A



B



C



D

Plate 4. *Ravenea moorei*. A, B. Vicinity of Boboni, west Karthala (Ngazidja); photos show large size of this species. C, D. Large fruiting female on track adjacent to Karthala summit road (Ngazidja).



Plate 5. *Ravenea* – putative hybrids. A. *Ravenea moorei* (left) and *R. hildebrandtii* (right) growing adjacent to each other on Mt. Karthala, indicating potential for hybridisation. B. *Ravenea* individual showing intermediate morphology, combining robust and tall habit (resembling *R. moorei*) with slender, highly elongate female inflorescence (resembling *R. hildebrandtii*), suggestive of a putative hybrid.



Plate 6. *Chrysalidocarpus lanceolatus*. A, C, D. Individuals at Tsinimouapanga (Ngazidja) showing robust habit (A), plumose leaflets (C) and long inflorescence (D). B. Individual at Fomboni Forest (Mohéli), showing presentation of inflorescence within crown.

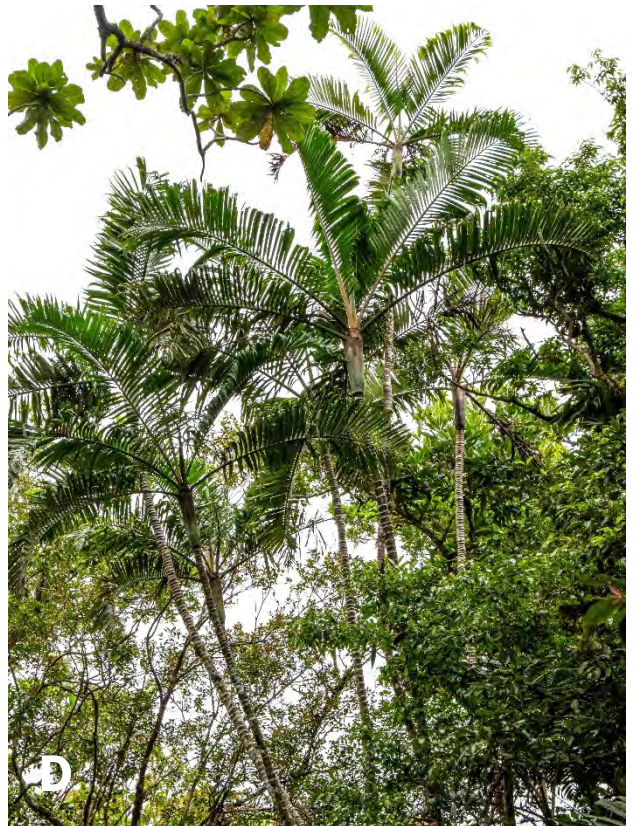


Plate 7. *Chrysalidocarpus lanceolatus* forms. A. Moderate-sized individual with plumose leaves, above Mdjoiezi, west Karthala (Ngazidja). B. Robust individual with plumose leaves, above Tsanimouapanga, east Karthala (Ngazidja). C. High elevation (~1200m) moderate-sized individual with regular, ascending leaflets (*Ravenea hildebrandtii* in foreground), Dindri (Anjouan). D. Robust, heavily clustering individual with regular, ascending leaflets Fomboni Forest (Mohéli).



Plate 8. *Chrysalidocarpus cabadae*. A, B. Individual on edge of Moroni (Ngazidja), showing clustering, glaucous stems, arching leaves with strongly ascending leaflets and pale yellow, glaucous leaf sheaths. C. Large individual in remnant lowland forest below Mdjoiezi (Ngazidja), severely threatened due to construction activities. D. Rescued individual that has been transplanted from a threatened site to an urban location in Moroni.

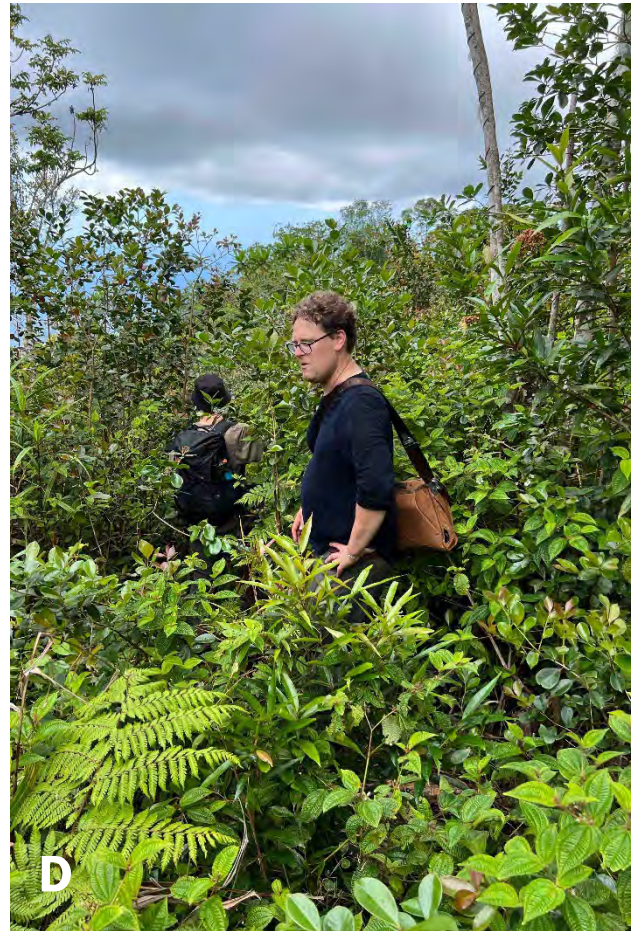


Plate 9. Threats to palms in the Comoro Islands. A. Cultivation of crops significant threatens *Ravenea moorei* near the Karthala summit road B. Illegal timber extraction affects the same population. C. The lowland habitat of *Chrysalidocarpus cabadae* is under extreme threat from construction and other transformative land uses. D. Invasive alien weeds (e.g. *Psidium cattleianum*, *Clidemia hirta*) severely threaten the natural vegetation of the Comoro Islands.



Plate 10. Palm training course 2024. A. Participants with *Ravenea moorei*. B. Palm seed cultivation practical exercise. C. Palm herbarium specimen training. D. Rector of the University, Dr. Ibouroi Ali Toibibou, plants an endemic palm in the grounds of the University administrative buildings in Moroni.